

**FISHERY MANAGEMENT PLAN UPDATE
AMERICAN EEL
AUGUST 2023**

STATUS OF THE FISHERY MANAGEMENT PLAN

Fishery Management Plan History

FMP Documentation:	ASMFC FMP	November 1999
	Addendum I	February 2006
	Addendum II	October 2008
	Addendum III	August 2013
	Addendum IV	October 2014
	Addendum V	August 2018

Comprehensive Review: 2022

American eel is managed under the Atlantic States Marine Fisheries Commission (ASMFC) Interstate Fishery Management Plan (FMP) for American Eel. The FMP was approved in 1999 (ASMFC 2000) and implements management measures to protect the American eel resource to ensure ecological stability while providing for sustainable fisheries. The FMP required all states and jurisdictions to implement an annual young-of-year (YOY) abundance survey to monitor annual recruitment of each year's cohort. In addition, the FMP required a minimum recreational size, a possession limit and a state license for recreational fishermen to sell eels. The FMP requires that states and jurisdictions maintain existing or more conservative American eel commercial fishery regulations for all life stages, including minimum size limits.

Addendum I, approved in November 2006, required states to establish a mandatory trip-level catch and effort monitoring program, including documentation of the amount of gear fished and soak time (ASMFC 2006). Addendum II, approved in October 2008, placed increased emphasis on improving the upstream and downstream passage of American eel (ASMFC 2008). No new management measures were implemented by Addendum II.

Addendum III was approved for management use in August 2013, with the goal of reducing mortality on all life stages of American eel. The Addendum was initiated in response to results of the 2012 Benchmark Stock Assessment, which found the American eel stock along the US East Coast was depleted. This addendum predominately focused on commercial yellow eel and recreational fishery management measures (ASMFC 2013). Addendum III implemented new size and possession limits as well as new pot mesh size requirements and seasonal gear closures.

Following approval of Addendum III, the ASMFC American Eel Management Board (Board) initiated the development of Addendum IV, which was approved in October 2014 (ASMFC 2014). As the second phase of management in response to the 2012 stock assessment, the goal of Addendum IV is to continue to reduce overall mortality and increase overall conservation of American eel stocks. The addendum addresses concerns and issues in the commercial glass and silver eel fisheries, and domestic eel aquaculture. Addendum IV established a coastwide catch cap and a mechanism for implementation of a state-by-state commercial yellow eel quota if the catch

cap is exceeded. Under Addendum IV, the coast wide catch cap was set at 907,671 pounds (1998-2010 harvest level, ASMFC 2014). Addendum IV established two management triggers:

- The coastwide catch cap is exceeded by more than 10 percent in a given year (998,438 pounds)
- The coastwide catch cap is exceeded for two consecutive years, regardless of the percent overage.

If either trigger is exceeded, a state-by-state commercial yellow eel quota would be implemented with North Carolina receiving an 11.8 percent allocation (107,054 pounds).

The aquaculture provision in Addendum IV allows states to submit an Aquaculture Plan to allow for limited harvest of glass eels for use in domestic aquaculture facilities. Specifically, states are allowed to request a harvest of up to 200 pounds of glass eels provided the state can objectively show the harvest will occur from a watershed that minimally contributes to the spawning stock of American eel.

In 2017, the 2012 stock assessment was updated with data from 2010-2016, however, neither reference points nor stock status could be determined. The trend analysis and stable low commercial landings support the conclusion that the American eel population in the assessment range remains depleted.

Addendum V was initiated in response to results of the 2017 stock assessment update and concerns that current management triggers do not account for annual fluctuations in landings. If a management trigger is exceeded immediate implementation of state-by-state quotas would pose significant administrative challenges (ASMFC 2019). Adopted in January 2019, Addendum V increases the yellow eel coastwide cap beginning in 2019 to 916,473 pounds due to a correction in the historical harvest; adjusts the method (management trigger) to reduce total landings to the coastwide cap when the cap has been exceeded; and removes the implementation of state-by-state allocations if the management trigger is met. The addendum maintains Maine's glass eel quota of 9,688 pounds.

Under Addendum V, management action is initiated if the yellow eel coastwide cap is exceeded by 10% or more in two consecutive years (10% of the coastwide cap = 91,647 pounds; coastwide cap + 10% = 1,008,120 pounds). If management is triggered, only those states accounting for more than 1% of the total yellow eel landings are responsible for adjusting their management measures.

The aquaculture provision in Addendum V allows states to harvest a maximum of 200 pounds of glass eels annually for use in domestic aquaculture facilities under an approved Aquaculture Plan. The provision from Addendum IV requiring states to demonstrate harvest would occur in watersheds that minimally contribute to the spawning stock was dropped in Addendum V and replaced with considerations that preferred harvest sites; have established or proposed glass eel monitoring programs, are favorable to law enforcement, and are in watersheds that are prone to relatively high mortality rates.

In December 2015, the DMF submitted an American Eel Aquaculture Plan to the ASMFC requesting approval to harvest up to 200 pounds of glass eels from coastal fishing waters which was approved in February 2016 (1 year). A second plan was submitted by DMF in 2016 and

approved by ASMFC that allowed for harvest in 2017 (1 year). The third plan submitted by the DMF in 2017 and approved by the ASMFC covered a 2-year period that allowed for harvest in 2018 and 2019. In May 2019, the DMF submitted another 2-year plan but was only approved by ASMFC for one harvest season (November 2019 through March 2020). The DMF has not submitted an American Eel Aquaculture Plan to the ASMFC since 2020.

For an approved aquaculture operation to legally harvest eels less than 9 inches, the facility needs to have a Declaratory Ruling from the NC Marine Fisheries Commission (MFC) exempting them from the 9-inch minimum size limit to possess, sell or take American eels. The approved aquaculture operation received Declaratory Rulings (2) that allowed for legally harvested American eels less than 9 inches in length to be cultivated or reared in a facility from: 1) outside of North Carolina and imported into the State, and 2) from Coastal Fishing Waters in the State of North Carolina.

In support of American eel aquaculture in North Carolina, several legal actions were taken by North Carolina legislatures. Senate Bill 513 (North Carolina Farm Act of 2015; Section 22.(a)) directed the DMF and the North Carolina Wildlife Resources Commission (WRC) to jointly develop a pilot American Eel Aquaculture Plan for the harvest and aquaculture of American eels. Senate Bill 410 (Marine Aquaculture Development Act; Section 3.1.(c)) allows American eels to be imported from Virginia or South Carolina for aquaculture purposes, and House Bill 374 (Section 17) allows American eels to be imported from Maryland for aquaculture purposes. The use of American eels imported from Maryland, Virginia, or South Carolina in an aquaculture operation are exempt from the permitting requirements of the Importation of Marine and Estuarine Organisms Rule.

In 2020, the ASMFC began work on a benchmark stock assessment which was peer-reviewed in late 2022. The assessment and peer review report were presented to the Board in February 2023 and is still under review.

To ensure compliance with interstate requirements, North Carolina also manages this species under the North Carolina Fishery Management Plan for Interjurisdictional Fisheries (IJ FMP). There are two main goals of the IJ FMP; first 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. Second, to 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 goals of these plans, established under the Magnuson-Stevens Fishery Conservation and Management Act (federal council) and the Atlantic Coastal Fisheries Cooperative Management Act (ASMFC), are similar to the goals of the N.C. Fisheries Reform Act of 1997 to “ensure long-term viability” of these fisheries (NCDMF 2015).

Management Unit

American eel is managed as a coastwide stock, from Maine through Florida, under the ASMFC Interstate FMP for American Eel (ASMFC 2000). The American eel's range extends beyond U.S. borders and more specifically ASMFC member states' territorial waters. However, the management unit is limited to ASMFC member states' territorial waters.

Goal and Objectives

The goals of the ASMFC American Eel FMP are to protect and enhance the abundance of American eel in inland and territorial waters of the Atlantic states and jurisdictions and contribute to the viability of the American eel spawning population with the aim to provide sustainable commercial, subsistence, and recreational fisheries by preventing over-harvest of any eel life stage. The following objectives will be used to achieve this goal:

- Improve knowledge of eel utilization at all life stages through mandatory reporting of harvest and effort by commercial fishers and dealers and enhanced recreational fisheries monitoring.
- Increase understanding of factors affecting eel population dynamics and life history through research and monitoring.
- Protect and enhance American eel abundance in all watersheds where eel now occur.
- Where practical, restore American eel to those waters where they had historical abundance but may now be absent by providing access to inland waters for glass eel, elvers, and yellow eel and adequate escapement to the ocean for pre-spawning adult eel.
- Investigate the abundance level of eels at the various life stages necessary to provide adequate forage for natural predators to support ecosystem health and food chain structure.

DESCRIPTION OF THE STOCK

Biological Profile

The American eel (*Anguilla rostrata*) is a catadromous species meaning they are born in saltwater, then migrate into freshwater as juveniles where they grow into adults before migrating back to the ocean to spawn. All American eel comprise one panmictic population meaning they are a single breeding population that exhibits random mating. For example, an American eel from the northern portion of the range could mate with an American eel from the southern portion of the range, and their offspring could inhabit any portion of the range. As a result, recruits to a particular system are likely not the offspring of the adults that migrated out of that system (ASMFC 2000). American eels require multiple habitats including the ocean, estuaries, freshwater streams, rivers and lakes. While American eels spend most their life in brackish and freshwater systems from South America to Canada, spawning occurs in the Sargasso Sea (a large portion of the western Atlantic Ocean south of Bermuda and east of the Bahamas; Facey and Van den Avyle 1987). Larvae develop at sea and change from glass eels (transparent post-larval stage) into elvers (pigmented young eels) in nearshore ocean waters and estuaries (ASMFC 2000). Elvers either remain in the estuary or migrate upstream. At approximately two years of age, they change to the yellow eel stage and resemble the adult form (Ogden 1970). Individuals can remain in the yellow phase for five to 20 years. In the yellow phase, American eels are nocturnal, feeding at night on a variety of invertebrates and smaller fish, but will also eat dead animal matter. American eels live in a variety of habitats but prefer areas where they can hide with soft bottom and vegetation. Females can grow to five feet in length, and males usually reach about three feet (ASMFC 2000). The mature silver eel life stage occurs at the time of downstream migration when individuals leave the estuaries to spawn and die in the Sargasso Sea (Facey and Van den Avyle 1987). This spawning migration

occurs annually in the late summer and fall. Information about abundance and status at all life stages, as well as habitat requirements, is very limited. The life history of the species, such as late age of maturity and a tendency for certain life stages to aggregate, can make this species particularly vulnerable to overharvest.

Stock Status

The 2017 stock assessment update found the American eel population remains depleted in U.S. waters (ASMFC 2017). No overfishing status determination can be made based on the analyses performed. The 2022 benchmark stock assessment was presented to the Board in February 2023 and is still under review.

Stock Assessment

The 2012 stock assessment was updated in 2017 with data through 2016. American eel indices of abundance were analyzed using three methods of trend analysis: Mann-Kendall, Manly, and ARIMA. The Mann-Kendall test detected significant downward trends in six of the 22 YOY indices, five of the 15 yellow eel indices, three of the nine regional YOY and yellow eel indices, and the 30-year and 40-year yellow-phase abundance indices. Only two indices had positive trends, all of the remaining survey indices tested had no trend. The Manly meta-analysis showed a decline in at least one of the indices for both yellow and YOY life stages. Results of ARIMA analysis indicated the probabilities of being less than the 25th percentile reference points in the terminal year for each survey were similar to those in the 2012 stock assessment and three of the 14 surveys had a greater than 50% probability of the terminal year being less than the 25th percentile reference point. Overall, the occurrence of some significant downward trends in surveys across the coast remains a cause for concern, so the assessment maintained the depleted stock status. While it is highly likely the American eel stock is depleted, no overfishing determination can be made based solely on the trend analyses performed.

A benchmark stock assessment for American eel began in 2020 and is ongoing. All potential data sources were reviewed, and the terminal year of the assessment was 2019. Many of the analyses explored in this benchmark assessment indicate decreasing or low population trends (e.g., Conn index, MARSS index, regime shift analysis, delay-difference model, Mann-Kendall Test). All evidence indicates the population is at low levels and the stock status of American eels, as determined by using an index-based method (I_{TARGET}), is overfished and likely experiencing overfishing in the last few decades based on the I_{target} method and additional methods explored in the assessment. As such, the Stock Assessment Subcommittee (SAS) recommend the coastwide yellow eel catch levels should be reduced to around 200,000-300,000 pounds rather than the current coastwide cap of 916,473 pounds. In February 2023, the assessment and peer review report were presented to the Board. The Board tasked the SAS with providing justification for not incorporating the peer review advice. In addition to providing justification, the Board also asked the SAS to provide additional analyses to show the influence of individual surveys on the resulting coastwide yellow eel index, consider other reference periods and configurations for I_{TARGET} . The peer review panel concluded that additional work is needed to establish threshold reference points in the management tool proposed (I_{TARGET}) and that work should be done using a simulation approach with management strategy evaluation (MSE) methods. The peer review panel also stated

that it is more appropriate to consider American eel depleted rather than overfished and likely experiencing overfishing as the SAS suggested.

A Technical Committee (TC) meeting is scheduled on June 27, 2023, where the TC will review the supplemental report, and upon approval from the TC, the report will be presented to the Board in August 2023.

DESCRIPTION OF THE FISHERY

Current Regulations

Management measures for yellow eels went into effect on January 1, 2014, under North Carolina Marine Fisheries Commission (MFC) Rule 15A NCAC 03M .0510. These measures included a nine-inch total length (TL) minimum size limit for both the commercial and recreational fisheries, a 25 eels per person per day bag limit for the recreational fishery, and crew members involved in for-hire employment are allowed to maintain the current 50 eels per day bag limit for bait purposes. The rule also made the possession of American eels illegal from September 1 through December 31 except when taken by baited pots. NCMFC Rule 15A NCAC 03J .0301 established a ½-by-½ inch minimum mesh size requirement for the commercial eel pot fishery. Eel pots with an escape panel consisting of a 1 by ½ inch mesh are allowed until January 1, 2017. In June 2021, the NCWRC modified Rule 15A NCAC 10C .0401 to allow eels greater than nine inches in length and with a minimum body depth greater than ½ inch to be cut for use as bait in Inland Fishing Waters.

Commercial Fishery

Average commercial landings from 2012 through 2021 was 31,639 pounds and in 2022, the commercial landings was 4,202 pounds (Table 1). Commercial landings have fluctuated since 1974 with a peak in 1980 and significant declines beginning in the late 1980s (Figure 1). In 1979 and 1980, over 900,000 pounds were landed, however, since the late 1980s landings have averaged less than 100,000 pounds and in 2022 landings were the second lowest recorded in the time-series.

Recreational Fishery

There are no recreational landings data available for American eels, which are not typically a recreationally targeted species. Since American eels are caught incidentally in the estuarine environment by recreational fishermen using hook and line, the Marine Recreational Information Program (MRIP) does not provide reliable harvest data. Also, the MRIP survey design does not provide information on the recreational harvest of American eel in inland waters. American eels are popular bait for many important recreational fisheries such as striped bass and cobia.

MONITORING PROGRAM DATA

Fishery-Dependent Monitoring

To comply with Addendum I to the American Eel Fisheries Management Plan, the DMF initiated (January 2007) mandatory reporting of harvest and effort information for American eels harvested by commercial eel pots, including eel pot soak time and number of eel pots fished. Commercial fishermen are required to participate in a monthly logbook program designed to monitor the harvest of American eels by eel pots. Soak time and number of eel pots fished are not reported on trip tickets.

Fishery-Independent Monitoring

The National Oceanic and Atmospheric Administration (NOAA) conducts the Beaufort Bridgenet Ichthyoplankton Sampling Program (BBISP), an ichthyoplankton survey at Beaufort Inlet, which is used to develop a North Carolina young-of-year relative abundance index for American eel. The BBISP samples once-weekly at night during floodtide from a fixed platform on Pivers Island Bridge, Beaufort, NC during October-May. Larvae are collected using a 2 m² plankton net fitted with a flow meter. Four replicate sets (tows) are made, with each filtering about 100 m³. Between 1987 and 2020, relative abundance of American eel (glass eel) has fluctuated from a low in 1991 to a high in 2005, with a 34-year average of 0.0125 eels per cubic meter (Figure 2). In 2020, American eel relative abundance (0.0127 eels per cubic meter) remained near the time-series average. Lengths of American eels captured in the BBISP from 2001 to 2020 (n=619) ranged from 41 to 153 millimeters (1.6 to 6.0 inches; Figure 3) and averaged 52 millimeters total length (2.0 inches; note: the 60+ millimeter category includes pooled fish lengths of 62, 91, and 153 millimeters). The BBISP continued their long-term sampling program in 2020 (January to March); however, no samples were collected in April and May, or in November and December due to COVID-19 restrictions. Currently, there is a two-year backlog of unsorted samples (2021 to 2022).

The North Carolina Division of Marine Fisheries (DMF) has no fishery-independent monitoring programs specifically for American eel; however, the North Carolina Estuarine Trawl Survey (Program 120) collects information on American eels caught incidentally. American eel catch data from Program 120 were used in the 2012 benchmark stock assessment. From 1973 to 2022, relative abundance has fluctuated from lows in 1973, 2000, and 2020 to a peak in 2011, and a 50-year average of 0.14 American eels per tow (Figure 4). Due to COVID restrictions all 2020 sampling was conducted in June. In 2022 there was an upward trend in relative abundance with a value of 0.10 eels per tow (Figure 4).

RESEARCH NEEDS

The items listed below are updated from the 2017 research recommendations broken down into future research and data collection and assessment methodology. Research recommendations from ASMFC 2012, 2017 remain important, but the following list is specific to what the SAS thinks could improve the next stock assessment. The SAS recommends an update be considered in five years and a new benchmark be considered in ten years.

Future Research and Data Collection

- Improve upstream and downstream passage for all life stages of American eels.
- Continue to improve the accuracy of commercial catch and effort data through ACCSP and state partners.
- Characterize the length, weight, age, and sex structure of commercially harvested American eels along the Atlantic Coast over time.
- Research coastwide prevalence of the swim bladder parasite *Anguillacolla crassus* and its effects on the American eel's growth and maturation, migration to the Sargasso Sea, and spawning potential.
- Improve understanding of the spawning contribution of unexploited portions of the stock (i.e., freshwater areas of coastal US).
- Characterize the length, weight, and sex structure in unharvestable habitats.
- Conduct a tagging study throughout the species range.
- Quantify recreational removals in marine and freshwater habitats and characterize length, weight, and sex structure.
- Evaluate the passage/passage efficiency of American eels through existing fishways at dams/barriers and evaluate barrier physical attributes (height, material) that can be passed by eel without fishways.
- Evaluate the use vs. availability of habitat in the inland portion of the species range, and how habitat availability has changed through time, including opening of habitat from recent dam and barrier removals. This could and should include assisted migration by trucking around dams.
- To the extent that the data allows, account for the proportion of the population (yellow, silver phase) represented by the inland portion of the species range.
- Evaluate the relative impact that commercial harvest has on population status versus the accessibility to inland habitats.

Assessment Methods

- Develop methods to assess spawner escapement and biological information pertinent to silver eels in major river basins.
- Perform a range-wide American eel assessment with various countries and agencies (e.g., Canada DFO, ASMFC, USFWS, Caribbean, US Gulf and inland states).
- Explore methods to characterize data by sex to support a female-only delay-difference model.

MANAGEMENT STRATEGY

Under Addendum V, the commercial yellow eel fishery is regulated through an annual coastwide catch cap set at 916,473 pounds. Management action is initiated if the yellow eel coastwide cap is exceeded by 10% in two consecutive years. The management trigger has never been tripped. If the management trigger is exceeded, only those states accounting for more than 1% (9,164 pounds) of the total yellow eel landings will be responsible for adjusting their measures. In 2022, the commercial landings in North Carolina were 4,202 pounds, therefore if the coastwide management trigger was exceeded, North Carolina would not be required to work with other states to adjust

harvest. A workgroup has been formed to define the process to equitably reduce landings among the affected states when the management trigger has been met.

The ASMFC adopted Addendum IV in 2014 that contained a provision allowing states to submit an Aquaculture Plan allowing for the limited harvest of glass eels for use in domestic aquaculture facilities. Specifically, states are allowed to request harvest of up to 200 pounds of glass eels under an Aquaculture Plan. The DMF submitted an American eel Aquaculture Plan to ASMFC requesting approval to harvest up to 200 pounds of glass eels from coastal fishing waters in 2015, 2016, 2017 and 2019. The DMF did not submit an American Eel Aquaculture Plan to the ASMFC in 2022 and does not have an active glass eel fishery.

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TABLES

Table 1: Commercial landings of American eel (in pounds) in North Carolina, 1974-2022.

Year	Pounds
1974	451,956
1975	237,684
1976	510,083
1977	258,296
1978	695,605
1979	954,534
1980	960,196
1981	436,007
1982	475,524
1983	404,157
1984	706,298
1985	224,263
1986	338,377
1987	127,964
1988	57,369
1989	152,656
1990	56,494
1991	12,082
1992	17,739
1993	32,711
1994	95,991
1995	173,698
1996	141,592
1997	128,668
1998	91,084
1999	99,939
2000	127,099
2001	107,070
2002	59,820
2003	172,065
2004	128,875
2005	49,278
2006	33,581
2007	37,937
2008	23,833
2009	65,481
2010	122,104
2011	61,960
2012	64,110
2013	33,980
2014	60,755
2015	57,791
2016	39,991
2017	24,752
2018	18,058
2019	8,154
2020	3,291
2021	5,505
2022	4,202
Mean	186,749

FIGURES

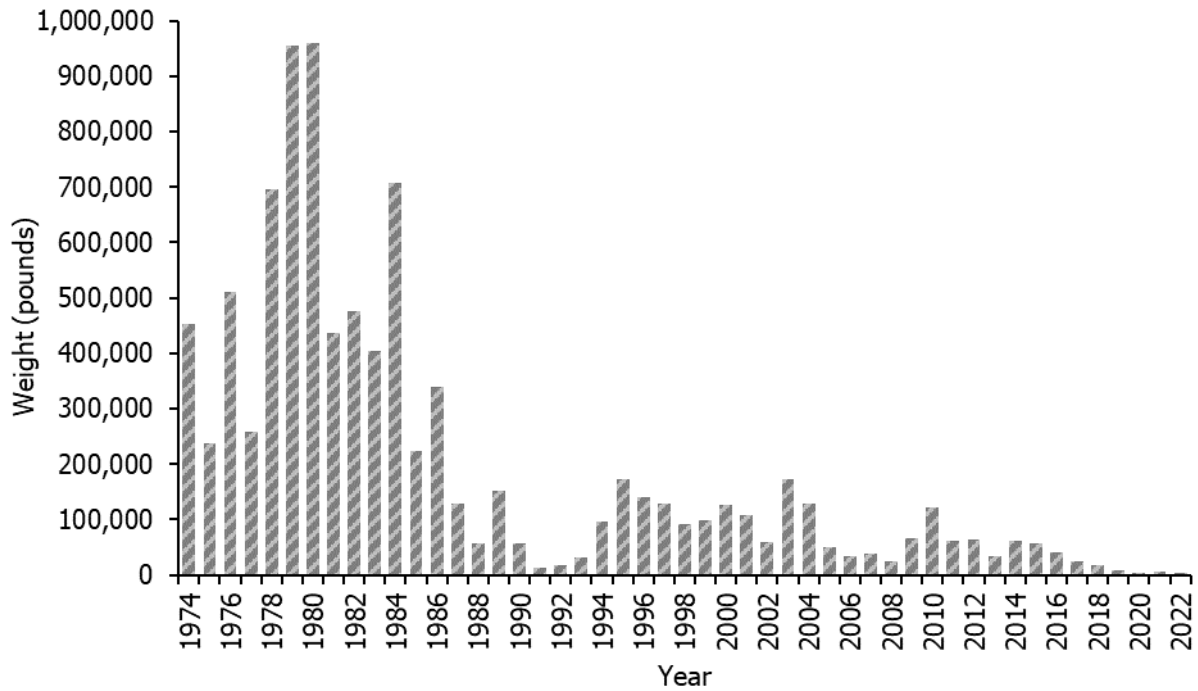


Figure 1: American eel commercial landings (pounds) reported through the North Carolina Trip Ticket Program, 1974–2022.

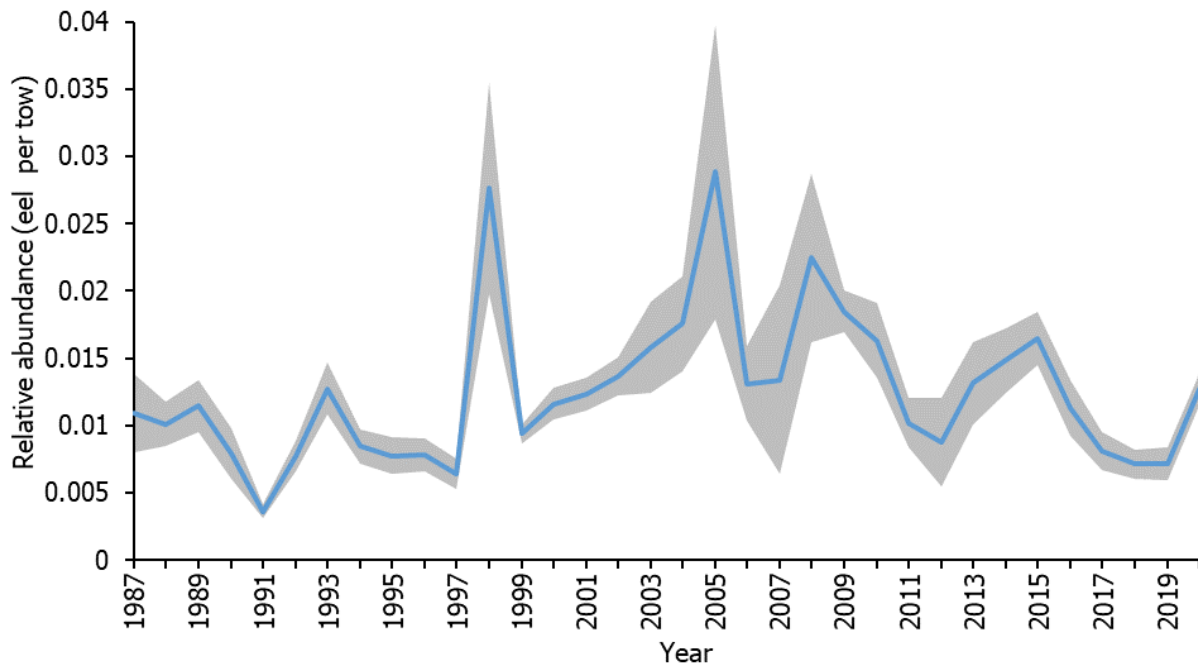


Figure 2: Relative abundance index (larval fish per tow) of American eel collected from the BBISP, 1987–2020. Error bars represent ± 1 standard error. There is a two-year backlog of unsorted samples (2021–2022).

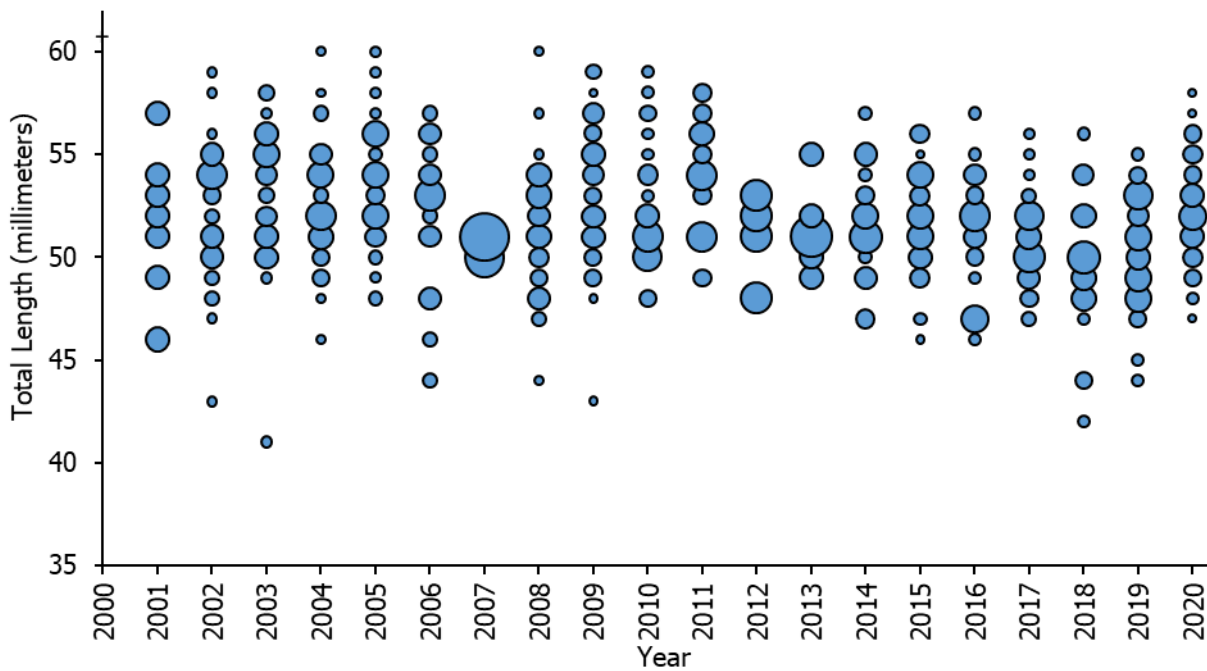


Figure 3: Length frequency (total length, millimeters) of American eel collected in the BBISP, 2001–2020. Bubbles represent fish at length and the bubble size is proportional to the number of fish at that length. There is a two-year backlog of unsorted samples (2021–2022). (Note: the 60+ category includes four fish; 61, 62, 91, and 153 millimeters).

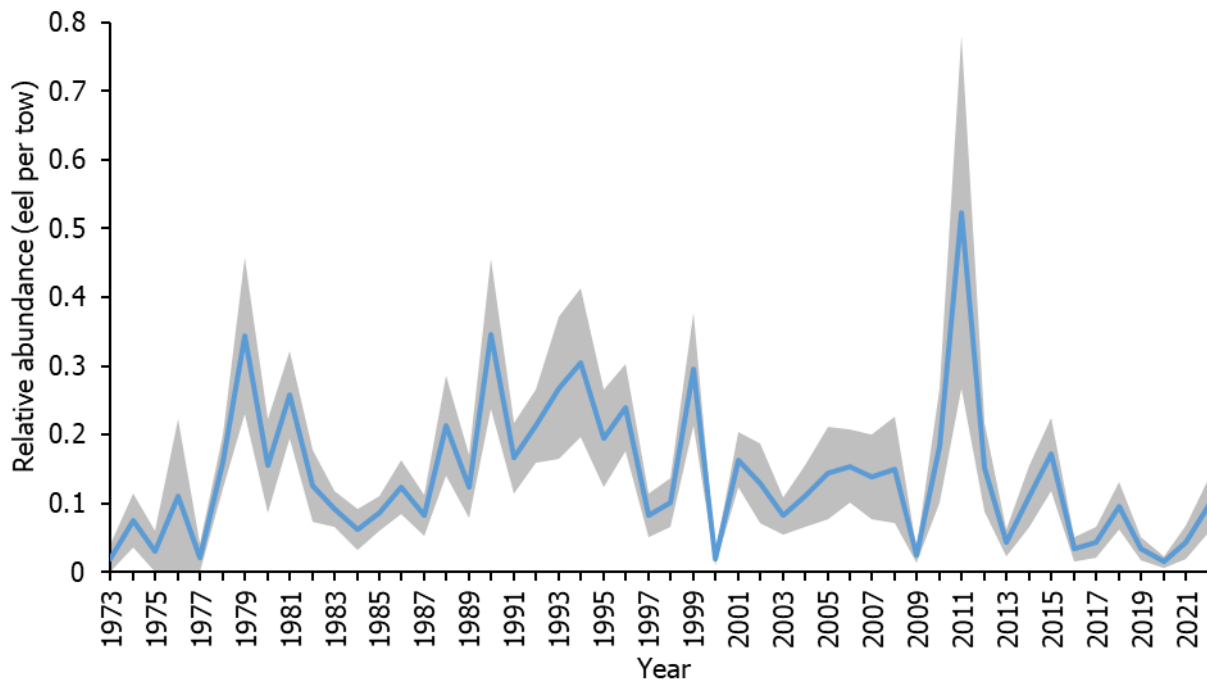


Figure 4. Relative abundance index (fish per tow) of American eel collected from the North Carolina Estuarine Trawl Survey (Program 120) from 1973–2022. Error bars represent ± 1 standard error.