Survey of Rare Native Fishes in the Deerfield and Westfield River Watersheds

Report to

The Natural Heritage and Endangered Species Program (NHESP)
Massachusetts Division of Fisheries and Wildlife
Route 135
Westborough, Massachusetts

By

Alex Haro, Ph.D.
S.O. Conte Anadromous Fish Research Laboratory
U.S. Geological Survey, Biological Resources Division
1 Migratory Way
Turners Falls, Massachusetts

December 2002

I. Introduction

Knowledge of the distribution and occurrence of freshwater fishes in western Massachusetts is based primarily on historic surveys conducted by state government resource agencies (Massachusetts Division of Fish and Wildlife, 1940 et seq.) and private organizations (Chandler et al.1997, Hartel et al. 2002). In the late 1940s and early 1950s, the Massachusetts Division of Fish and Wildlife (MDFW) surveyed over 300 ponds and lakes statewide for fishes and invertebrates. However, because these surveys targeted large game fishes, they may have underestimated abundance of non-game fish species. Resurveys were conducted in northeastern lakes in the 1980s and 1990s by the U.S. Environmental Protection Agency (Larsen et al. 1991). In 1993 and 1994, the New England Aquarium (NEAq) resurveyed some of these historic lake and river locations, in an effort to assess the current distribution of the bridle shiner, *Notropis bifrenatus*, a species of Special Concern, in central and western Massachusetts (Chandler et al. 1997). Although the NEAq survey was largely successful in documenting the presence of bridle shiner and other uncommon non-game fish species, habitats in the Deerfield and Westfield River watersheds were not resurveyed because of the low number of historic collection sites in those watersheds. Most of the historic collections have not been systematic or comprehensive in geographic scope. As a result, many aquatic habitats within the region have never been surveyed, have been surveyed infrequently, or with limited or game fish-biased collection methodologies.

Past surveys have identified four native minnow species in the Deerfield River (D) and Westfield River (W) watersheds that are known to be uncommon or rare in Massachusetts, and have been listed by the state as Endangered or of Special Concern:

Species	Common Name	Status	Watershed
Hybognathus regius	eastern silvery minnow	Special Concern	D
Notropis bifrenatus	bridle shiner	Special Concern	D,W
Phoxinus eos	northern redbelly dace	Endangered	D
Couesius plumbeus	lake chub	Endangered	W

Occurrence of these species in both watersheds is thought to be extremely limited; in many cases only one or two records exist for a species within an entire watershed. Biodiversity of minnow species in the Northeast is thought to be declining on a regional scale (Whittier et al. 1997), possibly due to predation and competition from exotic fish species and loss of habitat due to eutrophication and physical alteration of the littoral zone (Chandler et al. 1997).

In an effort to reassess the status of these and other fish species in this region, the Massachusetts Natural Heritage and Endangered Species Program (NHESP; Massachusetts Division of Fisheries and Wildlife) designated several sites in the Deerfield, Connecticut, and Westfield River watersheds to be resurveyed in this project using conventional and new fish collection methods.

II. Methods

Fishes were collected or observed using several methods, appropriate to particular habitats, including:

a) Small mesh fyke net; 61 cm diameter hoops with 0.6 cm (¼") knotless nylon mesh (two fykes with 10 cm diameter throats) fitted with a single 7.6 m long x 1 m deep lead (wing) constructed from 1.2 cm (½") knotless nylon mesh.
b) Smith-Root Model 12/12B backpack electrofisher; settings were typically 400-600 volts AC or pulsed DC, depending on water conductivity and depth. The anode was a standard 30 cm diameter aluminum ring; the cathode was a single steel cable type.
c) Snorkeling in a downstream direction, usually with one or two observers.

Fyke nets were usually set overnight in slow-moving sections of stream or adjacent ponds with leads extending from shore in water 0.5 to 0.75 m deep. Electrofishing was performed in faster-moving or shallower water, in an upstream direction, with assistance from two netters using 35 cm long x 20 cm wide electrofishing dipnets with 0.6 cm (¼") knotless mesh. Blocking seines (1/4" knotless mesh with 1/8" knotless mesh bag) were also used in conjunction with electrofishing at some locations. Most collections were made during periods of midsummer low flow and high water clarity.

Individual fish were enumerated from small catches (less than approximately 20 fish total); numbers of abundant species from larger catches or from snorkeling surveys were estimated (tens, hundreds, thousands). During electrofishing, very abundant non-target species (small brook trout, slimy sculpins) that could be identified were not netted. Because of the similarity in morphology and coloration of lake chub, bridle shiner, and northern redbelly dace with blacknose dace, all small minnow- or dace-like species were captured and individually examined for identification. Collected fishes were sorted and identified directly from nets or temporarily held in 5 gallon plastic buckets.

Several representative individuals of target species (bridle shiner, northern redbelly dace) were retained as voucher specimens; these were euthanized in a solution of methane tricaine sulfonate (MS-222), photographed if possible, and preserved in 10% buffered formalin. One dace specimen was also preserved in ethanol for genetic analysis. Voucher specimens were archived at the Harvard University Museum of Comparative Zoology Fish Collection (Cambridge, Massachusetts). Rare Animal Observation Forms (RAOF; Natural Heritage and Endangered Species Program, Massachusetts Division of Fisheries and Wildlife) were completed for each collection of target species. Unusual non-target species (i.e., fathead minnows) were similarly archived. Field collection data sheets were completed for each collection. All collected fishes that were not retained as vouchers were returned to the stream near their point of capture. Other rare or unusual vertebrate species (i.e., wood turtle at the Glen Brook site) were noted and RAOFs completed for those sightings.

II. Results

The following sections list (in italics) the historic collection site, the rare species previously collected, and the latest year of historic collection. Each site is then described, followed by a narrative of the collection technique and results. In some instances, more than one collection was made at each location, either to increase effort or to enhance detection of rare species by using multiple methodologies (i.e., supplementing fyke net catches with snorkeling surveys). Latitude and longitude estimates were made either with a GPS receiver on site, or by marking the site on a 1:25,000 digital topographic map with a computer and topographic digitizing software (Maptech Terrain Navigator 2001). A summary of all collection data is shown in **Table 1**.

Green River, South of Greenfield, ***Figure 1*** *(bridle shiner; 1962)*
This section of the Green River flows adjacent to Interstate 91 on the west bank and reforested farmland on the right bank, through the floodplain of the Green River valley. The river is seasonally dammed upstream of this site at the Green River Town Swimming Pool where removable stoplogs are used to impound the river to create a public swimming area. The riverbed contains considerable amounts of sand downstream of the dam that have been washed out of the swimming area, which receives a replenishment of beach sand annually. Turbidity in the river reach downstream of the swimming area increases dramatically when beach use is high. Other bottom types in the surveyed reach include gravel, cobble, riprap boulders, and broken concrete. Maximum depth is approximately 1.5 m in deeper pools.

This area was sampled initially with fyke nets approximately 200 m upstream of the Colrain St. bridge. These samples produced several species of note. Two American eels were captured here, at a location above two small dams in Greenfield that are not equipped with fish passage facilities. This is not an uncommon finding, as eels are able to ascend smaller dams by climbing wetted margins. The collections also yielded several fathead minnows, which are the first records for these species from the Green or Deerfield River watersheds. This species was probably introduced into the Green River by bait bucket releases, as has occurred elsewhere in other western Massachusetts sites. However, absence of previously collected bridle shiners in the fyke nets prompted two resurveys by snorkeling. Although these snorkeling surveys did not discover bridle shiners, common shiners and tessellated darters were observed that were not collected in the fyke nets. Also, large numbers of several minnow species were observed sheltering from the main river flow in root wads against the bank. (*See also Mill River Mouth at Green River*)

Green River, Northwest of Greenfield , ***Figure 2*** *(northern redbelly dace; 1966)*
This site consists of riffle-pool habitat of the Green River as it meanders through forested and agricultural floodplain of the Green River valley. Bottom type is cobble and gravel, with occasional woody debris (i.e., root wads of large trees along the banks). Mean depth is approximately 0.5 m, with deeper pools of up to 2 m depth. Aquatic macrophytes are lacking; this region experiences extensive ice jams in winter and scouring of the substrate with high spring flows.

The site was sampled later in the season than other sites due to delays in obtaining landowner permission to access the site. The mainstem of the Green River was electrofished so as to

include the location of a previous collection of northern redbelly dace. Many cyprinids were found to be using root wads for cover, similar to the south Greenfield site. However, no rare species were collected from either site.

Hinsdale Brook, Northwest of Greenfield, ***Figure 2*** *(not previously sampled)*
Two small tributaries, Hinsdale and Punch Brooks, converge and enter the Green River from the western valley after flowing approximately 1 km through the Green River valley floodplain. This tributary was sampled due to its morphological similarity to both the Glen Brook and Mill River sites, and proximity to the location of a historic collection of a northern redbelly dace in the Green River approximately 160 m downstream of the mouth of Hinsdale Brook.

The site was sampled later in the season than other sites due to delays in obtaining landowner permission to access the site. Hinsdale Brook was also electrofished from the point where it enters the Green River to a point 50 m upstream of the Plain Road culvert.

Glen Brook, Off Leyden Road, ***Figure 3*** *(northern redbelly dace; 1979, bridle shiner; 1962)*
Glen Brook drains into the Green River valley from the north; the upper portion of this tributary is impounded for a town water supply. The brook passes through forested and agricultural floodplain, with extensive meanders and occasional beaver ponds. The brook in the location of the historic sampling sites is generally riffle-pool habitat with gravel and cobble bottom, with some limited areas of exposed bedrock..

Two separate sections of Glen Brook were electrofished, each on either side of Leyden Road, corresponding to locations of previous collections of northern redbelly dace and bridle shiners. Both sections yielded large numbers of blacknose and longnose dace, as well as slimy sculpins. Northern redbelly dace were collected in small numbers from each section (4 and 9 individuals, respectively), typically from the upstream end of shallow pools with cobble bottom. No bridle shiners were collected from either section.

Mill River Mouth at Green River, ***Figure 4*** *(northern redbelly dace; 1940)*
The Mill River is also a tributary of the Green River, which drains the Green River valley from the northeast, primarily through forested and agricultural floodplain. In recent years, beavers have extensively dammed the central portion of this river, creating soft-bottomed pools. However, there are several reaches between dams that contain riffle-pool habitat with cobble and boulder bottoms, similar to that of the Glen Brook.

Two sites were sampled in the Mill River. The first site was 1.7 km upstream from the mouth, as denoted by lat./long. coordinates provided by NHESP database; this site proved difficult to access through shrub growth and to fish with the electrofisher, as it had been extensively dammed by beavers and the bottom consisted of deep muck. We attempted to electrofish a small reach impounded by two beaver dams; several common lentic species were identified. The second site was a reach extending from the mouth of the Mill River where it enters the Green River to the base of the box culvert that runs underneath Interstate 91 (the NHESP database describes this location as “mouth of the Mill River in Green River”). This site had a gravel and

cobble bottom, without much cover and a low density of fishes. One additional site was surveyed in the Green River upstream of the mouth of the Mill River to the base of the public swimming pool dam. This site had extensive sand substrate, likely washed downstream from the swimming pool; a single banded killifish was collected in this reach. No northern redbelly dace were collected at any of the sites.

Deerfield River, Route 5 & 10, ***Figure 5*** *(eastern silvery minnow; 1959)*
This lower section of the Deerfield River in the floodplain of Greenfield is wide and slow-moving, with a bottom of mud, sand, cobble, and occasional bedrock. Maximum depth is 3 meters. Flow in this section the river is variable and regulated by hydroelectric generation upstream (usually varying on a 24 hour cycle), and can also be influenced by flows and levels of the Connecticut River mainstem approximately 2.1 km downstream.

Varying river level complicated fishing this section with fyke nets, as sites had to be chosen where nets would not be exposed by a drop in river level. Also, the river at this location is very wide and only a small portion of the river profile could be sampled by the nets. No eastern silvery minnows were captured at this site; a more extensive effort and gear types other than small fyke nets (i.e., boat electrofisher, large beach seine) may be required to comprehensively sample for this species in this portion of the Deerfield River.

Connecticut River, Hockanum Flat, ***Figure 6*** *(eastern silvery minnow; 1950)*
This cove area consists of a blind inlet that originally had been part of the mainstem Connecticut River channel (Russel Cove). The cove and mainstem are still hydraulically connected, and a small amount of flow enters from or drains into the mainstem, dependent on river level. The cove is heavily vegetated with several species of aquatic macrophytes and is generally shallow (less than 0.5 m depth), but deep areas (> 2 m depth) exist along the eastern shore. Several other similar blind coves occur along the mainstem in this same area, including the Oxbow. Most of these coves are heavily vegetated with aquatic macrophytes and emergents, and moderately eutrophic.

The southern end of Russell Cove was fished with two fyke nets; adverse weather conditions did not allow for the nets to be retrieved for a 48 hour period. Species collected were representative of mainstem fish fauna, but only two cyprinids (both golden shiners) were captured.

Middle Branch Westfield River, Middlefield, ***Figure 7*** *(lake chub; 1952)*
This section of the Middle Branch of the Westfield River is at fairly high elevation (262 m), with a moderate gradient through riffle-pool habitat. Substrate is generally cobble and boulders, with a minor amount of bedrock. Maximum pool depth is 1 m; however, both ends of the reach are terminated by large, deep pools with a maximum depth of about 2.5 m that we could not electrofish effectively.

We extensively electrofished (3 hours) a long section of the reach to include the point determined by the lat./long. coordinates for this site provided by the NHESP database. Blacknose dace were an especially abundant species. Although they have been collected at this

site previously, and from reaches above and below this site in the Middle Branch, creek chub were surprisingly absent from this collection. No lake chub were collected from this site.

Tannery Pond, Savoy, ***Figure 8*** *(not previously sampled)*
Tannery Pond is an abandoned, non-functional mill pond in Savoy State Forest, which has largely been reclaimed and maintained as an impoundment by beaver activity. The pond has a sand and gravel shoreline that transitions to a soft muck bottom with aquatic macrophyte and extensive emergent vegetation.

As part of a public outreach walk for the Deerfield River Watershed Association, fyke nets were set in Tannery Pond as a demonstration. Nets were retrieved after only 2 hours of soak time; in addition to golden shiners and blacknose dace, at least a dozen bridle shiners were collected. This site has not been extensively sampled by the State of Massachusetts (T. Richards, pers. comm.).

IV. Discussion

Rare Species

Lake Chub
This species was not collected at the one historic site sampled in the Middle Branch of the Westfield River, and has not been found in this tributary since 1952. The disjunct population of lake chub in the upper Westfield has been noted to be declining; the reasons are unknown (Hartel et al. 2002). Future surveys should attempt to relocate and assess the status this species at the few remaining historic collection sites in the upper East and West Branches known to still retain lake chub, and perhaps sample new sites within this region to determine the extent of the relict population in this area.

Eastern Silvery Minnow
This species has historically been collected from the mainstem Connecticut River in the vicinity of Hadley, in areas of slow moving flow, coves, and heavy vegetation. The single historic site in this area (Russell Cove) and the reach of the Deerfield River that were sampled in this survey did not recover this species. The Russell Cove region is being slowly reclaimed by emergent vegetation and wet meadow habitat; open water areas have been much reduced. However, other nearby cove areas still have extensive connections and exchange of water with the mainstem, and several reaches of the mainstem itself have shorelines with dense patches of *Vallisneria*, which could provide appropriate habitat for eastern silvery minnows. Resurveys of these sites with fyke nets supplemented with snorkeling and sampling with large beach seines (or boat electrofishing in the case of the Deerfield site) might be more productive in confirming the presence of this species in these habitats.

Bridle Shiner
Bridle shiners were not collected from either of the historic sites (Green River south of Greenfield, Glen Brook); both of these habitats are somewhat atypical for this species, which normally inhabits well vegetated, quiet waters (Hartel et al. 2002). It is possible that the

individuals obtained in historic collections at these two sites (always few in number) had been washed out of upstream habitats (i.e., small beaver or other ponds in higher tributaries) by high flows and had taken refuge in deeper pools with appropriate cover (i.e., root wads) in downstream locations. Bridle shiners were fairly numerous in both nets set in Tannery Pond, suggesting that this habitat was more typical for this species in western Massachusetts. Interestingly, Tannery Pond collections also yielded no centrarchids, which may be potential predators (i.e., *Micropterus* spp.) or competitors (*Lepomis* spp.)(Whittier et al.1997) of bridle shiners. Additional surveys for this species in similar small, isolated, high elevation ponds may also prove productive.

Northern Redbelly Dace

This species was relocated twice in separate surveys of the Glen Brook, but not at any other site surveyed. A small remnant population appears to be sustained in the Glen Brook, as evidenced by their consistent presence in this tributary in previous collections. Habitat in the reaches where this species was collected in the Glen Brook was somewhat atypical for northern redbelly dace (which prefer boggy lakes, creeks, and ponds), although Hartel et al. (2002) noted that in Massachusetts, this species occurs in non-boggy clear streams and associated spring-fed seepage pools (probably referencing this site). Aquatic macrophytes are relatively absent in Glen Brook and substrates were typically cobble with a thin layer of brown algae. Northern redbelly dace are somewhat difficult to immediately discern from blacknose dace, and may be easily overlooked in habitats where blacknose dace are abundant (which is typically the case in most western Massachusetts streams). Other potential habitats in tributaries of the Green River that are similar to Glen Brook (Mill Brook, Hinsdale Brook, Punch Brook, Allen Brook) exist; these tributaries also deserve exploration, as they have not been extensively surveyed in the past (T. Richards, Massachusetts Division of Fisheries and Wildlife). This may be especially important in that the Glen Brook is presently the sole known statewide location of this state endangered species, and land use in the vicinity of this tributary within the Green River valley floodplain is changing from predominantly agricultural to developed residential.

Effectiveness of Survey

Methods used in this survey appeared to be adequate to detect northern redbelly dace and bridle shiners. Limitations in the amount of effort (i.e., revisits of sites only 2-3 times, availability of personnel for this small project) may have restricted detection of potentially very rare species (i.e., lake chub), or coverage of habitats with large areas (i.e., Deerfield River, Hockanum Flat). Because of their similarity in morphology and coloration, detection of northern redbelly dace and lake chub is also particularly difficult when blacknose dace are abundant. However, we were very careful to closely inspect each individual in these cases, and are confident that few if any northern redbelly dace or lake chub escaped our notice.

Future surveys for eastern silvery minnows may require additional effort or improved techniques than were used in this study. Because this species occupies habitats that are extensively vegetated and large in area (i.e., backwater areas of the Connecticut River mainstem), future surveys should employ boat or barge electrofishing, or large beach seines. It may also be fruitful to target other areas in proximity to the historic sites with suitable habitat (i.e., lower and mouth of Deerfield River, the Oxbow or other local backwaters off the Connecticut River mainstem in

Hadley. It should also be noted that snorkeling surveys in the Green River recorded larger numbers of individuals than fyke net or electrofishing surveys. At this site, snorkeling was very effective for locating concentrations of fishes (i.e., near root wads in deep pools) that would otherwise not be effectively sampled by other gear. Snorkeling may be an effective method to identify presence of rare species or suitable habitat that could be followed by directed collections using fyke nets or electrofishing in the same areas.

Given that populations of these rare species may be very local in nature, future surveys may benefit from targeting appropriate habitats in locations near or similar to that of the historic sites. In the case of northern redbelly dace, other small tributaries of the lower Green River may hold other remnant populations of this species; similarly, small isolated (i.e., high elevation) ponds with substantial vegetation may harbor additional populations of bridle shiners. Present fish surveys do not necessarily target these habitats, and may not be effective in detecting species morphologically similar to blacknose or longnose dace, which can greatly outnumber target rare species. Future surveys with a more focused effort that employ some of the new techniques tested in this study (small mesh fyke nets, snorkeling) may enhance understanding of distribution and abundance of rare fish species in Massachusetts.

V. Acknowledgements

I wish to thank the Natural Heritage and Endangered Species Program (NHESP) Massachusetts Division of Fisheries and Wildlife for supporting this work and providing details of historic collections. Dr. Karsten Hartel of Harvard University Museum of Comparative Zoology provided information on collection and specimen preservation techniques. The S.O. Conte Anadromous Fish Research Laboratory kindly donated the use of the backpack electrofisher. Many thanks also to Patricia Serrentino, Robert Packard, Jennifer Strules, Tim Sullivan, and Leah Brown, whose untiring effort, keen eyes, and swiftness with the dipnet made for enjoyable and productive fieldwork.

VI. References

Chandler, M., L. Kaufman, and K. Hartel 1997. Survey of the distribution and abundance of bridle shiners in central and western Massachusetts. A report to the Natural Heritage and Endangered Species Program and the Sweet Water Trust. New England Aquarium. 42 pp.

Hartel, K.E., D.B. Halliwell, and A.E. Launer 2002. Inland fishes of Massachusetts. Mass. Audubon Soc., Lincoln. 329 pp.

Larsen, D.P., D. L. Stevens, A.R. Selle, and S.G. Paulsen 1991. Environmental Monitoring and Assessment Program, EMAP – surface waters: a northeast lakes pilot. Lake Reservoir Manage. 7:1-11.

Whittier, T.R., D.B. Halliwell, and S.G. Paulsen 1997. Cyprinid distribution in Northeast USA lakes: evidence of regional-scale minnow biodiversity losses. Can. J. Fish. Aquat. Sci. 54: 1593-1607.

Table 1. Summary of species collected and survey collection data.

		Green River					Hinsdale Brook	Glen Brook		Mill Brook		Deerfield River	Connecticut River	Middle Branch Westfield River	
Species	**Common Name**	South of Greenfield				Northwest of Greenfield	Northwest of Greenfield	Off Leyden Road		Mouth at Green River	East of Leyden Road	Routes 5 & 10	Hockanum Flat	Middlefield	Tannery Pond, Savoy
Anguilla rostrata	American eel	2											1		
Couesius plumbeus	Lake chub														
Hybognathus regius	Eastern silvery minnow														
Notemigonus crysoleucas	Golden shiner									1			2		4
Notropis bifrenatus	Bridle shiner														~30
Luxilus cornutus	Common shiner			hundreds	hundreds	hundreds	tens		2	tens	hundreds			hundreds	
Notropis hudsonius	Spottail shiner	~20	~30	tens	tens					tens	hundreds	1			
Phoxinus eos	Northern redbelly dace							9	4						
Pimephales promelas	Fathead minnow	1			1					1					
Rhinichthys atratulus	Blacknose dace	3	3	hundreds	hundreds	hundreds	hundreds	hundreds	hundreds	hundreds	tens			thousands	24
Rhynichthys cataractae	Longnose dace	2		hundreds	several	tens	tens	10	hundreds	tens				hundreds	
Semotilus atromaculatus	Creek chub	~10	10	hundreds	tens	tens		tens	hundreds	tens	tens				
Semotilus corporalis	Fallfish	1													
Catostomus commersoni	White sucker		3	tens									2	hundreds	
Ameiurus natalis	Yellow bullhead	3											5		
Ameiurus nebulosus	Brown bullhead	2	4										6		
Salmo salar	Atlantic salmon									1				hundreds	
Salmo trutta	Brown trout			2			1		2					4	
Salvelinus fontinalis	Brook trout			1			tens	hundreds	hundreds					tens	
Fundulus diaphanus	Banded killifish									1					
Cottus cognatus	Slimy sculpin					2	hundreds	hundreds	hundreds					hundreds	
Ambloplites rupestris	Rock bass											2			
Lepomis gibbosus	Pumpkinseed	1							5				12		
Lepomis macrochirus	Bluegill		1								1	4	tens		
Micropterus dolomieu	Smallmouth bass											3			
Micropterus salmoides	Largemouth bass														
Etheostoma olmstedi	Tessellated darter			hundreds	1	tens				tens					

Collection Number	**AJH2002-1**	**AJH2002-2**	**AJH2002-5**	**AJH2002-10**	**AJH2002-13**	**AJH2002-14**	**AJH2002-6**	**AJH2002-7**	**AJH2002-9**	**AJH2002-8**	**AJH2002-4**	**AJH2002-12**	**AJH2002-11**	**AJH2002-3**
Collection Date	6/6/02	6/13/02	7/21/02	9/8/02	11/5/02	11/5/02	7/31/02	8/30/02	8/30/02	8/30/02	6/21/02	9/28/02	9/22/02	6/14/02
Start Latitude	42 35 33.40	42 35 39.60	42 36 19.06	42 35 35.26	42 37 09.19	42 37 12.36	42 38 26.16	42 38 36.45	42 36 20.15	42 36 40.75	42 34 05.75	42 17 10.03	42 21 44.91	42 37 15.16
Start Longitude	72 36 55.40	72 37 02.63	72 36 51.37	72 36 55.40	72 37 15.06	72 37 21.53	72 36 37.01	72 36 38.02	72 36 51.99	72 36 27.94	72 35 35.70	72 36 15.35	72 58 02.15	73 00 15.49
End Latitude			42 35 32.77		42 37 12.30	42 37 17.01	42 38 35.71	42 38 44.64	42 36 23.00	42 36 41.37	42 34 10.34	42 17 11.78	42 21 52.80	42 37 13.54
End Longitude			72 36 55.40		72 37 21.19	72 37 32.20	72 36 38.52	72 36 34.32	72 36 49.13	72 36 27.27	72 35 26.96	72 36 15.18	72 58 09.94	73 00 16.17
Elevation (m)	48	48	48	48	54	59	72	73	48	65	30	29	262	464
Effort (h)	10.0	10.0	2.0	1.0	0.8	0.8	2.0	1.5	0.5	1.0	14.0	40.0	3.0	2.0
County	Franklin	Franklin	Franklin	Franklin	Franklin	Franklin	Franklin	Franklin	Franklin	Franklin	Franklin	Hampshire	Hampshire	Berkshire
State	MA	MA	MA	MA	MA	MA	MA	MA	MA	MA	MA	MA	MA	MA
Collector(s)**	1	1	1,3	1	1,5	1,5	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,3	1,2	1,5	1,2
Gear Type	2' fyke	2' fyke	snorkel	snorkel	electrofish	electrofish	electrofish	electrofish	electrofish	electrofish	2' fyke	2' fyke	electrofish	2' fyke
Water Temp.	20	20	22	18	8	6	n/t	20	18	18	n/t	n/t	20.1	n/t

*** 1- A. Haro*
2 - P. Serrentino
3 - R. Packard
4 - J. Strules
5 - T. Sullivan

n/t - temperature not taken

Figure 1. Sampling locations in the Green River, south of Greenfield.

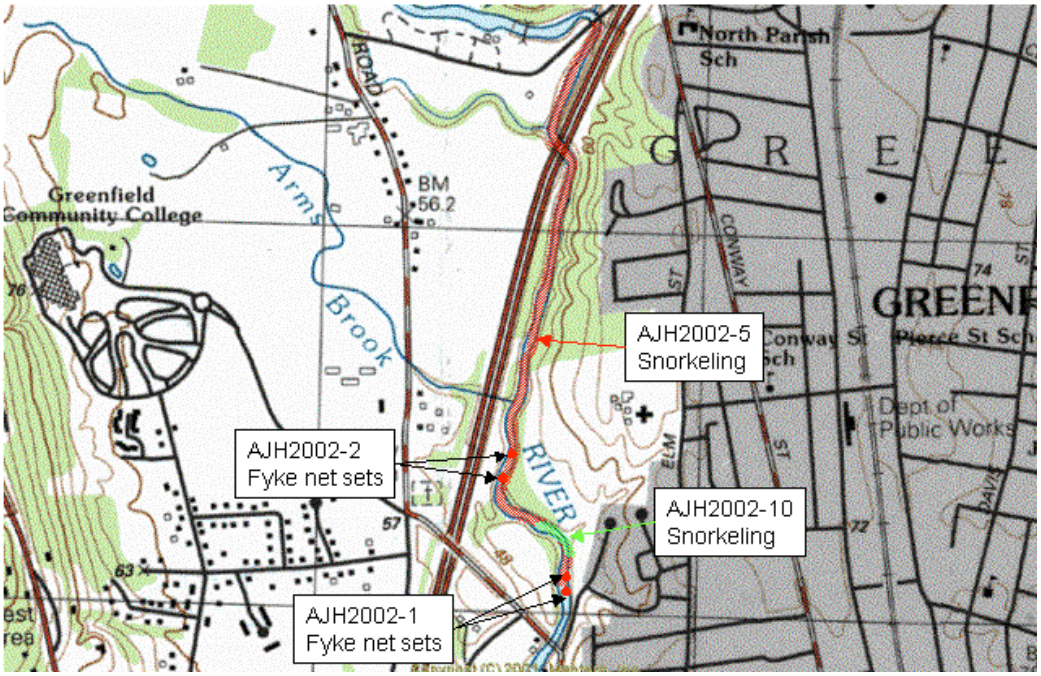

Figure 2. Sampling locations in the Green River and Hinsdale Brook, northwest of Greenfield.

Figure 3. Sampling locations in Glen Brook, north of Greenfield

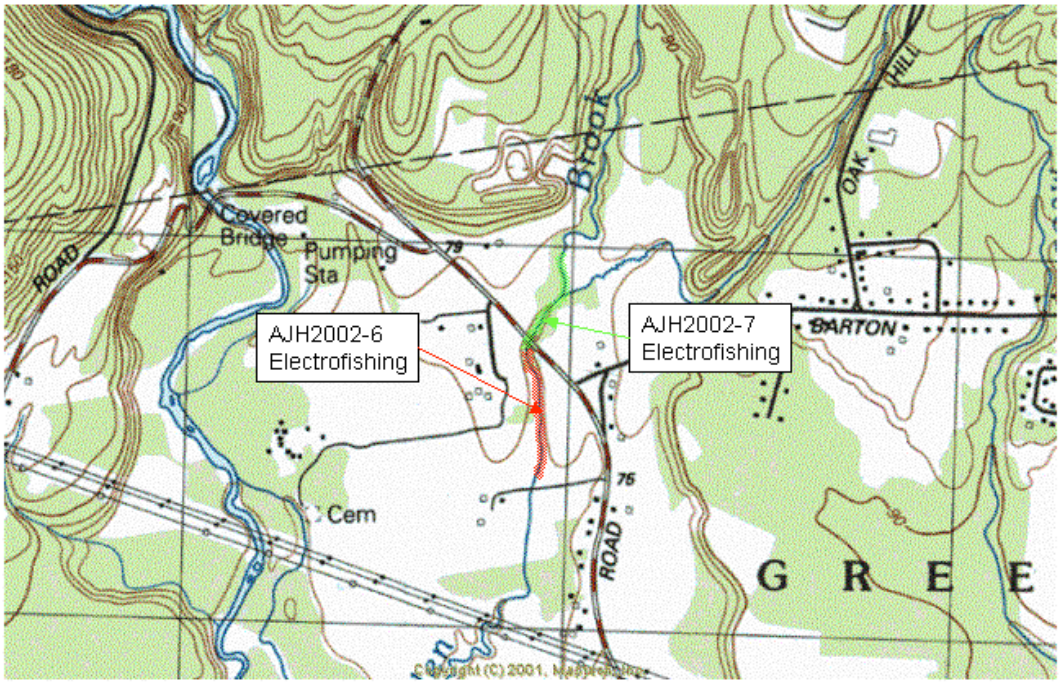

Figure 4. Sampling locations in Mill Brook, northwest of Greenfield

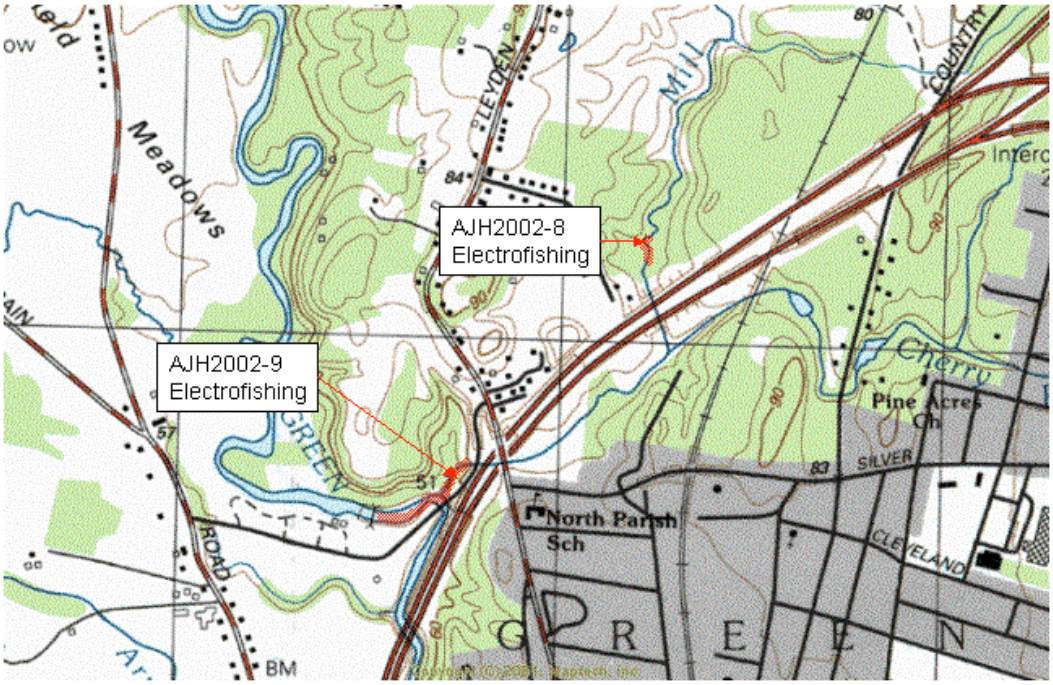

Figure 5. Sampling locations in the Deerfield River, south of Greenfield

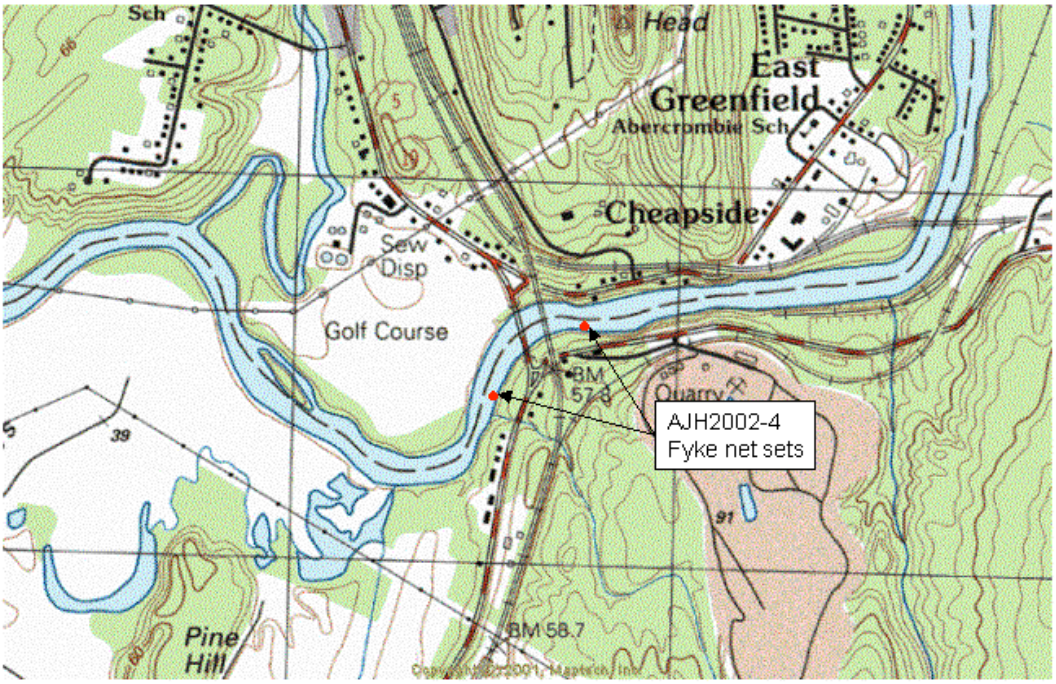

Figure 6. Sampling locations at Hockanum Flat, Connecticut River Mainstem

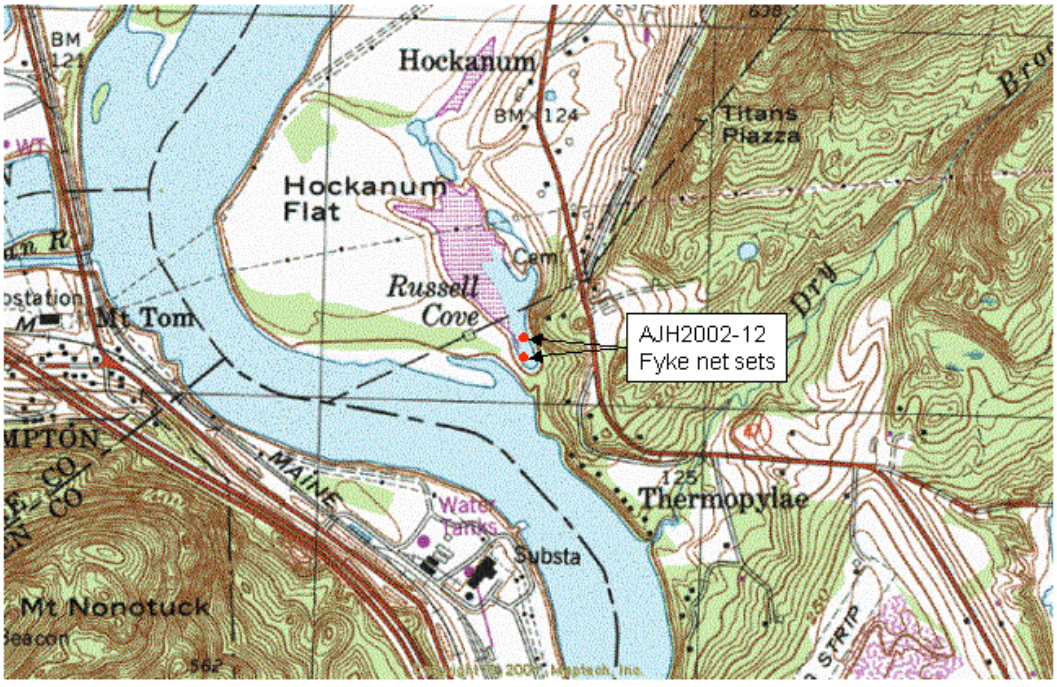

Figure 7. Sampling location at Middle Branch of Westfield River, Middlefield

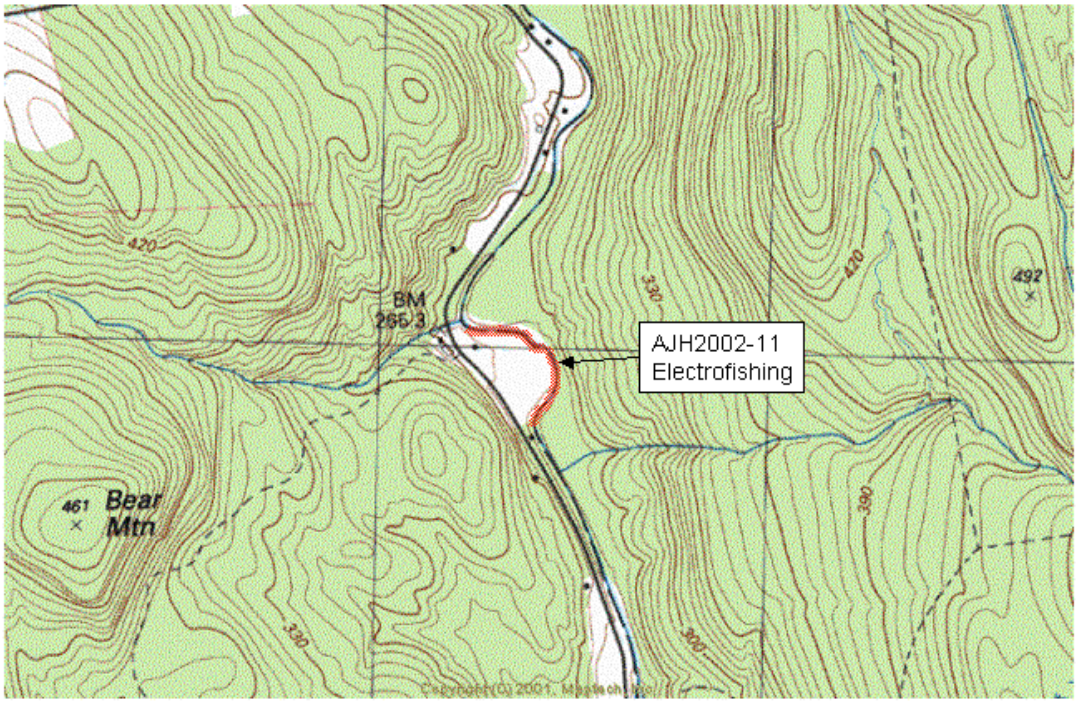

Figure 8. Sampling locations at Tannery Pond, Savoy