

## Nemasket River Sustainable Fishery Plan for River Herring

Developed Cooperatively by the Massachusetts Division of Marine Fisheries and  
Middleborough-Lakeville Herring Fishery Commission

August 2016

**Approved by the Shad and River Herring Management Board on October 2016**

### INTRODUCTION

The Taunton River watershed in southeastern Massachusetts contains at least 10 tributaries that support river herring runs of which the Nemasket River is acknowledged as the most productive in Massachusetts. River herring harvest in Massachusetts has been prohibited since 2006 due to concerns over declining stocks. The objective of this sustainable fishery plan is to allow a reopening of the recreational river herring fishery in the Nemasket River, located within the towns of Middleborough and Lakeville, Massachusetts (Figure 1).

River herring were an important food source for Native American tribes living along coastal rivers. Locally, the Wampanoag people established villages along the Nemasket River (which means “place of fish”) and caught herring during the annual spring migration. The Wampanoag taught the early European settlers to catch herring for sustenance and for fertilizer. Soon after Middleborough was incorporated as a town, laws were established for commercial and personal river herring harvesting. The early Middleborough rules provided allowances for citizens to catch herring, with shares given to widows, orphans, and the poor. Mill owners along the river were required to allow the passage of herring during the annual migration. Also around this time, a long-standing practice began to elect or appoint herring wardens to oversee the herring catch and enforce the fishery regulations. The Town of Lakeville split from Middleborough in 1853 and established itself as a separate town. The incorporating legislation specifically states that Lakeville and Middleborough jointly own and control the Nemasket River Herring Run and jointly share profits (Appendix 1).

The herring in the Taunton and Nemasket Rivers consist of two species, commonly known as river herring. Most river herring in the Nemasket River are alewives (*Alosa pseudoharengus*); typically arriving in mid-March, although in warm winters, they can arrive in late-February. Blueback herring (*Alosa aestivalis*) follow two to three weeks later. Herring are present throughout April and into May. Traditionally the upstream migration peaks in April and fades during the second or third week of May, although in times of abundance the run can continue into June.

## **WATERSHED**

The Taunton River starts at the confluence of the Matfield River and Town River, and flows into Mount Hope Bay near the City of Fall River. The Taunton River is unique among large coastal rivers in Massachusetts in having no main stem dams. The entire watershed is 562 mi<sup>2</sup> and covers a wide range of rural, suburban, and urban areas in 43 towns and cities. One stream flow gauge station is present on the main stem river in Bridgewater (USGS #01108000; drainage area = 261 mi<sup>2</sup>). The mean April discharge for the time series to present is 887 cfs. The river was used extensively for commerce and water power during colonial and industrial times. Presently, the mills have long since been closed, water quality has improved, and the Taunton River is now designated as a Wild and Scenic River by the U.S Congress.

The eleven-mile long Nemasket River starts at the Assawompsett Pond dam and flows north, entering the Taunton River near the Bridgewater/Middleborough line. The Nemasket River is flat and slow throughout the entire length and has only one small section of what could be considered rapids, a short distance below Wareham Street in Middleborough. The river is crossed by ten roads (including a multi-lane highway) and two railroad tracks. The low river slope and changes in water supply withdrawals may have contributed to recent increases in aquatic vegetation and siltation. The upper one third of the river forms the boundary between Middleborough and Lakeville. For approximately the lower two thirds of its length, the Nemasket River flows entirely within Middleborough.

Overall, river herring migrate approximately 23 miles and must pass three obstructions in the Nemasket River on the way from Mount Hope Bay to the spawning grounds in the Assawompsett Pond complex. A partially restored colonial mill complex is located at Oliver Mill Park, an attractive and popular public park that includes a large and functional pool and weir fish ladder (Figure 2). The second obstruction is a remnant industrial mill dam and a movable bascule gate from a previous power plant at Wareham Street. A concrete pool and weir fish ladder is located here; originally built in 1874 and reconstructed many times, most recently by *Marine Fisheries* in 1996 (Reback et al. 2004). The third obstruction is the Assawompsett Pond dam where a 1968 Denil fish ladder, the first Denil built in Massachusetts (Reback and DiCarlo 1972), provides passage. Recently, water level operations have allowed passage directly through the gates of the dam, negating the need for the fish to use the ladder.

## **SPAWNING HABITAT**

The Assawompsett Pond complex consists of Assawompsett Pond, Pocksha Pond, Great Quittacus Pond, Little Quittacus Pond, and Long Pond providing over 5,000 acres of river herring spawning and nursery habitat. The first four are directly connected, forming the largest naturally occurring pond in Massachusetts. This amount of habitat is certainly a contributing reason why the Nemasket River hosts the largest river herring run in Massachusetts. Much of the surrounding watershed land, except for Long Pond, is owned by cities, the state, or conservation trusts. Long Pond has experienced more traditional lakeside development, with many seasonal cottages now trending towards year-round neighborhoods.

All ponds in the Assawompsett Pond complex except Long Pond are protected water supply reservoirs for the cities of Taunton and New Bedford. As such, the cities vigorously protect the watershed, and did not even allow fishing from the shore for almost a hundred years. Given the protections and goals of the water supply, the lakes have maintained suitable water quality. The lakes are shallow and prone to temperature changes, although except for years of very low water, there has been no observed limitation of spawning or nursery habitat quality. Spawning adult herring can access the entire pond

complex, except for Little Quittacus Pond (not shown in Figure 1) which is gated off to ensure herring do not enter the intake pump at the New Bedford water treatment plant. Juvenile herring remain in the complex for several months, until exiting during a seaward migration occurring primarily in the fall.

## **HERRING FISHERY COMMISSION**

The towns of Middleborough and Lakeville have a long standing commitment to manage and protect the Nemasket River herring run. This tradition has been supported by monetary incentives and interest to sustain a natural resource used widely by the public. Over the years, individuals and commercial enterprises were allowed allotments of herring and commercial licenses were issued through annual bids. For many years, Middleborough and Lakeville residents were allowed one bushel of herring annually. Commercial herring fishing on the Nemasket River ended in 1965. For many decades, herring wardens were appointed by the Selectmen, but no formal program was in place. In 1996, the current Middleborough-Lakeville Herring Fishery Commission was established and new harvest rules were promulgated. Any Middleborough or Lakeville residents could buy a permit allowing up to four dozen (48) herring being taken per week, with four days open for harvest. Three hundred permits were reserved for residents of other communities. The harvest was overseen by the wardens and several volunteer observers. The season ran from the last Wednesday in March to June 15, although catching usually ended in May as the herring run faded. This system remained in place until *Marine Fisheries* instituted the ban on recreational herring harvest in 2006.

The current Commission consists of seven volunteer fish wardens, appointed jointly by the Boards of Selectmen in Middleborough and Lakeville. Wardens are the voting members of the Commission and are assisted by several volunteers. The Commission is broadly charged with administering and enforcing herring harvest regulations, maintaining and enhancing herring habitat, and public education on the herring run. It was agreed that since the spawning grounds and river boundaries were in both Middleborough and Lakeville, and the law gave control of the herring run to both towns, then both towns should work jointly to protect the herring. Operating as a Chapter 44, Section 53E and ½ revolving fund agency, Commission funds came solely from the sale of herring permits. With the ban on herring catching, no permits have been sold and no operating funds have been generated since 2005. Through frugal management practices the Commission presently maintains an annual operating budget.

## **POPULATION AND HARVEST ESTIMATES**

Early in the 20<sup>th</sup> century Belding (1921) reported the Nemasket River herring run was underperforming mainly due to blockages and pollution related to mill works on the river. The herring harvest in 1912 was reported as 200 barrels (about 140,000 fish) with an estimated potential of 2,000 barrels (about 1,400,000 fish) (Belding 1921). A review of more recent river herring surveys by *Marine Fisheries* (Reback and DiCarlo 1972; Reback et al. 2004) and Herring Commission files reveals a pattern of improvement in the herring run during the 20<sup>th</sup> century that may reflect rebounding habitat quality as mills closed, improved passage at obstructions, and the stewardship of the Herring Commission.

Volunteer herring counts were established in 1996 and utilize a ten-minute count at the top of the Wareham Street fish ladder, along with recording air temperature, water temperature, weather at the time of the count, and barometric pressure. The volunteer counts were provided to *Marine Fisheries*, who calculate annual estimates of herring passage based on extrapolating the ten-minute counts.

The Nemasket River herring count data was revisited in 2012 to generate run size estimates using a random stratified sampling design recommended by *Marine Fisheries* (Nelson 2006). The updated analysis partitions 10-minute counts into three periods of each day. This approach avoids bias that can

occur when counts are concentrated at a time of day of run peaks and these data influence the extrapolated results for other times of the day. The updated analysis results in lower run size estimates than the earlier method (Table 1, Figure 3). The run size time series shows a low point in 2004 and 2005 of less than 250,000 herring with a moderate increasing trend since the harvest ban in 2006. The series high estimate was over 1.3 million fish in 2002 followed by about 840,000 fish in 2013. These catch numbers relative to other herring counts in Massachusetts support the commonly held assertion of the Nemasket River being the largest herring run in the state.

For decades prior to 1996, the residents of Middleborough and Lakeville were allowed one bushel of herring per year, although recreational harvest enforcement was not consistent and was poorly reported. The illegal harvest of herring mainly for lobster and striped bass bait became a growing problem that no records can accurately describe. In 1996, local control was formally established and the Herring Commission has since endeavored to record recreational herring catch numbers. Issued permits were formatted to allow Herring Wardens at the catching station to record the number of fish taken on each catching day. Harvest permitting ceased with the state-wide ban in 2006.

**Stocking Source.** The Nemasket River has been a source of river herring for stocking to augment or create runs at other rivers for many decades. For the last ten years, the Commission participated in formal multi-year stocking programs in cooperation with *Marine Fisheries*. Typically, the Commission provided 2,000 herring per year to restock other runs on a five-year program. The five-year period allowed for one or two years of continued stocking after the first returns of spawning fish should have occurred. Stocking efforts have been recently conducted for the Town, Concord, and Ten Mile rivers, and in cooperation with the Rhode Island Department of Environmental Management, University of Massachusetts, and *Marine Fisheries* for stock enhancement and research purposes.

## **SUSTAINABLE HARVEST PLAN**

**ASMFC.** The Atlantic States Marine Fisheries Commission's (ASMFC) Amendment 2 to the Interstate Fishery Management Plan for Shad and River Herring gives states guidance for developing Sustainable Fishery Plans (SFP) for river herring (ASMFC 2009). These plans are to be developed and approved by State jurisdictions then reviewed by the ASMFC Technical Committee and if suitable forwarded to the ASMFC Shad and River Herring Management Board for approval. The premise is that SFPs should allow harvest while not diminishing the potential future reproduction and recruitment of herring stocks. The SFPs are based on Sustainability Targets that relate management responses to population action and warning levels. SFPs can be river-specific, regional or state-wide. The ASMFC guidelines also state that a minimum of 10 years of demographic data is needed to support Sustainable Fishery Plans.

***ASMFC Sustainability Targets.*** *The recommended sustainability targets in Amendment 2 included: spawning stock biomass, fish passage counts, mortality rates, repeat spawning ratio, and juvenile abundance indices. From these measures, thresholds or targets shall be set to prompt action level (mgt. action such as fishery closure or regulation change) or warning level responses (documentation and mgt. planning).*

*Five state plans were reviewed and approved during 2011–2012 (ME, NH, NY, NC and SC). Most sustainability targets are based on exploitation rates and escapement targets related to fishery dependent harvest or independent herring passage counts. Single applications occur for both using a recruitment failure definition and a juvenile index as targets. Two states are investigating the use of population metrics (mortality, length, CPUE, and repeat spawning ratio) as sustainability "measures" or warning limits.*

**Herring Commission Objectives.** The Middleborough-Lakeville Herring Fishery Commission sent an inquiry to *Marine Fisheries* on December 18, 2013 in regard to the potential and process for opening harvest of river herring at the Nemasket River. Consequently, several meetings occurred to discuss the topic and *Marine Fisheries* staff evaluated the available biological and count data that could be used to develop metrics for a river herring sustainable fishery plan. The Commission, with their decades of experience managing the Nemasket River run, stated their belief that their previous harvest system of permitting, reporting, and limited harvest days under Commission supervision would allow a sustainable harvest. They support this contention by outlining that the modest harvest of 1999–2005 averaged about 15% of the annual run count with no evidence of impact on future recruitment. Furthermore, these harvest years include the two lowest run counts in the time series (2004 and 2005) that were followed by nearly 10 years of steady improvements to run counts. Therefore, they expressed an interest in opening harvest to allow similar catches as occurred in 1999–2005, that when removed from the present stock, would constitute an exploitation rate of less than 10% of the run size.

**State Role.** *Marine Fisheries* supports this request conceptually and has proceeded to evaluate the existing biological and count data from the Nemasket River and four additional herring runs to provide regional context and to gain a wider perspective on recent stock changes. From this review, the following framework is presented for a Nemasket River Sustainable Fishery Plan for river herring. The proposed SFP would commence in 2017. The harvest ban would at that time have been in place for 11 years (2006–2016) and the count time series duration will be 21 years.

**Management Unit.** The SFP has a river-specific management unit of the Nemasket River herring run in the Towns of Middleborough and Lakeville.

**Sustainability Measures.** The ongoing run count with calculated run size will serve as the primary measure to monitor the Nemasket River run status.

**Sustainability Target.** One fishery-independent sustainability target will be used. Harvest will be capped at 10% of the time series mean (TSM). This value will be recalculated each year. This level was selected as a conservative level of harvest that will be lower proportionally than 1999–2005 harvest levels in the Nemasket River and will allow within-year management measures to adjust daily limits and close harvest when the harvest target is reached. Table 1 and Figure 3 provide the run count statistics that formed the basis of the recommended sustainability target. The review also considered reductions from the 25<sup>th</sup> percentile as conservative levels of harvest. The selected harvest target of 10% of the TSM produces a similar harvest as a 15% reduction from the 25<sup>th</sup> percentile and was preferred due to the reduced complexity.

**Primary Action Threshold.** The 25<sup>th</sup> percentile of the Nemasket River run count time series will serve as the primary action threshold to trigger a management response to declining run size.

**Management Actions.** With two consecutive years where the Nemasket River run count is below the 25<sup>th</sup> percentile, the sustainability target will be reduced to 5% of the TSM for the following year. Three consecutive years with the run count below the 25<sup>th</sup> percentile of the time series will trigger a minimum 3-year closure the following year. In order to reopen the harvest, an opening threshold of three consecutive years above the TSM would have to occur.

**Secondary Threshold.** An annual exploitation rate of 10% of the run size will serve as a secondary threshold or warning limit. An exploitation rate of 10% of annual run size would recently have been similar to a harvest target of 10% TSM; but also would provide an alternative annual signal of how harvest relates to run size. Two exploitation rates in approved SFP presently target 18% (SC) and 20% (NH) of average run counts. Annual exploitation rates will be

tracked each year with a threshold of 10% assigned as a warning limit. Following a single, annual exceedance of this threshold, *Marine Fisheries* will meet with the Middleborough-Lakeville Herring Fishery Commission to review harvest records and management practices and document the review and cause of increase in exploitation rate in a joint memorandum.

**Potential Future Metrics.** With the SFP implementation, and increasing time series, efforts will be made to develop additional primary and secondary thresholds. *Marine Fisheries* has conducted annual biological sampling of alewife and blueback sex, size, and age data at the Nemasket River since 2004 (Tables 2 and 3, and Figure 4). These data allow the calculation of age, length, and weight statistics and estimates of sex ratios, mortality, and survival. The target sampling level is 100 river herring per week for the duration of the run to meet suitable levels of power to discern trends (Nelson et al. 2011) for both sexes and species. The targeted run duration is usually six weeks. Aging is conducted using otoliths and following published *Marine Fisheries* protocols (Elzey et al. 2015).

The data derived from biological sampling can provide additional information on population status and supporting evidence for management measures. However, as found in Nelson et al. (2011), the length and age metrics for river herring analyzed to date in Massachusetts provide little predictive power when related to population abundance. Mean lengths and mean ages of fish within a run can point to long-term changes in demography, but the current time series appears to be tracking inter-annual fluctuations in year class recruitment into the population and indicates that robust age structure has not been recovered. With these conditions, it is not presently possible to clearly identify thresholds associated with the biological data. This limitation is not unexpected nor prevents the development of future metrics: 11 years of size and age data allows the tracking of only two generations of river herring. *Marine Fisheries* recommends that biological data continue to be collected from the Nemasket River herring run with the goal of developing population thresholds based on the following metrics:

**Age Structure.** Evidence of age structure truncation is present now in Massachusetts river herring populations, including the Nemasket River population. Additional cohorts to evaluate age structure or mortality rates may become useful for setting warning limits. Changes in age structure will be examined annually using the  $\chi^2$  test as described in Davis and Schultz (2009).

**Repeat Spawners.** A target percentage of repeat spawners in annual spawning run could be used for setting a warning limit. However, with the present focus on otoliths for aging, it would take a renewed effort to collect and process a subsample of scales from older Nemasket River herring to compare to earlier scale samples.

**Escapement Targets.** Alternatively to annually opening harvest at the start of the run, the Commission could consider not allowing harvest until a suitable escapement target of incoming spawners was met. The escapement target would depend on real-time reporting from an electronic or video counting station at one of the Nemasket River fishways and relate counts to a metric on spawning habitat productivity. For example, the Maine Department of Marine Resources uses a calculation based on spawners per surface acre of spawning and nursery habitat (Havey 1961, Havey 1973) to set escapement targets. This would guarantee a certain number of spawners entering the spawning habitat and guard against unexpected low returns. One potential drawback in some systems could be focusing the harvest on later arrivals that may have a higher proportion of younger fish or blueback herring.

## HARVEST MANAGEMENT

Opening harvest in a single river creates management and enforcement challenges given that Massachusetts has about 80 rivers within 48 coastal towns that contain river herring runs. The Nemasket River is presently the only river proposed for harvest in 2017. Ideally, a regional approach would be established to allow several runs to open at the same time. This would reduce concerns over harvest compliance and enforcement while providing a larger opportunity for Commonwealth citizens who are not town residents to purchase harvest permits. This has been a goal of *Marine Fisheries*; however, while several Towns have expressed an interest in opening harvest, no other herring runs presently have the full complement of favorable stock status, a suitable data series, and the infrastructure and dedication found in the Middleborough-Lakeville Herring Fishery Commission.

The prior system of harvest management in the Nemasket River was managed by the Middleborough-Lakeville Herring Commission until the 2006 state-wide ban (Appendix A2). They used a proven system of selling an unlimited number of permits to residents and 200–300 permits to non-residents with a weekly maximum catch of 48 fish that could be taken on four open days at only one catching area. Catching was only allowed in the presence of a Commission herring warden or volunteer observer. The permits were printed with punch-card features on the border that allowed the herring wardens to mark each weekly harvest.

The Commission was interested in opening harvest in 2017 with an approach similar to pre-2006 that allowed a large permit base to have access to 48 fish per week with the acknowledgement that many permit holders won't maximize their allowable catch. Following review of three alternative management options, the following approach was selected for balancing the interest of providing access to many harvesters and preventing overages of the harvest target (10% of TSM = 55,967 fish).

**Harvest Management.** Typically 600-700 resident permits were sold per year in the decade prior to the harvest ban and non-resident permits were capped at 200-300 and provided via lottery. The available harvest records do not presently allow a determination of the harvest rate per permit or number of inactive permits. However, the Commission's impression is that a majority of permits did not realize their maximum harvest rate and many were inactive or marginally used. Therefore, this proposal seeks to limit the potential for overharvesting the sustainability target by reducing the harvest period to five weeks, reducing the harvest days to three per week, and reducing the weekly catch limit per permit to 20 fish. Using the range of permits sold previously, this approach would have a potential maximum harvest that ranged from 80,000 to 100,000 fish (800 to 1000 permits). By allowing unlimited resident permits and 250 non-resident permits via lottery the Commission is expecting about 900 total permits. The maximum harvest under this scenario would be 90,000 fish. An assumed harvest rate of 50% of the maximum potential harvest would result in a harvest of 45,000 fish.

The potential for harvest to exceed the sustainability target exists for this approach if a high proportion of permit holders takes the full weekly harvest each week. This proportion is expected to be low given the Commission's past experience. This outcome is hard to predict but will be easily tracked once harvest is open. The SFP will diligently monitor harvest performance by permit and week in order to make annual adjustments to relate the harvest target to the numbers of permits issued.

The previous "punch-card" permit system would be augmented with the issuance of daily catch cards to each permit holder that harvests herring. The card would indicate the date, permit number, and

number of fish. State regulations will be changed by *Marine Fisheries* to require that any possession of river herring in Massachusetts be accompanied by the Nemasket River harvest permit and the daily harvest card. Herring frozen in bags must have the original daily harvest card placed in the bag. The permits and daily catch cards would be professionally printed on waterproof paper. The usage of harvested river herring trended sharply towards striped bass bait in the decade leading up to the state-wide harvest ban. *Marine Fisheries* recognizes that a component of the concern that led to the state-wide ban on river herring harvest was excesses in the harvest for striped bass bait. Recreational bait use will be allowed; however, the SFP seeks to promote and encourage traditional uses of consumption of river herring as grilled, pickled, and smoked fish and fried roe. To do this, the Commission will accommodate herring consumption requests as able. For example, requests for only females for roe harvest might be allowed when manageable. In these cases, the Commission should record the female only harvests and compensate on a daily basis as needed by providing males for bait use.

**Native American Harvest.** The Commonwealth of Massachusetts recognizes the aboriginal practice of the Wampanoag tribe to harvest river herring in Massachusetts. An agreement has been signed between the parties with the tribe agreeing to harvest only for sustenance purposes and to report their harvest by river to *Marine Fisheries*. The tribe's harvest is not bound to SFP measures; however, an accurate accounting of their harvest in the Nemasket River will be essential for a successful SFP. *Marine Fisheries* will discuss the possibility of issuing free permits to the Wampanoag tribe and to coordinate with the tribe to encourage responsible harvest and record keeping.

## **STATEWIDE REGULATIONS AND ENFORCEMENT**

For this harvest opening to be successful and enforceable, the process will need a tightly managed accounting system for daily harvest, well-planned coordination with the State Environmental Police, and participation from Town law enforcement. A coordination meeting will be held with the Massachusetts Environmental Police, *Marine Fisheries*, Town Police, and the Herring Fishery Commission each year prior to the season start. *Marine Fisheries* will enact changes to the existing state regulations that ban state-wide harvest to allow harvest and possession of Nemasket River herring in accordance to this SFP and the Herring Fishery Commission regulations. This process will include a review of existing penalties for non-compliance and updating the penalties as needed.

The Massachusetts Environmental Police has recommended that the Commission provide information on permit records and seasonal harvest records to improve the enforcement of harvest regulations. The ideal approach would be to have an online source of permit records and the names and schedules of herring wardens available at the start of each season with weekly updates in harvest by permit. The Commission does not have the present capacity to provide an online permit data source or online weekly updates of harvest. However, the Commission recognizes the value in these communications for law enforcement and will endeavor to work with *Marine Fisheries* to prepare a spreadsheet of permit holder information and river herring warden names, schedules, and phone numbers for the start of the 2017 season.



## REFERENCES

ASMFC (Atlantic States Marine Fisheries Commission) 2009. Amendment 2 to the Interstate Fishery Management Plan For shad and river herring (River Herring Management). Washington, D.C. USA.

Belding, D.L. 1921. A report upon the alewife fisheries of Massachusetts. Mass. Div. of Fish. and Game, Dept. of Natural Resources, 135 pp.

Davis, J. P., and Schultz, E. T. (2009). Temporal Shifts in Demography and Life History of an Anadromous Alewife Population in Connecticut. *Marine and Coastal Fisheries*, 1, 90–106.

Elzey, S.P., Trull, K.J., and K.A. Rogers. 2015. Massachusetts Division of Marine Fisheries Age and Growth Laboratory: Fish Aging Protocols. Mass. Division of Marine Fisheries Technical Report No. 58.

Havey, K. A. (1961). Restoration of anadromous alewives at Long Pond, Maine. *Transactions of the American Fisheries Society*, 90, 281–286.

Havey, K. A. (1973). Production of Juvenile Alewives, *Alosa pseudoharengus*, a Love Lake, Washington County, Maine. *Transactions of the American Fisheries Society*, (2), 434–437.

Nelson, G. A., Brady, P. D., Sheppard, J. J., & Armstrong, M. P. (2011). An Assessment of River Herring Stocks in Massachusetts. Mass. Division of Marine Fisheries Technical Report No. 46.

Nelson, G.A. 2006. A Guide to Statistical Sampling for the Estimation of River Herring Run Size Using Visual Counts. Mass. Division of Marine Fisheries Technical Report No. 25.

Reback, K. E. and J. S. DiCarlo. 1972. Completion report on the anadromous fish project. Mass. Div. Mar. Fisheries, Publication No. 6496, 113 pp.

Reback, K.E., P.D. Brady, K.D. McLaughlin, and C.G. Milliken. 2005. A survey of anadromous fish passage in coastal Massachusetts: Part 1. Southeastern Massachusetts. Mass. Division of Marine Fisheries Technical Report No. TR-15. <http://www.mass.gov/dfwele/dmf/publications/technical.htm>

**TABLES & FIGURES**

**Table 1.** River herring run counts and harvest data for the Nemasket River, Middleborough, MA. Recorded at the Wareham Street fishway.

Year	Original Run Count (No.)	Updated Run Count (No.)	Permits (No.)	Harvest (No.)	% of Count (%)	Summary Statistics	
1996	1,094,860	696,666				TSM	559,673
1997						Median	548,835
1998	866,538	651,441				Minimum	225,904
1999	1,043,906	766,694	742	104,992	0.14	Maximum	1,361,691
2000	1,069,286	560,986		76,426	0.14	75% TSM	419,755
2001	476,779	284,498	1966	59,514	0.21	1st Q	387,894
2002	1,919,402	1,361,691	2698	86,301	0.06		
2003	792,990	548,835	2113	61,945	0.11	10% of 1st Q	38,789
2004	578,000	244,832	2109	64,593	0.26	15% of 1st Q	58,184
2005	401,000	225,904	1931	33,964	0.15	20% of 1st Q	77,579
2006	505,246	313,242				10% of TSM	55,967
2007	659,880	462,000					
2008	848,848	392,451					
2009	760,717	383,338					
2010	763,884	489,931					
2011	662,052	512,139					
2012	NR	567,952					
2013	NR	840,033					
2014	NR	590,105					
2015	NR	741,048					

*Time series mean (TSM), 75% of TSM and first Quartile are derived from the count time series and displayed in Figure 2.*

**Table 2.** The number collected (n), mean length (mm), and standard deviation (SD) of river herring from the Nemasket River by sex during 2004-2014.

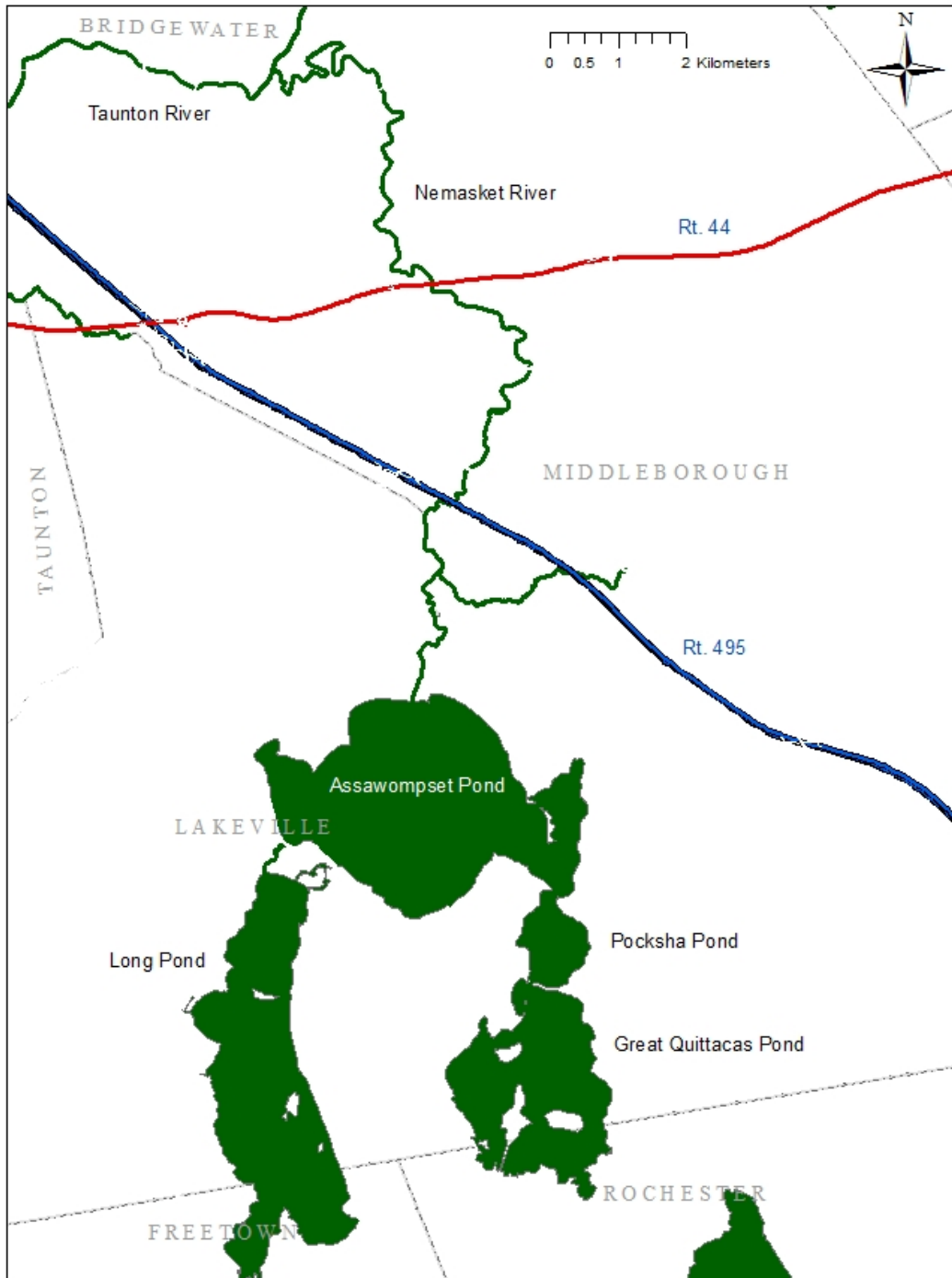
Year	Female			Male		
	n	Mean Length	SD	n	Mean Length	SD
2004	127	291.5	14.36	141	282.6	15.15
2005	130	280.4	15.20	148	273.0	16.11
2006	127	275.3	13.66	197	265.1	13.35
2007	255	278.1	12.41	395	276.6	12.84
2008	228	281.9	12.49	276	269.1	12.94
2009	191	278.3	11.33	313	268.1	11.06
2010	277	272.1	10.69	276	272.1	10.67
2011	220	287.1	11.21	283	275.2	11.42
2012	154	284.3	13.44	229	270.3	12.50
2013	213	279.5	9.79	284	270.5	10.14
2014	236	287.2	11.63	324	277.2	11.24

**Table 3.** The annual number alewife by age in biological samples collected from the Nemasket River during 2004-2014.

Age	Female										
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
2	0	0	0	0	0	0	0	0	0	0	0
3	0	4	27	22	2	0	22	17	59	115	73
4	23	50	56	163	38	48	80	95	72	48	93
5	52	54	34	59	134	60	71	57	19	6	6
6	40	19	6	5	33	36	14	7	2	2	1
7	8	1	1	1	5	4	2	2	2	0	1
8	0	1	0	1	0	0	0	0	0	0	0
Totals	123	129	124	251	212	148	189	178	154	171	174

Age	Male										
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
2	0	0	0	0	0	0	0	0	9	11	0
3	4	10	62	41	36	8	42	36	91	113	103
4	39	51	91	257	76	118	88	98	61	42	59
5	65	17	31	82	110	98	51	44	12	6	11
6	30	17	9	12	37	29	7	4	1	0	2
7	1	6	1	1	1	1	1	0	1	0	0
8	0	0	1	0	0	0	0	0	0	0	0
Totals	139	101	195	393	260	254	189	182	175	172	175

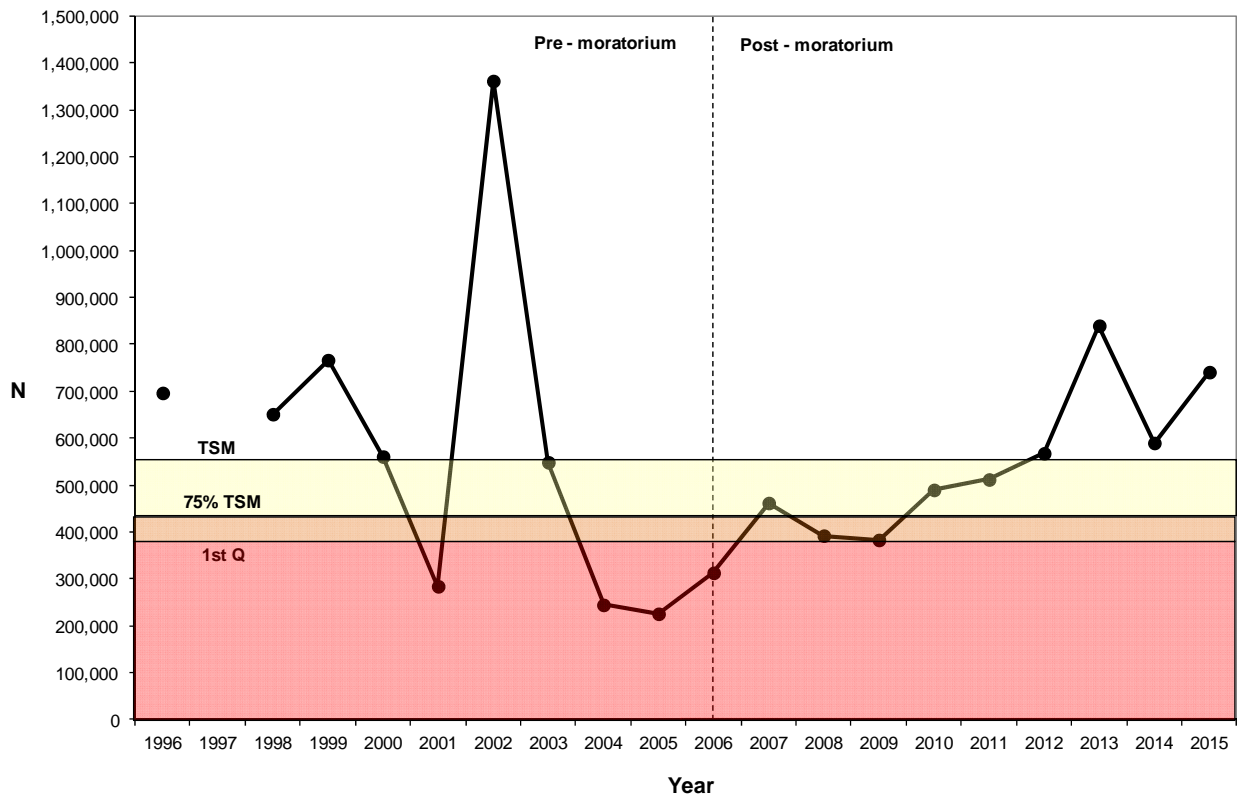
**Figure 1.** Nemasket River Watershed



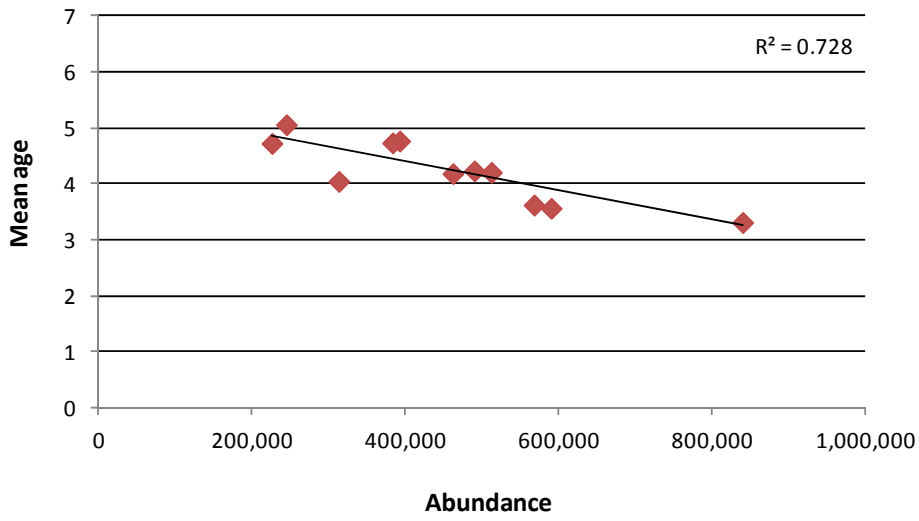
**Figure 2.** Oliver Mill Park, Nemasket River, Middleborough.



**Figure 3.** Annual river herring run count estimates for the Nemasket River, 1996 - 2015. The horizontal lines delineate the time series mean (TSM), 75% of the TSM, and 25<sup>th</sup> percentile (1<sup>st</sup> Q).



**Figure 4.** Scatterplot with linear trend and  $R^2$  value of the mean age in years against abundance (run count) for alewife sampled at the Nemasket River, Wareham Street, during the period 2004-2014. The age data combines male and female alewife.



## APPENDIX

**A1.** Massachusetts Legislature, Acts of 1853; Chapter 338, Section 5 of the Act incorporating the Town of Lakeville, Massachusetts.

*"The alewife fisheries of the Nemasket River shall be and remain the property of said towns of Middleborough and Lakeville, and the manner of taking said fish, and the whole management of said fisheries, shall be regulated by the selectmen of said towns; and the proceeds thereof shall be divided between the said towns, in proportion to the number of ratable polls in each respectively, and the respective parts of such protocols shall be disposed of by said towns respectively, in such a manner and for such purposes as each town shall for itself determine and direct."*

**A2. Middleborough-Lakeville Herring Fishery Commission: Herring Rules and Regulations, December 2004 (the last revisions prior to the state-wide ban in 2006).**



Bank Building, 20 Centre Street, Middleborough, Massachusetts 02346

## **HERRING RULES AND REGULATIONS**

A. No herring may be taken without a valid and signed permit. Herring may only be taken during posted hours with a Warden or Volunteer Observer on duty.

B. A **maximum** of 48 fish per week may be taken, in any combination of visits. The Warden or Observer on duty may limit the catch as conditions warrant.

C. Herring may **ONLY** be taken by hand-held hoop net **WITH A MESH OF 3/8 INCH OR SMALLER** or by hand. Herring that are "gilled" or otherwise injured must be harvested first.

D. Permits are sold at the Middleborough Town Clerk's Office, 20 Center Street, Monday through Friday from 8:45 AM to 5:00 PM. The Commission will determine the number of permits sold and the manner of sale each season.

E. Permit Fees: Valid identification will be required.

\$5.00 Middleborough/Lakeville Residents	\$25.00 Non-residents
\$1.00 Middleborough/Lakeville Senior Citizens	\$5.00 Non-resident Senior Citizen

Duplicate Permits \$2.00 (with proof of identification).

F. Catching Days and Times:

Wednesday:	4:00 PM to 8:00 PM
Friday:	6:00 AM to 7:00 PM
Saturday:	5:00 AM to 7:00 PM
Sunday:	6:00 AM to 10:00 AM

The season opens on the last Wednesday in March and ends June 15, unless closed earlier as dictated by the availability of fish.

Exception: To accommodate sport fishermen and tide considerations; herring may be taken at other times of the day or night, from May 15 to June 15 (depending on the availability of fish). The Middleborough Town Manager must be notified at least 24 hours in advance. Call (508) 947-0928 during business hours to set an appointment with a Warden or Volunteer Observer.



**G. Catching Area:**

1. The pool below the falls at the Wareham Street fish ladder in Middleborough is the **ONLY** legal catching area in Middleborough or Lakeville. **No herring may be taken without the direct permission of the Warden or Volunteer Observer on duty.**

2. No one is permitted to enter the fish ladder, including the concrete mouth of the ladder. No one is permitted to disturb, injure, hinder or obstruct the passage of herring in any fish ladder. Fishing in the pools above or below the fish ladders at Oliver Mill Park and Wareham Street with a rod and reel in a manner which disturbs the herring, or which could snag a herring is prohibited.

3. For safety reasons, to prevent disturbing herring eggs and to prevent hindering the passage of herring; no person is permitted to enter the river at any time.

**H. Littering in the general park area or throwing rocks, sticks or other objects into the fish ladders or catching areas is prohibited. Visitors and catchers shall assume all risk and liability.**

It is the Commission's intention to provide a safe recreational area. Disorderly conduct or public drunkenness will not be tolerated. Offenders will be ejected from park areas.

MGL Chapter 130 Sect. 95 applies throughout Middleborough and Lakeville:

**Taking Fish From Fisheries Without Permission**

*"Whoever takes, kills or hauls onshore or disturbs, injures, hinders or obstructs the passage of any herring, alewives or other swimming marine food fish ... shall be punished by a fine of not less than five nor more than fifty dollars."*

**The Towns of Middleborough and Lakeville and the Mass. Environmental Police may prosecute violation of these rules. Violators are subject to arrest, fine, seizure of equipment, and loss of permit.**

**All Rules and Regulations are subject to the discretion of the Warden or Volunteer Observer on duty. Regulations may be modified as conditions warrant.**

Revised: December 2004