FISHERY MANAGEMENT PLAN UPDATE
ATLANTIC MENHADEN
AUGUST 2023

STATUS OF THE FISHERY MANAGEMENT PLAN

Fishery Management Plan History

FMP Documentation:	August 1981	
	Amendment 1	July 2001
	Addendum I	August 2004
	Addendum II	October 2005
	Technical Addendum I	February 2006
	Addendum III	November 2006
	Addendum IV	November 2009
	Addendum V	November 2011
	Amendment 2	December 2012
	Technical Addendum I	May 2013
	Addendum I	August 2016
	Amendment 3	November 2017
Revisions:	Revision to the FMP	September 1992
Supplements:	Supplement to the FMP	October 1986
Comprehensive Review:	2026	

The first fishery management plan (FMP) for Atlantic menhaden (*Brevoortia tyrannus)* was approved by the Atlantic States Marine Fisheries Commission (ASMFC) in August 1981. The objective of the original plan was to achieve a coastwide age composition of landings in the purse seine fishery by spawners and achieve the greatest continuing yield for each area by determining age at harvest and eliminating other restrictions not contributing to management goals. A Revision to the FMP was approved in 1992 and was the result of an updated stock assessment. The 1992 FMP also included a suite of objectives intended to improve data collection and increase awareness of the fishery and its research needs. In 2001, Amendment 1 to the FMP was approved. This Amendment adopted a new stock assessment and new overfishing definition, as well as required mandatory reporting for all menhaden purse seine fisheries. Addendum I to Amendment 1 was approved in August 2004 to modify the biological reference points, stock assessment schedule and revise the habitat section. The 2003 stock assessment used a new model with a fecundity-based biological reference point to determine stock status. Addendum II was approved by the ASMFC Atlantic Menhaden Management Board in 2005 and established a five-year annual cap on reduction fishery landings in Chesapeake Bay and was implemented in 2006. Addendum II also established a research program to determine the menhaden population abundance in the Chesapeake Bay and to address localized depletion. Passed in November of 2006, Addendum III mirrored the intent and provisions of Addendum II, but incorporated 2005 landings data and allowed for the transfer of under-harvest to the following year's harvest. The Board then approved Addendum IV in November of 2009 which extended the Chesapeake Bay reduction fishery harvest

cap, established through Addendum III, for an additional three years (2011–2013). In 2010, the Board tasked the Atlantic Menhaden Technical Committee (TC) to develop alternative reference points. In addition, the ASMFC Policy Board directed the Multispecies TC to work with the Menhaden TC to explore reference points that account for predation. Addendum V was approved in November 2011 and established a new interim fishing mortality threshold and target (based on maximum spawning potential or MSP) with the goal of increasing abundance, spawning stock biomass, and menhaden availability as a forage species. The new threshold and target equated to a MSP of 15% and 30%, respectively.

The development of Amendment 2 established a 170,800 metric ton (MT) (376,549,543 pounds) total allowable catch (TAC) beginning in 2013 that continued until completion of and Board action on the 2015 benchmark stock assessment. The TAC was based on a 20% reduction from the 2009 to 2011 three-year average of total coastwide catch. Additionally, a bycatch allowance of 6,000 pounds per vessel per day was established when states met their TAC. The Board adopted new biological reference points for biomass based on MSP, with the goal of increasing abundance, spawning stock biomass, and menhaden availability as a forage species. In 2013, Technical Addendum I to Amendment 2 established a set aside program for episodic events. The 2015 Atlantic menhaden stock assessment update indicated menhaden are not overfished and overfishing is not occurring, which resulted in Board action to increase the TAC for both 2015 and 2016 to 187,880 MT (414,204,497 pounds), a 10% increase. Addendum I, approved in August 2016, modified the bycatch allowance to authorize two individuals fishing stationary gear from the same vessel to land 12,000 pounds per day. This Addendum supported a history, especially in the pound net industry, of cooperative fishing which enables fishermen to pool resources. In October 2016, the Atlantic Menhaden Board increased the TAC by 6.45% setting the 2017 TAC at 200,000 MT (440,924,523 pounds).

Amendment 3 maintained the single-species biological reference points management program until the review and adoption of ecological reference points (ERPs). The intent of menhaden-specific ERPs is to provide a method to assess the status of menhaden not only in regard to their own sustainability, but also in regard to their interactions with predators and the status of other prey species. This approach allows fishery managers to consider the harvest of menhaden within a broad ecosystem context, which includes other fish, birds, mammals, and humans who utilize and depend on marine resources. The TAC for the 2018 and 2019 fishing seasons was set at 216,000 MT (476,198,485 pounds) and maintained that TAC for 2020 with the expectation that it would be set in future years using ERPs. Subsequent years' TAC will be guided by menhaden-specific ERPs. Amendment 3 allocated a baseline quota of 0.5 % to each jurisdiction, and then additional TAC was allocated based on historic 2009–2011 landings. Additionally, the quota transfer program was maintained, quota rollover was prohibited, the 6,000-pound trip limit for non-directed and small-scale gears following the closure of the directed fishery was maintained, and 1 % of the TAC was set aside for episodic events from New York through Maine. Finally, the Chesapeake Bay reduction fishery cap was reduced from 87,216 MT (192,278,366 pounds) to 51,000 MT (112,435,753 pounds).

Atlantic menhaden are currently managed under Addendum I to Amendment 3. Addendum I addresses commercial allocations, the Episodic Event Set Aside (EESA) Program, and the Incidental Catch/Small-Scale Fishery (IC/SSF) Provision. Regarding allocations, the Addendum creates a three-tiered system for minimum allocations to the states, with Pennsylvania receiving

0.01%; South Carolina, Georgia, Connecticut, Delaware, North Carolina, and Florida receiving 0.25%; and the remaining states continuing to receive a minimum of 0.5%. Furthermore, the Addendum allocates the remainder of the TAC, excluding the 1% for episodic events in the states of New York through Maine under the EESA Program, on a state-by-state basis based on landings history of the fishery from 2018, 2019, and 2021. Under the IC/SSF provision, the Addendum codifies the ability for states to elect to divide their quotas into sectors, enabling individual sectors to enter into the provision at different times. Additionally, the Addendum removes purse seines as a permitted small-scale directed gear, thereby, prohibiting them from harvesting under the IC/SSF provision. Finally, the Addendum counts IC/SSF landings against the TAC and if IC/SSF landings cause the TAC to be exceeded, then the Board must take action to modify one or both of permitted gear types and trip limits under the provision. The Addendum also continues to prohibit the rollover of unused quota, maintains the 6,000 pounds trip limit for applicable gear types following the closure of a directed fishery, and keeps the current Chesapeake Bay Cap, which was first implemented in 2006 to limit the amount of reduction harvest within the Bay, at 51,000 mt. This recognizes the importance of the Chesapeake Bay as nursery grounds for many species by capping reduction landings from the Bay to current harvest levels.

The current TAC for the 2023 through 2025 fishing seasons is 233,550 mt, which is an approximate 20% increase from the 2021-2022 TAC based on the positive stock status of the resource under ecological reference point-based management. According to Technical Committee analysis, this increase has a less than 40% probability of exceeding the target set by the ecological reference points (ERPs) adopted in 2020. Given the positive results of the 2022 Stock Assessment Update, the Board approved this modest increase to provide additional fishing opportunities, while maintaining a conservative risk level of exceeding the ERP target.

To ensure compliance with the ASMFC Interstate FMP for Atlantic Menhaden, North Carolina also manages this species under the North Carolina FMP for Interjurisdictional Fisheries (IJ FMP). The goal of the IJ FMP is to adopt FMPs, 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) is like the goal of the Fisheries Reform Act of 1997 to "ensure long-term viability" of these fisheries (NCDMF 2015).

Management Unit

The management unit is defined as the Atlantic menhaden resource throughout the range of the species within U.S. waters of the northwest Atlantic Ocean from the estuaries eastward to the offshore boundary of the Exclusive Economic Zone (EEZ). The Atlantic states from Maine through Florida including Pennsylvania are included in the management unit.

Goal and Objectives

The goal of Addendum I to Amendment 3 is to manage the Atlantic menhaden fishery in a manner which equitably allocates the resource's ecological and economic benefits between all user groups.

The primary user groups include those who extract and utilize menhaden as a source of prey, and those whose livelihood depends on the health of the marine ecosystem (ASMFC 2022).

DESCRIPTION OF THE STOCK

Biological Profile

Atlantic menhaden are an estuarine-dependent species with a single stock along the Atlantic coast that range from northern Florida to Nova Scotia. Menhaden form large nearshore schools from early spring through early winter. By summer, schools divide by size and age, with older and larger menhaden distributed farther north. During fall and early winter, menhaden migrate south to the North Carolina capes to spawn 20–30 miles offshore. Sexual maturity is reached between ages 1 and 3. Floating egg masses hatch within two to three days of spawning and ocean currents carry larvae into estuarine nursery areas where they develop into juveniles and remain during their first year. Research indicates that the number of new fish that enter the fishery annually (year-class strength) is likely determined by environmental factors (currents, temperature, predation, etc.) acting on larvae as they approach and enter inlets and nursery areas. Atlantic menhaden can live up to 10 years. Atlantic menhaden strain microscopic organisms drifting or floating in the water column (plankton) while swimming in schools near the surface. Atlantic menhaden are important prey to many species including striped bass, bluefish, birds, dolphins, and whales.

Stock Status

In February 2020, the ASMFC accepted the results of the Atlantic Menhaden Single-Species and Ecological Reference Point (ERP) Benchmark Stock Assessments and Peer Review Reports for management use. The Single-Species Assessment, acting as a traditional stock assessment, indicates the Atlantic menhaden stock is not overfished or experiencing overfishing relative to the current single-species reference points under Amendment 3 (SEDAR 2020). These reference points used historical performance of the population during the 1960–2012-time frame, representing a period where the population was fished sustainably. Fishing mortality rates have remained below the overfishing threshold (0.6) since the mid–1970s, and below the overfishing target (0.22) since the mid–1990s. Fishing mortality was estimated to be 0.11 in 2017 (terminal year of the assessment). The reference point used to determine the population fecundity is defined as the mature egg production one would expect when the population is being fished at the threshold fishing mortality rate. Population fecundity was highest in the early 1960s and from the 1990s to present. In 2017, fecundity was estimated at 2.60×10^{15} eggs, above the Single-Species Assessment threshold (1.46×10^{15} eggs) and target (1.95×10^{15} eggs).

The Ecological Reference Points Stock Assessment evaluates the health of the stock in an ecosystem context and indicates that the fishing mortality (F) reference points for menhaden should be lower to account for menhaden's role as a forage fish (SEDAR 2020). The fishing mortality rate in 2017, terminal year of the assessment, was below both ERP target and threshold, indicating that the stock was not experiencing overfishing. Fecundity (a measure of reproductive capacity) in 2017 was above both the ERP target and threshold, indicating the stock was not overfished.

In August 2022, the ASMFC Board accepted the results of the Single-Species Update Assessment. Under the ERPs, Atlantic menhaden are neither overfished nor experiencing overfishing.

Stock Assessment

The 2020 Atlantic Menhaden Benchmark Stock Assessments, which were endorsed by an independent panel of fisheries scientists, used the Northwest Atlantic Coastal Shelf Model of Intermediate Complexity for Ecosystems (NWACS-MICE) in combination with the single-species model (Beaufort Assessment Model or BAM) to develop Atlantic menhaden ERPs by evaluating trade-offs between menhaden harvest and predator biomass (SEDAR 2020). The SEDAR 2020 document is comprised of two reports: the 2019 Atlantic Menhaden Single-Species Benchmark Assessment and the Ecological Reference Points Stock Assessment. The Beaufort Assessment Model (BAM), which was used in the previous stock assessment, was used in the single-species assessment. The BAM again incorporated a "fleet as areas" based model configuration, such that the reduction and bait fisheries were divided into northern, mid-Atlantic, and southern regions, creating three fleets. The Single-Species Assessment, acting as a traditional stock assessment, indicates the Atlantic menhaden stock is not overfished or experiencing overfishing relative to the current single-species reference points. The Ecological Reference Points Stock Assessment uses the NWACS-MICE to develop Atlantic menhaden ERPs. NWACS-MICE is an ecosystem model that focuses on four key predator species (striped bass, bluefish, weakfish, and spiny dogfish) and three key prey species (Atlantic menhaden, Atlantic herring, and bay anchovy).

In August 2020, the ASMFC approved the use of ERPs in the management of Atlantic menhaden. Atlantic striped bass was the focal species for the ERP definitions because it was the most sensitive predator fish species to Atlantic menhaden harvest in the model, so an ERP target and threshold that sustained striped bass would likely provide sufficient forage for other predators under current ecosystem conditions. By adopting ERPs, the Board will be accounting for the species' role as an important forage fish. The ERPs for Atlantic menhaden are:

- ERP target: the maximum fishing mortality rate (F) on Atlantic menhaden that sustains Atlantic striped bass at their biomass target when striped bass are fished at their F target.
- ERP threshold: the maximum F on Atlantic menhaden that keeps Atlantic striped bass at their biomass threshold when striped bass are fished at their F target.
- ERP fecundity target and threshold: the long-term equilibrium fecundity that results when the population is fished at the ERP F target and threshold, respectively.

Since the stock assessment peer review process was adopted by the ASMFC in 1998, Atlantic menhaden have been assessed several times. Prior to the 2020 Atlantic Menhaden Benchmark Stock Assessments, the most recent peer reviewed benchmark stock assessment was SEDAR 40 (2015), which was updated in 2017 (ASMFC 2017b). The BAM was used to provide management advice during the 2015 benchmark stock assessment and the 2017 update. The 2015 benchmark stock assessment and 2017 update found that Atlantic menhaden were neither overfished nor experiencing overfishing. Stock status was evaluated against the assessment's reference points, which used historical performance of the population during 1960–2012.

The ASMFC updated the 2019 Atlantic Menhaden Single Species Benchmark Stock Assessment in 2022. The stock assessment update added data through 2021, reran the peer reviewed BAM,

and determined stock status of Atlantic menhaden using the ERPs that were accepted for management use in 2020. The ERP assessment was not updated. The single species assessment update is the best information available on the status of the coastwide Atlantic menhaden stock for use in fisheries management. Both assessments are scheduled for benchmark assessments together in 2025. More information on the stock assessment update can be found here.

DESCRIPTION OF THE FISHERY

Current Regulations

No regulatory changes were made in 2022 that affected Atlantic menhaden. North Carolina's annual quota is currently 1,840 MT (4,056,588 pounds) or 0.96% of the coastwide allocation. Under Addendum 1 to Amendment 3, North Carolina's portion of the allocation will be dropping to 0.37% in 2023.

Effective January 1, 2013, a law was passed making it unlawful to harvest menhaden with a purse seine net deployed by a mother ship and one or more runner boats within North Carolina's three-mile jurisdiction.

Commercial Fishery

North Carolina's Atlantic menhaden landings have been on a decline, especially since the last menhaden processing factory in North Carolina closed in 2005. Landings have remained relatively constant since 2012 (Table 1, Figure 1). The average landings over the last 10 years is 624,547 pounds. Since 2013, landings have been regulated under the TAC initiated in Amendment 2. North Carolina has landed 10–14% of the state allocated portion of the TAC in the past three years, the majority of which is used for bait in the blue crab and recreational fisheries. The decline in commercial landings is due to the loss of North Carolina's last processing facility in 2005, which in turn led to the North Carolina General Assembly banning purse seines from near shore state waters in 2007 (15A N.C. Admin. Code 3J.0105). Gill nets are now the most common gear used to harvest menhaden throughout the state.

Recreational Fishery

In October 2011, the North Carolina Division of Marine Fisheries (DMF) implemented a recreational cast net and seine mail survey to develop catch and effort estimates for various species, including menhaden. Menhaden are used as live bait by recreational anglers, and during 2012–2022 recreational annual harvest averaged 183,139 fish harvested and 80,204 fish released (Table 1, Figure 1).

MONITORING PROGRAM DATA

Fishery-Dependent Monitoring

Commercial fishing activity is monitored in a variety of DMF fishery-dependent sampling programs for compliance with ASMFC. Monitoring includes the ocean sink net fishery, winter

trawl fishery, estuarine gill net fishery, long haul seine fishery, and sciaenid pound net fishery. Commercial landings of Atlantic menhaden are monitored through the DMF Trip Ticket Program. Table 2 describes the mean, minimum, and maximum lengths of Atlantic menhaden sampled from North Carolina fishery-dependent monitoring. Mean lengths in the menhaden commercial fishery have remained fairly consistent, with the exception of 2020 and 2021 where mean lengths increased (Figure 2).

Fishery-Independent Monitoring

Atlantic menhaden are sampled in a variety of DMF independent surveys for compliance with ASMFC requirements. Atlantic menhaden are sampled in the North Carolina Estuarine Trawl Survey (Program 120), Pamlico Sound Survey (Program 195), the Juvenile Anadromous Survey (Program 100), the Albemarle Sound Independent Gill Net Survey (Program 135), and the Fishery Independent Gill Net Survey (Program 915). The Estuarine Trawl Survey (Figure 3) and Fishery Independent Gill Net Survey (Pamlico Sound only, Figure 4) were used as data sources in the 2019 Atlantic Menhaden Single-Species Benchmark Stock Assessment.

The Program 120 relative abundance index for Atlantic menhaden in 2021 was 2.78, which was a decrease from 2021 (3.39 Atlantic menhaden per tow). The 2022 relative abundance index was a below the ten-year average (2013–2022, 5.13 Atlantic menhaden per tow). Due to the suspension of the survey, the Program 915 relative abundance index was not calculated for Atlantic menhaden from February 20, 2020, through June 30, 2021. The 2022 relative abundance index was 11.02.

RESEARCH NEEDS

- Continue current level of sampling from bait fisheries, particularly in the Mid-Atlantic and New England. Analyze sampling adequacy of the reduction fishery and effectively sample areas outside of that fishery.
- Conduct aging validation study to confirm scale to otolith comparisons. Use archived scales to do ratio isotope analysis.
- Develop a menhaden specific coastwide fishery independent index of adult abundance at age.
- Conduct studies on spatial and temporal dynamics of spawning.
- Conduct Management Strategy Evaluation (MSE) on the various reference point options for menhaden.
- Continue to develop an integrated length and age-based model.
- Develop a seasonal spatially explicit model, once sufficient age-specific data on movement rates of menhaden are available.
- Continue exploring the development of multispecies models that can take predator-prey interactions into account. This should inform and be linked to the development of assessment models that allow natural mortality to vary over time.
- Continue to improve methods for incorporation of natural mortality (e.g., multi-species statistical catch-at-age model).

- Study specific habitat requirements for all life history stages.
- Develop habitat maps for all life history stages.
- Develop a mechanism for estimating or obtaining data for economic analysis on the reduction fishery, due to the confidential nature of the data.
- Conduct studies to fully recognize the linkages between the menhaden fishery and the numerous other fisheries which it supports and sustains.

MANAGEMENT STRATEGY

In 2017, the ASMFC set the TAC at 216,000 MT (476,198,485 pounds) for 2018–2019 and maintained that TAC for 2020 with the expectation that it would be set in future years using ERPs. In October 2020, following the adoption of ERPs, the ASMFC approved a TAC of 194,400 MT (428,578,637 pounds) for 2021–2022, which represents a 10% reduction from the 2018–2020 TAC level. Based on projections, the TAC is estimated to have a 58.5% and 52.5% probability of exceeding the ERP *F* target in the first and second year, respectively. One percent of the TAC is set aside for episodic events. The remaining 192,456 MT (424,292,851 pounds) will be made available to the states based on the state-by-state allocation established by Amendment 3 of which North Carolina receives 0.96%. For 2021–2022, North Carolina's annual quota will be set at 1,840 MT (4,056,588 pounds).

In November of 2022, the ASMFC set the 2023 TAC at 233,550 MT, which is an approximate 20% increase from the 2021–2022 TAC based on the positive stock status of the resource under ecological reference point-based management. According to ASMFC Technical Committee analysis, this increase has a less than 40% probability of exceeding the target set by the ERPs adopted in 2020.

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TABLES

Table 1. Recreational harvest (number of fish landed and weight in pounds) and releases (number of fish) and commercial harvest (weight in pounds) of Atlantic menhaden from North Carolina, 1991–2022. Recreational weight landed for 2012 through 2022 are based on North Carolina recreational cast net and seine mail survey and an estimated individual fish weight of 0.35 pounds derived from Fishery-Independent sampling. Commercial landings based on North Carolina Trip Ticket Program, 1991–2022.

	Recreational			Commercial	
Year	Numbers Landed	Numbers Released	Weight Landed (lb)	Weight Landed (lb)	Total Weight (lb)
1991				110,528,754	110,528,754
1992				57,515,712	57,515,712
1993				64,711,384	64,711,384
1994				73,853,901	73,853,901
1995				58,374,046	58,374,046
1996				53,850,943	53,850,943
1997				97,727,057	97,727,057
1998				57,976,455	57,976,455
1999				42,799,080	42,799,080
2000				56,280,112	56,280,112
2001				56,012,396	56,012,396
2002				69,190,596	69,190,596
2003				48,936,502	48,936,502
2004				50,577,983	50,577,983
2005				13,387,423	13,387,423
2006				962,651	962,651
2007				1,134,208	1,134,208
2008				645,231	645,231
2009				2,124,734	2,124,734
2010				1,299,150	1,299,150
2011				3,530,003	3,530,003
2012	169,926	68,303	59,474	538,792	598,266
2013	221,014	96,004	77,355	454,206	531,561
2014	131,419	64,493	45,997	917,905	963,902
2015	271,824	162,539	95,138	898,322	993,460
2016	278,213	100,998	97,375	398,044	495,419
2017	261,203	96,573	91,421	752,799	844,220
2018	130,441	52,000	45,654	713,978	759,632
2019	152,247	83,285	53,286	551,849	605,135
2020	126,126	60,988	44,144	599,742	643,886
2021	152,722	37,343	53,453	419,127	472,580
2022	119,393	59,721	41,788	539,494	581,281
Mean	183,139	80,204	64,099	29,006,331	26,399,320

Table 2. Mean, minimum, and maximum lengths (fork length, inches) of Atlantic menhaden measured from the commercial fisheries, 1991–2022.

Year	Mean Length	Minimum Length	Maximum Length	Total Number Measured
1991	6.2	1.9	11.0	3,588
1992	7.0	4.1	17.5	1,832
1993	6.9	3.0	13.8	3,163
1994	7.0	4.3	11.4	1,077
1995	6.5	4.1	12.5	2,045
1996	7.7	3.7	12.9	2201
1997	8.8	3.8	15.6	1,623
1998	8.1	3.4	12.9	1,570
1999	7.4	3.3	14.9	1,702
2000	8.5	4.1	13.5	868
2001	9.6	2.6	15.9	1,266
2002	8.8	4.7	14.0	1,075
2003	9.3	4.4	14.4	621
2004	8.2	3.1	14.2	644
2005	8.5	4.0	13.4	1,197
2006	8.1	3.7	13.7	1,445
2007	8.3	4.3	15.7	1,424
2008	8.0	3.9	12.8	1,063
2009	8.9	3.9	13.5	1,124
2010	8.6	5.8	12.6	210
2011	9.2	3.7	13.7	1,346
2012	8.7	2.8	14.3	705
2013	9.3	5.6	15.2	845
2014	8.8	4.8	12.8	1,477
2015	9.1	4.8	13.7	1,165
2016	8.7	6.3	12.3	760
2017	9.4	5.6	12.4	891
2018	9.3	0.8	12.2	442
2019	8.5	5.6	11.3	179
2020	10.3	6.2	12.7	250
2021	9.9	5.4	12.5	416
2022	9.7	4.7	19.6	1,091

FIGURES

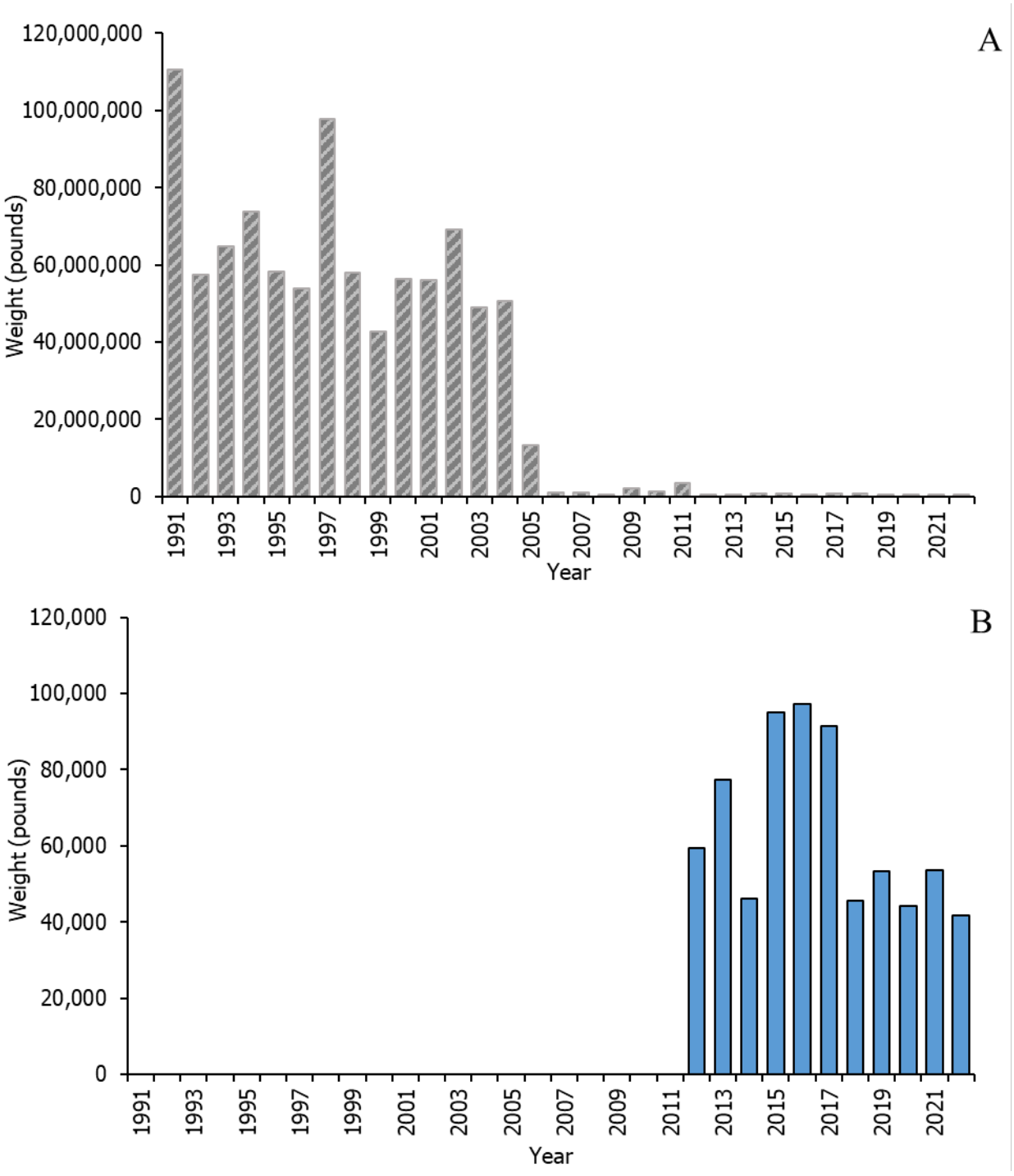

Figure 1. (A) Atlantic menhaden commercial landing (pounds) reported through the North Carolina Trip Ticket Program, 1991–2022, and (B) recreational landings (Type A + B1; pounds) estimated from the North Carolina recreational cast net and seine mail survey, 2012–2022.

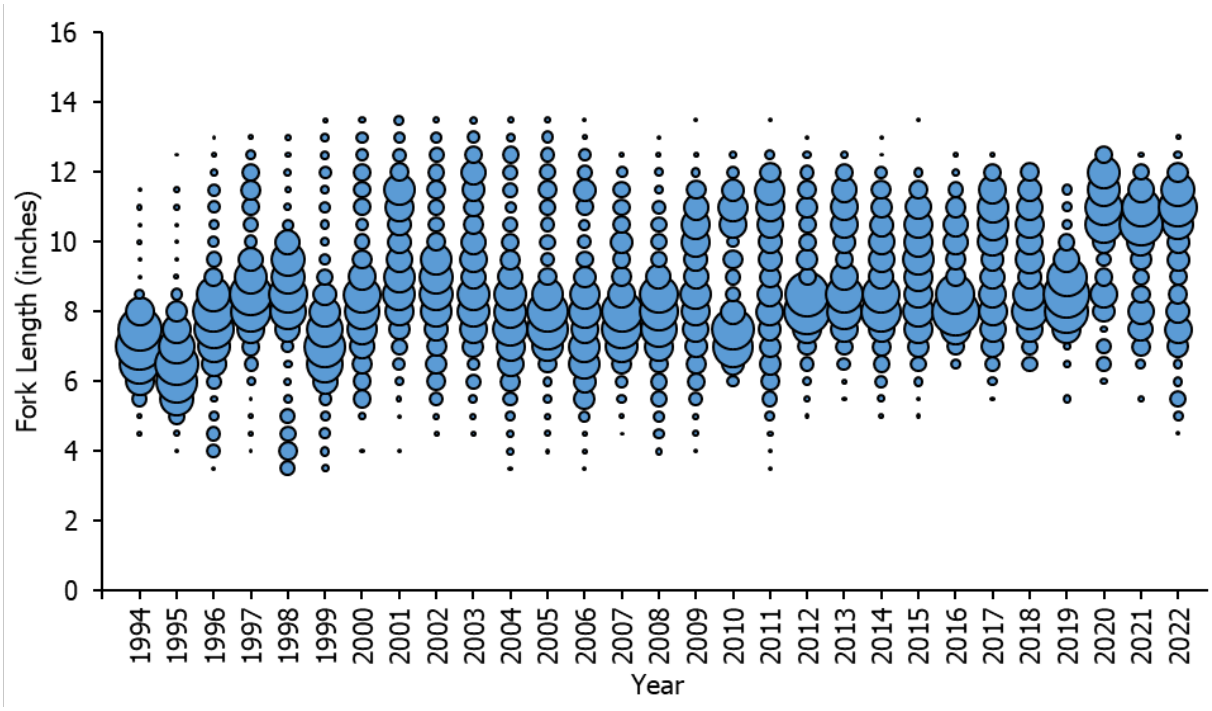

Figure 2. Commercial length frequency (fork length, inches) of Atlantic menhaden harvested from 1994 to 2022. Bubbles represent fish at length and the bubble size is proportional to the number of fish at that length.

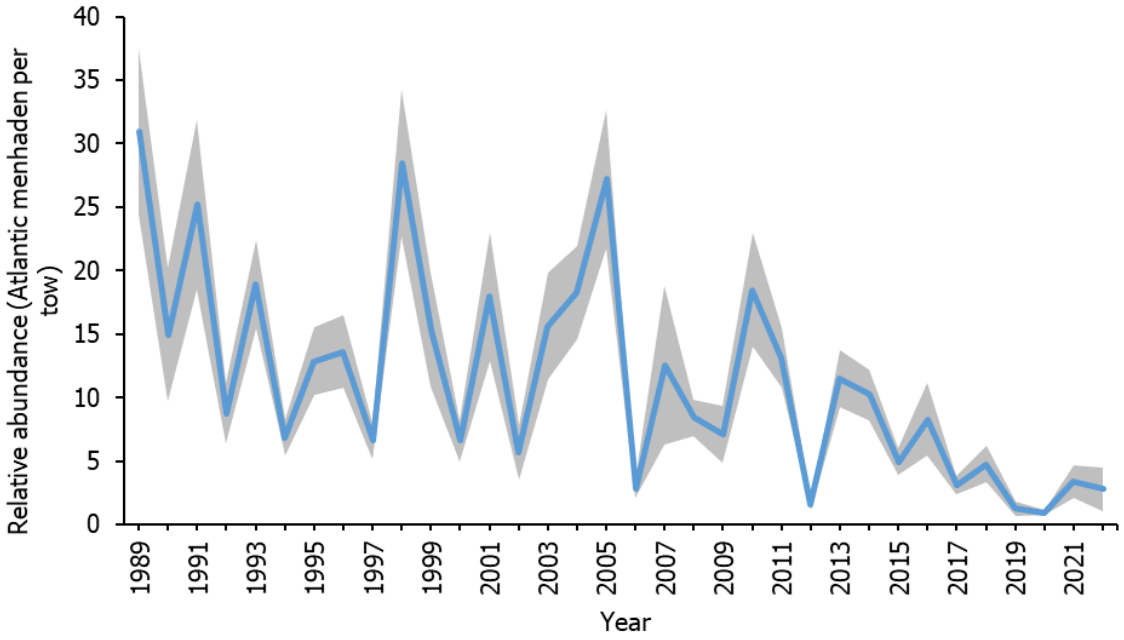

Figure 3. Relative abundance index (fish per tow) of Atlantic menhaden collected from the North Carolina Estuarine Trawl Survey (Program 120) during May and June 1989–2022. Error bars represent ± 1 standard error.

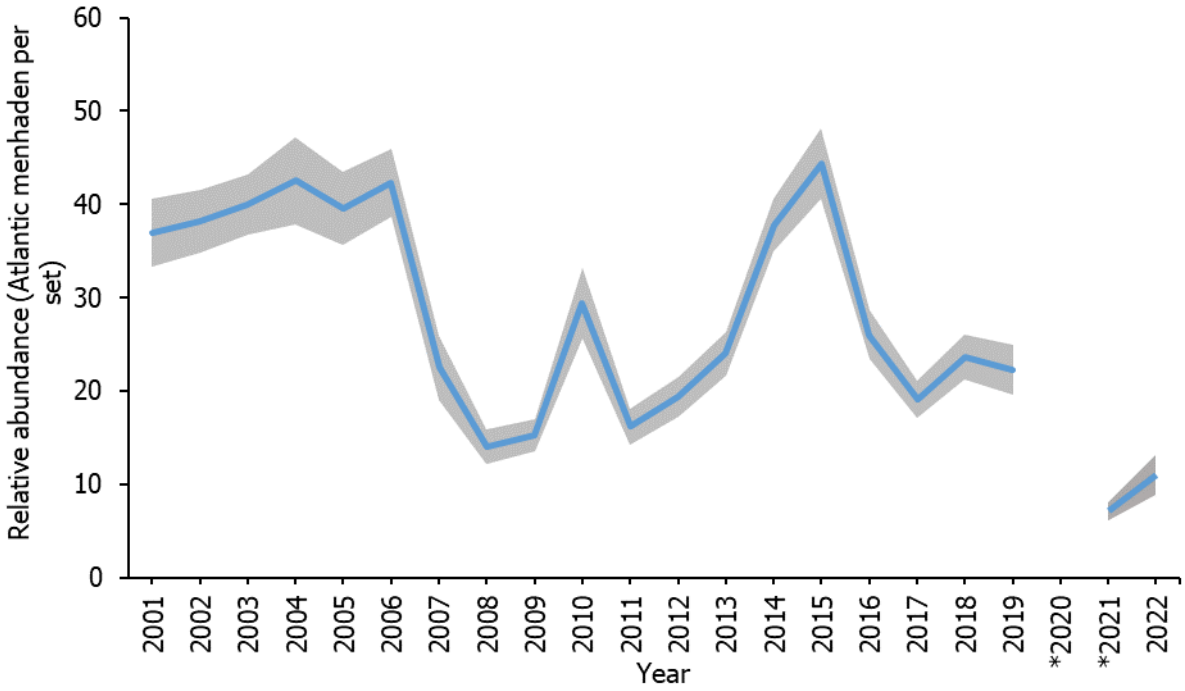

Figure 4. Relative abundance index (fish per set) of Atlantic menhaden collected from the Fishery-Independent Gill Net Survey (Program 915, Pamlico Sound only), 2001–2022. Error bars represent ± 1 standard error. *Survey suspended February 20, 2020, through June 30, 2021.