Action Plan 8 Restoring Migratory Fish Passage and Populations

Problem[111]

In the Buzzards Bay watershed, there are more than 8,000 acres of ponds and hundreds of stream miles. Prior to colonial settlements most of these ponds and streams were likely important habitat for fish species that spent portions of their life cycle in both fresh and marine waters. These diadromous species include river herring (bluebacks and alewife), historically the most predominate species, in many rivers. Other locally important diadromous fish are the eel, white perch, rainbow smelt, and sea run brook trout. All these species have declined dramatically in the Buzzards Bay watershed during the past 200 years. Historically, the declines were largely caused by river obstructions, particularly the widespread construction of milldams during the 19th century, but culvert installation, channelization of streams, loss of bordering tree and shrub vegetation, and pollution and sediment discharges have all been contributing factors. The loss of suitable river spawning habitat (gravel bottom streams with fast moving cool water, for example) has affected many species. Water diversion and pumping for agricultural purposes can impede migrations and result in juvenile fish mortality.

All these species will benefit most appreciably from the elimination of obstructions to migration and the creation of more suitable river and stream spawning habitat. In many cases, dam removal may be the best management option, in other cases, new fish ladder installations may be the only practical solution. Improved water management practices by cranberry growers, and preventing excessive drawdowns by municipal water supplies during drought years is important to avoid placing adult and juvenile populations at risk.

In the case of river herring, while there were some modest improvements in certain populations toward the end of the twentieth century, offshore fishing pressures, and bycatch takings have resulted in new dramatic declines. Restoration of river herring populations will require rigorous controls of offshore catch.

<u>Goals</u>

Goal 8.1. Ensure that the migration of fish species between salt and fresh water is unimpeded.

Goal 8.2. To restore degraded stream habitat and stream functions to ensure the diversity and abundance of fish in Buzzards Bay streams.

Goal 8.3. To manage fishing pressures on anadromous fish populations to ensure the fish harvest and bycatch are sustainable.

[111] In the 1991 Buzzards Bay CCMP, objectives and recommendations relating to fish migration were found in the "Protecting Wetlands" action plan.

<u>Objectives</u>

Objective 8.1. Ensure adequate funding of state fisheries restoration programs.

Objective 8.2. Ensure that local, state, and federal fisheries regulators manage better the catch and bycatch of river herring and other diadromous fish to promote their recovery and population sustainability.

Objective 8.3. Improve passageways and remove impediments and obstructions to fish migration.

Objective 8.4. Ensure adequate stream flow for fish migration.

Approaches

State and local managers must identify and restore priority fish habitat sites and remove obstructions to fish migration. Many smaller herring runs need to be elevated as a priority for restoration because of their cumulative benefits. A special focus of the state and towns should be a coordinated restoration of fish habitat along the entire length of the Weweantic River. While these river restoration efforts are underway, the National Marine Fisheries Service, Regional Fisheries Management Councils, and the Atlantic States Marine Fisheries Commission should limit the catch and bycatch of river herring in offshore waters and take other measures. DEP could require, as a condition in all state water withdrawal permits, that there is adequate flow in rivers during adult and juvenile migration periods for species in the stream. Permittees should always be required to use appropriate screening of water withdrawal intakes to prevent stranding, mutilation, entrainment, or impingement of young herring.

Costs and Financing

Developing and implementing designs to repair fish passageway structures in the watershed, and to remove obstacles, including dams, may cost millions. Federal grants can cover some of these costs but state and local government may need to provide additional funding for natural resource staff. Regulatory solutions have negligible costs to government. The installation of a fish counter on a particular stream may cost $10,000 or more.

Measuring Success

The number of restoration efforts undertaken, or quantifying the number of upstream or downstream river miles or pond acres newly accessible or restored are easily tracked. Different management actions may benefit some species and not others. Ultimately, the size of the fish species population will be the best measure of success and can be determined through automated fish counters, observations by volunteers, direct capture, or through catch, mark, and release programs.

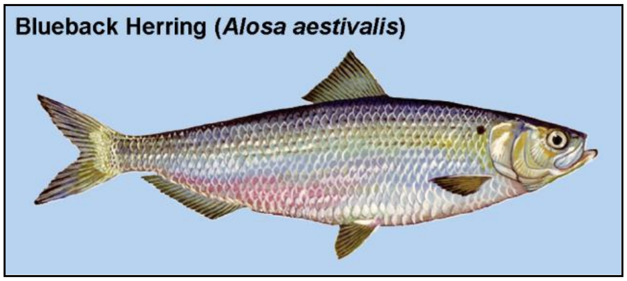

Figure 73. The blueback herring, *Alosa aestivalis*.

Background

For centuries, fish species that migrate between freshwater and saltwater habitat were historically important to the coastal economy and ecosystem of Buzzards Bay. Most of these species including "river herring" (the alewife *Alosa pseudoharengus and* blueback herring *Alosa aestivalis,* Figure 73), white perch, brook trout, tomcod, shad and rainbow smelt are defined as anadromous species because adults come from the sea to lay their eggs in fresh or brackish water. The American eel is defined as catadromous because the adults lay eggs in salt water and the young travel to or mature in freshwater streams and connected ponds. Collectively, anadromous and catadromous species are also called "diadromous" species.

These diadromous species likely inhabited most Buzzards Bay ponds and streams before development (Colette and Klein-MacPhee, 2002). Some of the present day larger diadromous habitat systems in the Buzzards Bay watershed are shown in Figure 72. These diadromous species, particularly the *Alosa* species, were not only once an important local fishery and food source in the Buzzards Bay watershed, but juveniles and adults of these species remain an important food species for many commercially and recreationally important fish, some whales, and many coastal birds, including the Roseate Tern (*Sterna dougallii*), a U.S. endangered species with 60% of the North American breeding population found in Buzzards Bay.

The historical loss of anadromous fisheries is well documented in town records, local historical texts, and state reports because these fisheries were so important to local economies and municipal revenues. Belding even notes how in some Massachusetts towns, widows received herring as a form of public charity.

Historically, river herring (alewife and blueback) were always the most economically important and abundant species in terms of biomass, so the ability of rivers to sustain these species is documented best (e.g. in Belding (1921) and Nelson et al., 2011). In many rivers, the most dramatic herring declines seemed to have occurred between 1800 and 1900 and were related primarily to changes in the natural flow regime of rivers and streams, although sewage and "trade wastes" from saw mills and

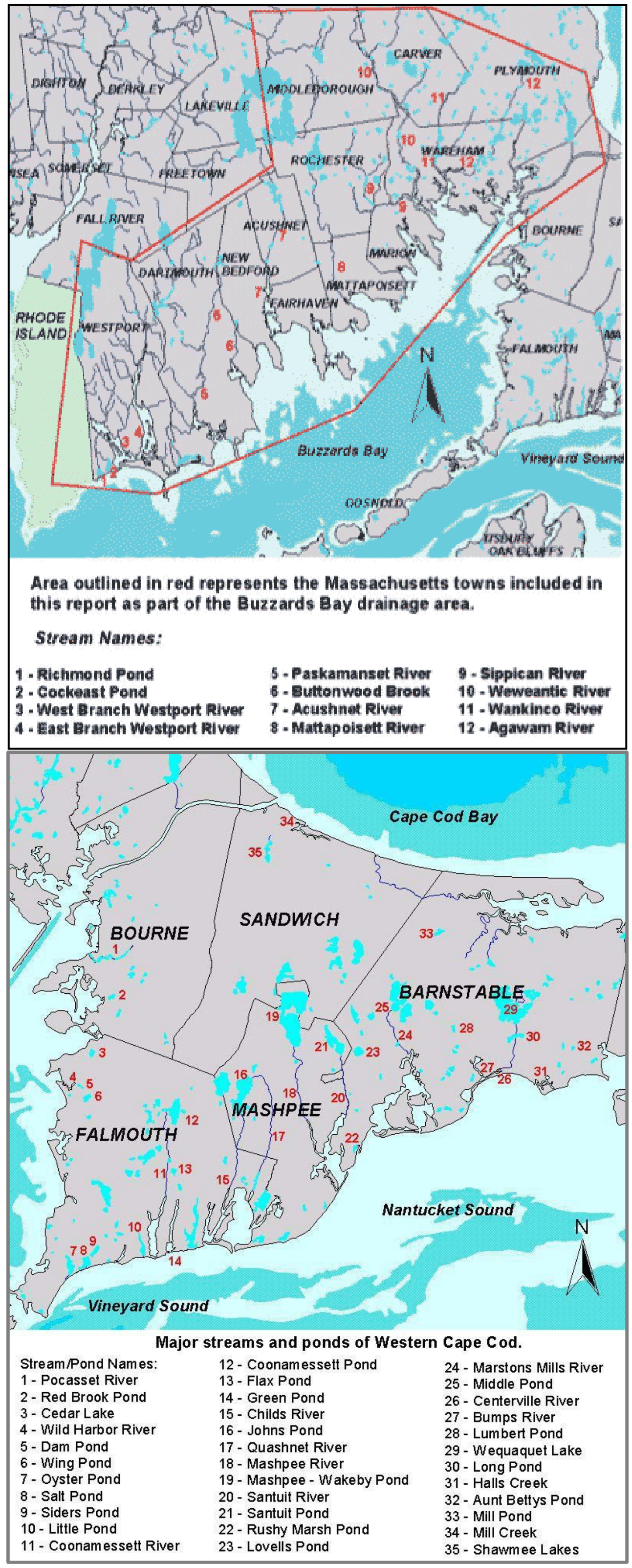

Figure 72. Map of major herring runs in the mainland portion of the Buzzards Bay watershed (top) and on Cape Cod (bottom) as contained in a DMF report.

Figures from Division of Marine Fisheries Technical Report TR-15A and TR-16A Survey of Anadromous Fish Passage in Coastal Massachusetts Part 1. Southeastern Massachusetts (Reback et al., 2004a, b). Note that not all the anadromous streams of Buzzards Bay are shown on these maps.

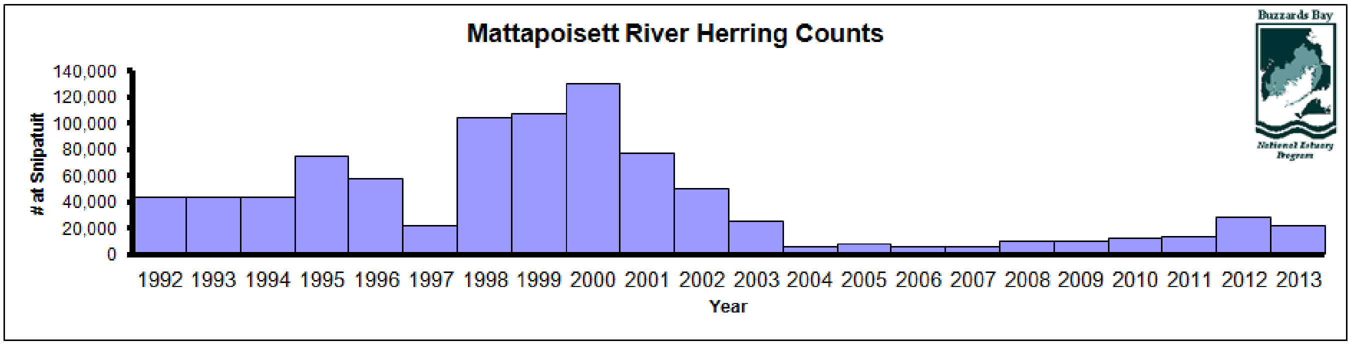

Figure 74. Counts of herring passing upstream as measured by a counter at Snipatuit Pond.
Data courtesy of Alewives Anonymous.

iron works were believed to contribute to some population declines (Belding 1921). Additional alterations in stream flows during the 20th century left most anadromous fish runs decimated compared to conditions in colonial times.

The changes in the natural flow and hydraulic regime of Buzzards Bay streams since colonial times, has also been documented in maps and texts, and can be inferred from other studies. As noted by various authors, prior to European settlement in the Northeast US, beavers were abundant[112], and many small second order streams were not free flowing because beavers dams created a massive network of interconnected streams and ponds (Naiman et al., 1986; Poff et al., 1997). By the early 1700s, beaver populations in southeastern Massachusetts were becoming extirpated (Griffith, 1913[113]; Crapo, 1912[114]). Many of these dams and beaver ponds became the sites of millpond dams to power water wheels for agricultural milling and sawmills, or stream crossings that became roads and bridges (Poff et al., 1997). In many respects, beaver dams and small milldams probably had similar effects on nutrient cycling, habitat, and fish migration, although the magnitude of beaver dam effects are presumably less because of their porosity and intermittent breakage (Hart et al., 2002). Thus, while early milldams and stream crossings may have helped preserve some of the early natural mosaic of beaver created shallow ponds and deep marshes after beaver were extirpated, their static nature and greater height required the creation of fish passage canals and ladders to maintain fish runs.

Belding (1921) and others document both successful and failed attempts to restore fish passage past milldams. Local efforts also included the creation of artificial connections to ponds. The most successful of the redirection of river flow was the connection of Snipatuit Pond to the Mattapoisett River. Formerly the pond connected at its north end to swamps feeding into Quittacas Pond, which then flows to both the Taunton and Acushnet Rivers. Until the past decade, the Mattapoisett River herring run was one of the largest in Buzzards Bay.

Prior to the 1930s, fish passage and river herring management was largely done by towns. After the publication of the Belding reports, there was a movement to establish new Massachusetts General Laws enhancing the ability of the state to better manage fish passage. The Massachusetts DMF created a Fishway Crew whose actions in the 1930s led to large gains in improved fish passage and increased fish abundance in many Massachusetts runs during the 1940s through the 1980s, although other factors could have contributed to these increases. The Fishway Crew continued to construct projects in the 1990s and 2000s but with fewer staff and lower resources due to repeated budget cuts.

In the 1991 Buzzards Bay CCMP, physical obstructions to migration were identified as one possible cause of some recent declines of diadromous species in Buzzards Bay rivers. Other impairments included impediments to spawning migration or escapement of adults or juveniles, overfishing, poor water quality, and habitat degradation (e.g., channelization of streams). Of these, physical obstructions in the form of dams, constraints associated with roadway construction (e.g. collapsing or obstructed culverts), failing fish bypass structures, and other obstructions were presumed to be the greatest impediments to herring migration in Buzzards Bay.

Because of these concerns, during the 1990s and into the 21st century, the Buzzards Bay NEP recommended increased support for the work of the state Division of Marine Fisheries. Where possible, the NEP provided funding and technical support to towns in their work with DMF to improve herring runs in the bay's most productive river systems (Table 28). The Buzzards Bay NEP's efforts, together with the more comprehensive contributions and leadership by the Massachusetts Division of Marine Fisheries (DMF), and actions by local officials appeared to payoff, and in the late 1990s, several area rivers showed increasing return of river herring Figure 74 and Figure 75).

[112] One of the first shipments from Plymouth to England was two barrels of beaver and mink pelts.
[113] Herring were able to migrate up Beaver Dam Brook in Carver.
[114] In a 1731 deposition, a beaver dam is noted by Snipatuit Pond in Rochester.

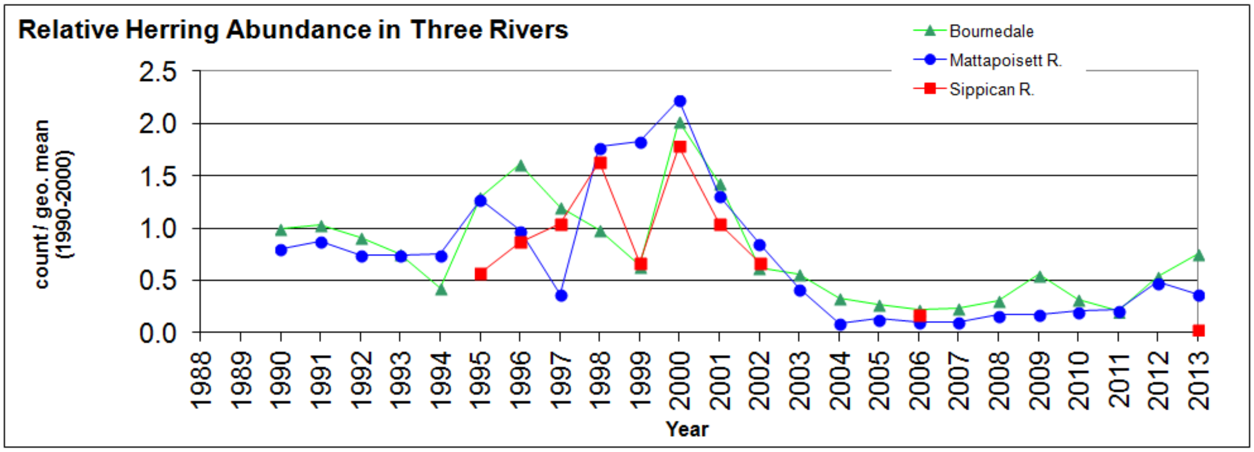

Figure 75. Herring counts in three Buzzards Bay area rivers plotted against the geometric mean of fish abundance during the period 1990-2013.

Note that the geometric mean for the Sippican River during this period was a few hundred fish, whereas the geometric mean for the Herring River for the same period was several hundred thousand fish. Counts were not available for the Sippican river from 2003 to 2005 and 2007-2012 because of various equipment technical issues. Herring River data courtesy of the Massachusetts Division of Marine Fisheries and Alewives Anonymous.

However, after 2000, river herring began to show new unprecedented and precipitous declines. These declines were observed not just in Buzzards Bay, but throughout the eastern seaboard of the U.S. herring runs that might have once had hundreds of thousands of returning fish, now were reported to have declines of 90% or more of the population. These new declines appeared to be independent of improvements or declines in water quality, changes in habitat, or development patterns of each river herring watershed. Thus, in one century, important herring runs like the Mattapoisett River went from sustaining millions of fish around 1900, to hundreds of thousands of fish in 2000, to just over 5,000 fish in 2004.

The large-scale disappearance of river herring in the past decade has generated considerable regional debate about the causes. Factors often cited as contributing to this decline include loss and degradation of habitat, overfishing (including offshore bycatch from ocean herring fisheries), and increased predation due to recovering striped bass populations (NMFS, 2007; Hass-Castro, 2006; Wilson, 2007). In 2006, the NOAA National Marine Fisheries Service designated both blueback herring and alewives as species of concern (NMFS, 2007).

To address alewife and blueback herring declines, Massachusetts implemented a three-year moratorium on the catch of herring in rivers and inshore areas beginning in December 2005. By the end of 2007, bans on herring fishing were also enacted by Rhode Island, Connecticut, and North Carolina.

These bans may have slightly improved stocks as there has been an increase in counts in both the Herring and Mattapoisett River runs by 2012 (Figure 75). Several fishing environmental groups asserted these actions would remain ineffective because overfishing by ocean mid-water trawling was the primary cause of these herring declines[115]. Because of the impacts to herring stocks, and presumed impacts to offshore ground fisheries, in December 2007, several environmental groups filed a lawsuit against the federal government to ban this trawling from certain ground fish areas[116].

Restoration Efforts

Generally, dam removal is one of the most effective strategies to increase anadromous fish spawning habitat upstream of the obstruction. Where dam removal is not an option, fish ladders can be used. Past diadromous fish restoration activities in the Buzzards Bay watershed have been spearheaded by the Division of Marine Fisheries, sometimes prompted or supported by municipalities, and largely focused on the construction and restoration of fish ladders. More recently, the Buzzards Bay Coalition has been initiating steps toward dam removals, both through municipal collaborations, and through the outright purchase of dam containing properties.

In some areas, non-profit organizations have been instrumental in promoting actions by state and federal government, and maintaining fish runs. Most notably, the citizens group Alewives Anonymous has long been a leader managing, promoting, and enhancing the herring runs in Marion and Mattapoisett. Their actions have in-

115 Herring Alliance. 2007. Empty Rivers The Decline of River Herring and the Need to Reduce Mid-water Trawl Bycatch. October 2007. Retrieved from www.herringalliance.org/images/stories/Herring_Alliance_River_Herring_Report.pdf. Last accessed October 2013.

116 Northwest Atlantic Marine Alliance and Midcoast Fishermen's Association versus United States Department of Commerce; case ongoing.

Table 28. Stream and herring restoration efforts in the Buzzards Bay watershed funded by the Buzzards Bay NEP.

Principal Calendar Year	Municipality	Buzzards Bay NEP Grant Award	Short Title	Primary or Secondary Benefits	Description / Comments / Outcome
1996	Mattapoisett	$5,000	Mattapoisett Herring Weir Reconstruction	primary	Construct a new concrete fish ladder and water control structure at the Mattapoisett River Herring Weir. Buzzards Bay NEP funds were to assist the town meet their match requirement on a larger state grant. DMF developed designs and oversaw the ladder construction.
1996	Rochester	$23,000	Snipatuit Road Culvert Replacement	primary	Replace inadequate culverts beneath Snipatuit Road to facilitate fish passage up Mattapoisett River into Snipatuit Pond for spawning.
1996	Westport	$2,241	Adamsville Herring Run Restoration	primary	Construct and install a new 30ft. Denil type fish ladder at Adamsville Pond in Westport. Buzzards Bay NEP assisted in permitting, DMF developed designs.
2001	Falmouth	$19,000	Cedar Lake Herring Restoration	primary	Culvert replacement under Chester St. Addressed some stormwater issues as well.
1998	Wareham	$35,000	Weweantic River Fish Ladder Construction at Horseshoe Pond		Buzzards Bay NEP wrote grant proposal and received funds from DEP and MET to construct a new ladder in the long defunct bypass. Project did not proceed because of failed negotiations between property owner and town.
2003	Falmouth	$16,000	Curley Blvd. Stormwater Discharge Designs	primary	Remediated discharge to Dam Pond above Wild Harbor and included culvert improvements to help herring migration.
2003	Westport	$3,500	Adamsville Pond Herring Ladder Restoration	primary	Included culvert and stream modifications.
2004	Plymouth	$15,000	Agawam River Stormwater Remediation	secondary	Reduce sediment discharges to herring stream.
2005	Fairhaven, Mattapoisett, Rochester	$73,000	Mattapoisett River Valley Aquifer Project	secondary	Multiple grants in 2004-2005 involving the purchase of lands or CRs for open space protection on hundreds of acres within water supply area, and protect stream water quality.
2005	Plymouth	$15,000	Agawam River Stormwater Remediation Project	secondary	Installation of BMPs along Mast Road with secondary benefits to stream water quality.
2006	Westport	$10,045	Cockeast Pond Culvert Replacement & Herring Run Improvement	primary	Replace defective culvert & improve fish approach on River Road. Buzzards Bay NEP assisted with permitting.
2009	Rochester	$7,500	Sippican River Sediment Sampling	secondary	The town used project funding to conduct sediment sampling on the Sippican River/Hathaway Pond and to obtain a legal opinion on water and access rights related to the removal of Hathaway Pond Dam as part of an evaluation of the feasibility of dam removal.
2009	Rochester	$20,000	Leonards Pond Anadromous Fishway Improvement	primary	Engineering/construction to replace inefficient wooden Denil fishway. May also provide passage for shad, eels, sea run trout, and river herring.
2009	Bourne	$15,000	Fishway Restoration Phase I	secondary	Survey the fishway, surrounding salt marsh and assess the feasibility of restoring the fish run.
2010	Bourne	$45,000	Herring Pond Ladder Improvements	primary	Replace collapsed culvert that is the sole entrance and exit point for a 376-acre pond that is prime herring spawning habitat.

Includes all projects completed after the completion of the 1991 Buzzards Bay CCMP.

cluded volunteer efforts to clean debris and trash from fish runs, and to enact other stream restoration efforts.

To better evaluate stream condition and the success of restoration efforts, the Buzzards Bay Coalition has organized volunteers to monitor herring runs, assist with herring counts, track the condition of herring runs, and monitor stream flows. They have also added, or will soon add, electronic fish counters to the Agawam, Wankinco, Acushnet, Sippican, and Weweantic Rivers. The Massachusetts Division of Marine Fisheries has embraced these and similar efforts and have held workshops and produced guides for the collection of data by these volunteers[117].

Most municipalities in Buzzards Bay have a herring inspector or other natural resource officer fulfilling that role. These individuals are responsible for enforcing herring catch limits, permit compliance, condition of the herring run, and sometimes maintenance of water control structures. In most instances, the demands of herring management far exceed the time availability of these municipal officers.

During the 1990s several river systems in the Buzzards Bay watershed were identified as priorities for herring restoration by DMF and the Buzzards Bay NEP including the Mattapoisett River, Weweantic River (in-

[117] Information Retrieved from www.mass.gov/eea/agencies/dfg/dmf/programs-and-projects/anadromous-fish-restoration.html. Last accessed April 22, 2013. See also Nelson (2006) at www.mass.gov/eea/docs/dfg/dmf/publications/tr-25.pdf.

cluding the Sippican River tributary), and the Agawam River. More recently, the Buzzards Bay NEP provided funding or technical assistance (in partnership with DMF) to a number of municipalities to help restore some of the of smaller herring runs including the Adamsville Pond system in Westport.

Herring Fishery

With the disappearance of the American shad from most Massachusetts rivers during the 1800s, herring became the most abundant and economically important diadromous species (Belding, 1921). Even today, blueback herring, and the alewife in particular remain, one of the most abundant of the diadromous fish. There are roughly 8,000 acres of open pond and lake systems in the Buzzards Bay watershed, but probably less than 40% of this area is accessible to alewife. A list of the ponds and major existing herring runs and habitat are shown in Table 29.

Although less important today than in past centuries, the commercial and recreational herring fishery remains relevant. Smoked or kippered herring and egg roe (served for example in omelets) remain local delicacies. Many more fish are captured as bait for recreational fisherman and lobster traps.

Prior to the 2005 moratorium on the taking of herring statewide, the taking of river herring was prohibited on Tuesdays, Thursdays, and Sundays, and they could be caught only with hand-held dip nets. River herring are also subject to additional regulations that may be imposed on the local community, and fishing may be banned from certain runs if the population is threatened.

The Mattapoisett River Herring Run

The DMF herring surveys (Reback et al., 2004a-b) contain good summaries of anadromous fish runs and impairments in the Buzzards Bay watershed, but because the Mattapoisett River run is the largest in Buzzards Bay, and considerable effort has been applied to its restoration, it is worth providing an overview of this run.

The Mattapoisett River, which begins at the 731-acre Snipatuit Pond in Rochester and flows 20 miles south to its discharge into Mattapoisett Harbor, has historically contained the watershed's most productive and abundant herring populations[118]. At the turn of the twentieth century, the river had an estimated annual sustainable yield of 3,000 barrels, or approximately 1.4 million fish, with the total fish stock estimated at 1.8 to 1.9 million fish per year, and was one of the best herring streams in the Commonwealth (Belding, 1921). During the past 30 years, the highest count observed was in 2000, with 130,000 fish, or 7% or less than the circa 1900 fish stock.

[118] Snipatuit Pond originally was connected to Quitticas Pond, but about 1755, colonists of Rochester dug a ditch to connect the Pond to the Mattapoisett River to establish a new run on that river.

Table 29. Acreage of existing Buzzards Bay alewife pond habitat.

River	Pond	Acres	Pond Primary Location
Acushnet River	Acushnet Sawmill Pond	8	Acushnet
Acushnet River	Hamlin Street	5	Acushnet
Acushnet River	New Bedford Reservoir	233	Acushnet
Agawam River	Halfway Pond	229	Plymouth
Agawam River	Pond above Glen Charlie	34	Plymouth
Agawam River	Glen Charlie Pond	168	Wareham
Agawam River	Maple Park	20	Wareham
Agawam River	Mill Pond	138	Wareham
Agawam River	Besse Bog Reservoir	34	Wareham
Agawam River	Kennard Bog	19	Wareham
Cedar Lake Ditch	Cedar Lake	21	Falmouth
Cockeast Pond Stream	Cockeast Pond	101	Westport
Gibbs Brook	Dicks Pond	47	Wareham
Herring Brook	Wings Pond	26	Falmouth
Mattapoisett River	Rochester Fish Hatchery	32	Rochester
Mattapoisett River	Snipatuit Pond	731	Rochester
Monument (Herring) River	Great Herring Pond	413	Plymouth
Monument (Herring) River	Little Herring Pond	81	Plymouth
Red Brook (Buttermilk)	White Island Pond	322	Plymouth
Red Brook Conrail Run	Red Brook Pond	19	Bourne
Richmond Pond	Richmond Pond	54	Westport
Russells Mills Pond	Paskamanset/Slocum	4	Dartmouth
Sippican River	Leonards Pond	53	Rochester
Sippican River	Hathaway Pond	19	Rochester
Wankinco River	Tihonet Pond	93	Wareham
Wankinco River	Parker Mills Pond	82	Wareham
Westport West Branch	Grays Mill Pond	3	Little Compton
Weweantic River	Horseshoe Pond	45	Wareham
Wild Harbor River	Dam Pond	7	Falmouth
Total		2,943	

Areas as reported in Reback (2004a) or as calculated by the Buzzards Bay NEP from apparent water surface boundaries, including some deep marsh area, as defined in 2009 DEP wetland conservancy maps and 2009 MassGIS aerial photographs. The area of some ponds has been variable. For example, Horseshoe Pond, which consists of roughly 32 acres of open water and 17 acres of deep marsh (circa 2009 imagery), has been variable during the past decade because of changes in water control structures. The site is also tidally influenced, and occasionally has intrusion of salt water. Some of the passages to these ponds, including Horseshoe Pond, are in poor or impaired condition. The value of pond habitat, and the biomass of fish it can sustain, is a function of pond depth (volume) and other factors. Great Herring Pond is on the boundary of the Buzzards Bay watershed and is often allocated to watersheds of Cape Cod Bay.

Local and state efforts, starting in around 1990, some partially funded by the Buzzards Bay NEP, helped allow the recovery of the herring population in the Mattapoisett River during the late 1990s. Specifically, near the river's headwater spawning area in Snipatuit Pond, five culverts beneath Snipatuit Road were undersized (30" diameter and submerged). Because herring typically migrate during daylight hours and lighted passages are required for migration, these long darkened culverts presented a significant obstacle to their upstream migration. The Buzzards Bay NEP funded solution included replacement of the small culverts with a single large box culvert, which would allow more light to reach the interior of the culvert and eliminate the existing obstacle to migration. The construction was performed by the Rochester Highway Department with guidance provided by the Massachusetts Division of Marine Fisheries.

Near the river's mouth at the Route 6 dam, additional problems were impeding fish passage on the Mattapoisett River. The fishway at the dam restricted upstream passage of alewives because it was both too steep and too turbulent. In addition, water elevations at the dam, which are controlled for municipal water supplies, required better management during normal operating conditions and during herring run season (March through May).

To accomplish these connected goals of improving the fish ladder and improving water management, the towns of Mattapoisett, Marion, Rochester, and Fairhaven joined together to seek funding for the project. Improvements to the dam structure were funded by the Commonwealth of Massachusetts with local support from each town. Additional funds for the fishway were provided by the Buzzards Bay NEP. The Massachusetts Division of Marine Fisheries helped design the Denil-type fish ladder and guide the installation efforts in December 1996.

At the time, this project resulted in a dramatic increase in herring population, and was considered a success story. While there were some improvements in the herring population to about the year 2000, (possibly due in part to the fish passage restoration efforts), the herring population began a collapse beginning in 2001 (see Figure 74). This new collapse, seen across most area fish runs, could be related to offshore fishing pressures or other factors.

The Weweantic River

The Weweantic River run is a historically noteworthy run. Until the late 1800s, river herring passed all the way up the Weweantic River to Federal Pond (36 acres), Crane Brook Pond (today 38 acres), and Sampson Pond (302 acres), and along another tributary all the way to Wenham Pond (48 acres) near the Middleborough border[119] (Figure 77). However, this run eventually was destroyed by modifications to the Tremont Pond dam[120]. At present, passage of anadromous fish only occurs in

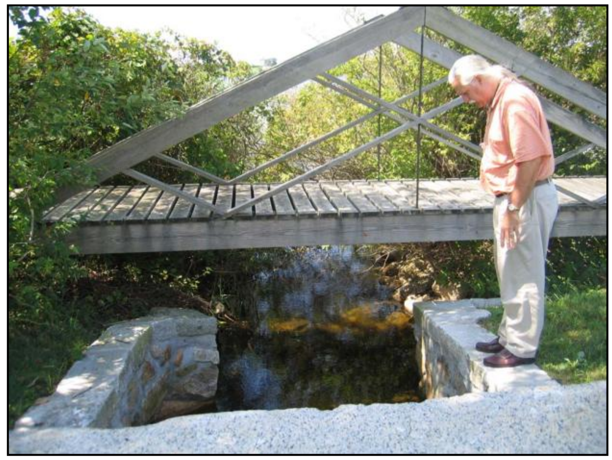

Figure 76. This water level control structure at Cockeast Pond, Westport was modified to enhance herring passage.

Many small runs need less infrastructure and cost less to restore anadromous fish passage.

Horseshoe Pond, and in the river below Tremont dam[121], although passage at the dam is considered generally ineffective (Reback et al., 2004a). The pond has become somewhat tidal because a central gate in the dam was removed sometime in the 1980s or 1990s (Figure 78).

Any anadromous fish restoration strategy for the upper Weweantic River will be defined by the restoration approach taken at Tremont Pond. That is because the dam at Tremont Pond[122] is now an insurmountable barrier to anadromous fish, cutting off hundreds of acres of ponds and dozens of miles of upstream habitat. Because water in the dam is 24 feet above stream level, either a fish elevator, or an expensive series of ladders and pools would need to be installed if the pond were to be preserved. Dam removal would only be viable if a broad consensus were developed between the town, abutters, and various agencies, and adequate financing available. Because Tremont Pond (31 acres) and all the previously mentioned former herring ponds upstream total 550 acres, a comprehensive Weweantic River anadromous fish restoration effort would increase anadromous fish habitat appreciably in the Buzzards Bay watershed.

The Weweantic River is of note because it contains the state's only rainbow smelt run with a spring taking allowed with net fishing (Reback, 2004a). Currently the smelt, which must lay their eggs in brackish water, only use the lower river to the Horseshoe Pond dam. In the 1990s, DMF had developed designs for the installation of a Denil Ladder at Horseshoe Pond (Reback, 2004a), but the project fell through because a lack of agreement with the dam owner of the time. More recently, the Buzzards Bay Coalition has purchased the dam property with

[119] See maps and sources at buzzardsbay.org/weweantic-herring-historical.html. Historical documents like Bliss (1888), Griffith (1913), and an 1815 description of the Town of Carver touch upon these historic pathways and ponds.

[120] There may have been a poorly function bypass up until the 1890s, but Belding (1921) suggested the vibrant historical Weweantic River run was all but destroyed by the creation of the first dam in the 1860s.

[121] See photos and observations reported at glooskapandthefrog.org/weweantic%20river%20revisited.htm.

[122] The dam is owned by the Town of Wareham and was once a functioning hydroelectric dam.

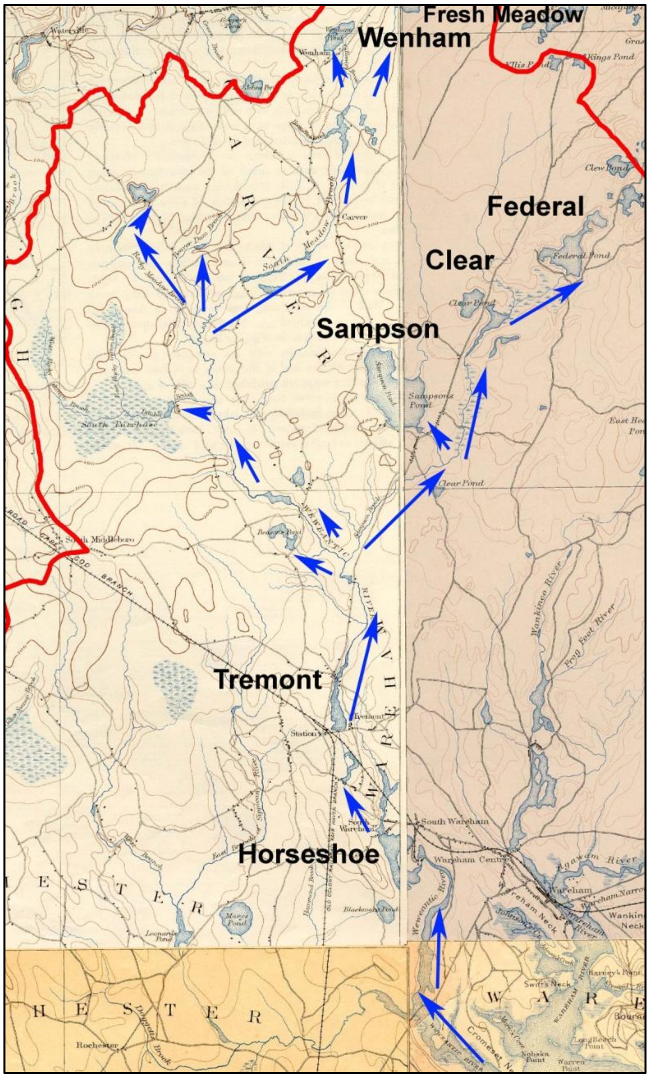

Figure 77. Likely Weweantic River diadromous fish passage prior to the 1890s.

Additional explanation at buzzardsbay.org/weweantic-herring-historical.html.

the intention of addressing the problems created by the dam, and the project is under consideration as part of the 2003 Bouchard oil spill natural resource damage restoration effort[123].

Smaller Herring Runs

There are a few small ponds in Buzzards Bay that may be used by herring and anadromous fish, and which are not in DMF's herring surveys. In fact, wherever there is a stream with unimpeded passage to a small pond, some number of river herring will attempt to travel to the pond. Some of these smaller ponds are functioning well for their size; others have various degrees of impairments.

[123] October 2, 2011 Boston Globe article, *$6M in hand, coast restoration is next*, at www.boston.com/news/local/articles/2011/10/02/oil_damage_settlement_to_be_used_to_restore_buzzards_bay/. Last accessed October 11, 2013.

Photo courtesy of Tim Watts.

Figure 78. Horseshoe dam during a spring high tide (view looking upstream).

Saltwater intrusion occurs in the pond during spring tides and storm surge conditions, allowing some fish passage.

Major Issues

Dam Removal

Dams not only impede the migration of diadromous fish, but they create environments that favor warm water and pond (lotic) spawning species, over species that favor cool water stream (lentic) habitats. As noted in ASFMC (2009), "wherever practicable, tributary blockages should be removed, dams should be notched, and bypassing dams or installing fish lifts, fish locks, fishways, or navigation locks should be considered. Full dam removal will likely provide the best chance for restoration; however, it is not always practicable to remove large dams along mainstream rivers." Whether or not dam removal is practical also depends in part on a variety of social, political, flooding, water rights, aesthetic, and other values associated with the water impoundment created by the dam (Lane, 2006). The discussion of these costs and benefits often becomes emotionally charged (Stanley and Doyle, 2003).

In this context, selecting sites for dam removal requires careful assessment to determine the costs, environmental benefits, public and private liabilities, and costs of maintaining dams that may be unsafe, whether any rare or endangered species would be affected by the loss of adjoining surface waters and bordering vegetated wetlands, and other factors. Many ponds in the Buzzards Bay watershed are agricultural impoundments, particularly cranberry bogs. Removal or alteration of these dams may involve complex water rights issues.

The removal of dams often involves an assessment of what is the natural flow regime for a particular river or stream. As noted above, the natural flow of rivers in the Buzzards Bay watershed have a long history of alteration beginning with the extirpation of beavers in colonial times, the construction of numerous mill and road dams in the 17th and 18th century, and the frequent channelization of streams through culvert installation during the expansive road construction and urbanization of the 20th century.

The cost of removing old milldams varies greatly and is site specific. Because small rivers flowing from impoundments can be impaired by many other stressors, Poff and Hart (2002) have argued that because dam removal can sometimes be expensive, and because the ecological effects of dam removal are hard to predict, "scientists need to develop a better framework for characterizing dams according to their current environmental effects, as well as to the potential environmental benefits that could accrue following removal."

Whatever management solution is selected for a particular river will affect diadromous species differently. Alewife and bluebacks are capable of spawning in a variety of freshwater environments in Massachusetts, but bluebacks tend to spawn in more riverine areas with gravel beds, whereas alewives tend to spawn in more lacustrine (ponds and lakes) areas (Nelson et al., 2011). Consequently, it has been noted that removal of dams on smaller high-order tributaries is more likely to benefit alewives rather than bluebacks or other shad (ASFMC, 2009; Waldman and Limburg 2003).

To date, only one large dam in Buzzards Bay was partially removed. In 2007, Buzzards Bay Coalition and other partners partially removed the dam at the former Acushnet Sawmill using New Bedford Superfund NRDA funds. At Hamlin Street, a series of step-pool weirs were created with granite blocks to create a fish passage system. These projects now allow river herring and American eel to better access the entire 8-mile length of the Acushnet River, the Acushnet River Reservoir, and other upstream habitats. On the Weweantic River, the removal of the dam at Horseshoe Pond was under consideration, as is the dam at Hathaway Pond on the Sippican River. Both dams are owned by the Buzzards Bay Coalition, although the Hathaway Pond dam may soon be transferred to an abutting cranberry bog operator for management for a 10-year period while water use issues are resolved.

Difficult Restoration Sites

In Belding's 1921 treatise on the alewife fishery of Massachusetts, he summarizes obstacles facing many of the runs in Buzzards Bay, including the need to construct fishways at a number of dams, or to enable passageways through certain bog systems. Many of the obstacles identified by Belding's report remain a problem 90 years later, notably including the need for fishways at Lake Noquochoke, Russells Mills, and Smith Mills dams in Dartmouth, and Tremont Pond dam in Wareham. Because of elevations at these sites, they require appreciable expenditures for ladders, perhaps approximately hundreds of thousands of dollars each. The lack of action at these sites may partly be the result of low priorities and lack of funding to municipal and state natural resource agencies. The installation of a fishway at Noquochoke is a particularly interesting case because it could also lead to access of pond habitat that did not exist in Belding's time. The 621-acre Copicut Reservoir at the headwaters of the Copicut River was not built until 1972.

Table 30. List of potential alewife pond habitat and acreage in the Buzzards Bay watershed.

River	Pond System	Acres	Primary Location of Pond
Agawam River	Half Way Pond	229	Plymouth
Bourne Pond Brook	Bourne Pond	11	Bourne
Buttonwood Brook	Buttonwood Park Pond	10	New Bedford
East Branch Westport	Copicut Reservoir	621	Dartmouth
East Branch Westport	Cornell Pond	16	Dartmouth
East Branch Westport	Lake Noquochoke	181	Dartmouth
East Branch Westport	Forge Pond Dam	4	Dartmouth
Mattapoisett River	Tinkham Pond	22	Mattapoisett
Paskamanset/Slocum	Smith Mills Dam	5	Dartmouth
Paskamanset/Slocum	Turner Pond	95	Dartmouth
Pocasset River	Mill Pond	1	Bourne
Pocasset River	Shop Pond	2	Bourne
Pocasset River	The Basin	2	Bourne
Pocasset River	Freeman & Upper Pond	4	Bourne
Wankinco	East Head Pond	85	Plymouth
Weweantic River	Sampson Pond	302	Carver
Weweantic River	Federal Pond	126	Plymouth
Weweantic River	Crane Brook Bog Pond	38	Carver
Weweantic River	Dunham Pond	49	Carver
Weweantic River	Wenham Pond	48	Carver
Weweantic River	Tremont Mill Pond	36	Wareham
Total		1,717	

The Buzzards Bay NEP calculated areas based on water surface boundaries, including some deep marsh area, as defined in 2007 DEP wetland conservancy maps. Some of these ponds, like those on the Weweantic River and Westport East Branch would never become accessible without overcoming the first dam on each system (Tremont Pond and Lake Noquochoke dams respectively), and even then, each subsequent pond may pose its own special set of obstacles. The value of pond habitat, and the biomass of fish it can sustain, is a function of pond depth (volume) and other factors.

Minor versus Major Habitat

As noted in the Division of Marine Fisheries Herring Atlas: "With a small number of exceptions, the important river herring spawning/nursery habitats on coastal streams have been made accessible through the construction of fishways. Many of these structures have become deteriorated and are often of obsolete design. The emphasis of future work should be on the replacement of these fish ladders in order to preserve or augment the populations they serve rather than to create new populations by accessing minor habitats" (Reback et al., 2004a). DMF prioritizes sites based on habitat quantity and quality and assessments of potential herring spawning and nursery habitat, the likelihood of success, and restoration potential and feasibility.

While this approach and policy makes sense from the state level in terms of allocating state resources, from the municipal perspective, some communities may host a number of impaired "minor habitats," and they may have a strong desire to restore these sites. Small pond systems often have small costs associated with their repair (culvert replacements, one or two-step concrete ladders). Adding fish passageways to some of these small pond systems could add hundreds of acres of alewife habitat to the Buzzards Bay watershed, so creating access to these ponds has merit. For example, the Buzzards Bay NEP funded two small herring projects in Falmouth, and one in Westport for a cumulative cost of $10,700 (Table 28). Cumulatively the surface area of minor ponds in Buzzards Bay exceeds the area of all the great ponds combined, although admittedly, many of these small ponds do not have the habitat quality of the larger systems, and with their smaller volumes, sustain less fish biomass than larger systems. Ultimately, the costs and benefits must be weighed in the face of limited availability of restoration funds at the local and state government.

Most large coastal freshwater systems in the Buzzards Bay watershed now have migratory fish access (with some notable exceptions like the upper Weweantic River) and improving deteriorated or poorly functioning structures will likely provide the greatest benefits at the least cost (per fish restored). Nonetheless, many of the larger restoration projects remain difficult to implement because of the high costs (e.g. Tremont Dam).

Water Management Issues and Bog Operations

Concerns are often raised about the potential impact of cranberry bog operations on herring passage and survival. As noted in the DMF herring reports (recommendations in Table 31), "large numbers of young herring are killed each year due to cranberry bog operations" (Reback, 2004a-c). Some of the past impacts could have been avoided by simple and inexpensive screening systems on water intakes and flumes. This led DMF to recommend that withdrawal permits issued by the state not only ensure that there is adequate flow in rivers during juvenile fall downstream migrations, but that permittees use appropriate screening of water withdrawal intakes to prevent stranding, mutilation, entrainment or impingement of young herring. Because of these concerns, in 2004 the Cape Cod Cranberry Growers Association worked with DMF and issued a grower advisory on protecting anadromous fish[124]. The advisory includes recommended practices for ensuring the springtime passage of adults and the fall passage of juveniles. Included in the advisory is a formula for sizing screens to prevent juveniles from being injured by the screen, and how to remove fry that have entered a bog.

While there has been increased awareness of the problem, and cranberry growers increasingly have implemented these practices, sometimes they have not. For example, in October 2010, thousands of juvenile herring were killed during harvesting in a North Falmouth cranberry bog[125].

The DMF has stressed that local officials and property owners often ignore the downstream passage of adults and juveniles, and juvenile mortality in particular can be an important limiting factor in population productivity. An often-reported impact is that water withdrawals or diversions can strand or kill thousands of juvenile fish. DMF (2004) notes "Large numbers of juvenile herring are killed each year due to cranberry bog operations. A simple, inexpensive screening system has been developed which will prevent most of these losses. Despite publicizing the availability of this system through industry media, growers have been reluctant to utilize it. Appropriate screening of water withdrawal intakes to prevent stranding, mutilation, entrainment, or impingement of young herring should be made a condition of any state permits required for the agricultural operation."

A related problem is that of strandings or cessation of stream flows that may be caused by heavy summer and fall withdrawals by municipal water suppliers or cranberry growers that cause the cessation of stream flow, or drops water levels in ponds that preclude juvenile migration. The issue is becoming increasingly problematic on the Mattapoisett River where continuing large municipal withdrawals during drought years, coupled with water diversions for cranberry operations have caused the river to run dry during critical herring migration periods. In Massachusetts, among 39 fish kills investigated in 2011, four were caused by "human-induced low-water conditions."[126] This issue has prompted DEP to initiate a Streamflow Criteria Workgroup to address this and other streamflow problems. Additional discussion of the topic is found in Action Plan 10 Managing Water Withdrawals to Protect Wetlands, Habitat, and Water Supplies.

Other Issues Identified by DMF

As noted in various DMF reports, river herring fisheries are mostly under local control through the authority granted by Section 94 of Chapter 130. Many towns however, are unaware that changes in their local regulations

[124] Retrieved from www.cranberries.org/pdf/advisories/fish_advisory.pdf. Last Accessed October 1, 2013.

[125] Gouveia, A. 2010. Cranberry grower charged in herring kill. Cape Cod Times. December 28, 2010. Retrieved from www.capecodonline.com/apps/pbcs.dll/article?AID=/20101228/NEWS/12280311/-1/rss02.

[126] Annual Report 2011. Massachusetts Division of Fisheries & Wildlife, 94pp.

must be approved of the Director of the Division of Marine Fisheries. In their 2004 report (Reback, 2004a-c) DMF recommended that "In order to insure biologically sound and legally valid local management, the Director should inform cities and towns of this condition and request them to submit current regulations and subsequent changes for approval."

Accidental release of pesticides from agricultural lands causing dramatic losses of juveniles is another recurring problem.

Shoaling of pond outlets and encroachment of vegetation has affected river herring populations in some systems. The deposition and shoaling of sediments, in combination with late season water levels has prevented the migration of large portions of juveniles. Increased water drawdowns by agriculture or public water supplies (both groundwater and surface waters) often exacerbate these problems. At sites with these recurring problems, DMF recommends the installation and maintenance of outlet structures that would retain depth, reduce deposition, and provide for easier maintenance. The emphasis of diadromous fish management in coastal streams has focused on river herring and American shad. Consequently, little is known about white perch, rainbow smelt, and tomcod populations in the Commonwealth. DMF has recommended that more resources should be directed toward these species and management strategies that would protect them be developed. The stocking of shad has been largely unsuccessful in Massachusetts. The Division of Marine Fisheries has recommended development of a program similar to that successfully adopted in other states of taking eggs by constructing a hatchery to rear fish to fry size before their release. This technique, however, may not be applicable to river and tributary habitat of Buzzards Bay.

Obligations and responsibilities of dam owners

MGL Chapter 130 Sections 19, 93, and 94, states that private property owners have the responsibility to provide fish passage if required by the Director of DMF. In recent years, repair mandates and enforcement actions against dam owners has been rare. Property owners need to be made better aware of their responsibilities defined in this statute. Property owners should also be made aware that their financial burdens could be ameliorated by state and federal restoration grants and technical assistance.

Management Approaches

Because offshore bycatch appears to be the one of important contributors to river herring population declines in Massachusetts, it should be an important focus of fisheries research and regulatory agencies. Management of bycatch is complex and requires action, controls, and coordination of the New England and Mid-Atlantic Regional Fisheries Management Councils, the Atlantic

Table 31. General recommendations for Massachusetts herring restoration.

From Reback et al., 2004b (with minor editing).

1. With a small number of exceptions, the important river herring spawning/nursery habitats on coastal streams have been made accessible through the construction of fishways. Many of these structures have become deteriorated and are often of obsolete design. The emphasis of future work should be on the replacement of these fish ladders in order to preserve or augment the populations they serve rather than to create new populations by accessing minor habitats.

2. Most river herring fisheries are under local control through the authority granted by Section 94 of Chapter 130. Many towns having this control, however, are unaware that approval of the Director of the Division of Marine Fisheries is required by the statute and often change their regulations without consulting DMF. In order to insure biologically sound and legally valid local management, the Director should inform cities and towns of this condition and request them to submit current regulations and subsequent changes for approval.

3. River herring passage issues have dealt primarily with upstream migration of adults. Downstream passage of adults, and more importantly juveniles, has been largely ignored, and in some systems may be an important limiting factor in population productivity. Future work should take this into consideration and place appropriate emphasis on this phase of the life cycle and the problems that are associated with it.

4. Large numbers of juvenile herring are killed each year due to cranberry bog operations. A simple, inexpensive screening system has been developed which will prevent most of these losses. Despite publicizing the availability of this system through industry media, growers have been reluctant to utilize it. Appropriate screening of water withdrawal intakes to prevent stranding, mutilation, entrainment, or impingement of young herring should be made a condition of any state permits required for the agricultural operation.

5. Shoaling of pond outlets and encroachment of vegetation has seriously affected river herring populations in some systems. Deposition of sandy material at the outlets in combination with low late summer/fall water levels has prevented the escapement of large segments of year classes and caused them to be lost to the population through winterkill or greatly reduced growth rates. Outlet structures that would retain depth, reduce deposition, and provide for easier maintenance, should be developed and installed at stream outlets where appropriate.

6. The emphasis of anadromous fish management in coastal streams has been on river herring, American shad and rainbow smelt. Consequently, little is known about white perch and tomcod populations in the Commonwealth. In the future, more attention should be directed toward developing more protective management strategies for these species.

7. Several large coastal streams, notably the Taunton, Charles, and Neponset Rivers, appear to have excellent potential for development of American shad populations. Many years of stocking with adult fish and eggs have yielded negligible results, however. Other states have had success through hatchery egg taking and rearing to fry size before release. This technique should be developed in Massachusetts and applied to the above streams.

8. Removal of dams should be considered as an alternative to fishway construction where appropriate.

States Marine Fisheries Commission, and the NOAA National Marine Fisheries to limit the catch and bycatch of river herring in offshore waters. This also means the New England and Mid-Atlantic Fishery Management Councils would need monitor more effectively the river herring bycatch. To protect river herring, the Secretary of Commerce should consider taking emergency action to implement these new measures where actions can be supported by research.

Because a large area of upstream habitat remains inaccessible in the Weweantic River watershed, DMF should consider and evaluate the fish ladders, bypasses, and dam removal options at Horseshoe Pond and the Tremont Pond dam. A fish elevator at Tremont Pond may cost hundreds of thousands of dollars, but the costs of dam removal may be higher and might involve the loss of dozens of acres of pond.

Water diversion and pumping for agricultural purposes is one of the most significant causes of juvenile herring fatalities. Simple requirements like requiring screens on intakes can greatly mitigate these impacts. Better management of water withdrawals is needed on some Buzzards Bay watershed rivers and tributaries. DEP could require, as a condition in all state water withdrawal permits, that there is adequate flow in rivers during juvenile fall downstream migrations. Permittees should always be required to use appropriate screening of water withdrawal intakes to prevent stranding, mutilation, entrainment, or impingement of young herring. The costs for the state to implement such requirements are negligible, and would be modest for water withdrawal permittees. Adoption of new rules and regulations could be achieved within two years of initiation of such an effort.

Many smaller herring runs may be a priority for restoration by municipalities, even though they may not be a priority by the state for funding. DMF already provides local assistance, but due to workforce and financial constraints, restoration of minor habitat is a low priority. While the state does not have the personnel and funding to restore the many lesser anadromous fish passageway impairments in the Buzzards Bay watershed, municipalities interested in restoring minor anadromous fish habitats should seek guidance from DMF on restoration strategies and secure local sources of funding.

The legislature should dedicate more funding to DMF to undertake its mandates and to fund more investigations of white perch, tomcod, sea run brook trout, and other less well studied anadromous and stream fish populations. Additional staff may be needed to conduct research and monitoring, and the effort might be undertaken in collaboration with university research studies.

DMF and municipal natural resource officers should identify juvenile herring impairment sites and develop written guidelines. They should develop Fishway Operations and Maintenance Plans for each ladder in partnership with relevant growers and property owners, to implement practices to minimize the stranding or destruction of juvenile and adult migrating fish. A watershed evaluation and GIS database could be used to track trouble sites, and would be a useful planning tool for all levels of government. This effort could be undertaken with existing staff. Site-specific written guidelines could help ensure compliance with adopted strategies and promote a better understanding of the problems and solutions for each site. Agreements could also be developed between town natural resource agencies and the property owner. NGOs could facilitate agreements.

Financial Approaches

The regulatory solutions identified in this action plan have negligible costs to government and modest costs to those with water withdrawal permits. Government (state and local) needs to provide some additional funding for natural resource staff and restoration projects. Most of the costs of this action plan are to develop and implement designs to eliminate or repair fish passageway structures and obstacles. These costs could be met through state and federal wildlife and habitat restoration grants, and local funding could be met through town meeting, or local grant programs under the Community Preservation Act. Private dam owners should be made better aware of their responsibilities under MGL Chapter 130 to provide and maintain fish passage, and encouraged to partner with municipalities and the state to attract funding from state and federal sources.

Monitoring Progress

The success of measures undertaken under this action plan can be measured by tracking the abundance of anadromous fish traveling upstream. These counts can be determined through automated fish counters and by the use of volunteers to undertake field counts on representative dates and times. The installation of a fish counter on a particular stream might cost up to $40,000, and federal grants might be available for such devices.

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