Sustainable Fishery Management Plan for River Herring

Herring Brook, Pembroke, Massachusetts

Developed Cooperatively by the Massachusetts Division of Marine Fisheries and the Pembroke Herring Fisheries Commission

Approved by Shad and River Herring Management Board
August, 2025

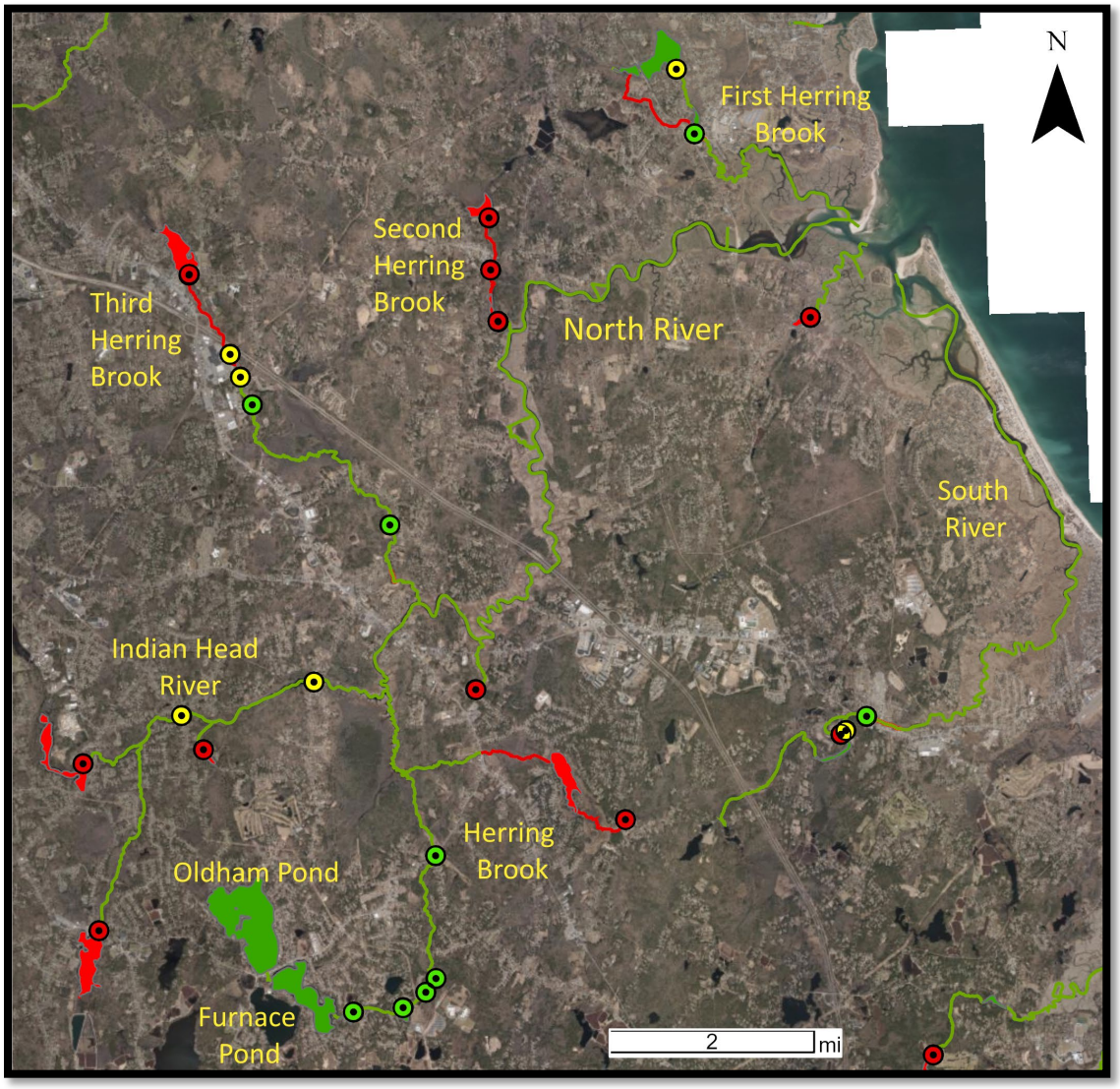
INTRODUCTION

The Herring Brook in Pembroke has historically been one of the largest river herring runs on the South shore of Massachusetts. Herring Brook is a tributary to the North River watershed that contains one of the largest fresh and saltwater wetlands in Massachusetts. The Herring Brook herring run has a long history of dedicated local management by the Pembroke Herring Fisheries Commission and prior Town entities. The Pembroke Fish Fry was held at the scenic Herring Brook Park for over 40 years to celebrate the herring run before being postponed during the 2020 pandemic. River herring harvest has been prohibited in Massachusetts since 2006 due to concerns over declining stocks. The objective of this sustainable fishery management plan (SFMP) is to allow a reopening of the traditional recreational river herring fishery in Herring Brook. The river herring run in the Herring Brook is primarily composed of alewife (*Alosa pseudoharengus*) with minor known occurrence of blueback herring (*Alosa aestivalis*). The river herring run begins in late-March and is typically over by the end of May.

WATERSHED

The North and South River watershed basin includes 114 mi^2 within eight towns in the South Shore Coastal Drainage Area. The watershed supports the municipal water supply for eight towns with a large dependency on groundwater (USDA 1982). The tidal North River meanders through extensive wetland that included 1,540 acres of salt marsh in the 1960s (Fiske et al. 1966). Tidal action strongly influences North River currents with a mean 8.8 ft tidal amplitude at the entrance and nearly 4 ft of tidal influence extending to the Indian Head River. Large fluctuations in salinity occur with each tide change. During summer high tides, salinity has been recorded over 11 miles upstream of the North River entrance (Fiske et al. 1966). Freshwater contributions are mainly provided by the following six tributaries: the South River, Herring Brook (also called Barker's River), Indian Head River, First Herring Brook, Second Herring Brook, and Third Herring Brook (Figure 1). Herring Brook has the headwaters of Oldham and Furnace Ponds and flows for approximately 4.5 miles in the Town of Pembroke to reach the North River. The drainage area of Herring Brook is 30.3 mi^2 with a 7-day/2-year flow of 1.0 cfs (USDA 1982). There is no USGS stream flow gauge station on Herring Brook.

Figure 1. North River Watershed. Waterways colored green are accessible to river herring and those colored red are impassable (MA DMF Diadromous GIS Data Layer).



The harvest of diadromous fish resources was important in the North River watershed for native Americans and colonial settlers. The abundance of sea-run fish declined in the 1700s with the advent of hydropower dams to support mill industries. The north-side tributaries of First, Second and Third Herring brooks all supported herring fisheries in the 1700s, although were reported to have few fish returning by 1831. Fiske et al. (1966) reported that river herring were nearly absent at the three north- side tributaries to the North River at the time of DMF's North River marine resource study. During Belding's survey of alewife fisheries in Massachusetts (1921) the watershed was heavily manipulated for hydropower and polluted by tack and rubber mills. Belding further reported that only Barker's River (Herring Brook) maintained a viable herring fishery at the time with three days open to public harvest per week during the run. This fishery was established as a public fishery to benefit the residents of Pembroke in 1790. Belding reported that 250 barrels (241,000 fish at 965 fish/barrel) of herring were harvested from the North River in 1912; of which the source was likely Barker's River.

Herring fisheries in Herring Brook and Indian Head River persisted after the herring runs in the other tributaries of the North River faded. By the 1960s, only Herring Brook maintained a viable fishery through

the diligent efforts of the Pembroke Herring Superintendent (Fiske et al. 1966). However, the Herring Brook herring run was reported to be declining in the 1960s, despite passage improvements and steady local stewardship, due to the introduction of beavers into the watershed in 1956, cranberry bog interactions with juvenile herring, and the construction of water supply pipeline in 1965 that diverted water (and juvenile river herring) from the Herring Brook watershed to the separate Silver Lake watershed (Reback and DiCarlo 1972). Reback and DiCarlo's (1972) anadromous fish survey portrayed a dire status for river herring at all North River tributaries, including the above concerns for Herring Brook. Their survey highlighted the need for stream channel maintenance and documented a robust American shad run in the Indian Head River and South River, as two of the few remaining shad fisheries in coastal Massachusetts.

The industrial-era mills that polluted the North River and tributaries are long gone. Although undocumented, it is likely that water quality in the watershed is better now than a hundred years ago. The present status of North River herring runs may be similar to the prior DMF reports with low numbers of herring in most tributaries (Chase 2006), and larger runs in Herring and Indian Head Brook. The third DMF/DFG survey of anadromous fish resources in 2000-2001 (Reback et al. 2005) reported that the Herring Brook herring fishery continued to underperform its potential due to degraded or inefficient fish passage at five fishways on the brook, and juvenile herring impacts from water supply operations and cranberry bog water management. Starting in 2011, much effort has gone into cooperative DMF and Pembroke Herring Fisheries Commission projects to restore the traditional herring run in Herring Brook.

FISHWAYS

The following three fishways are present in the Herring Brook watershed: Herring Brook Park off Barker Street; Third Mill Pond off Hobomock Street, and at the Gorman Mill Pond Dam. Two mill pond dams between Barker Street and Hobomock Street previously had wood fishways last build by the DMF Fishway Crew around 2000. The dams blew out during flood flows in 2005, eliminating the ponds and reducing the elevation changes to the point fishways were not needed. With no additional effort these stream channels have naturalized and readily pass migratory fish. The water diversion next to Gorham Mill Pond is also reported in this section; although not a fishway, the site has had potential to cause fish passage impacts.

Third Mill Pond Dam. A flume at the outlet of Third Mill Pond (also called Glover Mill Pond) used for cranberry farming was known to have a wood fish ladder for decades. The wood fish ladder was last rebuilt by the DMF Fishway Crew about 20 years ago. This fish ladder also blew out in the flood flows of 2005. The dam and fishway were reconstructed in 2011 under a project funded and managed by DMF with substantial engineering support from the MA Public Access Board. The scoping design was prepared by Dick Quinn of the USFWS. Engineering plans and permitting were provided by Tibbetts Engineering (Taunton, MA), and the construction was done by C. Naughton Corp. (Weymouth, MA). Design and permitting costs were approximately $19,000 and the construction costs were approximately $160,000 excluding the three 10 ft-sections of Alaskan Steeppass fish ladder contributed from DMF project stock. The new dam spillway has an elevation rise of 7 ft with a fishway length of 30 ft. and slope of 23.5%. A working draft Fishway Operation & Maintenance (O&M) plan was prepared for this site by DMF in 2011.

Herring Brook Park. The scenic and historic Herring Brook Park contains two channels that served former mill hydropower. The river-right channel has a gradual slope with no formal fishway needed but with a stone weir at the end of the channel that needs periodic adjustments. At the river-left channel remnants of mill works (Barker's Dam) at a culvert crossing that required both concrete stop-log slot weirs and rock weirs to raise water levels to allow fish passage through the culvert. This channel at the former mill works had long been a cause of fish mortality as fish struggled in the craggy channel and suffered from abrasion and stranding. The Town of Pembroke constructed a water wheel at the mill works in 2019. As part of this permitting, the DMF Fishway Crew conducted extensive rehabilitation of fish passage at this site with

repairs to granite channel walls, repairs to the culvert walls and floor, and the installation of new concrete and granite block weirs to step up water elevations through the mill works. The Fishway Crew returned in 2020 to add another concrete weir and raise the channel walls at some locations. A working draft Fishway O&M plan was prepared for this site by DMF in 2020.

Gorham Mill Pond. The Gorham Mill Pond Dam is a former mill complex owned by the City of Brockton and used for water supply purposes to backwater the Furnace Brook Diversion pipeline located at the other end of an earthen dam. The concrete dam at Gorham Mill Pond has a spillway width of 35.1 ft and height of 4.3 ft. A concrete sleave in the dam has housed wood fishways for decades. The DMF Fishway Crew removed a steel gate at the fishway exit in 2017 that had long caused physical damage to herring exiting the fishway and added an aluminum exit chute to allow safer passage and better fishway flow management. DMF last rebuilt the fishway in 2000 with a 20-baffle wood ladder (23 ft length and 1.6 ft width) The wood fishway degraded over time and required recent repairs by the Fisheries Commission and DMF. Following DMF's emergency repairs in March 2023, the fishway remarkably passed over a half million herring that season. In the summer of 2023, DMF replaced the wood ladder with a two-section, aluminum Alaskan steeppass section during a cooperative project with the Fisheries Commission.

Furnace Pond Diversion. The Furnace Brook diversion is owned and maintained by the City of Brockton to supplement their water supply at Silver Lake with diverted flow from Furnace Pond. The diversion intake is operated by gravity and raised concerns for decades that juvenile herring could be entrained through the trash rack (1" spacing) and diverted out of the Herring Brook watershed to Silver Lake. An agreement was made between DMF and the City of Brockton to design and install a new secondary screen at the diversion intake to prevent entry of juvenile river herring. A custom aluminum secondary screening system was funded and installed at the diversion by the City of Brockton in 2018. There have been no reports of river herring juveniles diverted from Furnace Pond to Silver Lake since 2018.

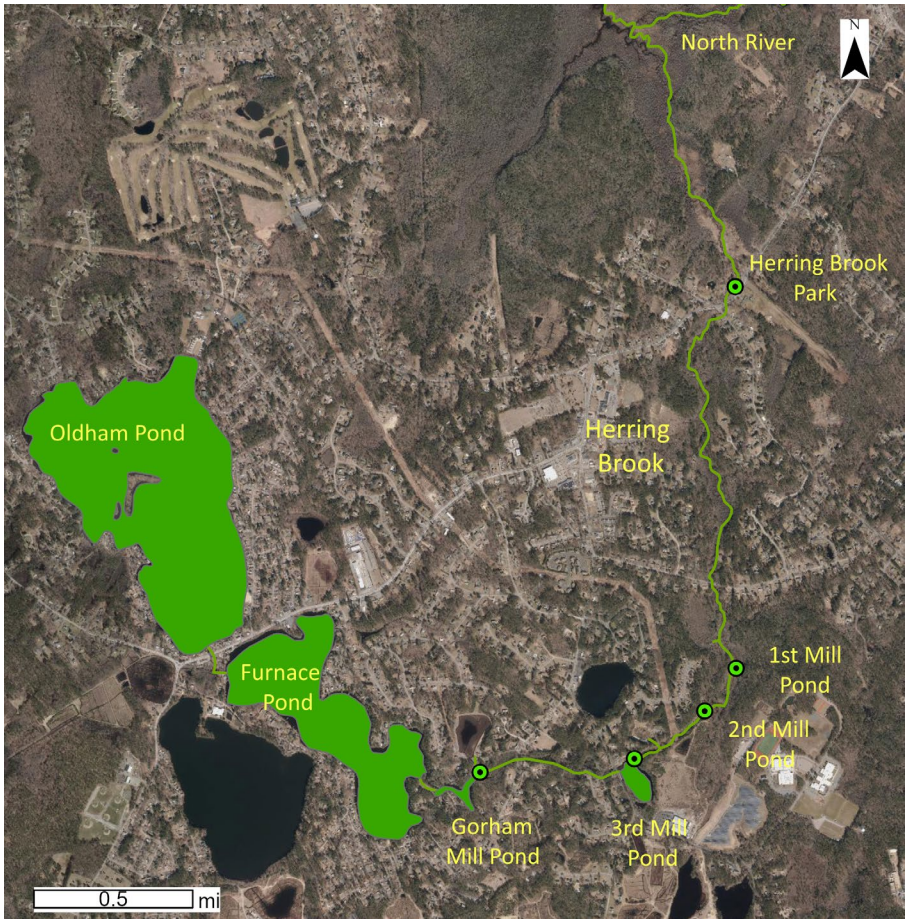
SPAWNING HABITAT

The primary spawning and nursery habitat for river herring in the Herring Brook watershed are Furnace and Oldham Ponds. A stream channel connects the 235-acre Oldham Pond to the 115-acre Furnace Pond. Outflow from Furnace Pond leads to the 2-acre Gorham Mill Pond. Herring Brook next flows to the 4-acre Third Mill Pond (Figure 2). All of these ponds are shallow and prone to excessive aquatic plant growth in summer. An aquatic plant harvester was deployed by the Town of Pembroke in 2020 to open the channel at the inlet of Third Mill Pond. Herbicide and alum treatments have been conducted by the Town of Pembroke to reduce the excessive growth of invasive plants in Furnace and Oldham ponds during the past 10 years. Belding (1921) reported that the herring run was also connected to Great Sandy Pond and Little Sandy Pond. Presently, river herring cannot access those ponds for spawning.

TOWN MANAGEMENT

There is a long history of active management of the Herring Brook herring run by the Town of Pembroke extending back to the 18th century. Belding (1921) describes this history in these words, "The alewife fishery on Barker's River is the traditional and sacred possession of the Town of Pembroke". Unlike many towns in coastal Massachusetts where mill works came to take precedence over the need for passage for migratory fish, from an early time, Pembroke required that mills allow for the spring migrations. In 1717, the Town of Pembroke authorized citizens to "go with neighboring Indians and clear the Herring Brook and to prosecute the author of any obstruction" – an early reference to fish passage and stream maintenance activities to ensure passage for sea-run fish[1]. In 1742, the Town ordered mills on Herring Brook to keep sluice gates for fish passage from April 1st until May 14th.

Figure 2. Primary river herring spawning and nursery habitat in Herring Brook, Pembroke.



Harvest in Herring Brook appears to have been mainly managed to allow spring spawning run netting for local sustenance. Commercial leases appear to have been limited to seining licenses in the main stem North River where each bordering town was granted a low number of leases. The seine fishery is reported by Belding (1921) to have largely been abandoned by 1898. Belding (1921) has no specific harvest numbers for the Herring Brook run other than to say that the run size was at 40% of its former potential and the North River total catch was 250 barrels of herring of which Herring Brooks was the most active site at the time. Town-managed harvest in the last 50 years was conducted under "local control" provisions of M.G.L. Chapter 130 §94 under which DMF authority to manage the river herring harvest was transferred to the Pembroke Board of Selectman under an approved plan in 1973.

Stream channel maintenance has long been an essential activity to ensure river herring can reach spawning ponds in Herring Brook. Concurrently with the reconstruction of the Third Mill Pond fishway in 2011-2012 a large cooperative effort began between DMF and the Pembroke Herring Fisheries Commission to investigate the entire brook channel from Furnace Pond to the North River confluence. Numerous significant blockages were found due to tree falls, debris jams and wetland plant encroachment. A stream maintenance plan was drafted by DMF in 2016 to guide responsible stream maintenance practices in Herring Brook. The reconstruction of the fishway at the impassible Third Mill Pond Dam in 2011 was certainly a main driver in the sharply increasing numbers of returning river herring in Herring Brook. The collective efforts of DMF and the Fisheries Commission to diligently conduct stream maintenance and repair fishways at the Herring Brook Park and Gorham Mill Pond Dam since 2011 are important contributions to this regional success story in river herring population restoration.

POPULATION AND HARVEST ESTIMATES

Historical information on the Herring Brook herring run is limited to the Belding (1921) survey and fragments from historical summaries. DMF installed a Smith-Root electronic fish counter at the Third Mill Pond fishway in 2015. The electronic count series at the Third Mill Pond Brook provides 11 years of spawning run count data from 2015 to 2025. A volunteer visual count at this same location has 13 years of counts during 2012-2025 following the methods of Nelson (2006). Using both count series, there are 14 years of spawning run counts since the fishway reconstruction, that can be used to develop sustainability metrics for the SFMP (Table 1). The spawning run counts of 2019, and 2023-2025 are among the highest reported, even considering anecdotal historical records. With over 350 acres of spawning and nursery habitat available in the watershed, these counts equate to approximately 1,000 fish per spawning acre. Relative to other river herring spawning runs with counts in Massachusetts this proxy for productivity is higher than average (DMF, unpublished data), and impressive contemporary run counts given the long-distance fish must travel from the tidal North River and the type and number of relatively small capacity fishways that must be passed.

The very low counts of 2021 and 2022 were unexpected, and a decline not seen with neighboring herring runs. These low counts caused DMF and the Town of Pembroke to pause plans in 2022 to develop a SFMP for herring harvest. The reasons for the sharp decline are not known; however, stream blockages were discovered during this period that may have limited Herring Brook access. Large spawning events of river herring were observed by DMF staff in the 1990s in the upper reaches of the main stem North River (Chase 2006). Given the rebound seen in 2023 and absence of other runs in Massachusetts showing this pattern, it is not expected that these low numbers represent recruitment failure. It is possible that an unknown proportion of the herring migrating to Herring Brook were compelled to spawn at other tributaries in the watershed or the main stem North River for those years.

The volunteer visual count produced a run count estimate for 13 of the 14 years during 2012-2025. Ten of the visual counts came concurrently with the electronic count, allowing a comparison of the two methods. The average ratio of the visual count to the electronic count is 0.34, with a range of 0.07 to 0.55. The ratios for the two low count years of 2021 and 2022 were noticeably lower than other years. Without those two years, the ratios are fairly consistent and average 0.40. The SFMP metric in Table 1 uses the average comparison ratio of 0.34 to allow the inclusion of 2012-2014 in time series. This adjustment includes the first few years after the Third Mill Pond fishway reconstruction. We expect that this approach and the inclusion of the dubious low count years of 2021 and 2022 are conservative influences on the time series mean.

Electronic Counting Station. DMF installed an eight-tube, Smith-Root 1601 electronic counter at the Third Mill Pond fishway in 2015. The counting station is managed by DMF staff and the Herring Commission with daily coverage throughout the spawning run. The counter accuracy is derived from daily, five-minute visual comparison counts. The ratio of fish observed, and fish counted are a proxy for counter accuracy. The DMF accuracy target is at least 90% for both average of all seasonal comparison counts, and the seasonal ratio of all counts summed. This accuracy target was met for the Pembroke station in 2023 and 2024 since adopting these quality assurance protocols for DMF electronic counters (Chase et al. *In Press*).

Table 1. River herring spawning run count data at Herring Brook, Pembroke. Volunteer visual counts began in 2012 at the Third Mill Pond Dam. Electronic counts began at the same location in 2015, with ten years of direct comparison.

Year	Visual Count (No.)	Electronic Count (No.)	Comparison Ratio (%)	Adjusted Count (No.)
2012	99,035			291,279
2013	81,902			240,888
2014	38,663			113,715
2015		125,010		125,010
2016	130,619	238,410	0.55	238,410
2017	114,350	307,832	0.37	307,832
2018	119,662	348,634	0.34	348,634
2019	180,414	476,609	0.38	476,609
2020	75,150	187,776	0.40	187,776
2021	2,519	38,117	0.07	38,117
2022	5,808	48,057	0.12	48,057
2023	190,177	568,877	0.33	568,877
2024	201,331	444,075	0.45	444,075
2025	200,679	470,380	0.43	470,380
Mean	110,793	295,798	0.34	278,547
Median				266,084
25th Percentile				140,702
10% of Mean				27,855

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 Management Plans (SFMP) for river herring (ASMFC 2009). These plans are to be developed and approved by State jurisdictions then reviewed by the ASMFC Technical Committee (TC) and if suitable forwarded to the ASMFC Shad and River Herring Management Board (Board) for approval. The premise is that SFMPs should allow harvest while not diminishing the potential future reproduction and recruitment of herring stocks. The SFMPs are based on Sustainability Targets that relate management responses to population action and warning levels. SFMPs can be river-specific, regional or state-wide.

> ***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 management planning).*
>
> *The first ASMFC review of SFMPs occurred during 2011-2012 when state plans from ME, NH, NY, NC and SC were approved. The sustainability targets from these SFMPs were mainly based on exploitation rates and escapement targets related to fishery dependent harvest or independent herring spawning run counts. A recruitment failure definition and a juvenile index were applied in one case each as sustainability targets. Several states indicated their intention to investigate*

the future use of population metrics (mortality, length, Catch-per-Unit-Effort, and repeat spawning ratio) as sustainability "measures" or warning limits.

ASMFC Update. During the 2017-2018 review of new SFMPs and renewals from 2011-2012, the TC identified several inconsistencies between state SFMPs and the requirements of Amendments 2 and 3. As a result, the Board tasked TC with developing proposed improvements to Amendments 2 and 3 with regard to the five items below. The Board reviewed the TC recommendations in February 2021 and subsequently directed TC to develop a technical guidance document to ensure that implementation of Amendment 2 and 3 requirements related to the issues outlined below is consistent with the TC recommendations. The guidelines were presented to the Board in April 2021 (ASMFC 2021).

1.) Management and monitoring of rivers with low abundance and harvest of shad and river herring.
2.) Standardization of SFMP requirements: content, metrics, and management responses to triggers.
3.) Incorporation of stock assessment information into SFMPs and discussion on the timeline for renewing plans.
4.) Clarification of de minimis requirements as they pertain to SFMPs.
5.) Review of the number of years of data are required before developing a SFMP.

The Herring Brook SFMP was prepared with consideration for the pertinent guideline updates with provisions adopted where applicable for items #2, 3 and 5:

Standardization of SFMPs. The 2021 TC guidelines recommend that standardized management responses are provided in SFMPs. For example, if a stock falls below the sustainability target or threshold identified in the SFMP, the state must notify the Board in the next annual compliance report and pursue implementation of the specified management response for the following calendar year. This approach is adopted in the Herring Brook SFMP and described below under "Management Actions".

Stock Assessment Information. The TC supported the inclusion of stock assessment information such as size, age and mortality data in SFMPs; however, the TC did not recommend that new requirements should be made at this time. Each jurisdiction should develop sustainability metrics for their SFMPs and review all available population data with each 5-year plan renewal to see if stock assessment updates or other data can be utilized as metrics in SFMPs. The Herring Brook SFMP discusses the collection of biological data for this population below under Potential Future Metrics.

Time Series Duration. The guidelines standardized the acceptable time-series duration for data supporting a sustainability metric to be 10 consecutive years for river herring, with allowance of a shorter duration of 7-9 years if the TC accepts additional information related to the proposed exploitation rate, stock size, or other relevant factors. The Herring Brook SFMP is based on 11 years of electronic spawning run count data with three additional years of visual count data.

Town of Pembroke Objectives. The Pembroke Herring Fisheries Commission sent a request to DMF in December 2020 to begin an evaluation of opening harvest of river herring in Herring Brook. The Herring Brook herring harvest was closed in 2006 with the coast-wide harvest moratorium. The Town cites improvements in spawning run counts since cooperative fish passage restoration began in the watershed in 2011 as justification to open the traditional recreational harvest. A draft SFMP was prepared in April 2022; however, the very low spawning counts of 2021 and 2022 prompted DMF and the Town to postpone

submittal of the SFMP to ASMFC. The improved counts of 2023 and 2024 caused the Town to request revisiting the draft SFMP.

State Role. The DMF supports this request and has proceeded to evaluate the existing spawning run count data from Herring Brook. From this review, the following framework is presented for a Herring Brook SFMP for river herring. The proposed SFMP would commence in 2026. The harvest ban would at that time have been in place for 20 years (2006–2025) and the count time series duration will be 14 years in total; with 11 years for the electronic count and 3 additional years for the volunteer visual count.

Herring Brook SFMP

Management Unit. The SFMP has a river-specific management unit of the Herring Brook herring run in the Town of Pembroke.

Sustainability Measures. The ongoing spawning run count will serve as the primary measure to monitor the Herring Brook 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 every three years. Table 1 provides the run count statistics that formed the basis of the recommended sustainability target.

Primary Action Threshold. The 25th percentile of the Herring Brook run count time series will serve as the primary action threshold to trigger a management response to declining run size.

Secondary Threshold. An annual exploitation rate of 10% of the run size will serve as a secondary threshold or warning limit. 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, DMF will meet with the Pembroke Herring Fisheries Commission to review harvest records and management practices and document the review and cause of increase in exploitation rate in a joint memorandum.

Management Actions. With two consecutive years that the Herring Brook run count is below the 25th 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 25th 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.

Biological Samples. DMF does not presently sample adult river herring in Herring Brook. DMF will work with the Herring Commission to record river herring length subsamples from harvested fish in 2026 as described below:

Potential Future Metrics. With the SFMP implementation, there may be opportunity to record biological data from harvested fish. The DMF Diadromous Fish Project may not have the resources to add the full biological sampling with age processing for another counting station at this time. However, it may be possible to collect robust samples of length by sex that can be used to prepare secondary sustainability metrics on mean length. Further, escapement targets could be calculated based on the relation of the spawning run count to spawning and nursery habitat area.

Mean Length. Mean length data provides similar evidence of demographic status as age data with reduced diagnostic capability due to interannual growth changes and the influence of cohort dynamics to shape mean data. However, these data are accessible and with growing duration of the time series, could become a useful index of population change. With the implementation of the SFMP, the Herring Commission will endeavor to measure samples of harvested river herring on open harvest days in cooperation with DMF staff. Permit holders will be asked if they are willing to have their weekly catch limit measured. The Herring Commission will target subsamples of 50 herring to record species, sex, and total length on each open harvest day.

Escapement Targets. Future SFMPs for Herring Brook could alternatively consider to annually open harvest following the meeting of a suitable escapement target of incoming spawners was met. The escapement target would depend on real-time reporting from the electronic counting station and relate counts to a spawning habitat productivity metric. For example, the Maine Department of Marine Resources uses a calculation based on spawners per surface acre of spawning and nursery habitat (Havey 1961 and 1973) to set escapement targets. This would guarantee a certain number of spawners entering the spawning habitat and guard against unexpected low returns.

HARVEST MANAGEMENT

Reopening harvest in a few individual rivers after 20 years of a coast-wide harvest ban creates management and enforcement challenges given that Massachusetts has about 100 rivers within 48 coastal towns that contain river herring runs. Presently, only the Nemasket River and Herring River, Harwich have approved SFMPs for river herring harvest in Massachusetts. However, these Towns have not elected to allow a harvest after receiving ASMFC approval. 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 DMF since the harvest ban; however, relatively few other herring runs presently have the full complement of favorable stock status, a suitable data series, and the infrastructure and dedication found with the local management in Middleborough-Lakeville, Pembroke and Harwich. The preparation of the Pembroke SFMP was done to be consistent with the two approved SFMPs. The intention is to develop an integrated and consistent approach to reopen river herring harvest in Massachusetts, with multiple sites for citizens to access fish.

Proposed Harvest Management. The numbers of permits, weekly catch limits and harvest days will be managed to avoid exceeding the harvest target of 27,855 (10% of TSM). The Town of Pembroke will have the prerogative to adjust the following harvest scenarios if they wish to target a harvest total lower than the SFMP maximum harvest amount. Because river herring are a natural resource under the jurisdiction of the Commonwealth of Massachusetts, all Massachusetts citizens should have potential access to the river herring harvest managed by the Town of Pembroke. Town residents can have preferred access with a lower cost permit. The permitting process for several Massachusetts Towns prior to the harvest ban was to set a ratio of permits for residents and non-residents, cap the total number of permits, and if needed, set a lottery system for non-residents.

A ratio of 4:1 for residents to non-residents is recommended for permits; with a maximum permit number of 300. Recommended costs for permits are $25 for residents with possible consideration for different costs for seniors and non-residents. In order to limit harvest to 10% of TSM sustainability metric, a truncated season would have to be closely managed. A cap of 225 resident and 75 non-resident licenses would be enacted with a weekly catch limit of 15 fish allowed over a five-week season with three open

days per week. The potential maximum catch under this scenario would be 22,500 fish. Assuming that half the permit holders catch their maximum allowance, and the other half only realize half of their maximum harvest, the harvest would be estimated to be 16,875 fish. This assumption is not based on past harvest records but the expectation that some permit holders will remain inactive or minimally active each year. These recommended permit/catch limits numbers may be modified by the Town of Pembroke as they manage annual harvest within the requirement of not exceeding the annual harvest limit.

Harvest Monitoring. The potential for harvest to exceed the sustainability target exists under all possible options if a high proportion of permit holders takes the full weekly harvest each week. This outcome is hard to predict but can be tracked once harvest is open. The SFMP 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. Harvest will only be allowed at Herring Brook Park during three open days per week. Set times for harvest will be posted on the open days and Town Herring Wardens will be present to supervise harvest and issue daily catch cards. The Town may allow permit holders to catch their own fish or have the wardens net fish for people. The Town of Pembroke is investigating whether Herring Wardens can be authorized to issue citations for harvest violations at the harvest location and other locations in Pembroke. No harvest will be allowed at other locations in Pembroke.

Harvest will be monitored through the issuance of daily catch cards to each permit holder that harvests herring. The card would indicate the date, permit number, number of fish and will expire in 30 days. State regulations will be changed by DMF to require that any possession of river herring in Massachusetts be accompanied by the Herring Brook 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 will be professionally printed on waterproof paper.

The usage of harvested river herring trended sharply towards striped bass bait in the decade leading up the state-wide harvest ban. Prior to that trend, cases of excessive herring harvest for lobster bait were reported to DMF. DMF recognizes that a component of the concern that led to the state-wide ban on river herring harvest was excessive bait harvest and related declining conservation ethics. Recreational bait use will be allowed; however, the SFMP seeks to promote and encourage traditional uses of consumption of river herring as grilled, pickled, and smoked fish and fried roe. There will be public outreach associated with the implementation of the SFMP that encourages responsible use of herring for bait and traditional use as food. The Pembroke Herring Fisheries Commission will also consider accommodating requests for food as able. For example, requests for only females for roe harvest might be allowed when manageable on-site during the three open days per week. In these cases, the Commission should record the female only harvests and compensate daily as needed by providing males for bait use.

Harvest Timing. Older repeat spawners are known to occur at a higher proportion at the onset of river herring spawning runs than later in the run (DMF, unpublished data). The Herring Commission will coordinate with DMF's daily monitoring of the electronic spawning run count to set the start date of the harvest two weeks after the run onset. This timing can be adjusted as experience is gained with harvest management.

Native American Harvest. The Commonwealth of Massachusetts recognizes the aboriginal practice of the Federally recognized tribes (Wampanoag and Aquinnah) to harvest river herring at ancestral river herring runs in Massachusetts. In prior years, a Memorandum of Agreement was signed between DMF and the Wampanoag tribe with the agreement that harvest was an aboriginal right for sustenance purposes only and that harvest would be reported by river to DMF. There does not appear to be much tribal harvest activity at Herring Brook. As needed, DMF will coordinate with Federally recognized tribes on harvest at Herring Brook 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 Massachusetts Environmental Police (MEP), and participation from Town law enforcement. A coordination meeting will be held with MEP, DMF, Town Police, and the Pembroke Herring Fisheries Commission each year prior to the season start. DMF recently enact changes to the existing state regulations that ban state-wide harvest to allow harvest and possession of river herring in accordance with approved SFMPs.

The MEP recommends that the Pembroke Herring Fisheries 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 provided online by the Town of Pembroke. This approach is recommended by the SFMP. The Town of Pembroke will endeavor to create this process during the initial SFMP 5-year period; recognizing that experiences of the first open season will instruct how to structure and manage this accounting.

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.

ASMFC (Atlantic States Marine Fisheries Commission) 2021. Technical Guidance for Implementation of Amendments 2 and 3 to the Shad and River Herring Fishery Management Plan. March 2021.

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

Chase, B.C. 2006. Rainbow smelt (*Osmerus mordax*) spawning habitat on the Gulf of Maine Coast of Massachusetts. Massachusetts Division of Marine Fisheries, Technical Report TR-30. http://www.mass.gov/dfwele/dmf/publications/tr30_smelt_spawning_habitat.pdf

Chase, B.C., J.J. Sheppard, S. Berkman, B. Gahagan, M. Burgess, and J. Holbeche. (*In Press*). River Herring Spawning Run Counting Method Guidance - Standard Operating Procedures. Massachusetts Division of Marine Fisheries, Technical Report Series.

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.

Fiske, J.D., C.E. Watson, and P.G. Coates. 1966. A study of the marine resources of the North River. Monograph Series No. 3. Mass. Div. Mar. Fisheries. 74 p.

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

FOOTNOTES

[1]Ancient Landmarks of Pembroke