FISHERY MANAGEMENT PLAN UPDATE
RIVER HERRING
AUGUST 2019

STATUS OF THE FISHERY MANAGEMENT PLAN

Fishery Management Plan History

Original FMP Adoption:	February 2000
Amendments:	Amendment 1 – September 2007 Amendment 2 – May 2015
Revisions:	None
Supplements:	None
Information Updates:	None
Recommended Schedule Change:	None
Next Benchmark Review:	May 2025
Next MFC Scheduled Review:	July 2020

In North Carolina blueback herring (*Alosa aestivalis*) and alewife (*Alosa peseudoharengus*), collectively known as river herring, are managed under Amendment 2 to the North Carolina River Herring Fishery Management Plan (FMP) for River Herring. The original North Carolina River Herring FMP adopted February of 2000, focused on issues pertaining to stock conditions (overfished and recruitment overfishing), habitat degradations, and research/monitoring expansion to provide assessment data and socioeconomic data (NCDMF 2000). Amendment 1 to the North Carolina River Herring FMP implemented a no-harvest provision for commercial and recreational fisheries of river herring in coastal waters of the state, effective in 2007 (NCDMF 2007). This was a result of the North Carolina Division of Marine Fisheries (NCDMF) 2005 stock assessment of river herring (data through 2003) that determined blueback herring and alewife were overfished and overfishing was occurring, there was minimal recruitment with continued declines in abundance for both species, and high fishing mortality rates (Grist 2005). Additional management strategies included gear restrictions and stock recovery indicators (based on blueback herring). It also included a 7,500 pounds limited research set-aside harvest to be used for data collection and to provide product to local herring festivals. The NCDMF Director allocated a maximum of 4,000 pounds to be used for this discretionary harvest season by permitted fishermen, which occurred in the Chowan River Herring Management Area around Easter week each year. Additional outcomes of Amendment 1 included implementing monitoring programs, endorsing additional research on predation, restoration, impediments, bycatch and supporting spawning area habitat protection.

Amendment 2 to the North Carolina River Herring FMP was finalized in 2015 with three issues: 1) eliminating the discretionary river herring harvest season and permit since it was not serving the intended purposes of providing biological data for stock analysis and local product; 2) moving the Albemarle Sound/Chowan River Herring Management Areas to 15A NCAC 03R .0202, which corrected a reference and corrected the boundary of the Cashie River Anadromous Fish Spawning Area, and 3) removing alewife and blueback herring from exceptions in the Mutilated Finfish Rule 15A NCAC 03M .0101 (NCDMF 2015a).

Due to the Rules Review Committee receiving at least 10 letters requesting legislative review (pursuant to G.S. 150B), a portion of the third issue to prohibit possession of river herring (alewife and blueback herring) greater than six inches aboard a vessel or while engaged in fishing from the shore or a pier underwent legislative review during the 2016 spring short session. Since a bill was not introduced specifically disapproving the rule, the rule was effective June 13, 2016 in the River Herring Rule 15A NCAC 03M .0513.

In addition to the state FMP, North Carolina river herring also are managed through Amendment 2 of the Atlantic States Marine Fisheries Commission (ASMFC) Interstate FMP for Shad and River Herring. Adopted in 2009, Amendment 2 requires management measures from the ASMFC be adopted by North Carolina as the minimum standard for the fishery, while the North Carolina plan can adopt additional measures (ASMFC 2009). Additionally, Amendment 2 requires that states and jurisdictions develop sustainable FMPs in order to maintain a commercial and/or recreational river herring fishery past January 2012.

To ensure compliance with interstate requirements, North Carolina also manages river herring under the North Carolina Fishery Management Plan for Interjurisdictional Fisheries (IJ FMP). The goal of the IJ FMP is to adopt fishery management plans, consistent with N.C. law, approved by the Mid-Atlantic Fishery Management Council, South Atlantic Fishery Management Council, or the ASMFC by reference and implement corresponding fishery regulations in North Carolina to provide compliance or compatibility with approved fishery management plans and amendments, now and in the future. The goal of these plans, established under the Magnuson-Stevens Fishery Conservation and Management Act (federal council plans) and the Atlantic Coastal Fisheries Cooperative Management Act (ASMFC plans) are like the goals of the Fisheries Reform Act of 1997 to "ensure long-term viability" of these fisheries (NCDMF 2015b).

Management Unit

Blueback herring (*Alosa aestivalis*) and alewife (*Alosa pseudoharengus*) management authority lies with the ASMFC. Responsibility for management action in the Economic Exclusive Zone (EEZ), located from 3 to 200 miles from shore, lies with the Secretary of Commerce through the Atlantic Coastal Fisheries Cooperative Management Act in the absence of a federal FMP. The NCDMF also has a state FMP in place for statewide management of river herring.

Goal and Objectives

The goal of Amendment 2 to the North Carolina River Herring FMP is to restore the long-term viability of the river herring population. To achieve this goal, the plan adopts the following objectives:

1. Identify and describe population attributes necessary to sustain long-term stock viability.
2. Protect, restore, and enhance spawning and nursery area habitats.
3. Initiate, enhance, and/or continue programs to collect and analyze biological, social, economic, fishery, and environmental data needed to effectively monitor and manage the river herring fishery.
4. Promote education and public information to help the public understand the causes and nature of problems in the river herring stocks, its habitats and fisheries, and the rationale for management efforts to solve these problems.

The goal of Amendment 2 to the ASMFC Interstate FMP for Shad and River Herring (River Herring Management) is to protect, enhance, and restore east coast migratory spawning stocks of alewife and blueback herring in order to achieve stock restoration and maintain sustainable levels of spawning stock biomass. To achieve this goal, the plan adopts the following objectives:

1. Prevent further declines in river herring (alewife and blueback herring) abundance.
2. Improve our understanding of bycatch mortality by collecting and analyzing bycatch data.
3. Increase our understanding of river herring fisheries, stock dynamics and population health through fishery-dependent and independent monitoring, in order to allow for evaluation of management performance.
4. Retain existing or more conservative regulations for American shad and hickory shad.
5. Promote improvements in degraded or historic alosine critical habitat throughout the species' range.

STATUS OF THE STOCK

Life History

River herring is a collective term for alewife and blueback herring. River herring are anadromous fish, meaning they migrate from the ocean, through inlets into coastal bays and sounds and ascend into freshwater rivers and streams to spawn. Alewife spawn in rivers, lakes, and tributaries from northeastern Newfoundland to South Carolina, but are most abundant in the Mid-Atlantic and the Northeast. Blueback herring prefer to spawn in swift flowing rivers and tributaries from Nova Scotia to northern Florida but are most numerous in waters from the Chesapeake Bay south. Mature alewife (ages 3 to 8) and blueback herring (ages 3 to 8) migrate rapidly downstream after spawning. Juveniles remain in tidal freshwater nursery areas in spring and early summer but may also move upstream with the encroachment of saline water. As water temperatures decline in the fall, juveniles move downstream to more saline waters. Little information is available on the life history of juvenile and adult river herring after they emigrate to the sea and before they mature and return to freshwater to spawn.

Adult river herring feed primarily on zooplankton (small, often microscopic animals floating in the water column) although they may also feed on fish eggs, crustacean eggs, insects and insect eggs, and small fish in some areas and in larger individuals. In general, alewife are larger than blueback herring of the same age and with each species females are larger than males. Total length for either species in North Carolina rarely exceeds 12 inches.

Stock Status

An Atlantic coast-wide stock assessment update for river herring was completed in August 2017, with data through 2015, by the Atlantic States Marine Fisheries Commission. Results indicate that river herring remain depleted and at near historic lows on a coast-wide basis (ASMFC 2017). The North Carolina portion of the coast-wide stock assessment is for the Chowan River blueback herring stock only, due to the long-term data available for this area. River herring in other parts of the state are currently listed as unknown by the ASMFC due to the lack of data for these systems. The stock assessment update found that, although the North Carolina stock in the Chowan River was not experiencing overfishing (harvesting from a stock at a rate greater than the stock's reproductive capacity to replace fish removed through harvest) due to the harvest moratorium, the stock still remains overfished. The factors leading to this recommendation of stock status remain largely unchanged since the 2012 stock assessment, despite a fishing pressure that is negligible. The spawning stock biomass (SSB) for blueback herring, a stock status indicator, remains 12% of the amount necessary to replace itself in the complete absence of fishing (Figure 1).

Stock Assessment

The ASMFC stock assessment update used a forward-projecting, age-structured statistical catch-at-age model for the Chowan River blueback herring stock. The stock assessment incorporated blueback herring data from total in-river catches, age compositions, length compositions and a fisheries-independent juvenile index to estimate age-3 abundance and mortality rates, from 1972 to 2015. Based on the 2015 fishing mortality rate and female spawning stock biomass estimates, the Chowan River blueback herring population is overfished but over-fishing is not occurring. Estimates of fishing mortality have been close to zero since the moratorium. Juvenile abundance is well below the target of 60 fish per haul with no increasing pattern evident. The percentage of repeat spawners varied from 2007 through 2010, remaining below the target of 10%, but has exceeded the target since 2011 to the highest level in 22 years of 16.8% in 2015. The SSB for blueback herring has been increasing since 2010, but still remains at approximately 12% of the target of 3.9 million pounds.

It is worthy to note the importance physical habitat and water quality play in the recovery of the river herring stocks in North Carolina and coast-wide (NCDMF 2009). In North Carolina, considerable habitat area has been lost through wetland drainage, stream channelization and conversion to other uses. Some streams are blocked by dams, storm debris, and other physical barriers. Migration and spawning may be affected by the replacement of small road bridges and culverts. Oxygen consuming wastes are discharged into several streams and practices to control non-point discharges are inadequate causing nuisance algal blooms, fish kills, and fish diseases over the years. The NCMDF initiated a survey of culverts and obstructions following

Amendment 1 to the 2000 River Herring FMP. The list created from the survey has resulted in the replacement of failing culverts and prioritized others for replacement or repair.

STATUS OF THE FISHERY

Current Regulations

In 2007, Amendment 1 to the North Carolina River Herring FMP implemented a no-harvest provision for commercial and recreational fisheries of river herring in coastal waters. The North Carolina River Herring FMP Amendment 2, adopted by the North Carolina Marine Fisheries Commission (NCMFC) in May 2015, eliminated the discretionary river herring harvest season and permit, removed alewife and blueback herring from exceptions in the Mutilated Finfish Rule, and prohibited the possession of river herring (blueback herring and alewife) greater than six inches aboard a vessel or while engaged in fishing from the shore or a pier.

Commercial Landings

North Carolina landings of river herring from 1972 through the mid-1980s peaked at 11.5 million pounds (Table 1 and Figure 2). Most landings occurred in the Chowan River and Albemarle Sound system. River herring landings declined sharply starting in 1986, prior to the implementation of regulations specific to river herring, first implemented in 1995. Amendment 1 implemented a no-harvest provision in 2007, allowing only for a limited discretionary harvest to provide local herring to festivals and continue NCDMF data collection from commercial fisheries. Table 2 includes information on landings data from 2007 through 2014 when the limited research set-aside season was prosecuted before being eliminated under Amendment 2 in 2015.

Recreational Landings

There is currently no recreational fishery for river herring per the no harvest provision outlined in Amendment 1. Formerly, most river herring caught recreationally were likely used for personal consumption or for bait. For the years leading up to the 2007 harvest closure, the extent of river herring harvest for personal consumption and bait in coastal North Carolina is unknown.

MONITORING PROGRAM DATA

Fishery-Dependent Monitoring

Commercial fishing activity is monitored through fishery-dependent sampling conducted by the NCDMF since 1972 in the Chowan River. The dominant gears for river herring were gill nets and pound nets. In 2007, the no-harvest provision essentially eliminated commercial landings. However, the Chowan River Pound Net survey was implemented in 2008, for the 2009 sampling year, to provide estimates of commercial catch-per-unit effort (CPUE), percent of repeat spawners, and age and sex data for alewife and blueback herring.

Table 3 and Table 4 describe the mean, minimum and maximum length data for blueback herring and alewife from 1972 to 2018. In 2018, a total of 1,232 blueback herring and 1,360 alewife were measured from the Chowan River pound net survey. The overall average size of blueback herring was 9 inches fork length and 9.25 inches fork length for alewife. Variation in modal, minimum, and maximum ages throughout the fishery-dependent monitoring is described in Table 5 for blueback herring and Table 6 for alewife, with little variation across the time-series. Figure 3 and Figure 4 illustrate the overall length at age (mean, minimum, and maximum) for blueback herring and alewife from all age samples collected at any given age from 1972 to 2018.

The NCDMF has monitored river herring repeat spawning since 1972 (Table 7 and Figure 5). Percent repeat spawners for blueback herring from the Chowan River spawning stock is one of the stock recovery indicators identified in Amendment 1. The Chowan River blueback herring spawning stock should contain at least 10% repeat spawners (percent of the spawning stock that have spawned more than once). Since 2011, percentages of blueback herring have increased to levels above the restoration target, with the exception of 2017. For alewife percentages have been above the restoration target since 2007, with the exception of 2014.

Total pound net effort (operable nets per week), estimated total river herring catch (pounds), and CPUE for the Chowan River Pound Net Survey (Table 8) shows a downward trend through 2012 followed by an increasing trend through 2017. In 2018, approximately 47% of the estimated total river herring catch were blueback herring, based on the weekly subsample of river herring from the survey.

Fishery-Independent Monitoring

The NCDMF has conducted an annual juvenile (age-0) seine survey for river herring since 1972. The seine survey has been conducted twice a month, at eleven fixed sites, in the Albemarle Sound-Chowan River area from June to October. Only the first pull from each month is used to calculate the index of abundance for juvenile river herring. Juvenile index of abundance of blueback herring is one of the stock recovery indicators identified in Amendment 1. The blueback herring juvenile index should exceed the three-year moving average 60-fish per haul. The relative annual abundance of juvenile blueback herring has remained well below the target of 60-fish per haul since the mid-1980's (Figure 6). Due to the low numbers of juvenile alewife caught across the time series, these data have not been used for management and are only shown here as an illustration of the trend in abundance (Figure 7). In 2018 overall mean CPUE was 0.02 for blueback herring and 3.0 for alewife, well below the restoration target.

Adult river herring are monitored using the NCDMF Albemarle Sound Independent Gill Net Survey (IGNS). The Albemarle Sound IGNS began collecting biological data on adult river herring in 1991, but did not start collecting aging structures until 2004. The survey uses a stratified random sampling scheme designed to characterize the size and age distribution for key estuarine species in the Albemarle Sound. River herring CPUE has been calculated from the Albemarle Sound IGNS since 1991. Blueback herring and alewife CPUE from the 2.5 and 3.0 inch stretched mesh (combined), January through May, 1991 to 2018 are shown in Table 9 and Figure 8. Catch of both species has increased since 2012.

Table 10 and Table 11 describe the mean, minimum and maximum length data for alewife and blueback from 1991 to 2018. In 2018, a total of 1,764 blueback herring and 1,950 alewife were measured from the Albemarle Sound IGNS. The overall average size of blueback herring was 9.50 inches fork length and 9.25 inches fork length for alewife. Variation in modal, minimum, and maximum ages throughout the fishery-dependent monitoring is described in Table 12 for blueback herring and Table 13 for alewife, with little variation since aging began in 2004. Figure 9 and Figure 10 illustrate the overall length at age (mean, minimum, and maximum) for blueback herring and alewife from all age samples collected at any given age from 2004 to 2018.

MANAGEMENT STRATEGY

Amendment 1 to the North Carolina River Herring FMP implemented four stock recovery indicators to evaluate stock status. Under Amendment 2 to the North Carolina River Herring FMP, the plan development team determined that only three of the stock recovery indicators were necessary and decided that the term stock status indicator was more appropriate, using blueback herring as the indicator species. The three stock status indicators were adopted by the North Carolina River Herring FMP plan development team, each based on a three-year moving average. The plan development team recommended using the first two stock status indicators (juvenile abundance and repeat spawners) as a trigger for doing a stock assessment earlier than 10 years. If a three-year moving average of each of the indicators was above the threshold, it would trigger the need for a new stock assessment, which would determine the third stock status indicator. The third stock status indicator sets the threshold that determines when the river herring fishery will re-open.

1. Catch per unit effort (CPUE) of 60 young-of-the-year per haul in the Albemarle Sound juvenile abundance survey.
2. Ten percent repeat spawners observed in fishery-dependent pound net samples.
3. Spawning stock biomass (SSB) of 30% unfished SSB, estimated in stock assessment model.

Collectively, these indices represent *minimal* stock rebuilding goals for the recovery of river herring stocks in the Albemarle Sound and Chowan River. In the 2012 stock assessment ASMFC recommended a ten-year interval between stock assessments (ASMFC 2012). The plan development team recommended using the first two stock status indicators (juvenile abundance and repeat spawners) as a trigger for doing a stock assessment earlier than 10 years. If a three-year moving average of the first two indicators was above the threshold, it would trigger the need for a new stock assessment, which would determine the third stock status indicator.

The stock status indicator for percent repeat spawners of blueback herring has exceeded the target of 10% since 2011, except for 2017. The increase in the percent repeat spawners is a positive sign, which means that the current management strategy is working. Juvenile abundance has remained well below the target since the early 1990s. Spawning stock biomass will need to continue to increase enough to see results in the juvenile index before the fishery could reopen.

RESEARCH NEEDS

The NCMFC implemented a series of management strategies under North Carolina River Herring FMP Amendment 2. These management strategies and their implementation status are listed in Table 13. On an annual basis the ASMFC publishes a prioritized list of research needs for American shad and river herring in the Review of the Atlantic States Marine Fisheries Commission Fishery Management Plan for Shad and River Herring (ASMFC 2018). For more information on research needs for American Shad please see: http://www.asmfc.org/uploads/file/5bc76a1dShad_RiverHerringFMPReview_2018.pdf.

FISHERY MANAGEMENT PLAN SCHEDULE RECOMMENDATION

Pertaining to the current FMP schedule, the plan development team recommended using the first two stock status indicators (juvenile abundance and repeat spawners) as a trigger for doing a stock assessment earlier than 10 years. If a three-year moving average of each of the indicators was above the threshold, it would trigger the need for a new stock assessment, which would determine the third stock status indicator. It is recommended the review schedule for river herring remain the same.

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TABLES

Table 1. Commercial harvest in pounds of river herring in North Carolina, 1972-2006, all waterbodies combined. Commercial harvest prohibited in 2007.

Year	Commercial Weight (lb)
1972	11,237,143
1973	7,925,898
1974	6,209,542
1975	5,952,067
1976	6,401,360
1977	8,523,813
1978	6,607,153
1979	5,119,150
1980	6,218,523
1981	4,753,723
1982	9,437,703
1983	5,868,332
1984	6,516,109
1985	11,548,278
1986	6,814,323
1987	3,194,975
1988	4,191,211
1989	1,491,077
1990	1,157,625
1991	1,575,378
1992	1,723,178
1993	916,235
1994	644,334
1995	453,984
1996	529,503
1997	334,809
1998	521,930
1999	443,494
2000	332,336
2001	306,761
2002	174,860
2003	199,716
2004	188,541
2005	250,021
2006	109,847

Table 2. Harvest landings and value of discretionary river herring harvest season in North Carolina, 2008-2014.

Year	# of Permits Issued	Quota (lb/permit/period)	Harvest (lb)	Value ($)
2008	13	250	1,292	775
2009	27	125	643	836
2010	30	125	1,765	1,765
2011	23	150	1,611	1,611
2012	18	150	678	678
2013	12	150	743	743
2014	27	150	989	1,319

Table 3. Length (fork length, inches) data of blueback herring sampled from the Chowan River commercial fisheries, 1972-2018. *In 2007 a no-harvest provision went into effect and the Chowan River Pound Net survey began in 2009.

Year	Mean Fork Length	Minimum Fork Length	Maximum Fork Length	Total Number Measured
1972	9.75	7.00	11.50	2,564
1973	9.75	5.50	11.50	2,208
1974	9.75	7.25	11.50	1,622
1975	9.50	6.00	11.00	2,428
1976	9.75	8.25	11.25	1,564
1977	9.75	5.50	11.75	1,425
1978	10.00	8.25	11.75	1,342
1979	10.00	8.25	12.25	1,218
1980	10.00	8.25	11.50	1,229
1981	10.00	8.50	12.00	1,469
1982	9.75	8.75	11.50	851
1983	9.50	8.25	11.25	482
1984	9.25	7.75	11.25	450
1985	9.50	8.50	11.25	388
1986	9.50	7.25	10.75	347
1987	9.50	8.00	11.00	318
1988	9.25	8.00	11.25	314
1989	9.25	8.25	10.75	273
1990	9.25	8.00	10.75	275
1991	9.25	8.00	11.00	357
1992	9.25	8.00	10.75	368
1993	9.25	7.50	10.50	160
1994	8.75	8.00	10.75	84
1995	9.25	8.25	10.50	322
1996	9.50	8.00	11.25	626
1997	9.50	8.00	11.25	625
1998	9.25	6.00	11.00	1,361
1999	9.50	7.75	11.00	720
2000	9.00	7.75	11.00	1,213
2001	9.25	7.75	10.75	667
2002	9.25	8.00	10.75	338
2003	9.00	7.50	10.50	304
2004	9.00	7.75	10.25	245
2005	9.00	7.75	10.75	305
2006	8.75	7.75	10.00	156
2007*	9.00	7.75	10.75	231
2008*	8.75	7.50	11.00	928
2009*	9.00	7.75	10.50	546
2010*	8.75	7.50	10.25	833
2011*	9.00	7.50	10.50	500
2012*	9.00	7.00	10.50	412
2013*	9.00	7.75	10.75	492
2014*	8.50	7.50	10.25	691
2015*	8.75	7.75	10.75	589
2016*	8.75	7.75	11.00	456
2017*	9.00	7.50	10.25	528
2018*	9.00	7.75	10.50	1,232

Table 4. Length (fork length, inches) data of Alewife sampled from the Chowan River commercial fisheries, 1972-2018. In 2007 a no-harvest provision went into effect and the Chowan River Pound Net survey began in 2009.

Year	Mean Fork Length	Minimum Fork Length	Maximum Fork Length	Total Number Measured
1972	10.25	6.25	12.25	1,337
1973	10.00	7.75	12.25	1,471
1974	9.00	5.75	11.25	616
1975	9.75	7.75	12.00	2,440
1976	9.75	8.25	12.00	2,029
1977	10.00	5.00	12.25	2,024
1978	10.25	7.75	11.50	997
1979	10.00	7.75	11.50	1,143
1980	10.00	8.50	12.25	551
1981	9.75	8.50	11.25	1,052
1982	9.75	8.50	12.00	752
1983	9.75	8.00	11.00	457
1984	9.75	8.75	11.75	351
1985	9.75	8.25	11.00	272
1986	9.25	8.25	11.00	203
1987	9.25	8.00	11.50	389
1988	9.50	8.00	10.75	312
1989	9.50	8.25	10.75	262
1990	9.50	8.00	11.00	194
1991	9.50	7.75	11.25	502
1992	9.25	7.75	11.00	300
1993	8.50	7.50	10.00	183
1994	8.50	8.00	9.00	2
1995	9.75	8.75	10.25	41
1996	9.50	8.50	10.50	42
1997	9.50	8.75	10.75	47
1998	9.50	7.75	11.00	55
1999	9.25	8.25	10.00	6
2000	9.25	7.75	10.50	798
2001	9.50	8.25	10.75	835
2002	9.75	7.75	10.75	963
2003	9.50	7.75	11.50	1,004
2004	9.50	8.00	11.25	720
2005	9.50	7.75	11.25	539
2006	9.50	7.75	12.25	553
2007	9.00	7.75	11.00	45
2008	9.00	7.50	11.25	1,872
2009*	9.25	7.75	10.75	1,000
2010*	9.50	8.00	11.00	822
2011*	9.75	8.00	11.25	806
2012*	9.75	7.50	11.25	641
2013*	9.25	7.75	13.00	854
2014*	9.25	8.00	11.50	1,037
2015*	9.25	8.00	11.00	998
2016*	9.25	7.75	11.25	773
2017*	9.25	7.75	14.00	1,336
2018*	9.25	7.75	11.25	1,360

Table 5. Blueback Herring aging data collected from North Carolina fishery-dependent monitoring, 1972-2018.

Year	Modal Age	Minimum Age	Maximum Age	Total Number Aged
1972	5	2	8	1,215
1973	5	3	8	1,092
1974	4	3	8	920
1975	4	3	8	951
1976	4	3	9	862
1977	5	3	8	767
1978	4	3	7	694
1979	5	3	8	942
1980	5	3	8	1,079
1981	5	3	9	794
1982	4	3	9	478
1983	4	3	8	314
1984	4	3	8	283
1985	5	3	7	249
1986	5	3	7	230
1987	4	3	7	208
1988	4	3	7	201
1989	4	3	6	184
1990	4	2	7	189
1991	4	2	7	242
1992	4	3	7	220
1993	5	2	8	112
1994	4	3	7	71
1995	5	3	7	192
1996	5	3	7	279
1997	4	3	7	180
1998	5	2	7	462
1999	5	3	7	389
2000	4	3	9	512
2001	5	3	7	311
2002	5	3	7	164
2003	5	3	7	147
2004	4	3	6	130
2005	4	3	6	162
2006	4	3	5	86
2007	5	3	6	143
2008	4	3	7	474
2009	4	3	7	251
2010	4	3	7	247
2011	4	3	6	175
2012	4	3	7	189
2013	5	3	7	217
2014	4	3	7	198
2015	4	3	7	184
2016	4	3	8	226
2017	5	3	7	250
2018	4	3	6	272

Table 6. Alewife aging data collected from North Carolina fishery-dependent monitoring, 1972-2018.

Year	Modal Age	Minimum Age	Maximum Age	Total Number Aged
1972	4	3	9	783
1973	4	3	9	721
1974	4	2	7	417
1975	4	2	9	842
1976	4	3	7	853
1977	5	3	8	759
1978	4	3	8	736
1979	4	3	8	701
1980	5	3	8	492
1981	5	4	8	532
1982	4	3	7	444
1983	4	3	7	295
1984	4	3	7	248
1985	5	3	7	195
1986	4	3	6	146
1987	4	3	7	266
1988	4	2	6	228
1989	4	3	7	179
1990	4	2	7	153
1991	5	3	7	319
1992	5	2	8	242
1993	4	2	7	130
1994	4	4	4	2
1995	5	4	6	40
1996	4	3	7	41
1997	4	3	7	18
1998				
1999	3,6	3	6	6
2000	5	3	7	300
2001	5	3	7	369
2002	5	3	7	341
2003	4	2	7	350
2004	5	2	7	318
2005	5	3	7	253
2006	4	3	7	260
2007	4	3	6	30
2008	5	4	8	588
2009	5	3	7	342
2010	6	3	7	277
2011	6	3	8	211
2012	6	3	8	259
2013	5	2	7	308
2014	4	2	6	328
2015	4	3	7	206
2016	4	3	8	311
2017	5	3	7	346
2018	4	3	7	375

Table 7. Blueback herring and alewife percent (%) repeat spawners from the Chowan River pound net survey 1972-2018. Blueback herring percent repeat spawner is a stock status indicator.

	Percent (%)	
Year	Blueback Herring	Alewife
1972	22	15
1973	17	14
1974	18	4
1975	6	10
1976	11	8
1977	9	5
1978	6	8
1979	16	9
1980	19	18
1981	48	29
1982	11	1
1983	14	2
1984	7	34
1985	10	12
1986	16	4
1987	22	
1988	11	6
1989	4	9
1990	12	17
1991	31	21
1992	26	48
1993	12	5
1994	5	
1995	6	8
1996	13	29
1997	15	29
1998	7	
1999	13	67
2000	14	8
2001	9	13
2002	13	38
2003	16	30
2004	9	20
2005	13	15
2006	0	9
2007	9	10
2008	5	14
2009	3	14
2010	6	41
2011	12	27
2012	13	29
2013	14	11
2014	13	5
2015	17	18
2016	16	20
2017	7	33
2018	11	31

Table 8. River herring total pound net effort, estimated catch and catch per unit effort for the Chowan River pound net survey 2009-2018.

Year	Total Effort (# of Active Sets)	Total RH (lbs)	Total CPUE
2009	217	89,245	411.3
2010	260	71,532	275.1
2011	286	74,485	260.4
2012	315	18,415	58.5
2013	238	27,396	115.1
2014	271	45,619	168.3
2015	253	49,560	195.9
2016	228	77,372	339.4
2017	231	137,374	594.7
2018	276	86,605	313.8
Total	257.5	67,760	273.2

Table 9. January-May adult river herring catch per unit effort (2.5 and 3.0 inch stretch mesh) from the North Carolina Albemarle Sound independent gill net survey 1991-2018.

Alewife					Blueback Herring				
Year	Effort	Sum	CPUE	PSE	Year	Effort	Sum	CPUE	PSE
1991	472	222	0.47	16	1991	472	4,817	10.21	15
1992	548	1,056	1.93	18	1992	548	3,197	5.83	13
1993	558	139	0.25	27	1993	558	1,838	3.29	16
1994	527	93	0.18	22	1994	527	638	1.21	20
1995	517	207	0.40	17	1995	517	2,672	5.17	19
1996	512	150	0.29	59	1996	512	1,514	2.96	17
1997	521	64	0.12	19	1997	521	3,338	6.41	17
1998	506	64	0.13	16	1998	506	2,364	4.67	17
1999	536	281	0.52	42	1999	536	2,600	4.85	16
2000	525	938	1.79	15	2000	525	4,039	7.69	15
2001	498	1,380	2.77	11	2001	498	2,534	5.09	15
2002	505	321	0.64	11	2002	505	1,457	2.89	17
2003	552	310	0.56	13	2003	552	2,312	4.19	15
2004	504	379	0.75	12	2004	504	1,674	3.32	17
2005	503	267	0.53	12	2005	503	1,617	3.21	20
2006	526	1,060	2.02	11	2006	526	2,361	4.49	12
2007	511	3,310	6.48	11	2007	511	1,566	3.06	14
2008	499	1,282	2.57	10	2008	499	833	1.67	17
2009	452	1,050	2.32	10	2009	452	1,011	2.24	15
2010	419	1,144	2.73	14	2010	419	669	1.60	16
2011	418	466	1.11	14	2011	418	465	1.11	17
2012	355	348	0.98	13	2012	355	307	0.86	18
2013	363	1,246	3.43	18	2013	363	1,642	4.52	16
2014	402	2,810	6.99	15	2014	402	1,077	2.68	18
2015	443	2,013	4.54	11	2015	443	2,470	5.58	20
2016	460	2,369	5.15	11	2016	460	2,802	6.09	15
2017	451	1,677	3.72	10	2017	451	2,373	5.26	15
2018	377	2,805	7.44	19	2018	377	3,054	8.10	14

Table 10. Length (fork length, inches) data of blueback herring sampled from North Carolina Albemarle Sound independent gill net survey from 1991-2018.

Year	Mean Fork Length	Minimum Fork Length	Maximum Fork Length	Total Number Measured
1991	9.75	6.50	13.25	2,315
1992	9.75	8.00	11.75	2,140
1993	9.75	7.50	13.25	1,334
1994	9.75	8.25	13.25	555
1995	9.50	6.50	11.25	1,324
1996	9.50	5.75	13.25	1,090
1997	9.25	5.00	12.75	1,530
1998	9.50	8.00	11.25	1,231
1999	9.50	6.50	13.75	1,917
2000	9.50	8.25	11.25	2,740
2001	9.50	6.50	11.50	1,862
2002	9.75	5.50	11.00	1,339
2003	9.50	7.75	11.75	1,924
2004	9.50	8.25	17.25	1,157
2005	9.25	5.75	11.50	1,039
2006	9.25	7.25	13.25	1,790
2007	9.25	8.00	10.75	1,204
2008	9.25	4.75	10.75	697
2009	9.25	5.25	11.00	815
2010	9.25	7.75	12.25	609
2011	9.25	7.25	13.75	445
2012	9.50	8.00	10.75	295
2013	9.00	7.75	11.50	1,163
2014	9.25	7.75	13.00	799
2015	9.25	8.00	13.50	1,206
2016	9.50	4.25	11.25	1,555
2017	9.50	8.00	13.25	1,433
2018	9.50	8.00	12.75	1,764

Table 11. Length (fork length, inches) data of alewife sampled from North Carolina Albemarle Sound independent gill net survey from 1991-2018.

Year	Mean Fork Length	Minimum Fork Length	Maximum Fork Length	Total Number Measured
1991	10.00	5.75	12.00	235
1992	10.00	8.50	13.75	860
1993	9.50	8.00	13.25	143
1994	9.25	8.50	11.00	99
1995	9.50	6.75	11.50	211
1996	9.75	4.50	13.50	102
1997	10.00	8.25	13.75	64
1998	9.75	7.75	11.50	64
1999	9.00	8.00	13.75	226
2000	9.25	8.25	11.25	1,436
2001	9.75	5.25	17.75	1,933
2002	10.00	8.00	11.00	477
2003	9.75	7.75	11.25	551
2004	9.75	8.00	14.00	388
2005	9.50	8.00	11.25	274
2006	9.25	8.00	13.50	1,006
2007	9.25	4.50	12.75	2,343
2008	9.50	6.25	12.00	1,221
2009	9.50	5.75	11.75	1,000
2010	9.75	8.00	13.75	1,036
2011	10.00	8.00	11.75	493
2012	10.25	7.75	12.00	363
2013	9.25	7.75	13.50	1,004
2014	9.50	8.00	13.75	1,930
2015	9.75	4.50	12.50	1,786
2016	9.75	7.75	13.00	2,042
2017	9.75	7.75	12.75	1,531
2018	9.25	7.75	12.00	1,950

Table 12. Blueback herring aging data collected from North Carolina Albemarle Sound independent gill net survey, 2004-2018.

Year	Modal Age	Minimum Age	Maximum Age	Total Number Aged
2004	4	3	6	98
2005	4	2	7	174
2006	4,5	3	7	213
2007	5	3	7	173
2008	4,5	4	7	45
2009	4,5	4	7	72
2010	4	3	5	45
2011	4	3	6	100
2012	4	3	8	80
2013	3	2	7	107
2014	3	2	5	40
2015	4	3	6	139
2016	5,6	3	7	157
2017	5	3	7	176
2018	4	3	7	228

Table 13. Alewife aging data collected from North Carolina Albemarle Sound independent gill net survey, 2004-2018.

Year	Modal Age	Minimum Age	Maximum Age	Total Number Aged
2004	4	3	6	106
2005	5	3	7	148
2006	4,5	3	7	283
2007	4	3	8	266
2008	5	4	7	96
2009	5	2	7	125
2010	6	4	7	122
2011	5	3	8	137
2012	6	3	8	129
2013	4	2	6	168
2014	4	3	6	110
2015	5	3	7	263
2016	5	3	7	173
2017	5	3	8	249
2018	4	3	8	331

Table 14. Summary of the N.C. Marine Fisheries Commission management strategies and their implementation status for Amendment 2 of the River Herring Fishery Management Plan

Management Strategy	Implementation Status
Eliminate the discretionary river herring harvest season and permit	Existing proclamation authority
Moving the Albemarle Sound/Chowan River Herring Management Areas to correct boundary reference for the Cashie River Anadromous Fish Spawning Area	15A NCAC 03R .0202
Remove alewife and blueback herring from the Mutilated Finfish Rule	15A NCAC 03M .0101
Prohibit possession of alewife and blueback herring greater than six inches aboard a vessel or while engaged in fishing from the shore or a pier.	15A NCAC 03M .0513

FIGURES

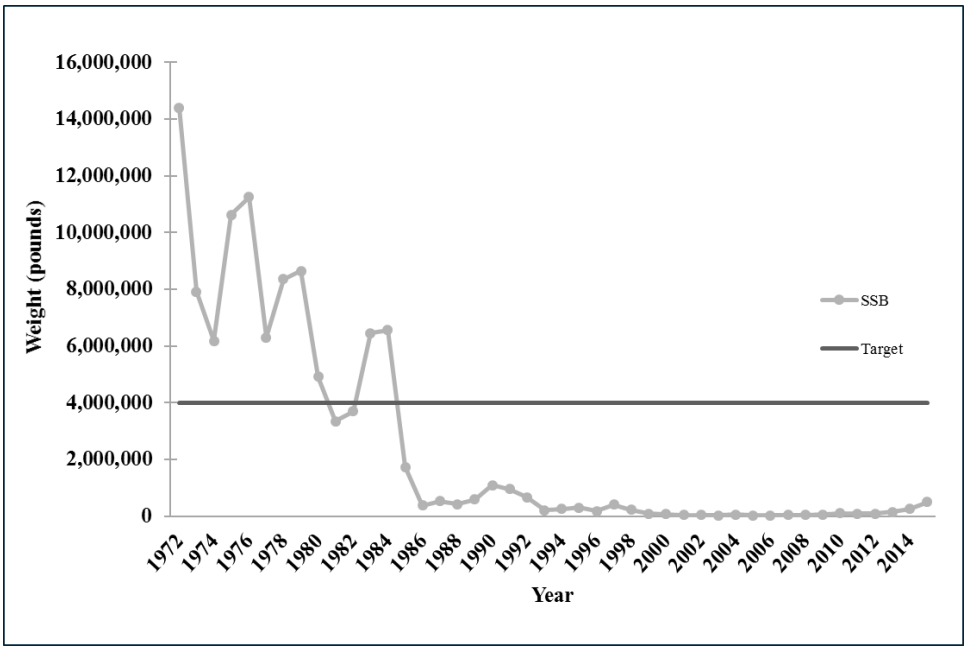

Figure 1. Annual estimate of blueback herring spawning stock biomass (SSB) in pounds for the Chowan River blueback herring stock, 1972-2015 (ASMFC 2017). Stock status indicator.

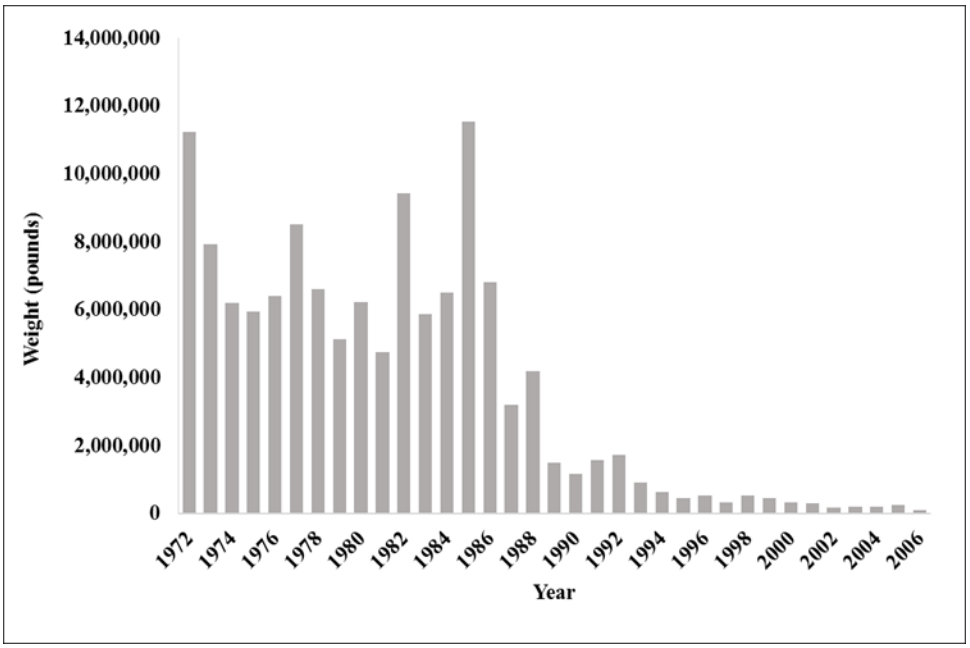

Figure 2. Commercial harvest in pounds of river herring (blueback herring and alewife combined) in North Carolina from 1972-2006, all waterbodies combined.

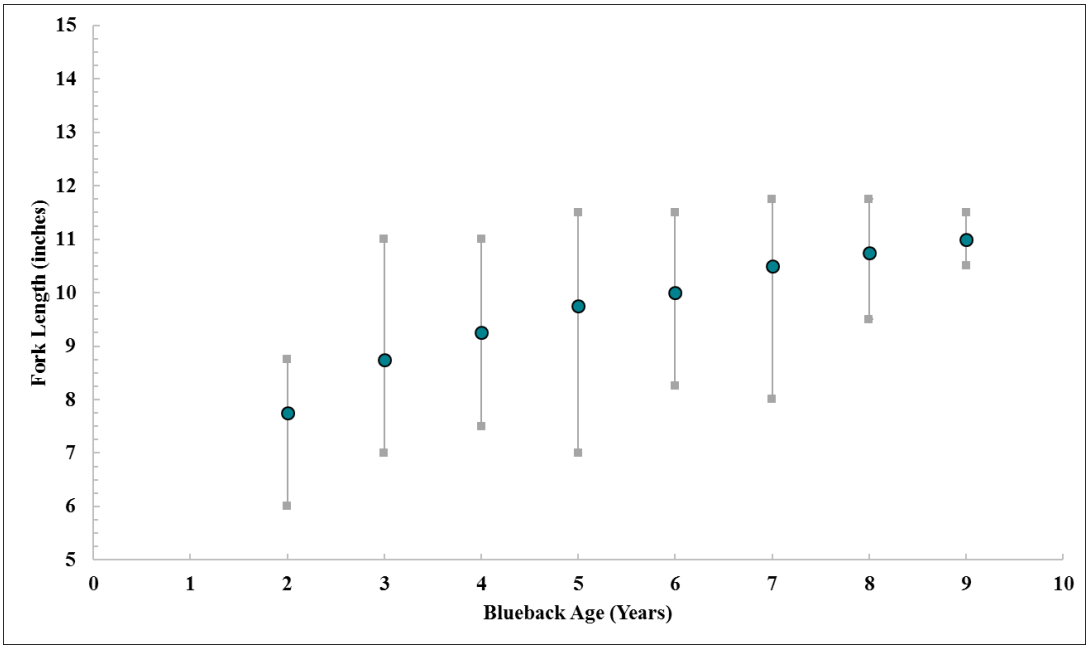

Figure 3. Blueback herring length at age from all age samples collected from fishery-dependent monitoring, 1972-2018. Blue circles represent the mean size at a given age while the gray squares represent the minimum and maximum observed size for each age.

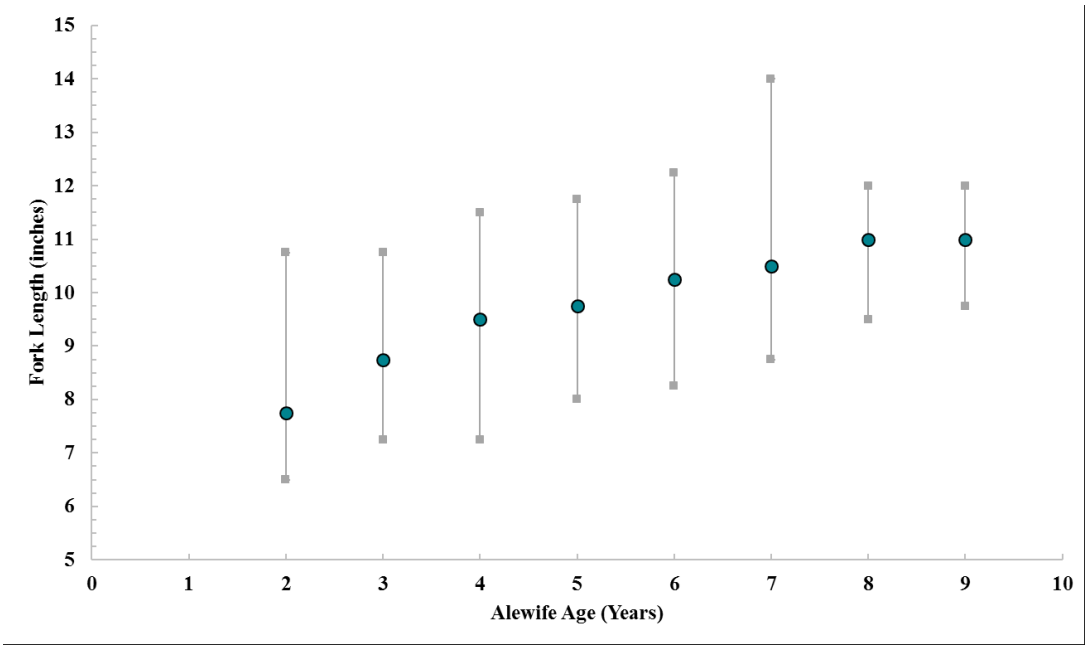

Figure 4. Alewife length at age from all age samples collected from fishery-dependent monitoring, 1972-2018. Blue circles represent the mean size at a given age while the gray squares represent the minimum and maximum observed size for each age.

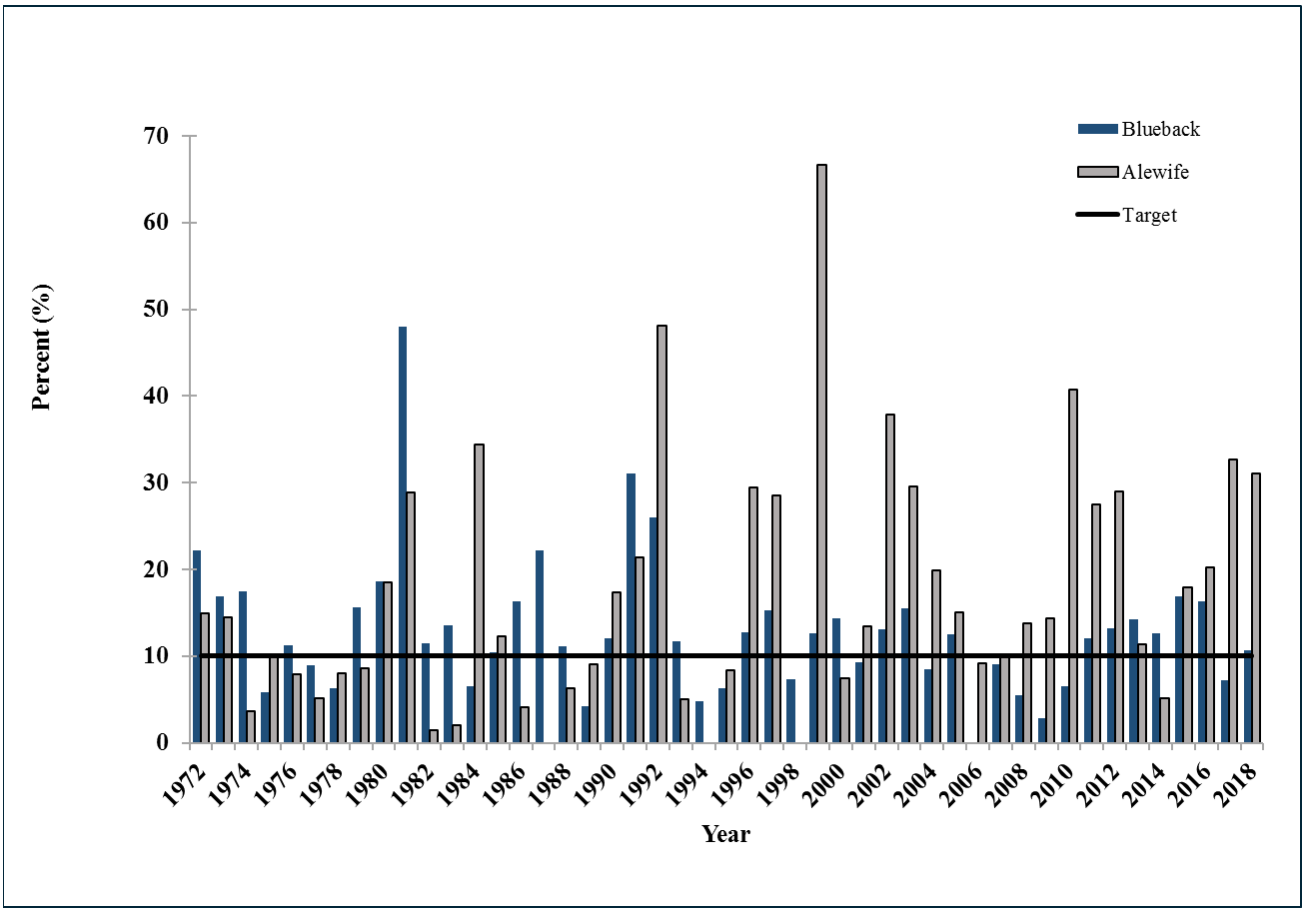

Figure 5. Percent of repeat spawners (blueback herring and alewife) in the Chowan River Pound Net Survey, 1972-2018. Blueback herring percent repeat spawner is a stock status indicator.

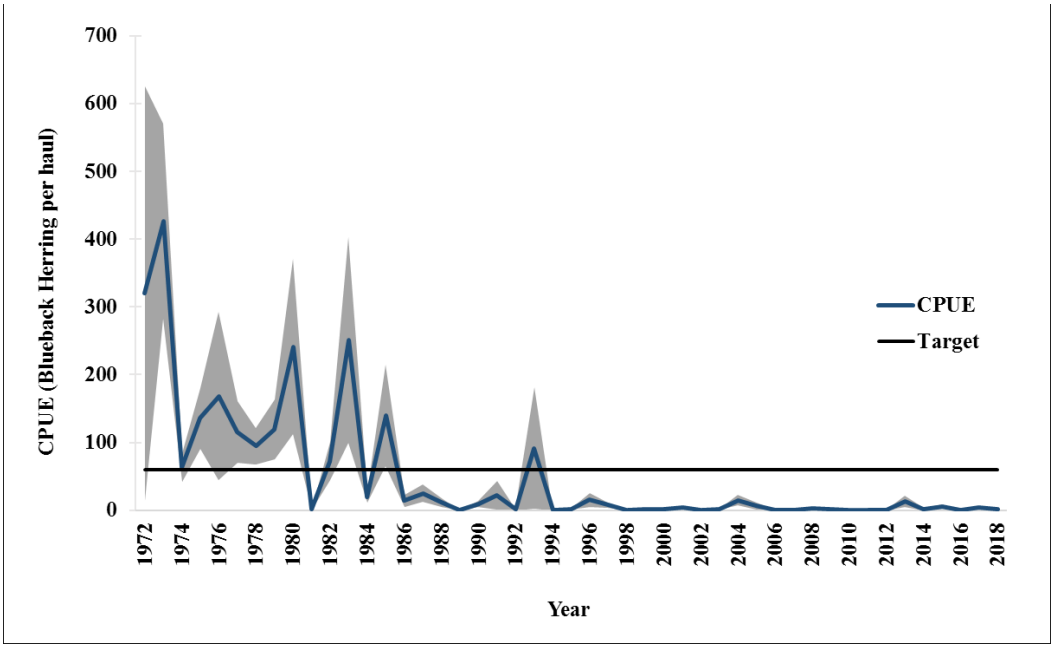

Figure 6. Blueback herring annual juvenile (age-0) abundance index from the NCDMF Albemarle Sound juvenile survey, 1972-2018. Stock status indicator.

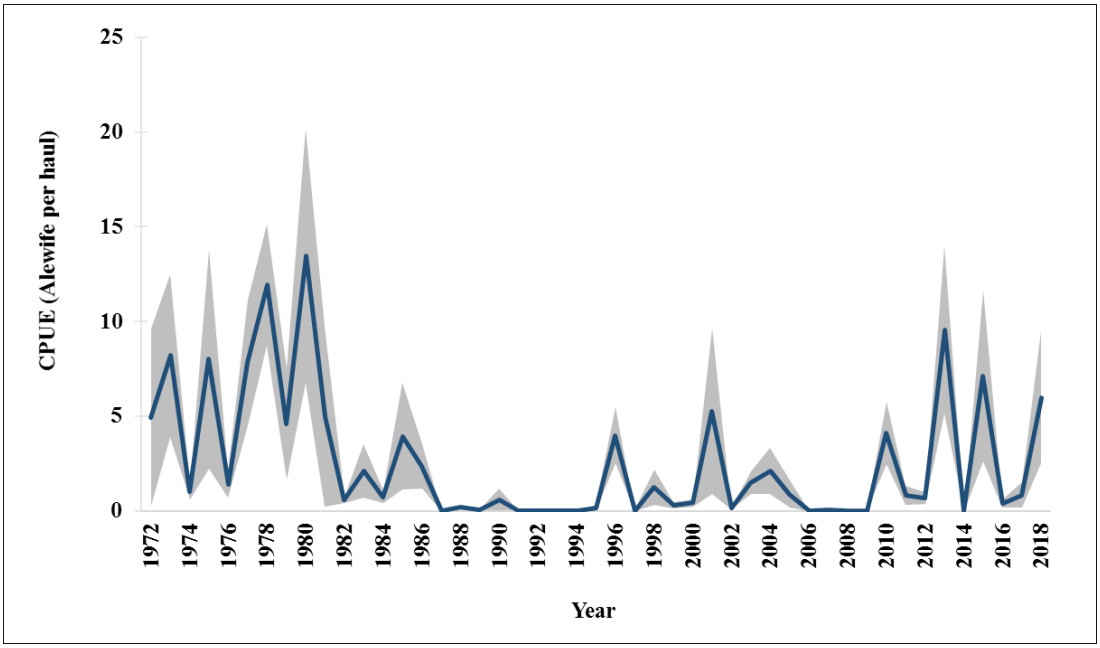

Figure 7. Alewife annual juvenile (age-0) abundance index from the NCDMF Albemarle Sound juvenile survey, 1972-2018.

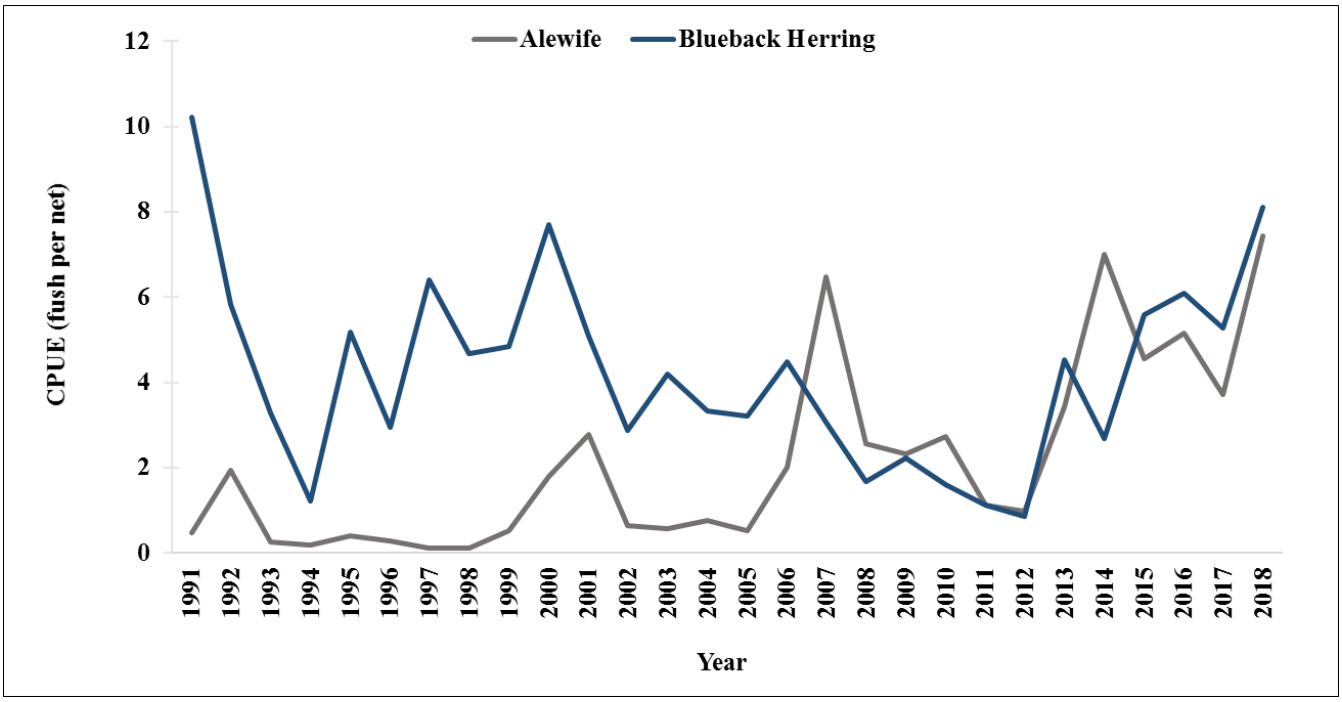

Figure 8. January-May adult river herring CPUE (2.5 and 3.0 inch stretch mesh) from the North Carolina Albemarle Sound independent gill net survey 1991-2018.

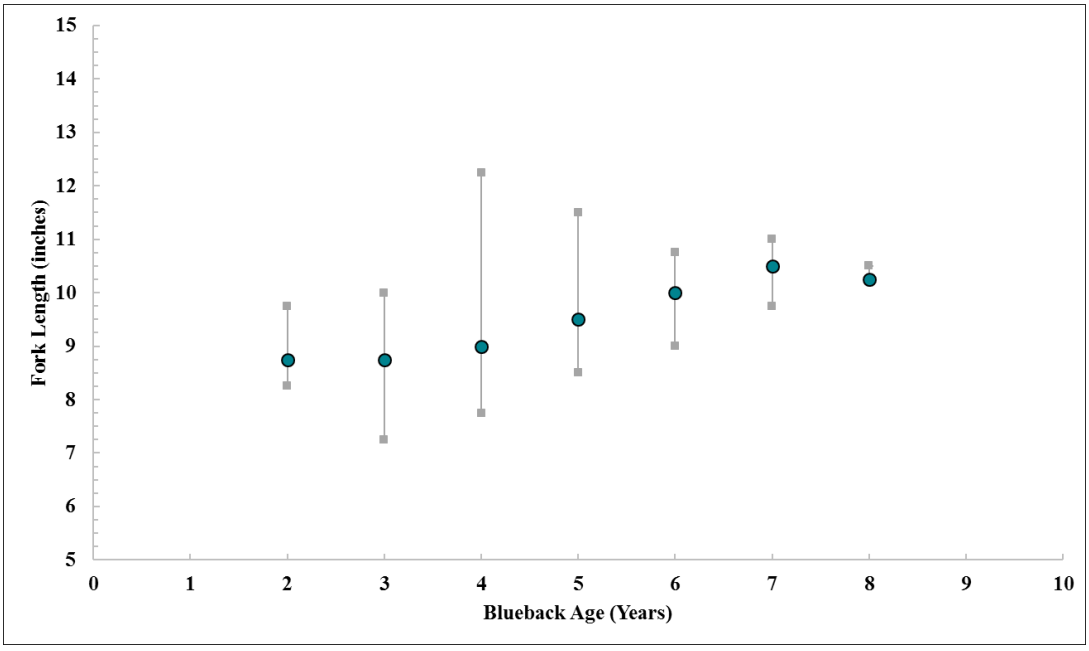

Figure 9. Blueback herring length at age from all age samples collected from North Carolina Albemarle Sound independent gill net survey, 2004-2018. Blue circles represent the mean size at a given age while the gray squares represent the minimum and maximum observed size for each age.

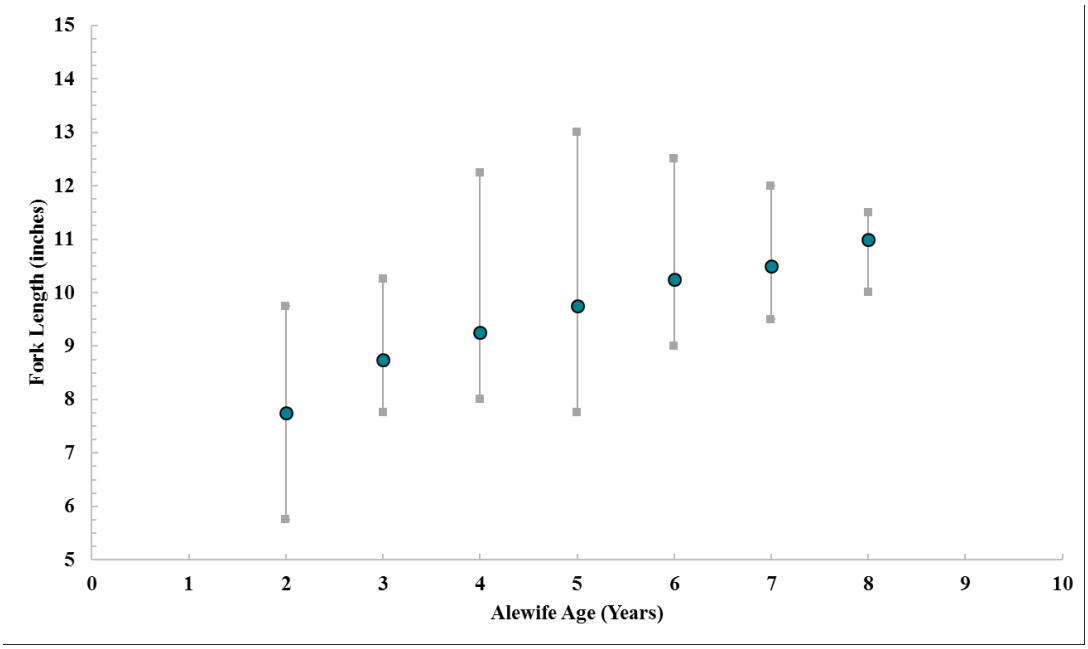

Figure 10. Alewife length at age from all age samples collected from North Carolina Albemarle Sound independent gill net survey, 2004-2018. Blue circles represent the mean size at a given age while the gray squares represent the minimum and maximum observed size for each age.