FISHERY MANAGEMENT PLAN UPDATE
AMERICAN SHAD
AUGUST 2024

STATUS OF THE FISHERY MANAGEMENT PLAN

Fishery Management Plan History

FMP Documentation:	October 1985	
	Amendment 1	April 1999
	Technical Addendum 1	February 2000
	Addendum I	August 2002
	Amendment 3	February 2010
Supplements:	Supplement	October 1988
Comprehensive Review:	To be determined	

The first Atlantic States Marine Fisheries Commission (ASMFC) Fishery Management Plan (FMP) for Shad and River Herrings was adopted in 1985. The FMP did not require any specific management approach or monitoring programs within the management unit, asking only that states provide annual summaries of restoration efforts and ocean fishery activity. It specified four management objectives: regulate exploitation, improve habitat accessibility and quality, initiate programs to introduce alosine stocks into historic waters, and recommend and support research programs. The 1988 Supplement (ASMFC 1988) reassessed the research priorities identified in the original 1985 plan and created a new listing of research priorities.

Amendment 1 (ASMFC 1999) reported that the majority of American shad (*Alosa sapidissima*) stocks were not overfished, but almost all were believed to be at or near historically low levels. Therefore, Amendment 1 required increased annual reporting requirements on juveniles, adult spawning stocks, annual fishing mortality, and habitat. A fishing mortality threshold (overfishing) was defined as a reference point of F_{30}. A fishing mortality rate of F_{30} will result in 30% of the maximum spawning potential in the female component of an unfished population. Amendment 1 also implemented the phase-out of the ocean intercept fishery for American shad (effective in 2005). Eliminating the North Carolina ocean intercept fishery was important to controlling harvest to specific river origins.

Technical Addendum 1 (ASMFC 2000) modified several technical errors and provided clarification of several monitoring requirements in Amendment 1.

Addendum I (ASMFC 2002) changed the conditions for marking hatchery-reared alosines. The addendum clarifies the definition and intent of de minimis status for the American shad fishery. It also further modifies and clarifies the fishery-independent and fishery-dependent monitoring requirements of Technical Addendum 1.

The ASMFC coastwide stock assessment completed in 2007 found that American shad stocks were at all-time lows and did not appear to be recovering to acceptable levels. Therefore, under ASMFC's Amendment 3 to the Interstate FMP for Shad and River Herring, individual states were required to develop Implementation Plans (ASMFC 2010). Implementation Plans consisted of two parts: 1. Review and update of the fishing/recovery plans required under Amendment 1 for the stocks within their jurisdiction; and 2. Habitat plans. North Carolina submitted fishing/recovery plans that meet the requirements of Amendment 3, known as the North Carolina American Shad

Sustainable Fishery Management Plan (SFMP) (NCDMF 2011, NCDMF 2017, and NCDMF 2023). North Carolina submitted habitat plans that meet the requirements of Amendment 3, known as the North Carolina American Shad Habitat Plan (NCDMF 2014 and NCDMF 2020).

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

The management units for American shad are all the migratory American shad stocks of the Atlantic coast of the United States. American shad and hickory shad management authority lies with the ASMFC and is coordinated by Atlantic coastal states from Maine through Florida through approved Sustainable Fishery Management Plans for American Shad. Responsibility for management action in the Economic Exclusive Zone (EEZ), located from three to 200 miles from shore, lies with the Secretary of Commerce through the Atlantic Coastal Fisheries Cooperative Management Act (ACFCMA) in the absence of a federal FMP.

Goal and Objectives

Migratory stocks of American shad have been managed under the ASMFC since 1985. These species are currently managed under Amendment 3 (American shad) and Amendment 1 (American and hickory shad (*Alosa mediocris*) to the ASMFC FMP, Technical Addendum 1, and Addendum I. Because of the scarcity of data on hickory shad populations, the ASMFC member states decided to focus Amendment I on American shad regulations and monitoring programs. However, the amendment requires states to initiate fishery-dependent monitoring programs for hickory shad while recommending continuance of current fishery-independent programs for these species. The goal of Amendment 3 is to protect, enhance, and restore Atlantic coast migratory stocks and critical habitat of American shad in order to achieve levels of spawning stock biomass that are sustainable, can produce a harvestable surplus, and are robust enough to withstand unforeseen threats. To achieve this goal, the plan adopts the following objectives:

- Maximize the number of juvenile recruits emigrating from freshwater stock complexes.
- Restore and maintain spawning stock biomass and age structure to achieve maximum juvenile recruitment.
- Manage for an optimum yield harvest level that will not compromise Objectives 1 and 2.
- Maximize cost effectiveness to the local, state, and federal governments, and the ASMFC associated with achieving Objectives 1 through 3.

DESCRIPTION OF THE STOCK

Biological Profile

American shad are anadromous fish, meaning they spend most of their adult lives at sea, only returning to freshwater in the spring to spawn. Shad young leave their home river within the first year and will spend the next few years at sea, schooling in large numbers with shad from other regions and feeding on plankton, small fish, and crustaceans. Upon reaching maturity, at about age 4, they return to the streams in which they were born to spawn. Males or "buck shad" return first, followed by females or "roe shad." They spawn usually at night or during overcast days. In the southern range (Cape Fear River to Florida), females release as many as 700,000 eggs during the spawning season, but both males and females normally die after spawning. In the northern range, females typically release 300,000 eggs or less during the spawning season; however, most shad will return to spawn in the following years, with some shad living up to 10 years.

Stock Status

The most recent coastwide stock assessment of American shad stated that populations in the Albemarle Sound, including Roanoke River, are sustainable and not depleted, whereas a determination of stock status could not be assigned for the Tar-Pamlico, Neuse, and Cape Fear rivers due to limited information (ASMFC 2020).

Stock Assessment

The 2020 American shad benchmark stock assessment found coastwide populations of American shad to be depleted. Factors such as overfishing, inadequate fish passage at dams, predation, pollution, water withdrawals, channelization of rivers, changing ocean conditions, and climate change are likely responsible for the decline from historic shad abundance levels. The assessment found that American shad recovery is limited by restricted access to spawning habitat, with 40% of historic habitat in the U.S. and Canada currently blocked by dams and other barriers possibly equating to a loss of more than a third of spawning adults. The abundance of American shad relative to historic levels is unknown for most systems but was determined to be depleted for the Potomac River and Hudson River, and not depleted for the Albemarle Sound. Coastwide adult mortality is largely unknown and juvenile mortality status cannot be determined due to insufficient data collection. The stock assessment chose to use the 'depleted' determination instead of 'overfished' because of the impact of fishing on American shad stocks cannot be separated from all other factors that impact abundance. The status for adult mortality rate and abundance could not be determined for the Tar-Pamlico and Cape Fear rivers. The Neuse River adult mortality rate was found to be sustainable (ASMFC 2020). The 2020 benchmark assessment for American shad was endorsed by the Peer Review Panel and accepted by the ASMFC Shad and River Herring Board for management use in August 2020. The ASMFC has not conducted a coastwide assessment of hickory shad.

DESCRIPTION OF THE FISHERY

Current Regulations

The MFC enacted a rule in 1995, which established a closed season for American shad and hickory shad. It is unlawful to take these species by any method except hook-and-line April 15–December 31. The ocean intercept fishery for American shad was closed to all harvest January 1, 2005 (ASMFC 2002).

In the Albemarle, Croatan, Roanoke, and Currituck sounds and tributaries (Albemarle Sound Management Area; ASMA), floating gill nets of 5.25-inch stretch mesh (ISM) to 6.5 ISM, were limited to 500 yards, could only be utilized from March 2 through March 17, and must be fished at least once during a 24-hour period (no later than noon each day; M-5-2023). A portion of the Albemarle Sound from the lower Chowan River to the western Albemarle Sound was closed to the use of all gill nets. The area closure was implemented to prolong the striped bass quota by reducing gear in hot spot areas, which also impacted harvest for American shad. The closing date for this gear occurred when the ASMA striped bass harvest quota was met to prevent additional striped bass discards. While American shad could still be harvested using other commercial gears February 15 through April 14, 2023, the gill net gear restriction, coupled with the area closure, had an impact on harvest for the remainder of the open commercial season for American shad.

The western portion of Albemarle Sound near the mouth of the Roanoke River (including Roanoke, Cashie, Middle and Eastmost Rivers) is closed to gill netting year-round. Gill nets with a mesh length of 3.25–4.0 ISM could not exceed 800 yards and were allowed from January 1 through April 30, 2023 (M-2-2023). Attendance for fixed or stationary small mesh gill nets (3.0–3.75 ISM) was required September 1–November 30 when the area reopened to this gear (M-10-2023). The ASMA was closed to all other gill nets except for 3.0–4.0 ISM run-around, strike, drop, and drift gill nets until the area was opened for estuarine flounder season on October 2, 2023 (M-16-2023). During the 2023 estuarine flounder season, the ASMA was open to gill nets configured for flounder, single overnight soaks, Monday night through Thursday morning until the commercial quota for this area was met and gear removed on October 21 (M-21-2023).

Since May 2016, in other areas outside of the ASMA (excluding the Cape Fear River), a statewide rule limits the amount of large mesh (4.0-inch and greater) gill net set in internal Coastal Fishing Waters to no more than 1,500 yards per vessel (M-4-2023). A prior version of the rule (3,000 yards maximum) was suspended for most internal Coastal waters as a result of sea turtle conservation measures to institute no more than 2,000 yards per vessel of 4.0–6.5-inch gill net in the Tar-Pamlico and Neuse rivers systems in earlier years. Additionally, in certain sections of the Tar-Pamlico and Neuse rivers, gill nets with a mesh size less than five inches must be attended at all times. Also, it is unlawful to use any gill nets in Joint Fishing Waters from midnight on Friday to midnight on Sunday each week (except for portions of Albemarle and Currituck sounds). These existing gill net measures have likely reduced American shad harvest since they have remained in effect since the spring 2012 fishing season and remain in effect indefinitely.

In the Cape Fear River there are different gill net restrictions than described above for the Tar-Pamlico and Neuse river systems (i.e., mesh lengths, spacing, set/retrieval days and times). Large mesh gill nets (4.0–6.5-inch) are prohibited in the Cape Fear River (north of the Railroad Bridge) and Northeast Cape Fear River (north of I-40 bridge) north of Wilmington, NC. Run-around, strike, drop, drift, and trammel gill net commercial operations are limited to 800 yards per commercial fishing operation (M-5-2023). It is unlawful to use gill nets of any mesh size on weekends in the Cape Fear system. This measure will remain in effect indefinitely.

A management response for striped bass has been in effect since March 18, 2019, prohibiting the use of all gill nets upstream of the ferry lines from the Bayview to Aurora ferry in the Tar-Pamlico River and the Minnesott Beach and Cherry Branch ferry in the Neuse River (Proclamation M-6-2019). This prohibition directed by the N.C. Marine Fisheries Commission was in response to Supplement A to Amendment 1 to the N.C. Estuarine Striped Bass FMP, and was intended to reduce striped bass fishing mortality, and has essentially protected American shad as well by removing gill nets from the normal fishing grounds for American shad in the Tar-Pamlico River.

At its August 2022 business meeting, the MFC approved Notice of Text for Rulemaking to begin the process to amend the Mutilated Finfish Rule (15A NCAC 03M .0101). The amended rule would provide flexibility to manage variable conditions for the use of finfish, including hickory shad, as cut bait by simplifying the rule such that only species subject to a possession limit are subject to the requirements unless otherwise specified in a MFC rule or a proclamation issued under the authority of a MFC rule. The MFC gave final approval of the rule at its February 2023 business meeting and the rule was scheduled to be reviewed for final approval by the Rules Review Commission (RRC) in June 2023.

At its June 15, 2023, meeting, the RRC objected to the Mutilated Finfish Rule in accordance with N.C.G.S. § 150B-21.10. At its August 25, 2023, business meeting, the MFC moved to keep the mutilated finfish rule as it was originally and grant proclamation authority to the Fisheries Director as Item (4) in the rule to add exemptions for other species. Following its October 5, 2023, special meeting, the RRC returned the mutilated finfish rule to the MFC in accordance with Session Law 2023-134, Section 21.2(m). Since the returned rule was a proposed amendment and the June 15, 2023, and the objection was not to existing language, there was no change to the N.C. Administrative Code. The mutilated finfish rule remains in force as readopted effective April 1, 2019.

Commercial Fishery

North Carolina's commercial landings in 2023 were 27,341 pounds (Table 1; Figure 1). Anchored gill nets configured for harvesting American shad were prohibited in the ASMA effective March 17, 2023, due to the ASMA striped bass commercial quota being met (Proclamation M-6-2023). While American shad could still be landed commercially until April 14, 2023, anchored gill nets are the primary gear used for shad in the ASMA and the gear and area restriction did have an impact on landings.

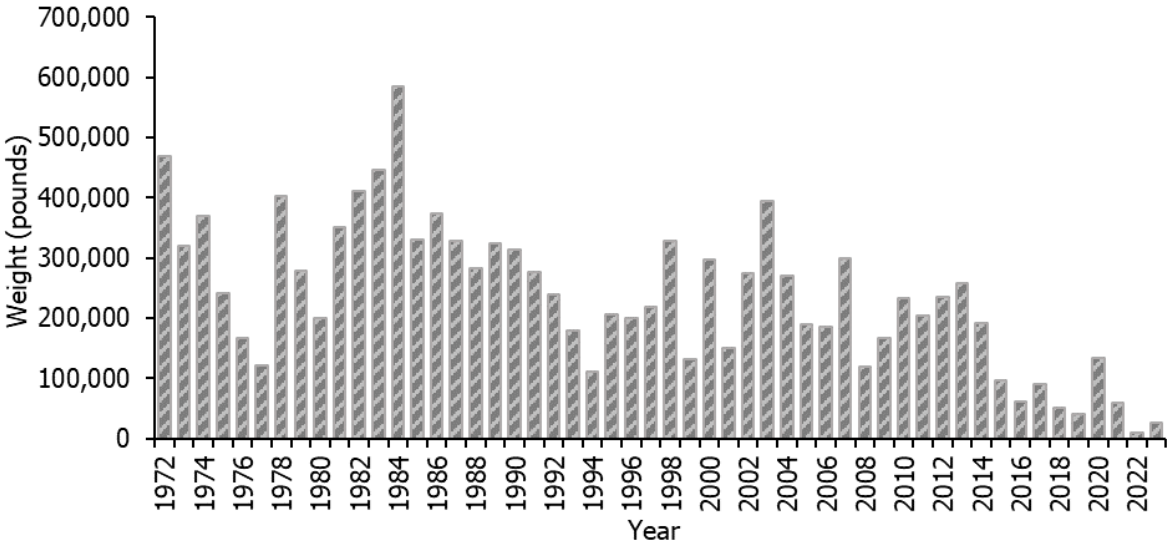

Figure 1. Commercial harvest (weight in pounds) of American shad from North Carolina, 1972–2023.

Table 1. Commercial harvest (weight in pounds) of American shad from North Carolina, 1972–2023. Commercial harvest from the Atlantic Ocean prohibited since 2007.

Year	Weight Landed (lb)	Year	Weight Landed (lb)
1972	468,484	1998	327,556
1973	321,000	1999	131,617
1974	368,833	2000	297,990
1975	241,240	2001	151,075
1976	167,190	2002	274,657
1977	120,201	2003	395,251
1978	402,017	2004	270,245
1979	277,818	2005	189,462
1980	199,206	2006	184,710
1981	351,500	2007	298,597
1982	407,034	2008	118,855
1983	380,897	2009	167,114
1984	382,331	2010	232,326
1985	190,044	2011	203,755
1986	279,142	2012	235,795
1987	111,860	2013	257,348
1988	111,567	2014	191,302
1989	52,997	2015	95,966
1990	30,833	2016	62,245
1991	29,037	2017	90,868
1992	38,020	2018	53,878
1993	12,544	2019	40,975
1994	110,975	2020	134,566
1995	205,867	2021	58,884
1996	199,638	2022	9,443
1997	219,526	2023	27,341
		Mean	199,104

Overall, landings show a decreasing trend until 2013 when average landings leveled off with the implementation of the American Shad SFMP. Commercial harvest is sporadic and cyclical and annual trends show these changes. Figure 2 describes the landings break down by the four areas of the state, as stated in the American Shad SFMP. The Albemarle Sound area accounts for approximately 91% of total state landings in 2023.

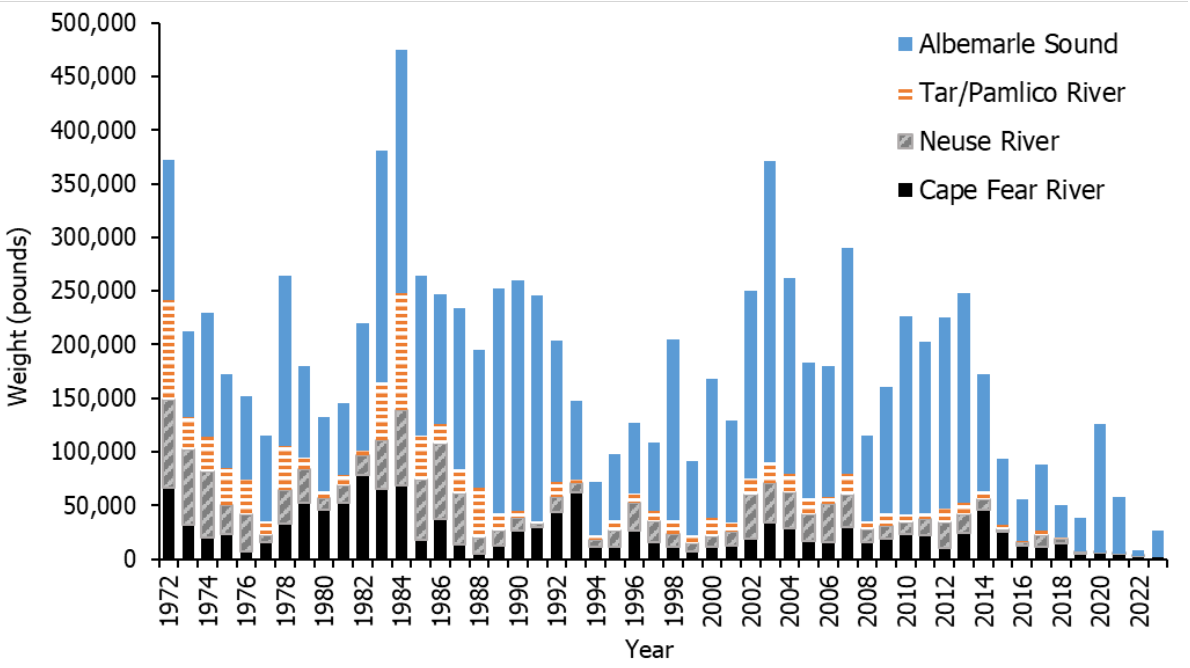

Figure 2. Commercial harvest (weight in pounds) of American shad from North Carolina by major waterbody, 1972–2023.

Recreational Fishery

Recreational fishing activity is monitored through coordination with the North Carolina Wildlife Resources Commission (WRC) and the DMF, methods were developed to conduct recreational creel surveys on the Roanoke, Tar-Pamlico, and Neuse rivers starting in 2012, and for the Cape Fear River in 2013. Recreational landings for American shad are minimal throughout the Albemarle Sound-Roanoke River due to limited to no effort focused on American shad in this system. The bulk of the North Carolina recreational fishery occurs in the Cape Fear River system where substantial effort is targeted on American shad with an estimated harvest of 2,079 fish in 2023 (Table 2).

Table 2. Recreational harvest (number of fish landed and weight in pounds) and releases (number of fish) and commercial harvest (weight in pounds) of American shad from the North Carolina Central Southern Management Area (CSMA), 2012–2023.

Neuse River					
	Recreational			Commercial	
Year	Numbers Landed	Numbers Released	Weight Landed (lb)	Weight Landed (lb)	Total Weight Landed (lb)
2012	968	511	2,277	23,985	26,262
2013	1,388	2,699	2,920	17,255	20,175
2014	413	995	992	9,778	10,770
2015	94	132	293	3,022	3,314
2016	252	1,389	426	2,568	2,994
2017	518	2,828	1,328	11,451	12,779
2018	112	356	286	3,987	4,273
2019	215	91	455	1,531	1,986
2020	830	1,933	1,770	109	1,879
2021	36	53	74	16	90
2022	36	170	123	248	371
2023	155	1,009	133	0	133
Tar-Pamlico River					
	Recreational			Commercial	
Year	Numbers Landed	Numbers Released	Weight Landed (lb)	Weight Landed (lb)	Total Weight Landed (lb)
2012	899	4,257	1,711	12,982	14,693
2013	2,479	7,053	6,830	9,776	16,606
2014	168	1,314	453	7,472	7,925
2015	1,006	2,784	3,262	3,418	6,680
2016	1,051	2,820	3,408	765	4,173
2017	898	2,217	2,159	4,412	6,571
2018	685	2,767	1,588	1,580	3,168
2019	544	3,028	944		944
2020	209	562	362	129	491
2021	731	4,236	1,945	59	2,004
2022	464	995	1,211	59	1,270
2023	821	2,096	717	0	717
Cape Fear River					
	Recreational			Commercial	
Year	Numbers Landed	Numbers Released	Weight Landed (lb)	Weight Landed (lb)	Total Weight Landed (lb)
2012				10,341	10,341
2013	18,484	6,154	42,571	24,888	67,459
2014	7,256	0	23,084	46,148	69,232
2015	4,136	6,125	11,504	25,039	36,543
2016	10,244	10,740	28,393	12,937	41,330
2017	1,352	2,669	3,787	11,049	14,836
2018	5,384	3,992	13,088	14,931	28,019
2019	2,266	1,101	5,786	5,076	10,862
2020	3,582	3,740	7,645	6,038	13,683
2021	2,624	6,914	6,623	4,838	11,461
2022	2,666	953	6,103	2,899	9,002
2023	2,079	5,775	2,444	1,428	3,872

MONITORING PROGRAM DATA

Fishery-Dependent Monitoring

Commercial fishing activity is monitored through fishery-dependent sampling conducted by the DMF since 1972, with a sampling gap during 1994–2000 due to lack of funding. Data collected in this program allow the size and age distribution of American Shad to be characterized by sex (female and male). The predominant fishery for American shad is estuarine gill nets and harvest is primarily focused on female American Shad, as they are harvested for their roe (eggs). In 2023, gill nets accounted for greater than 86% of the commercial landings.

A total of 316 females and 40 males were measured from the commercial fishery in 2023 (Tables 3 and 4). The average size was 17 inches fork length for female and 15 inches fork length for male American shad (Figures 3 and 4).

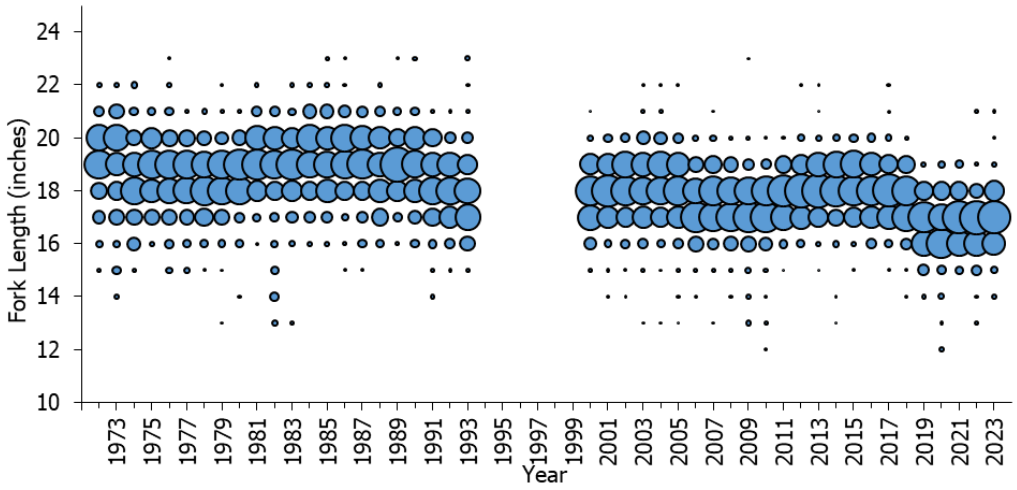

Figure 3. Commercial length frequency (fork length, inches) of female American shad harvested, 1972–2023. Bubbles represent fish at length and the bubble size is proportional to the number of fish at that length.

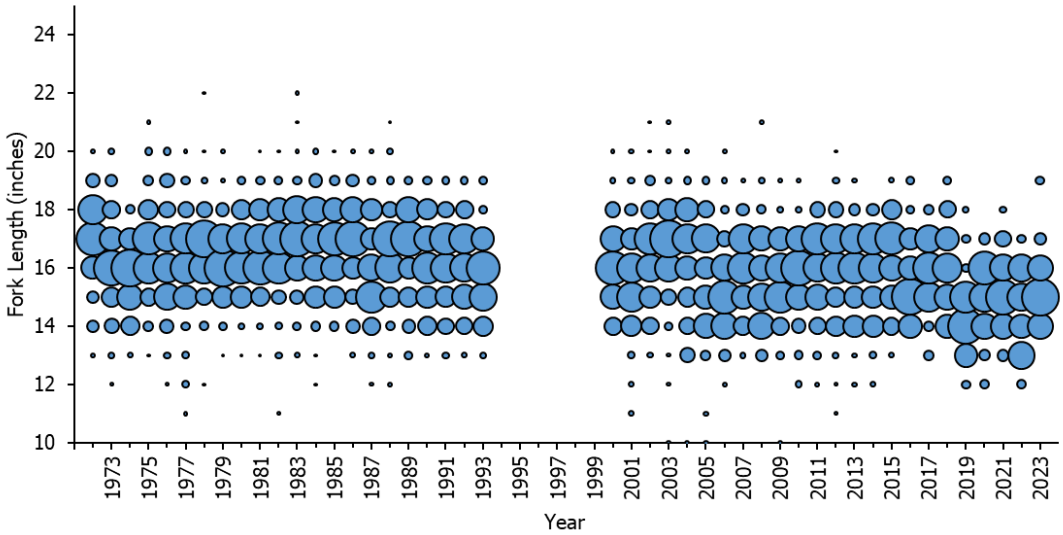

Figure 4. Commercial length frequency (fork length, inches) of male American shad, 1972–2023. Bubbles represent fish at length and the bubble size is proportional to the number of fish at that length.

Table 3. Mean, minimum, and maximum lengths (fork length, inches) of female American shad measured from the commercial fisheries, 1972–2023.

Year	Mean Length	Minimum Length	Maximum Length	Total Number Measured
1972	19	14	22	244
1973	18	14	21	345
1974	18	15	21	177
1975	18	15	21	774
1976	18	14	23	404
1977	18	14	20	515
1978	18	14	20	554
1979	18	10	22	691
1980	18	14	21	367
1981	19	16	21	374
1982	18	13	21	247
1983	18	12	21	464
1984	19	15	21	613
1985	19	15	23	561
1986	19	15	23	419
1987	19	14	21	360
1988	18	15	22	607
1989	18	15	23	470
1990	18	15	23	156
1991	18	13	20	330
1992	18	15	20	299
1993	17	15	22	220
2000	17	14	20	836
2001	17	13	20	711
2002	18	13	20	794
2003	18	13	22	545
2004	18	12	22	727
2005	17	13	21	847
2006	17	14	20	667
2007	17	12	20	785
2008	17	14	20	740
2009	17	12	22	702
2010	17	12	20	948
2011	17	15	19	1,103
2012	17	15	21	1,169
2013	18	15	21	1,363
2014	18	13	20	870
2015	18	14	20	678
2016	17	15	20	396
2017	17	15	22	456
2018	17	14	20	388
2019	17	14	19	444
2020	15	12	19	281
2021	17	15	19	415
2022	17	13	21	225
2023	17	14	21	316

Table 4. Mean, minimum, and maximum lengths (fork length, inches) of male American shad measured from the commercial fisheries, 1972–2023.

Year	Mean Length	Minimum Length	Maximum Length	Total Number Measured
1972	17	13	19	285
1973	16	12	20	365
1974	15	13	18	225
1975	16	12	20	466
1976	16	12	20	392
1977	16	11	19	253
1978	16	11	22	470
1979	16	13	20	533
1980	16	12	19	429
1981	16	13	19	486
1982	16	11	19	367
1983	16	13	21	630
1984	16	12	19	608
1985	16	13	19	475
1986	16	12	19	348
1987	16	12	19	299
1988	16	11	20	422
1989	16	12	18	346
1990	16	13	19	204
1991	16	12	19	248
1992	16	12	19	232
1993	15	12	19	153
2000	16	13	20	315
2001	15	11	20	130
2002	16	13	21	352
2003	16	10	20	284
2004	16	8	19	239
2005	15	7	18	160
2006	15	11	20	192
2007	15	12	18	216
2008	15	5	20	152
2009	15	12	18	213
2010	15	12	18	199
2011	15	12	18	159
2012	16	10	19	353
2013	15	11	19	175
2014	15	11	18	120
2015	16	12	18	124
2016	15	13	18	50
2017	15	12	17	58
2018	15	13	18	53
2019	14	12	18	85
2020	15	12	17	74
2021	15	13	18	71
2022	15	12	17	41
2023	15	13	19	40

Variation in modal, minimum, and maximum ages throughout the fishery-dependent monitoring is described in Table 5, for both sexes combined. The modal age has increased over the time series, while the minimum and maximum ages have remained relatively unchanged.

Table 5. Modal age, minimum age, maximum age, and number aged for American shad (male and female combined) collected through DMF fishery-dependent sampling programs, 1972–2022. *Age data unavailable for 2023.

Year	Modal Age	Minimum Age	Maximum Age	Total Number Aged	Year	Modal Age	Minimum Age	Maximum Age	Total Number Aged
1972	5	3	9	465	2001	5	3	8	423
1973	4	3	8	656	2002	5	3	8	580
1974	4	3	7	389	2003	6	3	8	543
1975	5	2	9	1,138	2004	5	3	8	645
1976	5	4	9	664	2005	5	3	8	477
1977	5	3	7	585	2006	6	3	8	499
1978	6	3	7	953	2007	6	3	8	439
1979	5	4	9	1,060	2008	6,7	3	9	447
1980	6	4	9	685	2009	7	4	10	431
1981	6	4	9	528	2010	6	3	9	453
1982	5	3	9	328	2011	6	3	8	403
1983	5	3	9	626	2012	5	3	8	526
1984	5	3	9	707	2013	7	3	9	449
1985	5	3	8	624	2014	7	3	9	418
1986	5	4	9	475	2015	7	4	8	406
1987	5	4	9	403	2016	7	4	8	280
1988	5	4	9	604	2017	7	4	9	382
1989	5	3	8	238	2018	7	3	8	278
1990	6	3	9	233	2019	6	4	8	273
1991	5	4	8	321	2020	6	4	8	255
1992	5	4	9	295	2021	6	4	8	301
1993	5	4	9	221	2022	6	4	8	180
2000	5	3	7	401	2023	*	*	*	*

Figure 5 and Figure 6 illustrate the American Shad length at age (mean, minimum, and maximum) for females and males from all age samples collected at any given age from 1972 to 2022. Age data for 2023 are incomplete and will be provided in next year's update.

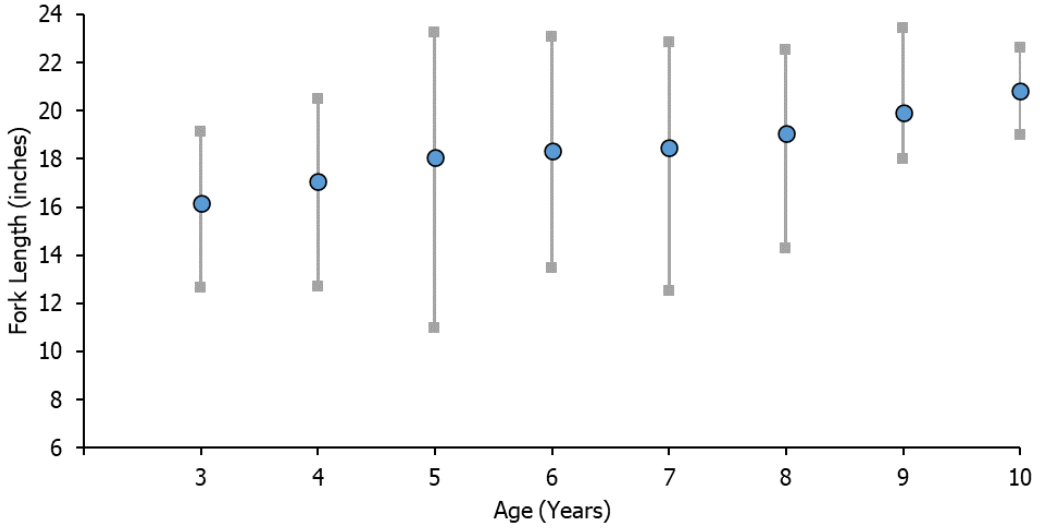

Figure 5. Female American shad length at age from all age samples collected from fishery-dependent monitoring, 1972–2022. Blue circles represent the mean size at a given age while the grey squares represent the minimum and maximum observed size for each age. Age data unavailable for 2023.

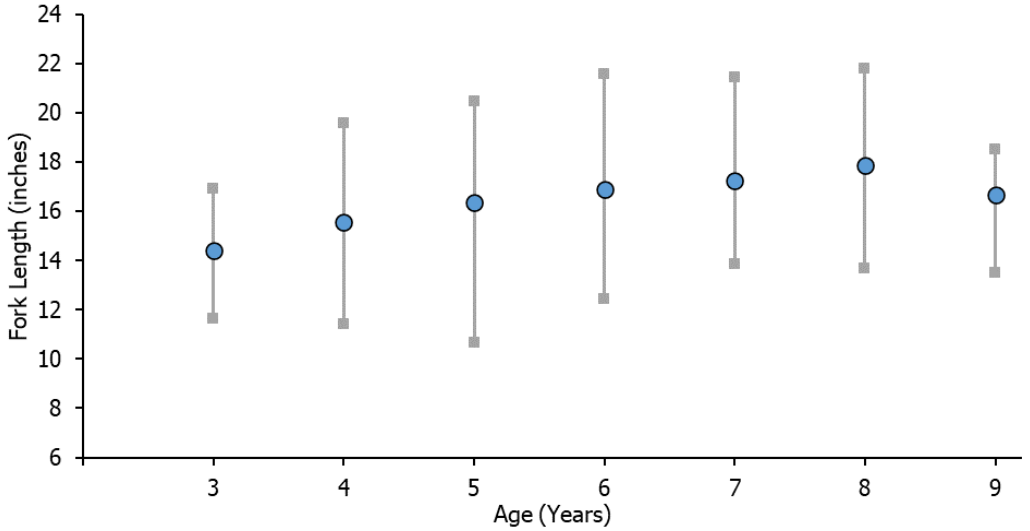

Figure 6. Male American shad length at age from all age samples collected from fishery-dependent monitoring, 1972–2022. Blue circles represent the mean size at a given age while the grey squares represent the minimum and maximum observed size for each age. Age data unavailable for 2023.

Fishery-Independent Monitoring

The DMF does not have a dedicated juvenile (age 0) survey for American Shad but conducts two juvenile beach seine surveys in the Albemarle Sound area, Juvenile Anadromous Survey (Program 100). Although the surveys were designed to monitor river herring [blueback herring (*Alosa aestivalis*) and alewife (*Alosa pseudoharengus*)] and striped bass, both surveys capture American shad. The river herring beach seine survey has been conducted in the Chowan River and Albemarle Sound area to monitor Blueback Herring and Alewife abundance since 1972. The survey established 11 stations in the near-shore nursery areas of the Chowan River and Albemarle Sound, sampled twice a month. The striped bass beach seine survey has been conducted in the western

Albemarle Sound to monitor juvenile striped bass since 1993. The survey established nine stations in the near-shore nursery areas of the western Albemarle Sound, where early-stage juvenile striped bass would be settling after larval metamorphosis from spawning grounds on the Roanoke River. The stations are sampled once a week, for six weeks (starting the first week in June). American shad captured are recorded but not consistently until 1995. Following the six weeks of sampling, the stations are sampled bimonthly through October.

The ASFMC 2007 benchmark assessment for American Shad only considered the juvenile river herring beach seine survey data for a relative abundance index for American Shad. Due to the consistently low level of catch since 1972, the authors felt that the survey did not adequately reflect the true abundance of juvenile American Shad and should not be used for management. During the ASMFC 2020 benchmark stock assessment for American Shad a combination of seine stations from the river herring survey (five stations) and the striped bass survey (nine stations), all samples June through October, were selected to determine a juvenile abundance starting in 1996 (zero catches in 1995). A Zero-inflated Negative Binomial GLM model was determined as the best recommended predictions of relative annual abundance. Water temperature, salinity, month and cloud cover were all shown to significantly impact catch rates and presence. The best performing model was Counts ~ Year + water temperature + salinity | salinity + cloud cover + month. Updates to annual trends in abundance are illustrated in Figure 7 as arithmetic mean, in lieu of updating the model annually. No American shad were caught in 2023 therefore relative abundance of American shad from this survey was zero.

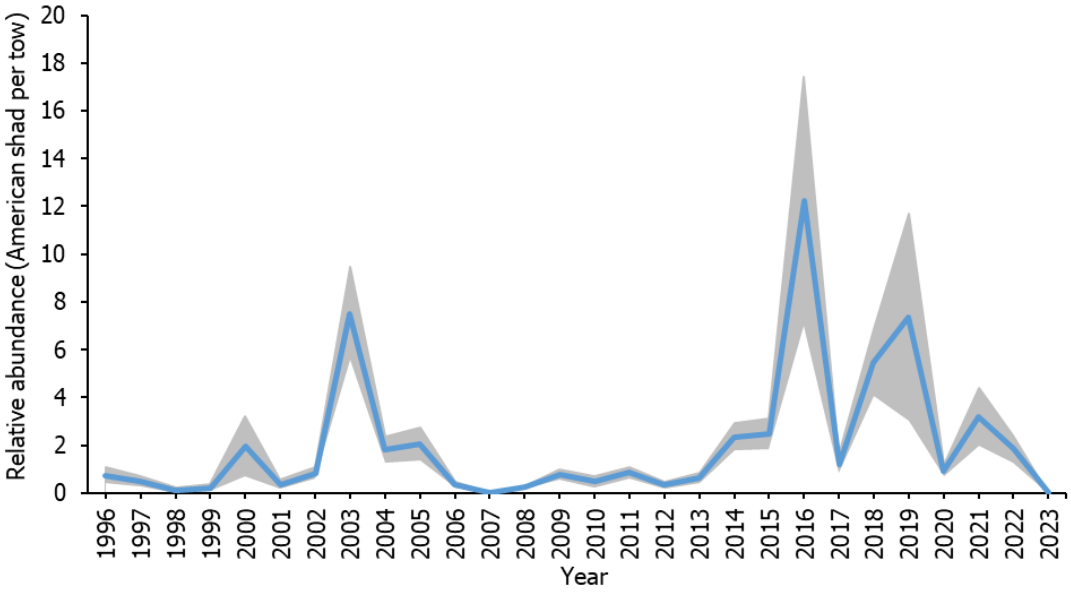

Figure 7. Relative abundance index (fish per tow) of American shad collected from Program 100 in Albemarle Sound during June through October 1996–2023. Error bars represent ± 1 standard error.

Adult American shad are monitored using the DMF Albemarle Sound Independent Gill Net Survey (Program 135) and WRC electrofishing surveys to estimate female relative abundance and relative fishing mortality in the Albemarle Sound-Roanoke River area. In other areas of the state, WRC conducts electrofishing surveys to estimate abundance and the relative fishing mortality. These data are incorporated into the North Carolina SFMP for American Shad described in more detail in the Management Strategy section.

Program 135 began collecting biological data on adult American Shad in 2000, sex was not recorded 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. American Shad intercepted by DMF gill net surveys outside to the Albemarle Sound-Roanoke River area are reported annually to the ASMFC, due to low numbers of catch relative abundance is not estimated.

Program 135 was suspended in February 2020 due to COVID-19 restrictions and protected species interactions. The survey resumed in the fall of 2021. In November 2021, the Albemarle Sound Independent Gill Net Survey (IGNS) expanded from six to eight zones and reduced soak time from 24-hours to 12-hours. Additionally, in March 2022, sink gill nets were removed from the survey, reducing effort to 480 yards per set (12 units of effort). Additional zones were added to meet DMF research priorities to expand the spatial coverage of the survey. Soak times were reduced and sink nets were removed to reduce interactions with endangered species through ongoing consultation with the United States Fish and Wildlife Service (USFWS) and the National Oceanic and Atmospheric Association (NOAA Fisheries). It should be noted that with such a major change in survey design, the index derived from this survey starting in November 2021 will not be directly comparable to the prior historical time series. When calculating female relative abundance using historical IGNS data, all sink gill nets were removed. It is important to note that most American shad intercepted in the IGNS survey are from float gill nets. Therefore, the removal of sink gill nets from the data set did not significantly impact the relative abundance estimates of American shad from the survey.

The female index of abundance for American shad from Program 135 uses the January through May catch of female American shad from float nets in the western Albemarle Sound. For 2023, the female index of abundance for American shad was 0.075 fish per net (Figure 8). Due to the survey suspension index values are not available for 2020 and 2021.

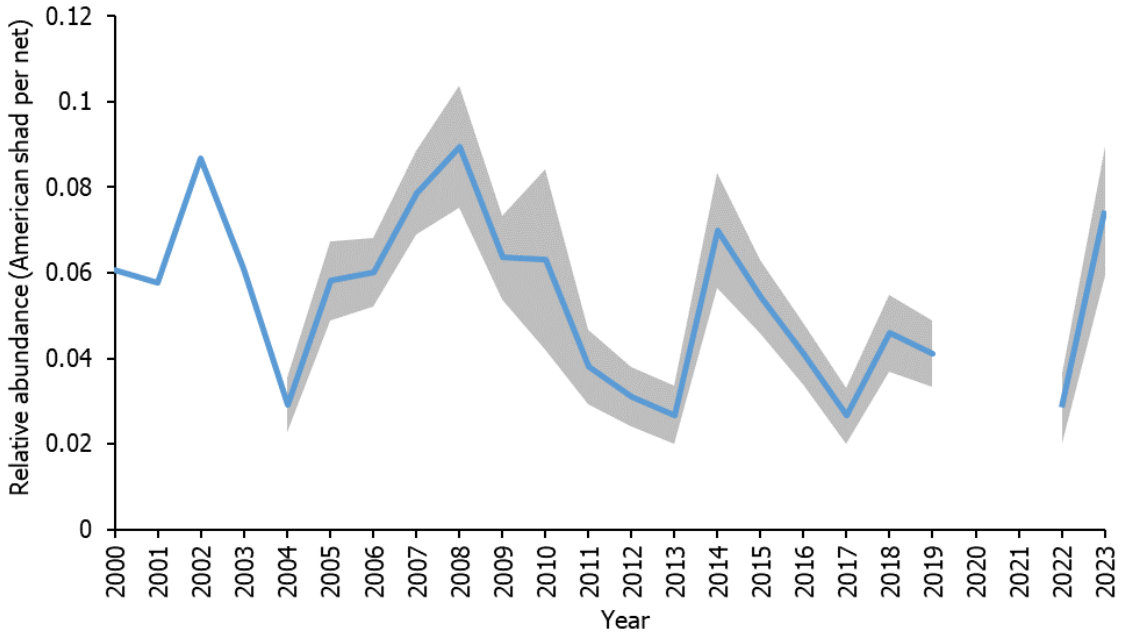

Figure 8. Relative abundance index of female American shad (fish per net, all float net mesh sizes) collected from Program 135 in Albemarle Sound during January through May 2000–2023. Error bars represent ± 1 standard error. * Survey suspended February 20, 2020, and did not resume until fall 2021.

A total of 66 females and 39 males were measured from the DMF fishery-independent monitoring (Tables 6 and 7) from all areas of the state. The average size of female American Shad is 16 inches fork length and male are 15 inches fork length.

Table 6. Mean, minimum, and maximum lengths (fork length, inches) of female American shad measured from DMF fishery-independent sampling programs, 2000–2023.

Year	Mean Length	Minimum Length	Maximum Length	Total Number Measured
2000	18	14	20	74
2001	17	15	21	198
2002	18	14	20	144
2003	18	15	20	161
2004	18	15	20	149
2005	18	15	20	106
2006	17	15	20	52
2007	17	14	18	35
2008	16	13	19	45
2009	17	16	19	22
2010	17	15	19	83
2011	17	15	19	14
2012	17	14	19	59
2013	17	13	19	73
2014	17	16	19	28
2015	17	16	18	18
2016	17	13	18	19
2017	17	14	19	65
2018	16	12	19	76
2019	16	6	19	95
2020	17	15	18	41
2021	17	15	18	9
2022	16	14	18	55
2023	16	9	18	66

Table 7. Mean, minimum, and maximum lengths (fork length, inches) of male American shad measured from DMF fishery-independent sampling programs, 2000–2023.

Year	Mean Length	Minimum Length	Maximum Length	Total Number Measured
2000	16	13	19	173
2001	15	13	18	84
2002	15	12	18	135
2003	16	12	19	87
2004	17	12	19	14
2005	15	13	17	30
2006	15	13	18	14
2007	15	13	17	34
2008	14	12	17	33
2009	15	13	17	18
2010	15	12	16	40
2011	15	14	17	12
2012	15	13	17	23
2013	15	13	16	34
2014	15	14	16	11
2015	15	14	16	3
2016	15	15	16	7
2017	15	11	17	57
2018	15	12	18	80
2019	15	11	17	91
2020	15	12	16	32
2021	15	13	16	6
2022	14	12	16	36
2023	15	12	17	39

Variation in modal, minimum, and maximum ages throughout the fishery-independent sampling is described in Table 8, for both sexes combined. The modal age has fluctuated over the time series, while the minimum and maximum ages have remained relatively stable.

Figure 9 and Figure 10 illustrate the American Shad length at age (mean, minimum, and maximum) for females and males from all age samples collected from the fishery-independent monitoring at any given age during 2000–2022. Age data for 2023 are incomplete and will be provided in next year's update.

Table 8. Modal age, minimum age, maximum age, and number aged for American shad (male and female combined) collected through DMF fishery-independent sampling programs, 2000–2022. *Age data unavailable for 2023.

Year	Modal Age	Minimum Age	Maximum Age	Total Number Aged
2000	5	3	7	247
2001	5	3	7	282
2002	4	3	8	279
2003	6	3	8	248
2004	6	3	8	163
2005	5	3	7	136
2006	4	3	8	66
2007	4	4	7	69
2008	5	3	8	78
2009	6	4	8	40
2010	6	3	8	123
2011	6	3	8	26
2012	6	4	8	82
2013	5	3	8	107
2014	6	4	7	39
2015	6,7	3	7	21
2016	6	3	8	26
2017	6	3	8	122
2018	5	3	8	146
2019	5	3	7	152
2020	6	3	8	71
2021	5	4	7	15
2022	6	4	8	90
2023	*	*	*	*

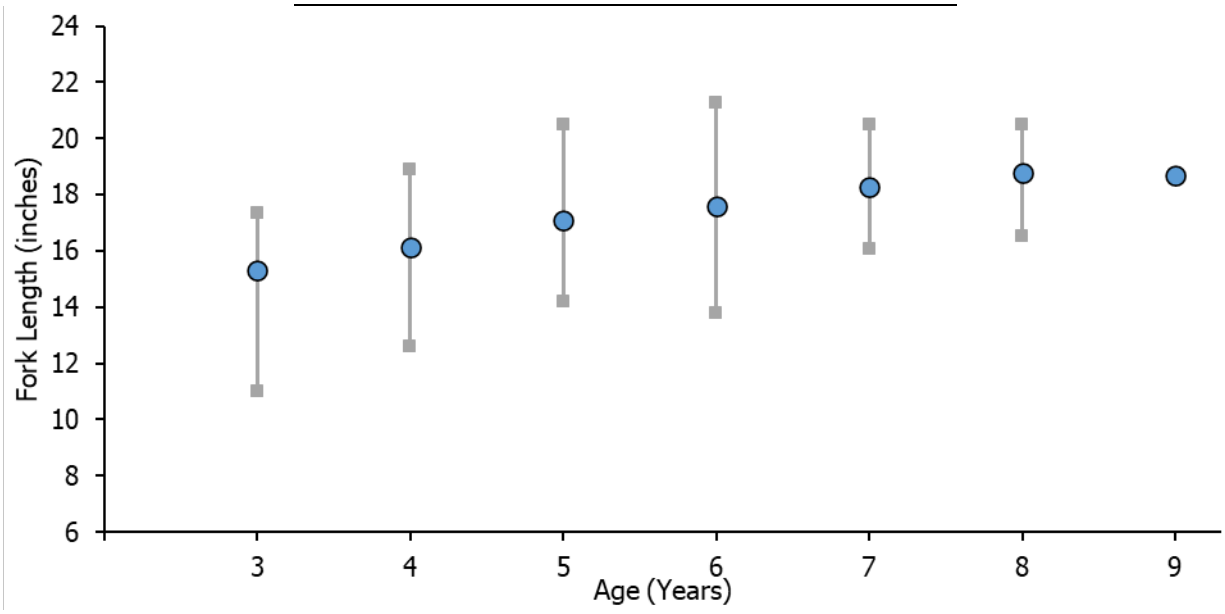

Figure 9. Female American shad length at age from all age samples collected through DMF fishery-independent sampling programs, 2000–2022. Blue circles represent the mean size at a given age while the grey squares represent the minimum and maximum observed size for each age. Age data unavailable for 2023.

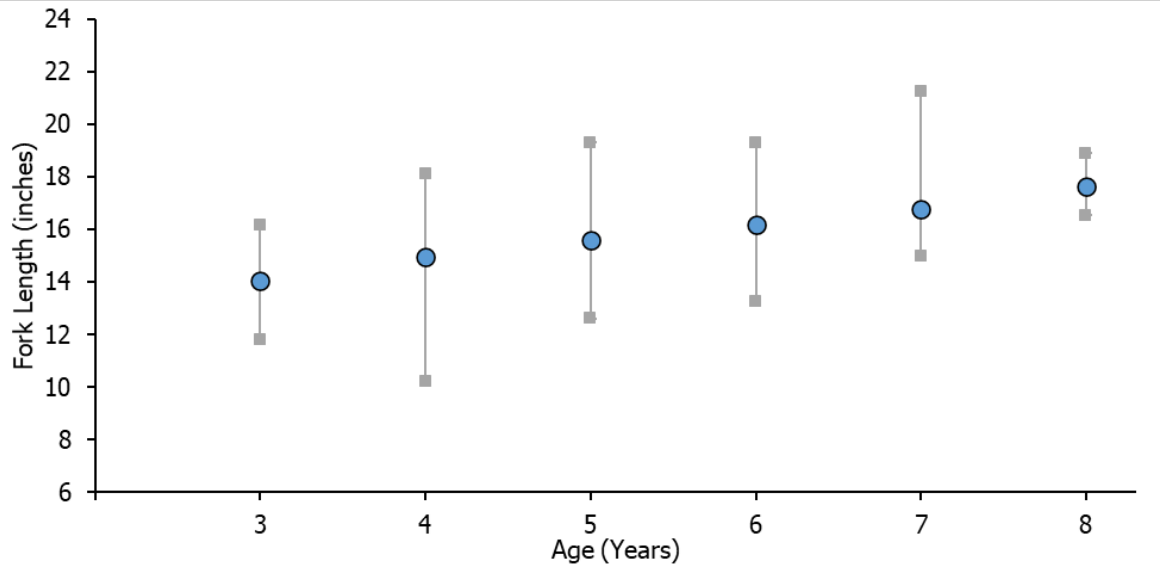

Figure 10. Male American shad length at age from all age samples collected through DMF fishery-independent sampling programs, 2000–2022. Blue circles represent the mean size at a given age while the grey squares represent the minimum and maximum observed size for each age. Age data unavailable for 2023.

RESEARCH NEEDS

On an annual basis the ASMFC publishes a prioritized list of short term and long-term 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 2020).

For more information on research needs for River herring please see: https://asmfc.org/uploads/file/653bf9e9ShadRiverHerringFMP_ReviewFY2022.pdf

MANAGEMENT

Shad are managed under Amendment 3 to the ASMFC Interstate FMP for Shad and River Herring. The Amendment requires states and jurisdictions to develop sustainable fishery management plans, which are reviewed by the ASMFC Technical Committee and approved by the ASMFC Shad and Herring Management Board, in order to maintain commercial and recreational fisheries past January 2013. The ASMFC requires that these plans be re-evaluated every five years to update and modify sustainable management measures. The first NC American Shad SFMP, effective in 2013 through 2017, identified sustainability parameters for four regions of the state: Albemarle-Roanoke River, Tar-Pamlico, Neuse, and Cape Fear River systems. Sustainability parameters are based on the female portion of the stock because the commercial fishery targets roe shad; roe landings can account for as much as 90% of the total American shad landings in a year. The second NC American Shad SFMP, approved October 2017 for 2018 through 2022, maintained the original sustainability parameters of relative fishing mortality (F) and abundance indices, but relative *F* will now be computed by dividing commercial landings by a hind cast 3-year average of a survey index. The previous plan used a centered 3-year average.

The third NC American Shad SFMP, approved January 2023 for 2023 through 2027 added a sustainability parameter for juvenile abundance in the Albemarle Sound-Roanoke River and updated female relative F parameters to include the commercial and recreational harvest for the Tar-Pamlico, Neuse, and Cape Fear river systems. Previously, relative F was computed for these

systems using only information from the commercial harvest of roes (females), in pounds of fish. Commercial harvest of American shad has continued to decline due to management regulations and reduced participation in the fishery in these areas. The addition of recreational data to the relative F calculation has shortened the time-series, but the estimates are more informative of total removals from the Tar-Pamlico, Neuse, and Cape Fear river systems. Thresholds have been established for indices in each system to define levels needed to reduce mortality and avoid diminishing potential stock reproduction and recruitment. Thresholds for sustainability parameters are fixed using available survey data through 2022 and will remain fixed during the next 5-year management period.

Albemarle Sound-Roanoke River

The Albemarle Sound-Roanoke River system has four sustainability parameters: juvenile abundance, female CPUE based on the DMF Albemarle Sound Independent Gill Net Survey (IGNS, Program 135), female CPUE based on the WRC electrofishing survey, and female relative fishing mortality (F) computed by dividing commercial landings by a hind cast 3-year average of the DMF IGNS index. As written in the 2023 SFMP, exceeding the juvenile abundance, female CPUE based on Albemarle Sound IGNS or the female relative *F* parameters for three consecutive years will trigger management action. The female CPUE based on the WRC electrofishing survey will be used in conjunction with a second index for triggering management action.

Figure 11 shows the juvenile abundance index from the DMF juvenile seine survey. The juvenile abundance index exceeded the threshold in 2023 but did not trigger management. Figure 12 shows the female CPUE based on the DMF Albemarle Sound IGNS. Figure 13 shows the CPUE based on the WRC electrofishing survey. Figure 14 shows the female relative *F* based on commercial landings and a hind cast three-year average of the DMF IGNS index.

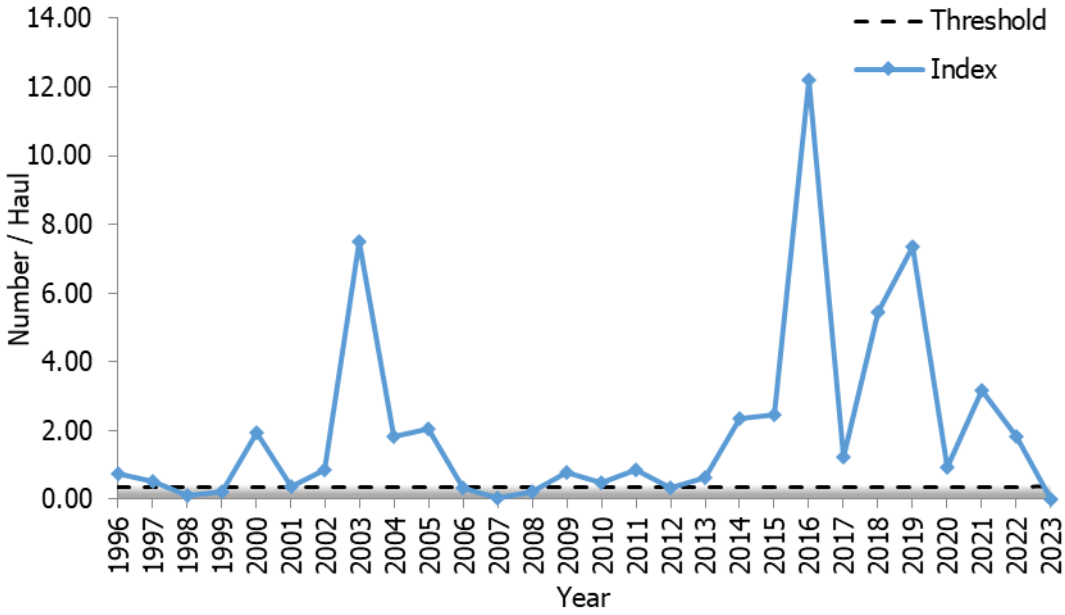

Figure 11 Juvenile abundance index from the DMF juvenile seine survey (Jun–Oct) for the Albemarle Sound, 1996-2023. Threshold represents 25th percentile (where 75% of all values are greater). Values in gray are below the threshold.

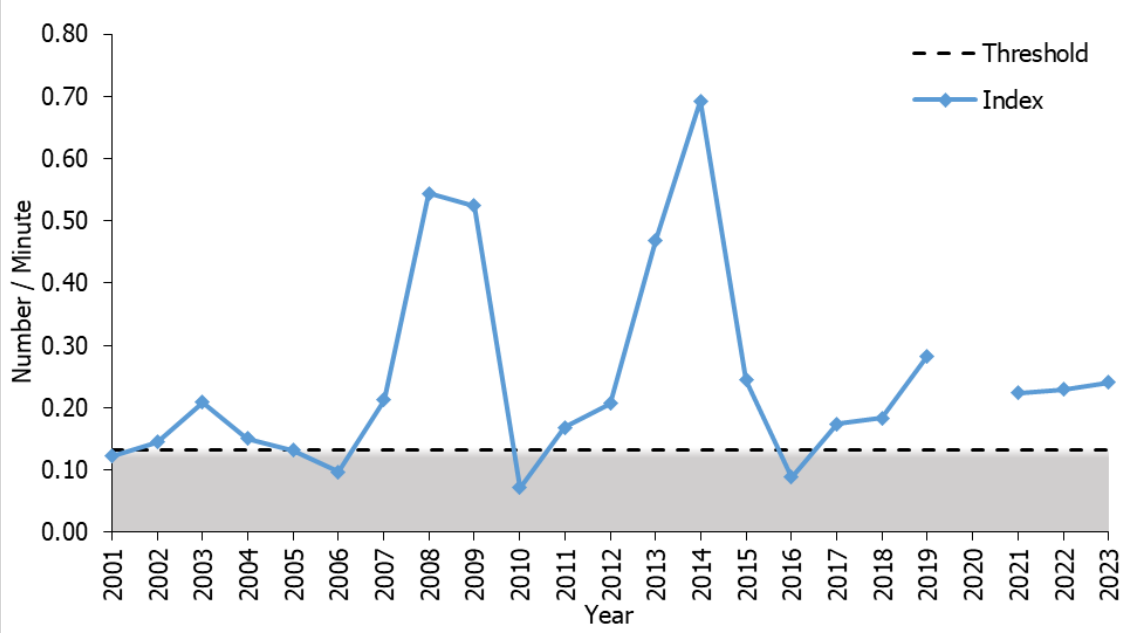

Figure 12. Female index from WRC electrofishing survey (March–May) for Roanoke River, 2001-2023. Threshold represents 25th percentile (where 75% of all values are greater). Values in gray are below the threshold. No survey data available for 2020.

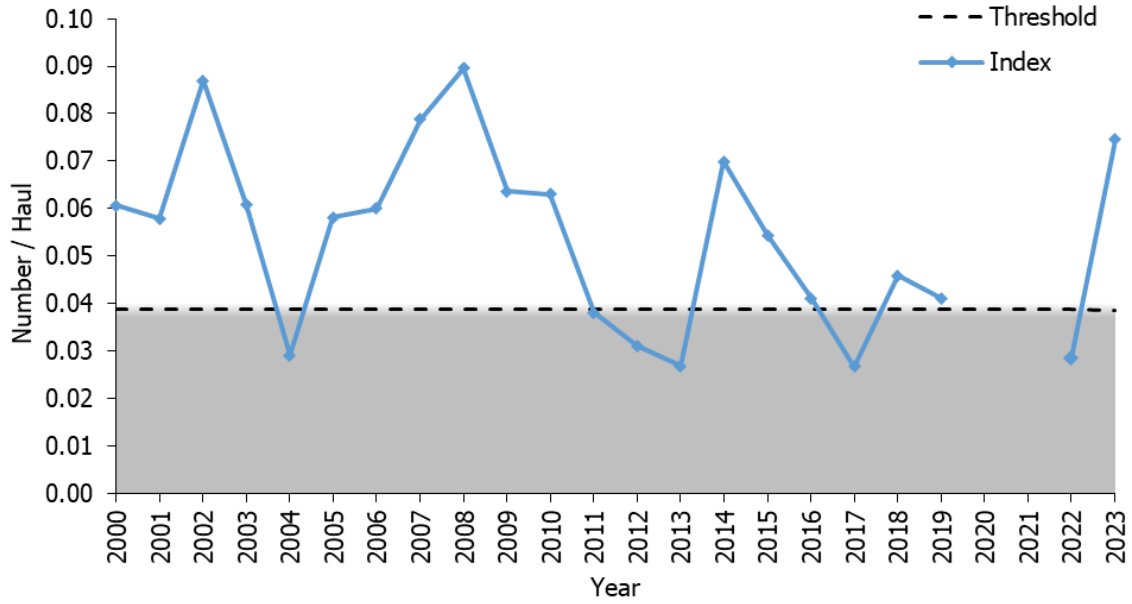

Figure 13. Female index from IGNS (January–May) for Albemarle Sound, 2000–2023. Threshold represents 25th percentile (where 75% of all values are greater. Values in gray are below the threshold. No survey data available for 2020-2021.

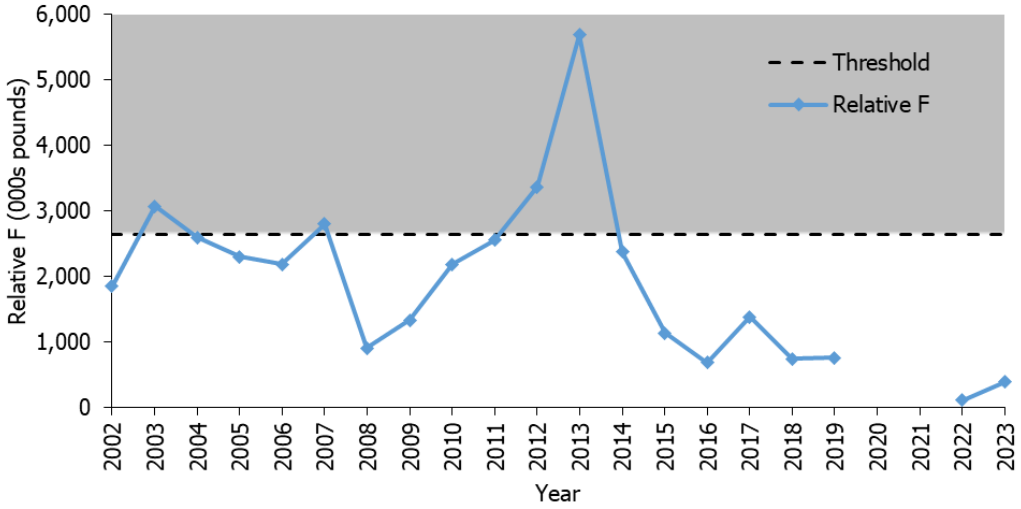

Figure 14. Albemarle Sound sustainability parameter for female relative *F* expressed in pounds of female fish, 2002–2023. The threshold represents the 75th percentile (where 25% of all values are greater), values in gray are exceeding the threshold. No survey data available for 2020 and 2021.

Tar-Pamlico River system

The Tar-Pamlico system has two sustainability parameters: female CPUE based on the WRC electrofishing survey, and female relative *F* based on the WRC electrofishing survey. Female relative *F* is calculated using the combined commercial and recreational harvest from the Tar-Pamlico River and the female CPUE index from the Tar-Pamlico River electrofishing survey.

Figure 15 shows the female CPUE based on the WRC electrofishing survey and Figure 16 shows the female relative *F* based on the WRC electrofishing survey.

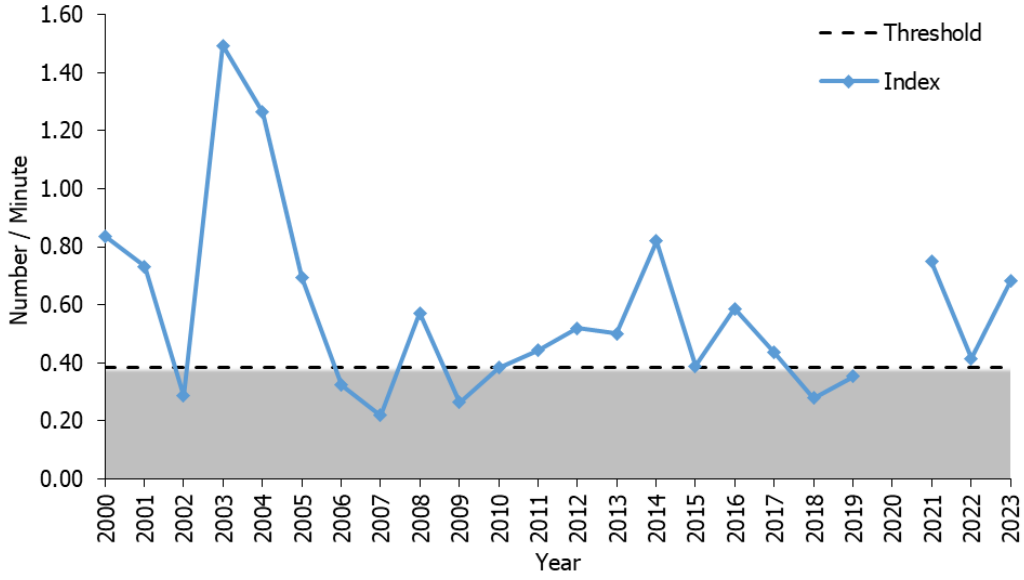

Figure 15. Female electrofishing index (March–May) for the Tar-Pamlico River, 2000–2023. The threshold represents the 25th percentile (where 75% of all values are greater). Values in gray are below the threshold. No survey data available for 2020.

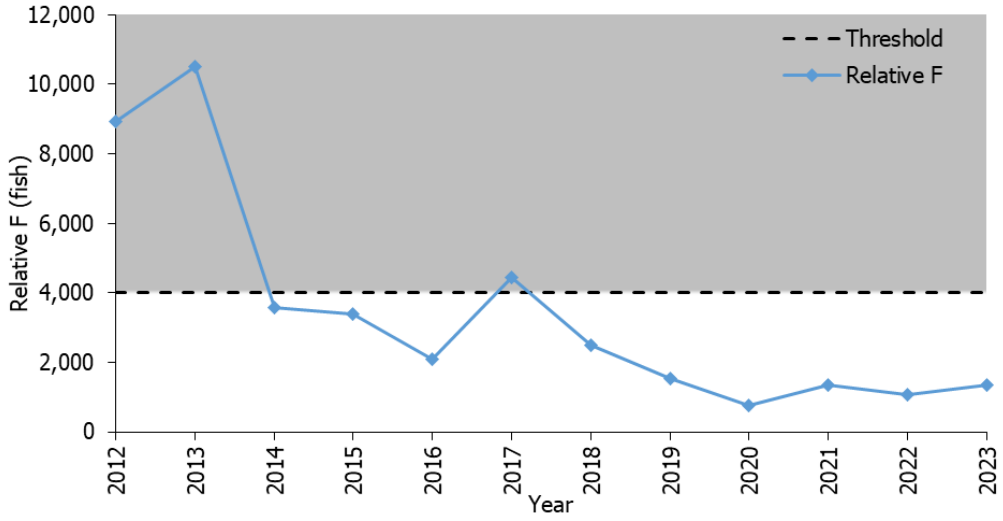

Figure 16. Tar-Pamlico River system sustainability parameter for female relative *F* in WRC electrofishing survey, 2002–2023. The threshold represents the 75th percentile (where 25% of all values are greater), values in gray are exceeding the threshold.

Neuse River system

The Neuse River system has two sustainability parameters: female CPUE based on the WRC electrofishing survey, and female relative *F* based on the WRC electrofishing survey. Female relative F is calculated using the combined commercial and recreational harvest from the Neuse River and the female CPUE index from the Neuse River electrofishing survey.

Figure 17 shows the female CPUE based on the WRC electrofishing survey and Figure 18 shows the female relative *F* based on the WRC electrofishing survey.

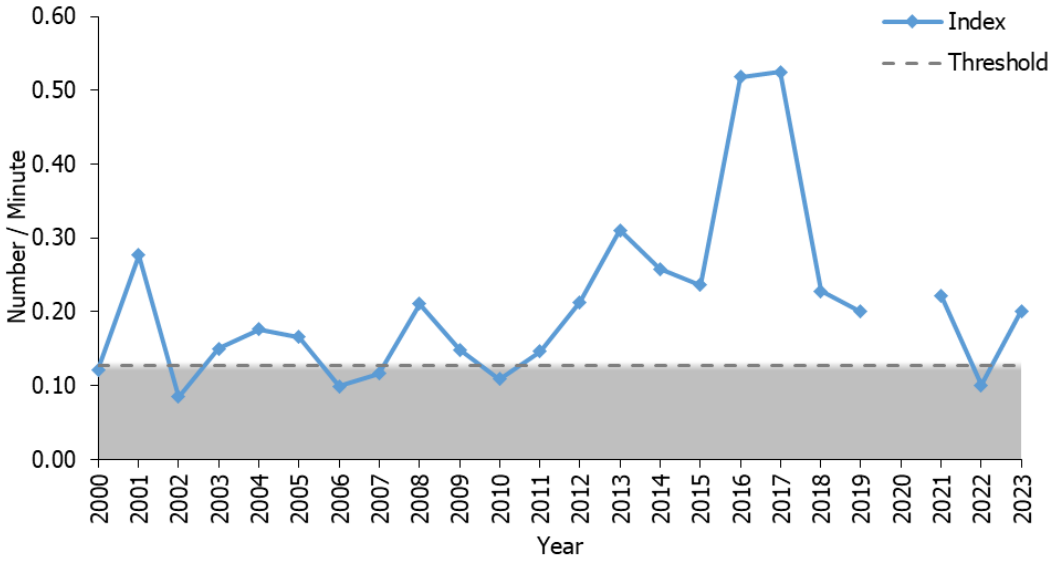

Figure 17. Female electrofishing index (March–May) for the Neuse River, 2000–2023. The threshold represents the 25th percentile (where 75% of all values are greater). Values in gray are below the threshold. No survey data available for 2020.

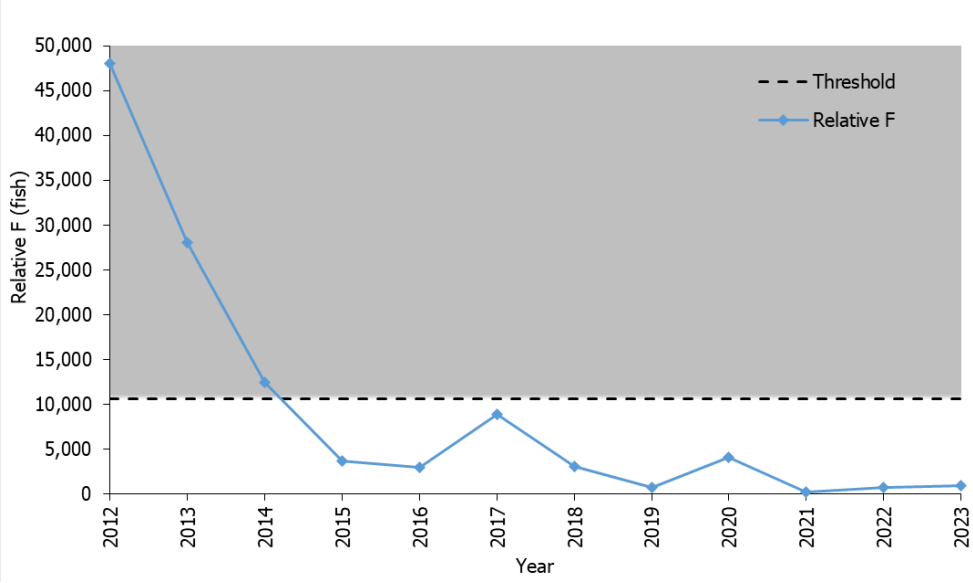

Figure 18. Neuse River system sustainability parameter for female relative F in WRC electrofishing survey, 2002–2023. The threshold represents the 75th percentile (where 25% of all values are greater), values in gray are exceeding the threshold.

Cape Fear River system

The Cape Fear River system has two sustainability parameters: female CPUE based on the WRC electrofishing survey, and female relative *F* based on the WRC electrofishing survey. Female relative F is calculated using the combined commercial and recreational harvest from the Cape Fear River and the female CPUE index from the Cape Fear River electrofishing survey.

Figure 19 shows the female CPUE based on the WRC electrofishing survey and Figure 20 shows the female relative *F* based on the WRC electrofishing survey.

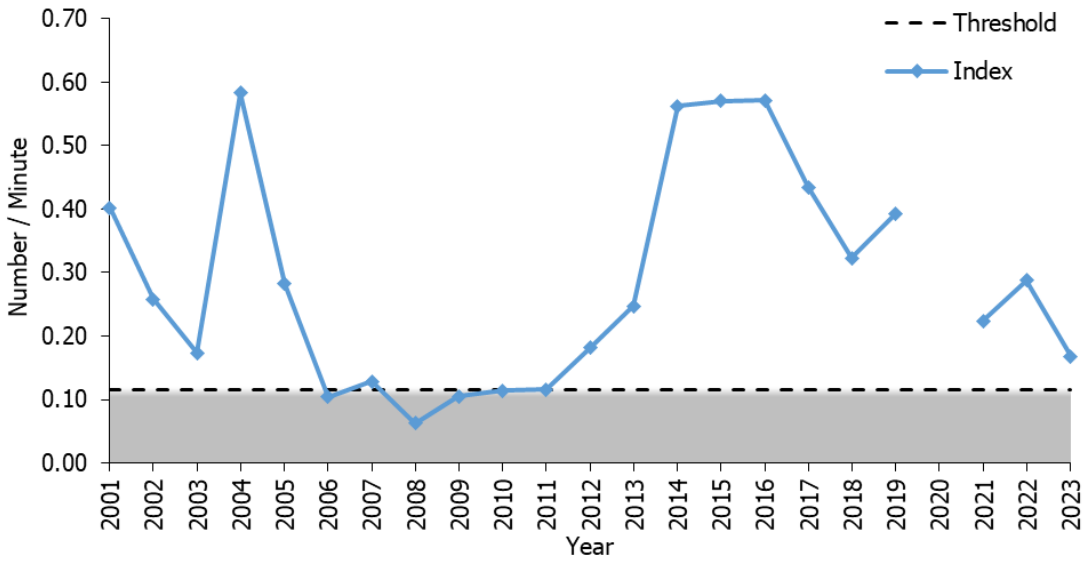

Figure 19. Female electrofishing index (March–May) for the Cape Fear River (LD-1 and LD-2, only), 2001–2023. The threshold represents the 25th percentile (where 75% of all values are greater). Values in gray are below the threshold. No survey data available for 2020.

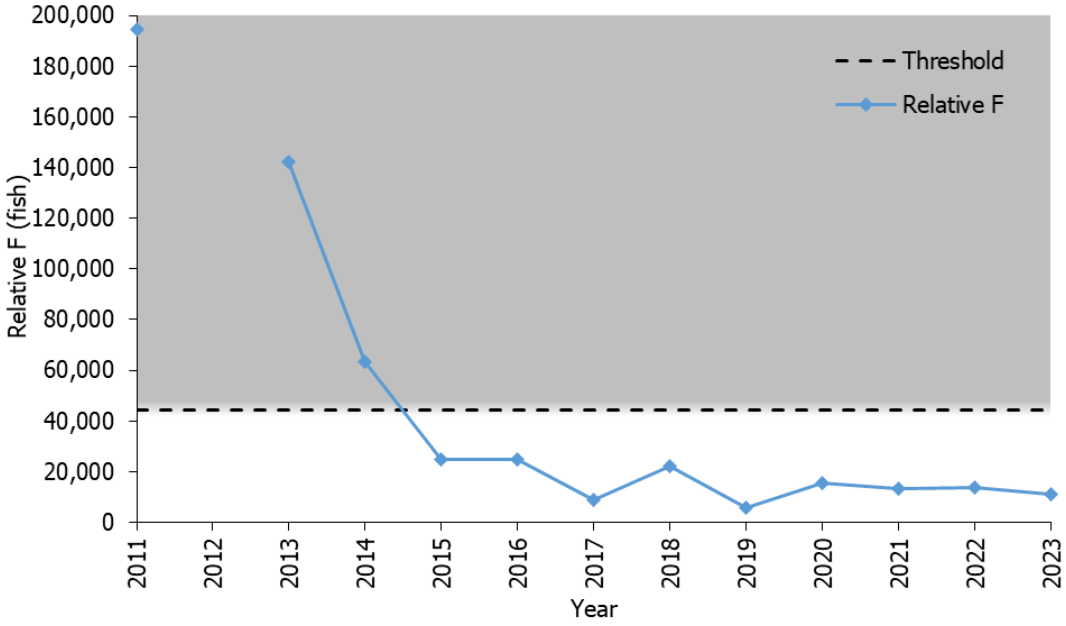

Figure 20. Cape Fear River system sustainability parameter for female relative F in WRC electrofishing survey, 2011–2023. The threshold represents the 75th percentile (where 25% of all values are greater), values in gray are exceeding the threshold.

All Other Internal Coastal and Joint Fishing Waters

The areas without specified sustainability parameters will fall under statewide management measures listed in the following section. The DMF monitors commercial landings through the North Carolina Trip Ticket Program to ensure landings remain low. Dedicated monitoring programs or area closures will be implemented if sudden increases in landings, indicating targeted effort, occur.

Management Measures for 2024

Recreational

Statewide Internal Waters including Albemarle Sound-Roanoke River, Neuse River, except as exempted below:

- It is unlawful to possess more than ten (10) American shad or hickory shad in the aggregate, per person per day taken by hook-and-line or for recreational purposes and only one (1) of the ten (10) may be an American shad.

Tar-Pamlico River, Pee Dee River

- It is unlawful to possess more than ten (10) American shad or hickory shad, in the aggregate, per person per day taken by hook-and-line or for recreational purposes.

Cape Fear River

- It is unlawful to possess more than ten (10) American shad or hickory shad in the aggregate, per person per day taken by hook-and-line or for recreational purposes and only five (5) of the ten (10) may be an American shad.

Commercial

Albemarle Sound Coastal and Joint Fishing Waters

- For 2024, a commercial season of February 15–April 14 has been established based on sustainability parameters for this system.
- The commercial season may occur anytime between January 1–April 14 for the 5-year tenure of this plan.

Tar-Pamlico River, Neuse River Coastal and Joint Fishing Waters

- For 2024, a commercial season of February 15–April 14 has been established based on sustainability parameters for this system.
- The commercial season may occur anytime between February 15–April 14 for the 5-year tenure of this plan.

Cape Fear River Coastal and Joint Fishing Waters

- For 2024, a commercial season of February 20–April 11 has been established based on sustainability parameters for this system.
- The commercial season may occur anytime between February 20–April 11 for the 5-year tenure of this plan.

All Other Internal Coastal and Joint Fishing Waters

- For 2024, a commercial season of February 15–April 14 has been established based on the Tar-Pamlico River, Neuse River, and Cape Fear River sustainability parameters.
- The commercial season may occur anytime between February 15–April 14 for the 5-year tenure of this plan.

While none of the selected sustainability parameters for any of the river systems have exceeded the triggers for management since 2013, the above measures for 2024 are considered prudent given the results of the 2020 stock assessment as they pertain to North Carolina. The Albemarle Sound is the only system in North Carolina where abundance status, relative to historic levels, was determined to be not depleted. The overall status for the other areas remains unknown, in large part due to a lack of juvenile data. The Albemarle Sound adult total mortality rate was determined sustainable, and abundance determined to be not overfished. Additionally, the Albemarle Sound juvenile abundance demonstrated an increasing trend during 2005–2017, the selected time period for abundance trends (ASMFC 2020). Given the Albemarle Sound status determination and the management measures in place for striped bass conservation also benefiting American shad (Section 4.2.1), the ASWG elected to expand the potential time frame in which the Albemarle Sound commercial fishery can occur from March 3–24 to January 1–April 14. The expanded time frame allows for flexibility in management to ensure that the fishery remains sustainable while maximizing the opportunity to stakeholders impacted by management restrictions for striped bass in this area. Commercial seasons, for all areas, will be determined after DMF and WRC jointly review the performance of the plan, annually, to determine management measures for the following season. Future changes to creel limits for American shad in the Inland Fishing Waters of the other river systems will also be complemented by DMF for Joint and Coastal Fishing Waters.

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