FISHERY MANAGEMENT PLAN UPDATE
RIVER HERRING
AUGUST 2018

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
Schedule Changes:	None
Next Benchmark Review:	May 2025

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. 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. 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. Additional management strategies included gear restrictions and stock recovery indicators. 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 research season, 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.

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. 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 this species 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 2015).

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 fishes, 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 6) 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 feed 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 coastwide stock assessment update for river herring was completed in the 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 coastwide basis (ASMFC 2017). The North Carolina portion of the coastwide 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 Atlantic States Marine Fisheries Commission 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 remains 12 percent 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 1972-2015. 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 percent, but has exceeded the target since 2011 to the highest level in 34 years of 16.8 percent in 2015. Female SSB has been increasing since 2010, but still remains at approximately 12 percent of the target of 1.8 million kilograms.

It is also 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. 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 other 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 (alewife and blueback herring) greater than six in aboard a vessel or while engaged in fishing from the shore or a pier.

Commercial Landings

Amendment 1 implemented a no-harvest provision in 2007. Table 1 includes information on landings data from 2007 through 2016 when the discretionary harvest season was prosecuted before being eliminated under Amendment 2. Landings from 1950 through the late 1970s averaged 11 million pounds annually and peaked in 1969 at approximately 20 million pounds (Figure 4). Most landings occurred in the Chowan River and Albemarle Sound system. River herring landings declined sharply in the late mid-1980s, prior to any regulations specific to river herring which weren't enacted until 1995.

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 1982. 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. Tables 2 and 3 describe the mean, minimum and maximum length data for the last 9 years 2009 to 2017 for alewife and blueback.

Tables 4 and 5 describe the modal age, minimum and maximum age, and total number aged from this survey. Aging for 2017 female bluebacks is incomplete therefore only the male ages are reported in Table 5. Total pound net effort, total river herring catch, and CPUE for the Chowan River Pound Net Survey (Table 6) shows a downward trend through 2012 followed by an increasing trend through 2017. Over 70 percent of the pound net catch is estimated to be alewife based on weekly samples for biological data collection from the pound net survey.

Figure 3 illustrates the blueback herring percent repeat spawners, the number of fish that have spawned two or more times, observed in the Chowan River Pound Net Survey from 2008 through 2017. From 2011 to 2016, the percent repeat spawners has exceeded the stock status indicator target of 10 percent.

Fishery-Independent Monitoring

River herring are monitored regularly in several of the division's fishery independent monitoring programs, including Program 100 (Juvenile Anadromous Independent Fishery), Program 135 (Striped Bass Independent Gill Net Survey), Program 150 (Adult Anadromous Spawning Area Survey), and Program 160 (Anadromous Egg and Larval Survey). Tables 7 and 8 show the modal, minimum, and maximum age for alewife and blueback from 2008 to 2017.

Data from Program 100 is used to annually calculate the juvenile abundance index (JAI) for blueback herring. The first of the stock status indices, it involves a CPUE of 60 young-of-the-year blueback herring for three consistent years in the Program 100 survey. Figure 2 illustrates that the target JAI for blueback herring has remained well below the target during the time series, 1972 through 2017.

MANAGEMENT STRATEGY

Amendment 1 to the 2000 North Carolina River Herring FMP implemented four stock recovery indicators to evaluate stock status. Under Amendment 2 to the 2000 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. The three stock status indicators were adopted by the 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 percent 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 has exceeded the target of 10 percent 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

Table 9 provides the NCMFC selected management strategies from Amendment 2 adopted in May 2015. The specific research recommendations identified in the current FMP (Amendment 2) and the priority and status of each are listed below.

Life History

- Conduct studies of river herring egg and larval survival and development in North Carolina river systems. **High priority**
- Conduct research on predation of all life stages of river herring in the Albemarle Sound and other systems in North Carolina (including invasive species such as blue catfish and other predators). **Medium priority**
- Conduct studies on energetics of feeding and spawning migrations of river herring in North Carolina. **Medium priority**

Stock Status

- Estimate bycatch and discard mortality of river herring captured incidentally in Atlantic Ocean fisheries coastwide. **High priority**
- Estimate bycatch and discard mortality of river herring captured incidentally in inside fisheries. **Medium priority**

Environmental Factors

<u>Water Quality Recommendations</u>

- Evaluate effects of existing and future water withdrawals on water quality, quantity and fisheries habitat in coastal watersheds. NCDCM and NCWRC review and comment on water withdrawals and their effect on fisheries and habitat. **High priority**
- Determine if contaminants are present and identify those that are potentially detrimental to various life history stages of river herring. Long term water quality monitoring devices have been maintained and deployed to identify shifts or swings in water quality in multiple tributaries in the Albemarle Sound area. **High priority**
- Evaluate the impacts/effects of reverse osmosis (RO) plants on receiving waters and aquatic resources. NCDCM and NCWRC provide comments on permit applications for RO plants;

some work by universities to evaluate effects of RO plants in local river systems. **Low priority**

Obstruction Recommendations

- Identify all man-made physical obstructions to river herring migrations (update Collier and Odom project) and prioritize impediments for removal /replacement after identification. The NCDMF has surveyed culverts in the Chowan River area and developed a priority list for replacement or repair. This information will be used by a paid graduate student to investigate fish friendly culverts. **High priority**
- Identify research needs regarding impediments to river herring migration**. High priority**

Impingement and Entrainment Recommendations

- Research is needed to determine the fate of river herring eggs, larvae and juveniles that are impinged, and then released through screen cleaning operations. **Low priority**

Climate change

- The specific effects of climate change, including warming water, increased drought severity, and loss of flood plain spawning habitat should be further investigated. **Low priority**

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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North Carolina Division of Marine Fisheries (NCDMF). 2015. Fishery Management Plan for Interjurisdictional Fisheries: Information Update. North Carolina Department of Environmental Quality. North Carolina Division of Marine Fisheries. Morehead City, North Carolina. 85 pp.

TABLES

Table 1. Harvest landings and value of discretionary river herring harvest season in North Carolina, 2008-2017.

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
2015*	--	--	--	--
2016*	--	--	--	--
2017*	--	--	--	--

*Discretionary harvest season eliminated in 2015 under Amendment 2 to the River Herring FMP.

Table 2. Blueback herring mean, minimum and maximum length data from 2008-2017 from dependent sampling surveys.

Year	Mean Length	Minimum Length	Maximum Length	Total Number Measured
2008*	225	191	279	928
2009*	225	198	267	546
2010*	224	192	260	833
2011*	229	190	264	500
2012*	229	180	265	412
2013*	229	196	276	492
2014*	217	191	260	691
2015*	225	198	274	589
2016*	225	199	278	456
2017*	226	193	261	528

*2008 a no-harvest provision went into effect and the Chowan River Pound Net survey began in 2009.

Table 3. Alewife mean, minimum and maximum length data from 2008-2017 from dependent sampling surveys.

Year	Mean Length	Minimum Length	Maximum Length	Total Number Measured
2008*	227	190	287	1,872
2009*	236	197	276	1,000
2010*	241	203	282	822
2011*	247	201	283	806
2012*	248	190	286	641
2013*	234	196	330	854
2014*	234	202	295	1,037
2015*	235	201	282	998
2016*	233	195	283	773
2017*	238	194	299	1,335

*2008 a no-harvest provision went into effect and the Chowan River Pound Net survey began in 2009.

Table 4. Alewife ages from the dependent sampling surveys, 2008-2017.

Year	Modal Age	Minimum Age	Maximum Age	Total Number Aged
2008*	5	4	8	588
2009*	5	3	7	342
2010*	6	3	7	277
2011*	6	3	8	211
2012*	4	3	8	259
2013*	3	2	7	308
2014*	3	2	6	328
2015*	4	3	9	309
2016*	4	3	8	311
2017*	5	3	7	346

*samples from the Chowan River pound net survey

Table 5. Blueback ages from the dependent sampling surveys, 2008-2017.

Year	Modal Age	Minimum Age	Maximum Age	Total Number Aged
2008*	4	3	7	474
2009*	4	3	7	251
2010*	4	3	7	247
2011*	4	3	6	171
2012*	4	3	7	181
2013*	5	3	7	210
2014*	4	3	7	198
2015*	4	3	7	184
2016*	4	3	8	226
2017*	5	3	7	243

*samples from the Chowan River pound net survey

Table 6. Total pound net effort, catch and CPUE for the Chowan River pound net survey 2009-2017.

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
Total	255.4	65,666.4	268.7

Table 7. Alewife ages from the independent gill net survey 2008-2017, Albemarle Sound.

Year	Modal Age	Minimum Age	Maximum Age	Total Number Aged
2008	5	3	7	428
2009	5	2	7	472
2010	6	3	8	490
2011	6	3	8	388
2012	5	3	7	181
2013	4	3	6	319
2014	4	3	7	361
2015	5	3	7	269
2016	5	3	7	183
2017	5	3	6	233

Table 8. Blueback ages from the independent gill net survey 2008-2017, Albemarle Sound.

Year	Modal Age	Minimum Age	Maximum Age	Total Number Aged
2008	4	2	7	254
2009	5	3	7	330
2010	4	3	6	127
2011	4	3	6	112
2012	5	3	6	69
2013	3	2	6	211
2014	3	2	5	320
2015	4	3	8	141
2016	5/6	3	7	157
2017	5	3	7	176

Table 9. 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

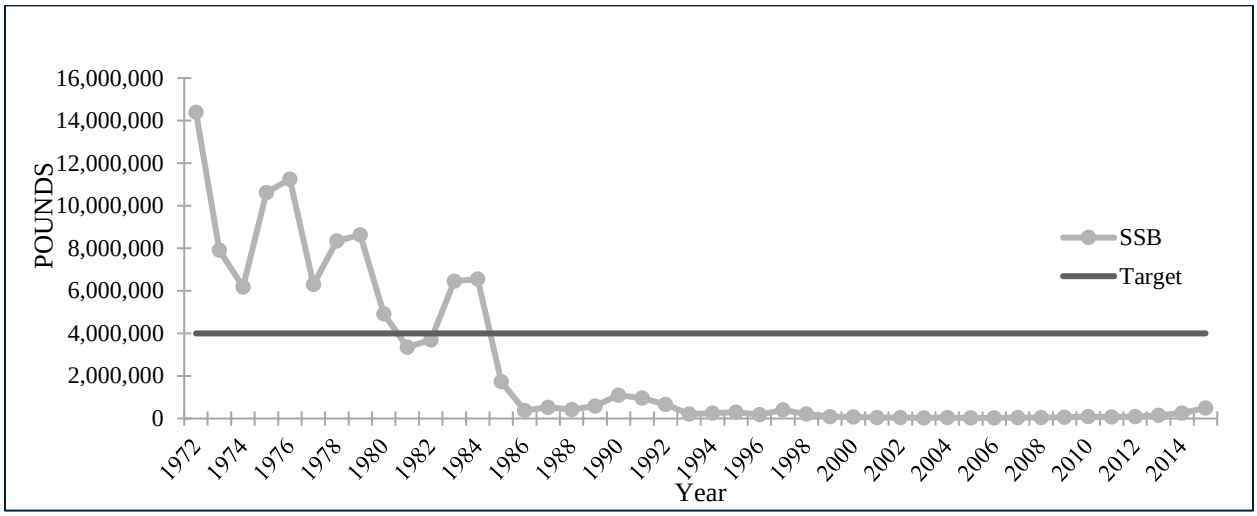

Figure 1. Annual estimate of female spawning stock biomass (SSB) in pounds for the Chowan River blueback herring stock, 1972-2015 (ASMFC 2017).

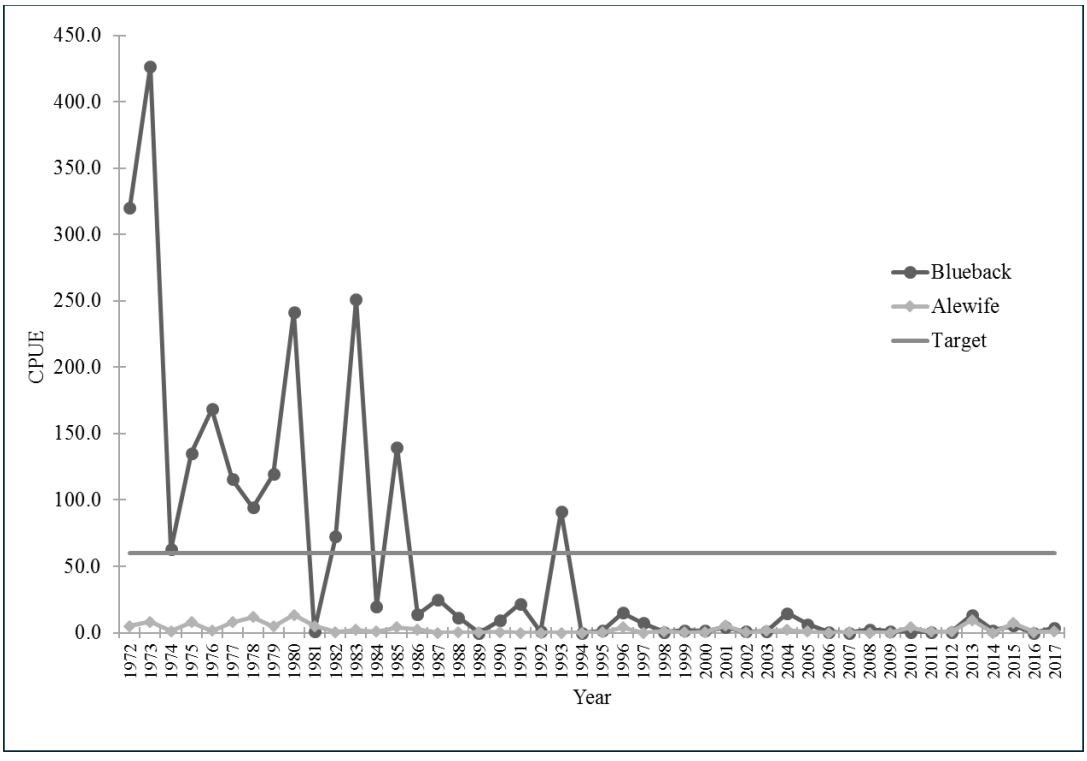

Figure 2. River herring (blueback and alewife) juvenile abundance index from the NCDMF Albemarle Sound juvenile survey, 1972-2017.

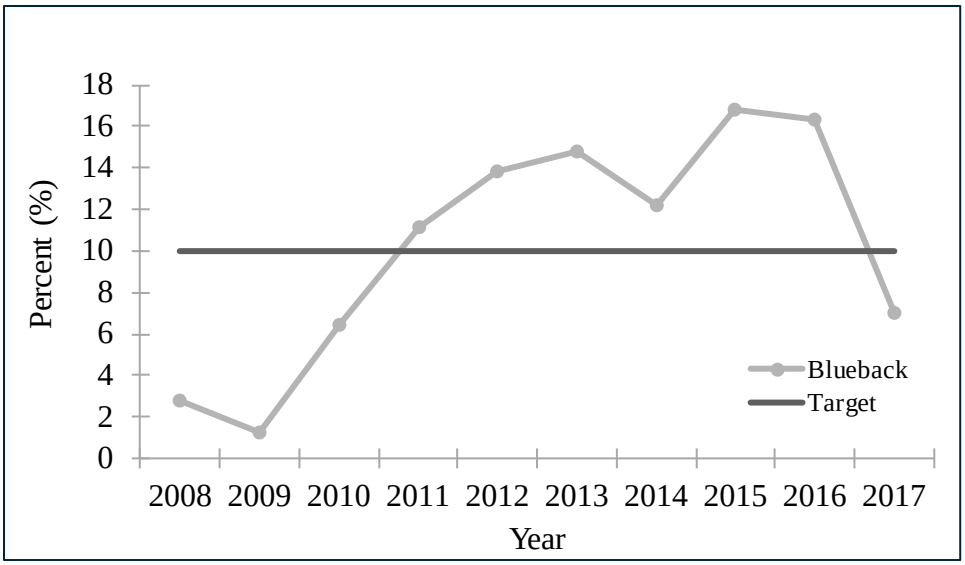

Figure 3. Percent of blueback herring repeat spawners in the Chowan River Pound Net Survey, 2008-2017.

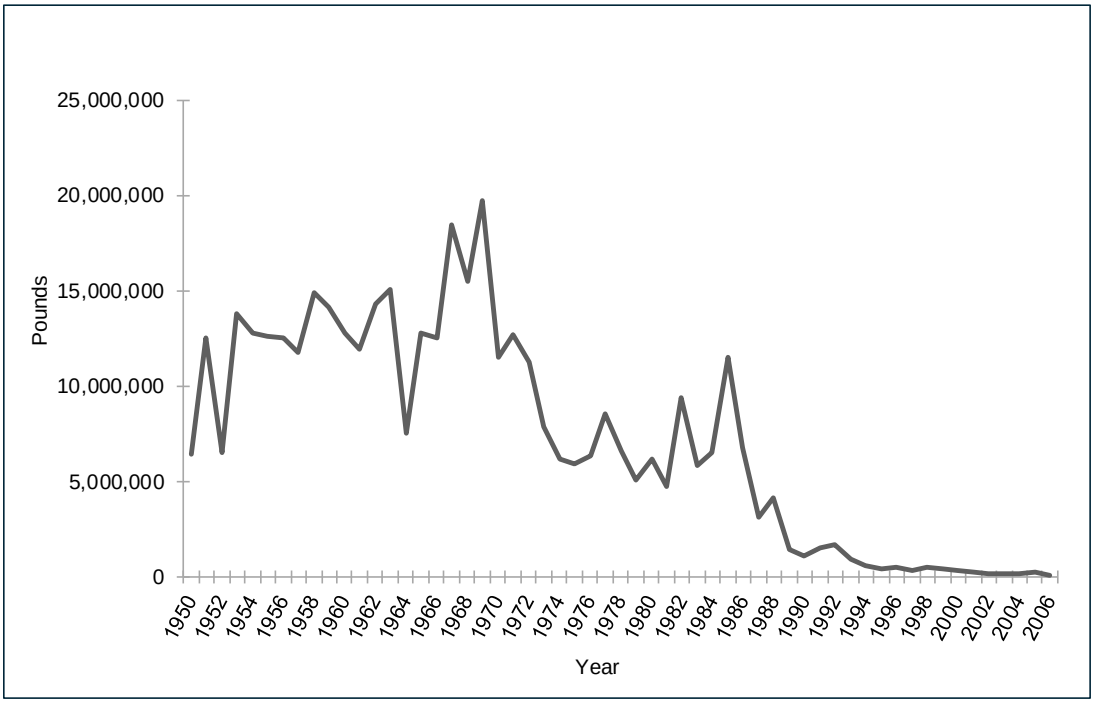

Figure 4. Statewide N.C. Commercial River Herring Landings, 1950 – 2006.