A Summary of Volunteer River Herring Counts in Massachusetts, 1997-2011

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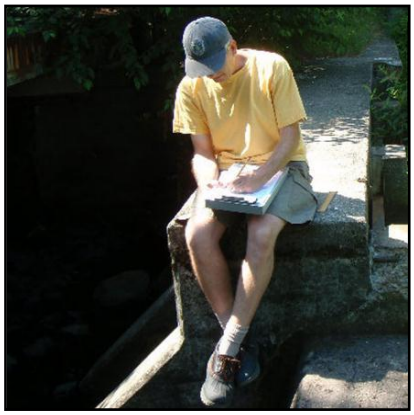

ABSTRACT

This report summarizes run size estimates of river herring runs in Massachusetts calculated from volunteer herring count data using methodologies and "Visual Counts" software developed by the Massachusetts Division of Marine Fisheries (Nelson 2006). Many river herring runs in Massachusetts have declined precipitously in recent years. In response to the decline, a number of watershed associations and herring wardens began conducting volunteer fish counts to better track the size of individual herring runs. While video counts and electronic counters have been used to estimate river herring run size, visual counts of migrating adult herring is the most commonly used method in the state. This document reports estimates of herring run size calculated using visual count data collected by volunteer groups. The purpose of the report is to quantify estimates of river herring run sizes between 1997 and 2011 for use by fisheries managers and biologists, restoration specialists, herring wardens, watershed associations, and concerned citizens.

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INTRODUCTION

The term "river herring" refers to two species of anadromous fish: the alewife (*Alosa pseudoharengus*) and blueback herring (*Alosa aestivalis*). Both species live in the ocean but spawn in fresh water. They grow to about a foot in length and full-grown adults typically weigh between half a pound and a pound. The major difference between the two species is behavioral: alewives generally spawn in ponds and other slow-moving bodies of water while blueback herring spawn in more riverine areas. In New England, alewives usually spawn between late March and early June while blueback herring start to spawn in late April through June. River herring have been shown to return to their natal systems to spawn. Females lay between 50,000 to 100,000 eggs yearly, though only a small percentage survive to adulthood (maturity occurs between three to five years of age). Both alewives and blueback herring are repeat spawners. River herring are two species that provide forage for a number of other animals including birds, snapping turtles, commercially and recreationally important fish species such as cod (*Gadus morhua*), striped bass (*Morone saxatilis*), and other fish and wildlife species (Nelson et al 2006). More than 100 coastal rivers and streams in Massachusetts are used by river herring as spawning habitat.

Historically, river herring were a significant and abundant fishery for both Massachusetts' native tribes (including the Wampanoag, Massachusett and others) and European colonists who used them for fertilizer and food. One 18th century colonist even described river herring as "a sort of fish appropriated by Divine Providence to Americans… for their reliefe" (Hanna 2007). Witnessing their great numbers, Captain Charles Whitbourne wrote in The Travels of Captain John Smith: "in April there is a fish much like a herring that comes up into the small brooks to spawn, and when the water is not knee deep they will press up through your hands, yea, thou you beat at them with cudgels, and in such abundance as incredible" (Whitbourne 1616).

River herring populations in recent decades have not been nearly as robust as those reported in colonial times. Declines have been linked to widespread construction of barriers to migration over the last two to three centuries, habitat and water quality degradation, over-exploitation of the stock, increased predation by striped bass and other predators, poaching, and bycatch in the Atlantic herring and other small mesh fisheries like those for mackerel and whiting. However, populations have declined even further in the last decade to alarmingly low levels. In 2005, the Massachusetts Division of Marine Fisheries (MA DMF) announced a moratorium on taking river herring, a restriction that was renewed from 2008 through 2011 and then exptended indefinitely in 2012. Similar moratoriums were enacted in Connecticut (2002), Rhode Island (2006) and North Carolina (2007). In 2006, river herring were declared a "Species of Concern" by the National Marine Fisheries Service due to observed declines across the range of river herring runs from North Carolina to Maine (blueback herring are found as far south as Florida). In 2011, the Atlantic States Marine Fisheries Commission (ASMFC) implemented a recreational and commercial fishing moratorium (Amendment 2 of the ASMFC fisheries management plan for shad and river herring), and beginning January 1, 2012 all river herring fisheries from Maine

through South Carolina will be closed unless states submit an approved "Sustainable Fisheries Plan." On August 1, 2011, the Natural Resources Defense Council petitioned the National Marine Fisheries Service (NMFS) to list both alewives and blueback herring as "threatened" species under the Endangered Species Act, and both are currently being reviewed for listing.

MA DMF has been utilizing electronic fish counters to estimate run size in several sentinel systems for many years and has also been working with researchers to develop videocamera imaging to count herring. However, these counting methods have only been installed in a handful of fish runs throughout the state (e.g., the Nemasket River, Mattapoisett River, Monument River and a few others). Meanwhile, a number of towns and citizen groups have been collecting visual count data from herring runs for several years using a visual count method designed by MA DMF (Nelson 2006) that can be conducted by trained volunteers using simple, inexpensive equipment. Visual count data can therefore provide another important source of information on river herring populations and migration characteristics such as timing, water temperature and other environmental factors. Finally, visual counts provide opportunities for engaging citizens in monitoring, thereby helping to build public support for restoration and protection of these important runs.

We anticipate that this will be the first in a series of annual reports summarizing estimates of herring run size in Massachusetts based on visual count data. These estimates can help improve the management of river herring both state-wide and in individual runs, provide an indicator of the success of restoration projects, and foster greater public interest in river herring in Massachusetts.

METHODS

Count data were obtained at seventeen river herring runs (Figure 1) by various watershed associations, herring wardens, and other river herring count program managers. These data were analyzed using MA DMF's Visual Counts software. More detailed information about this program can be found in Nelson (2006). Eleven of the runs had sufficient data for run size estimates to be calculated. Runs or years without a minimum of two mean counts per day during the count season were not analyzed due to a lack of sufficient data.

In most cases, count data were less than ideal, with common issues being:

- Double counts;
- Non-uniform time periods;
- Time of the count (AM / PM) was not specified; and
- Data did not fit the DMF format for use with Visual Counts

Where such issues occurred, the count data were adapted to be usable by the Visual Counts program. Since non-random double counts do not fit the prerequisite of randomly-selected sampling units, one of every double count (defined as being two or more counts by the same counter or pair of counters less than 30 minutes apart) was removed. Count data collected before the run season began and after it ended were not used in the analysis. The number of mean counts per day was calculated in order to determine which model to use. The model was selected according to the criteria that every period requires a minimum of two counts. Thus:

- the one-way stratified random sampling model was used if a count in any given year had at least 2 and less than 4 mean counts per day;
- the two-way stratified random sampling model with two periods was used if the count had at least 4 and less than 6 mean counts per day; or
- the two-way model with three periods was used if the count had 6 or more mean counts per day.

Each location (Figure 1) was analyzed separately, with individual reports grouped by region (North Shore, South Shore, and Cape Cod). Annual run estimates were graphed (+ or – standard errors) and visually analyzed. Additionally, text describing the watersheds is included for each herring run. Run size trends are described qualitatively in the results but no statistical trend analyses were carried out.

There are several factors that may reduce the accuracy of the estimates contained in this report. First, it is likely that some counters mistook other fish for river herring, inflating the run size estimate. Second, the Visual Counts software assumes that river herring only migrate during daytime hours, meaning that if large numbers of river herring are migrating at night as has been

observed in the Coonamessett River in Falmouth, the software may be greatly underestimating run sizes.

Figure 1. Map of Massachusetts river herring runs with volunteer fish count programs in 2011.

RESULTS

Table 1 on the following page summarizes the river herring run size estimates calculated using Visual Counts. Only runs with sufficient count data for analysis are listed.

Data available for each run ranged from one year (Cedar Lake and the Mashpee River) to 15 years (Parker River). In 2011, the Ipswich River, Marstons Mills River and Little River had estimates of less than 1,000 fish, while four runs had estimates of between 1,000 and 10,000 fish (Parker River, Jones River, Cedar Lake and the Wellfleet Herring River). Only two runs had an estimated run size of between 10,000 and 100,000 fish (the Harwich Herring River and Stony Brook), while two others had estimates of more than 100,000 for 2011 (Town Brook and the Mashpee River).

Though no statistical tests were performed to determine the significance of run size variation between years, it is possible to generally describe whether run estimates seem to be increasing or decreasing. Of the nine runs with sufficient data for more than one year, two suggest increasing annual trends: the Jones River and Stony Brook. Town Brook had a seemingly insignificant downtrend, while the Harwich Herring River does not have enough years of data to discern a pattern. The Parker River, Ipswich River, Little River, Marstons Mills River, and Wellfleet Herring River all appear to be declining based on the Visual Counts estimates. The most dramatically declining run was the Marstons Mills River, down in 2011 to 1% of the 2008 run size estimate.

Year	Parker River	Ipswich River	Little River	Jones River	Town Brook	Cedar Lake	Mashpee River	Marstons Mills River	Herring River, Harwich	Stony Brook	Herring River, Wellfleet
1997	6,815 ± 712	no count	no count	no count	no count	no count	no count	no count	no count	no count	no count
1998	5,440 ± 773	no count	no count	no count	no count	no count	no count	no count	no count	no count	no count
1999	8,513 ± 1,959	949 ± 556	no count	no count	no count	no count	no count	no count	no count	no count	no count
2000	16,740 ± 2,155	440 ± 92	no count	no count	no count	no count	no count	no count	no count	no count	no count
2001	2,958 ± 543	1,255 ± 250	8,664 ± 1,813	no count	no count	no count	no count	no count	no count	no count	no count
2002	10,458 ± 2,764	2,726 ± 1,529	3,370 ±1,026	no count	no count	no count	no count	no count	no count	no count	no count
2003	15,208 ± 9,787	668 ± 200	886 ± 133	no count	no count	no count	no count	no count	no count	no count	no count
2004	Insufficient data	Insufficient data	0	no count	no count	no count	no count	no count	no count	no count	no count
2005	1,684 ± 474	691 ± 96	1,263 ± 201	804 ± 176	no count	no count	no count	no count	no count	no count	no count
2006	Insufficient data	677 ± 200	Not enough data	1,843 ± 202	no count	no count	no count	6,482 ± 556	no count	no count	no count
2007	Insufficient data	213 ± 72	306 ± 89	2,651 ± 408	no count	no count	no count	15,136 ± 806	no count	22,348 ± 1,275	no count
2008	742 ± 150	2,125 ± 437	1,268 ± 366	560 ± 117	168,966 ± 31,686	no count	no count	43,948 ± 2199	no count	25,289 ± 2,938	no count
2009	3,754 ± 870	1,603.5 ± 226	3,431 ± 556	637 ± 91	155,015 ± 13,828	no count	no count	11,668 ± 863	19,336 ± 1,935	11,062 ± 1,185	21,870 ± 3,976
2010	2,799 ± 632	268 ± 91	not collated	4,512 ± 259	195,091 ±11,266	no count	no count	4,174 ± 419	41,254 ± 4,966	48,099 ± 2,172	12,052 ± 1,595
2011	3,624 ± 535	663 ± 194	956 ± 197	3,597 ± 257	142,633 ± 11,487	9,399 ± 1,485	114,988 ± 19,626	494 ± 64	10,466 ± 1,162	37,091 ± 1,185	9,534 ± 1,640

Table 1. Summary of estimated herring run sizes in various river systems in 2011, based on "Visual Counts" analysis.

North Shore

Figure 2. Map of North Shore river herring runs with volunteer fish count programs.

Parker River

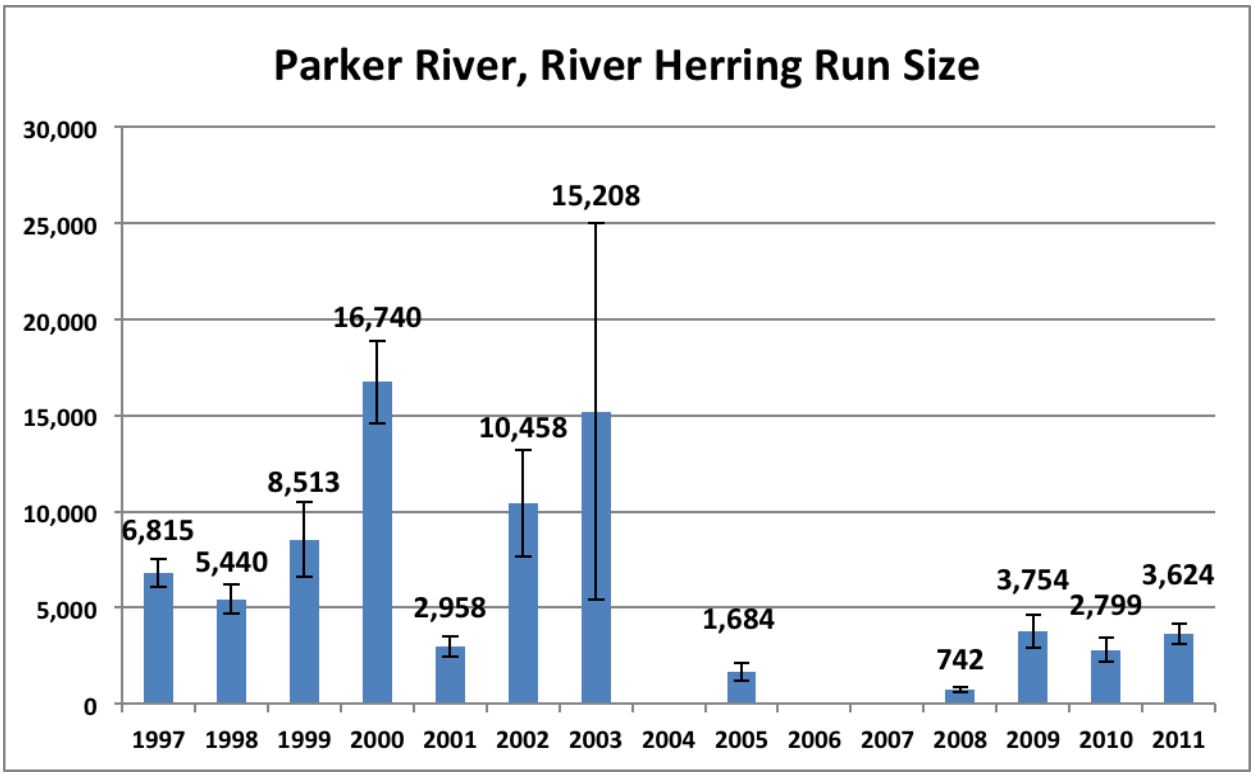
The 21-mile Parker River begins at the confluence of two unnamed streams in West Boxford and flows into Plum Island Sound in Newbury. It is one of the largest tributaries to the Sound, and provides habitat for blueback herring, alewives, rainbow smelt, brook trout and eels as well as other fish species. The Parker River provides **248 acres** of river spawning habitat in its headwaters of Crane Pond, Pentucket Pond, Rock Pond and others.

The Parker River in Newbury, courtesy of National Scenic Byways Online (www.byways.org).

There are six dams along the course of the Parker River between Plum Island Sound and the river's main spawning grounds in Pentucket Pond: the Central Street and Larkin Road Dams in Newbury, the Snuff Mill, Main Street and River Street Dams in Byfield, and the Pentucket Pond Dam in George-town. All dams are equipped with fish ladders, though many are in poor condition. The primary fish count for Parker River takes place at the Central Street Dam.

Run size estimates

The estimated size of the 2011 Parker River herring run was **3,624 ± ~248**. In the 1970's, the Parker River run size ranged from an estimated low of 6,654 in 1977 to a high of 38,163 in 1973 (Purinton et al 2003).



Ipswich River

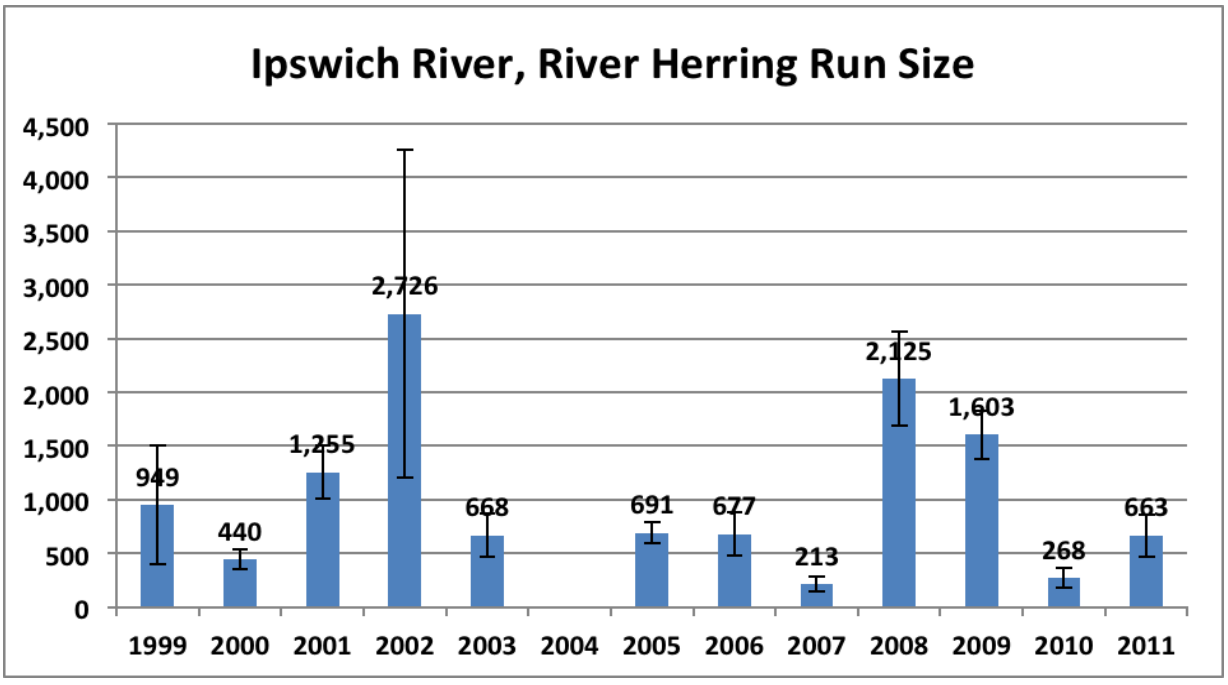
The Ipswich River is a 34-mile-long stream that originates at the confluence of Lubber and Maple Meadow Brooks in Wilmington and flows into the Atlantic Ocean at Ipswich Bay. The river provides spawning potential for river herring as well as other anadromous fish species such as American shad, and would provide approximately **278 acres** of river herring spawning habitat if free of obstructions.

The Ipswich River in winter.

There are three dams along the main stem of the Ipswich River: the Ipswich Mills/Sylvania Dam, the Willowdale Dam, and the Bostik Dam. The Ipswich Mills Dam is fitted with a relatively new concrete Denil fish ladder with wooden baffles, while the Willowdale Dam has an older, less efficient concrete notched weir-pool fish ladder. The Bostik Dam has no fish ladder and is not passable. The Ipswich River fish count takes place at the Ipswich Mills Dam.

Run size estimates

The estimated size of the Ipswich River run in 2011 was **663 ± ~194**. In 2004, not enough data were calculated to generate a run estimate. MA DMF used a trap to obtain absolute counts of run size in 2006, 2007, 2008, and 2009, finding 377, 158, 131 and 187 river herring for each year, respectively. These absolute counts reveal that Visual Counts may have overestimated run size in 2006 and particularly in 2008/2009, perhaps due to the difficulty of distinguishing between river herring and other fish at this site.



Little River

The Little River, looking downstream from Rt. 133.

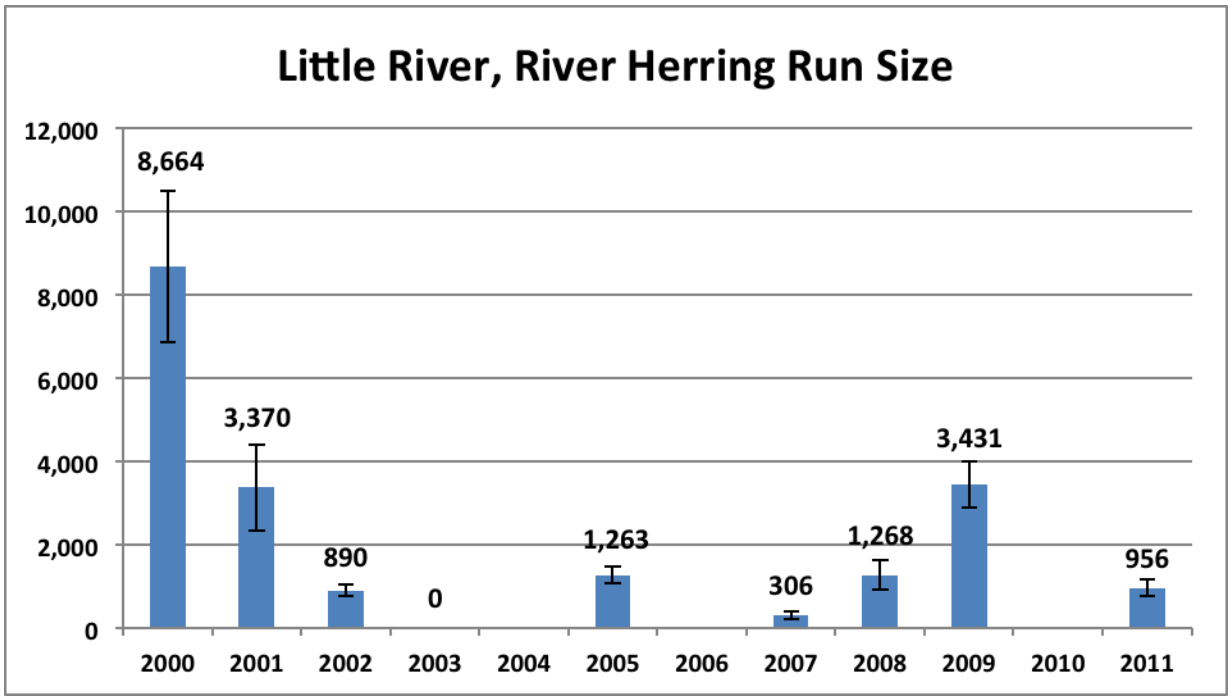
The Little River runs about 4 miles through Gloucester, Massachusetts, from 34-acre Lily Pond and 110-acre Dykes Pond into the Annisquam River estuary. The river provides **34 acres** of river herring spawning habitat since Dykes Pond is not currently accessible.

The West Gloucester Water Treatment Plant, built in the 1960's, is the largest obstruction to fish passage on the river. A notched weir-pool fish ladder winds along the side of the site. Finally, stone stream baffles and a wooden Denil fish ladder allow migrating river herring to access Lily Pond.

Run size estimates

Based on visual count data, the estimated size of the 2011 Little River run was **956 ± ~196**, more than the estimate for 2007 but less than those for 2008 and 2009.

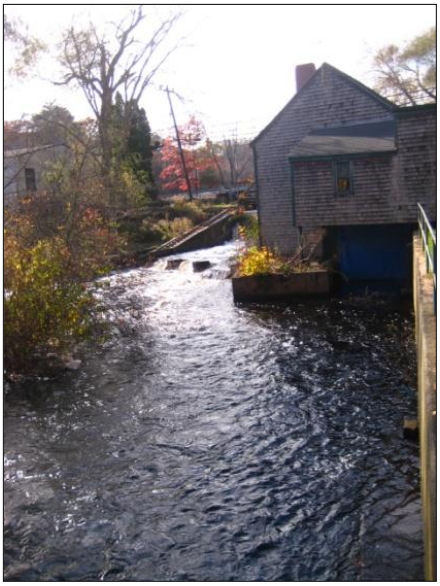
The Little River herring run declined from an estimated high of 8,664 in 2000 to between 300 and 3,500 in the past decade. In 2003, counts were taken but no fish were seen. Lily Pond was stocked with 1,300 alewives by the Division of Marine Fisheries in 2003 and 1,500 alewives in 2004. Data were collected though not analyzed in 2010. No count data were collected in 2004, and not enough data were collected in 2006 to calculate a run size estimate.



South Shore

Figure 3. Map of South Shore river herring runs with volunteer fish count programs.

Jones River



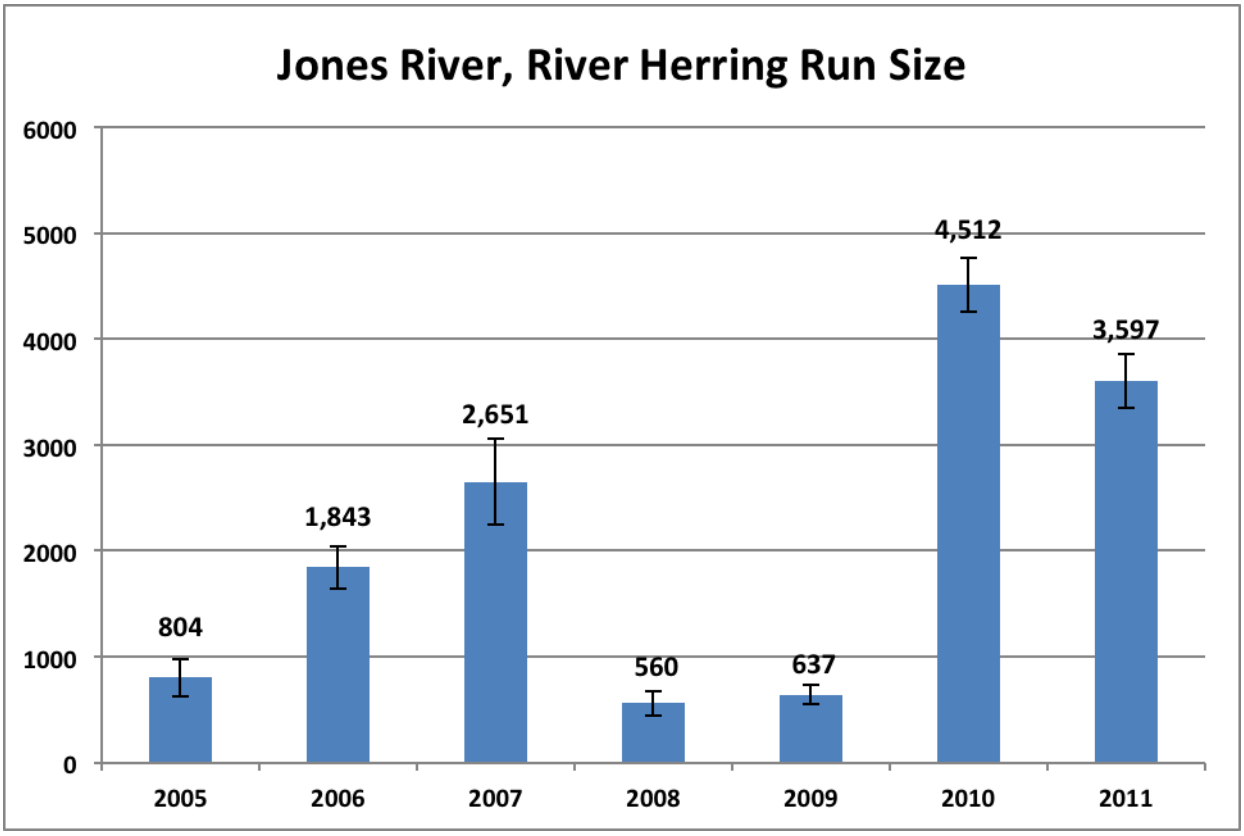
The Elm Street fish ladder.

The Jones River runs about 7.5 miles through the town of Kingston, Massachusetts from its headwaters in Silver Lake to Kingston Bay. It is one of the largest watersheds draining to Cape Cod Bay, and with fish passage fully restored, would provide **640 acres** of spawning habitat in Silver Lake in addition to the river's other tributaries.

Two dams currently stand between river herring and their spawning grounds in Silver Lake: the Elm Street Dam and the Forge Pond Dam. The Elm Street Dam is the first obstacle to fish passage, though it is fitted with an efficient Alaskan steep-pass fish ladder (installed in 2001). The Wapping Road Dam was recently removed (August 2011), making Forge Pond Dam the last completely impassable impediment to river herring passage to Silver Lake in the Jones River system.

Run size estimates

The estimated size of the 2011 Jones River herring run was **3,597 ± ~257**. This is less than the estimate from last year but more than estimates for 2005-2009.



Town Brook

Town Brook in Brewster Gardens.

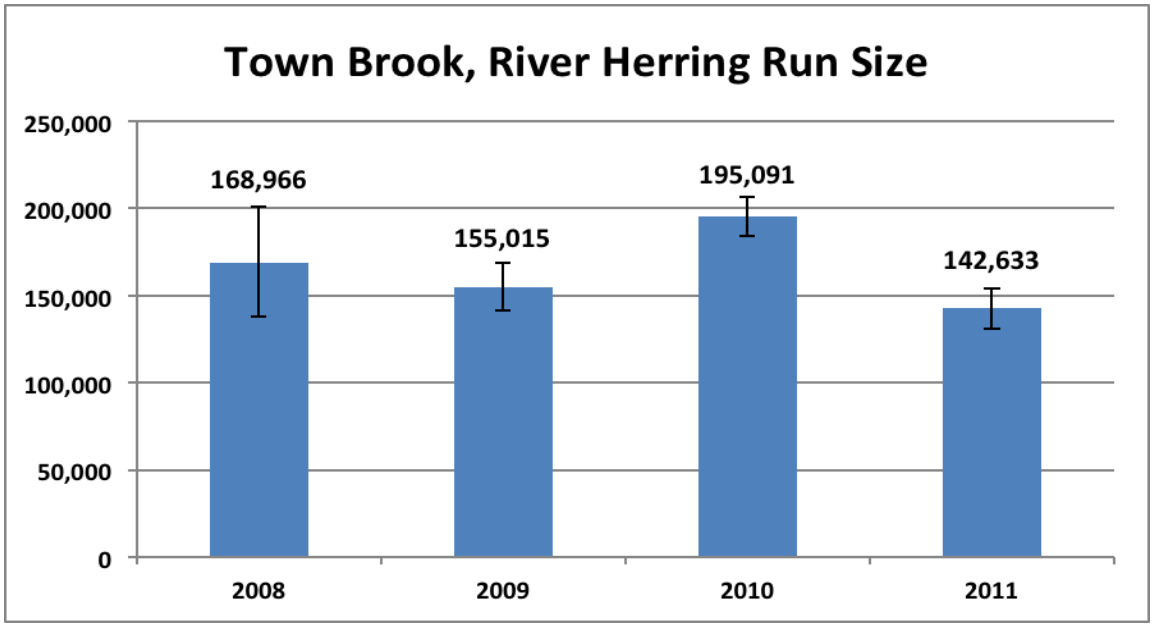
Town Brook is a stream in Plymouth, Massachusetts that runs about 1.5 miles from its headwaters in Billington Sea to Plymouth Harbor.

Once the historic herring run of the Pilgrims and the Patuxet Wampanoag, Town Brook is currently dammed or obstructed at six locations: the Water Street Dam, the Jenny Grist Mill Dam, the Newfield Street Dam, the Off Billington Street Dam, the Plymco Dam, and the Morton Park bog sluice.

The stream has been the focus of restoration efforts since 2000. An Alaskan steep-pass fish ladder was installed at the Newfield Street Dam in 2001, the Billington Street Dam (a seventh obstruction) was removed in 2002, the Water Street Dam was lowered by 18 inches in 2006, and the old fish ladder at the Jenny Grist Mill Dam was refitted with an Alaskan steep-pass insert in 2007. Town Brook's headwater pond of Billington Sea provides **270 acres** of river spawning habitat in addition to intermediary spawning areas.

Run size estimates

Based on visual count data, the estimated size of the 2011 Town Brook run was **142,633 ± ~11,487**.



Cape Cod

Figure 4. Map of Cape Cod river herring runs with volunteer fish count programs analyzed as part of this study.

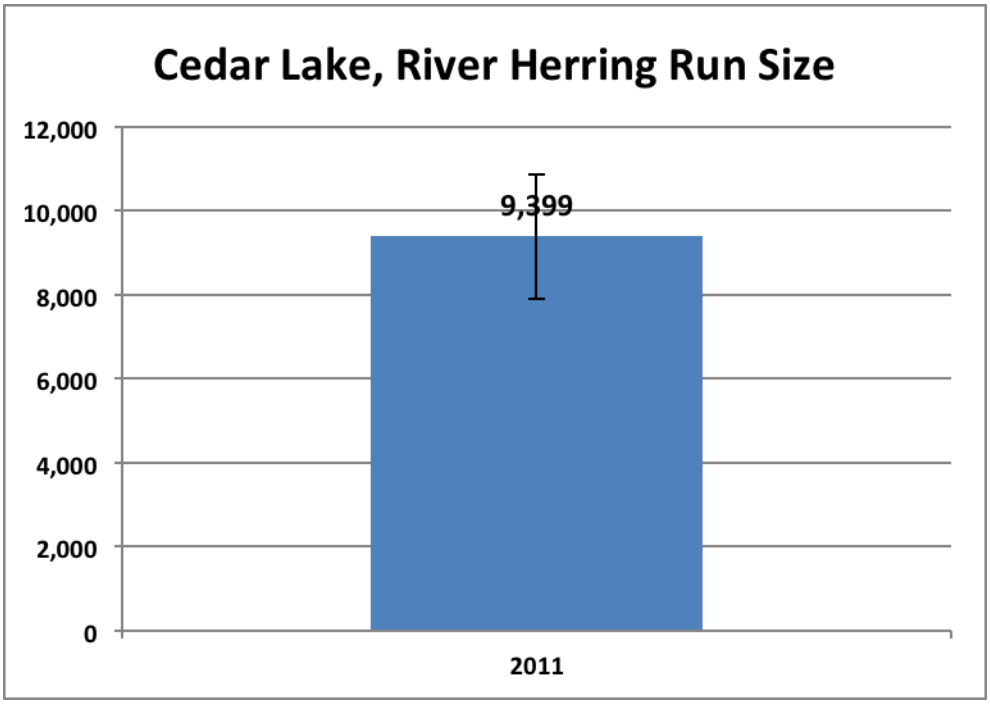
Cedar Lake

Located in the town of Falmouth, Cedar Lake is a small pond connected to Buzzard's Bay by a small half-mile stream. An old notched weir-pool fishway provides access to the impoundment and stream baffles allow river herring to enter the lake. The Cedar Lake system provides **20 acres** of spawning habitat in addition to a small 0.4 acre impoundment along the stream's course.

The Cedar Lake fish ladder.

Run size estimate

The estimated size of the 2011 Cedar Lake run was **9,399 ± ~1,485**.



Mashpee River

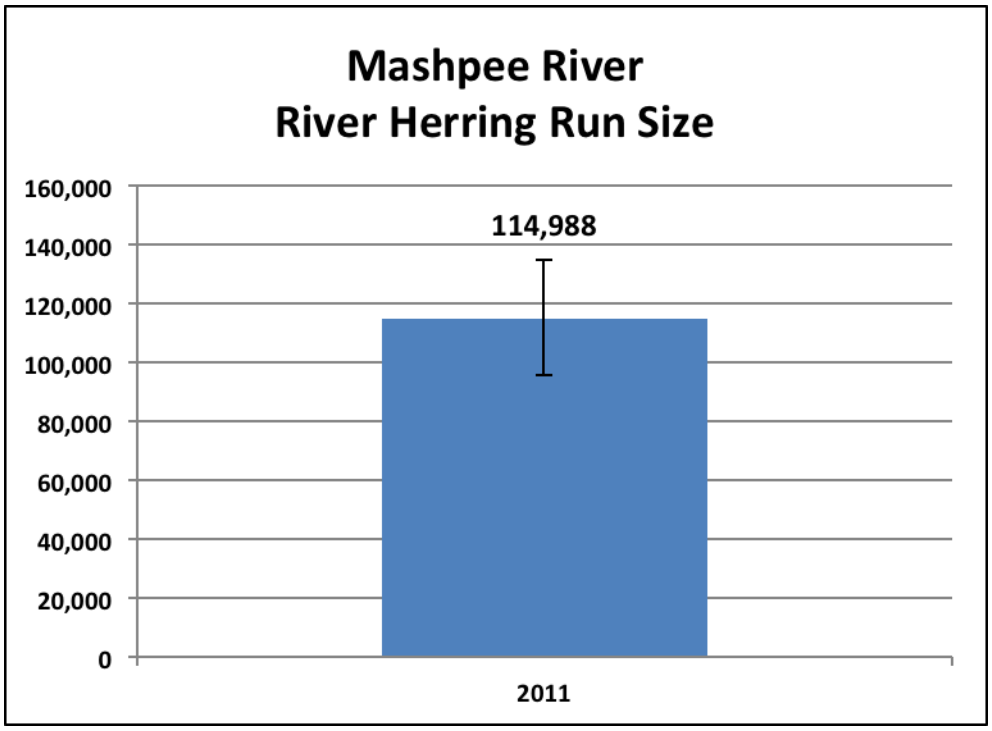
Located in the town of Mashpee, the Mashpee River flows approximately 4.8 miles from Mashpee-Wakeby Pond into Nantucket Sound.

There are five obstructions along the Mashpee River. The first is an old wooden bog sluice below Washburn Pond featuring an eroded bypass channel used by river herring to swim upstream. The second is the Washburn Pond control structure, which is not fitted with a fish ladder but has wooden boards that can be removed to permit fish passage. Upstream of Washburn Pond is the third obstruction, a small town-owned notched weir-pool fishway. The fourth obstruction is the dam at the Route 130 Crossing, fitted with a concrete weir-pool fish ladder with wooden baffles. Finally, the Mashpee Pond control structure is passable via a concrete weir-pool fish ladder.

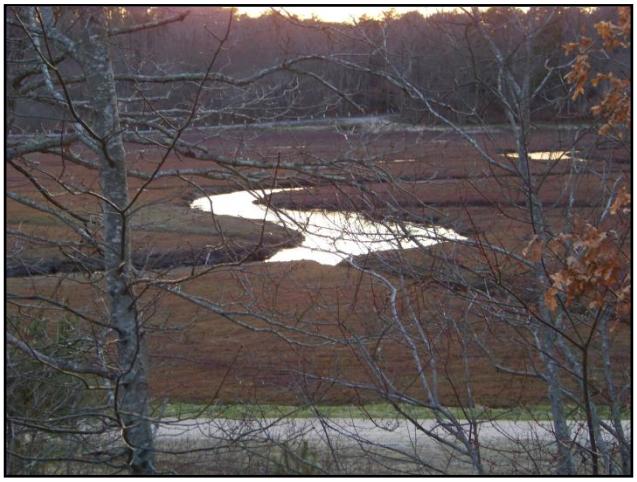
Much of the land along the Mashpee River is preserved as part of The Trustees of Reservation's Mashpee River Reservation. Land continues to be preserved through the five-mile, 780-acre Mashpee River Corridor Project, a cooperative effort of the Division of Fish and Wildlife, The Trustees of Reservation, and the Town of Mashpee. The Mashpee River system provides **736 acres** of spawning habitat between 729-acre Mashpee-Wakeby Pond and the seven acres of intermediary Washburn Pond. Along with the river's alewives and blueback herring, the stream is also home to a population of sea-run brook trout.

Run size estimate

The estimated size of the 2011 Mashpee River run was **114,988 ± ~19,626**.



Marstons Mills River



The Marston Mills River.

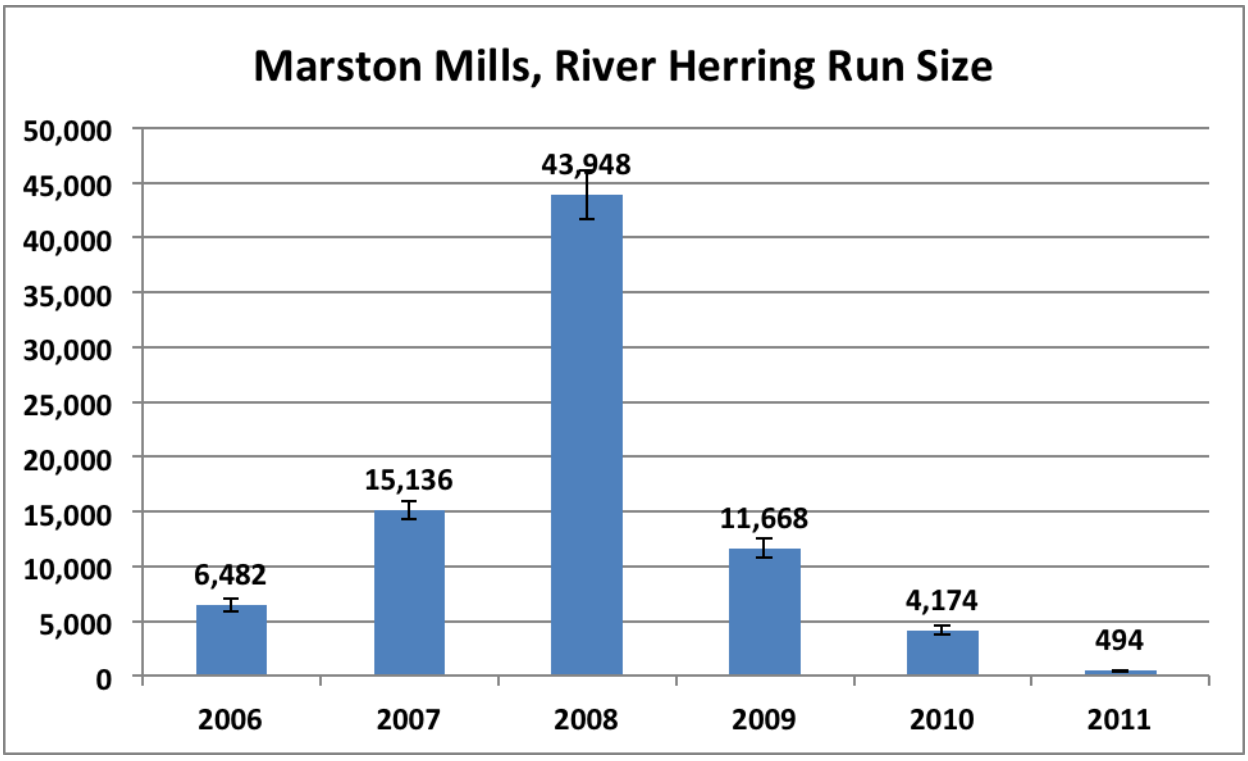
The Marstons Mills River is located in the town of Barnstable on Cape Cod. From its headwaters in 108-acre Middle Pond and 149-acre Mystic Lake, the stream runs approximately three miles before reaching Nantucket Sound. Mill Pond (30 acres) provides an intermediate spawning area about a mile from the ocean. In total, the Marstons Mills River watershed provides **287 acres** of river herring spawning habitat.

An elevation change at Route 28 is passable and fitted with stone baffles. The next obstruction is Mill Pond Dam, fitted with an inefficient concrete notched weir-pool fish ladder, followed by a bog sluice at river mile two. Finally, a 1,000-foot ditch fitted with a wooden sidewall provides access to Middle Pond and Mystic Lake.

Run size estimates

Based on visual counts, the estimated size of the 2011 Marstons Mills River run was **494 ± ~64**.

The Marstons Mills River herring run size estimates have declined from an estimated high of ~43,948 in 2008 to its current low of 494 in 2011. The estimated run size increased between 2006 and 2008 before declining steeply each year after 2008.



Herring River, Harwich

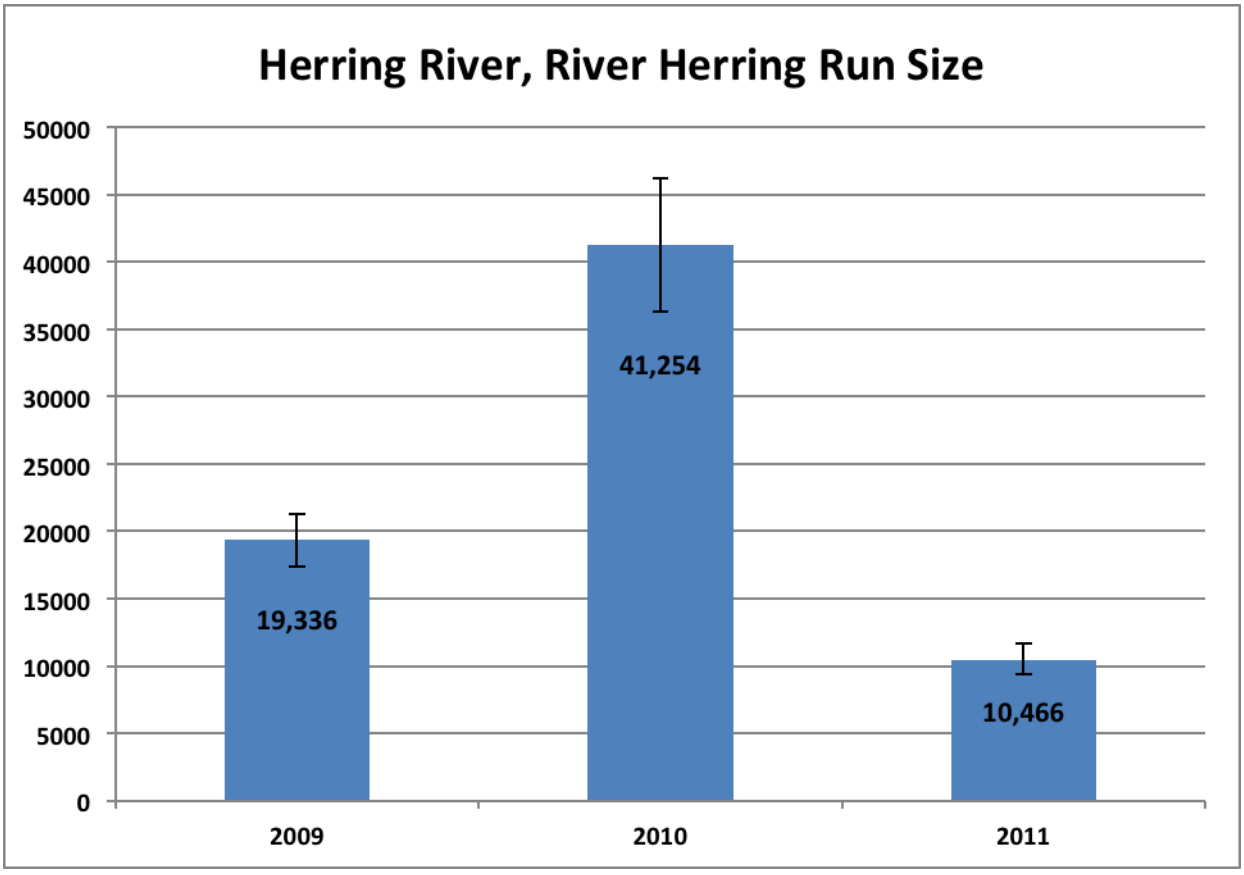
The Herring River in Harwich. Courtesy of Nicola Burnell.

Harwich's Herring River originates in three headwater ponds: 716-acre Long Pond, 171-acre Hinckleys Pond, and 181-acre Seymour's Pond. From these ponds, the river flows south ~7 miles into Nantucket Sound. Together with downstream impoundments, these ponds provide **1,119 acres** of alewife spawning habitat, making the Herring River one of the largest potential herring runs on the Cape in terms of spawning habitat.

There are three obstructions along the Herring River: the West Reservoir Dam, the Hinckleys Pond Control Structure, and the Long Pond Outlet Structure. All three are fitted with concrete and wood weir-pool fish ladders. The deteriorating steel fish ladder at the West Reservoir Dam was replaced with a new concrete ladder in 2004.

Run size estimates

Based on visual counts, the estimated size of the 2011 Herring River herring run was **10,466 ± ~1,162**, less than the 2009 run size estimate of **19,336 ± 1935** and the 2010 run size estimate of **41,254 ± 4966**.



Stony Brook

Stony Brook is an approximately 3 mile-long coastal stream that originates in five headwater ponds (Lower Mill Pond, Upper Mill Pond, Walker Pond, Slough Pond, and Canoe Pond) that together provide **386 acres** of river herring spawning habitat.

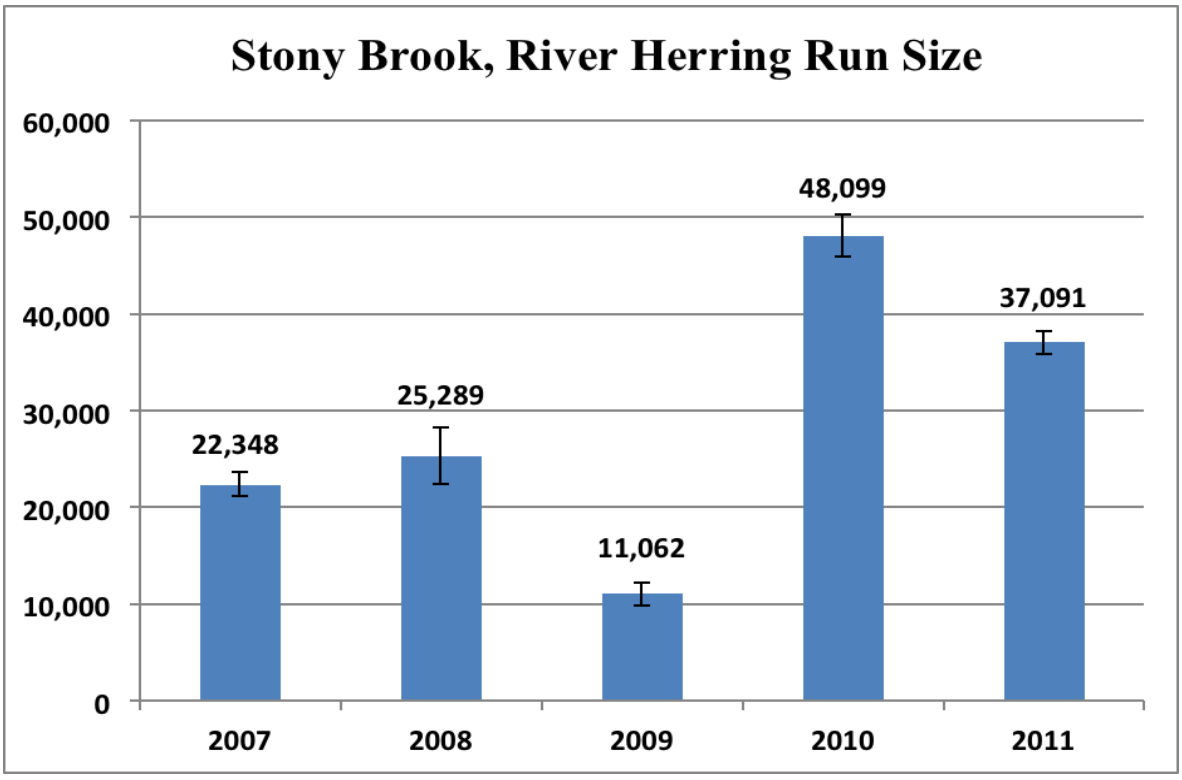
The stream runs through the town of Brewster into Cape Cod Bay. It is one of the most popular herring runs in the Commonwealth, according to MA DMF, and is the subject of John Hay's book The Run.

Stony Brook, looking downstream towards Route. 6A.

Some barriers to fish passage on Stony Brook include the Lower Mill Pond Dam, which is equipped with a stone notched weir-pool fish ladder, and the narrow shallow stream connecting Lower Mill Pond and Upper Mill Pond. The count is conducted at the Lower Mill Pond Dam fish ladder.

Run size estimates

Based on visual counts, the estimated size of the 2011 Stony Brook run was **37,091 ± 1,185**, more than estimates for 2007-2009 but less than that for 2010.



Herring River, Wellfleet

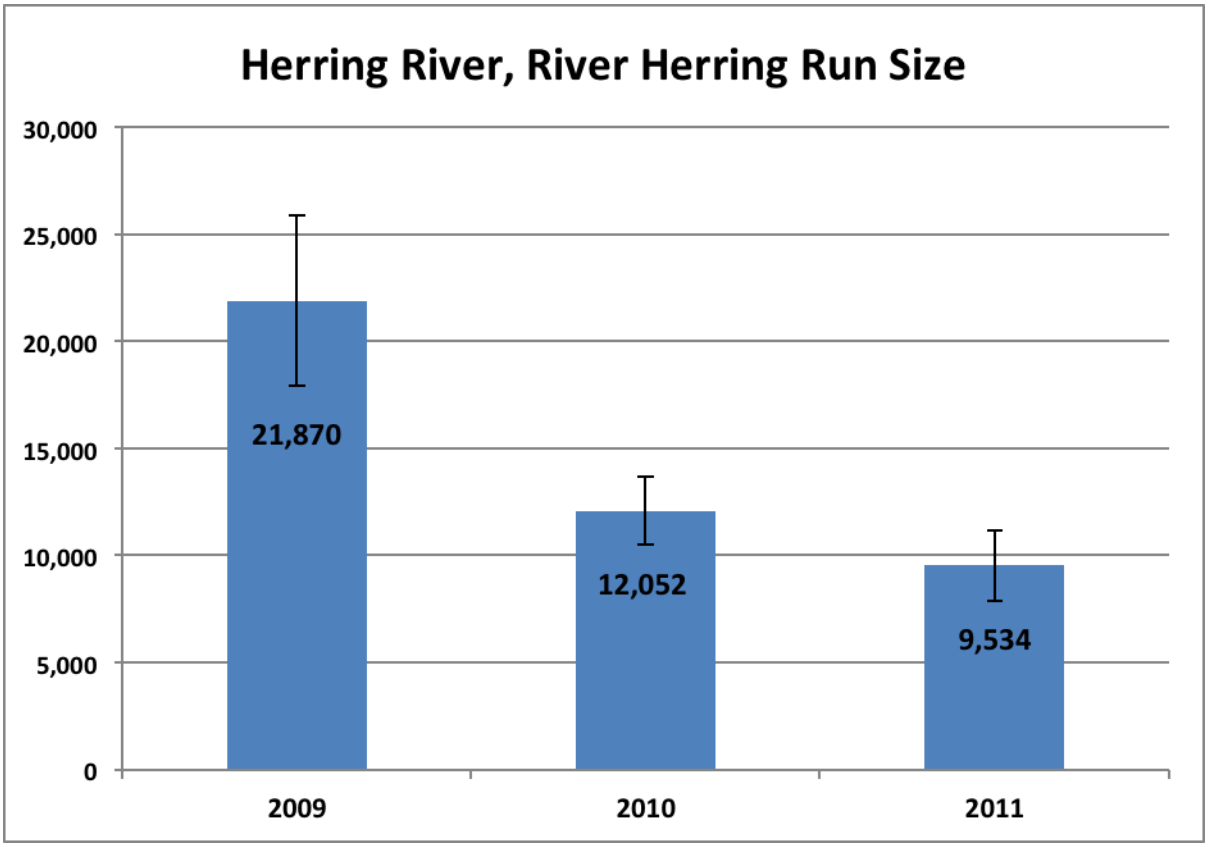
The Herring River just upstream of the Chequesset Neck tide gate.

Wellfleet's Herring River runs 4.7 miles from four ponds in the Cape Cod National Seashore into Wellfleet Bay. The Herring River estuary is the largest brackish-salt-marsh complex on Cape Cod. Wellfleet's Herring River provides **157 acres** of river herring spawning habitat.

The largest obstruction on the Herring River is the dike and tide gate system at Chequessett Neck Road. While passable, the tide gate nonetheless limits fish passage to a limited portion of the tidal cycle. This tidal restriction has impaired the 1,100 acres of former salt marsh and also likely reduces oxygen levels in the estuary area upstream, resulting in fish kills.

Run size estimates

Based on visual counts, the estimated size of this year's Herring River run was **9,534 ± ~1,640**, the lowest estimate since the fish count began in 2009.



Other River Herring Counts

Fish counts have been organized at several other rivers in Massachusetts, though not enough data were collected at these sites to generate viable estimates of run size. These include the Essex River on the North Shore, the North and South Rivers on the South Shore, Red Brook in Bourne, the Nemasket River in Middleborough, Pilgrim Lake in Orleans, the Quashnet River in Mashpee, and Mill Creek in Sandwich. A fifth count at the Coonamessett River in Falmouth uses a separate counting methodology that is not compatible with the Visual Counts program.

Essex River

The Essex River in Essex, Massachusetts provides fish passage to 271 acres of spawning habitat in Chebacco Lake and nearby Round and Coy Ponds via Alewife Brook. Fish counts have been conducted by Eight Towns and the Bay for several years though not enough data have been collected to calculate run size estimates.

North and South Rivers

The North and South Rivers Watershed Association has organized fish counts for multiple years at a number of sites including at the South River, Herring Brook, Second Herring Brook, Third Herring Brook, and Bound Brook, though not enough data have been collected to calculate run size estimates for these tributaries.

Red Brook

The Association to Preserve Cape Cod organized a fish count at Red Brook in Bourne for the first time in 2011, though not enough count data were collected to calculate a run size estimate.

Nemasket River

The Nemasket River in Middleboro, Massachusetts is the largest herring run in the state and is monitored by local fish wardens.

Pilgrim Lake, Orleans

Orleans has had an active herring count program since 2008, focusing on the Pilgrim Lake run and assisted by the Association to Preserve Cape Cod.

Mill Creek

The Association to Preserve Cape Cod organized a fish count at Mill Creek in Sandwich for the first time in 2011, though not enough data were collected to calculate a run size estimate.

Quashnet River

The Association to Preserve Cape Cod organized a fish count for the first time at the Quashnet River in 2011, though not enough count data were collected to calculate a run size estimate.

Coonamessett River

A volunteer fish count program has existed at the Coonamessett River since 2004. However, a different counting methodology is utilized that is not analyzable using Visual Counts. Volunteers count continuously (as much as possible) between 7 and 10 pm. This methodology is used because observers at the Coonamessett River have noted that most river herring come up the river in the evening hours.

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WEBSITES

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