

**FISHERY MANAGEMENT PLAN UPDATE
AMERICAN EEL
AUGUST 2020**

STATUS OF THE FISHERY MANAGEMENT PLAN

Fishery Management Plan History

Original FMP Adoption:	November 1999 Addendum I – February 2006 Addendum II – October 2008 Addendum III – August 2013 Addendum IV – October 2014 Addendum V – January 2019
Amendments:	None
Revisions:	None
Supplements:	None
Information Updates:	None
Schedule Changes:	None
Next Benchmark 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 (Table 1).

Following approval of Addendum III, the ASMFC American Eel Management 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:

1. The coastwide catch cap is exceeded by more than 10 percent in a given year (998,438 pounds)
2. 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 allowed states to submit an Aquaculture Plan to allow for the limited harvest of glass eels for use in domestic aquaculture facilities. Specifically, states are allowed to request for a harvest 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 benchmark stock assessment was updated with recent data from 2010-2016, however, neither reference points or stock status could be determined quantitatively. 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 in response to concerns that current management triggers do not account for annual fluctuations in landings and 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, are favorable to law enforcement, and are in watersheds that are prone to relatively high mortality rates.

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) 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

The 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 goal of the ASMFC American Eel FMP is 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; and provide for 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:

1. 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.
2. Increase understanding of factors affecting eel population dynamics and life history through increased research and monitoring.

3. Protect and enhance American eel abundance in all watersheds where eel now occur.
4. 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.
5. Investigate the abundance level of eel at the various life stages necessary to provide adequate forage for natural predators and support ecosystem health and food chain structure.

STATUS OF THE STOCK

Life History

The American eel 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, fresh water 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 2 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). The stock is at or near historically low levels due to a combination of historical overfishing, habitat loss, food web alterations, predation, hydroelectric turbine mortality, environmental changes, toxins and contaminants, and disease. The assessment updates

the 2012 American Eel Benchmark Stock Assessment with data from 2010-2016. Trend analyses of abundance indices indicated large declines in abundance of yellow eels during the 1980s through the early 1990s, with primarily neutral or stable abundance from the mid-1990s through 2016. Total landings remain low but stable. Based on these findings, the stock is still considered depleted. No overfishing status determination can be made based on the analyses performed.

Stock Assessment

In May 2016, the American Eel Technical Committee (TC) and Stock Assessment Subcommittee (SAS) recommended updating the 2012 stock assessment because there had not been enough new data sets or program developments to warrant a new benchmark assessment. The TC and SAS also recommended continuing to make progress on the research recommendations to support a benchmark stock assessment in the future.

The 2012 benchmark 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 a significant downward trend 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. The remaining surveys tested had no trend, except for two which had positive trends. 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 and the assessment maintained that the stock remains depleted. While it is highly likely the American eel stock is depleted, no overfishing determination can be made based solely on the trend analyses performed.

In March 2020, the American Eel TC and the American Eel SAS met to discuss the 2022 benchmark stock assessment for American eel. There were no changes recommended to the Terms of Reference, all potential data sources will be reviewed, and the terminal year will be 2019.

STATUS OF THE FISHERY

Current Regulations

New management measures for yellow eels went into effect on January 1, 2014 under North Carolina Marine Fisheries Commission (NCMFC) 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.

Commercial Landings

Average commercial landings and value from 2010 through 2019 was 49,157 pounds and \$120,107. In 2019, the commercial landings and value was 8,154 pounds (includes limited glass eel landings) and \$37,603 (Table 2). 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 2019 landings were the lowest recorded in the time-series.

Recreational Landings

There are no recreational landings data available for American eels, which are not typically a targeted species. Since American eels are caught incidentally in the estuarine environment by recreational fishermen by hook and line, the Marine Recreational Information Program (MRIP) does not provide reliable harvest data. Also, the survey design of MRIP 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 NCDMF initiated (January 2007) mandatory reporting of harvest and effort information for American eel 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 currently 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 flood-tide 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 2019, relative abundance of American eel (glass eel) has fluctuated from a low in 1991 to a high in 2005, with a 33-year average of 0.0125 eels per cubic meter (Figure 2). In 2019, American eel relative abundance (0.0072 eels per cubic meter) remained below the time-series average. Lengths of American eels captured in the BBISP from 2001 to 2019 (n=541) 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 North Carolina Division of Marine Fisheries (NCDMF) 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 1971 to 2019, relative abundance has fluctuated from lows in 1973 and 2000 to a peak in 2011, with a 26-year average of 0.144 per tow (Figure 4). In 2019, relative abundance (0.034 eels per tow) decreased after a two year increasing trend and remained below the time-series average (0.144 eels per tow) (Figure 4).

MANAGEMENT STRATEGY

Under Addendum V, the commercial yellow eel fishery is regulated through an annual coast wide 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 2019, the commercial landings in North Carolina were 8,154 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 American eel 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. In December 2015, the NCDMF 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 NCDMF in 2016 and approved by ASMFC that allowed for harvest in 2017 (1 year). The third plan submitted by the NCDMF in 2017 and approved by the ASMFC covered a 2-year period that allowed for harvest in 2018 and 2019. In May 2019, the NCDMF submitted another 2-year plan but was only approved by ASMFC for one harvest season (November, 2019 through March, 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 (NCMFC) 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 NCDMF and the North Carolina Wildlife Resources Commission (NCWRC) 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.

RESEARCH RECOMMENDATIONS

The items listed below are research needs identified in the 2012 benchmark stock assessment (ASMFC 2012) and progress toward accomplishing those objectives as described in the 2017 American Eel Stock Assessment Update (ASMFC 2017) based on input from the ASMFC American Eel TC and SAS. A single asterisk (*) denotes short-term recommendations and two asterisks (**) denote long-term recommendations. Recommendations formatted in **bold** identify improvements needed for the next benchmark assessment.

Data Collection

Fisheries Catch and Effort

- **Improve accuracy of commercial catch and effort data (NOTE: Some progress was made on this recommendation through Addenda III and IV)**
 - Compare buyer reports to reported state landings* (No Action)
 - Improve compliance with landings and effort reporting requirements as outlined in the ASMFC FMP for American eel (see ASMFC 2000a for specific requirements)* (Ongoing through the NC Trip Ticket Program and the American Eel Logbook Reporting Program)
 - Require standardized reporting of trip-level landings and effort data for all states in inland waters; data should be collected using the Atlantic Coastal Cooperative Statistics Program (ACCSP) standards for collection of catch and effort data (ACCSP 2004)* (Ongoing through the American Eel Logbook Reporting Program)
- Estimate catch and effort in personal-use and bait fisheries
 - Monitor catch and effort in personal-use fisheries that are not currently covered by the Marine Recreational Fishing Statistics Survey (MRFSS) or commercial fisheries monitoring programs* (No Action)
 - Implement a special-use permit for use of commercial fixed gear (e.g., pots and traps) to harvest American eels for personal use; special-use permit holders should be subject to the same reporting requirements for landings and effort as the commercial fishery** (No Action)
 - Improve monitoring of catch and effort in bait fisheries (commercial and personal-use)* (No Action)
- Estimate non-directed fishery losses
 - Recommend monitoring of discards in targeted and non-targeted fisheries* (No Action)

- Continue to require states to report non-harvest losses in their annual compliance reports* (Ongoing)
- **Characterize the length, weight, age, and sex structure of commercially harvested American eels along the Atlantic Coast over time**
 - Require that states collect biological information by life stage (potentially through collaborative monitoring and research programs with dealers) including length, weight, age, and sex through fishery-dependent sampling programs; biological samples should be collected from gear types that target each life stage; at a minimum, length samples should be routinely collected from commercial fisheries* (No Action)
 - Finish protocol for sampling fisheries; SASC has draft protocol in development* (No Action)
- Improve estimates of recreational catch and effort
 - Collect site-specific information on the recreational harvest of American eels in inland waters; this could be addressed by expanding the MRIP into inland areas** (No Action)
- Improve knowledge of fisheries occurring south of the U.S. and within the species' range that may affect the U.S. portion of the stock (i.e., West Indies, Mexico, Central America, and South America)** (No Action)

Socioeconomic Considerations

- Perform economics studies to determine the value of the fishery and the impact of regulatory management** (No Action)
- Improve knowledge regarding subsistence fisheries
 - Review the historic participation level of subsistence fishers and relevant issues brought forth with respect to those subsistence fishers involved with American eel** (No Action)
 - Investigate American eel harvest and resource by subsistence harvesters (e.g., Native American tribes, Asian and European ethnic groups)** (No Action)

Distribution, Abundance, & Growth

- **Improve understanding of the distribution and frequency of occurrence of American eels along the Atlantic Coast over time**
 - Maintain and update the list of fisheries-independent surveys that have caught American eels and note the appropriate contact person for each survey* (No Action)
 - Request that states record the number of eels caught by fishery-independent surveys; recommend states collect biological information by life stage including length, weight, age, and sex of eels caught in fishery-independent sampling programs; at a minimum, length samples should be routinely collected from fishery-independent surveys* (Ongoing through collecting number, length, and weight of eels caught in independent sampling programs)
 - Encourage states to implement surveys that directly target and measure abundance of yellow- and silver-stage American eels, especially in states where few targeted eel surveys are conducted** (No Action)
 - A coast-wide sampling program for yellow and silver American eels should be

developed using standardized and statistically robust methodologies** (No Action)

- Improve understanding of coastwide recruitment trends
 - Continue the ASMFC-mandated YOY surveys; these surveys could be particularly valuable as an early warning signal of recruitment failure* (In 2009, funding was cut for the NCDMF YOY survey; however, the NOAA BBISP is currently used for the YOY survey, as approved by the ASMFC American Eel Management Board)
 - Develop proceedings document for the 2006 ASMFC YOY Survey Workshop; follow-up on decisions and recommendations made at the workshop* (No Action)
 - Examine age at entry of glass eel into estuaries and freshwater** (No Action)
 - Develop monitoring framework to provide information for future modeling on the influence of environmental factors and climate change on recruitment** (No Action)
- Improve knowledge and understanding of the portion of the American eel population occurring south of the U.S. (i.e., West Indies, Mexico, Central America, and South America)** (No Action)

Future Research

Biology

- Improve understanding of the leptocephalus stage of American eel
 - Examine the mechanisms for exit from the Sargasso Sea and transport across the continental shelf** (No Action)
 - Examine the mode of nutrition for leptocephalus in the ocean** (No Action)
- Improve understanding of impact of contaminants as sources of mortality and non-lethal population stressors
 - Investigate the effects of environmental contaminants on fecundity, natural mortality, and overall health** (No Action)
 - Research the effects of bioaccumulation with respect to impacts on survival and growth (by age) and effect on maturation and reproductive success** (No Action)
- **Improve understanding of impact of *Anguillicoloides crassus* on American eel**
 - Investigate the prevalence and incidence of infection by the nematode parasite *A. crassus* across the species range* (No Action)
 - Research the effects of the swim bladder parasite *A. crassus* on the American eel's growth and maturation, migration to the Sargasso Sea, and the spawning potential* (No Action)
 - Investigate the impact of the introduction of *A. crassus* into areas that are presently free of the parasite** (No Action)
- **Improve understanding of spawning and maturation**
 - Investigate relation between fecundity and length and fecundity and weight for females throughout their range** (No Action)
 - Identify triggering mechanism for metamorphosis to mature adult, silver eel life stage, with specific emphasis on the size and age of the onset of maturity, by sex; a maturity schedule (proportion mature by size or age) would be extremely useful in combination

- with migration rates** (No Action)
- Research mechanisms of recognition of the spawning area by silver eel, mate location in the Sargasso Sea, spawning behavior, and gonadal development in maturation** (No Action)
- Examine migratory routes and guidance mechanisms for silver eel in the ocean** (No Action)
- Improve understanding of predator-prey relationships** (No Action)
- Investigating the mechanisms driving sexual determination and the potential management implications** (No Action)

Passage & Habitat

- **Improve upstream and downstream passage for all life stages of American eels**
 - Develop design standards for upstream passage devices for eels. The ASMFC 2011 Eel Passage Workshop (ASMFC 2013) made contributions to this goal. (NCDMF will continue to work with Dominion Energy and participate on the American Eel Working Group)
 - Investigate, develop, and improve technologies for American eel passage upstream and downstream at various barriers for each life stage; in particular, investigate low-cost alternatives to traditional fishway designs for passage of eel** (NCDMF will continue to work with Dominion Energy and participate on the American Eel Working Group)
- Improve understanding of the impact of barriers on upstream and downstream movement (No Action)
 - Evaluate the impact, both upstream and downstream, of barriers to eel movement with respect to population and distribution effects; determine relative contribution of historic loss of habitat to potential eel population and reproductive capacity** (NCDMF will continue to work with Dominion Energy and participate on the American Eel Working Group)
 - Recommend monitoring of upstream and downstream movement at migratory barriers that are efficient at passing eels (e.g., fish ladder/lift counts); data that should be collected include presence/absence, abundance, and biological information; provide standardized protocols for monitoring eels at passage facilities; coordinate compilation of these data; provide guidance on the need and purpose of site-specific monitoring** (NCDMF will continue to work with Dominion Energy and participate on the American Eel Working Group)
 - Use the information gained from the above evaluation and monitoring of barriers to American eel passage to develop metrics for prioritizing passage restoration projects. (NCDMF will continue to work with Dominion Energy and participate on the American Eel Working Group)
- **Improve understanding of habitat needs and availability**
 - Assess characteristics and distribution of American eel habitat and value of habitat with respect to growth and sex determination; develop GIS of American eel habitat in

U.S.** (No Action)

- Assess available drainage area over time to account for temporal changes in carrying capacity; develop GIS of major passage barriers** (No Action)
- Improve understanding of freshwater habitat and water quality thresholds for American eel. (No Action)
- Improve understanding of within-drainage behavior and movement and the exchange between freshwater and estuarine systems** (No Action)
- Improve estimates of mortality associated with upstream and downstream passage
 - Monitor non-harvest losses such as impingement, entrainment, spill, and hydropower turbine mortality* (NCDMF will continue to work with Dominion Energy and participate on the American Eel Working Group)
- Evaluate eel impingement and entrainment at facilities with NPDES authorization for large water withdrawals; quantify regional mortality and determine if indices of abundance could be established as specific facilities** (No Action)
- Investigate best methods for reintroducing eels into a watershed; examine approaches for determining optimum density* (NCDMF will continue to work with Dominion Energy and participate on the American Eel Working Group - data available from the Roanoke Rapids, NC)

Assessment Methodology & Management Support

- Coordinate monitoring, assessment, and management among agencies that have jurisdiction within the species' range (e.g., ASMFC, GLFC, Canada DFO)** (No Action)
- Perform a joint U.S.-Canadian stock assessment* (NC will continue to provide data for stock assessments)
- Perform periodic stock assessments (every 5–7 years) and establish sustainable reference points for American eel are required to develop a sustainable harvest rate in addition to determining whether the population is stable, decreasing, or increasing. (NC will continue to provide data for stock assessments)
 - Develop new assessment models (e.g., delay-difference model) specific to eel life history and fit to available indices** (No Action)
 - **Conduct intensive age and growth studies at regional index sites to support development of reference points and estimates of exploitation*** (No Action)
 - Develop GIS-type model that incorporates habitat type, abundance, contamination, and other environmental factors** (No Action)
 - Develop population targets based on habitat availability at the regional and local level** (No Action)
- Implement large-scale (coastwide or regional) tagging studies of eels at different life stages; tagging studies could address a number of issues including: (No Action)
 - Natural, fishing, and discard mortality; survival**

- Growth**
- Passage mortality**
- Movement, migration, and residency**
- Validation of ageing methods**
- Reporting rates**
- Tag shedding or tag attrition rate**

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TABLES

Table 1. Summary of management strategies and their implementation status from Addendum V and previous Addendums.

Management Strategy	Implementation Status
Establish a Coastwide Cap (916,473 pounds)	Accomplished with Addendum V
Establish a Coastwide cap (907,671 pounds)	Accomplished with Addendum IV
Establish aquaculture plans that allows for states and jurisdictions to request harvest of a maximum of 200 pounds of glass eels annually from within their waters for use in domestic aquaculture.	Accomplished with Addendum IV
Nine (9) in minimum size limit for both commercial and recreational fisheries.	Accomplished by N.C. Marine Fisheries Commission Rule 15A NCAC 03M .0510
Recreational possession limit of 25 eels / person / day.	
No possession of American eels from September 1 to December 31 unless they are taken with baited pots	
Minimum eel pot mesh size of one-half by one-half inch.	Accomplished by N.C. Marine Fisheries Commission Rule 15A NCAC 03J .0301
Mandatory trip level reporting by life stage, including number of units fished and unit soak time.	Accomplished by N.C.G.S. 113-170.3 and the American eel log book reporting program where fishermen are notified by letter of the monthly reporting requirement

Table 2. Commercial landings of American eel (in pounds) in North Carolina, 1974-2019.

Year	Pounds	Year	Pounds
1974	451,956	1997	128,668
1975	237,684	1998	91,084
1976	510,083	1999	99,939
1977	258,296	2000	127,099
1978	695,605	2001	107,070
1979	954,534	2002	59,820
1980	960,196	2003	172,065
1981	436,007	2004	128,875
1982	475,524	2005	49,278
1983	404,157	2006	33,581
1984	706,298	2007	37,937
1985	224,263	2008	23,833
1986	338,377	2009	65,481
1987	127,964	2010	122,104
1988	57,369	2011	61,960
1989	152,656	2012	64,110
1990	56,494	2013	33,980
1991	12,082	2014	60,755
1992	17,739	2015	57,791
1993	32,711	2016	39,991
1994	95,991	2017	24,753
1995	173,698	2018	18,058
1996	141,592	2019	8,154

FIGURES

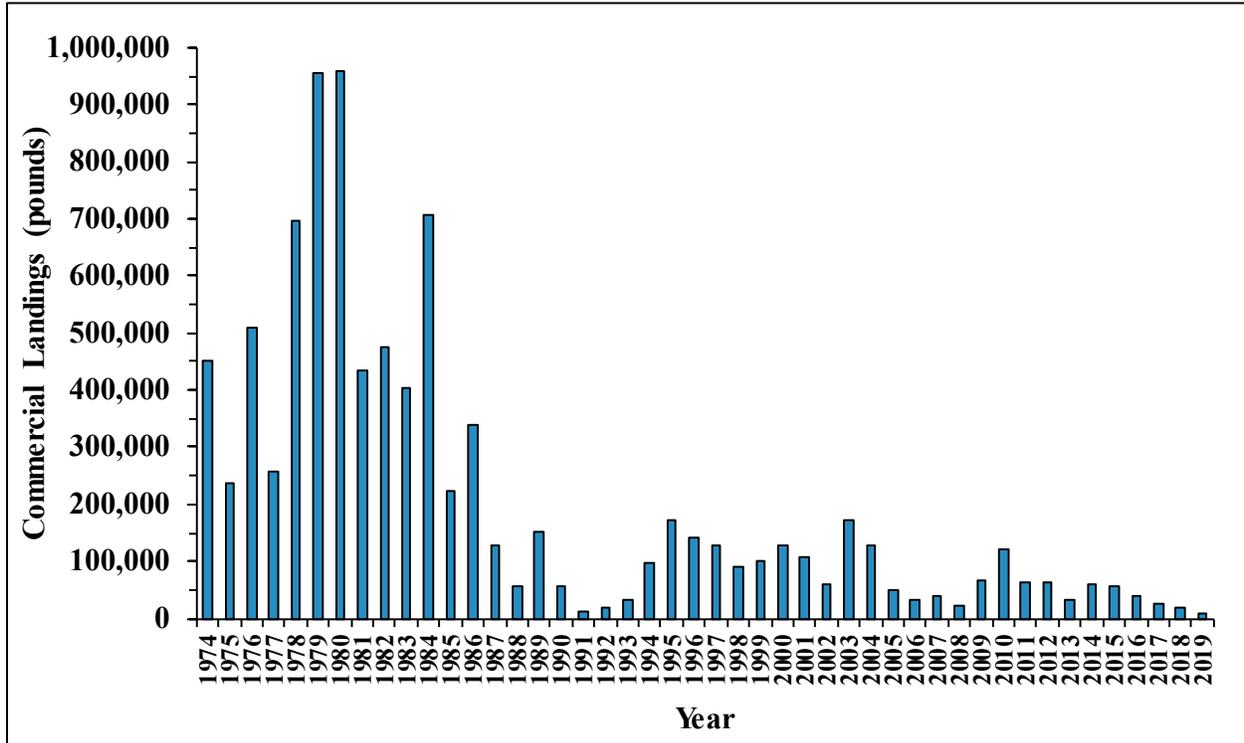


Figure 1. American eel commercial landings in N.C., 1974 – 2019.

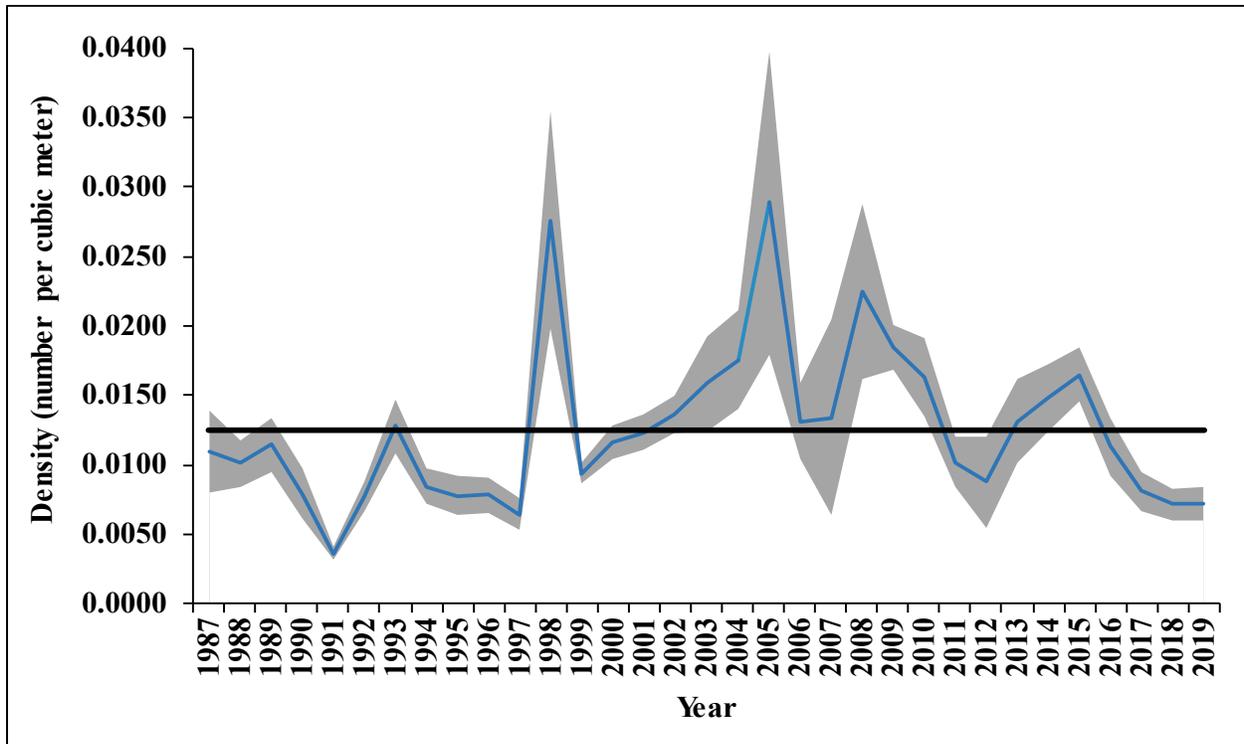


Figure 2. Average annual density (number of larvae per cubic meter) of American eel (glass eel) in the BBISP, 1987-2019. Solid black line represents time-series average. Shaded area represents standard error.

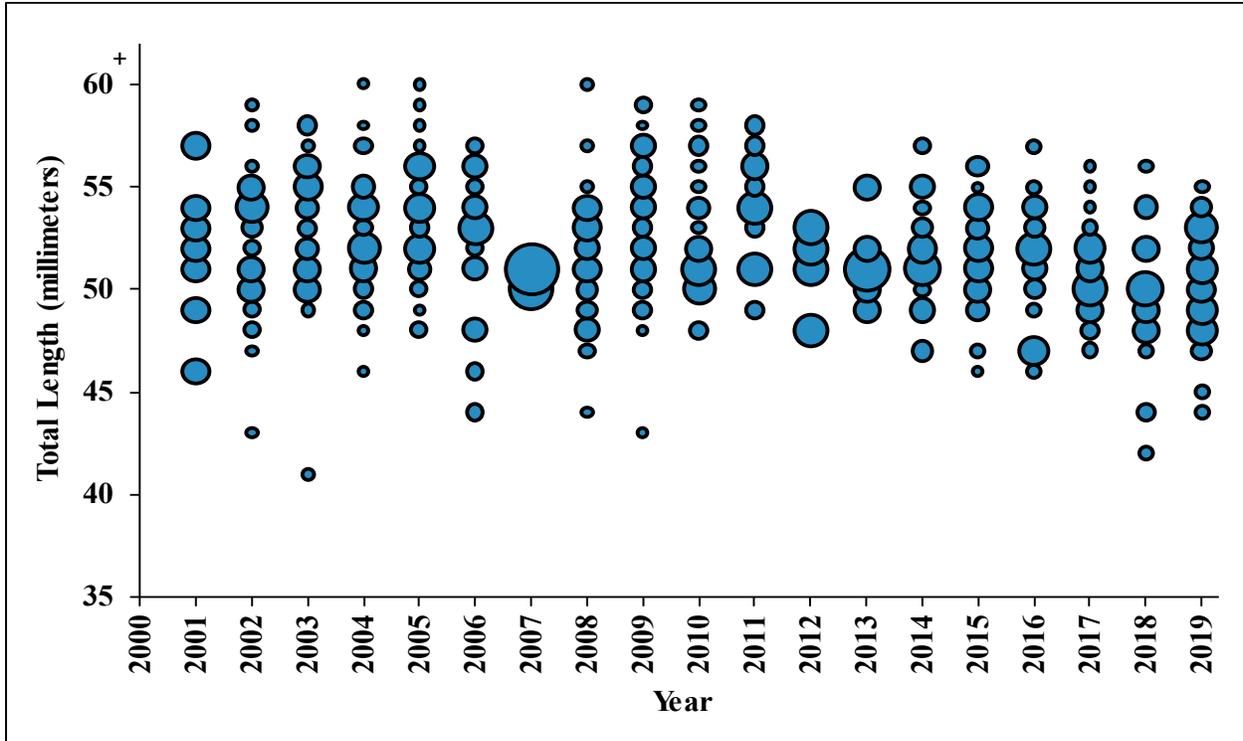


Figure 3. Average length frequency (total length, millimeters) of American eel collected in the BBISP, 2001-2019. Bubble represents the proportion of fish at length. (Note: the 60+ category includes three fish; 62, 91, and 153 millimeters).

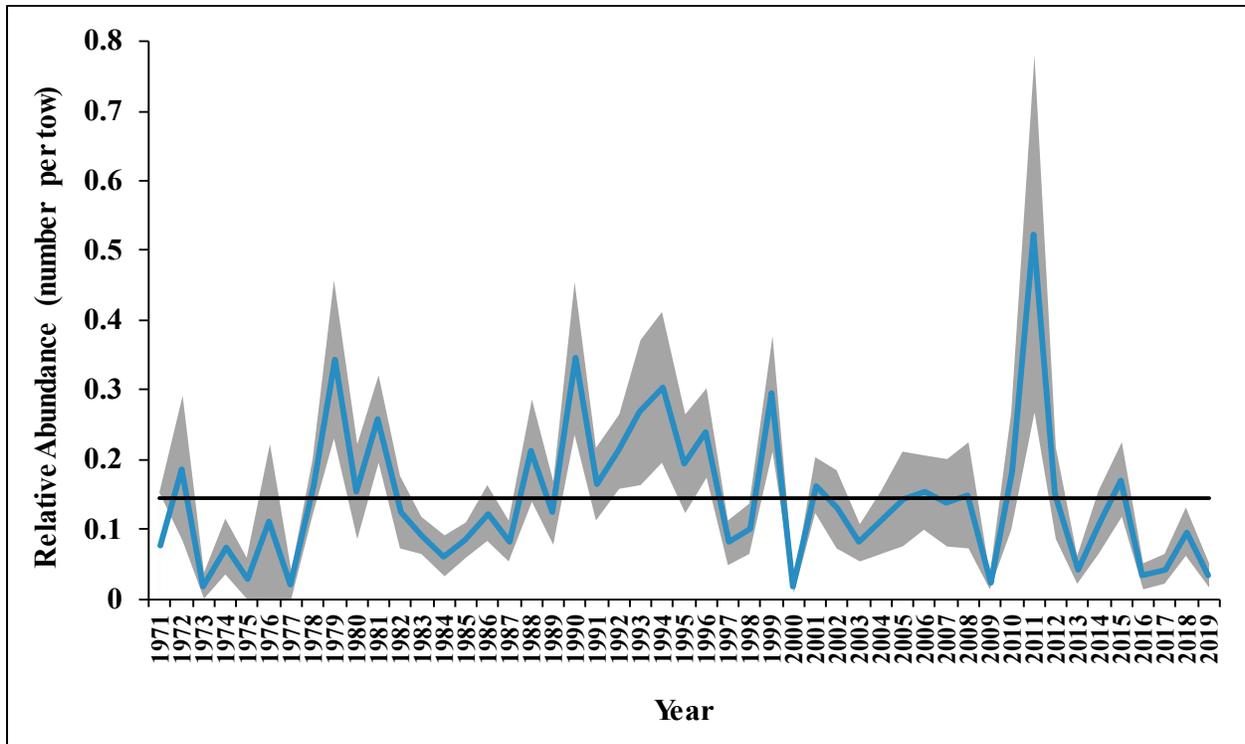


Figure 4. Relative abundance of juvenile (elver) American eel in the NCDMF Estuarine Trawl Survey, 1971-2019. Solid black line represents time-series average. Shaded area represents standard error.