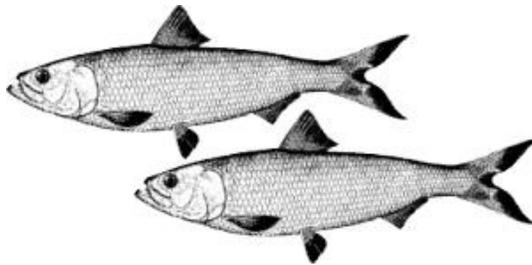


Connecticut River Atlantic Salmon Commission

**Management Plan for River Herring
in the Connecticut River Basin**



**Connecticut River Atlantic Salmon Commission
103 East Plumtree Road
Sunderland, Massachusetts 01375
January 16, 2003
(Amended October 5, 2004)**

Introduction:

River herring is a collective term for the alewife, *Alosa pseudoharengus*, and blueback herring, *Alosa aestivalis*, two anadromous fish species that are related to the American shad. The coastal range of the alewife extends from northeastern Newfoundland to South Carolina, while that of the blueback herring extends from Nova Scotia to Florida. Both species undertake upriver spawning migrations during spring. Alewives may live as long as 10 years and reach a length of 36 cm (14 in.). Blueback herring live for about 7 or 8 years and reach a maximum length of about 32 cm (13 in.). Due to similarities in size, appearance, and habits, the two species were seldom discriminated and thus the term “river herring,” referring to either or both species, often appears in the literature and historical records.

River herring were abundant historically in streams throughout New England but have experienced a decline in this century. There is ample evidence of the existence of river herring throughout the lower Connecticut River basin. Blueback herring range in the mainstem extends to Bellows Falls, VT, similar to American shad. Unlike blueback herring, alewives are rarely found in the Connecticut River north of Holyoke, MA. The most important factor limiting herring populations appears to be restricted access to spawning and rearing habitat due to dams. However, the population has continued to decline despite recent habitat restoration efforts, suggesting other detrimental factors like unfavorable marine conditions and/or overabundance of striped bass.

Habitat Requirements

Spawning: In general, river herring spawn in coastal streams and ponds as well as tributaries and backwaters of major rivers from April to mid-July when water temperatures range from 51 (alewife) or 57 (blueback) to 81 F. Upstream distribution of adults is a function of habitat suitability and hydrologic conditions permitting access to these sites. Immediately after spawning, surviving adult river herring migrate rapidly downstream.

Alewives spawn from northeastern Newfoundland to South Carolina, are most abundant in the mid-Atlantic and northeastern states, and usually spawn 3 to 4 weeks earlier than bluebacks in the same watershed. Spawning can occur in a diversity of physical habitats that includes large rivers, small streams, ponds, and large lakes over a range of substrates such as gravel, sand, detritus, and submerged vegetation. Alewives are still-water spawners and likely focused their reproductive efforts in the tidal portion of the river. In addition to the mainstem, alewives also likely used spawning habitat in Wethersfield Cove, Keeney Cove, Deadman Swamp, Salmon Cove, Hamburg Cove, and other backwaters in Middlesex County, CT. One stream in MA, Raspberry Brook in East Longmeadow, also currently supports alewife.

Blueback herring spawn from Nova Scotia to northern Florida, but are most numerous in warmer waters from Chesapeake Bay south. Spawning sites include swift flowing sections of freshwater tributaries, channel sections of fresh and brackish tidal rivers, and Atlantic coastal ponds over gravel and clean sand substrates, especially in northeastern rivers where the alewife and blueback herring coexist. In southeastern rivers where alewives are few, bluebacks exhibit greater flexibility in habitat use. We know that blueback herring in the Connecticut River basin migrate farther upstream in the mainstem (to Bellows Falls, VT) than alewives. They also likely

went all the way up the West Branch of the Farmington River in Otis, MA, the Chicopee River in MA, and other tributaries in all four states in the Connecticut River watershed.

Nursery: Juvenile river herring occur in non-tidal and tidal freshwater and semi-brackish areas (basically throughout the watershed in their natal areas) during spring and early summer, moving upstream during periods of decreased flows and encroachment of saline waters. Alewives remain deeper in the water column than blueback herring. Juveniles begin migrating from their nursery areas to the sea in the fall, cued by heavy rainfalls, high waters, or sharp declines in water temperatures. In some instances, high abundance of juveniles may trigger very early (e.g., summer) emigration of large numbers of small juveniles from nursery areas.

Adult resident habitat and migratory routes: In general, outside of spawning, river herring may be found in near-shore ocean waters from the Bay of Fundy, Canada, to Florida. Alewives are distributed from northeastern Newfoundland to South Carolina, but are most abundant in the mid-Atlantic and northeastern states. Blueback herring are distributed from Nova Scotia to northern Florida, and are most abundant from Chesapeake Bay south. However, little information is available concerning the distribution and movements of adults and sub-adults once they emigrate to sea. Both species migrate seasonally, are distributed over most of the Continental Shelf in late winter and spring during migration, and are confined to areas north of 40° north latitude in summer and fall. To some extent, the two species occupy different areas in the water column; the largest concentrations of alewives occur in greater depths than do the largest concentrations of bluebacks. Studies have determined that adult river herring are capable of migrating long distances (> 2000 km) along the Atlantic seaboard, and that migration patterns may be similar to those of American shad which feed in summer in the Gulf of Maine, Bay of Fundy, the St Lawrence estuary, and along the Labrador coast, then migrate south to over-winter off Florida, in the mid-Atlantic area, and in the Scotian Shelf-Gulf of Maine.

River Herring Population Status

River herring have supported one of the oldest documented fisheries in North America. The historic river herring fishery was a huge industry for CT. The two species of herring were lumped as one until the 1970s so it is difficult to make conclusions about historical abundance except to say that herring once numbered in the millions. Workers once seined huge numbers, salted them in barrels, and shipped the barrels to the Caribbean to feed slaves in the sugar cane fields. In return, the Caribbean traders sent molasses back to the North. Important centers for this fishery were located in Wethersfield and Rocky Hill, CT. Harvest likely took place from April to June. In MA, the harvest would likely have focused on bluebacks in May and June. The Wethersfield fishery operated until WWII and the Rocky Hill fishery lasted until the early 1970s.

Populations along the East Coast started to decline during colonial times, with overfishing, pollution, and the damming of spawning rivers and streams having drastic long-term effects. Recreational fishing harvests, largely for bait, have been minimal compared to the modest commercial harvests. These harvests, used for pet food and fish meal as well as for bait, declined considerably throughout New England between the turn of the century through the 1980s partly due to a loss of markets. In Chesapeake Bay, commercial landings had declined

about 98% by 1986. Except for by-catch offshore, commercial harvesting was exclusively a U.S. inshore and river fishery until the late 1960s, when distant-water fleets began fishing for river herring off the mid-Atlantic coast. Landings in this fishery peaked at over 24,000 metric tons (mt) in 1969 before declining to minimal levels in the late 1970s with implementation of the Fisheries Conservation and Management Act or FCMA (Figure 1). Intensification of this offshore fishery was associated with declining abundance in U.S. river systems.

Figure 1.

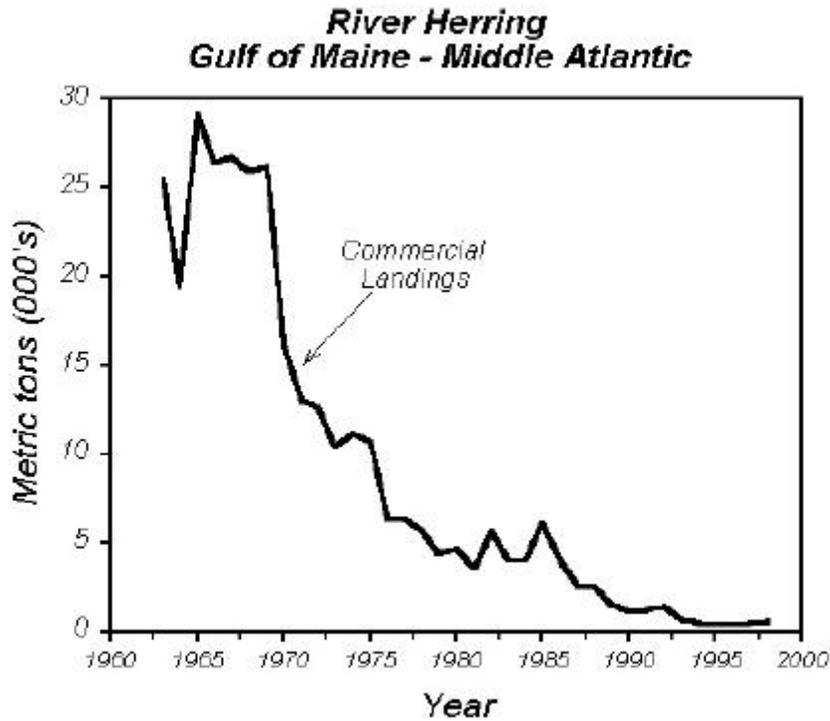


Figure from: **Status of the Fishery Resources off the Northeastern United States**, NOAA Resource Evaluation and Assessment Division, Northeast Fisheries Science Center

The principal fishing gear used to catch river herring are fish weirs, pound nets, and gill nets. The U.S. nominal catch (Gulf of Maine - mid-Atlantic) averaged 25,000 mt annually between 1960 and 1969. Landings subsequently declined to an average of 4,000 to 5,000 mt until the mid-1980s, and, more recently, to an average of about 500 mt from 1994-1998. Maine, North Carolina and Virginia typically account for more than 90 percent of total landings.

The dramatic decline in landings since the mid-1960s reflects substantial declines in resource abundance since that time, and several populations are still being exploited at higher than optimum levels. In addition, a great deal of historic spawning habitat remains unavailable. In response to the decline in landings and apparent resource conditions, the Atlantic States Marine Fisheries Commission (ASMFC) has prepared a comprehensive coastwide management plan for shad and river herring, to facilitate cooperative management and restoration efforts among the states. At present, there is limited information available on which to base regulations, but additional data collected under provisions of the Plan should provide a better basis for understanding resource status and for regulatory actions.

Status of Connecticut River river herring population

Currently there is no good model for estimating the river herring population for the Connecticut River basin. The historical usage of the term “river herring” effectively prevents any retrospective assessments of population numbers of alewives and blueback herring separately. However, the annual fish passage data collected at the Holyoke Dam in MA may provide a good measure of relative abundance, at least for blueback herring. As previously mentioned, alewives rarely occur in the Connecticut River as far north as Holyoke. Given the close similarities between the two species, one might presume that such an index holds some meaning for alewives as well as bluebacks in the lower portions of the Connecticut River basin. The Holyoke Dam is the first impassable barrier to upstream migration encountered as fish migrate from the ocean. A modern fishlift was constructed at this facility in 1976, and all fish that pass the facility are identified and enumerated. Blueback passage at Holyoke (Table 1) was modest (i.e., several thousand) when the new fishlift was opened, but quickly increased to over 200,000 in just 5 years and to over half a million in 10 years. In the 12-year period from 1981-1992 the annual herring passage averaged 433,000 and 1985 saw the record passage of 630,000. However, passage at Holyoke plummeted during the 1990’s, averaging only 44,000 in the 9-year period from 1992-2001 and reaching a low of 156 in 2004.

Existing Herring Management

In the 1999 Amendment to the “Interstate Fishery Management Plan for Shad and River Herring,” the Atlantic States Marine Fisheries Commission (ASMFC) set the management goal to “protect, enhance, and restore east coast migratory spawning stocks of American shad, hickory shad, and river herrings in order to achieve stock restoration and maintain sustainable levels of spawning stock biomass.” The Plan specifies four management objectives:

- 1) Prevent overfishing of American shad stocks by constraining fishing mortality,
- 2) Develop definitions of stock restoration, determine appropriate target mortality rates and specify rebuilding schedules for American shad populations within the management unit,
- 3) Maintain existing or more conservative regulations for hickory shad and river herring fisheries until new stock assessments suggest changes are necessary, and
- 4) Promote improvements in degraded or historic alosine habitat throughout the species’ range.

These objectives, including all of the ASMFC’s suggested methods for achieving Objective 4, are fully applicable to river herring. Although the Plan does not identify management measures specific to river herring, the principal measure set forth is the phase-out of the ocean intercept fishery for American Shad, an action which may afford herring populations some protection as it will end herring by-catch in the ocean shad fishery.

Current regulations regarding capture, possession, and use of herring in the Connecticut River in each of the basin states is summarized below:

Connecticut: Traditionally river herring in the Connecticut River were open for collection from April 1 through June 15, with weekly closures from midnight Saturday through midnight Tuesday, and a possession limit of 25. In response to recent declines, the CTDEP first instituted a number of area closures (e.g., CT River tributaries), then opted for a statewide ban on capture beginning in 2002.

Massachusetts: In the Connecticut River and its tributaries, alewife and blueback herring may be captured by hook and line only with a possession limit of 12. River herring may be used as bait, live or dead, in MA.

Vermont: In Vermont tributaries to the Connecticut River there are no specific rules or limits on herring capture. They can be used as bait in the water from which they are taken, but they cannot be transported, dead or alive, for use as bait in another water. The Connecticut River itself, including tributaries and setbacks to the first highway bridge on both sides of the river, is under New Hampshire regulations.

New Hampshire: There are no regulations in place on the harvest or possession of herring in the Connecticut River, including tributaries, in New Hampshire.

Existing Herring Restoration Efforts

Herring in the Connecticut River have benefited from the extraordinary efforts at Atlantic salmon and American shad restoration. Access to spawning and rearing habitat in the Connecticut River basin has been vastly improved. A modern fishlift was opened at the Holyoke dam in MA in 1976. Fish ladders were completed at the Turners Falls Dam, MA in 1980 and at the Vernon Dam, VT in 1981. On the tributaries, the Rainbow fishway was opened on the Farmington River, CT in 1976. The Leesville fishway was opened on the Salmon River, CT in 1980. The DSI fishway on the Westfield River, MA, opened in 1996. Efforts at dam removal have begun with the removal of the McGoldrick Dam (2001) and the Winchester Dam (2002) on the Asheulot River in NH. Access to habitat will improve further with a fishladder being planned for the first dam on the Manhan River in MA, and the removal of 2 more dams on the Ashuelot River in NH. In CT, herring have benefited from the construction of fishways on the Eightmile River and the Lieutenant River.

Downstream fish passage has been installed at all hydroelectric dams on the Connecticut River. These facilities were designed to pass juvenile shad and should function equally well for juvenile herring due to the species' similarities.

The Massachusetts Division of Fisheries and Wildlife (Division) is currently engaged in a blueback herring restoration program on the Westfield River. In 1996, upstream and downstream fish passage was installed at the Decorative Specialties International Inc. (DSI) dam in West Springfield, MA. The DSI Dam is the first dam on the Westfield River, located 4 miles upstream of the Westfield River/Connecticut River confluence. The fishway opened 14 miles of river habitat to anadromous fish. American shad passage at this facility has been increasing each year, with nearly 5,000 passing upstream in 2001. Although large numbers of herring have been observed in the lower Westfield River, few have used the fishway to access the habitat upstream

of the dam. In 2000, the Division established a trap-and-transfer program for brood stock blueback herring in order to establish a self-sustaining population in the Westfield River. Brood stock herring were collected from the mainstem Connecticut River by electrofishing. In 2000, approximately 200 gravid adult herring were released in the Westfield River; approximately 700 gravid adult herring were released in 2001 and 2002. The Division plans to stock up to 2,000 adult herring upstream of the DSI Dam annually from 2003-2005. Fish surveys in the Westfield River in the area immediately upstream of the DSI dam during the summer of 2002 found significant numbers of juvenile blueback herring. This would indicate that the trap and transfer program has resulted in successful herring spawning in the Westfield River.

The New Hampshire Fish and Game Department is currently engaged in a blueback herring restoration program on the Ashuelot River from the Keene City Dam (Colony Mill) to the confluence with the Connecticut River. There are currently runs of shad and herring in the Connecticut River extending past the confluence of the Ashuelot River to the Vernon and Bellows Falls Dams. The strategy for restoration is to provide fish passage around dams or to remove dams in the targeted area to allow adult access to historic spawning and nursery habitat. The McGoldrick and Winchester Dams were removed in 2001 and 2002, respectively. Upstream passage efficiencies will have to be very high at dams in the lower river (Fiske, Ashuelot Paper, and Lower Robertson) due to the minimal amount of habitat between these barriers. Downstream passage from these areas must also be provided, and, in fact, bypass pipes for juvenile outmigrants are in place at all three of these lower dams.

The plan calls for annual plants of prespawn herring over a 6 to 7 year period beginning in 2000. Approximately 750 blueback herring, when available, will be trapped and transferred from the Connecticut River below the Holyoke Dam. Juvenile production will be evaluated through sampling in the late summer. Upstream passage options will be explored as adult returns of migratory fishes are increased by the activities outlined in the plan. The presence of adult migratory fish of any species milling below a barrier should be impetus to provide passage around that barrier; however, downstream passage is the priority issue for the initial phase of this restoration plan.

Potential Connecticut River Blueback Herring Population Size

It is estimated that each hectare (10,000m²) of suitable habitat can support a population of 2,750 adult river herring (or 10 times the shad estimate of 275/ha). There is an estimated 61,792,647 m² (nearly 6200ha) of habitat available in the Connecticut River mainstem and tributaries from the mouth to Bellows Falls, VT. This leads to a staggering estimate of a potential herring population of 17 million adult fish (see Tables 2-4). With alewife occurrence documented as far north as Raspberry Brook in East Longmeadow, MA, the potential population in the lower Connecticut River basin from Raspberry Brook south for both species combined would be about 8.2 million. Assuming that alewife continue to remain south of the Holyoke Dam, the potential population of river herring in the mid-basin to VT would be about 8.8 million bluebacks (Table 2, Holyoke to Bellows Falls, Table 4 White Bk. to MA-NH-VT border). If the availability of additional habitat (as much as 4,780,606m², or about 478ha, Tables 2-4) within tributaries could be restored through the removal of obstacles and remediation of other problems, there is the potential for an additional 1.3 million river herring in the river basin. These estimates are very

rough approximations. The mainstem Connecticut River habitat estimate has been adjusted to half the total surface area, and there is some evidence that this may be a good approximation for shad and probably alewife. However, it is possible that blueback herring limit their spawning areas to faster flowing waters with gravel substrate and submerged aquatic vegetation, although, as previously suggested, they may prove more flexible in their habitat selection in the absence of competing alewives. Application of a more realistic habitat area estimate in the mainstem as well as consideration of community dynamics (e.g., competition for space with other species, predator-prey dynamics, etc.) could significantly reduce the estimated potential population size. Regardless, it is clear that the Connecticut River and its tributaries possess abundant herring habitat and therefore should support a significant population of river herring.

CRASC River Herring Management Goal

The CRASC should seek to restore and maintain a spawning river herring population within its historic range in the Connecticut River basin.

CRASC River Herring Management Objectives

- 1) Achieve and sustain annual passage of 300,000-500,000 adults at the Holyoke fish passage facility (this represents a return to the numbers documented in the 1980's, Table 1).
- 2) Achieve annual passage of 40-60% of the spawning run at each successive upstream barrier on the Connecticut River from Holyoke to Bellows Falls (based on % of habitat available between each barrier, Table 2).
- 3) Maximize outmigrant survival for juveniles and spent adult river herring.
- 4) Support tributary restoration programs (fish passage, barrier removal, and broodstock trap-and-transport).
- 5) Establish a research program to address questions related to Connecticut River river herring management goals and objectives (e.g., What is the target population size? How do we estimate the population? What are the root causes of the dramatic reduction in the blueback herring population witnessed over the last 10 years?).
- 6) Enhance, restore and maintain river herring habitat in the Connecticut River basin.
- 7) Establish baseline genetic characterization of Connecticut River stocks of herring for use in developing management plans to guide trap-and-transport and other restoration activities.

Table 1. Anadromous fish passage recorded at the Holyoke fishlift, Connecticut River, Massachusetts, 1975-2003 (0-999 are reported to the nearest individual; 1,000-9,999 to the nearest 100; 10,000-99,999 to the nearest 1,000; and greater than or equal to 100,000 to the nearest 10,000).

Year	American Shad	Blueback Herring	Atlantic Salmon	Striped Bass	Sea Lamprey	Gizzard Shad
1975	110,000	1,600	-	-	23,000	-
1976	350,000	4,700	-	-	32,000	-
1977	200,000	33,000	2	-	52,000	-
1978	140,000	38,000	23	-	43,000	-
1979	260,000	40,000	19	103	31,000	-
1980	380,000	200,000	126	148	34,000	-
1981	380,000	420,000	319	510	53,000	-
1982	290,000	590,000	11	231	26,000	-
1983	530,000	450,000	25	346	29,000	-
1984	500,000	480,000	66	110	22,000	-
1985	480,000	630,000	285	369	40,000	-
1986	350,000	520,000	260	187	20,000	27
1987	280,000	360,000	208	521	23,000	94
1988	290,000	340,000	72	256	16,000	95
1989	350,000	290,000	80	923	15,000	294
1990	360,000	390,000	188	1,000	22,000	956
1991	520,000	410,000	152	1,200	41,000	486
1992	720,000	310,000	368	327	28,000	1,100
1993	340,000	100,000	167	194	23,000	341
1994	181,000	32,000	256	159	30,000	165
1995	190,000	110,000	150	1,309	18,000	2,100
1996	280,000	55,000	202	537	45,000	1,100
1997	300,000	64,000	94	679	32,000	2,100
1998	320,000	11,000	196	492	97,000	1,100
1999	190,000	2,700	91	859	20,000	35,000
2000	230,000	11,000	64	489	21,000	38,000
2001	270,000	11,000	28	1,217	49,000	5,500
2002	370,000	1,900	39	1,104	73,000	3,100
2003	290,000	1400	32	883	53,000	859
Total	9,450,000	5,910,000	3,500	14,000	1,010,000	92,000

Table 2. Estimated Connecticut River Blueback herring habitat (m²) and potential population estimates.

Reach	m²	Adjustment	m²	% of total	Potential Population
Mouth to Holyoke	56,766,060	Half of area	28,383,030	46	7,805,333
Holyoke to Turners	13,688,717		13,688,717	22	3,764,397
Turners to Vernon	7,620,241		7,620,241	12	2,095,566
Vernon to Bellows Falls	10,421,641		10,421,641	17	2,865,951
Lower River Tribs	1,362,527		1,362,527	2	374,694
Mid River Tribs	316,491		316,491	1	87,035
Totals			61,792,647		16,992,976

Mainstem-Estimated surface areas from Michelle Babione USFWS GIS

Table 3. Lower River Tributaries, Mouth to Enfield Dam (from SFRO/CTDEP)

Tributary	Total length (m)	Available	Potential	Total	% of Potential
		habitat (m ²)	habitat (m ²)	barriers	Habitat Available
Asylum Bk.	2,043	2,486	23,306	1	10
BlackHall R	7,420	62,883	0	0	100
Boweyns Bk.	3,473	482	7,989	2	6
Broad Bk.	16,907	12,386	131,923	1	9
Buckhorn Bk.	1,194	> 1000	0	0	100
Carr Bk.	8,030	10,189	71,488	2	12
Chester Cr.	10,827	90,874	27,092	5	77
Coginchaug R.	13,273	54,036	43,155	2	56
Deep R.	6,307	7,056	99,619	5	7
Dividend Bk.	6,059	1,778	32,452	2	5
Dry Bk.	7,608	3,117	22,346	1	12
Duck R.					0
Eightmile R.	18,348	82,673	116,310	1	42
Falls R.	7,650	11,504	43,630	4	21
Goff Bk.	4,441	15,429	0	0	100
Hales Bk.	6,374	1,000	0	0	100
Higganum Cr.	5,338	2,911	94,366	2	3
Hockanum R.	24,536	27,795	1,052,487	6	3
Hubbard Bk.	9,209	10,131	22,498	2	31
Hubbard Pond	2,466	5,837	70,127	1	8
Joshua Cr.	4,200	3,523	61,056	2	5
Ketch Bk.	8,445	15,033	78,915	1	16
Kettle Bk.	3,894	0	10,343	2	0
Lieutenant R.	10,979	101,247	1,183,059	3	8
Longhill Bk.	6,669	10,317	80,401	2	11
Mattabesett R.	27,366	133,988	84,822	3	61
Mill Cr.	3,261	3,722	8,120	2	31
Moodus R.	6,422	6,908	1,576,021	4	0
Namerick Bk.	4,341	11,451	0	tree snags	100
Pewterpot Bk.	8,647	9,004	18,590	1	33
Podunk R.	9,640	50,662	76,359	2	40
Porter Bk.	8,867	37,916	0	0	100
Rawlings Bk.	3,861	3,194	4,479	1	42
Reservoir Bk.	7,075	15,097	115,438	1	12
Roaring Bk.	15,707	3,672	142,394	3	3
Roaring Bk.	9,608	5,881	62,781	1	9
Salmon Bk.	11,949	31,043	46,933	2	40
Scantic R.	39,319	493,202	39,288	3	93
Smith Bk.	4,734	3,630	0		0
Spring Glen	2,003	>1000	0	0	100
Stony Bk.	18,276	12,437	53,747	5	19
Stoughton Bk.	2,721	4,107	0	0	100
SuccorBk.	4,175	3,926	4,736	2	45
Total	383,662	1,362,527	5,506,270	77	20

Table 4. Mid-River Tributaries, Enfield Dam to MA-NH-VT border (from SFRO)

Tributary	Total Length (m)	Available Habitat (m²)	Potential Habitat (m²)	% of Potential Habitat Available
Deep Bk.	2,546	356	356	100
Freshwater Bk.	5,458	3,480	18,312	19
Grape Bk.	5,461	2,182	2,182	100
Waterworks Bk.	3,827	318	318	100
Threemile Bk.	6,584	3,914	18,365	21
Fourmile Bk.	5,772	3,073	3,073	100
Raspberry Bk.	3,267	17,667	17,667	100
Longmeadow Bk.	6,538	1,473	1,473	100
Cooley Bk.	2,281	401	401	100
Westfield R.	DSI to Woronoco	15,160	15,160	100
<i>Subtotal 1</i>		<i>48,024</i>	<i>77,307</i>	
White Bk.	2,007	2,335	2,335	100
Bagg Bk.	4,035	1,395	1,395	100
Goldine Bk.	3,823	930	930	100
Tannery Bk.	1,662	1,653	1,653	100
Mill R. Diversion	19,995	39,269	215,625	18
Stoney Bk.	17,022	16,812	88,950	19
Bachelor Bk.	23,194	26,344	26,344	100
Fort R.	18,904	144,158	144,158	100
Cow Bridge Bk.	2,091	5,889	104,758	6
Sugarloaf Bk.	4,761	1,041	2,096	50
Lake Warner Bk.	11,514	10,164	269,326	4
Russelville Bk.	9,130	8,350	8,350	100
Gunn Bk.	3,100	810	810	100
Dry Bk.	12,448	2,861	2,861	100
Roaring Bk.	4,189	1,890	1,890	100
Pauchog Bk.	4,383	2,820	2,820	100
Noname (above French King Bridge)	2,457	1,746	1,746	100
<i>Subtotal 2</i>		<i>268,467</i>	<i>876,047</i>	
Total	186,449	316,491	953,354	32

References:

ASMFC. 1999. Interstate Fishery Management Plan for Shad & River Herring: Amendment 1. Fishery Management Report #35 of the Atlantic States Marine Fisheries Commission. vii & 76 pp.

Loesch, Joseph G. 1987. Overview of Life History Aspects of Anadromous Alewife and Blueback Herring in Freshwater Habitats. American Fisheries Society Symposium 1:89-103.

Ross, Michael R., and Robert C. Biagi. xxxx. Marine Recreational Fisheries of Massachusetts: River Herring. Marine Recreational Fisheries series, University of Massachusetts Cooperative Extension, Amherst, MA, and Massachusetts Division of Marine Fisheries, Boston, MA. 4pp.

Slater, Caleb. 2000. Anadromous Fisheries Management Plan for the Westfield River 2000-2010. Massachusetts Division of Fisheries and Wildlife, Westborough, MA.

Sprankle, Kenneth. 1998. Plan For The Restoration Of Migratory Fishes To The Ashuelot River Basin, New Hampshire. New Hampshire Fish and Game Department, Inland Fisheries Division.

USFWS. 1993. Alewife and Blueback Herring (*Alosa pseudoharengus* and *Alosa aestivalis*). USFWS Chesapeake Bay Field Office. 2pp. (December 1993 reprint).

USFWS. 1996. Evaluation of River Herring Habitat in Tributaries to the Connecticut River Between the Enfield Dam in CT and the Massachusetts- Vermont-New Hampshire Border. USFWS Sunderland Office of Fisheries Assistance, Sunderland, MA.

USFWS and CTDEP. 1996. Evaluation of Tributaries to the Lower Connecticut River for Anadromous River Herring Restoration and Improvement. USFWS Sunderland Office of Fisheries Assistance, Sunderland, MA, and Connecticut Department of Environmental Protection: Fisheries Division. iv & 42pp plus appendices.