FINAL REPORT

Cooperative Winter Tagging Cruises, 2013-2016, for Atlantic Striped Bass and Affiliated Species

(Period covered by this report: July 1, 2012 to June 30, 2017. This grant covered the 2016 Cruise and a no-cost extension was granted through December 31, 2017. The 2013 and 2015 Cruises were funded by North Carolina Coastal Recreational Fishing License (CRFL) grants; all are included for the sake of completeness. CRFL funding was matched with S-K grant funds.

Grant Award #: Contract 6982

Submitted to the NC Department of Environmental Quality, Division of Marine Fisheries
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COASTAL RECREATIONAL FDISHING LICENSE
FINAL REPORT

Recipient: Roger A. Rulifson and R. Wilson Laney

Grant Award #: Contract 6982

Grant Title: Cooperative Winter Tagging Cruise, 2016, for Atlantic Striped Bass and Affiliated Species

Grant Award Period: 15 September 2016 – 31 December 2017

Performance Reporting Period: **1 July 2012 to September 30, 2017**
[Note: We have included for the sake of completeness the 2013 and 2015 Cruise operations, which were covered by the North Carolina Coastal Recreational Fishing License (CRFL) grant program funds, and the 2014 Hook and line operation funded by CRWL and USFWS funds provided by NMFS per the MOU with ASMFC]

Project Costs:

Expenditures for the Contract.

Category	Expenditures
Personnel	
Fringe	
Travel	
Equipment	
Supplies	
Construction	
Contractual	
Other	
Total Direct	
Indirect	
TOTAL	$

Total Cumulative Expenditures: $104,961
Total Remaining Balance: $ 830.78

Prepared By: Roger A. Rulifson, Ph.D. **Date:** December 31, 2017

Signature of Principal Investigator

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III. EXECUTIVE SUMMARY

Winter monitoring (including tagging) of Striped Bass and Atlantic Sturgeon in the Atlantic Ocean off the coasts of NC and VA occurred during the winters of 2013, 2015 and 2016 using NC Marine Resources Fund (Coastal Recreational Fishing License, CRFL) grant program with additional funds provided by the NOAA/NMFS Saltonstall-Kennedy (S-K) grant funds program as partial match. Funding for the annual Cooperative Winter Tagging Cruises is a complicated story; suffice to say here that the last four years of the CWTC were covered in part or in whole by the CRFL program. In brief, the 2016 study (see Appendices) addressed within this final report was a match to a second year of Saltonstall-Kennedy funding; the first year of that S-K funding matched the third year of a CRFL grant that included 2013-2015 sampling seasons, and which required a cash-match in the second and third years (the first year was fully funded). In the second year, no large match was forthcoming and so the US Fish and Wildlife Service provided enough funds to cover the match of a parallel hook-and-line tagging study, which was a part of the original CRFL grant awarded in 2012.

We include here data from the 2013, 2015, and 2016 Cooperative Winter Tagging Cruise (hereinafter, CWTC, or Cruise) for completeness and comparison of the last four years of the program. In addition, a second component – a charter boat tagging cruise – was used to catch Striped Bass exclusively by hook and line for examination, tagging, and release. These two tagging efforts – one from capture by trawl, and the second by hook and line – allow modelers to determine relative estimates of survival from the two methods, and provide a better estimate of total and annual mortality rates of the Striped Bass offshore migratory stock. The fact that both methods were employed during 2013, 2015 and 2016 also provides an opportunity for any necessary calibration between the two methods, as the hook-and-line method is presently the only one funded for future implementation. Cruise data are used to determine total and fishing mortality on the mixed coastal migratory stock of Striped Bass, which include those coastal migrants from the Albemarle-Roanoke stock. The Cruise provides a fishery-independent examination of the Striped Bass, which are/were targeted in the NC and VA winter ocean recreational fishery, and is otherwise sampled offshore only from fishery-dependent sources. The Cruise is and remains the only fishery-independent project conducted in the mid-Atlantic during the winter months. The project continues to build a database of information on fish habitat use and community structure in mid-Atlantic areas used for wintering by Atlantic Sturgeon, Spiny Dogfish, Striped Bass, Weakfish and other species of commercial, recreational and cultural importance (e.g., alosines, other sciaenids and skates).

Objectives of the project as conducted during 2013-2016 were as follows: 1) Capture, document, tag and release Striped Bass on the NC/VA wintering grounds; 2) Characterize the age structure of the Striped Bass stock on the winter grounds; 3) Estimate fishing mortality (F) of the coastal migratory Striped Bass stock; 4) Map the distribution of Striped Bass and associated species during the winter study period; 5) Map the movements and migration of Striped Bass using recapture data; 6) If possible employ acoustic tags in a subset of tagged Striped Bass to assess catch/release mortality of trawl-caught versus hook-and-line caught fish; 7) Capture, document, tag and release any Atlantic Sturgeon encountered during the Cruise; 8) Tag Atlantic sturgeon over 800 mm TL with acoustic tags; 9) Document all alosine species encountered (Alewife,

American Shad, Blueback Herring and Hickory Shad); 10) Document and retain any species needed by NCDMF for aging to meet ASMFC and Atlantic Coastal Cooperative Statistics Program (ACCSP) targets; 11) Completely characterize each trawl catch to document all Striped Bass associates; and 12) Provide a final report of publishable quality for submission to fishery management agencies.

All objectives with the exception of Objectives 6 and 8 were accomplished to a significant degree. Detailed methodology used for each of the objectives is provided within the body of the final report. A total of 6,119 Striped Bass were captured using trawl and hook-and-line gear. Of the total, 5,804 were tagged and released. Fish recaptured that had been tagged by other programs, and those released without processing when holding tank capacity was exceeded, account for the difference between number captured and number tagged/released. Length-frequencies and ages were typical of what was expected for the Atlantic migratory stock of Striped Bass. Hook-and-line captured Striped Bass were significantly ($p < 0.05$) larger than trawl-caught fish for all three years of comparison (2013, 2015, and 2016). In addition, the ages of hook-and-line tagged Striped Bass were significantly greater ($p < 0.05$) than those of trawl-tagged fish for 2013 and 2015, but there was no age difference ($p = 0.62$) observed in 2016. Differences in estimated total (Z) and fishing (F) mortality rates were comparable to those measured in prior years and not significant between the gears. For trawl the instantaneous estimate ranges were 0.120-0.125 for F and 0.331 for M, with total mortality (Z) ranges of 0.452-0.457. For hook and line, estimate ranges were 0.121-0.126 for F, 0.332 for M, and 0.453-0.459 for Z. The distribution of captured Striped Bass was found to have shifted northward and offshore, in comparison to prior years when fish were often in NC waters and much closer to shore. In 2016, Striped Bass were not encountered in significant numbers until sampling was conducted in waters off Maryland, further north than any prior Cruises had traveled. Of the Striped Bass tagged and released, percentages recaptured (through October 30, 2017) ranged from 11.1 (for H&L tagged fish in 2016) to 16.2 (for both gear types in 2013). Recapture locations ranged from NC through the St. John River in Canada, and the distribution pattern was as expected, a reflection of Striped Bass seasonal movements and spawning migrations, and locations where fishing effort is high.

Twelve Atlantic Sturgeon were captured incidental to Striped Bass tagging operations during the Cruises. None of the twelve had been previously tagged. The six sturgeon encountered during the 2015 Cruise were tagged and released. All Atlantic Sturgeon captured were in a presumptive adult size range.

Alosine species, with the notable exception of American Shad, were encountered and documented each year. Most Alewife encountered were adults and distribution was largely nearshore, concentrated north of Oregon Inlet in NC waters, and north of the mouth of Chesapeake Bay. Alewife length-frequency and ages are provided. Multiple species were retained and otoliths removed for ageing by the NC Division of Marine Fisheries. Approximately 144 species or species groups were associated with Striped Bass in the study area. Distributions and habitat associations were determined for the species or species groups of management interest. Distribution maps and length-frequencies are provided for the more abundant species.

Additional needed work beyond that accomplished during 2013-2016 is proposed. Needed work includes: placement of acoustic transmitters in migratory Striped Bass offshore; placement of acoustic transmitters in more juvenile or adult shark species offshore; additional Atlantic Sturgeon acoustic tag implantation and winter sampling in the offshore mid- and south Atlantic; continued fishery-independent sampling to characterize the winter fish and invertebrate community and continue progress toward implementation of ecosystem-based fishery management; and continue annual Cooperative Winter Tagging Cruises to document continued changes in the distribution of Striped Bass and other species of interest.

IV. INTRODUCTION

Background: Winter tagging of Striped Bass and Atlantic Sturgeon in the Atlantic Ocean off the coasts of NC and VA (see Figure 1) was initiated by the North Carolina Division of Marine Fisheries (NCDMF) in the late 1960s and early 1970s (see Holland and Yelverton 1973). Tagging of these species, as well as others, was reinitiated in 1988 at the recommendation of the Atlantic States Marine Fisheries Commission's (ASMFC's) Striped Bass Technical Committee by five principal partners (ASMFC; Maryland Department of Natural Resources-Fisheries Service (MDNR-FS); National Oceanic and Atmospheric Administration (NOAA), National Marine Fisheries Service (NMFS); North Carolina Division of Marine Fisheries (NCDMF); and the U.S. Fish and Wildlife Service (USFWS), Northeast and Southeast Regions) (see Rago 1987; Richards 1989). These partners along with others including multiple university partners and participants conducted the Cooperative Winter Tagging Cruises (CWTCs, or Cruise) from 1988 through 2010 (see Benton 1992; Laney 2008). The Cruise is only one component of multiple tagging programs that comprise the ASMFC's Coastwide Cooperative Striped Bass Tagging Program (see U.S. Fish and Wildlife Service 2000, and the following URL: https://www.fws.gov/northeast/marylandfisheries/projects/Striped%20Bass.html).

Although originally designed and envisioned as a stratified random survey (Richards 1989), practical considerations for ensuring that adequate numbers of Striped Bass were tagged in order to generate a robust estimate of annual total (Z) and fishing mortality (F) resulted in the Cruise stations being selected on a more opportunistic basis (i.e., with an objective to tag a maximum number of Striped Bass each year). Therefore the Cruise evolved more for monitoring purposes than as a formal survey, and was mandated as part of the ASMFC Striped Bass management program (see ASMFC 1995, ASMFC 2003).

Despite the absence of a statistical design, Cruise results and analysis for both Striped Bass and Atlantic Sturgeon, as well as other species, have previously been published in both peer-reviewed (see Sprankle et al. 1996, Laney et al. 2007, Welsh et al. 2007) and informal reports. Data generated for Striped Bass, and Atlantic Sturgeon, have been used in stock assessments for those species (i.e., see Northeast Fishery Science Center 2013, ASMFC 2017a, 2017b). Other species tagged during Cruises have included Horseshoe Crab, Red Drum, Spiny Dogfish, Summer Flounder, and Winter Skate. Cruise-generated data have also served as the basis for multiple graduate theses and dissertations (e.g., see Sprankle 1994, Register 2006, Bangley 2011, Cudney 2015, Osborne –in preparation) during a two-decade span. The Cruises have provided the only long-term fishery-independent winter data for the study area.

Due to the decline of funding to support NOAA research vessel use, as well as reductions in ship time, hook-and-line gear tagging cruises were initiated in 2011 and continued through 2016, using the protocol employed by the Massachusetts Division of Marine Fisheries. In the future (2018 and beyond), the intent is to fund the hook-and-line tagging trips by NCDMF using Wildlife and Sport Fish Restoration (WSFR) funds administered by USFWS (Charlton Godwin, NCDMF, Elizabeth City, NC, personal communication). Cruise data are used to determine total and fishing mortality on the mixed coastal migratory stock of Striped Bass, which includes those coastal migrants from the Albemarle-Roanoke stock, Chesapeake Bay, Delaware, and Hudson River. The Cruise provides a fishery-independent examination of the Striped Bass, which

are/were targeted in the NC and VA winter ocean recreational fishery, and is otherwise sampled while offshore only from fishery-dependent sources. NOAA historically provided funding for vessel operations as previously described; however as of 2011, this source of funding was not forthcoming. Partners sought a more stable source of funding beyond 2012.

Funding received from the NOAA/NMFS Saltonstall-Kennedy (S-K) grant funding program matched two NC Marine Resources Fund (Coastal Recreational Fishing License, CRFL) grants used to conduct the Cruise for 2013, 2015 and 2016. In addition, a second component – the charter boat cruise – is being used to catch Striped Bass exclusively by hook and line for examination, tagging, and release. These two tagging efforts – one from capture by trawl, and the second by hook and line – will allow modelers to determine relative estimates of survival from the two methods, and may provide a better estimate of population size of the offshore migratory stock. The fact that both methods were employed during 2013, 2015 and 2016 also provides an opportunity for any necessary calibration between the two methods, as the hook-and-line method is presently the only one funded for future implementation.

Cooperative Winter Tagging Cruise Partners and Final Report Authors: For a detailed list of all Cruise partners and individual participants during the 2013-2016 operations, see Section VI.B. below and the referenced tables. The principal authors of this report are those individuals included on the cover page, listed in alphabetical order, following the two co-principal investigators: Dr. Chuck Bangley (at the time ECU, Greenville, NC; currently with Smithsonian Estuarine Research Center (SERC)); Charlton Godwin (NCDMF, Elizabeth City, NC); Dr. R. Wilson Laney (USFWS and NCSU, Raleigh, NC); Josh Newhard (USFWS, Annapolis, MD); Jillian H. Osborne (formerly East Carolina University (ECU), Greenville, NC, but currently North Carolina Wildlife Resources Commission, Brevard, NC); Dr. Roger A. Rulifson (ECU, Greenville, NC); Brian Van Druten (USFWS, Manteo, NC); and Beth Versak (MDDNR-FR, Annapolis, MD). Their roles in Cruise planning, implementation, and data management and analysis as well as their specific contributions to this final report, are detailed below in Section VI. Additional individuals are listed below and also in the ACKNOWLEDGEMENTS, Section IX.

Funding: The funding for all aspects of Cruise operations during 2013-2016 was provided by two North Carolina CRFL grants and a matching S-K grant plus in-kind funding provided by all partners and many Cruise participants (Table 1). Some funding from the allocation to the USFWS provided by NMFS in accordance with the agreement with ASMFC, as part of the Atlantic Coastal Fisheries Cooperative Management Act (per the MOU among ASMFC, NMFS and USFWS) was used to support the 2014 hook-and-line tagging (Table 1).

Equipment Purchased and Vessels Employed: There was no equipment purchased using funds from any of the grants. Vessels employed as stern-trawling platforms for the trawl-based tagging were the National Science Foundation R/V Cape Hatteras (2013) home-ported in Beaufort, NC, at the Duke University Marine Laboratory, and the University of Georgia's R/V Savannah (2015 and 2016), which is home-ported in Savannah, GA, at the Skidaway Institute of Marine Sciences. Hook-and-line tagging was conducted aboard the F/V Midnight Sun, the F/V Poacher and the F/V Smokin' Gun II (all 2013), and thereafter only on the F/V Midnight Sun

(2014-2016). The fishing vessels all fish out of Rudee Inlet, VA, near Virginia Beach, during the winter months.

V. PURPOSE

Detailed description of problem or impediment of fishing industry that was addressed: The proposed project responded to the 2012 S-K Program Priority 5, *Ecosystem Studies*. It also responded to Program Priority 2, *Optimum Utilization of Harvested Resources under Federal or State Management* since it included a mandatory component of ASMFC Amendment 6 (ASMFC 2003) monitoring for migratory Atlantic Striped Bass to continue a 25-year time series (1988-2013) of Striped Bass annual tag-based mortality estimates (see Welsh et al. 2007). It also built upon a 24-year time series (1988-2010, 2013) of Atlantic Sturgeon capture data and continued to build a database of Atlantic Sturgeon habitat use and distribution within the study area (see Laney et al. 2007), which also was used as an index of abundance within the current Atlantic Sturgeon benchmark stock assessment (ASMFC 2017a). The data collected for Atlantic Sturgeon contribute to the ongoing ASMFC Atlantic Sturgeon stock assessment process (completed as of August, 2017, accepted by the Peer Review Panel, and presented to the ASMFC Sturgeon Management Board on October 18, 2017; see ASMFC 2017a). The Board accepted the assessment for management advice. In addition to the two primary target species, the Cruise S-K proposal also committed to document and collect information on all other ASMFC and federal Fishery Management Council (Mid-Atlantic Fishery Management Council-MAFMC, New England Fishery Management Council-NEFMC, and South Atlantic Fishery Management Council-SAFMC) species. Data from the entire time series were at the time of the proposal being compiled in a database and will be analyzed for the first time from an ecosystem perspective (Jillian H. Osborne, ECU, MS thesis project; the database has been completed and discussions are underway regarding provision of all data for the entire Cruise time series, 1988-2016, to both ASMFC and SEAMAP for archiving).

The proposed project was responsive to multiple ASMFC and Council Fishery Management Plans (FMPs) as well as to multiple fishery-related strategic planning and management documents (i.e., see Sport Fishing and Boating Partnership Council 2013).

The anticipated impacts of the project on the fisheries resource and the fishing community were deemed beneficial in ecological, economic and cultural terms, with minimal adverse impacts. The Cruise is and remains the only fishery-independent project conducted in the mid-Atlantic during the winter months. The project continues to build a database of information on fish habitat use and community structure in mid-Atlantic areas used for wintering by Atlantic Sturgeon, Spiny Dogfish, Striped Bass, Weakfish and other species of commercial, recreational and cultural importance (e.g., alosines, other sciaenids and skates). Additional analyses of these data, and data collected during previous years of the Cruise, were proposed to further the understanding of winter population dynamics in the study area and ensure progress toward ecosystem-based fishery management (EBFM) as mandated for NOAA, the Councils and the ASMFC. The project enables partners to complete required monitoring for coastal migratory Striped Bass as mandated by Amendment 6, and assist in documenting that the stock is not overfished. The project was deemed to yield valuable information comparing survival of hook-and-line caught to trawl-caught striped bass.

Detrimental impacts of the project were anticipated to be minimal. In the previous 24 years of the time series, the Cruise averaged 166 tows per year (ASMFC, USFWS and partners, unpublished data). Given that tow times were no longer than 30 minutes in duration, the maximum amount of fishing time for the proposed project was stated to be limited to less than 83 hours (if we presumed maximum tow times; tow times are generally 20 minutes or less). Survival rates of target species that are tagged (Atlantic Sturgeon, Striped Bass) have generally been high as a consequence of short tow times, cold winter temperatures, and minimal handling/tagging times. Starting in 2010 we began documenting the entire catch, so mortality of other species not targeted for tagging likely increased somewhat due to longer handling and processing time required for counting, measuring and weighing the remainder of the catch. Some specimens (all alosines, selected other species) were retained for further analysis and/or as museum voucher specimens (in collaboration with the North Carolina State Museum of Natural Sciences) and were thereby removed from the ecosystem/population. Cruise impact was minimal in view of the fact that fishing occurs for only up to ten days, and we employed measures designed to avoid any impacts to protected resources (Atlantic Sturgeon) that were encountered.

Objectives of the project:

1. Capture, document, tag and release Striped Bass on the NC/VA wintering grounds.
2. Characterize the age structure of the Striped Bass stock on the winter grounds.
3. Estimate fishing mortality (F) of the coastal migratory Striped Bass stock.
4. Map the distribution of Striped Bass and associated species during the winter study period.
5. Map the movements and migration of Striped Bass using recapture data.
6. If possible employ acoustic tags in a subset of tagged Striped Bass to assess catch/release mortality of trawl-caught versus hook-and-line caught fish.
7. Capture, document, tag and release any Atlantic Sturgeon encountered during the Cruise.
8. Tag Atlantic sturgeon over 800 mm TL with acoustic tags.
9. Document all alosine species encountered (Alewife, American Shad, Blueback Herring and Hickory Shad).
10. Document and retain any species needed by NCDMF for ageing to meet ASMFC and Atlantic Coastal Cooperative Statistics Program (ACCSP) targets.
11. Completely characterize each trawl catch to document all Striped Bass associates.
12. Provide a final report of publishable quality for submission to fishery management agencies.

VI. APPROACH

Detailed description of the work that was performed:

Objective 1: Capture, document, tag and release Striped Bass on the NC/VA wintering grounds: Each year, the USFWS and the ECU Principal Investigators (PIs) were responsible for planning, implementing and overseeing the trawl-based Cruises. Arrangements were made in advance of each Cruise to charter vessels capable of towing the capture gear. Scientific Party members were recruited from Cruise partners and other interested agencies, universities, or NGOs. All participants were responsible for arranging their own transportation and covering their own travel costs to/from the ships. Salary costs for all participants during the Cruise were underwritten by their agencies or institutions if that was approved. Watch assignments were six hours -- a 6-12 Watch and a 12-6 Watch -- so each scientist was working a minimum of 12 hours each day, e.g., two six-hour watches, separated by six-hour rest intervals). Watch Chiefs (usually scientists who had extensive prior Cruise experience) were assigned to lead each Watch.

The traditional study area for the Cruises has been the nearshore Atlantic Ocean from Cape Lookout, NC, north to the vicinity of Cape Charles, VA. Historically, most tows took place in state waters (i.e., inside three miles from shore). However, due to the fact that in recent years Striped Bass have remained in Virginia waters, or in the Exclusive Economic Zone (EEZ) off Virginia, tows have also taken place well offshore into the EEZ. In 2016, the Cruise was actually extended further north, into Maryland waters, before significant numbers of Striped Bass were encountered (Figure 1).

Two stern-trawling government research vessels (R/V Cape Hatteras in 2013; R/V Savannah in 2015 and 2016) were chartered to conduct the Striped Bass capture and tagging using a high-opening bottom trawl designed by NMFS (Kendall M. Falana, Fisheries Equipment Specialist, NMFS Southeast Fisheries Science Center, Pascagoula, MS; see Figure 2). The trawl was a 65-foot, 2-seam sampling trawl (see Appendix 1 for detailed specifications). Mesh sizes were 8" in bosom, wings and corners; 4" in the intermediate portions; 2" in the extension; and 3.25" in the cod end. Vessels, Cruise dates and the number of tows successfully completed are in Table 2. Under the conditions of the authorizations provided by the NMFS, Southeast Region, each sampling effort was for no longer than 30 minutes and most often was between 10-20 minutes in duration (Figure 3). The vast majority of the tows were of either 15- or 20-minute duration, with very few tows lasting a full 30 minutes (Figure 3). All of the trawl-based Cruises departed from and returned to the Duke University Marine Laboratory (DUML) dock in Beaufort, NC.

Cruise equipment and supplies were loaded onto the research vessel, once the vessel was docked at DUML. Most gear is stored annually at Edenton National Fish Hatchery in Edenton, NC, and transported from there to Beaufort via rental truck. Other equipment and supplies provided by USFWS and MDDNR-FR partners for use during the Cruise (long measuring boards for Striped Bass and sturgeon, Striped Bass internal anchor tags and Atlantic Sturgeon PIT and t-bar tags) were transported from Annapolis, Maryland, to Beaufort. Nets were stored at the NMFS, Southeast Fishery Science Center Laboratory in Pascagoula, MS, and were transported to the research vessels in their home ports by NMFS staff prior to each Cruise.

Once the Scientific Party was aboard the ship, the ship's crew conducted all required safety drills and reviewed all other shipboard procedures. The Chief Scientist (Dr. Laney for all three years) and Watch Chiefs reviewed the protocols and procedures to be used for processing each catch and removing, processing, tagging, and releasing Striped Bass and/or other species targeted for tagging or otolith removals (see Objectives 7, 9, 10 and 11). Trawl cod ends were usually opened just above the deck, the catch deposited on the deck (in the case of really clean catches, Striped Bass were placed directly into the holding tanks), and all fish and invertebrates captured were sorted to species for further processing (see subsequent following objective discussions for more details). Striped Bass and any Atlantic Sturgeon (or other species targeted for tagging, e.g., Winter Skates) were placed in holding tanks on the deck, which were supplied with ambient flow-through seawater from the ship's pump system. If Striped Bass numbers were large, scientists and deck crew members closely monitored the fish to ensure that they continued moving in the tanks, prior to being removed and processed.

For Striped Bass, all specimens captured were removed from the holding tanks individually. Each fish was measured (TL to the nearest mm). Scales were taken systematically from each fish encountered until each length bracket was filled. Length brackets used were 10-mm increments beginning at 400 mm and running through 1210 mm, and the first five individuals in each interval were sampled, for fish between 400-800 mm. Scales from Striped Bass in increments exceeding 800 mm TL were taken from at least ten individuals. A check-off sheet was provided to track the number of fish sampled in each length interval. Scales were placed in individual scale envelopes with the fish number, date, TL, Tow Number and tag number recorded on the outside of the envelope. Scales were also collected from any previously-tagged fish recaptured during the Cruises. Scales were provided to the NCDMF for ageing (see below for ageing protocol). An approximately 1-cm incision was made with a curved scalpel blade on the left side of each fish tagged. An internal anchor tag (USFWS, Floy internal anchor tag) was then inserted into the fish and twisted to ensure that the plastic internal anchor was correctly oriented inside the abdomen.

Recaptures previously tagged (with the exception of any fish recaptured that had been tagged during the same Cruise) had the tag number recorded along with TL. All recaptures had a scale sample taken. Tag streamers (the external portion of the tag) were left in place. Any tags removed (i.e., if a fish was dead, or severely injured and unlikely to survive) were placed in a labeled scale envelope and kept with the data sheets. Tags recovered other than USFWS internal anchor tags (i.e., American Littoral Society (ALS) yellow dorsal loop tags, or Hudson River Foundation yellow internal anchor tags) were noted on the data sheets. If the tag recovery was the internal anchor only (i.e., the external portion had been previously removed), then the fish was sacrificed, scales sampled, otoliths removed, and tag removed to secure the number. Digestive tracts were also removed and frozen to allow determination and documentation of stomach contents. Any fish sacrificed had gender recorded.

Field data books were provided by MDDNR-FR for each year's Cruise. The data recording method was as follows: Pages were double-sided with identical fields on each side. Each sheet had two sections, a top section for tow-specific information, including tow number and all associated environmental data, and a lower section for biological data. The upper section

contained fields for date, haul number, and associated physical data (air and water surface temperature, start and stop times, duration, start and stop latitude and longitude, tow speed, minimum and maximum depth, and number of nets in each haul). Times were recorded in military format for the beginning of the tow (i.e., net on the bottom fishing) and the end of the tow (beginning of haul-back). Duration was recorded as the amount of time the gear fished, in hour fractions. Locations for start and stop times were recorded in decimal degrees from the ship's readouts. NOAACODE was determined by MDDNR-FR using ARC VIEW as the data were being entered. Maximum and minimum tow speeds were recorded (in knots). Water temperature was recorded in degrees Celsius, to the tenth of a degree, as was air temperature. Salinity was recorded in ppt, also to tenths. The minimum and maximum depths of each haul were recorded, usually in meters. For the 2013-2016 Cruises, the number of nets was always 1, since the ships were rigged for stern trawling.

An individual fish number was assigned to each Striped Bass. If high numbers of fish were captured in a single haul, individual numbers could be assigned after the tow. Each fish was measured for TL. Tag numbers were recorded as full numbers (i.e., all digits) any time there was a change in tag sequence. Scale codes were recorded as "R" if the scales were taken because the fish was one of the first five in the size category, or was greater than or equal to 800 mm in length. A code of "N" was used when scales were taken from a fish because it was a tag recapture not from the present Cruise, or had been sacrificed for any reason. A blank in the scale column indicated that no scales were taken from that fish. The following information was recorded in the "Remarks" column: "RETURN" if the fish was a recapture; "M" or "F" if gender was determined; "D" if the fish was dead upon capture; "Sac" if the fish was sacrificed; "G" if any tissue was taken for genetic analysis; and "PCB" if tissue (fillets) was retained for PCB analysis. Anomalies were recorded if noted. These included the anomaly type, percent coverage, distribution on the fish, and severity. Detailed descriptions of these anomalies were provided in the front of each data book for reference. Multiple (usually three) data books were prepared for each Cruise in the event that individual hauls were so large that more than one tagging team was working, and also to hopefully accommodate large amounts of data for many tagged Striped Bass. In cases where so many Striped Bass were encountered that the holding tank capacity was exceeded, all fish in excess of the tanks' capacity were counted overboard in order to minimize mortality.

The hook-and-line (H&L, or "Hook") Cruises were annually planned, coordinated and conducted by Charlton Godwin of the North Carolina Division of Marine Fisheries. He and ECU personnel contracted for the charter vessels, and Charlton recruited all volunteer anglers for each of the ten trips each year. All trips originated from Rudee Inlet, Virginia. Three charter boat fishing vessels were contracted to serve as platforms for hook-and-line (H&L) tagging during the 2013-2016 winter seasons. Three different vessels were employed in 2013 (F/V Midnight Sun, F/V Poacher, and F/V Smokin' Gun II). The F/V Midnight Sun (50', 800 hp C-15 Caterpillar Marine Diesel) was the best-configured vessel for the tagging work (deck arrangement as well as number of anglers it could comfortably carry) and was chartered for the 2014-2016 H&L work. Vessels, tagging dates, and the numbers of Striped Bass captured and tagged/released each day using hook-and-line gear are in Table 3. Striped Bass were captured by trolling using rods by Penn, Ugly Stick and Raise 'Em Rods, with reels by Penn, Release and Shimano. Two lures with two hooks each comprised the parachute rigs used for trolling, with lures in various colors,

predominantly white or green. Vessel trolling speed was as per normal charter boat operations with a usual spread of six lines. Rods were handled by volunteer anglers (some agency staff, some private citizens) who reeled fish in as expeditiously as possible to avoid unduly tiring the fish. Fish were netted and hoisted aboard the vessel by the mate, removed from the lures and placed in a holding tank. Fish were removed singly and processed as described above for the trawl-captured fish. Scale sampling protocol was the same as for the trawl-captured fish.

As noted above, environmental data (depth, air temperature, surface water temperature, and salinity) were recorded during trawling at the start and end of each tow. Latitude and longitude for starting and ending positions were also recorded on paper bridge logs by a scientist stationed on the bridge, and later entered into Excel with all fish data. The ship's system was also continuously recording environmental parameters during each voyage. The same environmental parameters were recorded on the charter fishing vessels using a YSI proSeries 2020. Scientists recorded DO, pH, conductivity, salinity, temperature and percent saturation at the beginning and end of each H&L set. Latitude and longitude and depth data were recorded from the fishing vessel instruments.

All Atlantic Sturgeon and Striped Bass capture data were provided to MDDNR-FR for entry into an electronic database maintained by that agency. Data for all tows, regardless of whether Striped Bass were captured, included in the MDDNR-FR database.

Objective 2: Characterize the age structure of the Striped Bass stock on the winter grounds: Striped Bass captured by both gear types were subsampled for scales to be used for ageing, as noted above. Table 4 shows the number of Striped Bass that were sampled for scales in each year, by gear type. An age-length key was developed for each year from the aged subsample, and ages derived from the scales were then applied to the entire sample of Striped Bass tagged and released each year, based on the age-length relationship.

The protocol for reading Striped Bass scales collected during the Cruises is presented here with minor editing and somewhat summarized from NC Wildlife Resources Commission and NC Division of Marine Fisheries (2012). Striped Bass scales were removed from the left side of the fish in a region above the lateral line and below the gap of the spiny and soft dorsal fins. Scales from each individual fish were placed in a labeled scale envelope with collection information recorded as specified for the Cruise protocol. Each scale envelope was allowed to air dry prior to pressing. Between four and six non-regenerated scales of uniform size and with even margins were selected from each scale envelope and prepared for pressing. While most scales did not need to be cleaned prior to pressing, scales with dried blood or dried slime were cleaned with a toothbrush and soapy water. Selected scales were pressed into acetate clear film (040 x 5 x 6 AA) with a Carver 'Model C' electrically heated laboratory press. To maximize scale pressing efficiency, scale envelopes were sorted by fish length so that the scales were of uniform size. Acetate scale impressions were returned to the original scale envelope or placed in a new envelope stapled to the original scale envelope prior to the age determination process. Regenerated scales were excluded from further analysis.

Once pressed on acetate slides, scale impressions were examined on a microfiche projector by a primary and secondary reader to estimate Striped Bass age. Readers were prohibited from any

knowledge of the information associated with the scale collections, except for collection date (Merriman 1941; Hattala and Kahnle 1991) and scale envelope number. Given the above scale sorting process for pressing (i.e., by fish length for pressing efficiency), readers were to read scale impressions in a similar order (e.g., small to large, C. Godwin, NCDMF, personal communication).

Readers were allowed to use multiple magnifications to view primary components of the acetate scale impressions to assign age. Measurements (mm x magnification) were obtained with rulers, micrometers, sonic digitizers or digital microfiche readers; yet final measurements were based on the actual distance on the scale surface for consistency and repeatability with any of the measurement options. For example, a distance of 45 mm measured at 24X magnification would equate to a distance of 1.9 mm across the surface of the scale, whereas the same distance (1.9 mm) would be measured at 68 mm at 36X magnification.

At a minimum, scale readers recorded measurements from the focus center to the first and second annulus. In addition, these measurements were recorded from a single scale with defined attributes that best represented the scale set. This specific scale impression was marked by the primary reader, so the second reader could measure and interpret the same scale impression. For example, if the primary reader placed a small dot above or below the scale impression with a fine tip marker; the second reader would record measurements from the same scale impression.

Annuli were counted to estimate age and assign a year-class. Annuli are considered a strong interruption in anterior growth with equal intensity across the entire width of the scale with circuli disruption and cutting over along the sides and lateral posterior corners (Hattala and Kahnle 1991; Liao et al. 2009). In some instances, circuli may also be broken around the lateral anterior corners and exhibit new radii.

To be counted, annuli must be followed completely around the scale, especially along the baseline (Hill 1991). Early and Bradford (1989) provided criteria for classifying annuli on the scales of Striped Bass collected in Maryland and these criteria should be referenced when interpreting Striped Bass scales for defining annuli and assigning ages from North Carolina. Additional details regarding classification of annuli and how to interpret them are provided in NCWRC and NCDMF (2012).

To improve annulus interpretation among readers, readers measured the distance from focus to first annulus and focus to second annulus for later comparison among readers. Primary readers might request additional focus-to-annulus measurements as necessary for better comparison. Readers were urged to keep in mind that distances for annuli three through six appear to be smaller with each annulus, as summer growth generally decreases proportionally.

For ages greater than 6, annuli tend to become crowded near the outer margins of the scale. This crowding may influence edge interpretation. At this point, readers may focus on the anterior margins for straightening of the circuli (Liao et al. 2009).

An archive of measured distances may be beneficial for expert readers and new trainees alike. Results from a scale ageing workshop in December 2011 suggest measured distances from focus

to first and second annuli on Striped Bass scales may not be applicable to all Striped Bass collected in coastal North Carolina.

By convention, fish collected from waters in the northern hemisphere are assigned a January 1 hatch date (DeVries and Frie 1996). True annulus formation is generally assumed to occur when growth slows or ceases during winter months, although annuli on Striped Bass scales are typically visible in late spring (Merriman 1941) and are generally viewed on Striped Bass scales collected between April and May in the Albemarle Sound and Roanoke River (Trent and Hassler 1968; Humphreys and Kornegay 1985). Yet, Striped Bass scales collected in North Carolina between January 1 and June 30 may not always exhibit the most recent annulus so the scale edge has been counted in addition to the observed annuli on the scale to assign the age based on correct year-class (Godwin and West 2009). For Striped Bass collected between July 1 and December 31, readers should count and record the number of observed annuli, as annulus formation is assumed complete by June 30. Still, scale readers should be careful when reading striped bass scales collected during the spring, especially in April and May. With annulus formation likely occurring during this period, correct interpretation is imperative as an annulus may or may not be present on the scale edge. For example, an automatic addition of an annulus may overestimate the scale age and inaccurately assign age and year class. Scale edge assessment of fish scales is often subjective and can be difficult to visually quantify as measurements may be miniscule. A preferred option to assess scale edge is to utilize a relative scale based on the relative distance between the last annulus observed and the scale edge. If an annulus was present on the scale margin edge with no discernible growth, readers recorded a ‘0’. If there was a discernible amount of growth, yet the reader would not anticipate annulus formation, readers recorded a ‘1’. If annulus formation appeared imminent, but no annulus was observed, then readers recorded a ‘3’. Readers assessed the sampling date, number of observed annuli and the relative assessment of the scale edge to assign age.

Ageing precision is a measurement of the reproducibility of repeated measurements on a given structure for ageing. Precision should not be confused with accuracy, which reflects how close an age estimate is to the true age. Accuracy can only be assessed through an appropriate validation study; precision should not be used as a proxy for accuracy and vice versa. A minimum of two independent reads of a subsample for age analysis is required to estimate precision. A primary reader for each respective waterbody was designated. The second reader was chosen randomly from the group of primary readers annually.

The primary reader read the entire age sample (subsample of all collected structures) and, at a minimum, randomly selected 20% of the subsample from each stratum for the second reader (Kimura and Lyons 1991). In other words, 20% of the samples in each length group were randomly selected by the primary reader and then read by the second reader. As an example, for length bins with 15 scale sets available, the second reader would read 3 sets from each bin group.

Readers should have no knowledge of the fish length during the initial reads and the second reader should have no knowledge of the first reader age estimates with the exception that fish will be sorted from the earlier scale pressing process. Independent reads were compared by the primary reader to identify any discrepancies among the readers. Discrepancies were resolved by the respective readers or, if agreement could not be reached, they were eliminated from age

analysis. Options to reach a consensus for any discrepancies in independent initial reads include: 1) rereading the structures independently, 2) both readers jointly reading the structure, 3) comparison of measurements from focus to annulus and scale edge assessments or any combination with efforts to reach consensus. Incorporation of available biological information (e.g., length or sex) may be conducted during this resolution process.

Ageing precision was calculated annually. Average percent agreement (APE; Beamish and Fournier 1981), percent agreement and coefficient of variation (CV) were calculated and recorded for the consensus age determination. Primary readers were encouraged to use the National Marine Fisheries Service ageing precision template (NOAA 2011) to evaluate age estimates and document results for reporting purposes. Primary readers could request the entire age subsample be read by the second reader should analysis reveal any concerns with the scale ageing process.

With regard to accuracy, age analysis of scales from recaptured tagged Striped Bass may allow for comparison and evaluation of annulus formation in scales of Striped Bass, particularly from internal anchor tagged phase-II stocked striped bass (known-age) or from individuals at large for a minimum of 1 year. For recaptured fish, scale samples should be collected and compared to previous data and available scale sets (Winslow 2010).

Objective 3: Estimate fishing mortality (F) of the coastal migratory Striped Bass stock: Striped Bass recaptures of fish tagged and released during the Cruises were reported by researchers and commercial and recreational fishermen to the U.S. Fish and Wildlife Service, Maryland Fish and Wildlife Conservation Office, Annapolis, Maryland, via a toll-free telephone number. A central database designed and managed by the U.S. Fish and Wildlife Service stores coast wide tagging information and fishery-dependent and independent survey and monitoring data (USFWS 2000) from the Cruises and multiple other Striped Bass tagging programs conducted by ASMFC member jurisdictions.

Dr. Stuart Welsh (Assistant Leader-Fisheries, West Virginia University Cooperative Fish and Wildlife Research Unit, USGS) of the ASMFC Striped Bass Tagging Subcommittee analyzed the recapture data to estimate total (Z) and fishing (F) mortality. Stuart followed the ASMFC approach for Seber model analysis with Program MARK which is described in Striped Bass Stock Assessment Subcommittee and Striped Bass Tagging Subcommittee (2011). The report is available at:

http://www.asmfc.org/uploads/file/2011StripedBassAssmtUpdate.pdf

The model structure is explained on page 32, with the exception that the fifth regulatory period goes from 2003 to 2014. The ASMFC approach for instantaneous rates (IRCR) was followed as described in a 2013 report (NE Fisheries Science Center 2013):

http://www.asmfc.org/uploads/file/529e5ca12013StripedBassBenchmarkStockAssessment_57SAWReport.pdf

The model structure is explained on pages 658-659, with exception that the sixth regulatory period goes from 2007 to 2014. For analysis of these data presented herein, the model for the regulatory period was extended through 2016.

Dr. Welsh also provided the Z estimates, just to emphasize that Z estimates from MARK and IRCR are similar, but the F estimates diverge owing in part to the differences in M. We use a constant 0.15 M for MARK and the IRCR estimates M. The M estimates from IRCR after year 1999 get relatively large, possibly associated with the mycobacteriosis issue (for a good recent discussion of the impact of mycobacteriosis on Striped Bass mortality, see Hoenig et al. 2017).

Finally, the estimates from trawl-tagged, versus H&L-tagged, fish were compared to assess any differences. Results from all of the analysis are included in Section VII of the report under Objective 3.

Objective 4: Map the distribution of Striped Bass and associated species during the winter study period: Capture locations of Striped Bass were mapped by USFWS staff (B. Van Druten) from Alligator River National Wildlife Refuge. Associated species capture locations were mapped by ECU graduate student J. Osborne using ArcGIS 10.1 ArcMap to depict species distributions within the study area and the environmental conditions (i.e., bottom type, organic content, grain size) associated with locations of capture. Plotted map locations used the geo-coordinates from the end of each tow as an approximate capture location. Detailed methodology for each of the maps produced by Van Druten is provided below.

North Carolina Cruise Data: Tow Stop Locations for Trawl Tows- 2013-2016: Van Druten used the data provided by B.Versak in Microsoft Excel. Location data were converted from degrees decimal minutes to decimal degrees so ArcMap could interpret the data and use them to create a shapefile. The file was opened in ArcMap 10.3.1 by Adding XY data. The data were then exported as a shapefile and assigned a projection of WGS 84 since they were GPS data. ESRI Base Maps were used as the backdrop in the map and also used to find any points that seemed anomalous (over land, way offshore, etc.). Four apparently erroneous points were observed, and Van Druten consulted with Versak on suggested edits. Checking the ship logs confirmed there were errors and that the four points needed correction. Tow Stop Locations were used to show capture sites based on information from PIs. A query was performed to just show the trawl locations (vs having the hook and line data show as well, since they were in the same file). We verified that each point was easily differentiated from another so readers could do the same. Unique symbology was used for gear type and year (Figure 4).

North Carolina Cruise Data: Tow Stop Locations for Hook & Line - 2013-2016: Van Druten again used the Cruise field data provided by B. Versak in Microsoft Excel. Location data were again converted from degrees decimal minutes to decimal degrees so ArcMap could interpret the data and use them to create a shapefile. That file was opened in ArcMap 10.3.1 by Adding XY data. It was further exported as a shapefile and assigned a projection of WGS 84 since it consisted of GPS data. ESRI Base Maps were used as the backdrop in the map and also used to again find any points that seemed anomalous (over land, way offshore, etc.). The decision was made to use the Stop Locations to show fishing (trolling) locations based on information from the PIs and co-authors. A query was performed to just show the hook and

line trolling locations (versus having the trawl data show). Van Druten made sure that each point was easily differentiated from another so readers could do the same. Unique symbology was used for gear type and year (Figure 5).

North Carolina Cruise Data: Tow Stop Locations by Method - 2013-2016: The same procedure as described above was used to produce this map (Figure 6).

North Carolina Cruise Data: Tow Stop Locations by Species - 2013-2016: The same basic procedure was followed in developing this map (Figure 7). In addition, Van Druten used unique symbology to show No Catch (of either Striped Bass or Atlantic Sturgeon in a given tow), Striped Bass, and Atlantic Sturgeon catches based on the data found in the data table originally provided in Excel (and used to make the shapefile).

Mapping Environmental Conditions Associated with Capture of Striped Bass, Atlantic Sturgeon and Associated Species: Jillian Osborne analyzed the distributions of key finfish species collected by the CWTC using ArcGIS. Details of the much larger 1988-2013 Cooperative Winter Tagging Cruise analysis are reported in Osborne (In preparation). Briefly, the 'Oceans' basemap from ESRI ArcGIS® 10.1was used as the base layer. The WGS_1984_Web_Mercator_Auxiliary_ Sphere projected coordinate system is the default projection of this layer. The coordinate notations for all subsequently added layers were converted to, or layer projection transformed into WGS_1984_Web_Mercator_Auxiliary_ Sphere. After the Cruise tows were plotted, an analysis mask was created by drawing a polygon along the shoreline of the basemap from North of the northernmost Cruise tow to South of the southernmost Cruise tow, and extending to the first continental shelf break denoted on the basemap. The polygon graphic was then converted to a shapefile for use as the analysis mask and to delineate the study area for the project. The *alt_ext* shapefile is an extracted dataset from the 'usSEABED Atlantic Data' files, pertaining to the entire United States East Coast and containing data on sediment type and grain size, water depth, and percent organic carbon (USGS 2005). Osborne downloaded this shapefile from the United States Geological Survey (USGS) website's public data catalog and imported it into the dataframe, expressed as a vector point layer. The shapefile was then intersected with the analysis mask and copied into the dataframe to produce individual layers for each of the habitat parameters of water depth (m), sediment type (Shepard Code), sediment grain size (in phi units), and percent organic carbon (%orgC). Spatial interpolation was then used to produce prediction models, allowing the assignation of habitat parameters to CWTC tows within the study area. The diagnostic statistics of the root mean square (RMS) error and standardized root mean square (RMS-S) error of cross-validations of interpolation models were examined for of all the spatial interpolations conducted, and compared with the predicted, error, standardized error, and normal QQ plot distributions produced by the interpolation methods to choose the best fitting model.

Four maps were produced. The <u>water depth layer</u> (Figure 8, top) was created as a prediction map through local polynomial interpolation, after 'no data' values were removed from the attribute table. A stand-alone table was exported into the dataframe, and a new point vector layer was created following the same methods from the Cruise layer creation. The model parameters for the local polynomial interpolation included a first order polynomial with an exponential kernel function; advanced parameters were not enabled. Prediction errors resulted in an RMS of 71.81

and an RMS-S of 0.956 (n=917), and the average standard error was 76.69. The prediction map was exported into a geostatistical layer with filled contour type, then intersected with the analysis mask. Once restricted to the analysis mask, the maximum predicted depth ranged from 9 to 2000 meters within the study area. This predicted depth range includes portions of the study area located within the analysis mask that are beyond the continental shelf margin, in the transition zone into ocean depths. The sediment type layer (Figure 8, bottom), denoted by the categorical parameter of Shepard Code, was mapped by creating Theissen polygons from the Shepard Code, dissolving the boundaries between like categories, and then intersecting the resulting layer with the analysis mask. Within the study area, 11 distinct sediment types were identified. Polygons that represented locales with no available data to match the spatial interpolation parameters were included in the Shepard Code category of 'Other' for bottom type. Sediment types included the following Shepard Codes: clayey sand; clayey silt; gravel; gravelly sediment; sand; sand silt clay; sandy silt; sediment; silt; silty clay; and silty sand. The sediment grain size layer (Figure 9, top) was created as a prediction map through local polynomial interpolation, after 'no data' values were removed from the attribute table. A new standalone table was exported into the dataframe, and a new point vector layer was created using the same methods as for creating the Cruise data layers. The model parameters for the local polynomial interpolation included a first order polynomial with an exponential kernel function; advanced parameters were not enabled. Goodness of fit was 1.37 (RMS), based on cross-validation results (n= 709). Prediction errors resulted in an RMS-S of 0.987, and the average standard error was 1.40. The prediction map was exported into a geostatistical layer with filled contour type, then intersected with the analysis mask. Once restricted to the analysis mask, the minimum predicted grain size ranged from -0.155 to 6.197 phi. Grain sizes were defined by bins (Figure 9, top). Bin 1was excluded because no fish were captured in that range. The percent organic carbon (%orgC) layer (Figure 9, bottom) was also created as a prediction map through local polynomial interpolation, after 'no data' values were removed from the attribute table. A new standalone table was exported into the dataframe, and a new point vector layer was created using the same methods as for creating the Cruise data layers and the sediment grain size layer. The model parameters for the local polynomial interpolation included a first order polynomial with an exponential kernel function; advanced functions were not enabled. Goodness of fit for this model was 1.22 (RMS), based on cross-validation results (n= 278). Prediction errors resulted in an RMS-S of 0.802, and average standard error was 1.58. The prediction map was exported into a geostatistical layer with filled contour type, then intersected with the analysis mask. Once restricted to the analysis mask, the minimum predicted sediment organic carbon content ranged from 0 to 2.54%. Percent organic carbon of the sediment was defined by bins (Figure 9, bottom). All layers created were spatially joined with the point shapefiles of the Cruise tows to allow each individual tow to be assigned an additional water depth along with sediment type, sediment grain size, and sediment percent organic carbon. Parameters for the spatial joins of habitat layers to Cruise tow layers were intersecting one-to-one joins, keeping all target features, and with a search radius of one-half (0.5) of a mile.

Spatial trends across years – Spatial trends for taxa of interest were assessed by identifying the central latitude of the distribution of captured individuals for that year. Tows that had recorded catches for the taxa were selected from all tows from each Cruise year and exported into new tables. The minimum, maximum, mean, and median latitudes and longitudes, along with standard deviation, total number of fish captured, and the number of tows containing fish of each

taxa were calculated for each year. The median latitudes, by year, were mapped as the central latitude of distribution for each taxon. The range of latitudes for each taxon was used to delineate the North-South span of the distribution observed each year by mapping the latitudinal median, as a line segment the length of the latitudinal range, along the longitudinal plane. Shapiro-Wilk's test for normality was applied to the calculated coordinates, with $\alpha = 0.05$. H_0 for the Shapiro-Wilk test was that the median latitude follows a normal distribution. Grubbs test was used to identify outliers for each taxon and species group, with $\alpha = 0.05$. H_0 for the Grubbs test was that there were no outliers in the data. P values and Z-scores were used to determine rejection of the null hypothesis. Linear regressions were performed on the median coordinates for all taxa examined, and included the 95% confidence intervals.

Taxa Co-occurrence – Although taxa co-occurring with Striped Bass is covered under Objective 11, it makes sense to address the methods of the analyses in conjunction with map construction as detailed above. Co-occurrence of the different taxa within habitat types was assessed by querying the data within the attribute table (defined above) to identify tows where taxa occurred within the same tow. Queries were designed using the 'COUNTIFS' function within Microsoft® Excel, and results were transferred into matrices, for each year, enumerating the number of tows for each taxa where an instance of co-occurrence was recorded.

Objective 5: Map the movements and migration of Striped Bass using recapture data: Individual Striped Bass recaptures were also mapped by USFWS staff from Alligator River National Wildlife Refuge. Recaptures by month were mapped by USFWS staff from the Maryland Fish and Wildlife Conservation Office (Josh Newhard) in order to show seasonal patterns. The following text provides a detailed explanation of how the data provided by anglers or commercial fishermen for reporting recaptures were used to construct the map depicting their locations.

North Carolina Cooperative Tagging Program Recaptures Tagged From 2013-2016: The map was developed to depict the recapture location of Striped Bass tagged off Virginia and North Carolina as part of the Atlantic Migratory Striped Bass Coastwide Tagging Program while the fish are present on their wintering grounds. Traditionally, there is a base point for each NOAA code used to depict the tag return location when mapping recaptures. For the map provided in this report (see Findings, Section VII) we used the Recapture Site description and the Region description from each tag return in the database for recaptures from the Cruises to search in Google Earth or on the Internet for the best representation of the actual location where the Striped Bass was recaptured. Points were not laid directly over each other, even when the recapture site was listed as the same location, so that all recaptures would show on the map. The big difference between this approach and prior recapture mapping methods is that by using the Recapture Site and Region description, the map depicts recaptures in some of the harbors and rivers in the Northeastern United States (i.e., shows a finer resolution for recapture sites). For instance, a return for the Hudson River displayed using the associated NOAA code would put it at the mouth of the river, but if we had the description to say "Hudson River near Catskill, NY", that could be used to better display where the fish was actually recaptured. At times Google was used to search the internet when locations could not be found in Google Earth, especially if there was a fishing spot listed in the Recapture Site. The best interpretation of the Recapture Site description was used and although it may not be the exact spot where the fish was caught, it does

paint a better picture of the general area of recapture versus the NOAA code as previously described.

Objective 6: If possible employ acoustic tags in a subset of tagged Striped Bass to assess catch/release mortality of trawl-caught versus hook-and-line caught fish: Grant funds were secured from the University of North Carolina Sea Grant Program for purchasing acoustic tags for implantation into Striped Bass captured off NC. Unfortunately, no Striped Bass were captured in NC waters during any of the three years in which trawling was conducted, or in the four years in which H&L tagging was conducted. Therefore no acoustic transmitters were implanted in Striped Bass and this objective was not accomplished.

Objective 7: Capture, document, tag and release any Atlantic Sturgeon encountered during the Cruise: All Atlantic Sturgeon captured during the 2013, 2015 and 2016 Cruises were removed from the net, measured (FL and TL), and scanned for PIT tags. Individuals captured during 2013 and 2016 were not tagged since there was no scientist on board with proper NMFS authorization to tag any Atlantic Sturgeon captured offshore. The Atlantic Sturgeon captured during 2015 were tagged and released using conventional t-bar tags, and PIT tags (Eyler et al. 2004). All sturgeon were scanned using an AVID Power Tracker II or Biomark FST2001FT PIT tag reader. If no tag was present, and authorization was granted (2015 only), a 16-mm Biomark PIT tag (Model IMI 1000, 400 kHz) was inserted on the left side of the fish at the base of the dorsal fin. A tissue sample was taken from the caudal fin and placed in 95% ethanol for future genetic analysis. Tissues samples were provided to the USGS, Leetown Science Center, Leetown, West Virginia, where the NMFS Sturgeon Tissue Repository had been transferred from Charleston, SC, to Dr. Tim King and colleagues. A USFWS plastic t-bar tag was inserted on the left side of the fish at the base of the dorsal fin. Data for all Atlantic Sturgeon captured are provided below in Section VII, Findings, under Objective 7.

Objective 8: Tag Atlantic sturgeon over 800 mm TL with acoustic tags: Our plan was to secure a scientist with the proper NMFS authorizations to participate as a member of the Scientific Party and implant acoustic tags in appropriately-sized Atlantic Sturgeon. Unfortunately, none of the scientists who had authorizations for acoustically-tagging Atlantic Sturgeon in inshore waters were authorized to tag them offshore. Therefore this objective was not accomplished.

Objective 9: Document all alosine species encountered (Alewife, American Shad, Blueback Herring and Hickory Shad): Once each trawl catch was placed on the deck, the catch was sorted by species, and all alosines in trawl samples were identified. No alosines were captured in 2014 because only the hook-and-line study was conducted, and the gear used was ineffective for alosine capture. Samples of each alosine species collected were retained, bagged, labeled and frozen in the ship's freezers for transport back to East Carolina University for additional study. In most cases all fish from a given tow were retained. All total lengths (TL, mm) were measured, but fork length (FL, mm) was inconsistently recorded.

Objective 10: Document and retain any species needed by NCDMF for ageing to meet ASMFC and Atlantic Coastal Cooperative Statistics Program (ACCSP) targets: Any species for which the NCDMF needed specimens for meeting agency, ASMFC and/or Atlantic Coastal Cooperative Statistics Program otolith collection targets was counted, measured and then either

processed on deck (with otoliths removed and placed in labeled scale envelopes) or bagged and frozen for later processing in the NCDMF ageing laboratory in Morehead City, NC. Species which were targeted for retention included: Atlantic Croaker, kingfishes (Northern Kingfish, Southern Kingfish, Gulf Kingfish), Red Drum, Sheepshead, Southern Flounder, Spot, Spotted Seatrout, Summer Flounder and Weakfish. Not all species were present in the trawls, so not all were successfully sampled during the Cruises.

Objective 11: Completely characterize each trawl catch to document all Striped Bass associates: All trawl catches were documented to the extent possible, regardless of whether Striped Bass were present in the catch. After any Atlantic Sturgeon and Striped Bass were removed from the catch and secured in the holding tanks, the rest of the catch was sorted by species or species group into individual containers (plastic bushel fish baskets, plastic fish totes, or small plastic buckets) and held for processing until all Atlantic Sturgeon and Striped Bass had been processed and released as above-described under Objectives 1 and 7. All species, including invertebrates, were counted. All fish were measured to the nearest millimeter. If there were less than 30 individuals of a given species, all were measured. If there were over 30 individuals, then 30 randomly-selected individuals, with attention to try to include the largest and smallest individuals, were selected and measured. The remainder was counted. All elasmobranchs were counted, measured and gender of each recorded. All sharks were measured for both FL and TL. Wing width (disc width or wing span) of all skate species was measured to the nearest mm.

All Horseshoe Crabs were measured at the widest point of the prosoma. Mature Horseshoe Crabs (as determined by examination of the first set of claws, and the genital pore; see Shuster et al. 2004; Silva 2011) were tagged as part of the ASMFC/USFWS Coastwide Horseshoe Crab Tagging Program (Smith et al. 2006). All juvenile Horseshoe Crabs were counted, measured and released. Adult males and females were tagged with standard button tags. Tags were 4.4 cm in diameter, bore a unique tag number and carried instructions on the tag for reporting a captured tag. Tags were attached to the posterior (rear) point of the prosoma (first section of the body). A small hole (5/32-inch) was drilled through the prosoma near the dorsal edge, after any epibionts (barnacles, etc.) were cleaned from the attachment site. The plastic rivet in the center of the tag was attached by pushing into the hole as far as it would go. Tag number, gender, prosomal width in mm, date tagged, and collection location were all recorded on separate Horseshoe Crab data sheets as well as in the Cruise data books. Further details on tags and tagging methods are described in Brousseau et al. (2004).

In addition to the documentation of all species captured, ancillary projects requested by partners or other collaborators were conducted during each year as time permitted. These included the following described additional projects. In 2013, fish specimens and tissue were collected for the North Carolina State Museum of Natural Sciences (NCSM; points of contact for fishes, Dr. Wayne Starnes, and Ms. Gabriela Hogue). Winter Skates were tagged (150 tags were provided; contact, Dr. Michael G. “Mike” Frisk, Stony Brook University, School of Marine and Atmospheric Sciences; see Frisk et al. 2010 for background). We continued to tag mature adult Horseshoe Crabs (contact, Dr. Sheila Eyler, USFWS, Maryland Fishery Resources Office, Annapolis) as part of the ASMFC/USFWS coastwide tagging program for that species. We continued to collaborate with NCDMF to retain specimens for ageing (this year: Atlantic Croaker, Gulf Flounder, Gulf Kingfish, Northern Kingfish, Southern Flounder, Southern

Kingfish, Spot, Summer Flounder, and Weakfish); and we engaged in collaboration with Dr. Erik Palkovac of Stanford University, and Dr. Tom Schultz of Duke University, to provide them with tissue from river herring (Alewife and Blueback Herring) for genetic analysis of the stocks along the US east coast.

In 2015 and 2016, we collected and documented gravid female Atlantic Menhaden in collaboration with the Beaufort Laboratory, Southeast Fishery Science Center, NMFS (contact, Dr. Amy Schueller); collected Spiny Dogfish stomach contents using gastric lavage in collaboration with ECU (contact, Dr. Chuck Bangley); tagged Sandbar Sharks with acoustic transmitters (contact, Dr. Chuck Bangley), and again collected fish and invertebrate specimens and tissues as vouchers and for use in genetic analysis for the NCSM (contacts for fishes, Dr. Alex Dornburg and Ms. Gabriela Hogue; contact for decapod crustaceans, Dr. Bronwyn Williams; contact for mollusks, Dr. Arthur Bogan).

The Winter Skates were tagged using Floy t-bar tags inserted into the dorsal musculature along the spine on the right side above the tail. Only skates over 60 cm (600 mm) TL were tagged. Dr. Frisk provided 150 tags and all but two (broken) were deployed.

The Atlantic Menhaden target for examination in both 2015 and 2016 was 500 specimens. We were to process 25 female menhaden from each 1-cm length bin between 15 cm FL to 35 cm FL. A tally sheet was provided to keep track of the numbers sampled. Only gravid female menhaden $\geq$ 15 cm FL were to be retained. An incision was made with scissors from the vent forward to verify the sex of each specimen. Any males inadvertently retained were to be discarded. Gravid females in January should possess rotund, orange-to-yellow ovaries which occupied a major portion of the body cavity with individual ova readily visible through the ovarian membrane. Females with undeveloped ovaries (i.e., ovaries that were thin) were to be discarded. Each female which met the criteria for retention was measured (FL, mm) and weighed (g). A scale patch of about 20-25 scales was removed from the left flank, about mid-body below the insertion of the dorsal fin, and placed in a scale envelope, which was labeled with the station number and specimen number. The paired ovaries were placed in plastic, 6-oz. jars and covered with buffered formalin. Labels with the station and specimen number were placed in each jar, and the same numbers written on the lid of each jar. Samples were provided to the NMFS Beaufort Laboratory upon return to Beaufort.

Diet samples from Spiny Dogfish were collected by gastric lavage during the 2015 and 2016 Cruises. No more than 10 individuals of each sex from an individual tow were sampled for stomach contents. Stomach content collection was accomplished in 2006-2007 and 2010 by removing whole stomachs; pulsed gastric lavage (Bangley et al. 2013) was used during 2015-2016 cruises. Stomach contents were preserved in 10 % buffered formalin for transport to the laboratory. Total length (mm) and sex were recorded for all sampled Spiny Dogfish.

Sandbar Sharks captured were implanted with acoustic transmitters. Three juvenile Sandbar Sharks (*Carcharhinus plumbeus*) were tagged with Vemco V9 or V16 69 kHz acoustic transmitters during the 2015 cruise. Two individuals were tagged with V9 transmitters carrying temperature and depth sensors, and one was fitted with a standard V16 transmitter. Tagging procedures were similar to those developed by Heupel and Heuter (2001). During surgery, the

shark was placed in a state of tonic immobility by resting it on its back on a foam operating bed. A seawater hose was placed in the shark's mouth to maintain water flow over the gills during tagging. The incision site was chosen at a location on the ventral side of the shark approximately 1/3 of the distance from the pelvic fins to the pectoral fins, and the area surrounding the site was anesthetized using a 0.2-mL injection block of lidocaine. A 2-3 cm incision was made into the body cavity of the shark and a sterilized acoustic transmitter carrying temperature and depth sensors was inserted through the incision. The incision was then closed using an interrupted suture pattern.

The acoustic transmitters carried by the tagged sharks transmitted a unique ID number, the current depth of the sensor (m), and the current temperature (°C) every 60 seconds at a 69 kHz frequency. These acoustic signals were detected and recorded on Vemco VR2W 69 kHz acoustic receivers. Acoustic detections data were collected by receivers deployed as part of the Atlantic Cooperative Telemetry (ACT) Network Brown (2012).

The protocol for NCSM specimens entailed preservation of the entire specimen collected and separate preservation of a small portion of tissue for genetic analysis and archiving. In 2013, small individuals were selected and the left pelvic fin removed and placed in a vial of ethyl alcohol (ETOH). The specimen was then labeled with a NCSM tag and preserved in formalin. During 2015 and 2016, very small specimens were to be placed entire in a small vial of ETOH with a label including tow number and date. Separate data sheets were maintained for the NCSM specimens. For larger specimens, a 1-cm square of tissue was removed from the caudal fin, and placed in very small vials in a separate plastic box. Vials were numbered with the tow number, and a NCSM tag, also with the tow number, was sewn onto the fish. Data sheets were completed for each specimen. Very large specimens were photographed, and caudal fin tissue was collected and placed in little vials. The vials were numbered, again with the tow number, and digital photographs were provided to Ms. Hogue. The target species for the NCSM Ichthyology Collection during 2016 were: Lionfish (*Pterias* spp.), Oyster Toadfish (*Opsanus tau*), triggerfish (any species of *Balistes* spp., *Canthidermis* spp., or *Xanthichthys ringens*), any shark species (except Smooth Dogfish or Spiny Dogfish), any skate, or any stingray species.

Non-molluscan invertebrates collected for NCSM (crabs, mantis shrimps, all other shrimps, echinoderms including brittle stars, starfishes, heart urchins, keyhole urchins, sand dollars, sea urchins and sea cucumbers) were placed whole into glass jars of ETOH. The target was 5-10 specimens of each species. Labels with date and tow number associated with each specimen were placed in the jars. All specimens saved were recorded in the Cruise data books.

In addition, we partnered with Dr. Rob Aguilar, of the Smithsonian Environmental Research Center (SERC), to collect fish species they needed for their genetic tissue collection. We were asked to seek the following species: Bighead Searobin (*Prionotus tribulus*); Blackwing Searobin (*Prionotus rubio*); Southern Stargazer (*Astroscopus y-graecum*); Northern Stargazer (*Astroscopus guttatus*); and on the off chance Longnose Batfish (*Ogcocephalus corniger*). We were requested to collect a few (no more than 5) individuals of any of these species. The protocol was to provide them frozen with associated capture info (date, location, and gear). The smaller the better (takes up less jar space), but SERC indicated they would take what we could get. Their purpose was to quickly fill in some gaps before publishing a big Atlantic-wide fish barcoding paper in early spring, 2016.

Standard NMFS protocols were also provided for handling sea turtles, and marine mammals, should any be captured by the gear. None were captured during any of the Cruises.

Taxa Co-occurrence -- Taxa co-occurring with Striped Bass were also addressed under Objective 4 methods. Co-occurrence of the different taxa within habitat types was assessed by querying the data within the attribute table (as defined under Objective 4 methods) to identify tows where taxa occurred within the same tow. Queries were designed using the 'COUNTIFS' function within Microsoft® Excel, and results were transferred into matrices, for each year, enumerating the number of tows for each taxa where an instance of co-occurrence was recorded.

Objective 12: Provide a final report of publishable quality for submission to fishery management agencies: The PIs, co-authors and additional collaborators prepared materials for the final report by analyzing all available data, and preparing text, tables, figures and appendices. B. Versak was responsible for data transcription, quality assurance and quality control for all Striped Bass and Atlantic Sturgeon data entered into the MDDNR-FR database maintained in Annapolis. J. Newhard was responsible for receiving all tag return reports and entering them into the USFWS database maintained in the USFWS Maryland Fish and Wildlife Conservation Office. He and B. Van Druten did all of the Striped Bass and Atlantic Sturgeon distribution (i.e., capture) and recapture (for Striped Bass only) mapping. J.H. Osborne did the mapping for all other species. She also constructed a database of the entire Cruise time series (1988-2016) and analyzed the association of 10 selected species with measured environmental variables. C. Godwin provided all of the H&L-derived data, constructed the age-length keys for Striped Bass for each year, provided the scale-age data, and used the age-length keys to estimate ages for the entire Striped Bass catch each year. R. Rulifson constructed the associated species figures and tables, and conducted analyses for those species. W. Laney did much of the final report text assembly, doing some original writing but also using text provided by co-authors and text from the previous interim reports, or other Cruise documents. Laney assembled the LITERATURE CITED and appendices.

Project management: List individuals and/or organizations actually performing the work and how it was done: Successful implementation of the trawling and H&L Cruises could not happen without the support of a very large number of individuals from multiple agencies and institutions, including universities and NGOs, and especially not without the highly-skilled and competent Captains and crews of both fishing and research vessels. A supplemental appreciation for everyone involved is provided in the ACKNOWLEDGEMENTS section, but we provide lists here of those who were directly involved in scheduling the research vessels, providing logistical and administrative support, and gathering the data on the research vessels and the fishing vessels. They accomplished the work by directly participating in data collection, data entry, and data management and analysis. In addition, we offer our appreciation to those citizen volunteer fishers, without which we could not have accomplished the charter boat hook and line tagging effort for adult Striped Bass.

Citizen Volunteer Fishers for the Hook and Line Tagging Program:
Alan Mizelle, Albert Spells, Amy Batdorf, Amy Larimer, Anthony Overton, Benjamin Smith, Bernie McCants, Beth Egbert, Beth Versak, Brian Van Druten, Bryan Pearson, Buck Perry, Carson Miller, Casey Knight, Charlie Roy, Charlton Godwin, Chris Smith, Christina Conover, Cindy Williams, Clay Caroon, Coley Hughes, Corrin Flora, Daniel Meads, Daniel Zurlo, Dewayne Fox, Dorothy Godwin, Doug Faircloth, Ed Greene, Elizabeth Barnard, Eric Diadorrio, Eric Lehm, Ervin Simmons, Evan Knight, George Perry, Greg Lynch, Heather Corbett, Holly White, Hunter Kailps, Jacob Boyd, Jake Rennert, Jason Rock, Jeff Dobbs, Jeff Horne, John Cece, John Diadorrio, John Ellis, John McConnaughey, John Peart, Jon Chapleau, Josh Brothers, Kevin Pettigrew, Kirby Rootes-Murdy, Lloyd Blagdon, Loren Lustig, LT. Reitmeyer, Marty Gary, Matt Berriman, Matt Breece, Michael Luisi, Michelle Duval, Mike Loeffler, Mike Waine, Mr. Dobbs, Paul Cole, Philip Cornelison, Rene Barrera, Rick Barrera, Mike White, Ricky Radcliffe, Robert Preston, Ronnie Smith, Sam Pollock, Sam Roy, Sara Winslow, Sarah Watts, Sean Darsee, Shelby White, Simon Brown, Steve Johnson, Tim Miller, Timberly Chapman, Tom Crews, Tom Sinclair, Tommy Watson, Tyler McGuire, Tyler Swanson, Walter Rogers, Will Creef, William Barnard, Wilson Laney, and Zach Fasking.

2013 Cooperative Winter Tagging Cruise Implementation and Support Team

Captain and Crew of the R/V Cape Hatteras, 2013, Cruise CH-13-01:

- Commanding Officer: Capt. Dale Murphy (now retired)
- Chief Engineer: Mark Smith (presently with the NC Coastal Federation)
- Chief Mate: Bobby Daniels (presently Commanding Officer, R/V Cape Hatteras, for Cape Fear Community College, Wilmington, NC)
- Second Mate: Larry Morris
- Second Mate: John Wilder
- Able-bodied Seaman: Casey Jones
- Able-bodied Seaman: John Nelson
- Cook and Unlimited Able-bodied Seaman: Bob Hotchkiss

Data Entry and QA/QC Support:

- Mike Mangold: Maryland Fisheries Resources Office, USFWS, Annapolis, MD
- Joshua Newhard: Maryland Fisheries Resources Office, USFWS, Annapolis, MD
- Ian Park: Maryland Fisheries Resources Office, USFWS, Annapolis, MD
- Beth Versak: MDDNR-Fisheries Service, Annapolis, MD

DUML Support Staff:

- Rebecca Smith: Marine Superintendent, DUML, Beaufort, NC

ECU, NMFS and USFWS Administrative Support Staff:

- Marie Bullock: Office Administrator, Edenton National Fish Hatchery, USFWS, Edenton, NC
- Dr. Lisa DesFosse: Technical Monitor, NMFS, Pascagoula, MS
- Cindy Harper: Administrative Assistant, Institute for Coastal Science and Policy, ECU, Greenville, NC

- Stephen Jackson: Manager, Edenton National Fish Hatchery, USFWS, Edenton, NC
- JoAnn Pittman: Office Administrator, Ecological Services, USFWS, Raleigh, NC
- Robert Sadler: Grants Monitor, NMFS, St. Petersburg, FL
- Rick Smiley: Assistant Director, Office of Sponsored Programs, ECU, Greenville, NC

Fishing Vessel Captains and Mates:

- Capt. Ryan Rodgers, F/V Midnight Sun, home-porting in Reedville, VA
- Mate Doug Gray
- Capt. Devin Cage, F/V Poacher, home-porting in Nags Head, NC, Oregon Inlet Fishing Center
- Mate Russel Long
- Capt. Chandler Hogg, F/V Smokin' Gun II, home-porting in Hampton, VA
- Mate Ed Stonich

Hook-and-Line Scientific Parties

- Charlton Godwin, NCDMF, H&L Coordinator, and volunteers listed above.

Scientific Party on the R/V Cape Hatteras, 2013, Cruise CH-13-01:

- Dr. Matthew "Matt" Balazik: Research Associate, Virginia Commonwealth University (VCU), Richmond,VA
- Amy Batdorf: Biologist, MDDNR-Fisheries Service, Annapolis, MD
- Amy Comer: MS Candidate, Delaware State University, Dover, DE
- John Ellis: Senior Staff Biologist, USFWS, Ecological Services, Raleigh, NC
- Jeff Gearhart: Gear Specialist, NMFS, SE Fishery Science Center, Pascagoula, MS
- John Gill: Fishery Biologist, USFWS, Maryland Fisheries Resources Office, Annapolis, MD
- Jeff Kipp: Stock Assessment Scientist, ASMFC, Arlington, VA
- Cecelia Krahforst: PhD Candidate, ECU, Greenville, NC
- Dr. Wilson Laney: Coordinator, South Atlantic Fisheries, USFWS, Raleigh, NC
- Mike Loeffler: Marine Biologist, NCDMF, Elizabeth City, NC
- Jillian Osborne: MS Candidate, East Carolina University, Greenville, NC
- Walt Rogers: MS Candidate, East Carolina University, Greenville, NC
- Stephen "Steve" Taylor: Supervisory Biologist, NCDMF, Wilmington, NC
- Michael "Mike" Waine: FMP Coordinator, ASMFC, Arlington, VA

2014 Cooperative Winter Tagging Cruise H&L Implementation and Support Team

ECU, NMFS and USFWS Administrative Support Staff:

- Marie Bullock: Office Administrator, Edenton National Fish Hatchery, USFWS, Edenton, NC
- Dr. Lisa DesFosse: Technical Monitor, NMFS, Pascagoula, MS
- Cindy Harper: Administrative Assistant, Institute for Coastal Science and Policy, ECU, Greenville, NC
- JoAnn Pittman: Office Administrator, Ecological Services, USFWS, Raleigh, NC
- Robert Sadler: Grants Monitor, NMFS, St. Petersburg, FL

- Rick Smiley: Assistant Director, Office of Sponsored Programs, ECU, Greenville, NC

Fishing Vessel Captain and Mates:
- Captain Ryan Rodgers, F/V Midnight Sun
- Mate Doug Gray

Hook-and-Line Scientific Parties
- Charlton Godwin, NCDMF, H&L Coordinator, and volunteers listed above.

2015 Cooperative Winter Tagging Cruise Implementation and Support Team

Captain and Crew of the R/V Savannah, 2015, Cruise SAV-15-01:
- Commanding Officer: Raymond "Ray" Sweatte
- First Mate: Peter "Pete" Casserleigh
- Second Mate: Jordan Soloman
- Engineer: Chris Keene
- Marine Tech (and NCSU graduate): John Bichy
- Deck Hand: Terrell Scarboro
- Cook: Susan Redwine

Data Entry and QA/QC Support:
- Mike Mangold: Maryland Fisheries Resources Office, USFWS, Annapolis, MD
- Joshua Newhard: Maryland Fisheries Resources Office, USFWS, Annapolis, MD
- Beth Versak: MDDNR-Fisheries Service, Annapolis, MD

DUML Support Staff:
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Fishing Vessel Captains and Mates:
- Capt. Ryan Rodgers, F/V Midnight Sun
- Mate Doug Gray

Hook-and-Line Scientific Parties

- Charlton Godwin, NCDMF, H&L Coordinator, and volunteers listed above.

Scientific Party on the R/V Savannah, 2015, Cruise SAV-15-01:

- Dr. Matthew "Matt" Balazik: Research Faculty, VCU, Richmond, VA
- Charles "Chuck" Bangley: PhD candidate, ECU, Greenville, NC
- Kevin Brown: Gear Development Specialist, NCDMF, NC Department of Environment and Natural Resources (NCDENR), Morehead City, NC
- Amy Comer: Marine Biologist I, NCDMF-NCDENR, Washington, NC
- John Ellis: Senior Biologist, Division of Ecological Services (ES), USFWS, Raleigh, NC
- John Gill: Fisheries Biologist, Maryland Fishery Resources Office, USFWS, Annapolis, Maryland (and 6-12 WATCH CHIEF)
- Nick Hopkins**:** Fisheries Method Equipment Specialist, Mississippi Laboratories, Southeast Fisheries Science Center, NMFS, NOAA, Pascagoula, MS
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2016 Cooperative Winter Tagging Cruise Implementation and Support Team

Captain and Crew of the R/V Savannah, 2016, Cruise SAV-16-01:

- Commanding Officer: Raymond "Ray" Sweatte
- First Mate: John Bichy
- Second Mate: Terrell Scarboro
- Mate: Jordan Soloman
- Engineer: Chris Keene
- Marine Superintendent: Michael Richter
- Marine Tech: Zach Tait
- Cook: Jack Van Dyke

Data Entry and QA/QC Support:

- Mike Mangold: Maryland Fisheries Resources Office, USFWS, Annapolis, MD
- Joshua Newhard: Maryland Fisheries Resources Office, USFWS, Annapolis, MD
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- JoAnn Pittman: Office Administrator, Ecological Services, USFWS, Raleigh, NC
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Fishing Vessel Captains and Mates:
- Captain Ryan Rodgers, F/V Midnight Sun
- Mate Doug Gray

Hook-and-Line Scientific Parties
- Charlton Godwin, NCDMF, H&L Coordinator, and volunteers listed above.

Scientific Party on the R/V Savannah, 2016, Cruise SAV-16-01:
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- Charles "Chuck" Bangley: PhD candidate, ECU, Greenville, NC
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- Steve Poland: Marine Fisheries Biologist, NCDMF-NCDEQ, Morehead City, NC
- Dr. Carol Price: Contractor, NOAA, National Ocean Service, NCCOS, Center for Coastal Fisheries and Habitat Research, Beaufort, NC
- Kirby Rootes-Murdy**:** Fishery Management Plan Coordinator, ASMFC, Arlington, VA
- Stephen D. Taylor**:** retired from NCDMF, now USFWS volunteer (and 12-6 WATCH CHIEF), Wilmington, NC

VII. FINDINGS

Actual accomplishments and findings, by objective:

Objective 1: Capture, document, tag and release Striped Bass on the NC/VA wintering grounds: Table 2 (trawl sampling) and Table 3 (hook-and-line capture) document the numbers of Striped Bass captured and tagged in each year, by gear type. A collective total of 6,119 Striped Bass were captured using both methods for the period 2013-2016. A collective total of 5,804 were tagged and released. The 315-fish difference between numbers captured versus those tagged and released is due to the fact that during the trawling Cruises, on at least one occasion the number of large Striped Bass captured in one tow exceeded the holding capacity of the tanks, so the additional fish were counted and returned overboard in order to avoid unnecessary mortality. On the hook-and-line Cruises, fish which were noticeably bleeding from gills or had other tissues due to hook injury were documented (counted and measured) but not tagged. Fish counted overboard due to crowding were not measured. Additional fish were recaptures from prior tagging and were not counted in the totals.

All Striped Bass captured were in either Virginia (2013, 2015) or Maryland (2016) waters, and most of them were within the EEZ (Figure 10). Length-frequencies for Striped Bass captured during the Cruises are presented in Figure 11 by year and gear type. Adult Striped Bass were caught, tagged and released each year from both gear types with the exception of 2014, which was the year for which the CWTC Trawl survey was not funded. In general, the largest size classes were caught by the Hook & Line (H&L) effort compared to the trawl (Figure 11). The average sizes of Striped Bass captured by trawl (Table 5) were smaller than those collected by hook and line (Table 6). The smallest fish were caught by trawl with the exception of 2016, when a 578 mm TL fish was caught by rod and reel (Table 6). The largest fish were caught by the hook and line tagging effort in all years (Tables 5 and 6).

Results of the trawl sampling showed a consistent increase in the average size of Striped Bass caught, even though the number of fish captured declined over the same period (Table 5). The Hook and Line sampling also showed a consistent average size increase over the four-year period, but numbers of fish caught remained near or more than 1,000 individuals (Table 6).

Overall, trawl-captured Striped Bass ranged in length from 567 mm to 1,193 mm TL, with the average length by year ranging from 833.9 to 960.3 mm (Table 5). Hook-and-line captured Striped Bass ranged in length from 578 to 1,355 mm TL, with annual mean lengths ranging from 931 to 984 mm TL (Table 6).

For the trawling Cruise data combined for all three years, an overall 24.1 percent of the tows were positive for Striped Bass (Table 7), with annual percentages ranging from 32.1 for 2013 to a low of 12.7 for 2016. There appears to be a clear relationship between the percent tows positive for Striped Bass and the number of successful tows completed in a given year; generally the more tows, the more positive ones. For positive tows, numbers of Striped Bass captured ranged from 1 to 209 individuals, with an average catch per tow (data have not yet been adjusted to account for variable tow duration) of 11.5 Striped Bass in 2013, 15.7 in 2015, and only 8.5 in

2016. Hook-and-line trip production ranged from 0 for some trips, to a maximum of 315 for a trip made on February 6, 2016. All hook-and-line trips were day trips only. Many scheduled trips were cancelled and rescheduled for later dates, due to adverse weather. The dates and number of striped bass caught and tagged during the H&L cruises are presented in Tables 8-11.

Means and ranges of the environmental and physical variables measured during the trawl Cruises are reported in Tables 12-14 for Cruise years 2013, 2015, and 2016. Environmental and physical variables were recorded during the H&L Cruises but have not yet been compiled.

Objective 2: Characterize the age structure of the Striped Bass stock on the winter grounds: The numbers of Striped Bass from which scales were removed for ageing are provided in Table 4. Striped bass captured during the three trawling Cruises ranged in age from 4-18 years (Table 15). In 2013, trawl-caught fish were age 5 (2008 Year Class, YC) to age 18 (1995 YC); dominant ages 7 and 8 were from the 2006 and 2005 YC, respectively (Figure 12). In 2015, trawl-caught fish ranged from age 4 (2011 YC) to age 15 (2000 YC); dominate ages of 5-7 were from the 2008-2006 YC, respectively. In 2016, ages ranged from age 5 to age 17, with the 2006 YC most abundant (Table 15).

Those Striped Bass captured using hook-and-line for the four-year period ranged in age from 4 to 21. Captures in 2013 ranged from age 6 to age 21, with dominant year classes from 2004-2001. In 2014, ages ranged from 6 to 20 years with year classes 2006-2002 most abundant. In 2015, the age structure dipped in range from age 4 to age 18, with dominant year classes from 2007-2004. The 2016 hook and line sampling caught Striped Bass ranging from age 6 to age 17, with year classes 2008-2004 most abundant (Table 15). Year-class frequency plots for each year are presented in Figure 12. The H&L-caught fish were generally older than trawl-caught fish. The numbers of fish in each year class, by gear, are provided in Table 15 and Figure 12.

Objective 3: Estimate fishing mortality (F) of the coastal migratory Striped Bass stock:

The number of Striped Bass recaptured for tagged fish released during the 2013-2016 cruises are in Table 16. The fishing mortality of the stock was estimated by Dr. Stuart Welsh, Assist Leader-Fisheries, West Virginia University and U.S. Geological Survey, West Virginia Cooperative Fish and Wildlife Research Unit, once a year has passed, based on reports of tag returns received (Table 17; Figure 13). Dr. Welsh is a member of the Atlantic States Marine Fisheries Commission (ASMFC) Striped Bass Tagging Subcommittee. All tag recaptures were reported to the U.S. Fish and Wildlife Service (USFWS), Maryland Fish and Wildlife Conservation Office, located in Annapolis, Maryland, and were incorporated into the databases for the ASMFC/USFWS coastwide striped bass tagging program. Two databases are maintained. The primary database is maintained by the Maryland Department of Natural Resources-Fisheries Service, at their Annapolis, Maryland offices. That database contains the data for all Atlantic Sturgeon and Striped Bass captured during all Cruises, both trawling, and hook-and-line. A second database is maintained by the USFWS at the Maryland Fish and Wildlife Conservation Office, also located in Annapolis, MD. That database contains only the data for tagged Striped Bass, both releases and recaptures. A separate database maintained by the USFWS at the same office, houses all Atlantic Sturgeon capture, tag, and recapture data.

Objective 4: Map the distribution of Striped Bass and associated species during the winter study period:

Locations for trawl samples and hook-and-line capture locations were mapped as previously described by USFWS staff (Van Druten). The end points of trawl tows are depicted in Figure 4. Hook-and-line capture locations are depicted in Figure 5. All sample points combined for both gears are depicted in Figure 6. The locations at which Atlantic Sturgeon, and Striped Bass, were captured by the two sampling gears is depicted in Figure 7.

In contrast to prior years, no Striped Bass were detected by the two sampling gears in ocean waters off North Carolina (Figure 10). All Striped Bass captured, either by trawl or hook-and-line, were captured in ocean waters off Maryland or Virginia. Few if any Striped Bass have been taken by recreational anglers in state waters of the ocean for the last three years (Charlton Godwin, NCDMF, personal communication) and no tag returns have been reported from the ocean for either NC or VA.

Other target species counted and measured during the 2013-2016 Cruises included the Spiny Dogfish *Squalus acanthias*, Skate species, species of the drum family Sciaenidae, and flounders. The Spiny Dogfish was ubiquitous throughout the study area every year (Figure 14), ranging from just below Oregon Inlet in North Carolina to near the Delaware border. Skate species included the Clearnose Skate *Raja eglanteria*, Little Skate *Leucoraja erinacea*, Thorny Skate *Amblyraja radiata*, and Winter Skate *Leucoraja ocellata*. The distribution of the combined skate species is depicted in Figure 15. Skate species were most abundant in Virginia, especially near the mouth of Chesapeake Bay (Figure 15). The Sciaenidae included the Atlantic Croaker *Micropogonius undulatus*, Banded Drum *Larimus fasciatus*, Star Drum *Stellifer lanceolatus*, both the Northern and Southern Kingfishes (*Menticirrhus saxatilis* and *M. americanus*, respectively), Silver perch *Bairdiella chrysoura*, Spot *Leiostomus xanthurus*, and Weakfish *Cynoscion regalis*. Largest groups were south of Chesapeake Bay off the northern Outer Banks of North Carolina, and north of Chesapeake Bay along coastal Virginia northward to Maryland (Figure 16). The flounders included the Bay Whiff *Citharichthys spilopterus* and the Spotted Whiff *C. macrops*, Dusky Flounder *Syacium papillosum*, Fringed Flounder *Etropus crossotus*, Smallmouth Flounder *Etropus microstomus*, Southern Flounder *Paralichthys lethostigma* and close cousin Summer Flounder *P. dentatus*, and Windowpane *Scopthalmus aquosus*. During the 2013-2016 study period, relatively few trawl samples were taken south of Cape Hatteras, but some of the largest flounder catches were located there (Figure 17). From Oregon Inlet northward the incidence of founder species was fairly common, and larger aggregations were observed along coastal Virginia and just over the Virginia-Maryland Border (Figure 17).

Objective 5: Map the movements and migration of Striped Bass using recapture data:

Of the 5,654 Striped Bass tagged and released during the four years of the study, 4,318 (76.4 percent) were tagged via hook-and-line capture, and 1,336 (23. percent) were trawl-caught Table 16). Of the total captured, tagged and released, 14.0 percent (n = 790) were recaptured and reported to the USFWS Maryland Fish and Wildlife Conservation Office in Annapolis as of October 30, 2017 (Table 16). Sportfishers reported the highest number of recaptures over the four-year period (572, 72.4 percent). Charter boats reported the second highest number (131,

16.6 percent) or recaptures followed by 68 (8.6 percent) from commercial sources (either commercial fishermen, or from seafood markets or purchasers). A total of 10 fish were reported by researchers, 7 by "other", and only 2 recaptures were from unknown sources (Table 16).

Figure 18 depicts the location of reported Striped Bass recaptures, from all years combined (2013-2016). The geographic range of recovery, as well as the pattern, is similar to that determined from prior tagging done on the Cooperative Winter Tagging Cruises during 1988-2010 (ASMFC, Maryland DNR-FR, NCDMF and USFWS, unpublished data). The recoveries during the spring spawning season from within Chesapeake Bay, the Hudson River, the Delaware River, and other rivers further north document the fact that the aggregation of Striped Bass offshore during the winter months is a mixed stock comprised of fish from spawning stocks from North Carolina through Maine. Past studies have also documented that the majority of the fish tagged from the mixed offshore stock originated in Chesapeake Bay, with smaller percentages from NC (Albemarle-Roanoke Ecosystem), the Delaware, and Hudson rivers. More recoveries are reported from areas that are popular for recreational fishing and where fishing effort is greater. Striped Bass were recaptured in coastal ocean waters, and in inland rivers on presumptive spawning grounds, from NC through ME. One fish was recaptured in the St. John River, Canada (Josh Newhard, USFWS, personal communication; USFWS unpublished data). The fish was tagged January 16, 2016, and recaptured in September, 2017, and based on a check of the database (J. Newhard), was the first recapture from Canadian waters in over 20 years.

This general pattern of migration was documented for the Roanoke River stock of Striped Bass through acoustic tagging of larger fish by J. Harris with results reported in Callahan et al. (2015). They found that large Roanoke River Striped Bass (>900 mm TL) rapidly emigrated (>59 km/d) after spawning to distant (>1,000 km) northern ocean waters (New Jersey to Massachusetts), where they spent their summers. They then migrated southward in the fall to overwintering habitats off Virginia and North Carolina and completed their migration circuit the following spring by returning to the Roanoke River to spawn. Their results showed no evidence of straying or skipped spawning, as all migrants successfully returned (homed) to the Roanoke River the next spring to spawn.

Figure 19 depicts the recaptures, by month, for all years combined. The color-coding shows the seasonal pattern of spring captures on inland spawning grounds, followed by summer and fall captures in New England waters, as mature Striped Bass migrate northward in the Atlantic Ocean after making their spring spawning runs. These fish generally move back to more southern waters in late fall and winter and become part of the wintering mixed stock offshore. Again, this pattern was documented for Roanoke River Striped Bass via acoustic tagging with detections along the entire Atlantic Coast (Callihan et al. 2015) as noted above.

Objective 6: <u>If possible employ acoustic tags in a subset of tagged Striped Bass to assess catch/release mortality of trawl-caught versus hook-and-line caught fish:</u> As explained previously, a grant was secured from the University of North Carolina Sea Grant Program, and acoustic tags were procured. However, since the intent was to deploy acoustic tags in Striped Bass captured off NC, and none were captured off NC during any of the four monitoring/sampling years, none were ever deployed.

Objective 7: Capture, document, tag and release any Atlantic Sturgeon encountered during the Cruise: A total of 12 Atlantic Sturgeon were captured during the three years of trawling (Figure 20). All were documented through counting, measuring (FL, TL and girth) and scanned for PIT tags and visually checked for external tags. None of the Atlantic Sturgeon captured during the Cruises in 2013, 2015 or 2016 had been previously captured, tagged and released. The data for all Atlantic Sturgeon captured and documented during the Cruises is presented in Table 18. Only 12 Atlantic Sturgeon were captured during the research vessel trawling, but as previously noted, scientists were attempting to avoid capturing the species due to its having been federally-listed in 2012. Prior known "hotspots" for capturing Atlantic Sturgeon were avoided. The Atlantic Sturgeon captured ranged in size from 1178 to 1974 mm TL, all within the range of mature adults.

Objective 8: Tag Atlantic sturgeon over 800 mm TL with acoustic tags: No Atlantic Sturgeon were tagged with acoustic transmitters during any of the trawling Cruises, due to the above-noted factors (see Section VI, Objective 8).

Objective 9: Document all alosine species encountered (Alewife, American Shad, Blueback Herring and Hickory Shad): All alosines in trawl samples were identified (Table 19). Only the Alewife was present in all three Cruise years. The most numerous of the alosines was Alewife: 78 specimens in 2013, 9 in 2015, and 28 in 2016. Blueback Herring were collected in both 2015 (95) and 2016 (10; see Table 19). Small numbers of Hickory Shad were collected in 2013 and 2015, and none were observed in 2016. No American Shad were collected in any of the years (Table 19). No alosines were captured in 2014 because only the hook and line study was conducted, and the gear used was inappropriate for alosine capture.

The average size of Alewife caught in trawls was similar among the three years (Table 20). The average size ranged from a low of 235 mm FL in 2016 to a high of 246 mm FL in 2015 (also the smallest catch of Alewife). Minimum sizes were large compared to earlier Cruises (Table 20), suggesting that all these specimens were adults. In 2015, Blueback Herring were collected in numbers large enough for comparison to previous Cruise years. Both the minimum and average sizes were larger; however, these sizes decreased in 2016 largely due to the small number of individuals collected (Table 20).

Both Alewife and Blueback Herring were seldom caught in CWTC trawls starting in the year 2000 (Table 21). In some years (e.g., 2000, 2002, 2003) the incidence of River Herring present in tows was < 2 percent. Cruises in 2009 and 2010 resulted in the highest incidences, with both species present in 17 to 33 percent of all tows (Table 21). However, an examination of CWTC cruise data from 2013, 2015, and 2016 indicated that Alewife and Blueback Herring varied widely in being caught together in any one tow (Table 21). Since Blueback Herring were not captured in 2013, the co-occurrence did not exist. For the 2015 and 2016 Cruises the co-occurrence was 17.9 and 28.6 percent, respectively. We then compared these results to previous CWTCs dating back to the year 2000. Overall, in those years in which both species were present, co-occurrence in trawls ranged from a low of 12.5 percent in 2007, to a high of 81.8 percent the following year (2008, Table 21).

Spatially, however, Alewife and Blueback Herring were caught in similar geographic areas

(Figure 21). Some were collected along the Outer Banks of North Carolina near Oregon Inlet. The majority of those encountered were located in coastal ocean waters at or north of the mouth of Chesapeake Bay almost to the Virginia-Delaware border (Figure 21).

The number of Alewife caught for laboratory processing was more (N=79) in 2013 than in previous years, and was more than those collected in 2015 (7) and 2016 (28). The average size (FL) of Alewives measured in the three years of this study was larger than those from previous years (Table 20). Minimum sizes were larger, and maximum sizes were smaller, than during CWTC years dating back to 2005 (Table 20).

Alewife were divided into 1-cm size class bins to identify patterns in size distribution. In 2013 males were slightly smaller than females, ranging from size classes of 23 to 30 cm TL (Figure 22). The 25-cm and 26-cm size classes were most dominant, with a second peak at the 28-cm size class. Females were slightly larger, ranging from sizes classes 24 to 31 cm TL (Figure 22). The most dominant size bins were 25-27 cm, with a second peak at 29-31 cm, suggesting that both females and males were exhibiting multiple age classes. In 2015, sample size was small (n=9), but was primarily the smaller individuals of size classes 27-29 (Figure 23). In 2016, more individuals were examined (n=28) and again size class bins 27-30 were most prevalent (Figure 23).

As noted above, during the 2015 CWTC not all Blueback Herring were recorded correctly on the raw data sheets. None were captured in 2013, 95 were collected for laboratory processing in 2015, and only 9 were observed in 2016 samples. The average size of Blueback Herring in 2015 was 217.7 mm FL, much larger than those measured in 2016 and in previous years (Table 20). Small yearling fish were observed in 2015.

Alewife Ageing

To date only alosines for the 2013 CWTC have been aged. In that year only Alewife were collected (n = 79). Alewife ages were compared to total fish length (Figure 24). A wide range of fish lengths was observed for each age class, and those ranges of lengths were spread throughout ages 2-5. The wide disparity of length-at-age resulted in a significant, but poorly fit linear relationship: the length (TL) at age (years) equation was

$$TL = 14.919*Age + 224.5;\ R^2 = 0.30;\ n = 68. \qquad (2013)$$

In 2013, Alewife ranged from Age 2 (2011 year class) to age 5 (2008 year class, (Figure 24). Age 3 was most abundant in the samples (Figure 25). Age 3 (2010 YC) dominated the catch comprising 48.5%. Ages 2 and 4 comprised 23.5% each, while Age 5 represented less than 5% of the catch (Figure 25). Otoliths for 2015 and 2016 CWTCs are currently being photographed for ageing.

For Alewife, the relationship between fish length (FL, mm) and gonad size (weight, g) was different each year and by sex; the time of year that the CWTC occurred combined with prevailing temperatures may have influenced the results (Figures 26-29). For 2013 the equation for predicting female gonad weight (g) as a function of length (FL, mm) was:

Female GWT = -81.363 + 0.426FL; r^2 = 0.76, n = 39, F = 116.12; P<0.001. (2013)

In 2013 ovaries were observed developing by 215 mm FL, but gonads were not staged for maturity (Figure 26). Predicting male Alewife testes size as a function of fish length exhibited a similar linear trend (Figure 27). The relationship was:

Male GWT = -31.692 + 0.182FL; r^2 = 0.69; n = 40; F = 84.53; P<0.001. (2013)

In 2016 the number of Alewife caught and saved for lab examination was smaller, and the relationships of gonad weight to fish length were not linear (Figures 28 and 29). This suggested that those Alewife collected in 2013 were of a similar maturation stage compared to those collected in 2016, which varied widely in gonad weight and therefore gonad maturity. A further examination of location (i.e., haul) caught during a similar timeframe (January 8-16, 2013 vs January 12-18, 2016) may provide clues as to whether collected fishes were from multiple spawning populations, or from an offshore mixed stock. Albemarle Sound is considered the most southern end of range in which large spawning populations still exist, primarily in the Chowan River. However, if fish were collected farther north in 2016, then those examined could have been a mix of spawning stocks from within the Chesapeake Bay, or between Chesapeake Bay and Albemarle Sound spawning stocks (Figure 21).

Blueback Herring were collected in numbers great enough to analyze only in 2015.The size class structure of those captured clearly was bimodal (Figure 30) with the largest peak at the 20- and 21-cm size classes, and a substantial more broad peak at the 25-27-cm size classes (Figure 30). For female Bluebacks, there were several specimens that showed developing gonads at smaller body sizes, but were considered too small to be mature (Figure 31). The overall relationship was linear. The range for Blueback Herring extends southward of North Carolina to Florida watersheds. The relationship for predicting gonad weight by fish length was:

Female GWT = -14.540 + 0.079FL; r^2 = 0.64; n = 30; F = 49.99; P <0.001. (2015)

Male Blueback Herring collected in 2015 showed a similar linear relationship, but again the variability of gonad weight at the largest size classes was indicative of a mixed stock (Figure 32). The relationship for male gonad weight related to fork length was:

Male GWT = -12.456 + 0.069FL; r^2 = 0.55; n = 35; F = 39.743; P<0.001. (2015)

Objective 10: Document and retain any species needed by NCDMF for ageing to meet ASMFC and Atlantic Coastal Cooperative Statistics Program (ACCSP) targets: Species retained by NCDMF staff for ageing using otoliths were noted previously in the text. Currently, the NCDMF has processed those species listed in Table 22, including Bluefish, Atlantic Croaker, Black Drum, Southern Flounder, Summer Flounder, Northern and Southern Kingfishes, Atlantic Menhaden, Weakfish, Sheepshead, and Spot.

Objective 11: Completely characterize each trawl catch to document all Striped Bass associates: The catch of species in trawl samples, by species and number is documented in Table 23. Table 24 indicates the number of each species measured. Tables 25, 26, and 27 provide the count of fish measured for either total length (TL, mm) or wing width (WW, mm) in the case of skates

and rays, the average size + standard deviation, the minimum size and maximum size. Graphs of the size classes encountered for the most abundant species collected are provided in Figures 33-72. Species with enough individuals to plot length frequencies included Atlantic Croaker (Figure 33), Atlantic Cutlassfish (Figure 34), Atlantic Herring (Figure 35), Atlantic Mackerel (Figure 36), Atlantic Sturgeon (Figure 37), Bay Anchovy (Figure 38), Bay Whiff (Figure 39), Bluefish (Figure 40), Butterfish (Figure 41), Fringed Flounder (Figure 42), Horseshoe Crab (Figure 43), Longspine Porgy (Figure 44), Atlantic Menhaden (Figures 46, 46), Northern Kingfish (Figure 47), Northern Searobin (Figure 48), Pigfish (Figure 49), Red Hake (Figure 50), Silver Hake (Figure 51), Silver Perch (Figure 52), Smallmouth Flounder (Figure 53), Snakefish (Figure 54), Southern Hake (Figure 55), Southern Kingfish (Figure 56), Spiny Dogfish (Figures 57-59), Spotted Hake (Figure 60), squid species (Figure 61), Summer Flounder (Figure 62, 63), Weakfish (Figure 64), and Windowpane (Figure 65, 66). The scientific names of all species are listed in Table 23 (names follow Page et al. 2013; Turgeon et al. 1998; and Williams et al. 1989), and the number of individuals plotted in each graph are listed in Table 24.

Approximately 144 species groups were recorded for the 3 Cruise years in which trawling was conducted (Table 23). Pelagic, demersal, schooling, and singular fish species were interspersed among the tows, and tows were interspersed among habitat types. (Figures 8 and 9). Because the Cooperative Winter Tagging Cruises were originally designed primarily as tagging efforts for Striped Bass in coastal waters of the continental shelf during the wintering period, the search patterns for Striped Bass took precedence over a more traditional survey since the primary objective (as mandated by Congress in the Atlantic Striped Bass Conservation Act of 1984) was to determine the stock status of the target species to drive the management and policy decisions. In more recent years agencies have been mandated to move more toward ecosystem-based fisheries management. Therefore, in the course of these last three years of the CWTC, 2013, 2015, and 2016, we made a concerted effort to identify and enumerate all biological captures from each tow (Table 23), and measure some or all of everything brought onboard (Table 24).

We examined the relationship between Striped Bass and the most important species groups of concern to the Atlantic States Marine Fisheries Commission (ASMFC) and the Mid-Atlantic Fisheries Management Council (MAFMC), since much of the CWTC sampling efforts occur within state waters. Table 25 indicates those species which were most often found in association with Striped Bass. Spiny Dogfish is at the top of the list, co-occurring with Striped Bass in tows 97-100% of the time (Figure 14). Since we conduct benthic tows, it is not surprising to find species associated with the bottom in the catches. Members of the skate family were also highly associated with Striped Bass, occurring in 70-90 percent of all tows in which Striped Bass were present (Figure 15). Flounder species were more varied in trawl presence, as depicted in Figure 17, ranging from a co-occurrence with Striped Bass in about 33 percent of the tows in 2015 to 100 percent of the time in 2016 (Table 31). Co-occurrences of the Sciaenidae and the Clupeidae with Striped Bass were also highly variable. Clupeidae ranged from a low of 30 percent co-occurrence with Striped Bass in 2013, to a high of 85 percent in 2016 (Table 31). The Family Sciaenidae had the lowest co-occurrence in trawls, ranging between 3 and 23 percent (Table 31). However, this does not reflect their presence in trawls throughout the study area (Figure 16), perhaps indicating that members of the drum family may possibly avoid areas of Striped Bass presence along the continental shelf.

Ancillary Project Findings:

Habitat Importance and Identifying Parameters (J. Osborne) -- Habitats can be delineated based on a variety of physical, biotic, and abiotic factors. Major physical habitat types found in the continental shelf area of this study include Carolina hard bottoms, shipwrecks, artificial reefs, and canyons; the majority of tows occurred over loose sediments of sand and silt, as well as pebble and gravel beds since Cruise sampling avoided hard substrates of any sort. Soft bottoms in the ocean environment provide a myriad of services to the system. The natural biogeochemical processes of soft bottom sediments allow for the deposition, resuspension, and recycling of nutrients, toxins, and organic material as summarized by the NC Coastal Habitat Protection Plan (CHPP, Deaton et al. 2010). These substrates provide habitat for benthic microalgae, which can aid in the stabilization of the sediments (Deaton et al. 2010). Along with the microalgae colonies that provide important primary production in these systems, in the study area for this project, more than 600 species of benthic invertebrates and over 100 Polychaeta taxa have been identified; bivalves, crabs, and amphipods are also present in these soft bottom habitats (Deaton et al. 2010).

Bottom type and sediment size play a key contributing role to the species found in any given habitat, and they can be a key factor in assessing potential changes in migratory fish populations which utilize the continental shelf waters (Caddy 2013). Prey items for species such as Atlantic Sturgeon, flounders, and any opportunistic benthic feeders – such as Spiny Dogfish and several species of the Sciaenidae family – can be habitat-specific to the grain size of the sediments in which they are found. The NC CHPP (2010) highlights the importance of the presence of these species and benthic communities as foraging areas for larger biota. While this project did not examine the benthic community, or conduct diet studies on the species collected during this period (2013-2016) with the exception of Spiny Dogfish, existing evidence and information on species allows for the examination of bottom type and sediment grain size as defining variables for these species' habitats.

Other habitat parameters examined in this project include depth, salinity, temperature, and the percent organic carbon content of the sediment. The depth, salinity, and temperature of the water in which species are captured can be compared to previous years' data to assess for changes in the movement patterns and habitat utilization of the various species.

Species Associations With Habitat (J. Osborne) -- More than 99 percent of each species group was captured in habitats with a sediment grain size between 1.6-3.3 phi due to the simple observation that this phi size was the dominant particle size of the study area (Figure 9). Striped Bass and sciaenids showed an increase of percent capture in habitat with larger grain sizes, when compared to previous years of sampling. Atlantic Sturgeon had a slight increase in association with larger grain sizes (2.2-2.6 to 2.6-3.3 phi), while flounder species tended to be more evenly distributed among smaller grain sizes, compared to previous years. The majority (90+ percent) of fishes were captured between 11 and 21 meters of depth (Figure 8). More than 75 percent of each species group was recorded as captured in habitats with organic carbon content of the sediment ranging from 0.2-1.3%. More than 86 percent of each species group was captured in water with salinities between 26-35ppt. Water temperatures ranging from 1-12° C accounted for over 92 percent of the catch for all species. Atlantic Sturgeon, Spiny Dogfish, sciaenids, and

skates all showed a slight increase and a wider distribution in warmer water temperatures compared to previous sampling years. The 'sand' bottom type accounted for 50-75 percent of the catch overall. (J. Osborne, ECU, unpublished data).

Special Studies on Sharks (C. Bangley) – Spiny Dogfish stomach contents were collected from 478 sharks captured by trawl in January and February 2006-2007, 2010, and 2015-2016 during the Cooperative Winter Tagging Cruise (see Bangley 2011; Bangley et al. 2013; Evans and Bangley 2015); size class distributions for 2015 and 2016 are shown in Figures 58, 59. Sampling stations covered the area of the U.S. East Coast from Chincoteague Bay, Virginia to Cape Lookout, North Carolina. Results were published previously in Bangley et al. (2013), and Evans and Bangley (2015). During 2015, there were 62 Spiny Dogfish sampled, with 45 being female, 3 male, and 14 unidentified. Of the 62 sampled, 9 had no prey species recovered from their stomach contents. There were 108 individual prey species recovered from the 53 sharks with stomach contents. The species that had the highest percent occurrence was the Atlantic Menhaden followed by the Bay Anchovy and then squid. The species with the highest percent by weight was the Octopus followed by the Atlantic Menhaden followed by a tie between tonguefish and squid (see Figures 1-5 in Evans and Bangley, 2015).

Two acoustically-tagged Sandbar Sharks were detected post-cruise. Shark 10855 was detected during May, August, and September 2015 in the lower Chesapeake Bay. Shark 46254, which was the largest of the tagged sharks, was detected near shore off Jones Beach, Long Island in July 2016 and over the continental shelf in October 2016 within an area designated as a potential wind farm site (see Figures 67 and 68). This is a really interesting detection because the shark was probably at about the maximum size that could still be considered a juvenile when it was tagged, so this recapture likely documents the shift from juvenile to adult or subadult behavior (C. Bangley, SERC and ECU, personal communication and unpublished data).

Special Study on Searobin Taxonomy -- Scientists collected five juvenile searobins which keyed to Bighead Searobin, during Tows 65 and 67, January 16, 2016. These were frozen whole in seawater and shipped to Dr. Aguilar, in collaboration with Dr. Todd Kellison of the NMFS, Beaufort, NC, laboratory. We were notified in July of this year (2017) of the following: SERC finally got back sequence data for the 5 Bighead Searobin. All five were processed and sequences recovered from 4 individuals. Three individuals grouped with fish SERC called *P. evolans* (Striped Searobin) and 1 individual grouped with an individual SERC called *P. rubio* (Blackwing Searobin). This was interesting to SERC. The Virginia Institute of Marine Sciences (VIMS) trawl survey picked up a juvenile Bighead, which also grouped with *P. evolans*. SERC thinks they need to collect an adult Bighead and see where that falls out genetically. The results could indicate incomplete separation between the species (just very closely related, similar to the case with river herring) or that the juveniles look so similar they are difficult to key out. SERC (Dr. Aguilar) will keep us updated.

Other Species Tagging Efforts -- A total of 371 Horseshoe Crabs were captured during the trawling Cruises. Size classes are depicted in Figure 43. Mature males and females received USFWS tags; only a relatively small proportion of the crabs captured were mature, and therefore tagged. We tagged four Horseshoe Crabs during the 2013-2016 Cruises, three of them in 2013, and one in 2015. All of them were mature males with prosomal widths from 200-211 mm. None

of these crabs have to date been recaptured. Overall, for the entire time series (1988-2016), Cruises have tagged a total of 46 mature Horseshoe Crabs (includes the four noted in the previous sentence), from which there have been three recoveries. All three of those crabs were tagged and released during the 2007 Cruise, and were recaptured in August, 2008 (tag only recovered), June, 2011 (still alive), and December, 2012 (dead). The overall tag recovery rate of 6.5 percent is not too far below the 10-12 percent return rate experienced by other partners who are tagging Horseshoe Crabs (Josh Newhard, USFWS, Maryland Fish and Wildlife Conservation Office, personal communication; USFWS unpublished data).

Specimen Collection for the NC State Museum of Natural Sciences (NCSM) -- In 2013: We collected seventeen species for NCSM: Atlantic Mackerel, Atlantic Herring, Atlantic Menhaden, Bay Anchovy, Black Sea Bass, Butterfish, Cutlassfish, Fringed Flounder, Hickory Shad, Leopard Sea Robin, Little Skate, Silver Hake, Spot, Spotted Hake, Summer Flounder, Weakfish, and Windowpane. In 2015, we provided: Atlantic Cutlassfish (1), Banded Drum (1), Dusky Flounder (1), Little Skate (2), and Thresher Shark (2 neonates). In 2016, the following specimens were provided (number provided in parenthesis): Atlantic Cutlassfish (2), Atlantic Herring (6), Atlantic Mackerel (1), Atlantic Midshipman (1), Bay Anchovy (1), Bighead Searobin (1), Black Sea Bass (1), Blue Runner (4), Bullnose Ray (1, tissue only), Butterfish (1), Cubbyu (1), Gray Triggerfish (1), Greater Amberjack (1, tissue only), Leopard Searobin (5), Little Tunny (1, tissue only), Longspine Porgy (3), Ophicthidae (1), Red Hake (3), Sea Lamprey (1), Sheepshead (4, tissue only), Silver Hake (4), Silver Perch (2), Skilletfish (*Gobiesox* sp., 1), Smallmouth Flounder (43), Smooth Butterfly Ray (1), Southern Hake (2), Spotted Hake (3), Star Drum (2), Striped Burrfish (1), and Windowpane (1).

See Appendices for details on Museum documentation for all three years of the trawl sampling (2013, 2015, and 2016).

Objective 12: Provide a final report of publishable quality for submission to fishery management agencies: This report constitutes the publishable quality final report suitable for distribution to fishery management agencies. Once the final report has been accepted and approved by NMFS, it is the authors' collective intent to assist in the distribution of the report to interested parties and cruise partners.

If significant problems developed which resulted in less than satisfactory or negative results, they should be discussed:

Weather and Equipment Issues -- Weather was the most significant factor which interfered with our ability to accomplish all objectives with occasional gear outages also causing delays due to the necessity to switch out nets. During 2013 we had two gear outages, both occasioned by encounters with uncharted obstructions. The first occurred (Haul 207) during the 12-6 Watch on January 11, 2013, when the trawl struck an object and one of the bridles snapped. We were very fortunate to recover the entire trawl, intact except for the single snapped cable, a definite testimony to the skill of our Captain and crew's expertise. On the second occasion (Haul 223), the net (same one still) was ripped nearly in half, so it was removed and one of the spares installed.

Travel Time versus Ship Time and Shifting Natural Resources -- During the 2016 Cruise, Striped Bass were located further north than for any other Cruise in the entire time series, necessitating traveling a greater distance before Striped Bass were encountered. Additional issues forced the number of hours trawling to be reduced. The R/V Savannah is a slower vessel than research vessels used on previous Cruises, which meant more time had to be allocated for travel between stations. Also during the 2016 Cruise, changes which had been made on the ship while it was in the yard for scheduled maintenance, resulted in the accelerated loss of the freshwater supply on board, necessitating a trip into Ocean City, Maryland, to secure sufficient fresh water for the remainder of the cruise.

Taxonomic Identification – Finally one additional issue which developed during the trawling cruises is that the Watch teams occasionally failed to set aside specimens of species for which identification was uncertain, especially for invertebrates but also for some fishes. This is reflected in the number of entries in Table 23 for which we have recorded "*(unknown, not keyed).*" Taxonomic expertise varied widely within each Scientific Party, and the Chief Scientist asked that specimens be set aside for later identification if the watch members were not certain regarding identification to species. This did not happen as often as it should have. Efforts were made to teach Scientific Party members key characters, especially for decapod crustaceans, but that was only partially successful. During the 2016 Cruise, multiple specimens of invertebrates (decapod crustaceans, echinoderms, and mollusks) with tentative identifications were preserved for later determination by experts, but those identifications have not yet been provided. Should future Cruises be funded, this problem will be rectified by requiring the retention and vouchering of any individual whose species is not known with any certainty, and we will make every effort to provide copies of the most recent taxonomic keys in the wet lab for use by Watch members. Further, we will prepare training for the scientists who are members of the Scientific Party during the Watch orientations and follow up after each tow to make sure that any questionable identifications are resolved during the Cruise.

<u>Description of need, if any, for additional work</u>: There is an unquestionable need for additional work during the winter period off the mid-Atlantic coast of the United States for a variety of reasons. The nearly three-decade Cruise time series as well as past historic cruises (Holland and Yelverton 1973) have demonstrated that work in the winter period, although definitely challenging at times due to the unpredictable weather, is possible. Here is our list for consideration, and we plan to continue pursuit of funding to try and accomplish some or all of these tasks:

- **Placement of acoustic transmitters in migratory Striped Bass offshore**: although some investigators are currently implanting acoustic transmitters in mature Striped Bass in various locations (i.e., see Callihan et al. 2014, Callihan et al. 2015, Harris and Hightower 2017, Dr. Dave Secor work ongoing), to our knowledge no one has yet implanted any in fish from the mixed-stock winter Striped Bass assemblage off the mid-Atlantic. Since there are few acoustic receivers located offshore in the Cruise study area, it would be good to implant fish offshore and have them detected in the inshore receiver arrays to document their rivers of origin as well as the offshore locations which they were using when captured. The acoustic transmitters and receiver arrays enable the acquisition of far more data than are provided by conventional tagging, although the use of such

conventional tags remains important as an independent check on mortality rates.

- **Placement of acoustic transmitters in more juvenile or adult species of sharks offshore**: Other past and the 2013-2016 Cruises implanted acoustic transmitters in 50 adult Spiny Dogfish (see Cudney 2015) and a limited number of juvenile Sandbar Sharks (C. Bangley, unpublished data and this report). But we know that the mid-Atlantic nearshore ocean serves as a nursery for juveniles of other species (i.e., Common Thresher Sharks, a few of which we have tagged using conventional dart tags, as well as other species; see McCandless et al. 2007a; McCandless et al. 2007b), so additional tag implantation would be useful in further identifying and defining shark nursery areas.

- **Further Atlantic Sturgeon acoustic tag implantation and winter sampling in the offshore mid-, and south Atlantic:** Although more work has been done on Atlantic Sturgeon offshore distribution and habitat use in recent years (i.e., see Stein et al. 2004, Laney et al. 2007, Dunton et al, 2010, Erickson et al. 2011, Dunton et al. 2012, Dunton et al. 2015, Breece et al. 2016, Breece et al. 2017), partly as a consequence of federal listing (Risenhoover 2012a, 2012b) of the species under the Endangered Species Act (ESA), knowledge regarding the use of offshore habitats and the associated physical and biological features (PBFs) necessary for defining critical habitats for that species remains scant. The NMFS designated federal Critical Habitat (CH) for the species this year (see Rauch 2017) but declined to designate any CH in estuarine or marine waters due to the lack of specific information regarding the PBFs needed by the species in those habitats. More work is therefore needed. Existing offshore trawl surveys (i.e., Northeast Monitoring and Assessment Program, NEAMAP; Southeast Monitoring and Assessment Program, SEAMAP; and the NMFS Northeast Fishery Science Center Trawl Survey) do not encounter very many Atlantic Sturgeon. None of those surveys sample during the winter months. The Cooperative Winter Tagging Cruises have identified at least one Atlantic Sturgeon "hot spot" off North Carolina, which would allow for targeted sampling to further define habitat needs and implant more acoustic tags, given the proper authorization. Additionally, work by the Rulifson laboratory at East Carolina University has documented a portion of the ocean migratory pathway of Atlantic Sturgeon using an Acoustic Array deployed in the southern bight of Cape Hatteras in Raleigh Bay (Rulifson et al. 2015). The array documented the seasonal patterns of migration for Atlantic Sturgeon tagged elsewhere (especially those by Dr. DeWayne Fox in Delaware Bay, and others farther to the south).

- C**ontinued fishery-independent sampling to characterize the winter fish and invertebrate community and continue progress toward implementing Ecosystem-Based Fishery Management (EBFM)**: In the latter years of the Cruise time series, Cruise partners have begun to collect comprehensive data from all species encountered during sampling. These data have already been contributing to species stock assessments, and will be more valuable in the future as agencies move toward multi-species and EBFM approaches (see Link 2002; Link et al. 2002). EBFM approaches rely upon and need these data in order to build more effective models, which provide management insights and ultimately may provide management advice. We have also discussed the need to return to the original Cruise stratified random design (Richards

1989), which would increase the statistical rigor and utility of the dataset.

- **Continue the annual Cooperative Winter Tagging Cruises to document continued northward shifts in Striped Bass overwintering habitats and other species of interest.** The CWTC time series to date has clearly shown a northward and seaward progression of Striped Bass away from North Carolina waters into those waters off Chesapeake Bay and into the continental shelf waters of Maryland. Documenting this type of distribution change will lead to new management considerations and actions in the foreseeable future. We recommend continued winter monitoring of these fish stocks in the face of climate change (see Limburg et al. 2016).

VIII. EVALUATION

Describe the extent to which the project goals and objectives were attained. This description should address the following:

Were the goals and objectives attained? How? If not, why?

Objective 1: Capture, document, tag and release Striped Bass on the NC/VA wintering grounds.

This objective was largely met (nearly 75 percent) if the previous long-term trawl captures are used as a basis for evaluation. Total numbers of Striped Bass captured and tagged/released, when numbers from trawl-based and H&L-based tagging are combined, were 6,138 and 5,661, respectively. The average numbers captured and tagged/released during previous Cruises, which were solely trawl-based, from 1988 through 2010 (23-year period) were 2,056 captured and 1,923 tagged/released. This compares to averages for the immediate past four-year period (2013-2016) of 1,534 captured and 1,415 tagged/released. These 2013-2016 numbers therefore constitute 74.6 and 73.6 percent of the historic annual totals for the period 1988-2010.

The reduction in capture and tagging success can be attributed at least in part to the northward shift in distribution of the Striped Bass requiring much longer transit times to productive fishing grounds. This shift results in many more non-productive (from a Striped Bass perspective) trawls made during the long trip north to where the fish are now concentrated in Virginia waters. There were also some significant periods during the 2013-2016 Cruises when operations were not possible due to the weather, or other factors, which also reduced the number of tows as well as fishing time. The average annual number of tows during the 1988-2010 time period was 163 (range of 53-329), which compares well with the 166 average annual number of tows from the three-year (2013, 2015-2016) period covered by this report.

Objective 2: Characterize the age structure of the Striped Bass stock on the winter grounds.

This objective was fully met.

Objective 3. Estimate fishing mortality (F) of the coastal migratory Striped Bass stock.

This objective was fully met, and actually exceeded since separate estimates can now be

calculated for trawl-tagged and H&L tagged individuals.

Objective 4. Map the distribution of Striped Bass and associated species during the winter study period.

This objective was fully met for Striped Bass, Atlantic Sturgeon, and associated species.

Objective 5. Map the movements and migration of Striped Bass using recapture data.

This objective was fully met.

Objective 6. If possible employ acoustic tags in a subset of tagged Striped Bass to assess catch/release mortality of trawl-caught versus hook-and-line caught fish.

This objective was not met as previously indicated.

Objective 7. Capture, document, tag and release any Atlantic Sturgeon encountered during the Cruise.

This objective was partially met. Six of the twelve Atlantic Sturgeon encountered during the 2013 and 2015-2016 Cruises were tagged and released. The remaining six were not due to a lack of authorization. The objective was therefore 50 percent met. Another factor that affected the numbers of Atlantic Sturgeon encountered during this period is that the Chief Scientist purposefully avoided known Atlantic Sturgeon hotspots in order to avoid interacting with a species that was federally listed in 2012.

Objective 8. Tag Atlantic sturgeon over 800 mm TL with acoustic tags.

This objective was not met for reasons described elsewhere in this report.

Objective 9. Document all alosine species encountered (Alewife, American Shad, Blueback Herring and Hickory Shad).

This objective was largely met. Some samples were lost for processing due to freezer failure at East Carolina University.

Objective 10. Document and retain any species needed by NCDMF for ageing to meet ASMFC and Atlantic Coastal Cooperative Statistics Program (ACCSP) targets.

This objective was met.

Objective 11. Completely characterize each trawl catch to document all Striped Bass associates.

This objective was fully met.

Objective 12. Provide a final report of publishable quality for submission to fishery management

agencies.

Submission of this final report fulfills Objective 12.

Were modifications made to the goals and objectives? If so, explain.

Modifications were made to Objectives 7 and 8, when it became apparent that we would be unable to recruit any scientist who had been authorized to tag Atlantic Sturgeon in offshore waters, and when time did not permit us to secure the necessary authorizations to implant acoustic tags using existing personnel. Objective 7 was partially met in that Atlantic Sturgeon captured in 2015 were tagged with conventional and PIT tags prior to release.

None of the other objectives were modified.

Ancillary projects, which were not included in the original Cruise objectives, were completed, and those are described in the Approach and Findings sections.

Dissemination of Project results:

Explain, in detail, how the project's results have been, and will be, disseminated:
Data from the project have been provided to the Maryland Department of Natural Resources-Fisheries Service, for archiving in the database of Atlantic Sturgeon and Striped Bass capture and tagging records which they maintain. All of the Atlantic Sturgeon and Striped Bass recapture data have been archived and are maintained by the USFWS Maryland Fish and Wildlife Conservation Office located in Annapolis, Maryland. Data are available to all participating partners in the Cooperative Coastwide Striped Bass Tagging Program, as well as to ASMFC staff.

These data have been used annually by the Atlantic States Marine Fisheries Commission's Striped Bass Tagging Subcommittee, and Science Division staff, to conduct several Atlantic Striped Bass stock assessments and annual updates. Atlantic Sturgeon data from the CWTCs were employed in the current benchmark assessment as one index of abundance (ASMFC 2017a and b).

The final report, once approved/accepted by the NMFS, will be distributed to all partners and other interested parties.

The PIs and co-authors will continue to analyze and interpret the data generated by the Cruises and plan to publish multiple peer-reviewable papers in the near future.

IX. ACKNOWLEDGEMENTS

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charterboat cruises. All of us express our deepest appreciation to our family members who endured long absences while we were at sea, sampling.

We are indebted to the captains, crew members and mates of the research vessels and charter fishing vessels employed as sampling platforms during our operations for their dedication, professionalism and expertise in conducting sampling in a safe and efficient manner. Dr. Todd Kellison, Ken Brennan, Dr. James Morris and other staff in the NOAA/NMFS Beaufort Laboratory assisted us each year in moving holding tanks from the laboratory to the research vessels. Dr. Joe Luczkovich at ECU greatly assisted with merging datasets in "R" statistical package as well as converting various file formats to those necessary for our use in this document. We are also indebted to Dr. Lisa DesFosse, NMFS SE Fisheries Science Center, for providing highly capable and qualified staff with tremendous gear expertise for participation in the Scientific Party during the 2013 (Jeff Gearhart) and 2015 and 2016 (Nick Hopkins) Cruises. Jeff and Nick also transported our nets from Pascagoula, MS, to the ships and returned them to MS. Wilson Laney is particularly indebted to the USFWS and USGS colleagues in other programs, including the USFWS Northeast Region, and multiple other offices for data analysis and participation in both hook-and-line and trawling operations. We especially appreciate the GIS mapping and data management done by Josh Newhard, and Brian Van Druten; past Horseshoe Crab data management and coordination by Dr. Sheila Eyler; Scientific Party duty by John Ellis and John Gill; all the administrative and logistical support from Edenton National Fish Hatchery; and the analysis of the Striped Bass tag returns to estimate mortality by Dr. Stuart Welsh, Assistant Leader-Fisheries, West Virginia Cooperative Fish and Wildlife Research Unit, West Virginia University and U.S. Geological Survey.

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Publication of this document does not signify that the contents reflect the views of the U.S. Fish and Wildlife Service. References to trade names or manufacturers do not imply government endorsements of commercial products.

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XI. FIGURES AND TABLES

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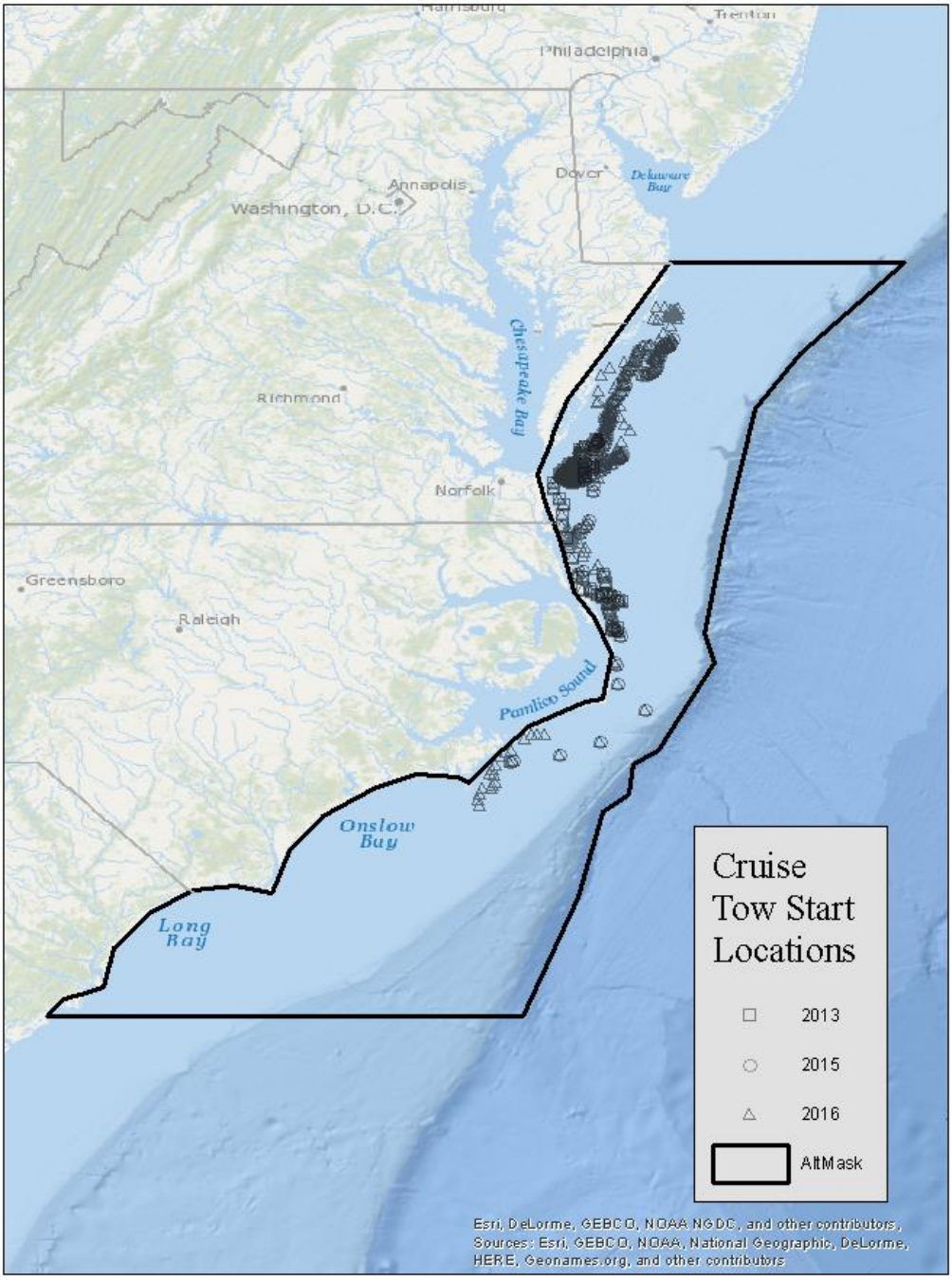


Figure 1. Polygon graphic delineation of study area on base map with analysis mask and Cruise tow locations for 2013-2016 (J. Osborne).

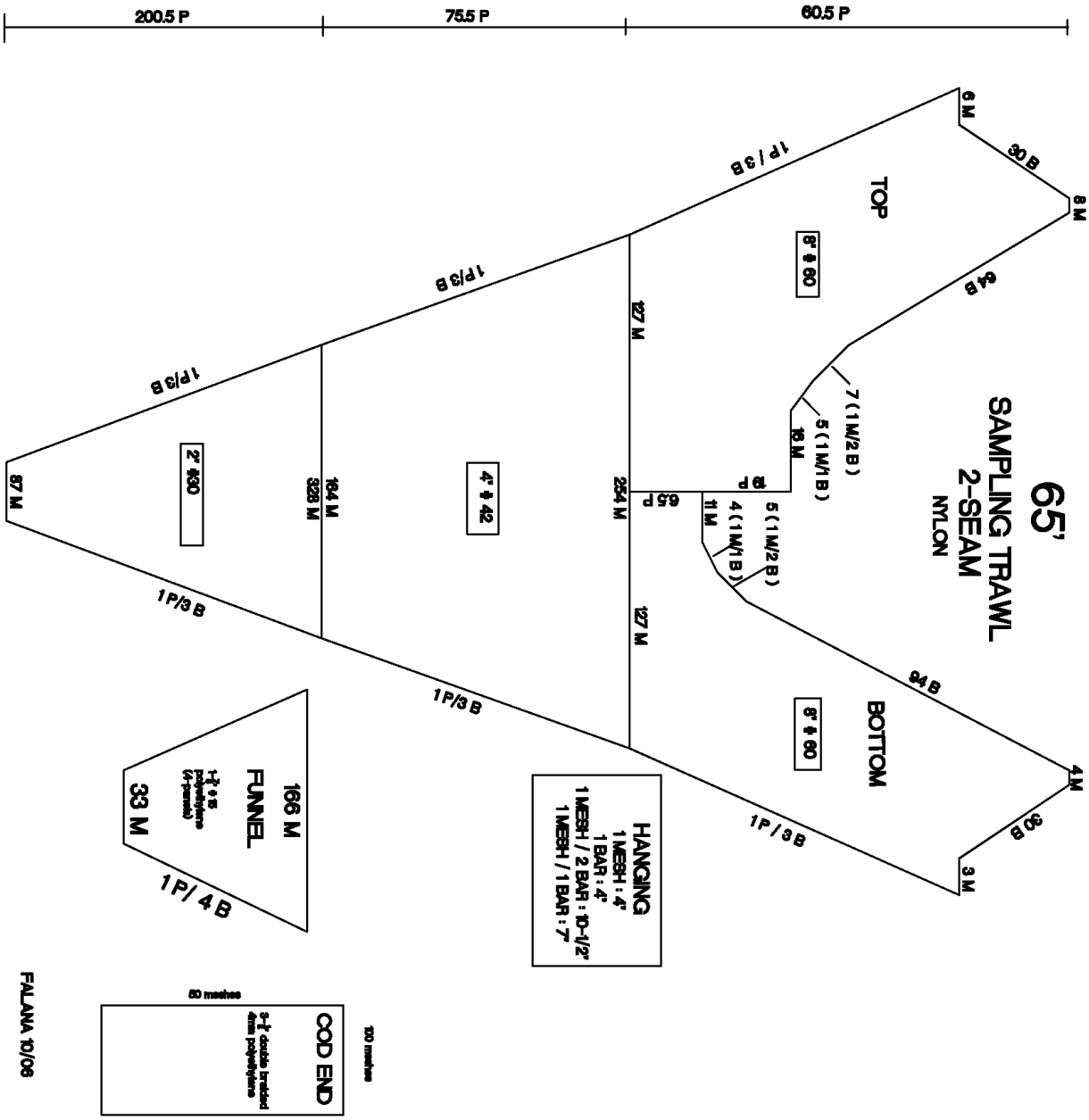


Figure 2. Dimensions of the 65-foot, 2-seam high-opening trawl designed by NMFS for the Cooperative Winter Tagging Cruises.

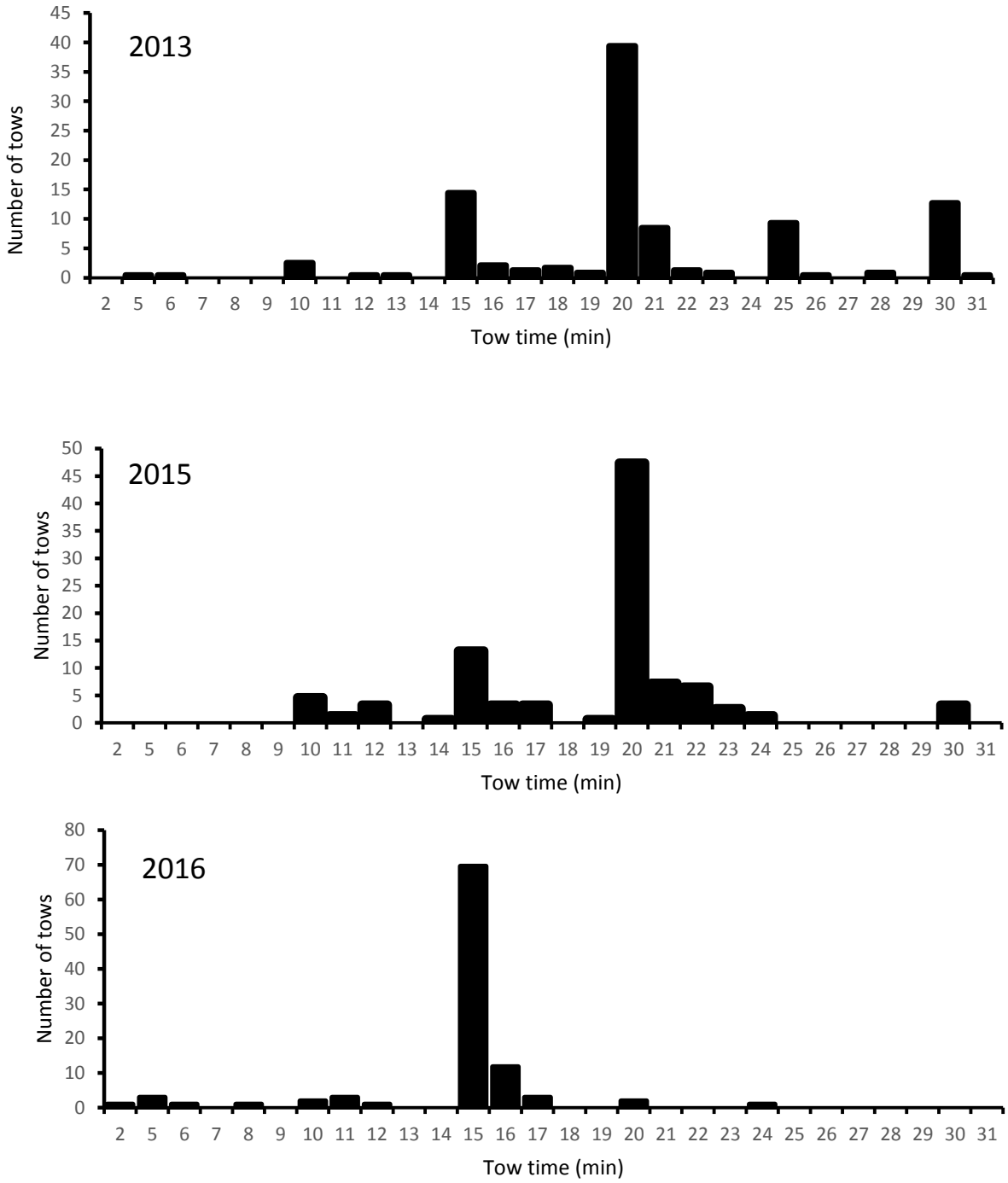


Figure 3. The number of tows made for tow times (minutes) ranging from 2 to 28 minutes during the 2013, 2015, and 2016 Cooperative Winter Tagging Cruises. (R. Rulifson).

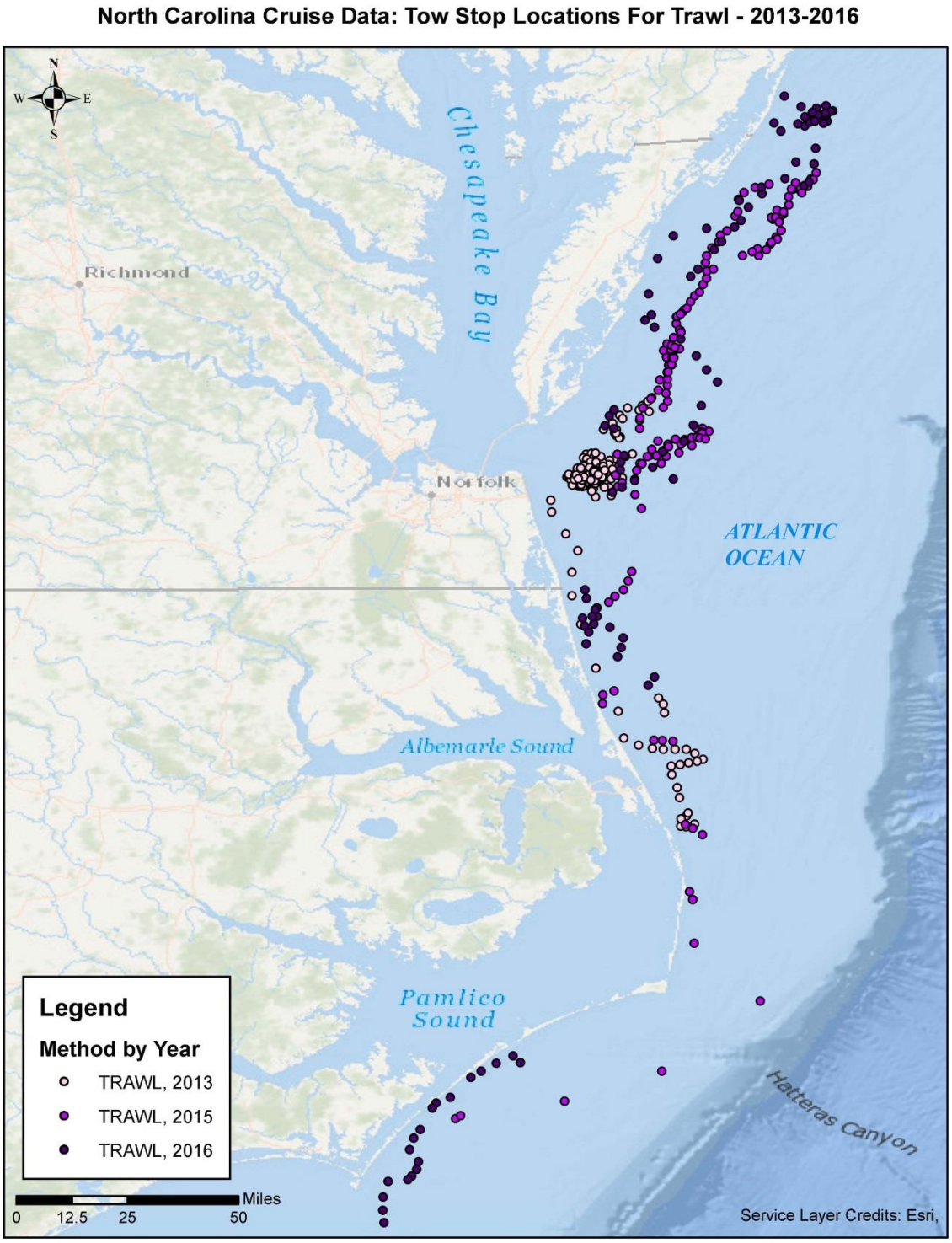


Figure 4. Locations of research vessel trawl sampling station end points, by year, for 2013, 2015 and 2016 sampling during the annual Cooperative Winter Tagging Cruises. (B. Van Druten).

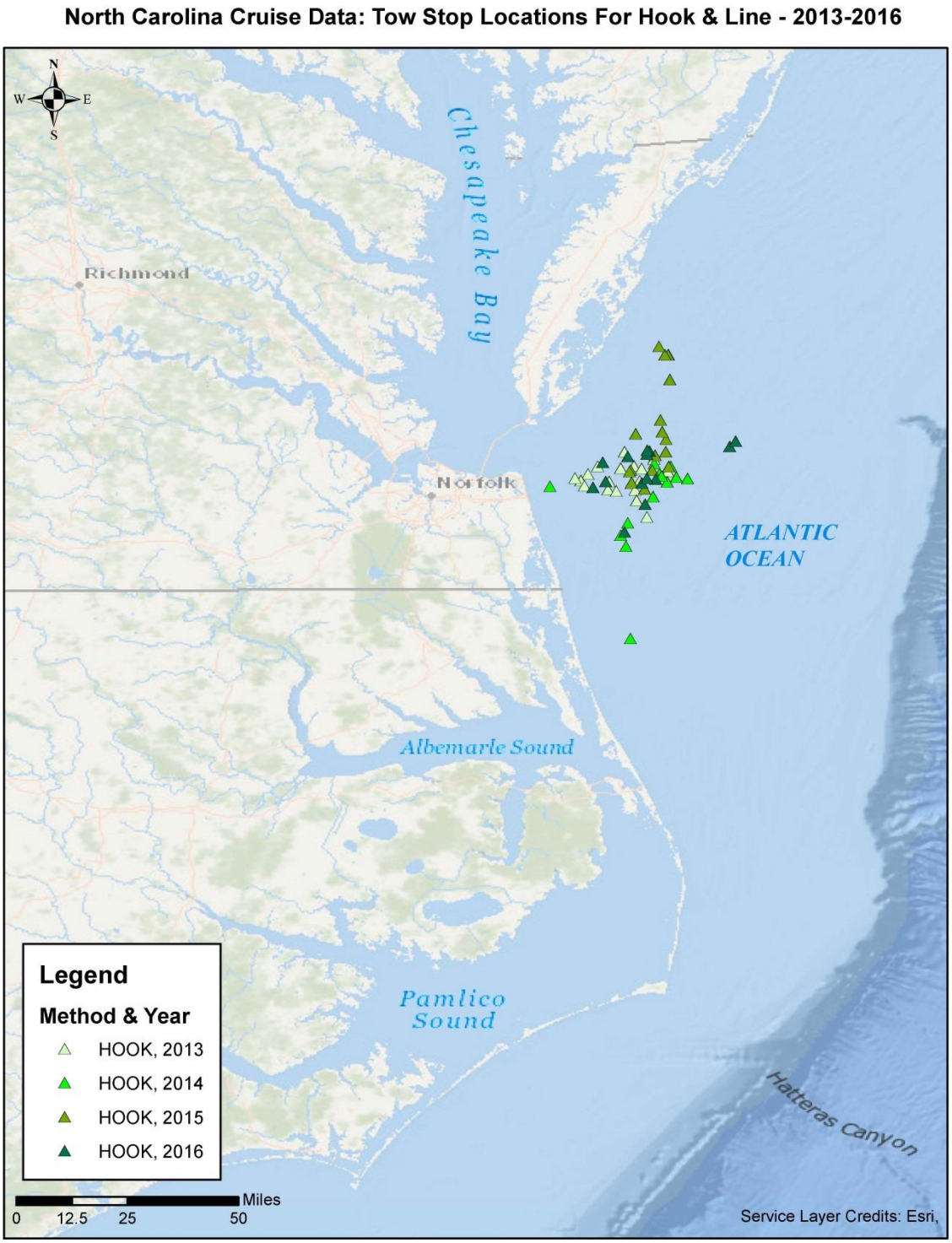


Figure 5. Locations of charter vessel hook-and-line sampling station points, by year, for 2013, 2014, 2015 and 2016 Cooperative winter Tagging Cruises. (B. Van Druten).

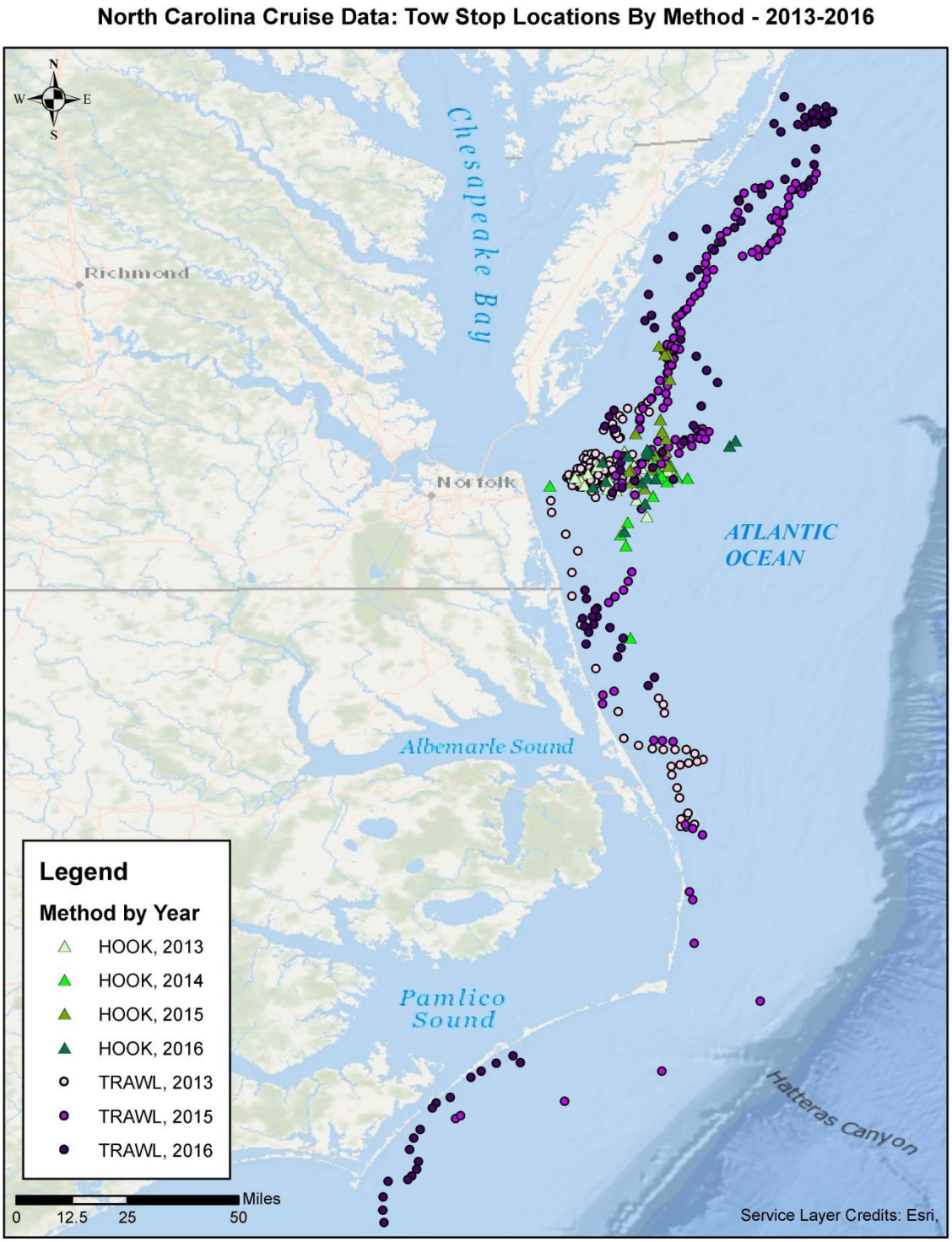


Figure 6. Locations of the ending points for trawl stations and charter vessel hook-and-line sampling stations, by year, for the 2013, 2014, 2015 and 2016 Cooperative Winter Tagging Cruises. (B. Van Druten).

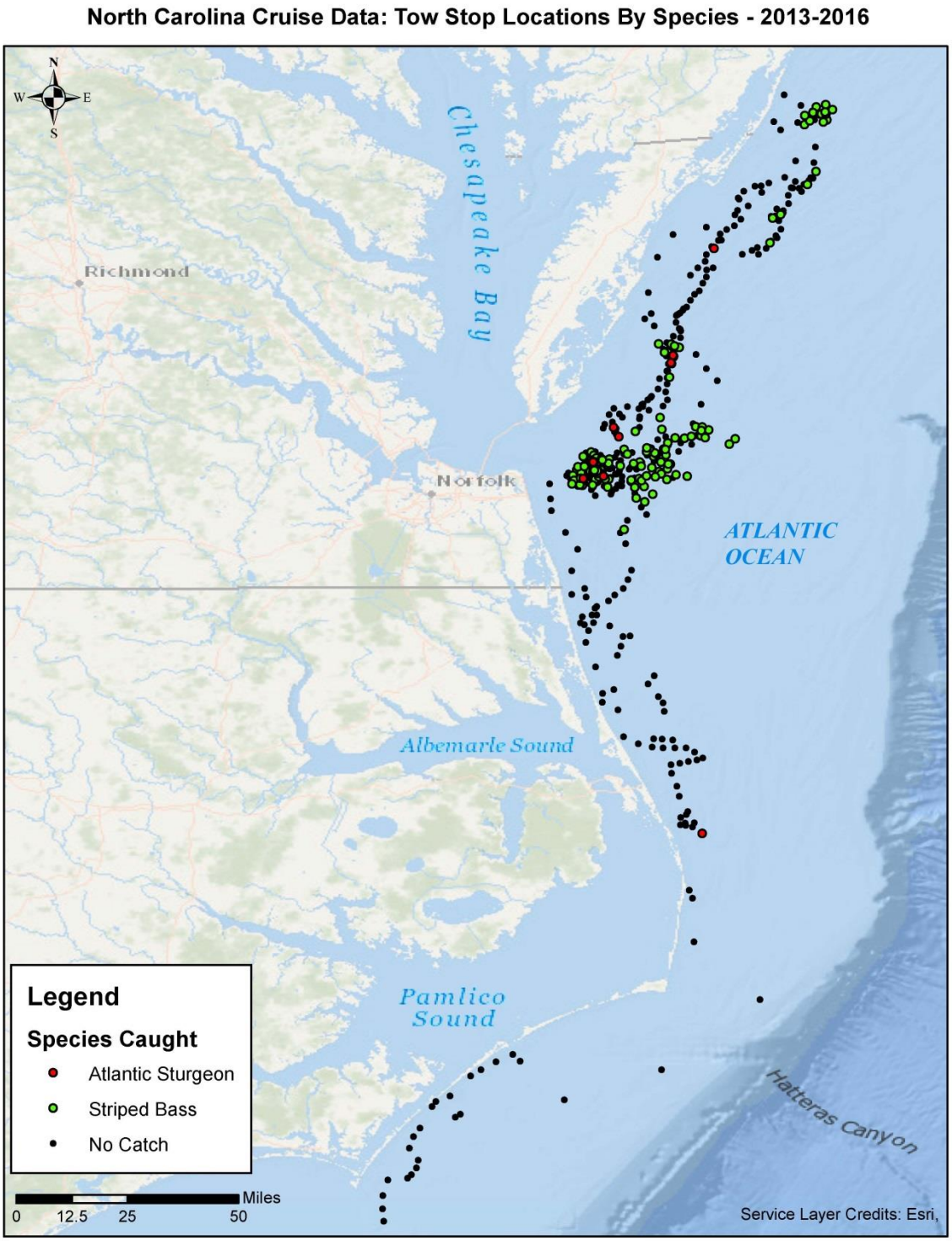


Figure 7. Trawl stations at which Atlantic Sturgeon and Striped Bass were captured, and charter vessel sampling stations at which Striped Bass were captured, by year, for the 2013, 2014, 2015 and 2016 Cooperative Winter Tagging Cruises. (B. Van Druten).

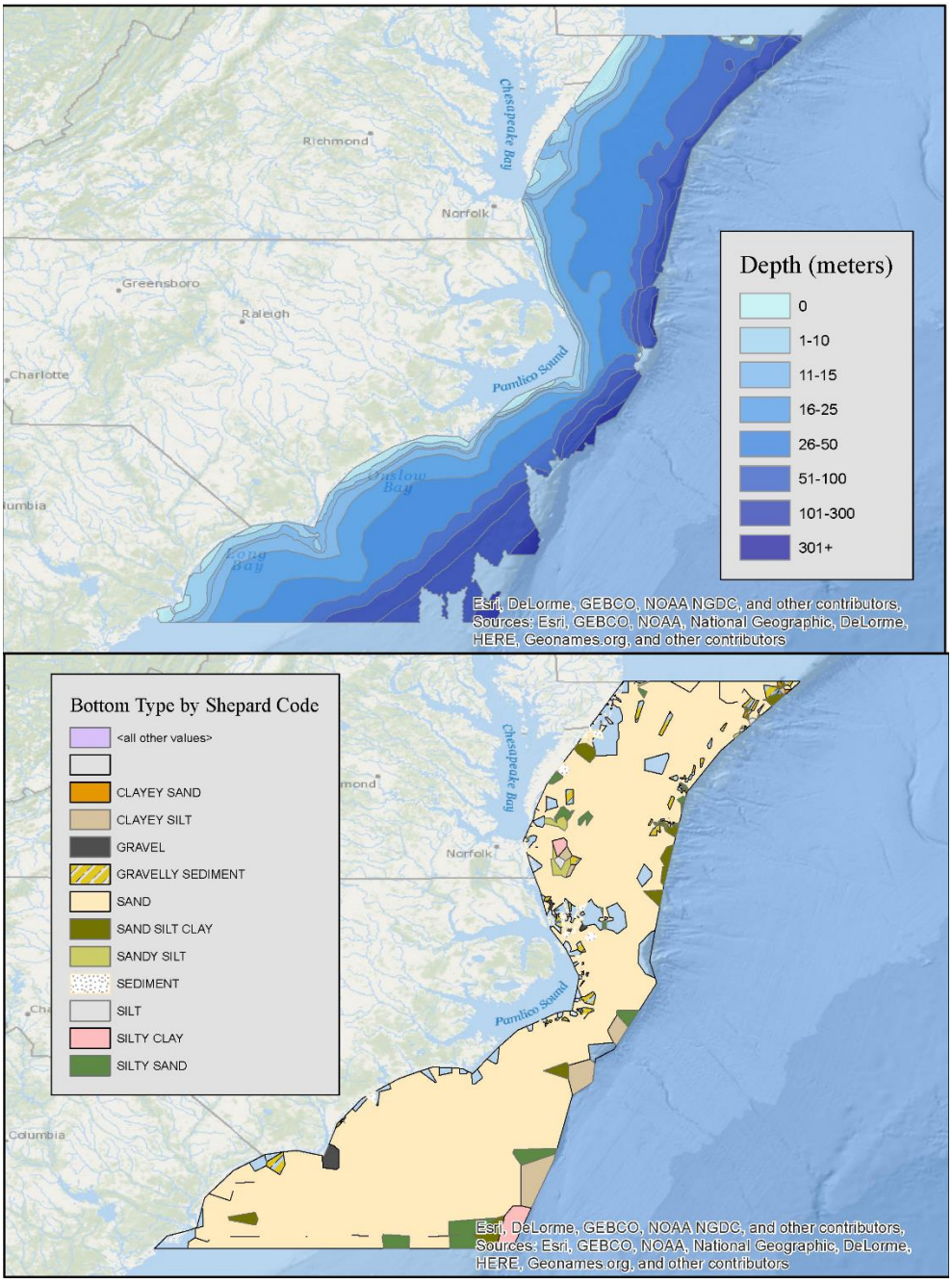


Figure 8. The water depth layer (m, top) and the sediment type layer (Shepard Code, bottom) of the CWTC study area for associating target species with bottom characteristics, created using a GIS base map with overlays (see Objective 4 methods for details). (J. Osborne).

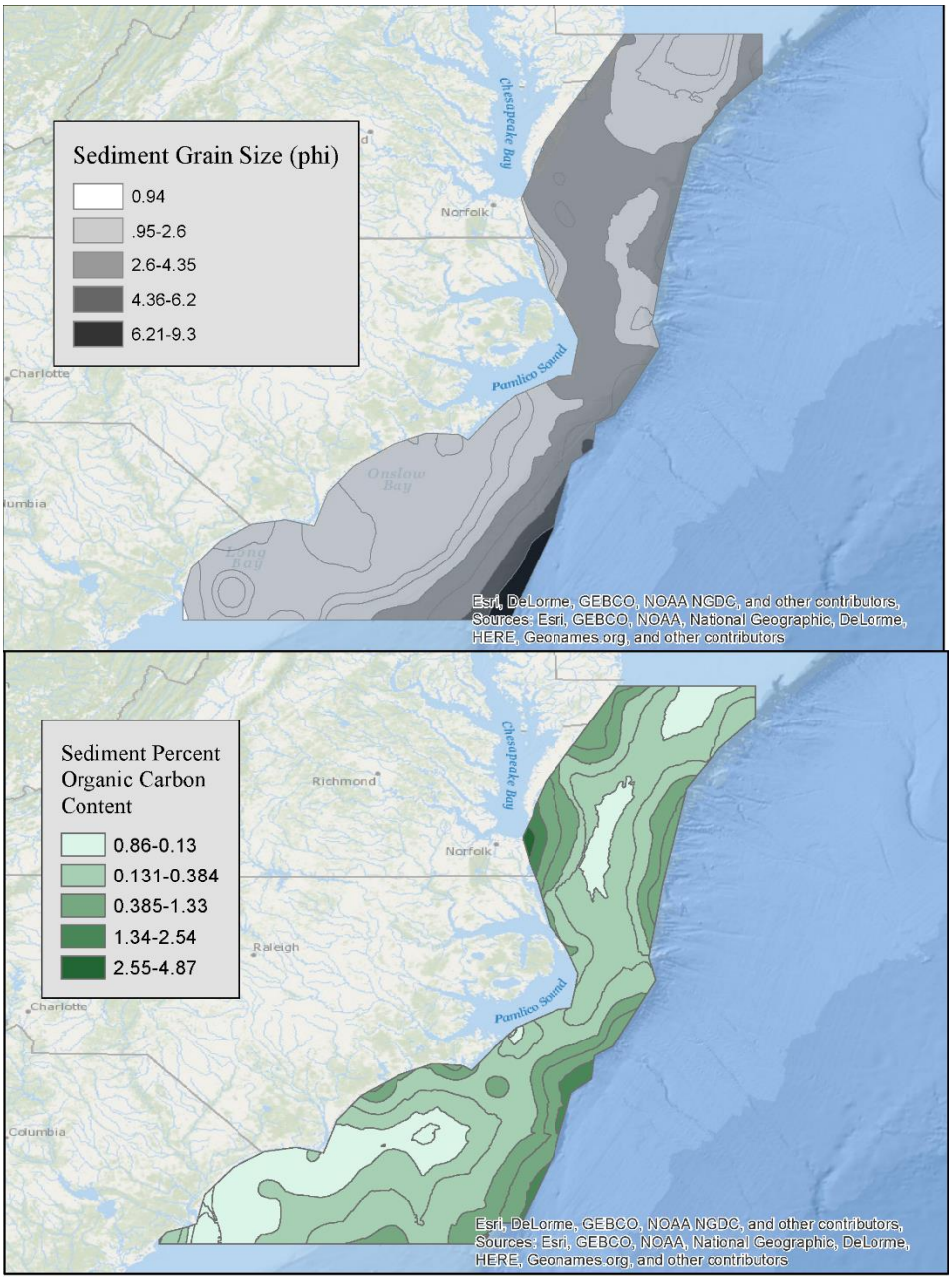


Figure 9. The sediment grain size layer (phi, top) and the sediment percent organic carbon content layer (percent, bottom) of the CWTC study area for associating target species with bottom characteristics, created using a GIS base map with overlays (see Objective 4 methods for details). (J. Osborne).

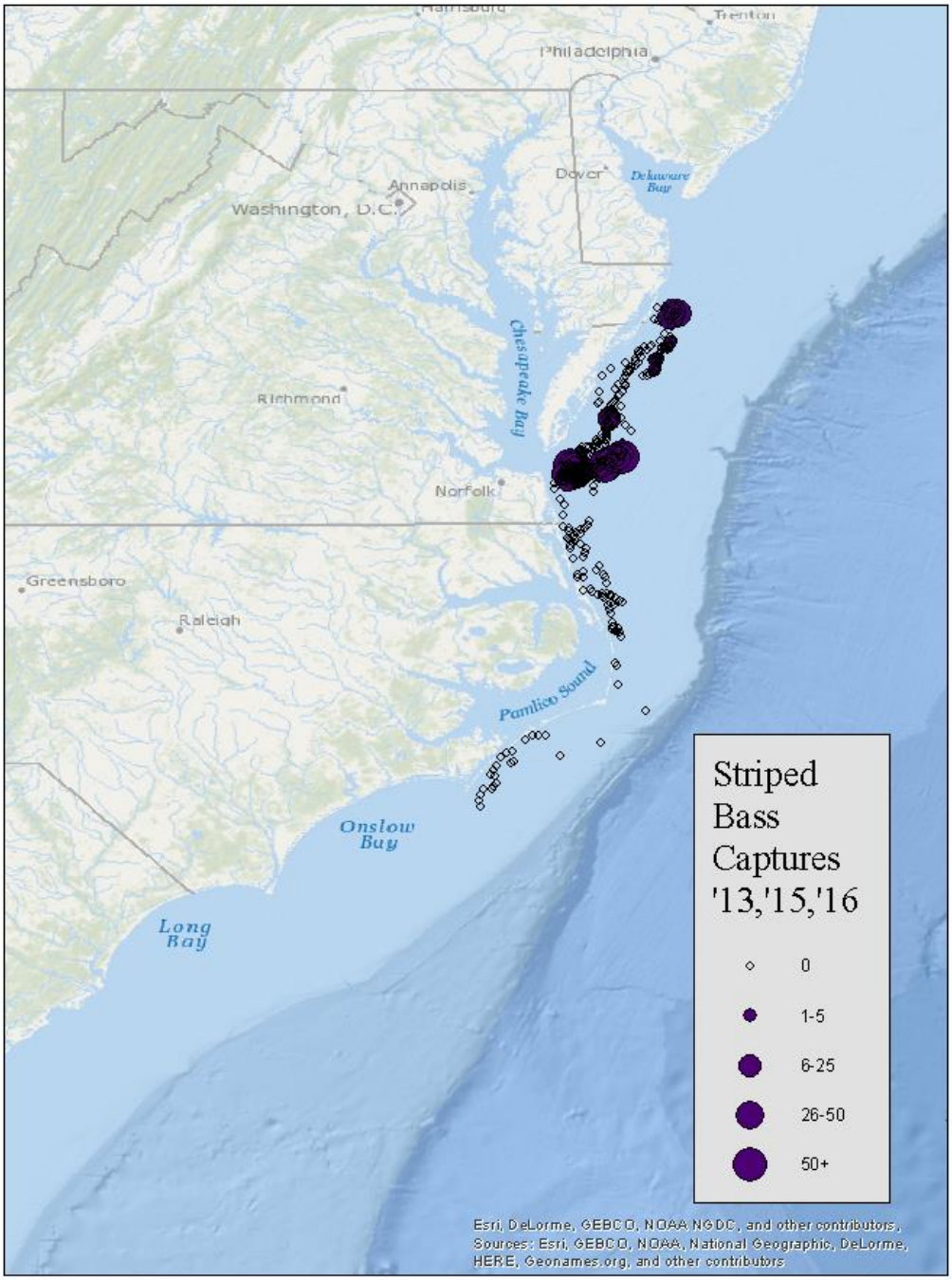


Figure 10. Locations of Striped Bass captured during the 2013, 2015, and 2016 Cooperative Winter Tagging Cruises. (J. Osborne).

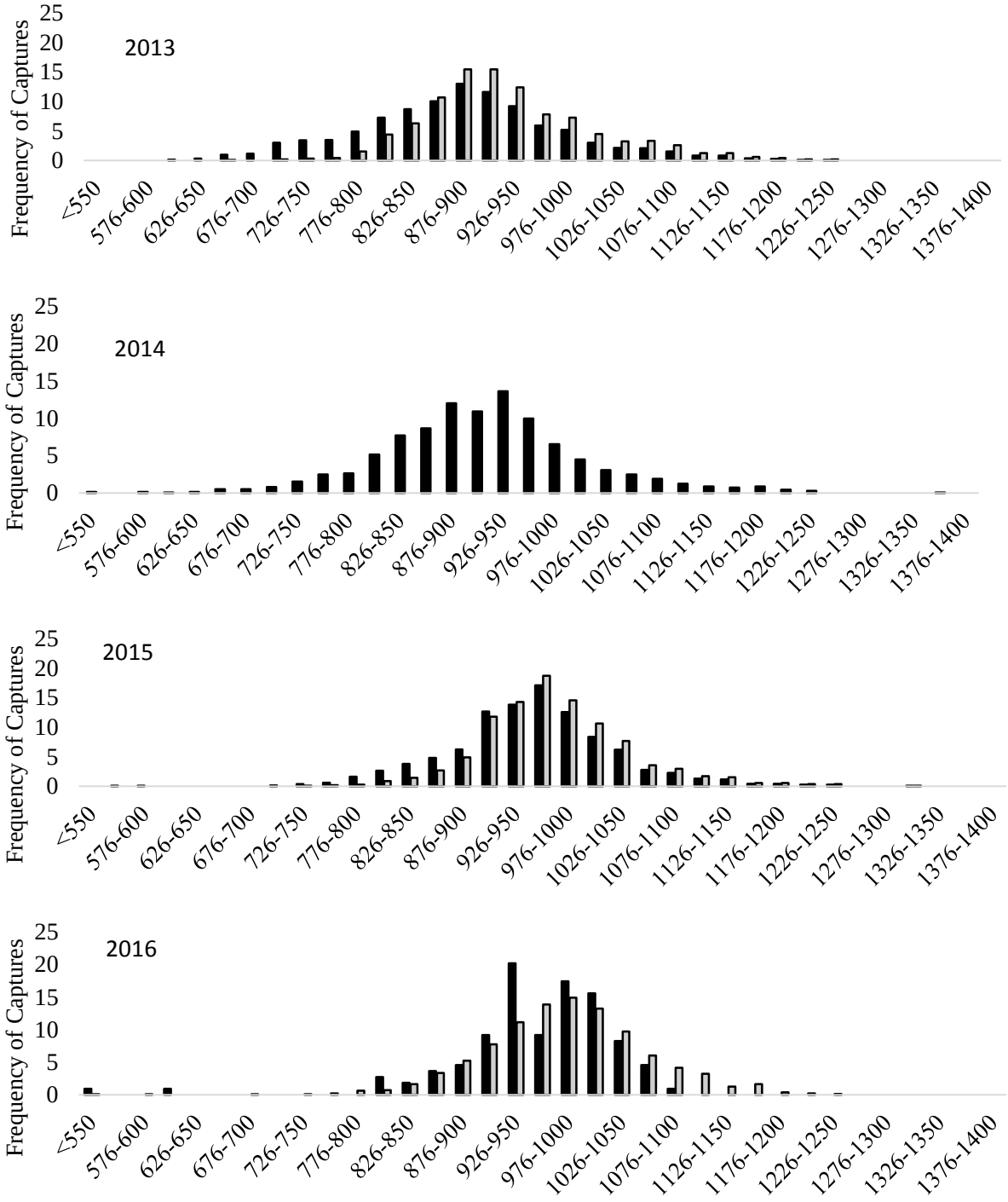


Figure 11. Striped Bass length-frequency, by year and gear type caught during the annual Cooperative Winter Tagging Cruises, 2013-2016. Grey bars, hook-and-line, Black bars, trawl. (C. Godwin).

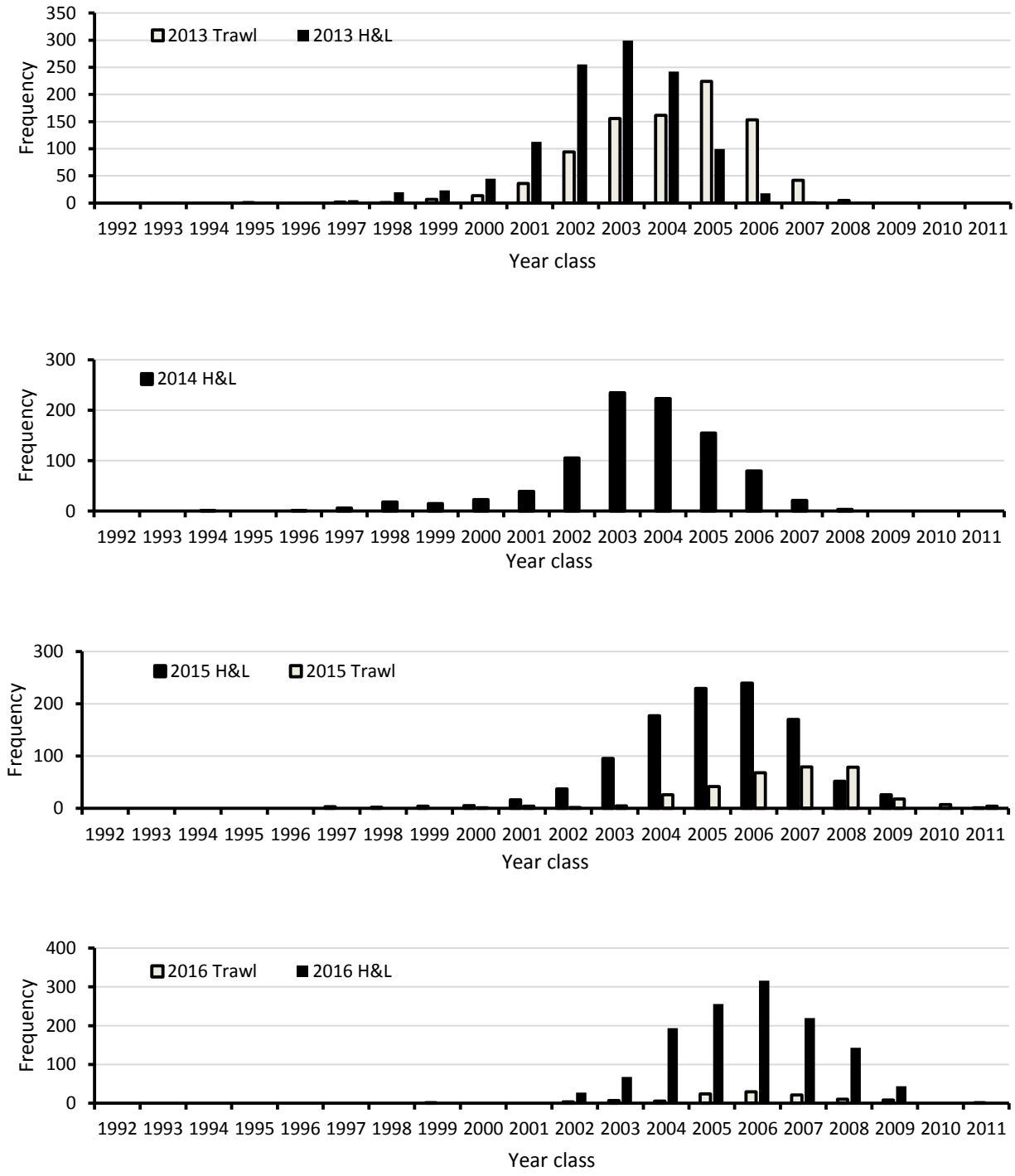


Figure 12. Year class distribution of Striped Bass by gear type for the Cooperative Winter Tagging Cruises in 2013, 2014 (H&L only), 2015, and 2016. Black = H&L; Gray = Trawl. (R. Rulifson).

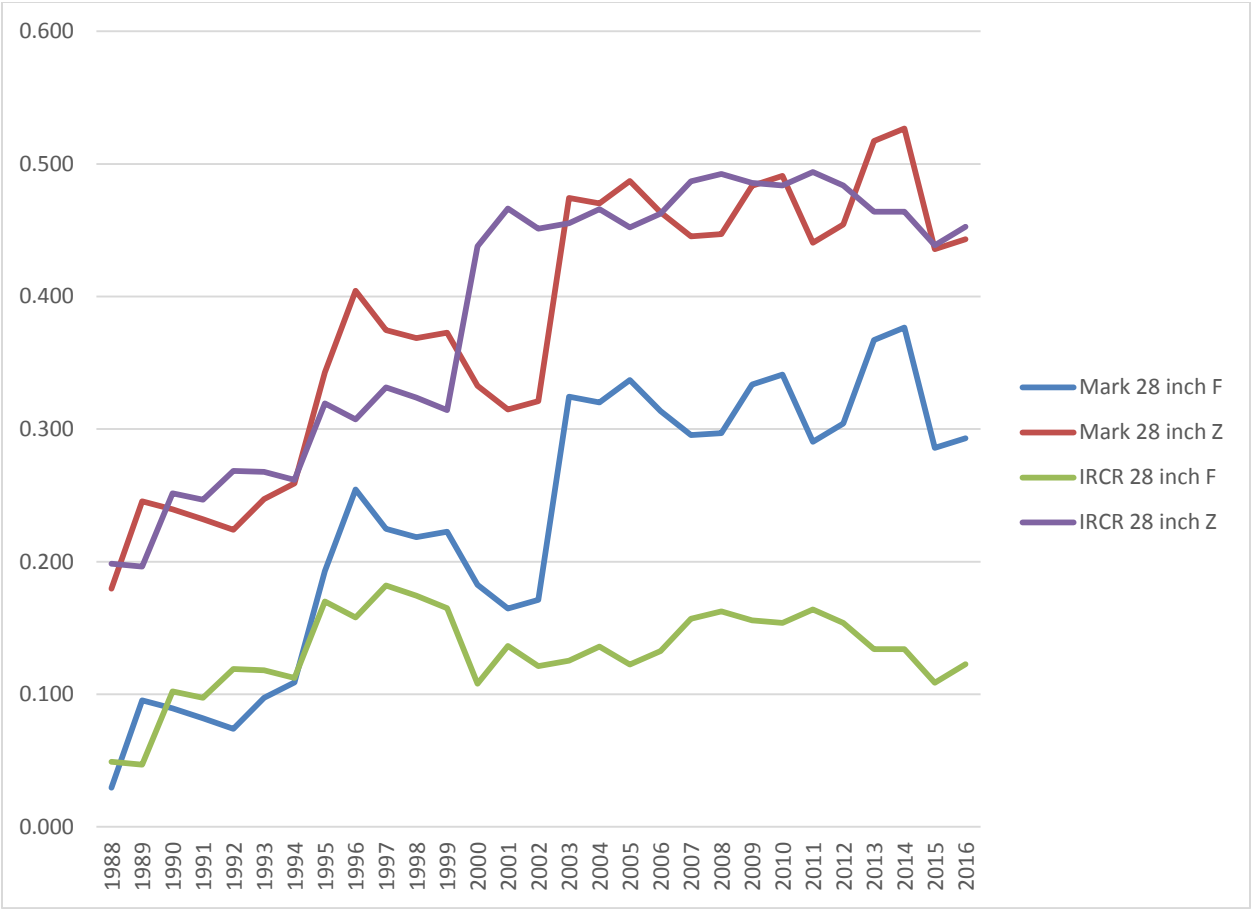


Figure 13. Plots of total (Z) and fishing (F) mortality for Striped Bass tagged on the Cooperative Winter Tagging Cruises, 1988-2016 (includes recaptures of both trawl-tagged and hook-and-line tagged fish). (S. Welsh).

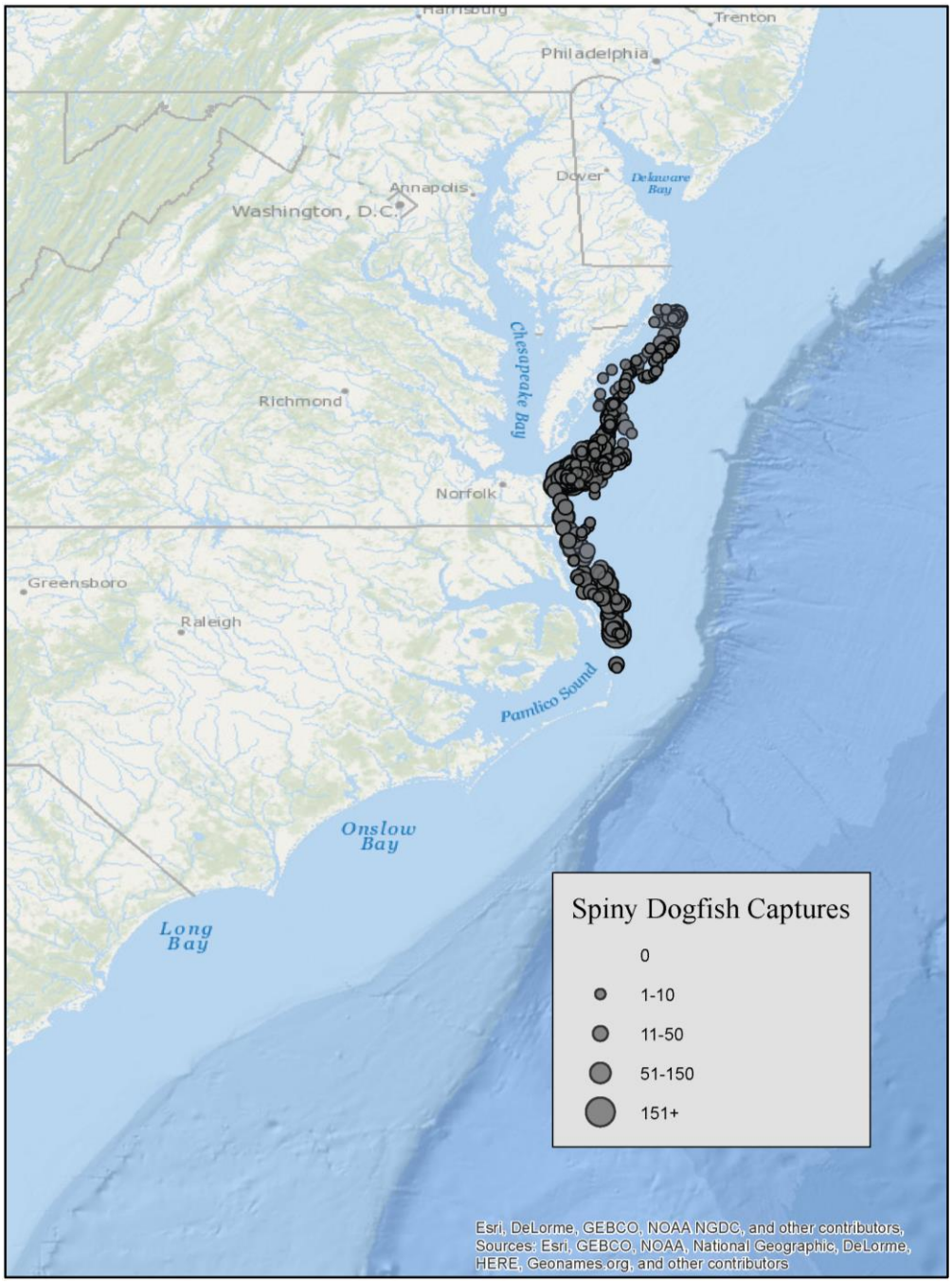


Figure 14. Locations of Spiny Dogfish captured during the 2013, 2015, and 2016 Cooperative Winter Tagging Cruises. (J. Osborne)

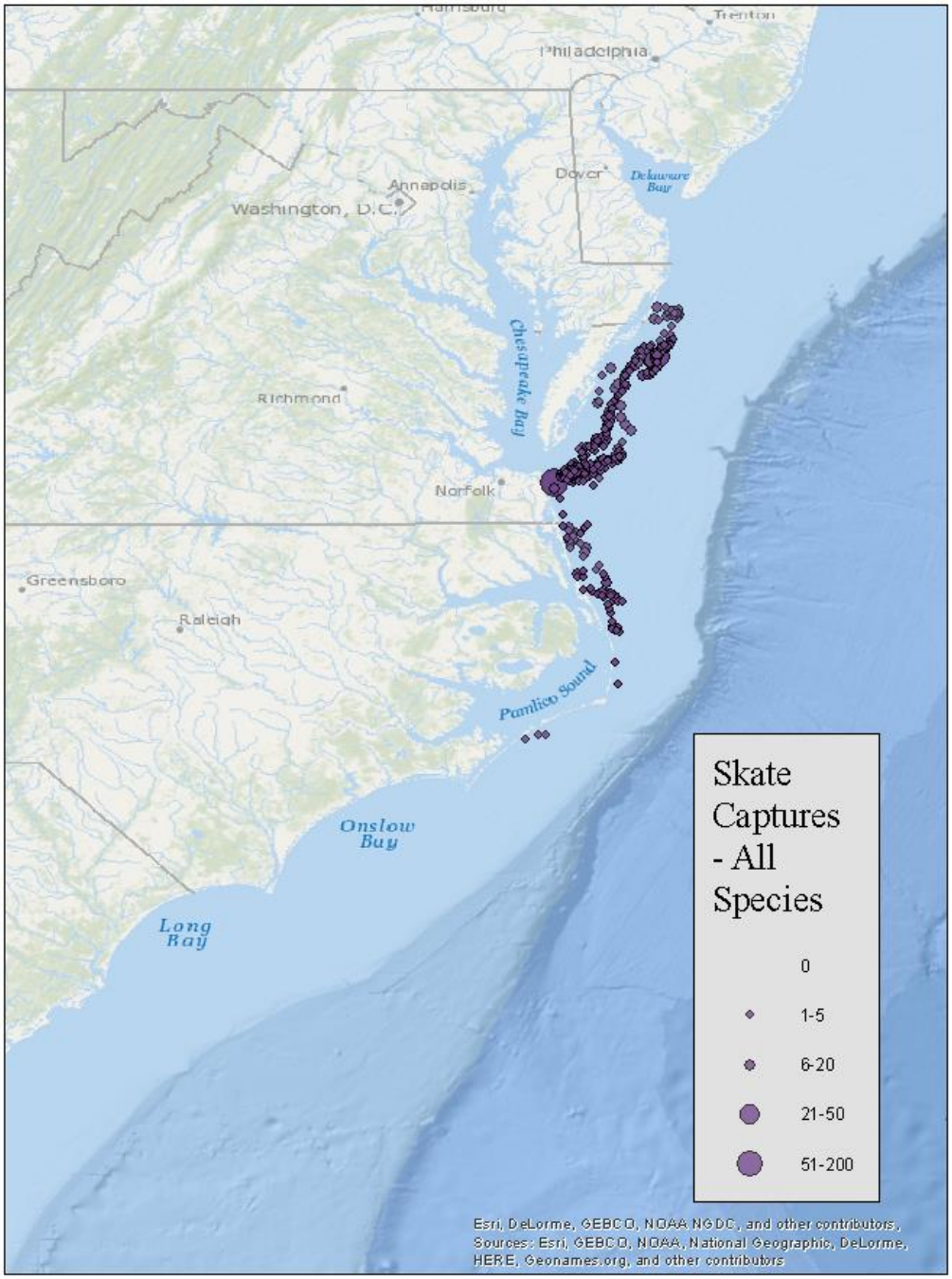


Figure 15. Locations of Skate species captured during the 2013, 2015, and 2016 Cooperative Winter Tagging Cruises. (J. Osborne)

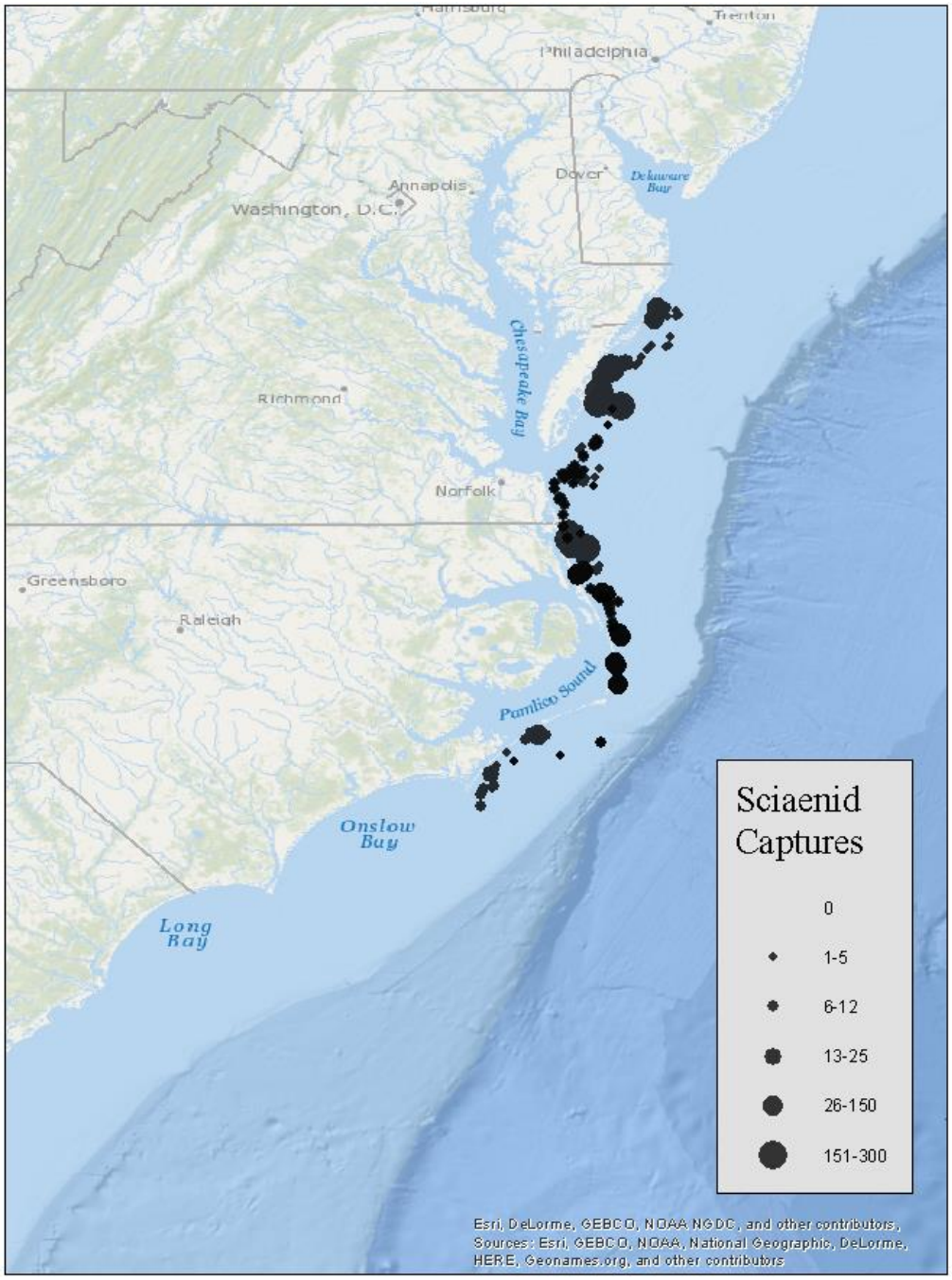


Figure 16. Locations of species of the drum family (Sciaenidae) captured during the 2013, 2015, and 2016 Cooperative Winter Tagging Cruises. (J. Osborne).

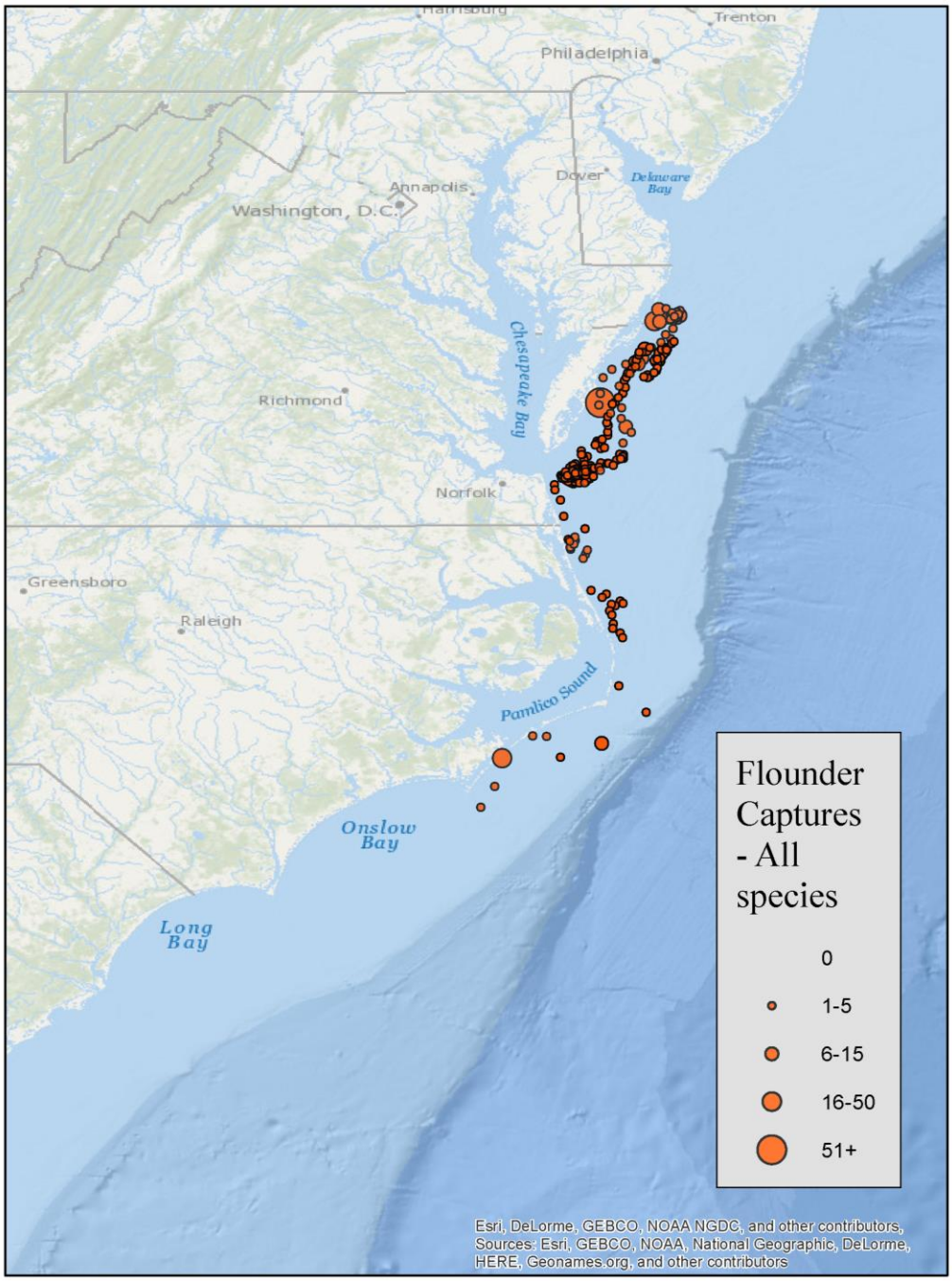


Figure 17. Locations of flounder species captured during the 2013, 2015, and 2016 Cooperative Winter Tagging Cruises. (J. Osborne).

North Carolina Cooperative Tagging Program Recaptures Tagged From 2013-2016

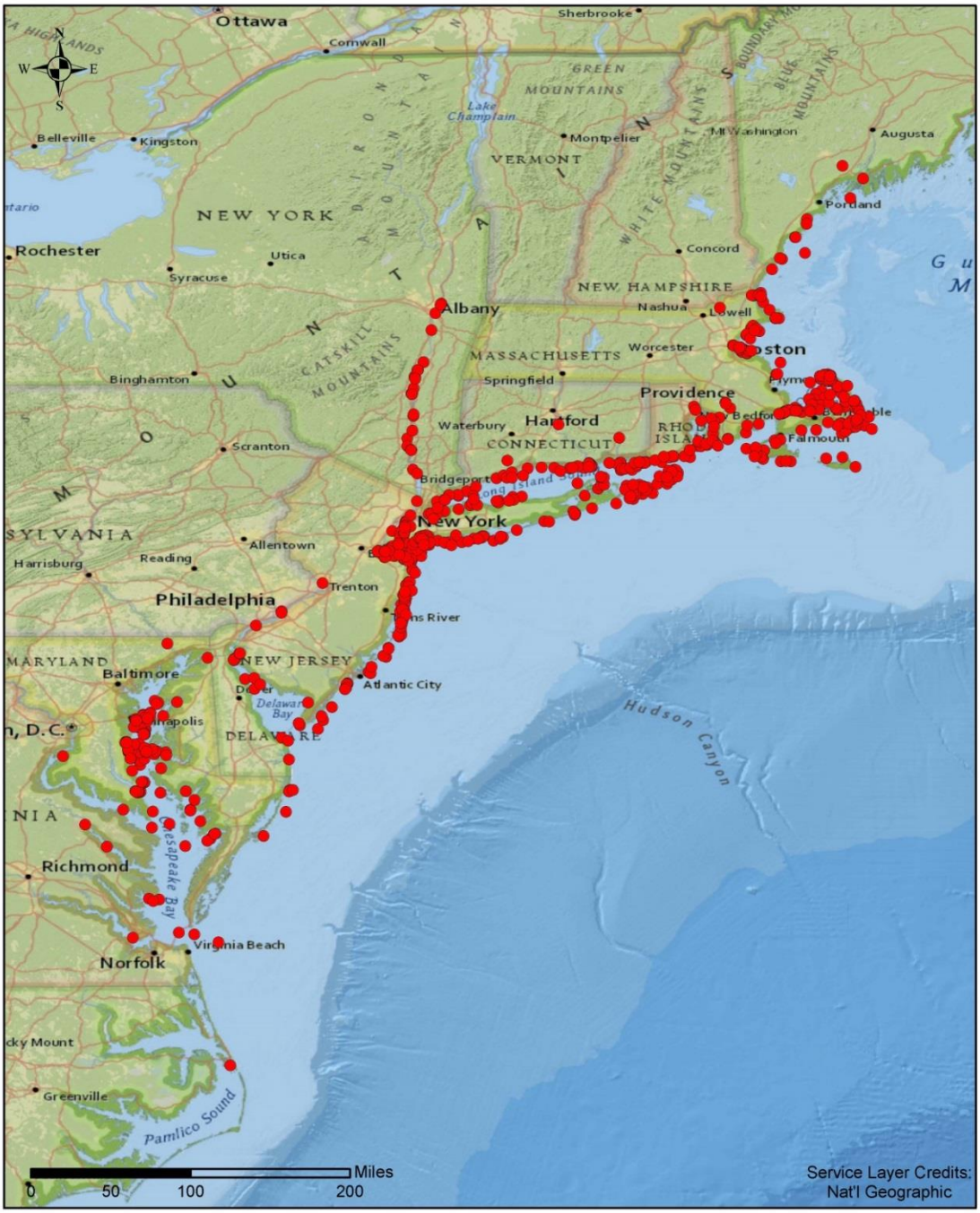


Figure 18. Locations of reported Striped Bass recaptures for fish tagged during the 2013-2016 Cooperative Winter Tagging Cruises. Recapture data plotted through August 2017. One fish recaptured in the St. Johns River, Canada, is not depicted. (B. Van Druten).

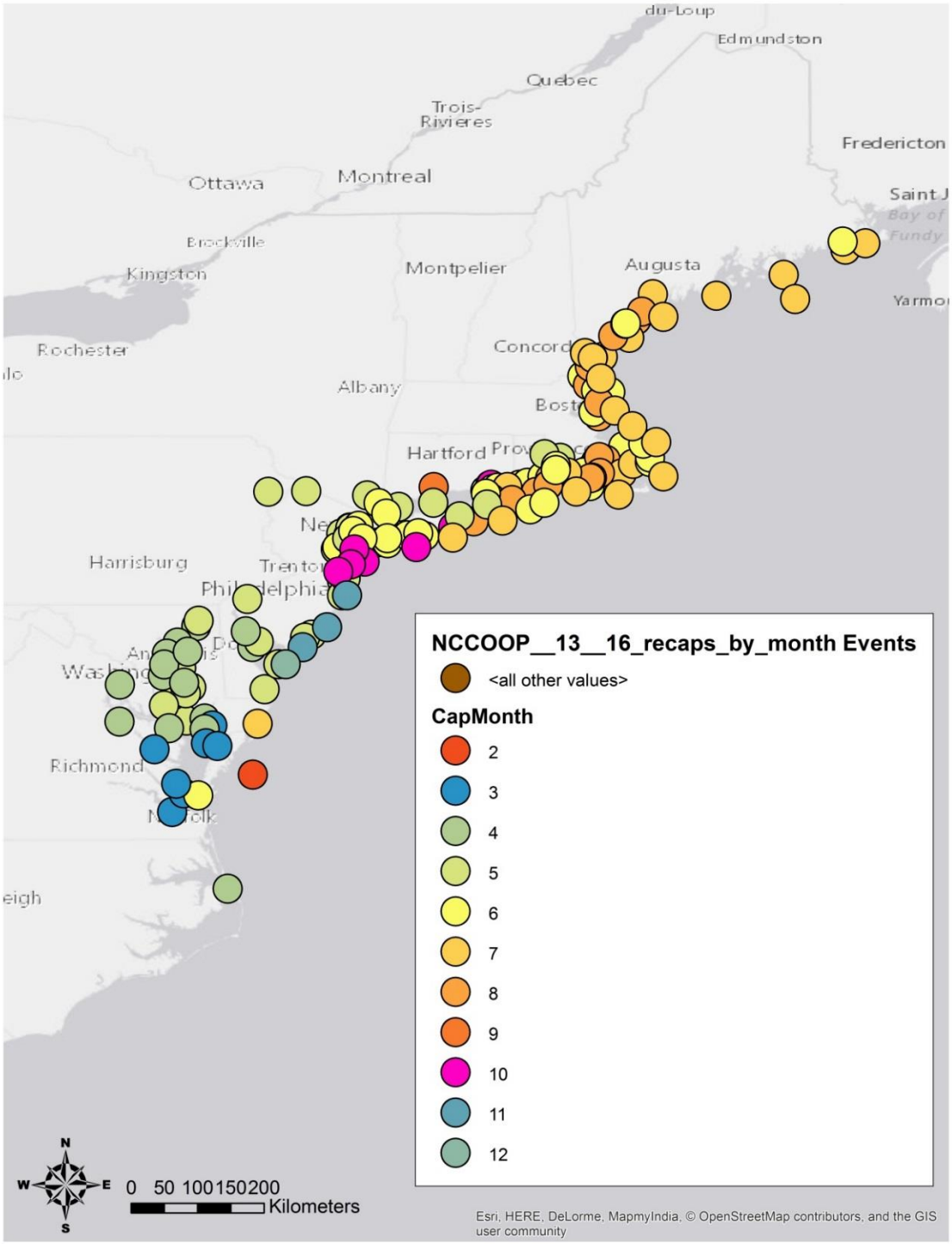


Figure 19. Striped Bass recaptures from those fish tagged and released during the Cooperative Winter Tagging Cruises, trawl and hook-and-line data combined, through August 2017, depicted by month of capture. (J. Newhard).

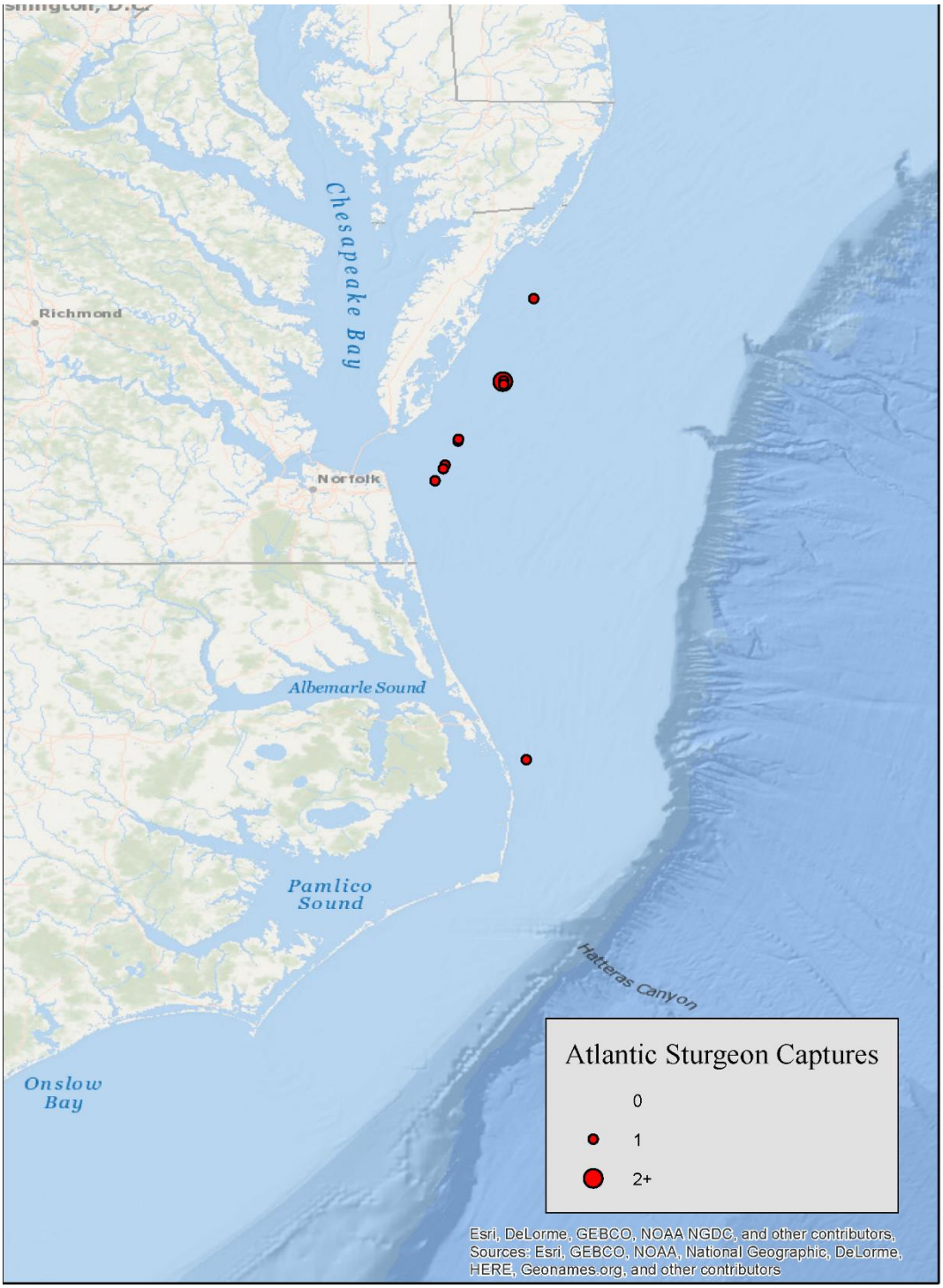


Figure 20. Locations of Atlantic Sturgeon captured by trawl during 2013, 2015, and 2016 Cooperative Winter Tagging Cruises. (J. Osborne).

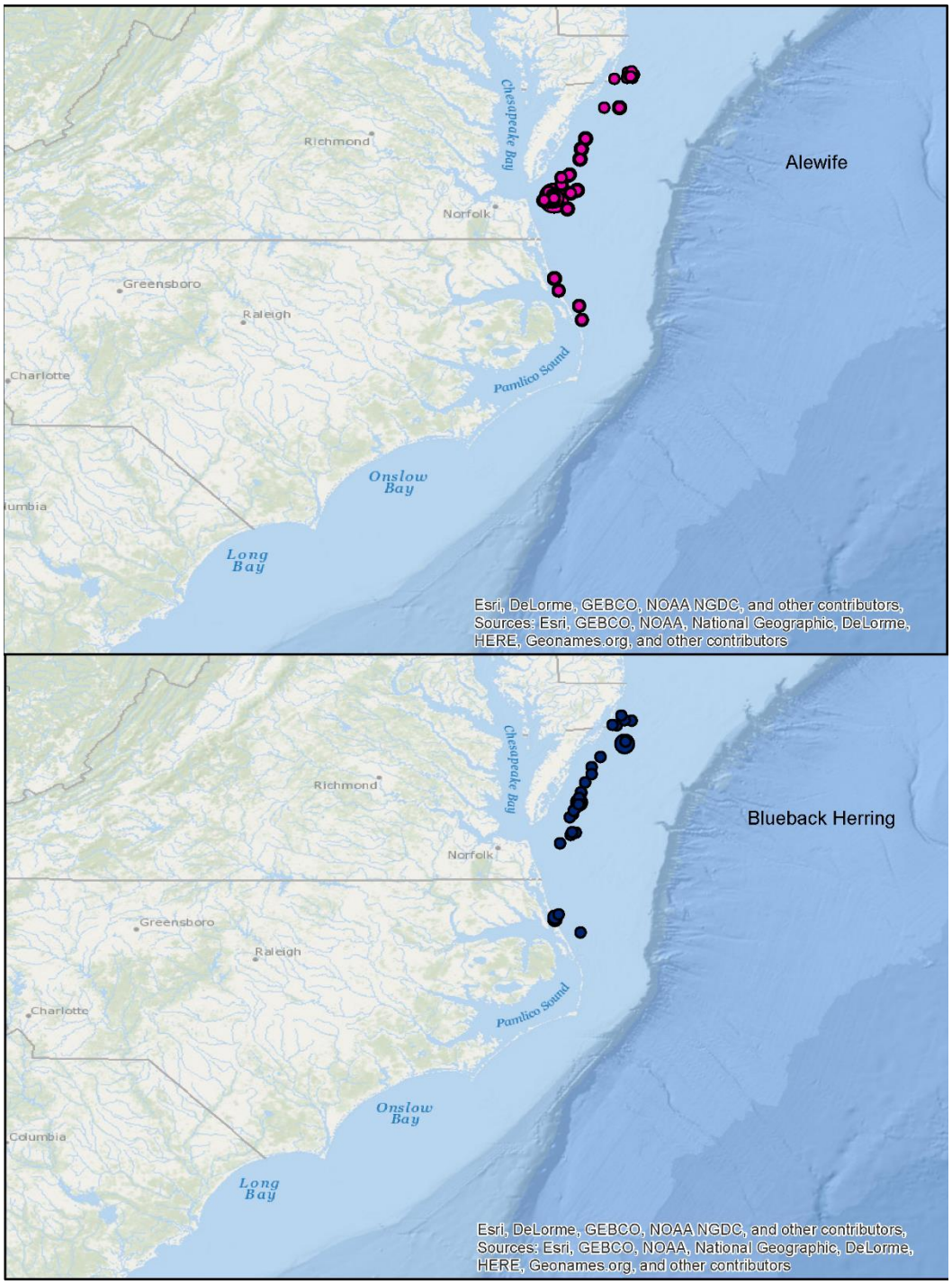
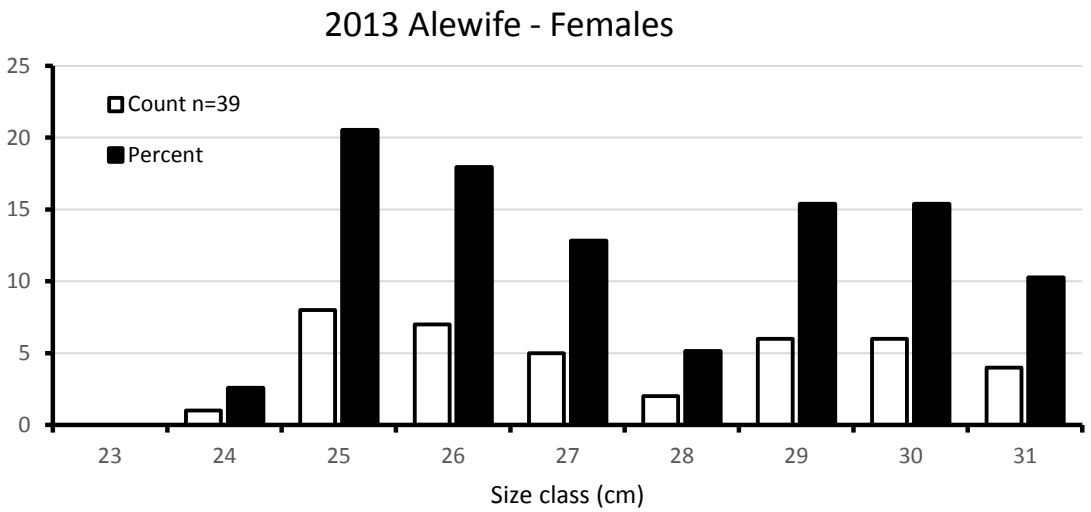


Figure 21. Locations of Alewife (top) and Blueback Herring (bottom) captured by trawl during 2013, 2015, and 2016 Cooperative Winter Tagging Cruises. (J. Osborne).



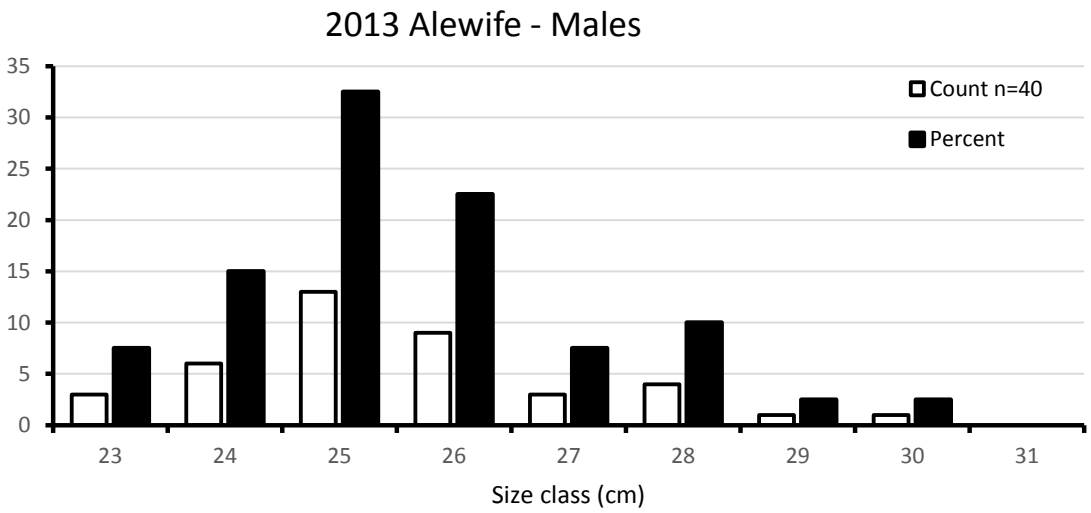


Figure 22. Size classes (TL, cm) of female (top) and male (bottom) Alewife captured by trawl during the 2013 Cooperative Winter Tagging Cruise. (R. Rulifson).

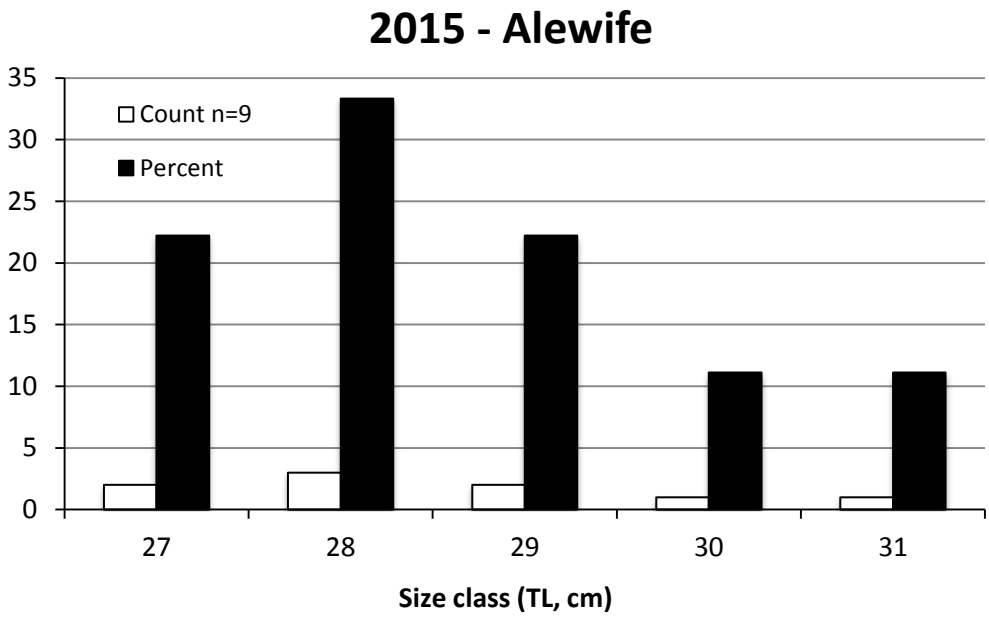


Figure 23. Size classes (TL, cm) of Alewife captured by trawl during the 2015 (top) and 2016 (bottom) Cooperative Winter Tagging Cruises. (R. Rulifson).

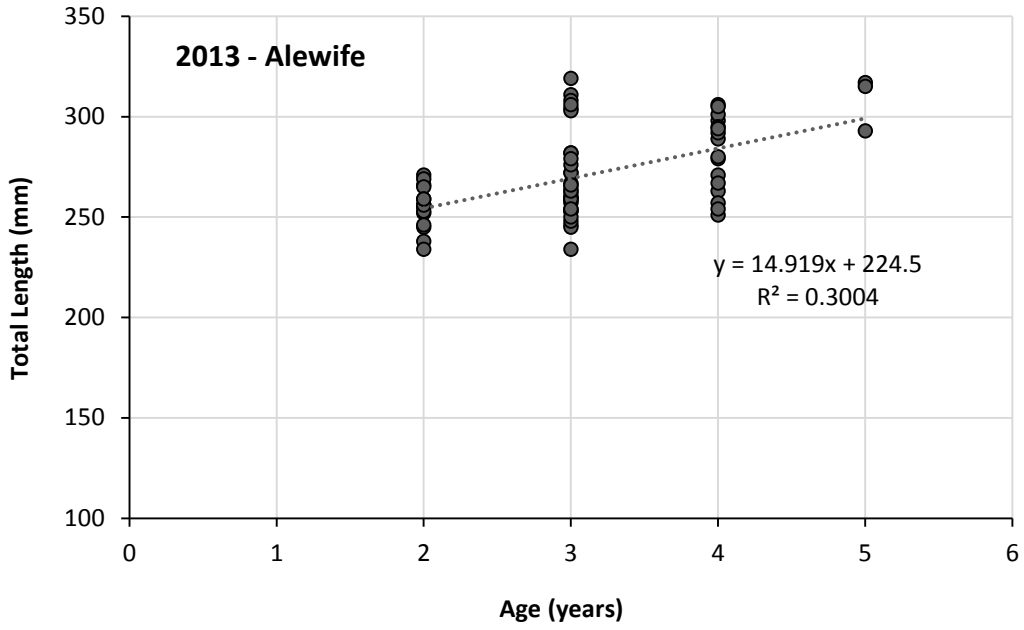


Figure 24. Length (TL, mm) at age (years) relationship of Alewife collected on the continental shelf off the Outer Banks of North Carolina during the 2013 Cooperative Winter Tagging Cruise. (R. Rulifson).

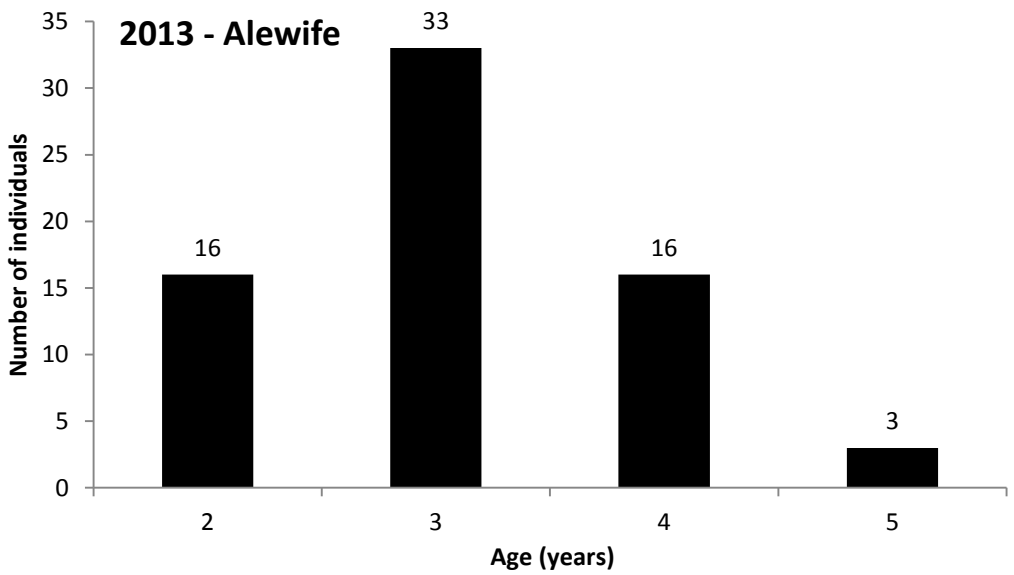


Figure 25. Age frequency of Alewife collected on the continental shelf off the Outer Banks of North Carolina during the 2013 Cooperative Winter Tagging Cruise. (R. Rulifson).

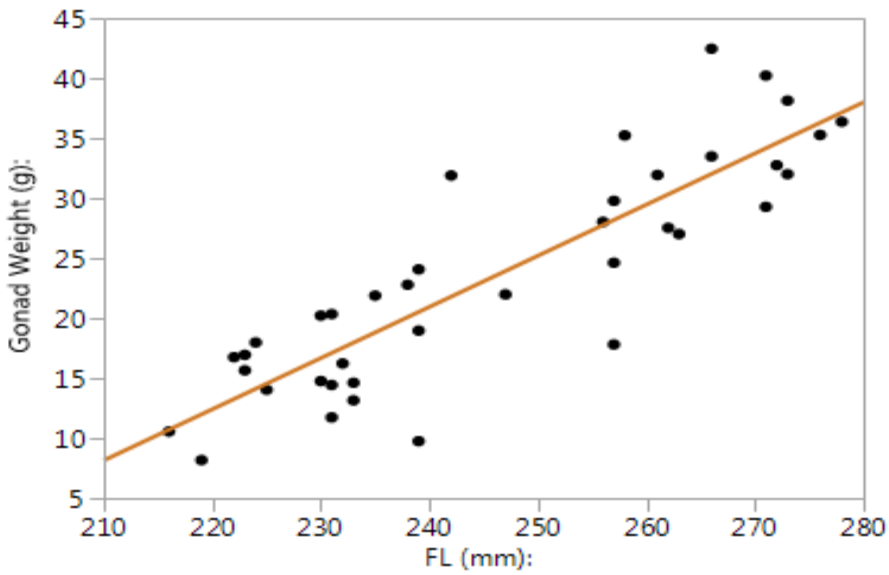


Figure 26. The relationship of gonad weight (GWT) to fish length (FL, mm) of female Alewife caught during the 2013 CWTC, January 8-16, 2013. GWT = -81.363 + 0.426FL; r^2 = 0.76, n = 39, F=116.12; P<0.001. (R. Rulifson).

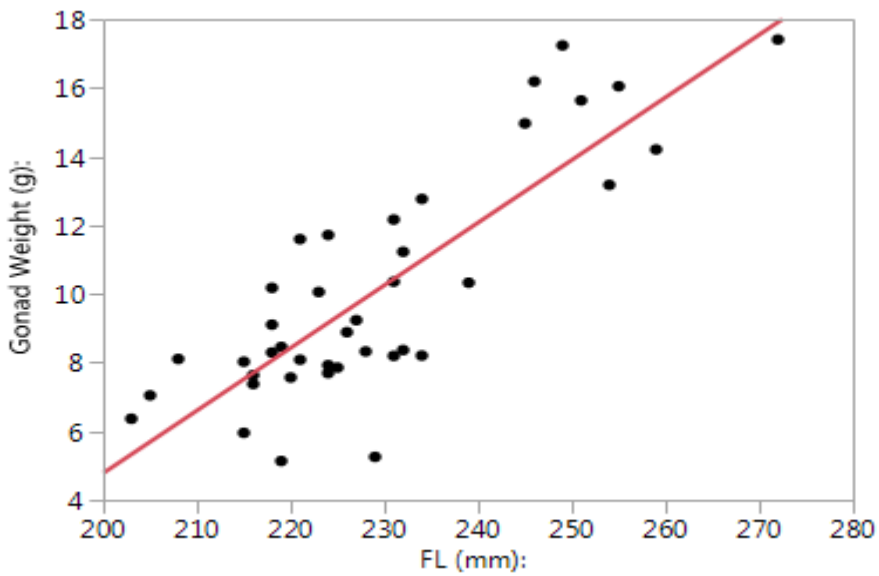


Figure 27. The relationship of gonad weight (GWT) to fish length (FL, mm) of male Alewife caught during the 2013 CWTC, January 8-16, 2013. GWT = -31.692 + 0.182FL; r^2=0.69; n=40; F=84.53; P<0.001. (R. Rulifson).

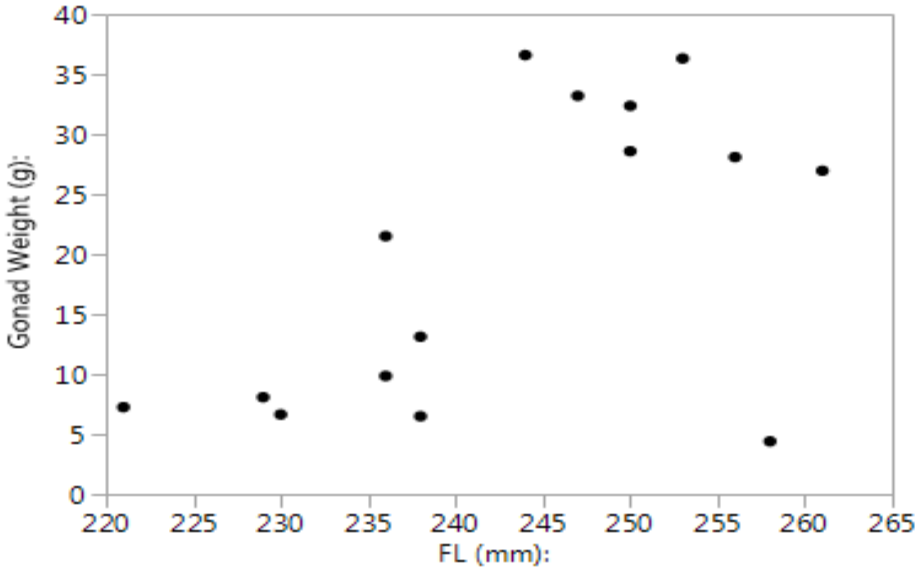


Figure 28. The relationship of gonad weight (g) to fish length (FL, mm) of female Alewife caught during the 2016 CWTC, January 12-18, 2016. (R. Rulifson).

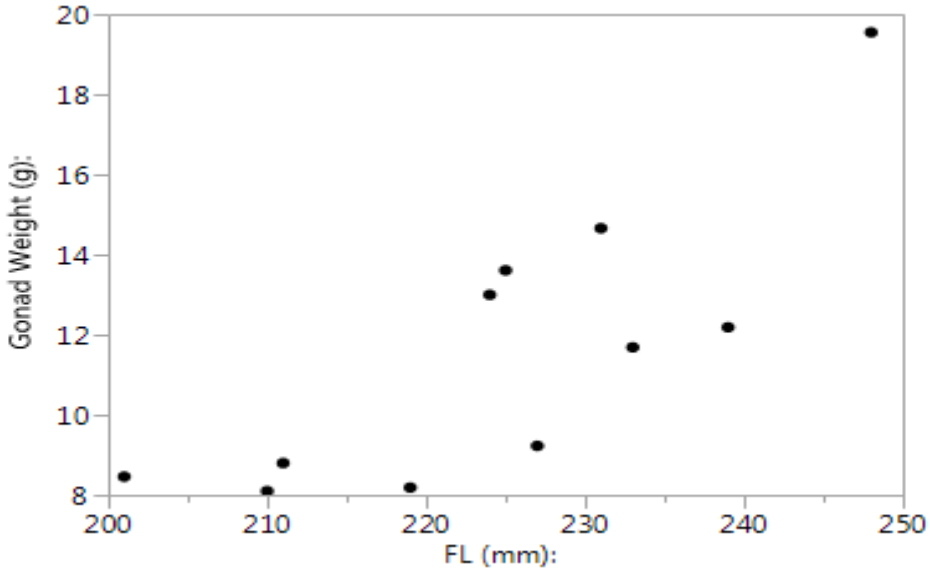


Figure 29. The relationship of gonad weight (g) to fish length (FL, mm) of male Alewife caught during the 2016 CWTC, January 12-18, 2016. (R. Rulifson).

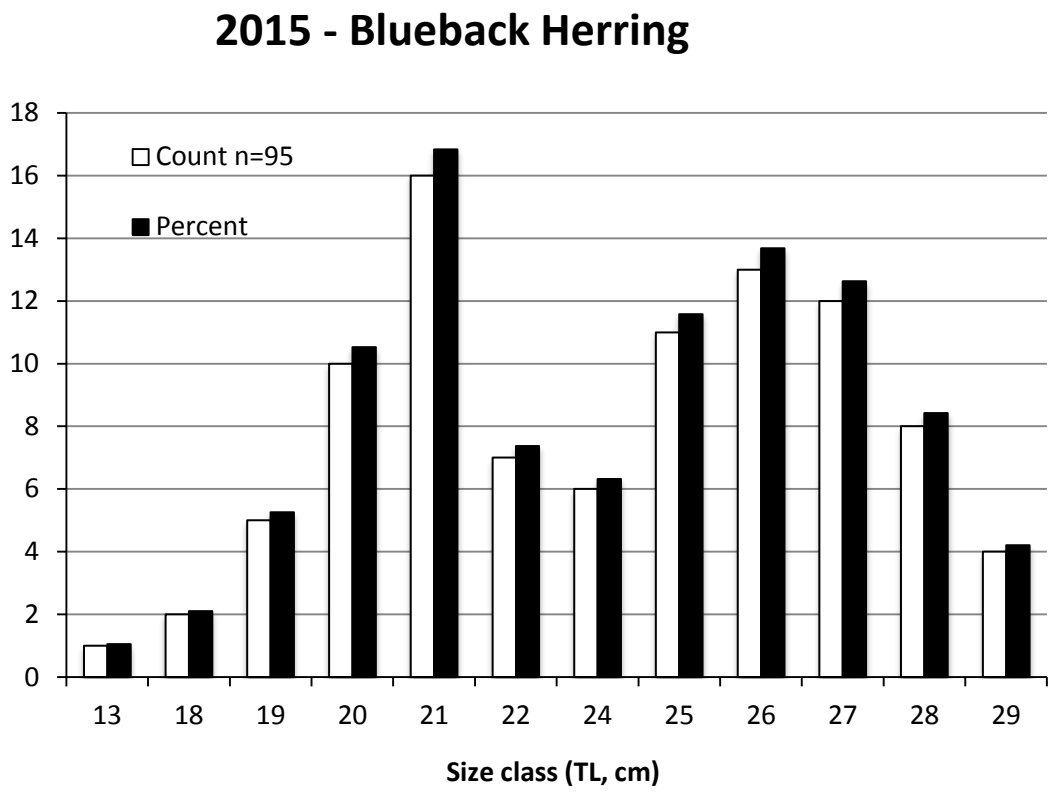


Figure 30. Size classes (TL, cm) of Blueback Herring collected during the 2015 Cooperative Winter Tagging Cruise. No Blueback Herring were caught during the 2016 CWTC. (R. Rulifson).

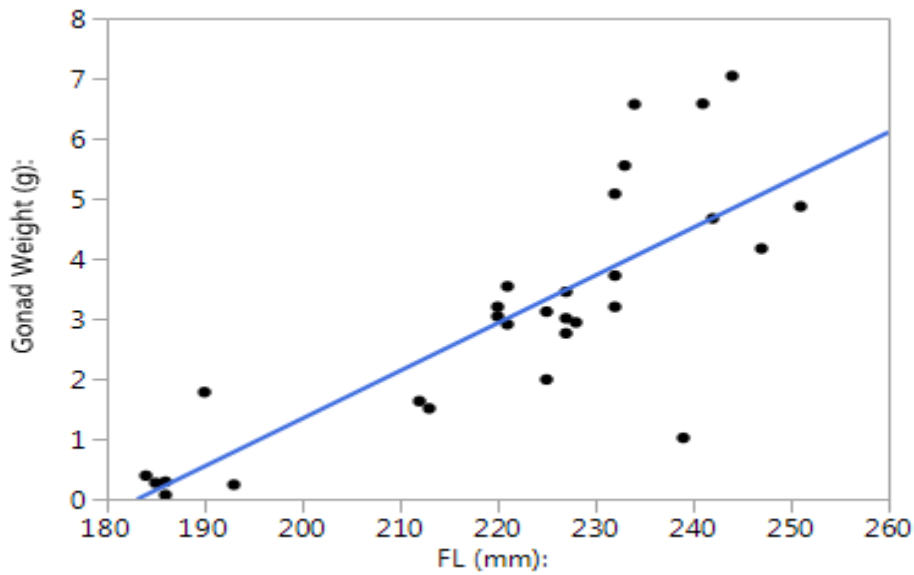


Figure 31. The relationship of gonad weight (GWT, g) to fish length (FL, mm) of Female Blueback Herring caught during the 2015 CWTC, January 10-18, 2015. GWT = -14.540 + 0.079FL; r^2 = 0.64; n = 30; F = 49.99; P <0.001. (R. Rulifson).

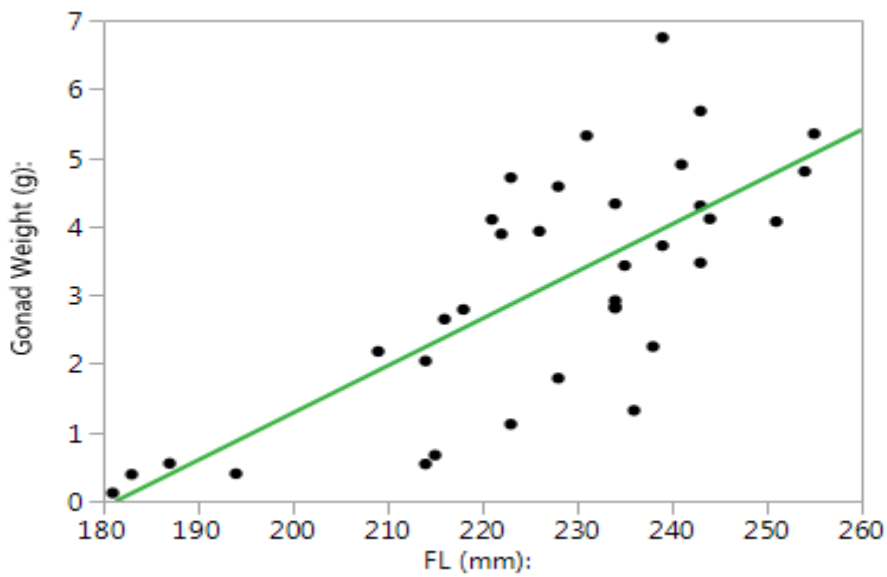


Figure 32. The relationship of gonad weight (GWT, g) to fish length (FL, mm) of male Blueback Herring caught during the 2015 CWTC, January 10-18, 2015. GWT = -12.456 + 0.069FL; r^2 = 0.55; n = 35; F = 39.743; P <0.001. (R. Rulifson).

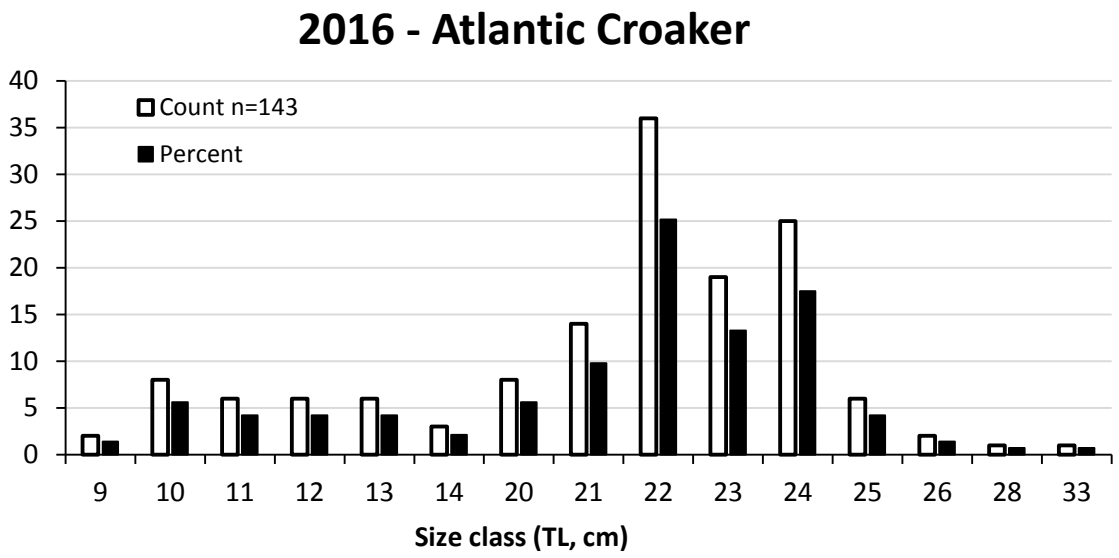
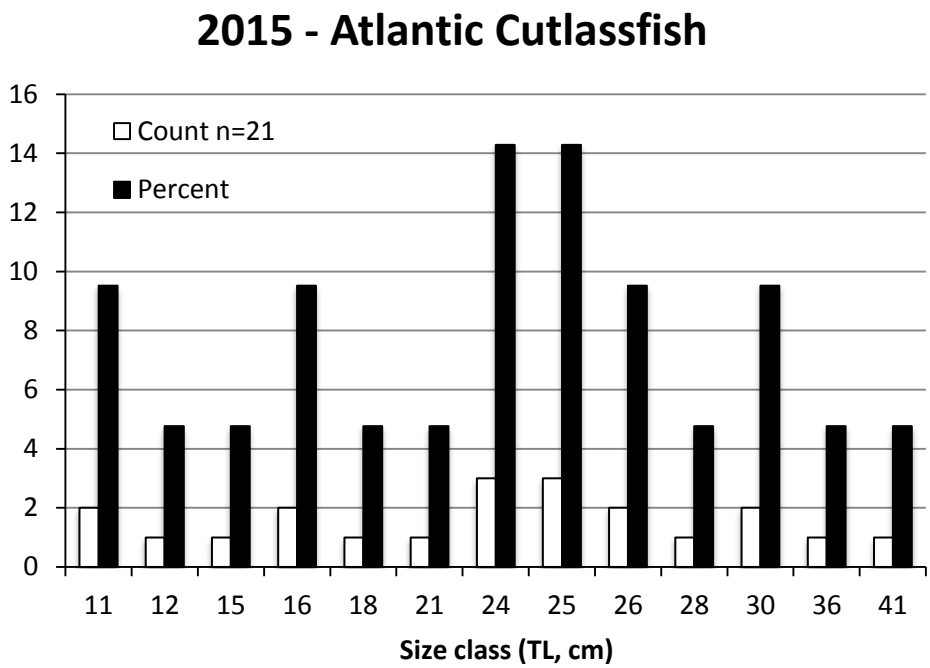


Figure 33. Size classes (TL, cm) of Atlantic Croaker collected during the 2016 Cooperative Winter Tagging Cruise. (R. Rulifson).



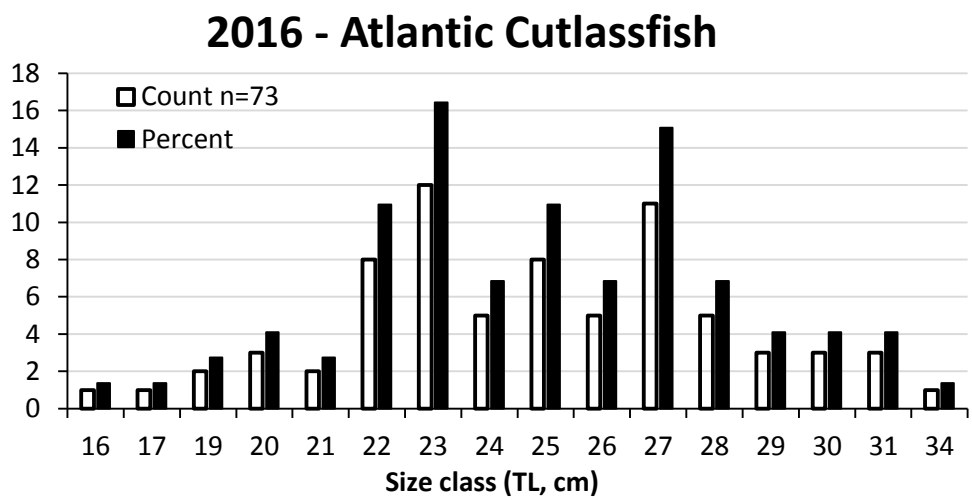
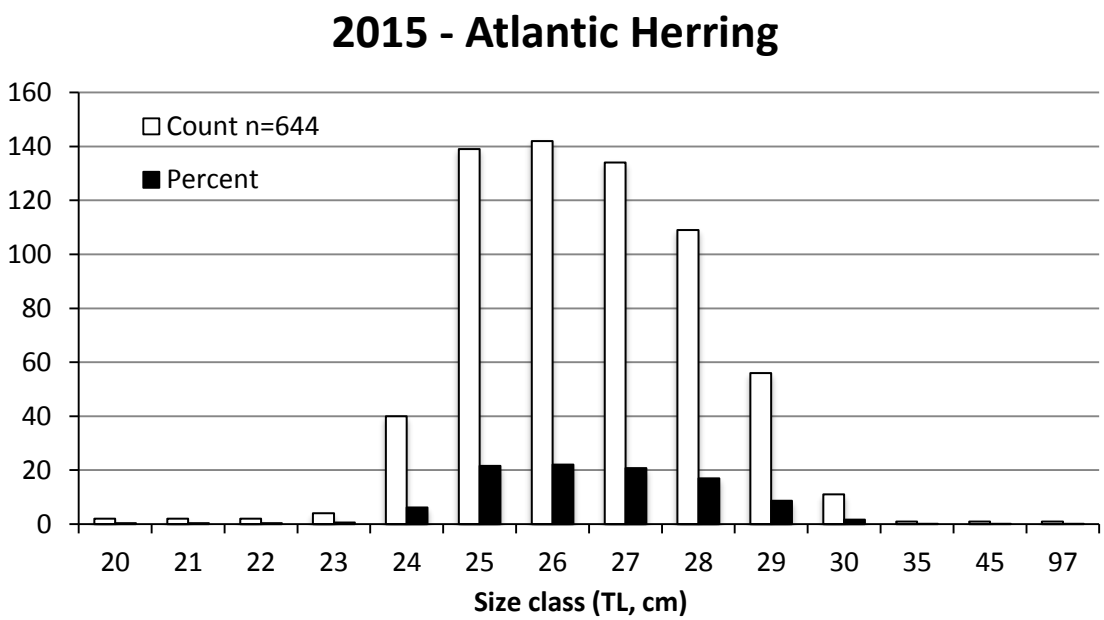


Figure 34. Size classes (TL, cm) of Atlantic Cutlassfish collected during the 2015 (top) and 2016 (bottom) Cooperative Winter Tagging Cruises. (R. Rulifson).



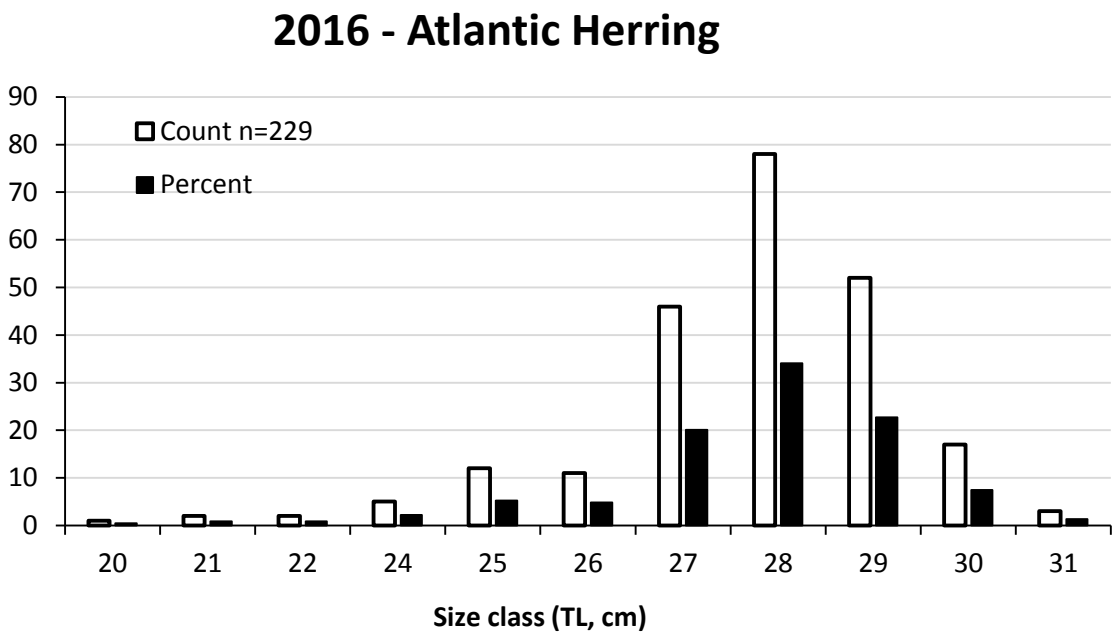


Figure 35. Size classes (TL, cm) of Atlantic Herring collected during the 2015 (top) and 2016 (bottom) Cooperative Winter Tagging Cruises. (R. Rulifson).

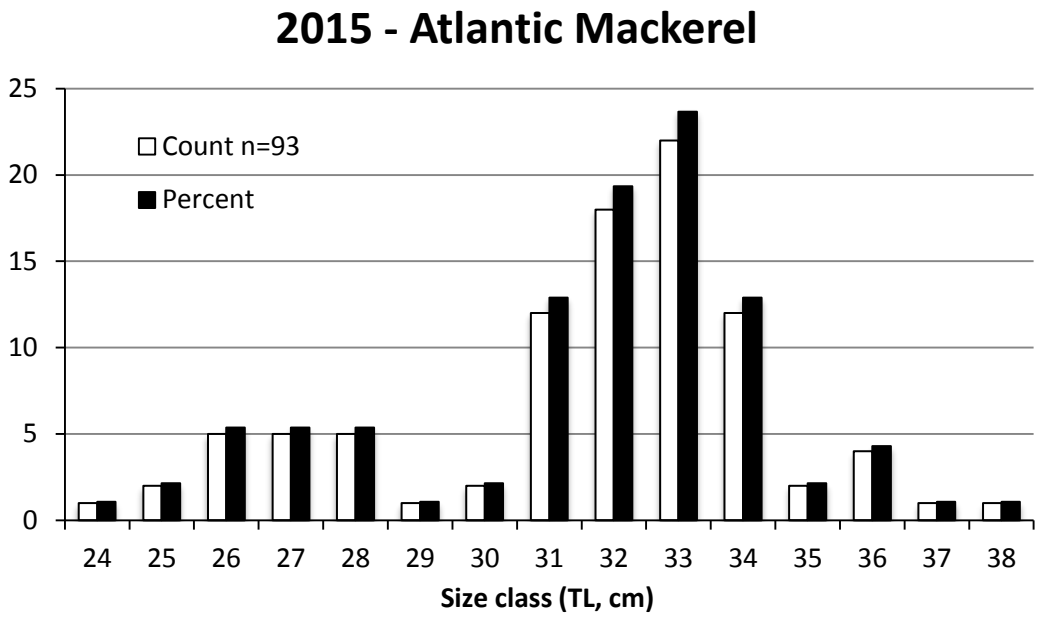


Figure 36. Size classes (TL, cm) of Atlantic Mackerel collected during the 2015 Cooperative Winter Tagging Cruise. (R. Rulifson).

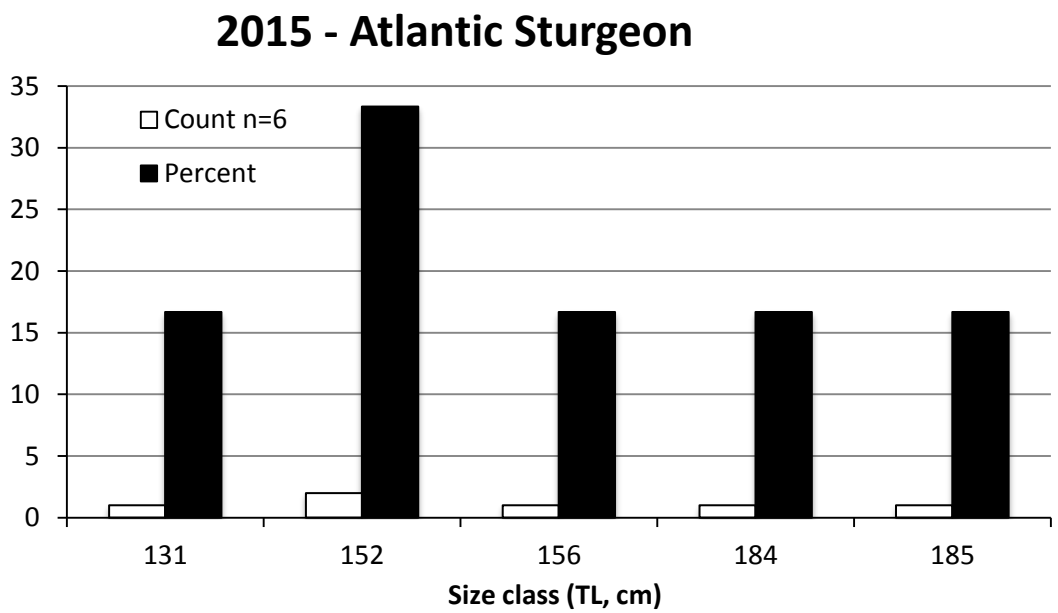
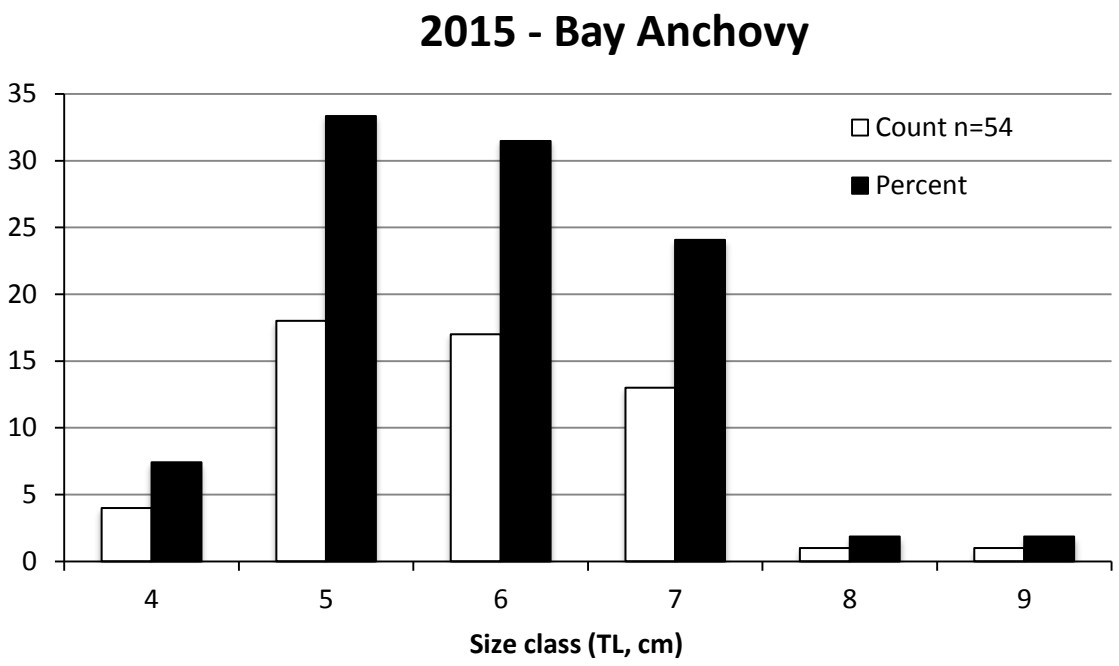


Figure 37. Size classes (TL, cm) of Atlantic Sturgeon collected during the 2015 Cooperative Winter Tagging Cruise. (R. Rulifson).



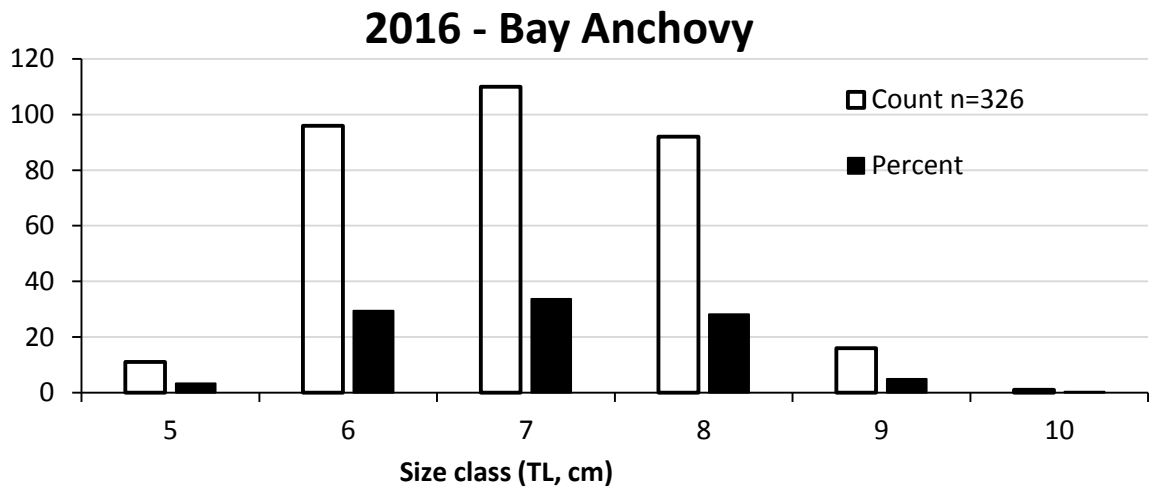


Figure 38. Size classes (TL, cm) of Bay Anchovy collected during the 2015 (top) and 2016 (bottom) Cooperative Winter Tagging Cruises. (R. Rulifson).

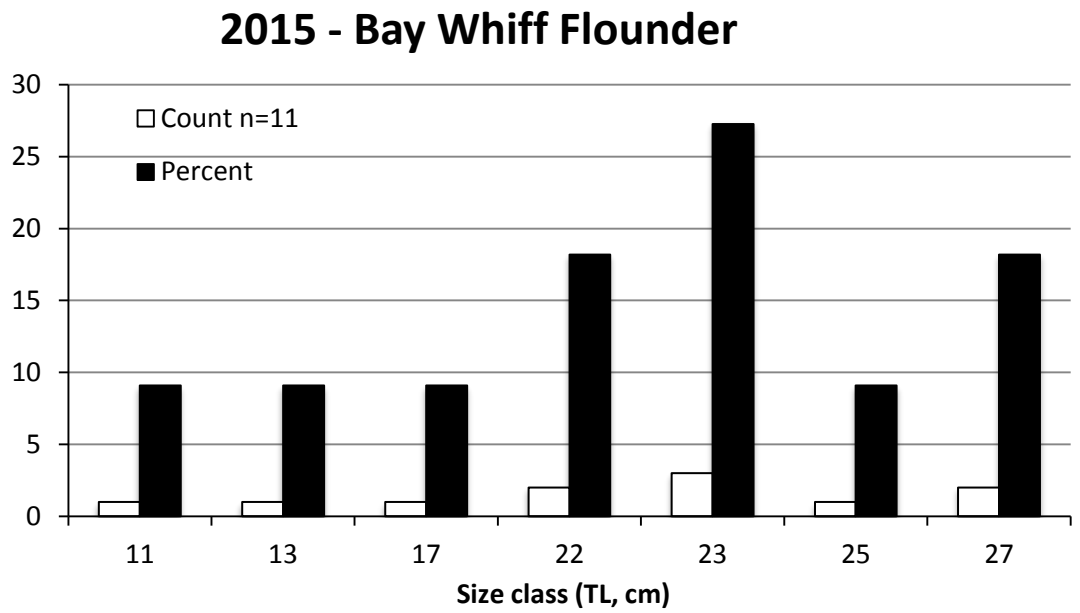


Figure 39. Size classes (TL, cm) of Bay Whiff flounder collected during the 2015 Cooperative Winter Tagging Cruise. (R. Rulifson).

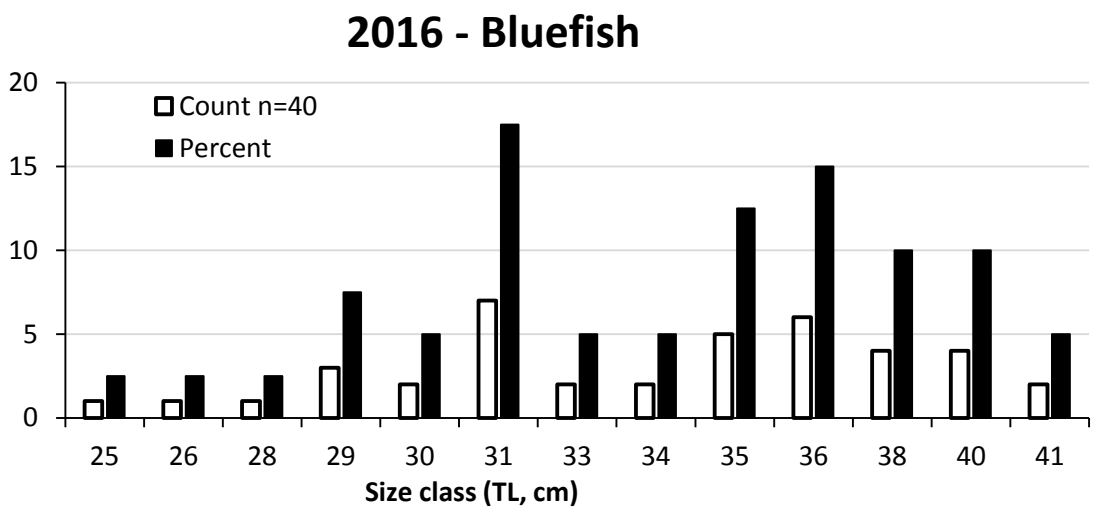
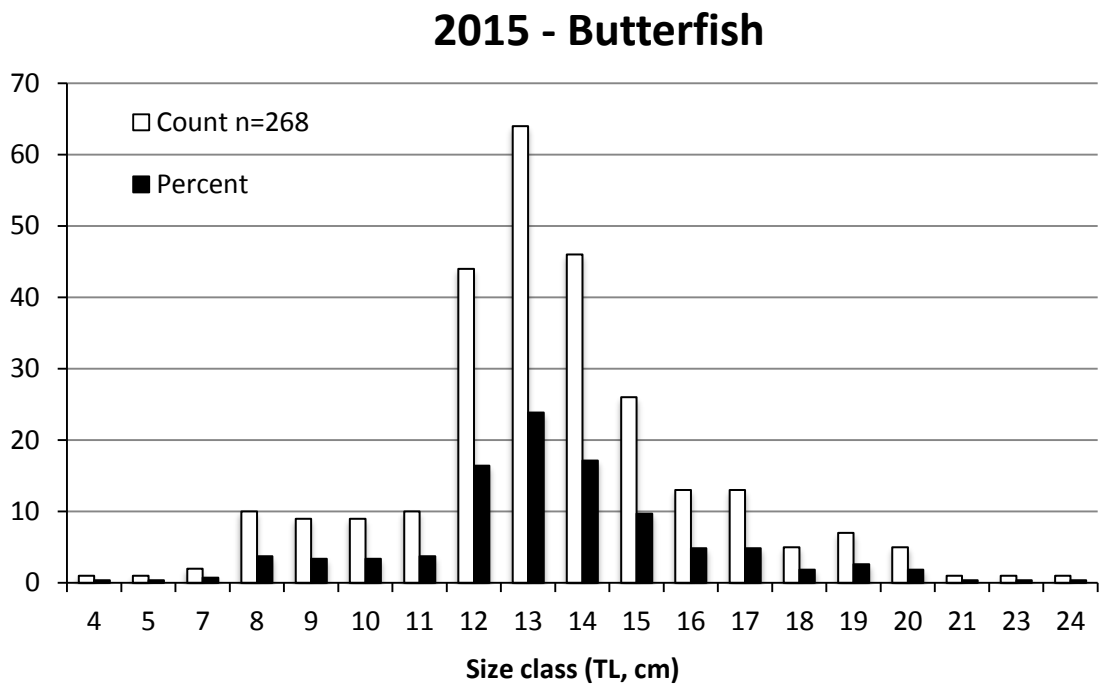


Figure 40. Size classes (TL, cm) of Bluefish collected during the 2016 Cooperative Winter Tagging Cruise. (R. Rulifson).



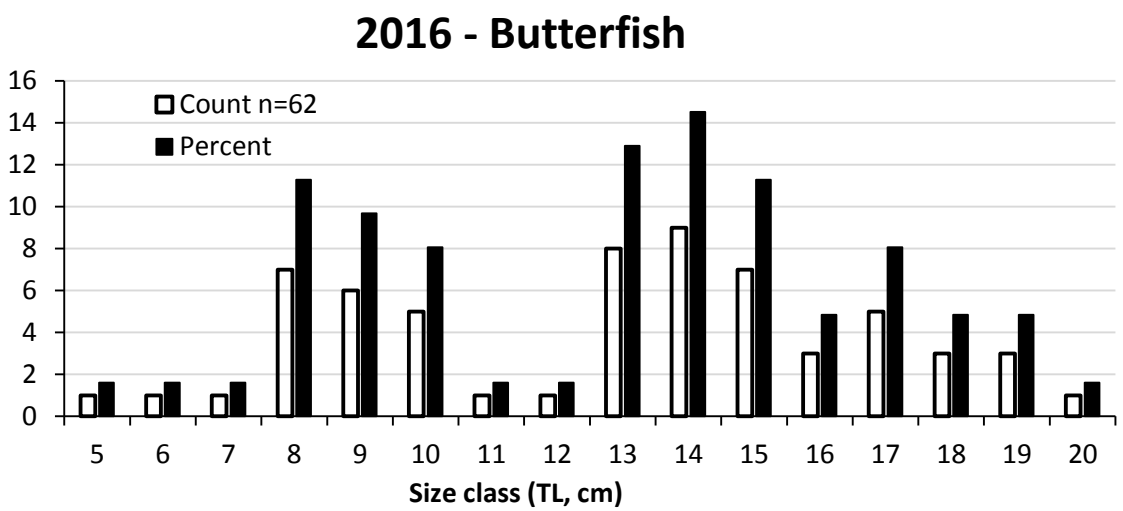


Figure 41. Size classes (TL, mm) of Butterfish collected during the 2015 (top) and 2016 (bottom) Cooperative Winter Tagging Cruises. (R. Rulifson).

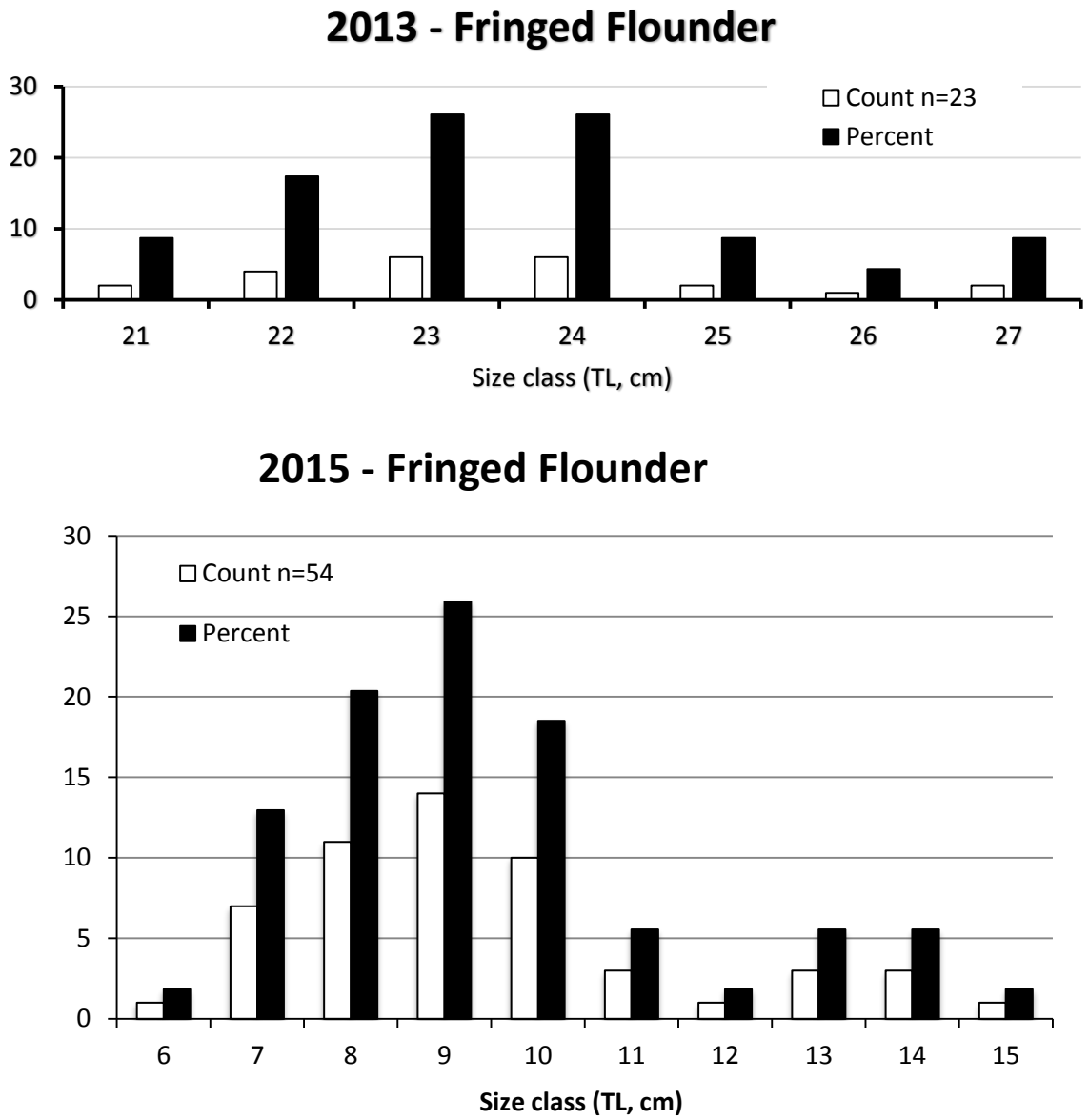


Figure 42. Size classes (TL, mm), by sex, of Fringed Flounder collected during the 2013 and 2015 Cooperative Winter Tagging Cruise by size class count and percent of total caught. (R. Rulifson).

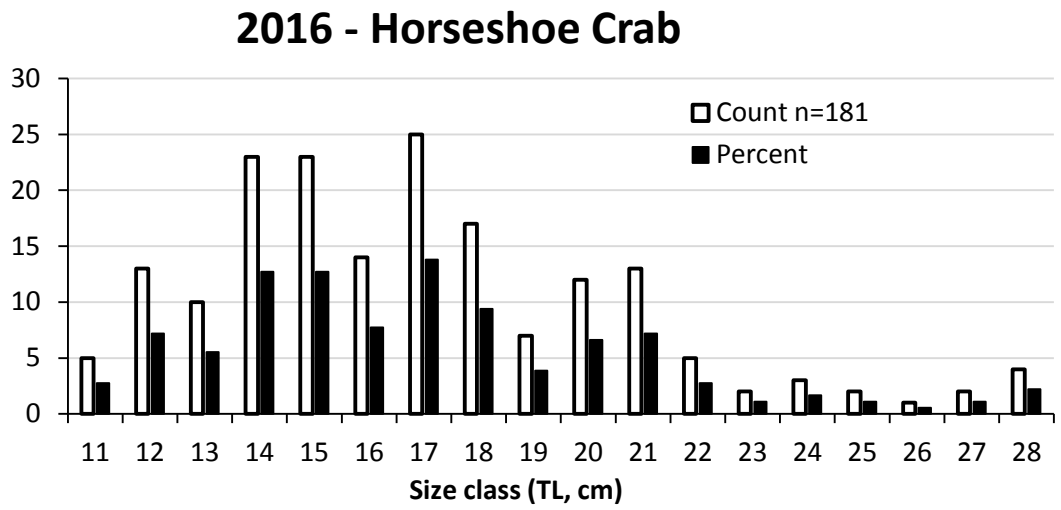


Figure 43. Size classes (prosomal width, cm) of Horseshoe Crab collected during the 2016 Cooperative Winter Tagging Cruise by size class count and percent of total caught. (R. Rulifson).

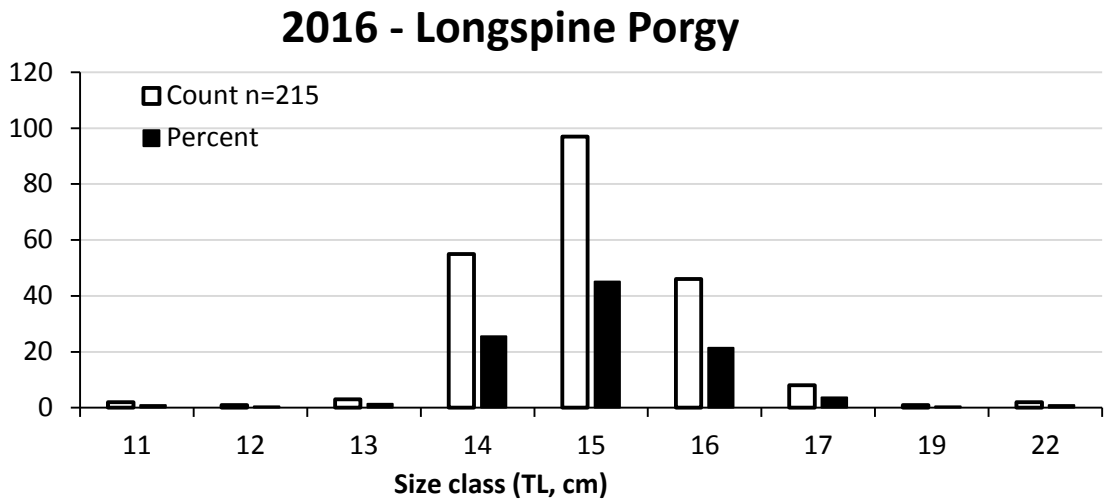


Figure 44. Size classes (TL, mm) of Longspine Porgy collected during the 2016 Cooperative Winter Tagging Cruise. (R. Rulifson).

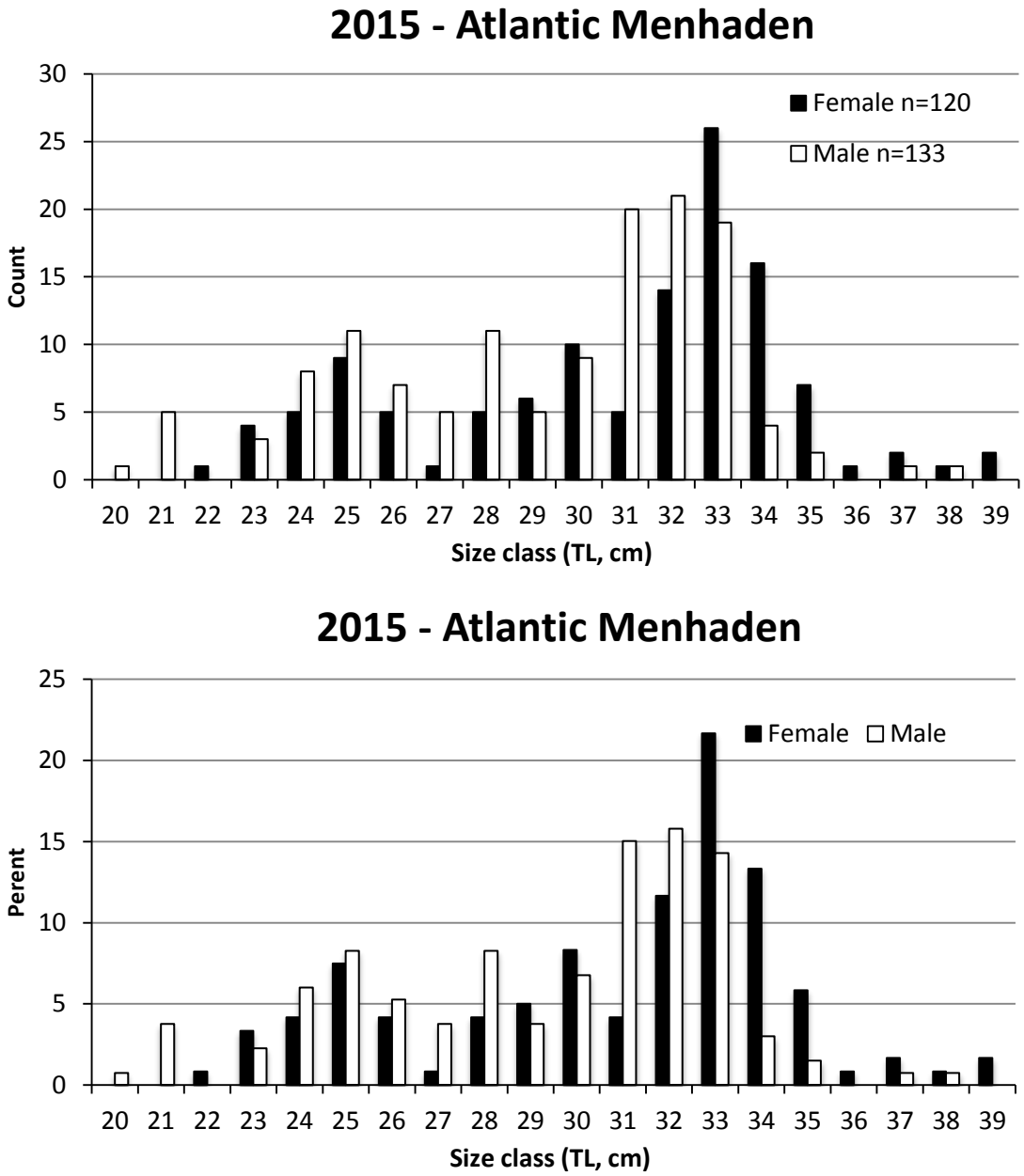


Figure 45. Size classes (TL, cm), by sex, of Atlantic Menhaden collected during the 2015 Cooperative Winter Tagging Cruise by size class count (top) and percent of total caught for that sex (bottom). (R. Rulifson).

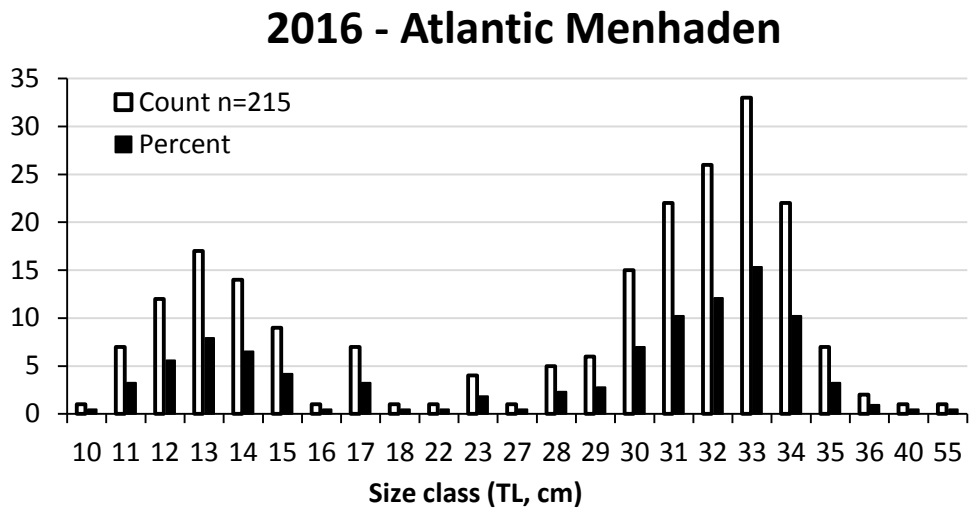
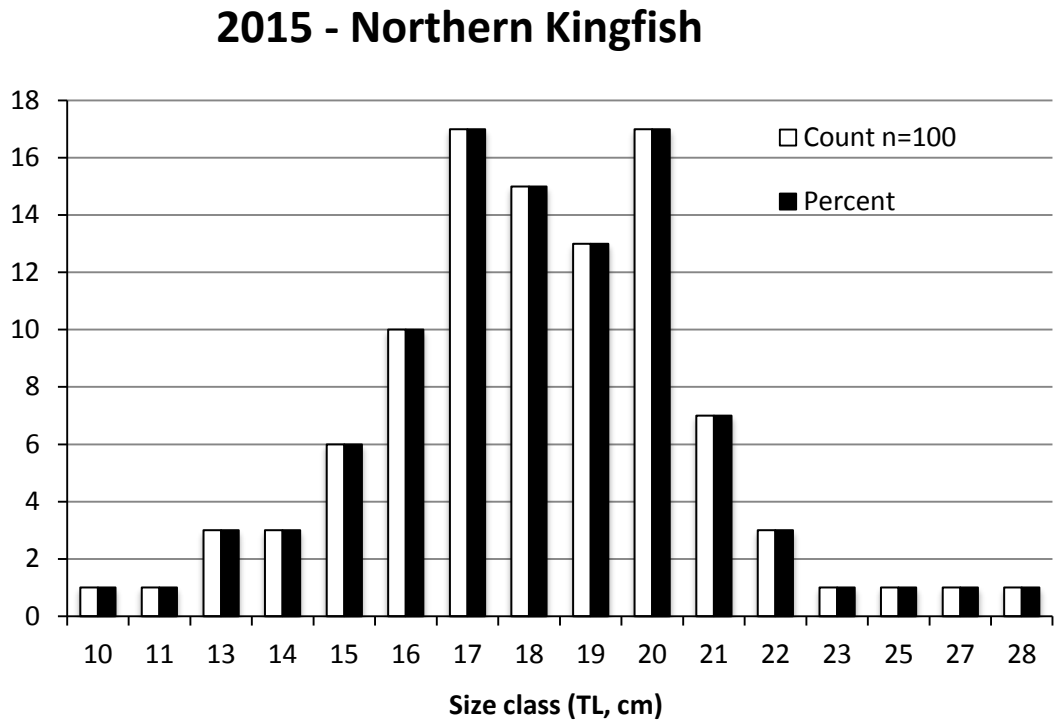


Figure 46. Size classes (TL, cm) of Menhaden collected during the 2016 Cooperative Winter Tagging Cruise. (R. Rulifson).



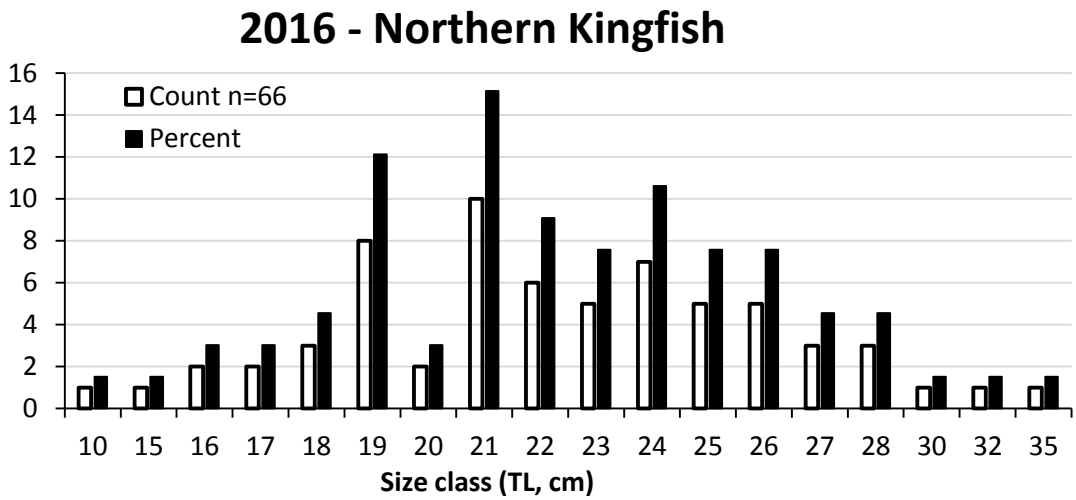


Figure 47. Size classes (TL, cm) of Northern Kingfish collected during the 2015 (top) and 2016 (bottom) Cooperative Winter Tagging Cruises. (R. Rulifson).

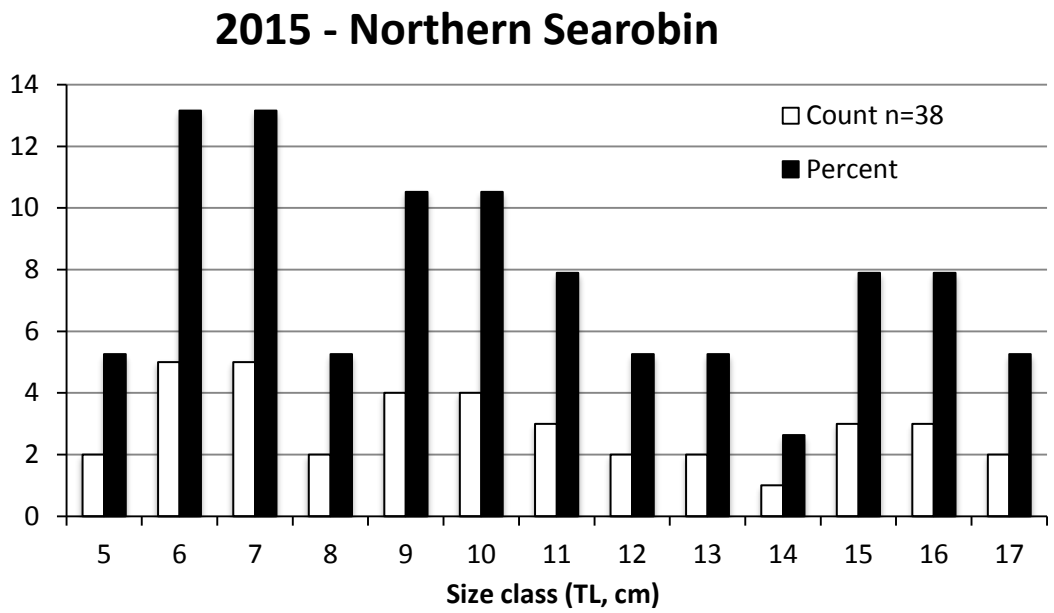


Figure 48. Size classes (TL, cm) of Northern Searobin collected during the 2015 Cooperative Winter Tagging Cruise. (R. Rulifson).

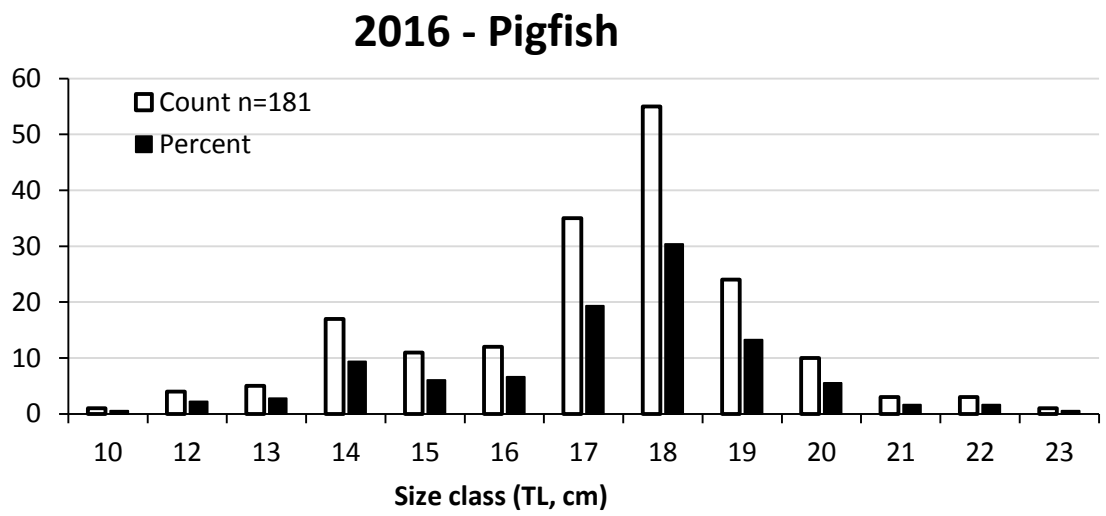


Figure 49. Size classes (TL, cm) of Pigfish collected during the 2016 Cooperative Winter Tagging Cruise. (R. Rulifson).

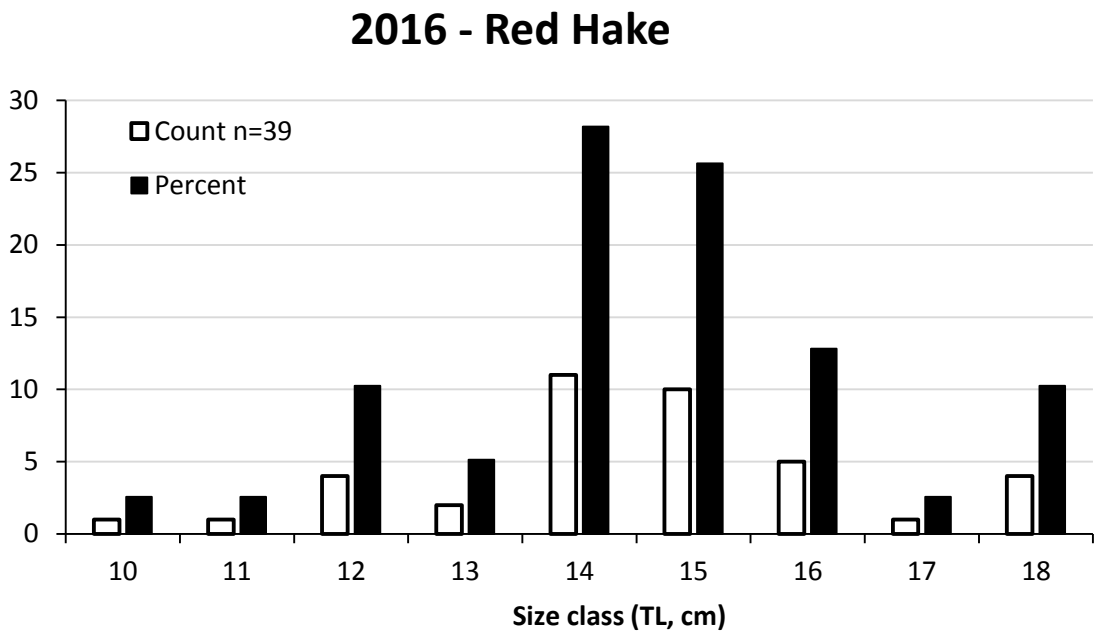
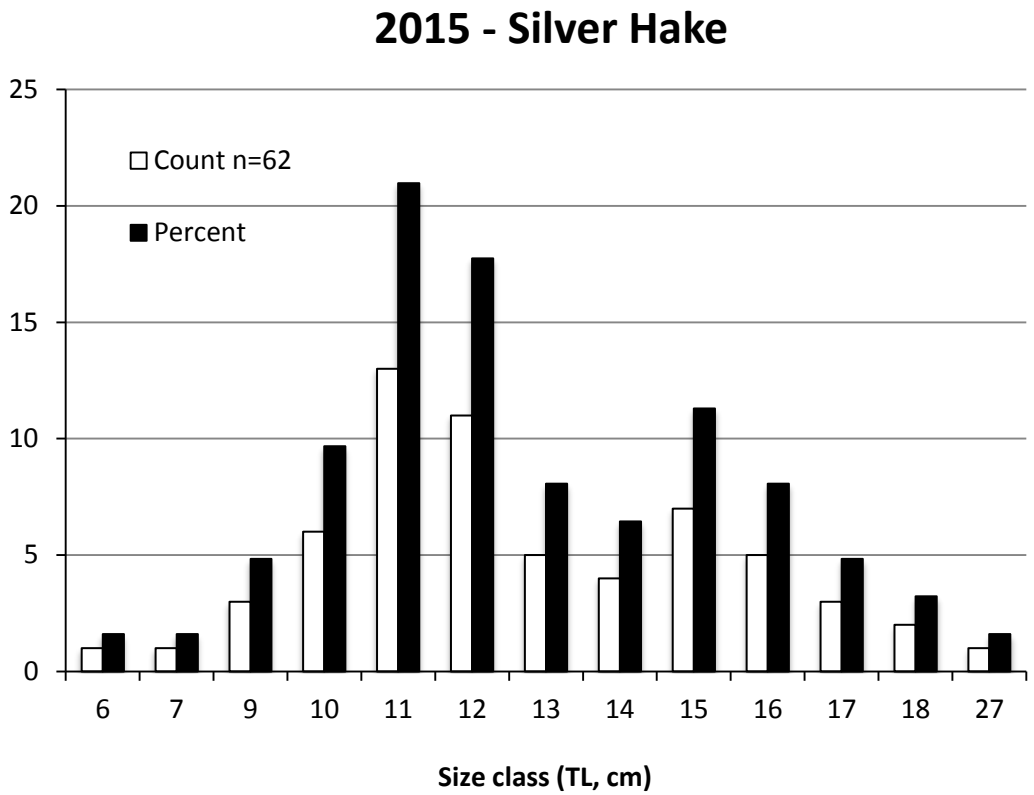


Figure 50. Size classes (TL, cm) of Red Hake collected during the 2016 Cooperative Winter Tagging Cruise. (R. Rulifson).



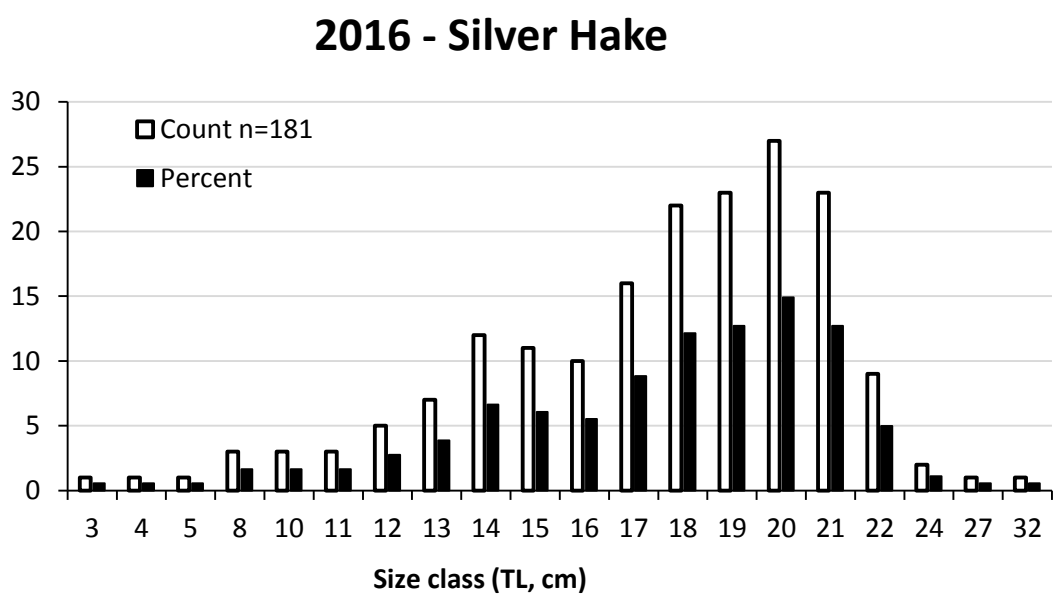


Figure 51. Size classes (TL, cm) of Silver Hake collected during the 2015 (top) and 2016 (bottom) Cooperative Winter Tagging Cruises. (R. Rulifson).

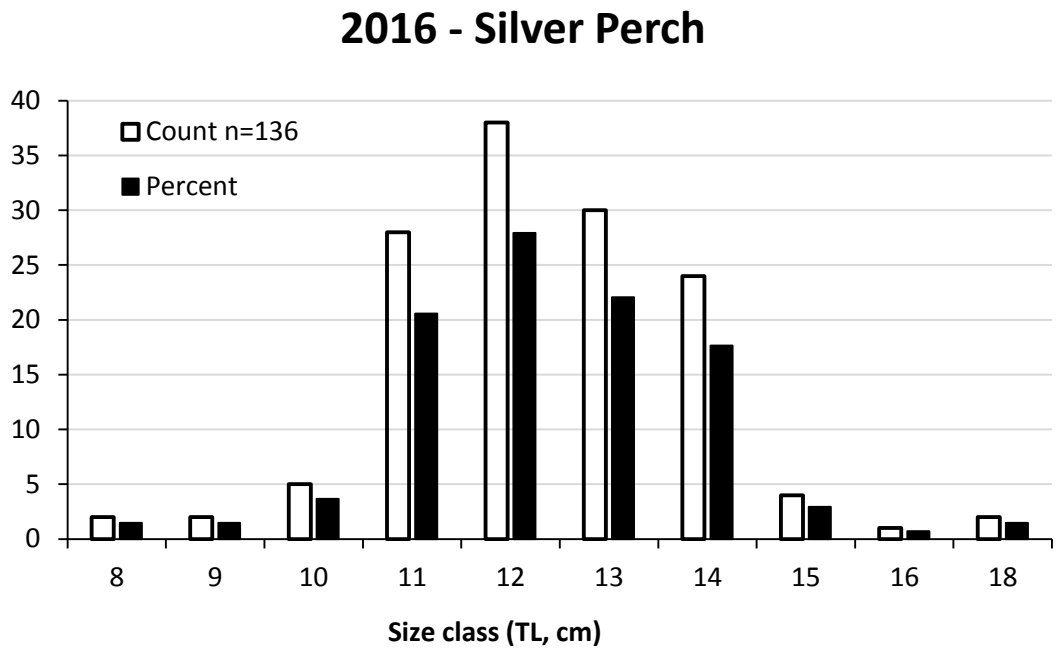


Figure 52. Size classes (TL, cm) of Silver Perch collected during the 2016 Cooperative Winter Tagging Cruise. (R. Rulifson).

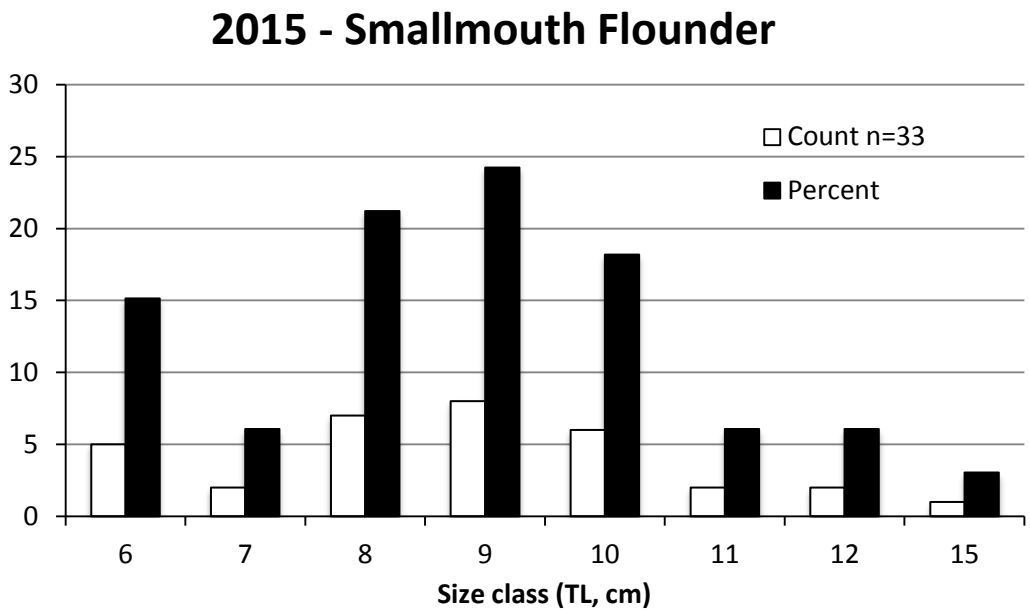


Figure 53. Size classes (TL, cm) of Smallmouth Flounder collected during the 2015 Cooperative Winter Tagging Cruise. (R. Rulifson).

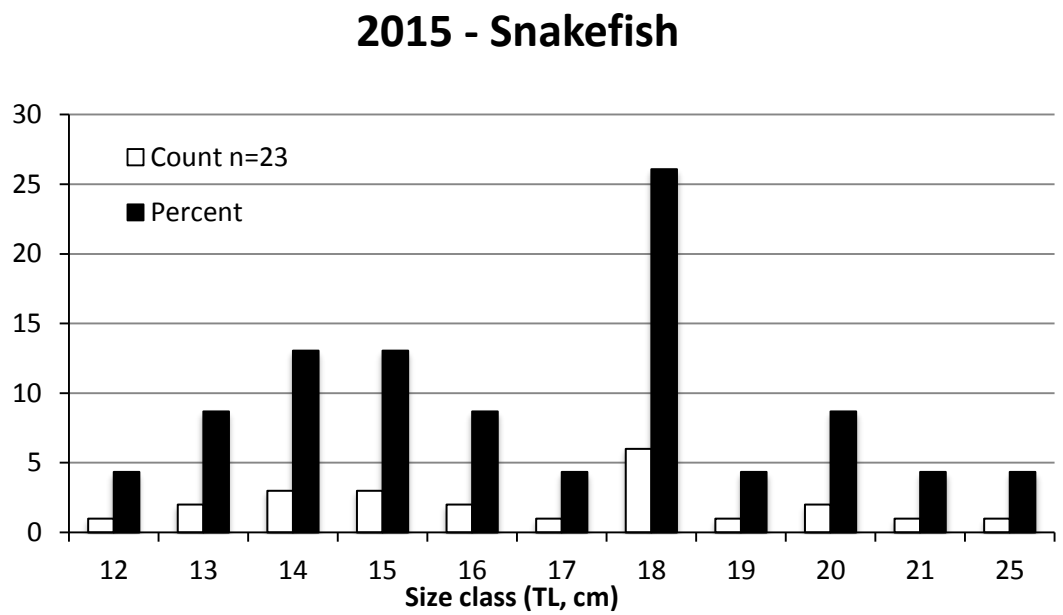


Figure 54. Size classes (TL, cm) of Snakefish collected during the 2015 Cooperative Winter Tagging Cruise. (R. Rulifson).

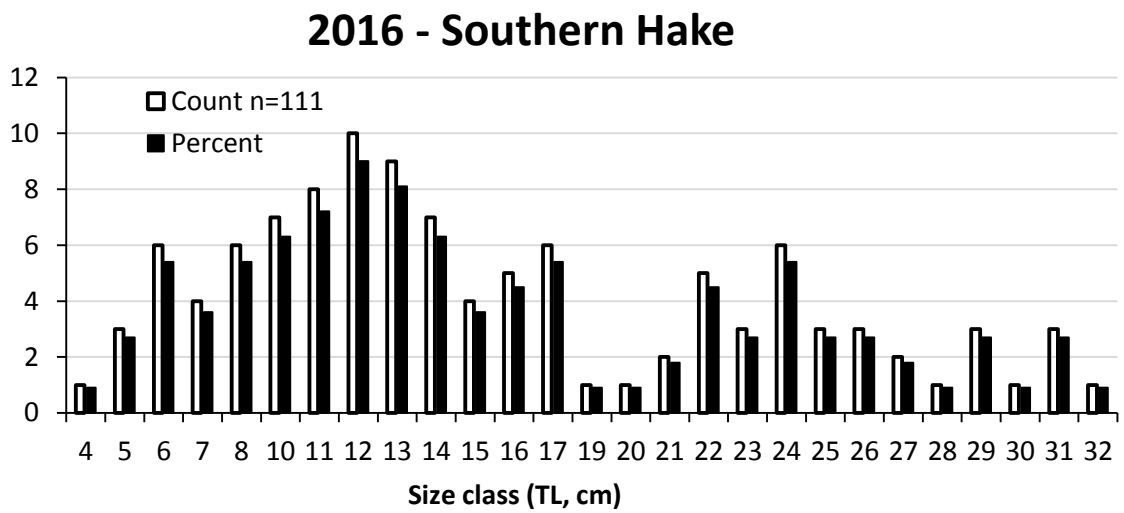
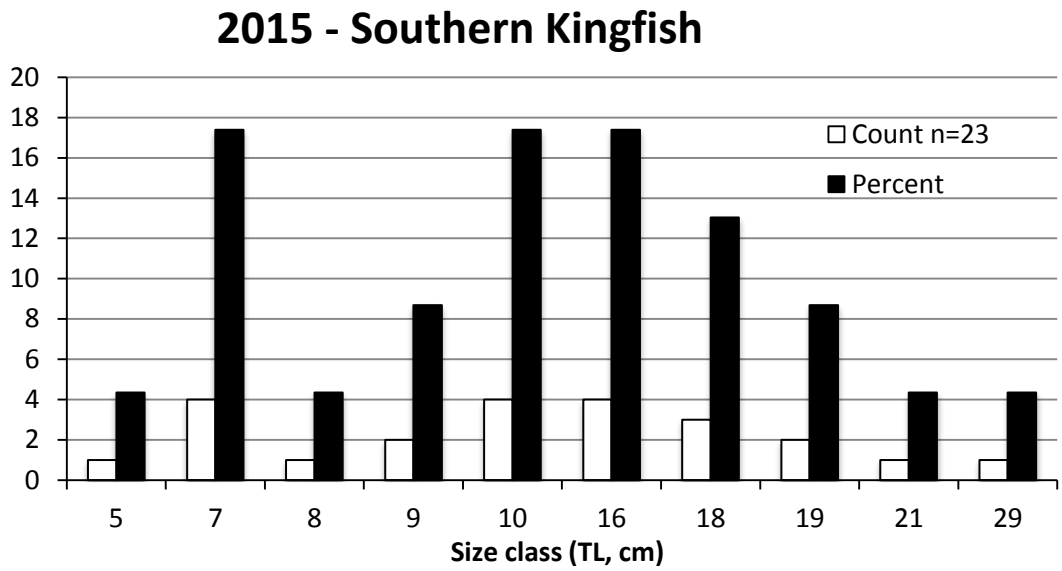


Figure 55. Size classes (TL, cm) of Southern Hake collected during the 2016 Cooperative Winter Tagging Cruise. (R. Rulifson).



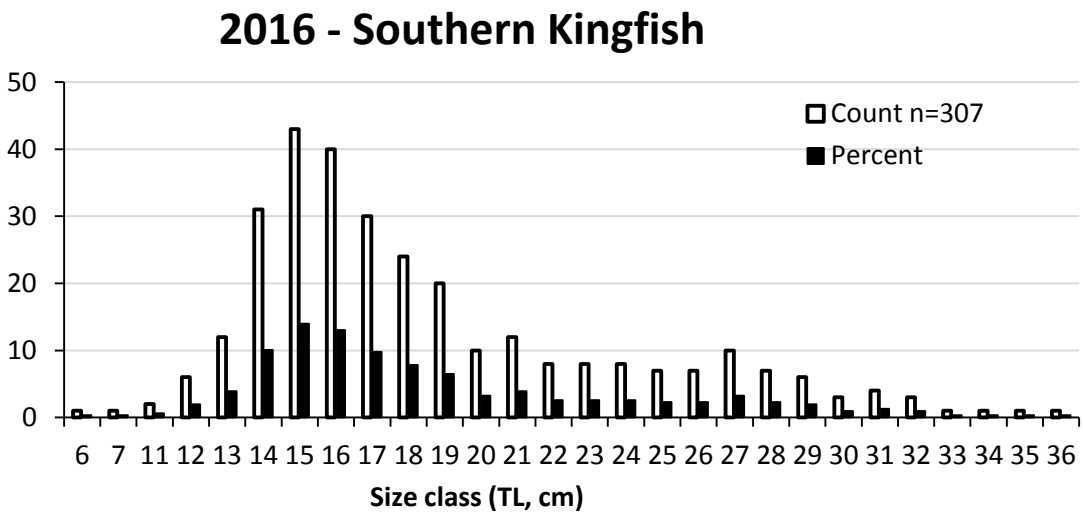
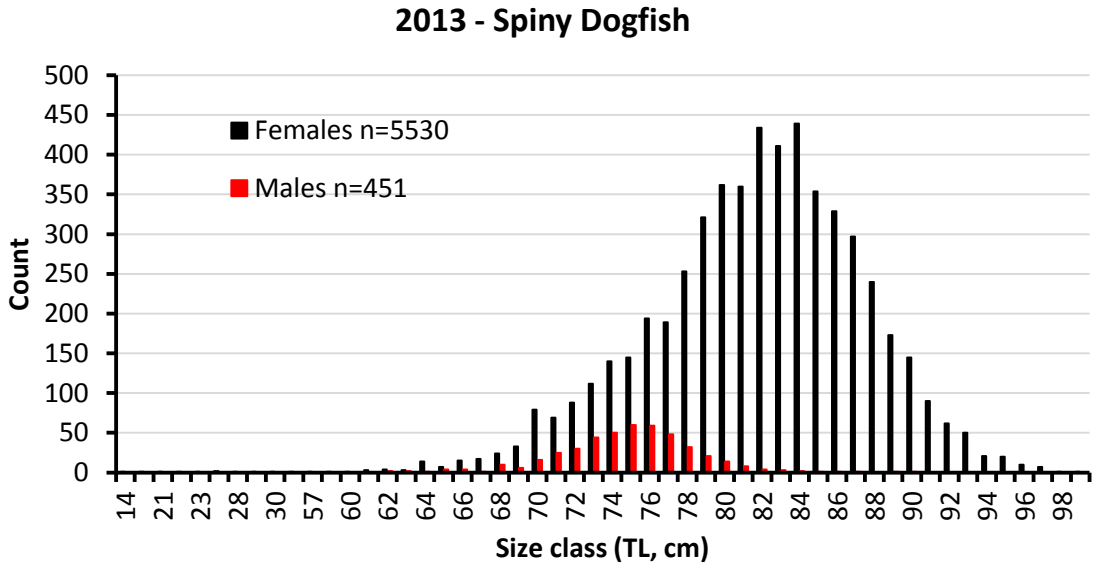


Figure 56. Size classes (TL, cm) of Sothern Kingfish collected during the 2015 (top) and 2016 (bottom) Cooperative Winter Tagging Cruises. (R. Rulifson).



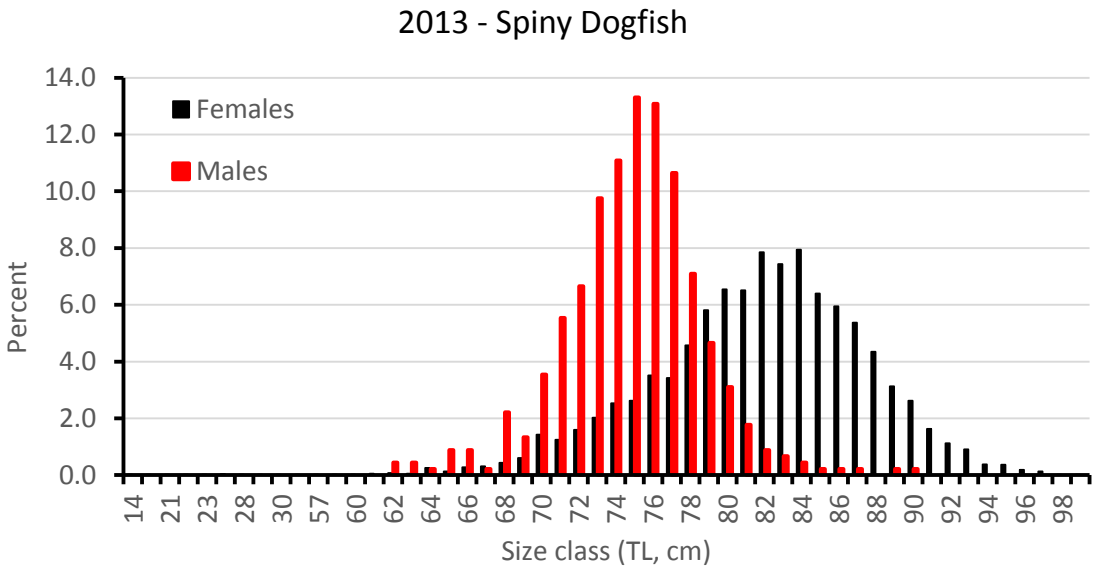
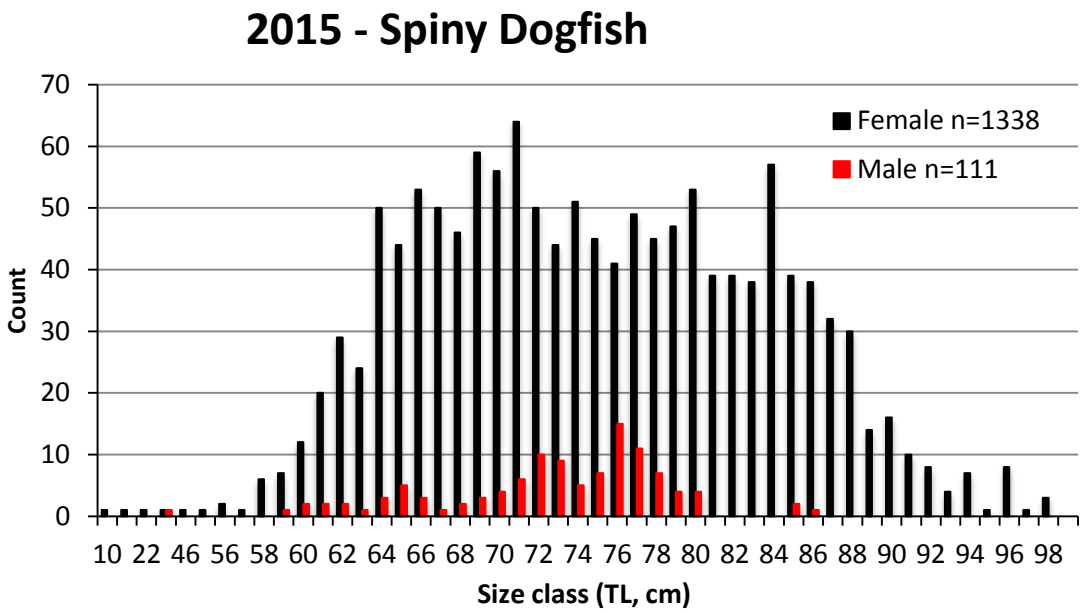


Figure 57. Size classes (TL, cm), by sex, of Spiny Dogfish collected during the 2013 Cooperative Winter Tagging Cruise by count (top) and by percent of total by sex (bottom). (R. Rulifson).



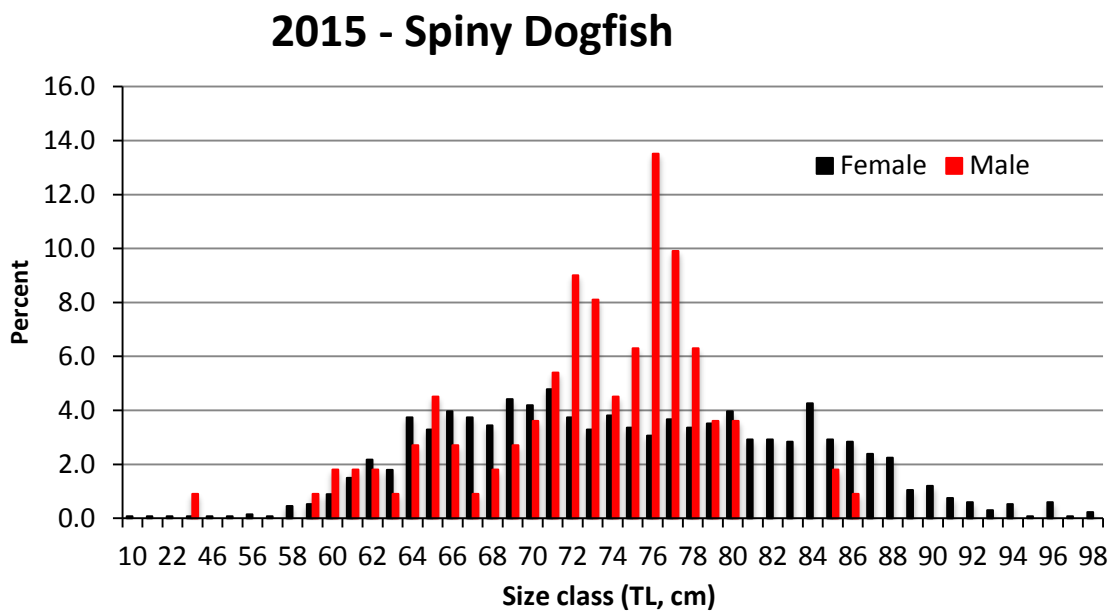
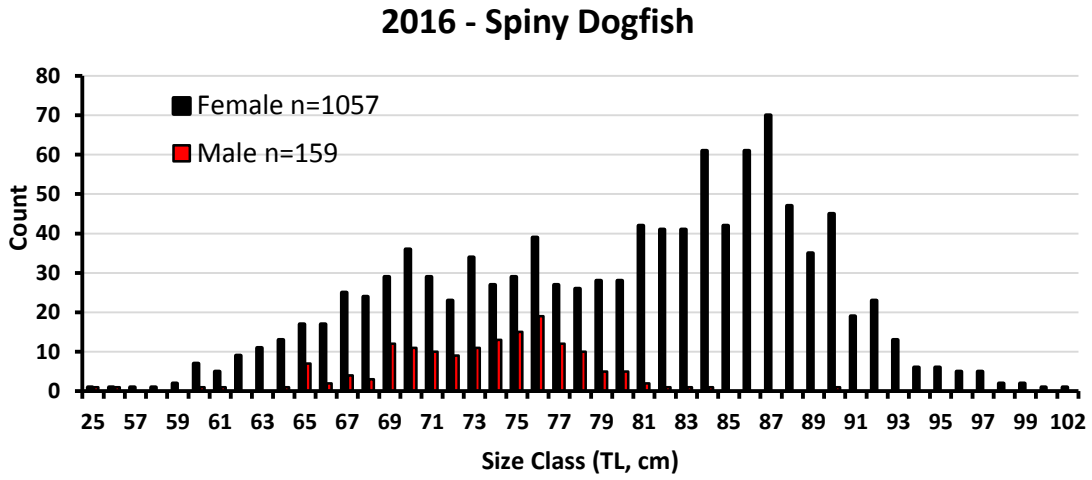


Figure 58. Size classes (TL, cm), by sex, of Spiny Dogfish collected during the 2015 Cooperative Winter Tagging Cruise by count (top) and by percent of total by sex (bottom). (R. Rulifson).



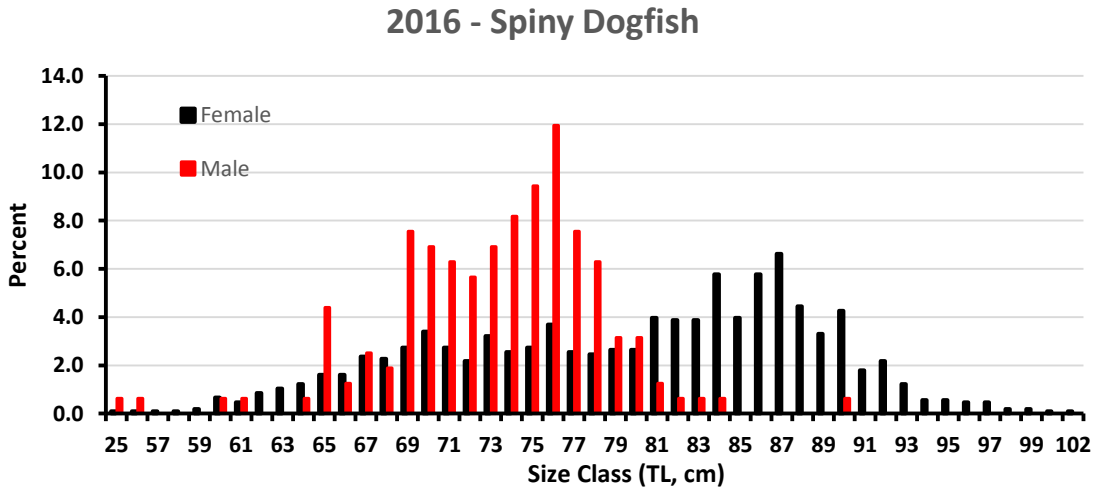
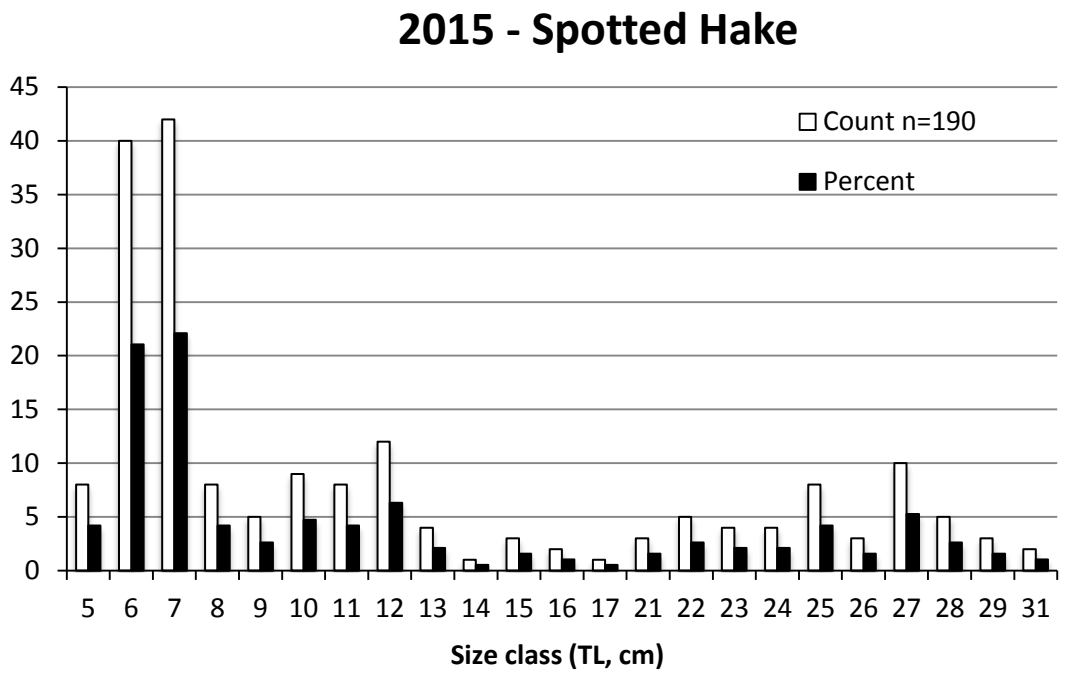


Figure 59. Size classes (TL, cm), by sex, of Spiny Dogfish collected during the 2016 Cooperative Winter Tagging Cruise by count (top) and by percent of total by sex (bottom). (R. Rulifson).



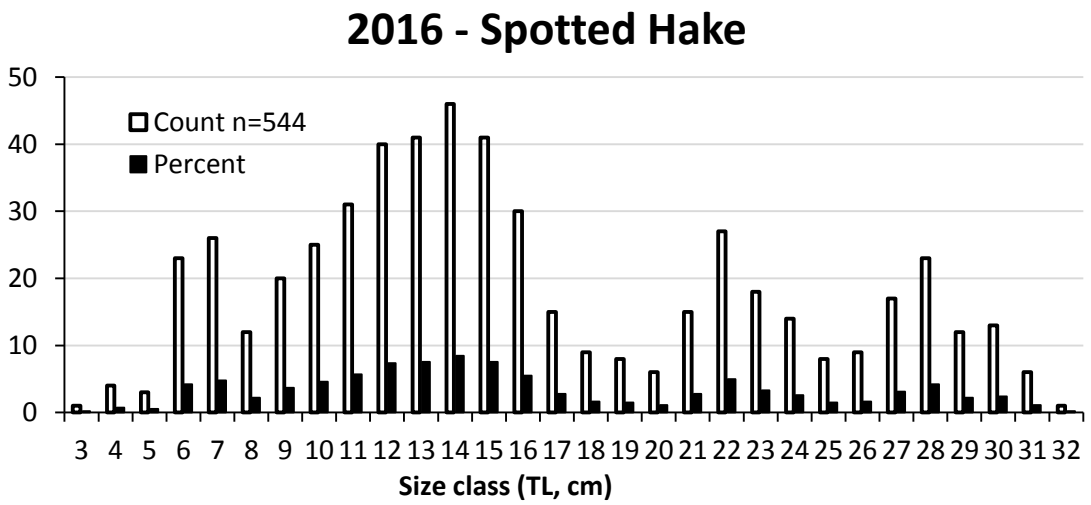


Figure 60. Size classes (TL, cm) of Spotted Hake collected during the 2015 (top) and 2016 (bottom) Cooperative Winter Tagging Cruises. (R. Rulifson).

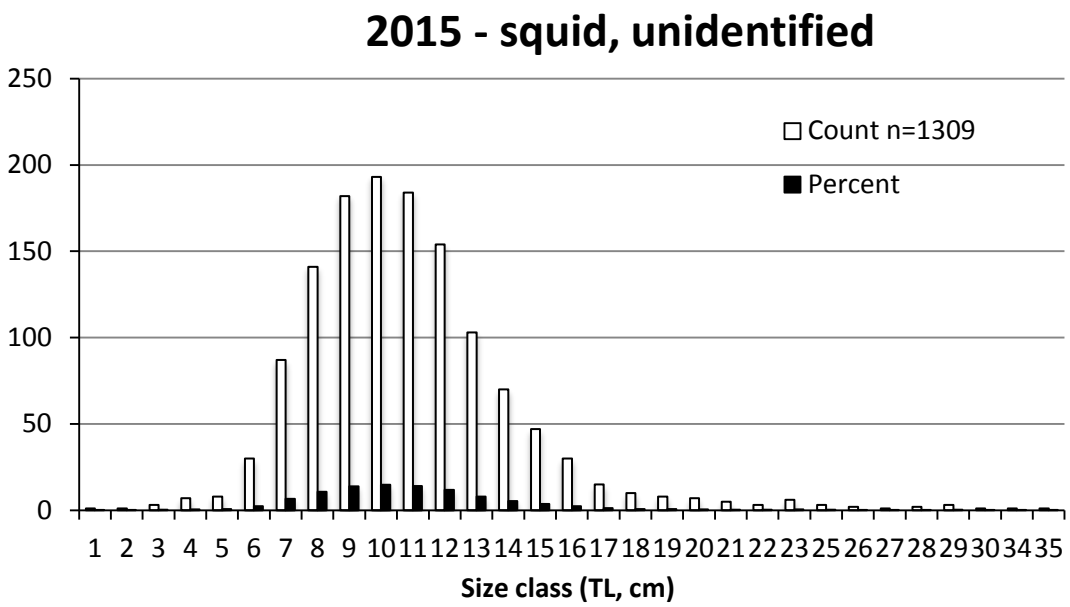
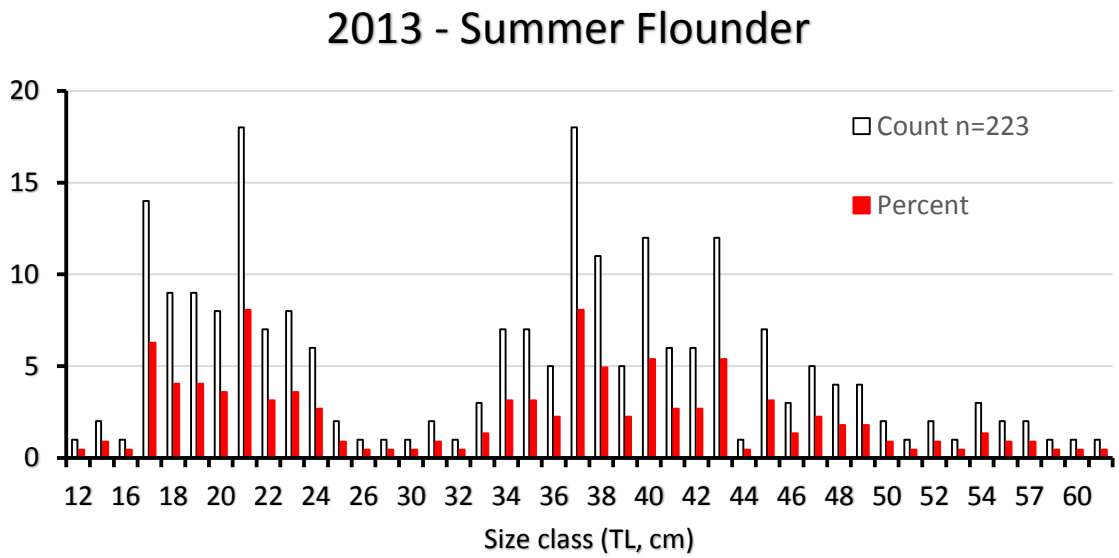


Figure 61. Size classes (TL, cm) of squid collected during the 2015 Cooperative Winter Tagging Cruise. Squid were not identified to species. (R. Rulifson).



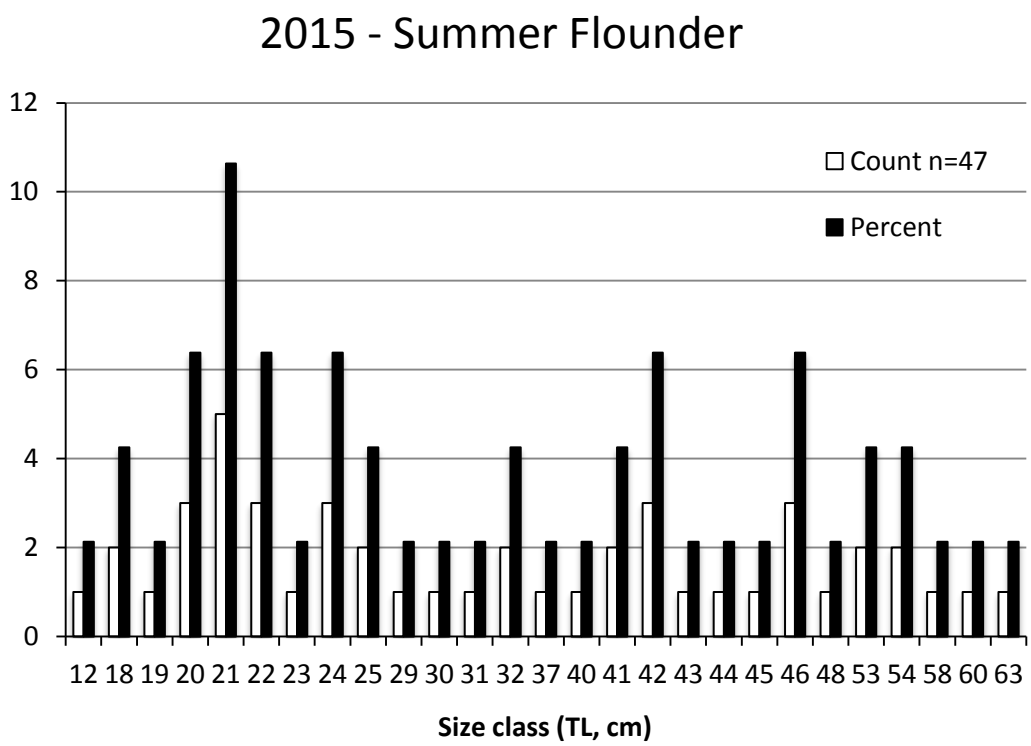


Figure 62. Size classes (TL, cm) of Summer Flounder collected during the 2013 (top) and 2015 (bottom) Cooperative Winter Tagging Cruises. (R. Rulifson).

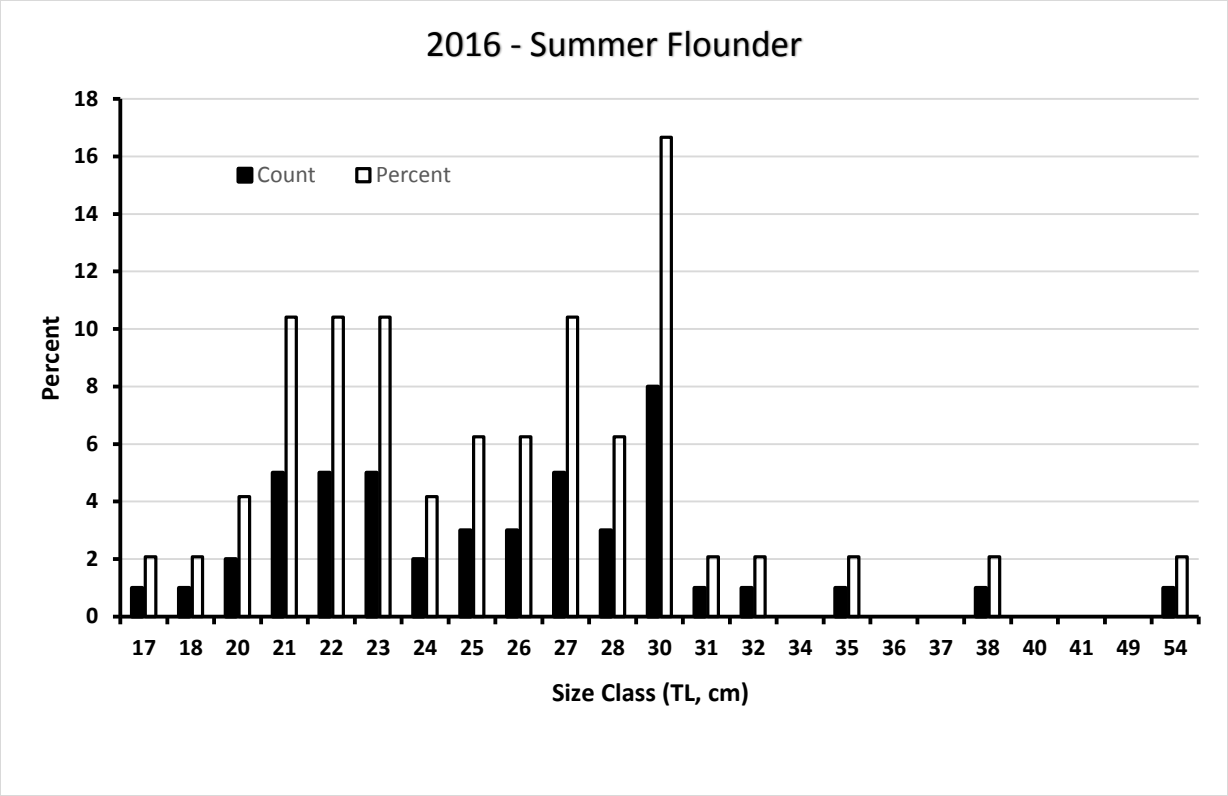
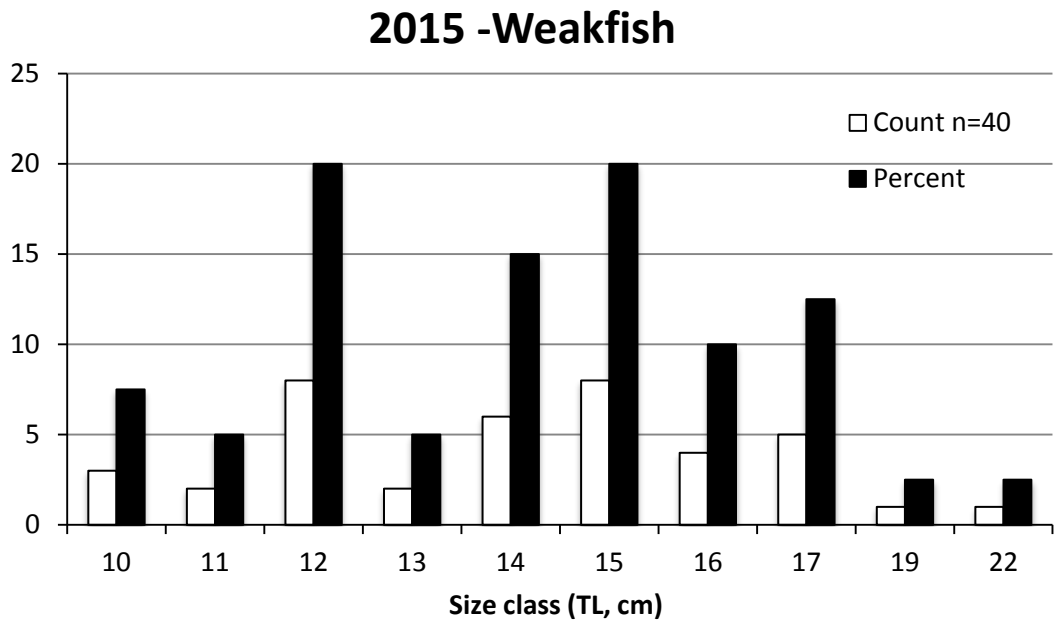


Figure 63. Size classes (TL, cm) of Summer Flounder collected during the 2016 Cooperative Winter Tagging Cruise. (R. Rulifson).



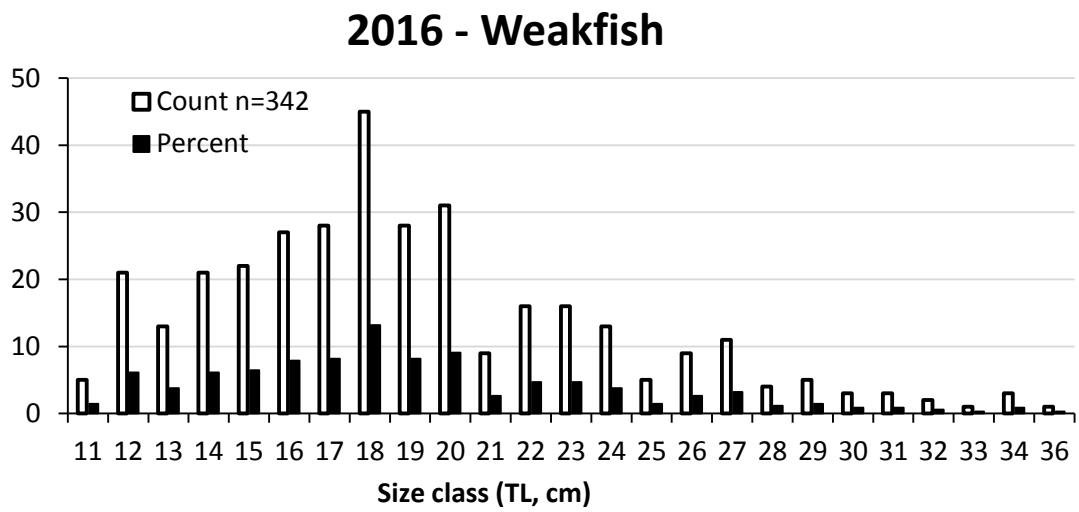
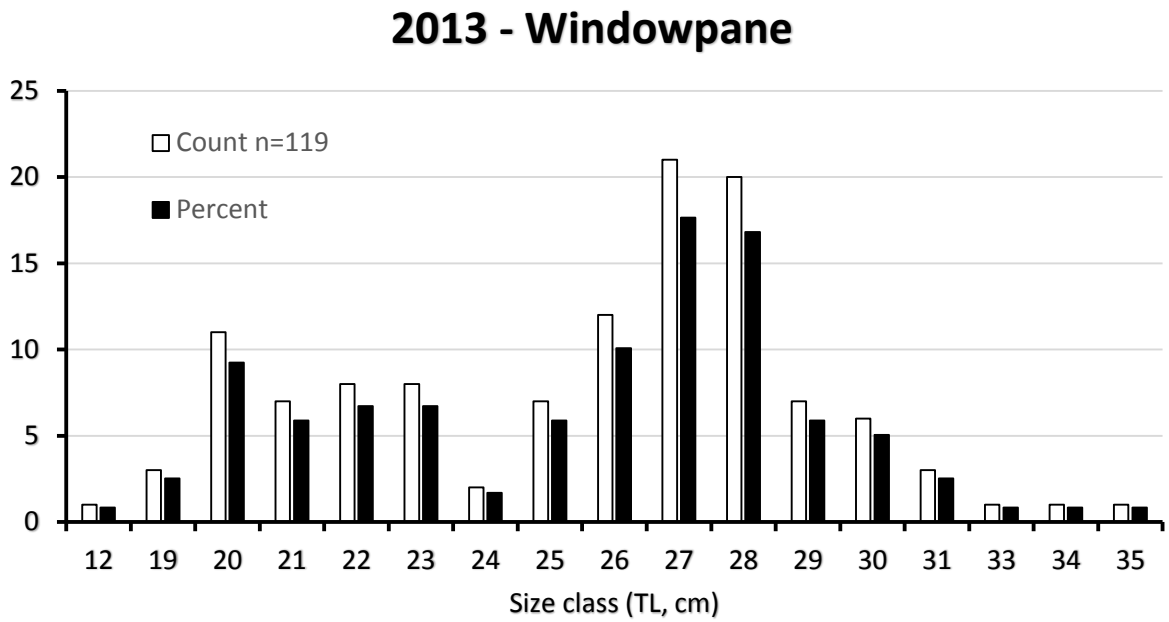


Figure 64. Size classes (TL, cm) of Weakfish collected during the 2015 (top) and 2016 (bottom) Cooperative Winter Tagging Cruises. (R. Rulifson).



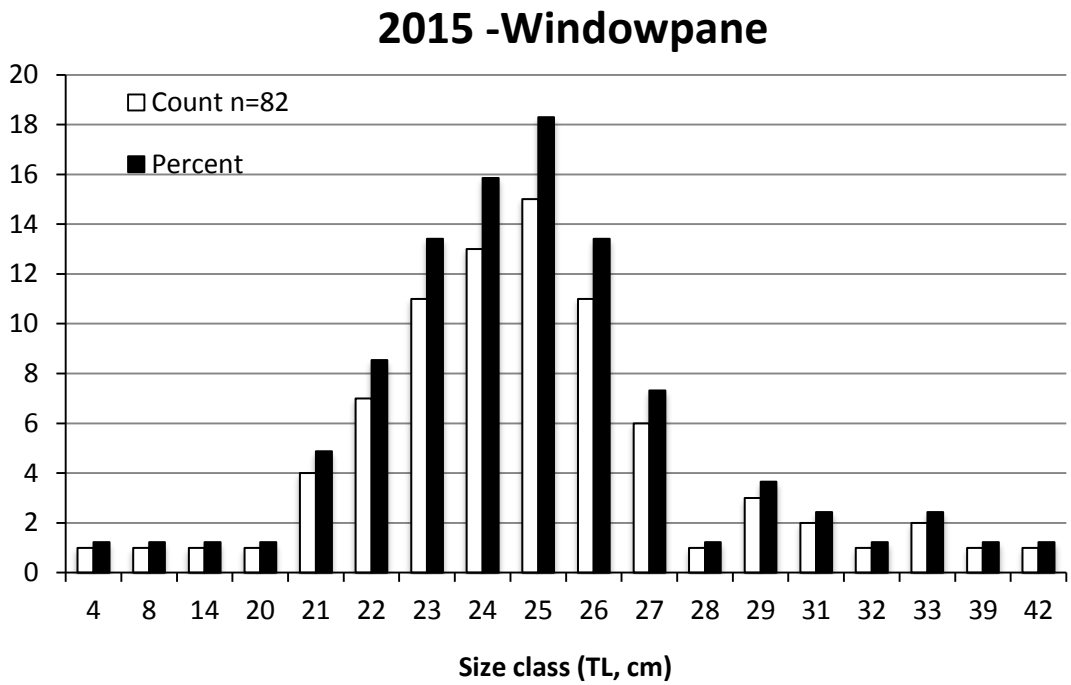


Figure 65. Size classes (TL, cm) of Windowpane collected during the 2013 (top) and 2015 (bottom) Cooperative Winter Tagging Cruises. (R. Rulifson).

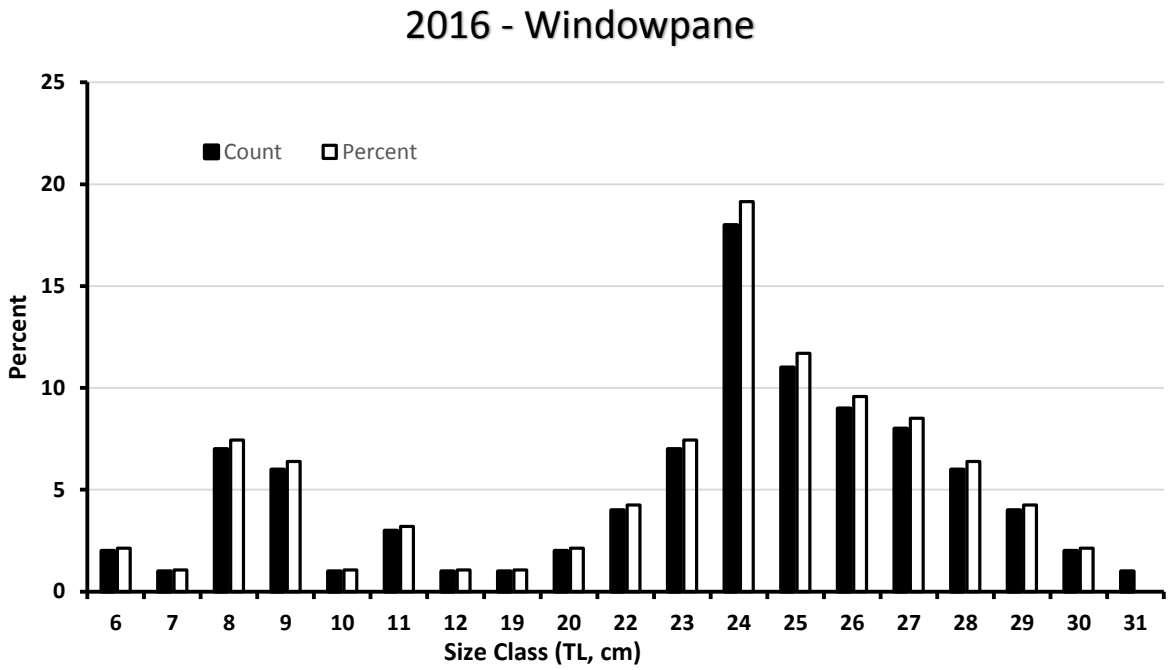


Figure 66. Size classes (TL, cm) of Windowpane collected during the 2016 Cooperative Winter Tagging Cruise. (R. Rulifson).

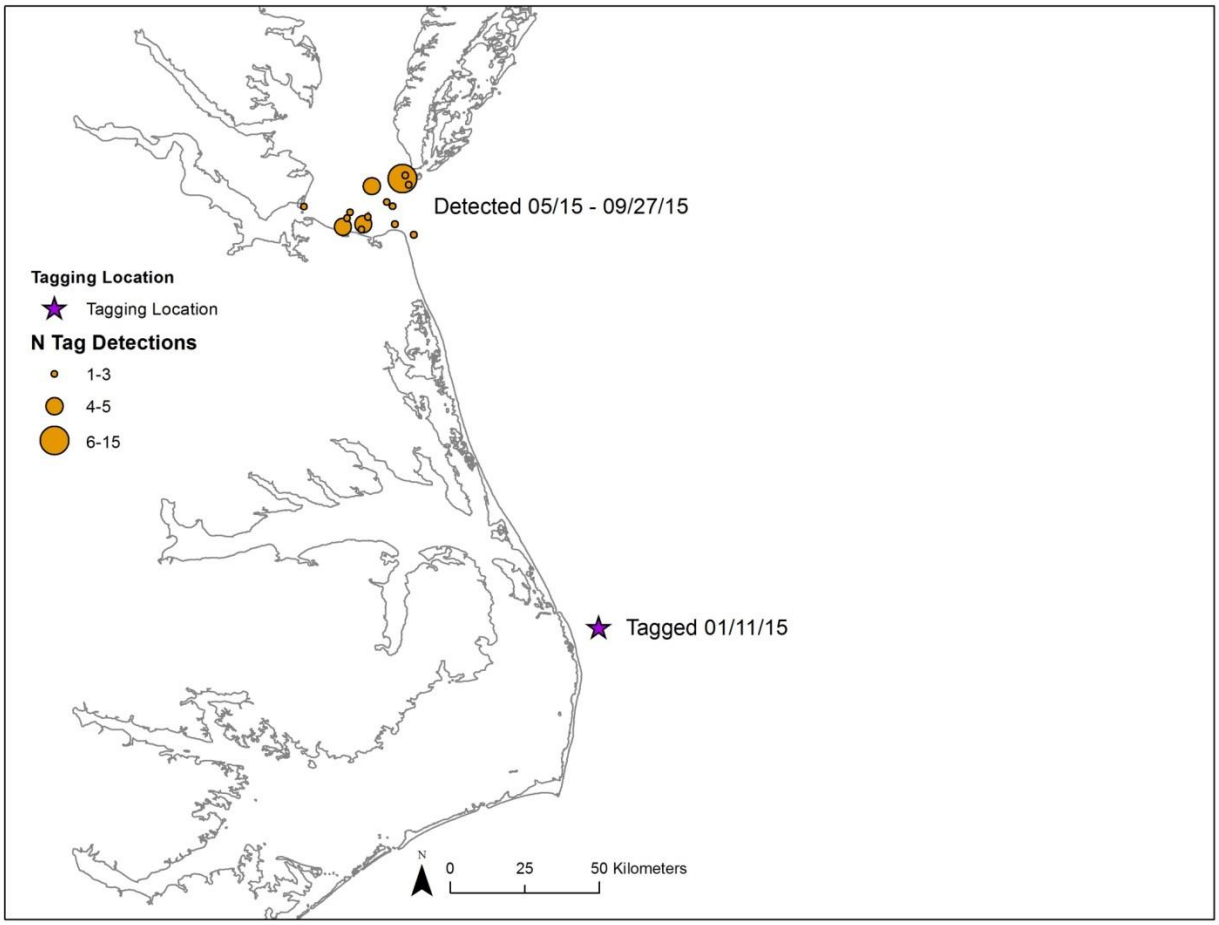


Figure 67. Detections of Sandbar Shark 10855 in the lower portion of Chesapeake Bay, following tagging on the Cooperative Winter Tagging Cruise in 2015. (C. Bangley).

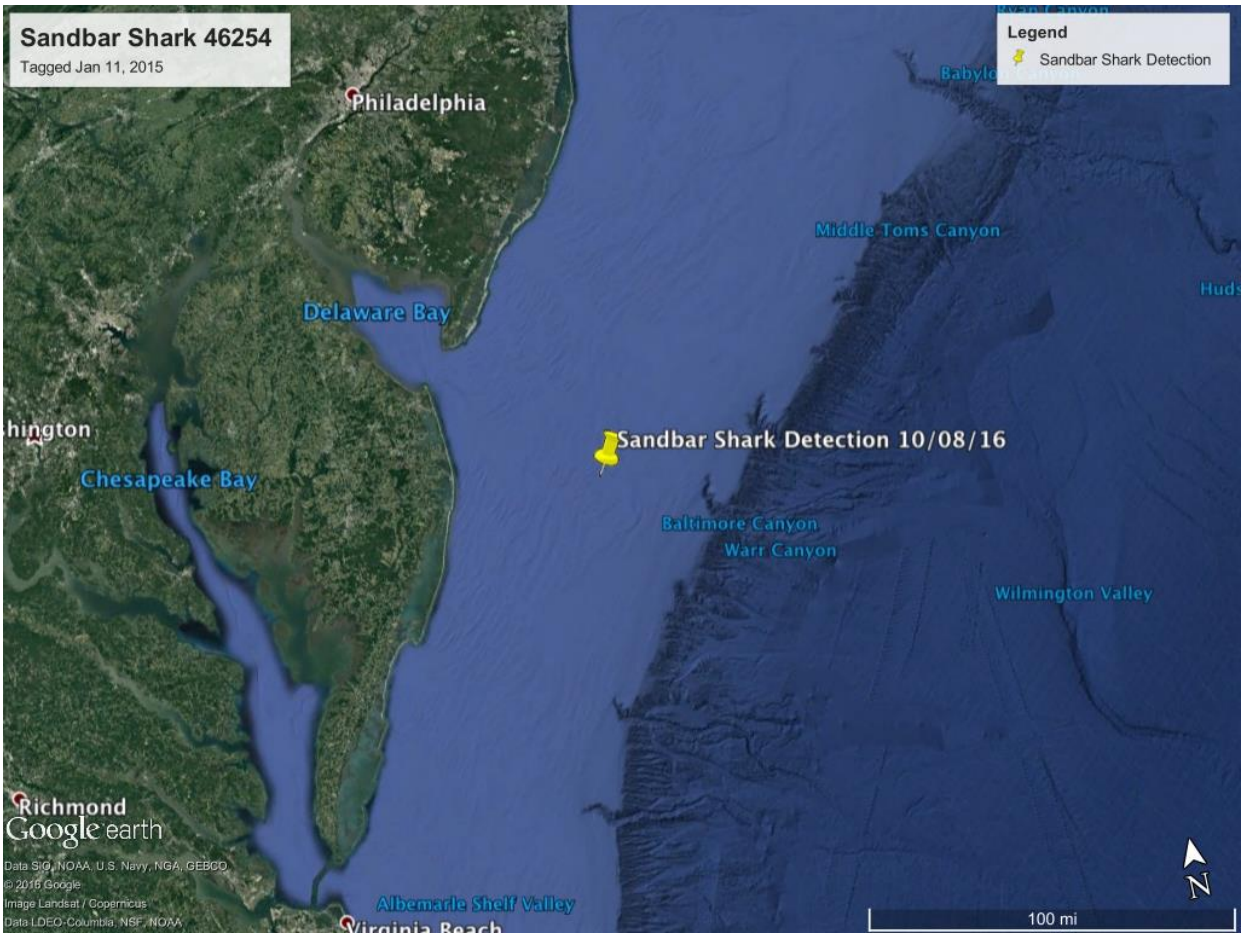


Figure 68. Detections of Sandbar Shark 46254 in the Atlantic Ocean October 8, 2016, after having been tagged during the Cooperative Winter Tagging Cruise at a location off North Carolina January 11, 2015. (C. Bangley).

Table 1. Funding sources used for conducting Cooperative Winter Tagging Cruises trawl-based (2013, 2015 and 2016) and hook-and-line based (2013, 2014, 2015 and 2016) Striped Bass monitoring in the Atlantic Ocean off NC, VA and MD. Funding award letters and/or other agreements are provided in the APPENDIX. Amounts awarded to ECU by granting agencies include overhead. Total for the four-\year period does not include in-kind contributions in the form of time and effort by state and federal employees and non-profits, transportation costs, and contributed supplies and equipment.

SOURCE and DATE	AMOUNT	PRINCIPAL INVESTIGATOR
NC CRFL, awarded January 12, 2012 (ECU 212533)	$238,836	Dr. Roger A. Rulifson, ECU
USFWS, ACFCMA funds for hook-and-line tagging, 2014	$8,000	Dr. R. Wilson Laney, USFWS
S-K, grant NA14NMF4270042, to ECU, awarded March 27, 2014 (ECU 213091)	$194,084	Dr. Roger A. Rulifson, ECU
Matching funds for S-K grant, from partners (ECU 213188 & 213559)	$155,267	Dr. Roger A. Rulifson, ECU
TOTAL for 2013-2016	$596,187	

Table 2. Research vessels, Cruise dates, numbers of trawl tows successfully completed, and number of Striped Bass captured, tagged, and released during 2013-2016. Data compiled from Excel #LN00023.

Research Vessel	Year	Cruise Dates	Tows Completed	SB Cap/Tag
R/V Cape Hatteras	2013	January 8-16	245/243*	1,061/893
None	2014	No trawling conducted this year, no funding	0	0/0
R/V Savannah	2015	January 10-19	152	457/333
R/V Savannah	2016	January 11-18	102	199/110
Totals-Four Year				**1,717/1,336**

*In 2013, only 243 tows were successful: Tow 207 was deployed erroneously and therefore no catch, and for Tow 223 the tailbag opened during deployment.

Table 3. Charter fishing vessels, trip dates, and numbers of Striped Bass captured, tagged and released using H&L gear. Data compiled from Excel #LN00023.

Fishing Vessel(s)	Year: Dates	Trips	SB Cap/Tag
F/V Midnight Sun, F/V Poacher, F/V Smokin' Gun II	2013: Jan 21-Feb 13	10	1,136/1,117
F/V Midnight Sun	2014: Jan 27-Feb 19	10	931/922
F/V Midnight Sun	2015: Jan 10-26	10	1,061/1,044
F/V Midnight Sun	2016: Jan 26-Feb 12	10	1,274/1,246
Totals-Four Year			**4,402/4,468**

Table 4. Number of adult Striped Bass captured by hook- and-line, and by trawl, during the annual Cooperative Winter Tagging Cruises, 2013-2016. Data calculated from Excel #LN00023.

Year/gear	Not_aged	Aged	Expanded fish count
Counts			
2013			
HOOK	781	355	1,129
TRWL	881	184	895
2014			
HOOK	478	453	924
2015			
HOOK	714	347	1,058
TRWL	253	210	334
2016			
HOOK	918	356	1,271
TRWL	95	106	110
Total	4,120	2,011	6,131
Percent			
2013			
HOOK	68.8	31.3	100
TRWL	82.7	17.3	100
2014			
HOOK	51.3	48.7	100
2015			
HOOK	67.3	32.7	100
TRWL	54.6	45.4	100
2016			
HOOK	72.1	27.9	100
TRWL	47.3	52.7	100

Table 5. Number measured, mean length (TL, mm), standard deviation, and minimum and maximum lengths of Striped Bass, by year, for CWTC trawl-captured fish. Data compiled from Excel #LN00023.

YEAR	N	MEAN TL	SD	MIN TL	MAX TL
2013	1,061	833.9	91.61	606	1,193
2015	457	890.8	70.64	567	1,071
2016	199	960.3	69.00	602	1,100

Table 6. Number measured, mean length (TL, mm), standard deviation, and minimum and maximum lengths of Striped Bass, by year, for hook-and-line caught fish. Data compiled from Excel #LN00023.

YEAR	N	MEAN TL	SD	MIN TL	MAX TL
2013	1,136	931.0	82.73	670	1,238
2014	931	941.0	90.95	690	1,355
2015	1,061	975.3	70.17	737	1,321
2016	1,274	984.6	75.94	578	1,230

Table 7. Number of CWTC trawl tows, number positive for Striped Bass, and percent Striped Bass positive (SB+) tows, by year. For 2013 tows-243 was used to calculate percentage of time Striped Bass were present. Data compiled from Excel #LN00023.

YEAR	TOWS	SB +	PERCENT
2013	245/243*	78	32.1
2015	152	29	19.1
2016	102	13	12.7
TOTALS	**497**	**120**	**24.1**

*In 2013, only 243 tows were successful: Tow 207 was deployed erroneously and therefore no catch, and for Tow 223 the tailbag opened during deployment.

Table 8. Results of the 2013 Cooperative Winter Tagging Cruise hook-and-line tagging effort for Striped Bass, January 21-February 13, 2013. Data compiled from Excel #LN00023.

Trip #	Date	Tagged	Caught
1	1/21	72	75
2	1/25	109	111
3	1/28	164	164
4	1/29	32	34
5	1/30	52	53
6	2/5	196	200
7	2/6	201	201
8	2/7	0	2
9	2/12	283	287
10	2/13	8	9
Totals		1,117	1136

Table 9. Results of the 2014 Cooperative Winter Tagging Cruise hook-and-line tagging effort for Striped Bass, January 27-February 19, 2014. Data compiled from Excel #LN00023.

Trip #	Date	Tagged	Caught
1	1/27	0	1
2	2/3	0	2
3	2/5	0	1
4	2/7	0	1
5	2/8	116	116
6	2/9	274	275
7	2/15	215	216
8	2/16	7	7
9	2/18	281	282
10	2/19	29	30
Totals		922	931

Table 10. Results of the 2015 Cooperative Winter Tagging Cruise hook-and-line tagging effort for striped bass, January 10-26, 2015. Data compiled from Excel #LN00023.

Trip#	Date	#Tagged	#Caught
1	1/10	0	0
2	1/11	69	71
3	1/12	1	1
4	1/19	130	138
5	1/20	157	158
6	1/21	0	1
7	1/22	125	127
8	1/23	253	254
9	1/25	263	265
10	1/26	46	46
Totals		1,044	1,061

Table 11. Results of the 2016 Cooperative Winter Tagging Cruise hook-and-line tagging effort for striped bass, January 26-February 12, 2016. Data compiled from Excel #LN00023.

Trip#	Date	#Tagged	#Caught
1	1/26	203	209
2	1/27	10	10
3	1/28	8	8
4	1/30	220	224
5	1/31	9	9
6	2/1	157	164
7	2/2	60	63
8	2/6	310	315
9	2/9	99	101
10	1/12	170	171
Totals		1,246	1,274

Table 12. The ranges and means of tow speeds (knots), tow depths (meters), water temperatures (ºC), and salinities (ppt) for the 245 trawls conducted during the CWTC January 10-19, 2013 onboard the R/V Cape Hatteras.

Variable	Number of tows	Mean	Min	Max
Tow speed (min, kts)	241	2.9	1.8	4.1
Tow speed (max, kts)	239	3.1	2.2	4.2
Water temp (ºC)	241	8.9	2.9	10.1
Air temp (ºC)	241	10.2	7.0	19.0
Salinity (ppt)	241	29.7	26.9	38.2
Depth (min, meters)	241	16.0	10.6	25.0
Depth (max, meters)	238	17.5	11.3	27.4

Table 13. The ranges and means of tow speeds (knots), tow depths (meters), water temperatures (ºC), and salinities (ppt) for the 152 trawls conducted during the CWTC January 10-19, 2015 onboard the R/V Savannah.

Variable	Number of tows	Mean	Min	Max
Tow speed (min, kts)	152	3.3	2.1	3.8
Tow speed (max, kts)	152	3.3	2.1	3.8
Water temp (°C)	152	7.8	4.7	20.5
Air temp (°C)	152	6.0	0.4	11.9
Salinity (ppt)	152	33.2	21.6	36.4
Depth (min, meters)	151	20.0	9.4	30.0
Depth (max, meters)	151	22.0	10.2	32.9

Table 14. The ranges and means of tow speeds (knots), tow depths (meters), water temperatures (ºC), and salinities (ppt) for the 102 trawls conducted during the CWTC January 11-18, 2016 onboard the R/V Savannah.

Variable	Number of tows	Mean	Min	Max
Tow speed (min, kts)	102	3.1	2.8	3.5
Tow speed (max, kts)	102	3.1	2.8	3.5
Water temp (°C)	102	11.2	7.5	18.9
Air temp (°C)	102	6.4	-0.6	12.2
Salinity (ppt)	102	33.4	31.1	37.8
Depth (min, meters)	102	17.8	7.4	31.8
Depth (max, meters)	102	19.1	7.4	31.8

Table 15. CWTC cruise years and the estimated strength of Striped Bass year classes captured by trawl and by hook and line. Data are expanded from fish subsampled for ageing from scales (see Table 4). Data compiled from Excel #LN00023.

	CWTC YEAR						
Year class	2013 Trawl	2013 H&L	2014 H&L	2015 Trawl	2015 H&L	2016 Trawl	2016 H&L
1992	0	1	0	0	0	0	0
1993	0	0	0	0	0	0	0
1994	0	1	1	0	0	0	0
1995	1	1	0	0	0	0	0
1996	0	2	1	0	0	0	0
1997	2	5	6	0	3	0	0
1998	1	20	18	0	2	0	0
1999	7	23	15	0	4	1	1
2000	13	45	23	1	5	0	2
2001	36	113	39	4	16	0	1
2002	94	256	105	2	37	3	27
2003	156	299	235	5	95	7	68
2004	161	242	223	26	177	5	193
2005	224	99	155	42	229	24	256
2006	153	18	79	68	239	29	316
2007	42	3	21	79	170	21	220
2008	5	0	3	79	52	10	143
2009	0	0	0	18	26	8	43
2010	0	0	0	7	0	0	1
2011	0	0	0	4	1	1	0
Total extrapolated	895	1,129	924	334	1,058	110	1,271

Table 16. Recaptures of Striped Bass tagged and released by two gear types during the 2013, 2015, and 2016 Cruises, showing returns by recapture type. Data from J. Newhard, current as of Feb 2018.

	2013		2014	2015		2016		Total by recap type
Recap type	Trawl	H&L	H&L	Trawl	H&L	Trawl	H&L	
Commercial	12	16	12	5	11	3	9	68
Charter	17	30	27	9	29	2	17	131
Other	3	0	2	0	0	1	1	7
Researchers	6	1	0	0	0	0	3	10
Sportfishers	107	133	85	35	94	11	107	572
Unknown	0	0	0	0	1	0	1	2
Totreturn	145	180	126	49	135	17	138	790
Totrelease	893	1,114	921	333	1,042	110	1,241	5,654
% Returned	16.2	16.2	13.7	14.7	13.0	15.5	11.1	100

Table 17. A comparison of the catch rates of Striped Bass ≥ 711 mm TL captured by hook-and-line (Hookline) during the charter boat sampling, and by trawl during the CWTC trawl survey, and released near the point of capture for 2013, 2014, and 2015 (S. Welsh, Feb 2018). Estimated reporting rate = 0.43. Adjusted mortality of 9% for H&L-released fish is more like 1% for winter releases (C.H. Godwin, pers. comm.). Also refer to Appendix 11 for latest revisions of fishing mortality, natural mortality, and total mortality.

Capture method, and estimate assuming 9% mortality for H&L fish	Year	Number released	Recap mortality	Recaps release alive	Catch rate
Hook & line	2013	1114	53	19	0.150
Hook&9% Mort	2013	1014	53	19	0.165
Trawl	2013	893	51	26	0.201
Hook & line	2014	921	49	16	0.164
Hook&9% Mort	2014	838	49	16	0.180
Trawl	2014	0	0	0	
Hook & line	2015	1044	50	25	0.167
Hook&9% Mort	2015	950	49	25	0.181
Trawl	2015	333	17	9	0.182
Hook & line	2016	1241	59	26	0.159
Hook&9% Mort	2016	1129	59	26	0.175
Trawl	2016	110	7	1	0.169

Table 18. Summary of Atlantic Sturgeon captured during the 2013, 2015, and 2016 Cruises; n=12.

Date	Haul #	Start Time	Stop Time	Start Latitude	Start Longitude	Stop Latitude	Stop Longitude	Min. Tow Speed	Max. Tow Speed	Water Temp. °C	Air Temp. °C	Salinity (ppm)	Min. Depth (m)	Max. Depth (m)	Total Length (mm)	Fork Length (mm)	Girth (mm)	Tagged Y/N	Genetics Y/N
1/9/2013	45	19:46	20:07	3657.01	7544.31	3657.32	7545.60	3.0	3.2	8.9	13.0	29.6	16.6	16.9	1944	1770	870	N	N
1/12/2013	121	4:19	4:39	3653.11	7547.40	3654.12	7547.55	3.0	3.1	8.8	12.0	27.9	17.1	17.2	1178	1030	465	N	N
1/12/2013	145	23:07	--	3703.50	7541.23	3702.28	7540.60	2.9	3.3	9.0	7.0	30.3	17.9	18.6	1265	1130	--	N	N
1/13/2013	199	16:25	16:50	3655.68	7544.62	3654.57	7543.61	3.2	3.3	9.7	11.0	29.4	16.0	19.6	1551	1350	630	N	N
1/11/2015	9	11:05	11:20	35.7333	-75.4080	35.7459	-75.4052	3.0	3.0	13.7	10.7	34.2	20.0	61.7	1310	1170	--	Y	Y
1/16/2015	103	16:37	16:57	37.2942	-75.5037	37.2758	-75.5052	3.4	3.5	7.3	6.8	33.4	60.4	63.1	1522	1330	660	Y	Y
1/16/2015	103	16:37	16:57	37.2942	-75.5037	37.2758	-75.5052	3.4	3.5	7.3	6.8	33.4	60.4	63.1	1841	1598	780	Y	Y
1/16/2015	103	16:37	16:57	37.2942	-75.5037	37.2758	-75.5052	3.4	3.5	7.3	6.8	33.4	60.4	63.1	1858	1630	781	Y	Y
1/16/2015	105	18:08	18:29	37.2980	-75.4996	37.2792	-75.5068	3.3	3.3	7.3	6.8	33.4	55.3	63.4	1560	1350	--	Y	Y
1/16/2015	106	18:54	19:16	37.2830	-75.5009	37.3029	-75.5004	3.3	3.3	7.2	6.8	33.4	60.0	63.8	1520	1290	--	Y	Y
1/13/16	21	13:24	13:39	37.0571	-75.6872	37.0686	-75.6935	3.0	3.0	10.5	-0.3	32.5	15.5	17.9	1760	1550	--	--	--
1/13/16	27	22:15	22:30	37.6385	-75.3769	37.6515	-75.3662	3.1	3.1	9.6	2.3	33.0	17.6	14.5	1670	1380	--	--	--

Table 19. Alosine species captured during the annual Cooperative Winter Tagging Cruises, 2013-2016. Data compiled from Excel 2013-2016 SumCatch.

Species	2013	2015	2016
American Shad	0	0	0
Alewife	78	9	28
Blueback Herring	0	95	10
Hickory Shad	3	1	0

Table 20. The number, average size (FL ± SD, mm) and range of Alewife and Blueback Herring retained for laboratory examination from the 2013-2016 Cooperative Winter Tagging Cruises compared to data from 2005, 2008, 2009, and 2010 Cruises. Data compiled from Excel 2013-2016-CWTC-Alosines-Book5.

Species	2005	2008	2009	2010	2013	2015	2016
Alewife							
N	15	26	50	70	79	7	26
Mean FL	132.1	227.7	233	217	237.4	246.1	235.2
STD FL	48.8	24.3	29.7	45.2	19.1	11.1	15.5
Min FL	81	159	110	114	203	230	201
Max FL	225	276	335	266	278	263	261
Blueback Herring							
N	21	97	159	390	0	72	9
Mean FL	113.9	197.6	187.8	198.5		220.5	175.1
STD FL	35.7	23	29.8	24.2		21.6	6.9
Min FL	77	75	103	34		176	165
Max FL	177	250	266	247		255	188

Table 21. CWTC results for River Herring from 2000-2016, showing the number of tows Alewife and Blueback Herring were present, and the percentage of tows each year that contained both species, using Blueback Herring presence as the divisor.

Year	Species	# Tows present	Fish count	#Co-occurring tows	Total tows	% of tows present	% co-occurrence
2000	Alewife	2	6	1	141	1.4	50.0
	Blueback	2	2			1.4	
2001	Alewife	6	6+	2	163	3.7	1.2
	Blueback	17	17+			10.4	
2002	Alewife	0	0	0	226	0	N/A
	Blueback	0	0			0	
2003	Alewife	1	1+	0	227	0.4	0
	Blueback	2	2+			0.9	
2004	Alewife	17	24+	7	258	6.6	53.8
	Blueback	13	13+			5	
2005	Alewife	36	41+	13	149	24.2	76.5
	Blueback	17	34+			11.4	
2006	Alewife	3	3+	0	302	1	0
	Blueback	6	6+			2	
2007	Alewife	1	1+	1	185	0.5	12.5
	Blueback	8	28			4.3	
2008	Alewife	35	88	18	329	10.6	81.8
	Blueback	22	53			6.7	
2009	Alewife	57	274	37	210	27.1	52.1
	Blueback	71	500			33.8	
2010	Alewife	35	82+	25	200	17.5	41.0
	Blueback	61	374+			30.5	
2013	Alewife	31	78	0	244	12.7	0
	Blueback	0	0			0	
2015	Alewife	8	9	5	152	5.3	17.9
	Blueback	28	95			18.4	
2016	Alewife	11	27	2	102	10.8	28.6
	Blueback	7	9			6.9	

Table 22. List of species collected by NC Division of Marine Fisheries for ageing by otoliths.

Species	2013	2015	2016	Total
Bluefish		1	8	9
Croaker, Atlantic	1	52	8	61
Drum, Black			1	1
Flounder, Southern	5	2		7
Flounder, Summer		17	22	39
Kingfish, Northern	1	36	37	74
Kingfish, Southern		1	74	75
Menhaden, Atlantic		1		1
Seatrout, Weakfish	34	14	40	88
Sheepshead			17	17
Spot	31	13		44

Table 23. Number of each species collected by trawl during the 2013, 2015, and 2016 Cooperative Winter Tagging cruises. Some species were sexed; F=female, M=male, Unid=not noted. Data compiled from Excel 2013-2016 SumCatch.

		Year			
Species	**Scientific name**	**2013**	**2015**	**2016**	**Total**
Alewife	*Alosa pseudoharengus*	78	9	28	115
Amer.Lobster	*Homarus americanus*	1	1	2	4
Arrow_Crab	*Stenorhynchus seticornis*	1	0	0	1
Atl.Croaker	*Micropogonius undulatus*	4	163	260	427
Atl.Cutlassfish	*Trichiurus lupturus*	1	23	73	97
Atl.Herring	*Clupea harengus*	636	657	274	1,567
Atl.Mackerel	*Scombrus scombrus*	56	93	5	154
Atl.Menhaden	*Brevoortia tyrannus*	1,423	451	280	2,154
Atl.Silverside	*Menidia menidia*	0	2	0	2
Atl.Spadefish	*Chaetodipterus faber*	0	0	3	3
Atl.Sturgeon	*Acipenser oxyrinchus*	4	6	2	12
Atl.Thread_Herring	*Opisthonema oglinum*	0	2	0	2
Baby's_Ear	*Sinum sp. prob. perspectivum*	1	1	3	5
Bay_Anchovy	*Anchoa mitchilli*	59	60	709	828
Blue_Runner	*Caranx crysos*	0	0	9	9
Blueback_Herring	*Alosa aestivalis*	0	95	9	104
Bluefish	*Pomatomus saltatrix*	0	1	40	41
Butterfish	*Peprilus triacanthus*	206	282	61	549
Chiton	*(unknown, not keyed)*	0	1	0	1
Clam,Razor	*(unknown, not keyed)*	0	1	0	1
Clam,Surf	*Spisula solidissima*	2	2	1	5
Clupeids,All	*Clupeidae*	2,140	1,213	591	3,944
Cobia	*Rachycentrum canadum*	0	1	0	1
Crab,Blue	*Callinectes sapidus*	10	0	2	12
Crab,False_Blue	*Callinectes similis?*	0	1	3	4
Crab,Hermit	*(unknown, not keyed)*	6	4	3	13
Crab,Jonah	*Cancer borealis*	10	42	35	87
Crab,Lady	*Ovalipes ocellatus*	1	11	126	138
Crab,Mud	*(unknown, not keyed)*	0	0	3	3
Crab,Ornate_blue	*Callinectes sp.*	0	2	38	40
Crab,Portunid	*Portunis sp.*	4	0	13	17
Crab,Rock	*Cancer irroratus*	0	10	30	40
Crab,Sand	*Arenaeus cribrarius*	0	0	106	106
Crab,Spider	*Libinia prob. emarginata*	5	6	29	40
Crab,Horseshoe	*Limulus polythemus*	104	63	204	371
Crab,Unid	*(unknown, not keyed)*	7	17	17	58
Cubbyu	*Equetus umbrosus*	0	0	1	1
Dogfish,Spiny_Tot	*Squalus acanthias*	9,065	1,485	1,233	11,783

Dogfish,Spiny-F	*Squalus acanthias*	5,529	1,361	1,055	7,945
Dogfish,Spiny-Fover	*Squalus acanthias*	2,799	0	13	2,812
Dogfish,Spiny-M	*Squalus acanthias*	456	122	159	737
Dogfish,Spiny-Mover	*Squalus acanthias*	289	0	6	295
Drum,Banded	*Larimus fasciatus*	0	2	1	3
Drum,Black	*Pogonius cromis*	0	0	2	2
Drum,Star	*Stellifer lanceolatus*	0	0	4	4
Eel,Amer.	*Anguilla rostrata*	1	0	0	1
Eel,Cusk	*Ophidion sp.*	0	0	2	2
Etropus,Unid	*Etropus sp.*	0	53	0	53
Flounder,Bay_Whiff	*Citharichthys spilopterus*	0	11	1	12
Flounder,Dusky	*Syacium papillosum*	0	1	1	2
Flounder,Fringed	*Etropus crossotus*	18	1	1	20
Flounder,Smallmouth	*Etropus microstomus*	0	34	103	137
Flounder,Southern	*Paralichthys lethostigma*	5	3	0	8
Flounder,Spottail	*(unknown, not keyed)*	0	1	0	1
Flounder,Spotted_Whiff	*Citharichthys macrops*	0	0	0	0
Flounder,Summer	*Paralichthys dentatus*	234	49	54	337
Flounder,Windowpane	*Scopthalmus aquosus*	123	82	124	329
Flounder.Unid	*(unknown, not keyed)*	0	3	38	41
Gadidae,Unid	*Gadidae*	0	0	2	2
Goby,Unid	*Gobiidae*	0	1	0	1
Greater_Amberjack	*Seriola dumerili*	0	0	1	1
Grey_Triggerfish	*Balistes capriscus*	0	0	4	4
Hake,All	*Urophysis spp.*	381	429	1,031	1,841
Hake,Silver	*Merluccius bilinearis*	0	63	222	285
Hake,Southern	*Urophycis floridana*	0	0	110	110
Hake,Spotted	*Urophycis regius*	0	206	643	849
Jellies,Unid	*(unknown, not keyed)*	46	0	0	46
Jelly,Box	*(unknown, not keyed)*	0	0	2	2
Jelly,Comb	*Ctenophora sp.*	0	1	0	1
Jellyfish	*(unknown, not keyed)*	0	0	1	1
Jellyfish,Moon	*(unknown, not keyed)*	0	89	2	91
Jellyfish,Unid	*(unknown, not keyed)*	0	1	0	1
Kingfish,All	*Menticirrhus spp. combined*	2	126	558	686
Kingfish,Northern	*Menticirrhus saxatilis*	0	103	69	172
Kingfish,Southern	*Menticirrhus americanus*	0	23	489	512
Lizardfish,All	*Synodus sp.*	0	5	33	38
Longspine_Porgy	*Stenotomus caprinus*	0	0	896	896
Midshipman	*Porichthys notatus*	0	0	1	1
Monkfish	*Lophius americanus*	0	1	0	1
Moon_Snail	*Prob. Neverita duplicata*	1	7	3	11
Octopus	*Octopus sp.*	4	0	0	4

Pigfish	*Orthopristus chrysoptera*	1	1	331	333
Pinfish	*Lagodon rhomboides*	1	0	140	141
Planehead_Filefish	*Stephanolepsis hispidus*	0	1	5	6
Pollock	*Gadus morhua*	0	1	0	1
Puffer,Northern	*Spheroides maculatus*	0	0	50	50
Puffer,Unid	*(unknown, not keyed)*	0	8	0	8
Ray,Bullnose-F	*Myliobatis freminvillii*	0	0	16	16
Ray,Bullnose-M	*Myliobatis freminvillii*	0	0	10	10
Ray,Cownose	*Rhinoptera bonasus*	0	1	0	1
Ray,Smooth_Butterfly-F	*Gymnura micrura*	0	0	1	1
Ray,Smooth_Butterfly-M	*Gymnura micrura*	0	0	3	3
Ray,Spiny_Butterfly -F	*Gymnura altavela*	0	0	10	10
Ray,Spiny_Butterfly-M	*Gymnura altavela*	0	0	5	5
Ray,Spiny_Butterfly-Unid	*Gymnura altavela*	0	2	0	2
Ray,Spotted_eagle	*Aetobatus narinari*	0	0	2	2
Round_Herring	*Etrumeus teres*	0	0	2	2
Sand_dollar	*Mellita quinquiesperforata*	1	2	12	15
Sciaenids,All	*Sciaenidae*	146	488	2,299	2,933
SeaBass,Black	*Centropristus striata*	2	1	2	5
SeaBass,Rock	*Centropristus philadelphica*	0	0	1	1
Searobin,Bighead	*Prionotus tribulus*	0	0	29	29
Searobin,Leopard	*Prionotus scitulus*	0	0	41	41
Searobin,Northern	*Prionotus carolinus*	0	38	122	160
Searobin,Striped	*Prionotus evolans*	0	9	11	20
SeaRobin,Unid	*Triglidae*	3	0	1	4
Shad,Amer.	*Alosa sapidissima*	0	0	0	0
Shad,Hickory	*Alosa mediocris*	3	1	0	4
Shark,Atl.Angel	*Squatina dumeril*	0	0	1	1
Shark,Atl.sharpnose	*Rhizoprionodon terraenovae*	0	0	6	6
Shark,Sandbar	*Carcharhinus plumbeus*	0	4	0	4
Shark,Thresher	*Alopias vulpinus*	0	1	0	1
Sheepshead	*Archosargus probatocephalus*	0	0	17	17
Shrimp,All	*All shrimps, summed*	7	35	73	115
Shrimp,Brown	*Farfantepeneaus aztecus*	0	0	1	1
Shrimp,Flathead	*(unknown, not keyed)*	0	11	7	18
Shrimp,Mantis	*Squilla prob. empusa*	0	0	5	5
Shrimp,Penaeid,Unid	*(unknown, not keyed)*	0	0	6	6
Shrimp,Pink	*Farfantepeneaus duorarum*	0	0	15	15
Shrimp,Pink_Speckled	*(unknown, not keyed)*	0	0	7	7
Shrimp,Roughhead	*(unknown, not keyed)*	0	0	14	14
Shrimp,Roughneck	*(unknown, not keyed)*	0	0	2	2
Shrimp,Sand	*Crangon septimspinosa*	0	0	2	2
Shrimp, *Trachypenaeus* sp.		0	0	1	1

Shrimp,Unid	*(unknown, not keyed)*	6	23	1	30
Shrimp,White	*Litopenaeus setiferus*	1	12	12	25
Silver_Perch	*Bairdiella chrysoura*	2	3	105	110
Silver_Porgy	*Diplodus caudimacula*	0	0	5	5
Skate,Clearnose-F	*Raja eglanteria*	118	66	50	234
Skate,Clearnose-M	*Raja eglanteria*	187	66	19	272
Skate,Litte-F	*Leucoraja erinacea*	23	84	59	166
Skate,Little-M	*Leucoraja erinacea*	55	175	102	332
Skate,Thorny	*Amblyraja radiata*	1	0	0	1
Skate,Winter-F	*Leucoraja ocellata*	175	175	102	452
Skate,Winter-M	*Leucoraja ocellata*	231	144	101	476
Skates,All	*(species combined)*	789	710	434	1,933
Slippershell	*Crepidula fornicata*	0	2	0	2
Snakefish	*Trachinocephalus myops*	0	23	3	26
Spadefish	*Chaetodipterus faber*	0	7	0	7
Spinycheek_Scorpionfish	*Neomerinthe hemingwayi*	2	2	0	4
Spot	*Leiostomus xanthurus*	9	27	37	73
Spotted_Trout	*Cynoscion nebulosus*	0	0	0	0
Squid,Bobtail	*Sepiolida*	0	23	22	45
Squid,Brief	*Lolliguncula brevis*	0	2	14	16
Squid,Longfin	*Loligo pealeii*	0	0	1068	1068
Squid,Shortfin	*Illex illecebrosus*	0	0	24	24
Squid_sp.	*(unknown, not keyed)*	1,651	1,355	1,128	4,134
Starfish	*Asterias forbesii*	64	12	25	101
Stingray,Atl.	*Dasyatis sabina*	0	0	3	3
Stingray,Roughtail	*Dasyatis centroura*	0	1	0	1
Stingray,Southern	*Dasyatis americana*	0	1	1	2
Striped_Anchovy	*Anchoa hepsetus*	0	8	18	26
Striped_Bass	*Morone saxatilis*	1,196	334	110	1,640
Striped_Burrfish	*Chilomycterus schoepfi*	0	0	5	5
Urchin,Unid	*(unknown, not keyed)*	0	6	104	110
Weakfish	*Cynoscion regalis*	138	41	778	957
Welk,Channeled	*Busycotypus canaliculatus*	3	0	1	4
Whelk,Knobbed	*Busycon carica*	3	0	0	3
Whelk_sp	*Busycon sp.*	0	0	2	2
White Urchin	*(unknown, not keyed)*	0	0	1	1

Table 24. Counts of species measured during the 2013, 2015, and 2016 Cooperative Winter Tagging Cruises. Data=2013-2016-Species_Measured.

Species	2013	2015	2016	Total
Alewife	79	9	28	116
Amer.Lobster	1	1	2	4
Arrow_Crab	1	0	0	1
Atl.Croaker	4	161	143	308
Atl.Cutlassfish	1	21	73	95
Atl.Herring	372	644	229	1245
Atl.Mackerel	56	93	5	154
Atl.Menhaden	140	445	215	800
Atl.Midshipman	0	0	1	1
Atl.Sheepshead	0	0	17	17
Atl.Silverside	0	2	0	2
Atl.Spadefish	0	7	3	10
Atl.Sturgeon	4	6	2	12
Atl.Thread_Herring	0	2	0	2
Bay_Anchovy	0	54	326	380
Blue_Runner	0	0	9	9
Blueback_Herring	0	95	10	105
Bluefish	0	1	40	41
Butterfish	203	269	62	534
Clam,Surf	0	2	1	3
Cobia	0	1	0	1
Crab, Portunid	3	0	0	3
Crab,Blue	9	0	1	10
Crab,False_Blue	0	1	0	1
Crab,Horseshoe	198	63	181	442
Crab,Jonah	10	42	36	88
Crab,Lady	0	7	19	26
Crab,Lesser_Blue	1	0	0	1
Crab,Mud	0	0	3	3
Crab,Ornate_Blue	0	2	0	2
Crab,Portunid	0	0	4	4
Crab,Rock	0	8	30	38
Crab,Spider	2	4	18	24
Crab,Unid	0	8	3	11
Cubbyu	0	0	1	1
Dogfish,Spiny	5981	1474	1216	8671
Drum,Banded	0	2	2	4

Drum,Black	0	0	1	1
Drum,Star	0	0	4	4
Eel,Cusk	0	0	2	2
Etropus sp.	0	53	0	53
Flounder,Bay_Whiff	0	11	1	12
Flounder,Dusky	0	1	2	3
Flounder,Fourspot	0	0	3	3
Flounder,Fringed	23	1	1	25
Flounder,Smallmouth	0	33	28	61
Flounder,Southern	5	3	0	8
Flounder,Spottail	0	1	0	1
Flounder,Summer	223	47	57	327
Flounder,Unid	0	3	25	28
Flounder,Windowpane	119	82	97	298
Gadidae,Unid	0	0	2	2
Goby,Unid	0	1	0	1
Greater_Amberjack	0	0	1	1
Grey_Triggerfish	0	0	4	4
Hake,Red	0	0	39	39
Hake,Silver	138	62	181	381
Hake,Southern	0	0	111	111
Hake,Spotted	175	190	544	909
Hake,Unid	0	418	1	419
Hake,White	0	0	1	1
Inshore_Lizardfish	1	5	33	39
Kingfish,Northern	2	100	66	168
Kingfish,Southern	0	23	307	330
Longspine_Porgy	0	0	215	215
Monkfish	0	1	0	1
Octopus	1	0	0	1
Ophichthidae	1	0	0	1
Pigfish	1	1	181	183
Pinfish	1	0	126	127
Planehead_Filefish	0	1	5	6
Pollock	0	1	0	1
Puffer	0	8	0	8
Puffer,Northern	0	0	50	50
Ray, Smooth_Butterfly	0	0	4	4
Ray,Bullnose	0	0	26	26
Ray,Cownose	0	1	0	1
Ray,Southern	0	1	0	1
Ray,Spiny_Butterfly	0	2	15	17
Ray,Spotted_Eagle	0	0	2	2

Round_Herring	0	0	2	2
SeaBass,Black	2	0	2	4
SeaBass,Rock	0	0	1	1
SeaBass,Unid	0	1	0	1
Searobin,Bighead	0	0	29	29
Searobin,Leopard	3	0	48	51
Searobin,Northern	0	38	63	101
Searobin,Striped	0	9	11	20
Searobin,Unid	0	0	1	1
Shad,Hickory	3	1	0	4
Shark,Atl._Angel	0	0	1	1
Shark,Atl._Sharpnose	0	0	7	7
Shark,Sandbar	0	4	0	4
Shark,Thresher	0	1	0	1
Shrimp,Brown	0	0	1	1
Shrimp,Mantis	0	0	5	5
Shrimp,Penaeid	0	0	6	6
Shrimp,Pink	0	0	16	16
Shrimp,Pink_Speckled	0	0	7	7
Shrimp,Roughhead	0	0	6	6
Shrimp,Roughneck	0	0	10	10
Shrimp,Sand	0	0	2	2
Shrimp,Trachypenaeus sp.	0	0	1	1
Shrimp,Unid	0	23	1	24
Shrimp,White	1	12	12	25
Silver_Perch	4	3	136	143
Silver_Porgy	0	0	5	5
Skate,Clearnose	304	130	68	502
Skate,Little	70	258	162	490
Skate,Thorny	1	0	0	1
Skate,Unid	0	2	0	2
Skate,Winter	284	317	202	803
Snakefish	0	23	3	26
Spinycheek_Scorpionfish	0	2	0	2
Spot	93	25	37	155
Squid, Unid	0	1309	0	1309
Squid,Bobtail	0	22	0	22
Squid,Brief	0	1	2	3
Stingray,Atl.	0	0	2	2
Stingray,Roughtail	0	1	0	1
Stingray,Southern	0	0	1	1
Striped_Anchovy	0	7	18	25
Striped_Bass	895	334	110	1339

Striped_Burrfish	0	0	5	5
Weakfish	138	40	342	520
Whelk,Channeled	0	0	1	1
Whelk,Knobbed	0	0	1	1
Grand Total	**9,553**	**7,037**	**6,142**	**22,732**

Table 25. Species measured (TL, WW, or CW in mm) during the 2013 Cruise. WW = wing width; CW = carapace width. The grand total measured exceeds that of Table 24 because skate species may have both TL and WW measurements.

Species	No.TL count	Mean TL	TL SD	TL Min	TL Max	No.WW count	Mean WW	WW SD	WW Min	WW Max
Alewife	79	270.6	21.3	234	319					
Amer.Lobster						1	300.0		300	300
Arrow_Crab						1	58.0		58	58
Atl.Croaker	4	155.3	58.5	98	212					
Atl.Cutlassfish	1	901.0		901	901					
Atl.Herring	372	284.6	15.5	181	395					
Atl.Mackerel	56	298.3	33.5	206	389					
Atl.Menhaden	140	278.6	55.9	115	351					
Atl.Sturgeon	4	1484.5	345.3	1178	1944					
Butterfish	203	188.3	24.3	98	237					
Crab, Portunid						3	45.0	5.0	40	50
Crab,Blue						9	127.7	10.8	112	145
Crab,Horseshoe						198	151.9	36.2	112	511
Crab,Jonah						10	53.7	19.5	12	82
Crab,Lesser_Blue						1	54.0		54	54
Crab,Spider						2	46.5	20.5	32	61
Dogfish,Spiny	5981	815.6	63.4	143	1000					
Flounder,Fringed	23	99.9	17.8	73	142					
Flounder,Southern	5	367.6	103.5	207	477					
Flounder,Summer	223	336.2	118.5	124	675					
Flounder,Windowpane	119	259.0	37.3	126	351					
Hake,Silver	138	146.1	35.6	45	224					
Hake,Spotted	175	144.7	82.6	37	338					
Inshore_Lizardfish	1	62.0		62	62					
Kingfish,Northern	2	312.0	91.9	247	377					
Octopus	1	50.0		50	50					
Ophichthidae	1	378.0		378	378					
Pigfish	1	125.0		125	125					
Pinfish	1	120.0		120	120					
SeaBass,Black	2	257.5	26.2	239	276					
Searobin,Leopard	3	109.3	22.0	84	124					
Shad,Hickory	3	394.7	27.6	374	426					
Shrimp,White	1	147.0		147	147					
Silver_Perch	4	114.3	20.7	95	138					
Skate,Clearnose	141	660.9	40.8	513	760	300	430.0	49.9	140	744
Skate,Little	33	478.6	81.6	373	815	69	284.1	56.5	225	500
Skate,Thorny						1	99.0		99	99
Skate,Winter	202	628.4	138.4	270	962	283	389.4	87.8	216	642

Spot	93	167.9	157.6	78	1652	
Striped Bass	895	833.6	91.5	606	1193	
Weakfish	138	303.8	61.9	121	522	
Tot count (TL; WW; CW)	**9,045**					**878**

Table 26. Species measured (TL, WW, or CW in mm) during the 2015 Cruise. WW = wing width; CW = carapace width. The grand total measured exceeds that of Table 24 because skate species may have both TL and WW measurements.

Species	No.TL count	Mean TL	TL SD	TL Min	TL Max	No.WW count	Mean WW	WW SD	WW Min	WW Max
Alewife	9	287.3	12.4	271	310					
Amer.Lobster						1	374.0		374	374
Atl.Croaker	161	182.7	55.3	70	340					
Atl.Cutlassfish	21	234.1	78.1	114	411					
Atl.Herring	644	270.2	32.9	201	975					
Atl.Mackerel	93	320.1	29.0	242	382					
Atl.Menhaden	445	280.1	54.5	100	397					
Atl.Silverside	2	98.5	16.3	87	110					
Atl.Spadefish	7	126.4	12.0	106	141	5			0	0
Atl.Sturgeon	6	1601.8	211.1	1310	1858					
Atl.Thread_Herring	2	135.5	0.7	135	136					
Bay_Anchovy	54	62.4	10.6	40	91					
Blueback_Herring	95	241.7	33.5	130	296					
Bluefish	1	211.0		211	211					
Butterfish	269	137.8	29.3	5	245					
Clam,Surf						2	55.5	0.7	55	56
Cobia	1	1072.0		1072	1072					
Crab,False_Blue						1	62.0		62	62
Crab,Horseshoe						63	161.1	26.3	62	220
Crab,Jonah						42	56.7	16.7	18	95
Crab,Lady						7	52.1	18.1	34	86
Crab,Ornate_Blue						2	47.0	0.0	47	47
Crab,Rock						8	53.9	19.1	34	85
Crab,Spider						4	74.3	15.3	52	87
Crab,Unid						8	45.5	19.3	10	65
Dogfish,Spiny	1474	750.7	89.3	105	982					
Drum,Banded	2	92.0	8.5	86	98					
Etropus sp.	53	97.6	21.1	63	150					
Flounder,Bay_Whiff	11	216.0	51.6	119	274					
Flounder,Dusky	1	280.0		280	280					
Flounder,Fringed	1	83.0		83	83					
Flounder,Smallmouth	33	92.8	19.5	61	154					
Flounder,Southern	3	408.3	25.6	384	435					
Flounder,Spottail	1	135.0		135	135					
Flounder,Summer	47	343.4	136.3	126	630					
Flounder,Unid	3	115.3	31.3	82	144					
Flounder,Windowpane	82	251.4	47.3	47	421					
Goby,Unid	1	50.0		50	50					

Hake,Silver	62	132.6	32.0	60	273					
Hake,Spotted	190	128.2	79.8	52	316					
Hake,Unid	418	64.8	10.1	39	147					
Inshore_Lizardfish	5	248.2	48.4	205	330					
Kingfish,Northern	100	186.0	27.7	103	285					
Kingfish,Southern	23	136.8	60.2	52	292					
Monkfish	1	495.0		495	495					
Pigfish	1	147.0		147	147					
Planehead_Filefish	1	129.0		129	129					
Pollock	1	416.0		416	416					
Puffer	8	119.1	15.9	105	155					
Ray,Cownose						1	340.0		340	340
Ray,Southern						1	470.0		470	470
Ray,Spiny_Butterfly						2	1145.0	176.8	1020	1270
SeaBass,Unid	1	94.0		94	94					
Searobin,Northern	38	106.9	36.7	52	179					
Searobin,Striped	9	98.0	36.3	66	187					
Shad,Hickory	1	326.0		326	326					
Shark,Sandbar	4	931.5	329.7	622	1380					
Shark,Thresher	1	1730.0		1730	1730					
Shrimp,Unid	23	109.7	25.5	57	136					
Shrimp,White	12	134.0	11.1	115	146					
Silver_Perch	3	135.7	9.0	127	145					
Skate,Clearnose						130	423.6	61.2	164	910
Skate,Little						258	253.1	36.1	59	363
Skate,Unid	2	62.5	13.4	53	72					
Skate,Winter						317	338.7	95.2	91	630
Snakefish	23	172.6	29.4	123	252					
Spinycheek_Scorpionfish	2	74.0	12.7	65	83					
Spot	25	116.0	15.9	100	160					
Squid, Unid	1309	113.2	34.9	11	355					
Squid,Bobtail	22	20.6	12.4	11	71					
Squid,Brief	1	35.0		35	35					
Stingray,Roughtail	1	2260.0		2260	2260	1	1160.0		1160	1160
Striped_Anchovy	7	79.6	5.6	71	86					
Striped_Bass	334	891.4	70.6	567	1071					
Weakfish	40	146.1	25.8	103	225					
Weakfish	40	146.1	25.8	103	225					
Striped_Bass*										
Tot count (TL; WW; CW)	**6,230**					**853**				

Table 27. Species measured (TL, WW, or CW in mm) during the 2016 Cruise. WW = wing width; CW = carapace width. The grand total measured exceeds that of Table 24 because skate species may have both TL and WW measurements.

Species	No.TL count	Mean TL	TL SD	TL Min	TL Max	No.WW count	Mean WW	WW SD	WW Min	WW Max
Alewife	28	276.6	23.4	200	315					
Amer.Lobster						2	262.5	31.8	240	285
Atl.Croaker	143	202.0	49.8	90	331					
Atl.Cutlassfish	73	247.1	34.2	159	340					
Atl.Herring	229	276.8	16.8	198	313					
Atl.Mackerel	5	328.0	22.4	301	345					
Atl.Menhaden	215	260.2	90.2	103	547	2	345.0	63.6	300	390
Atl.Midshipman	1	245.0		245	245					
Atl.Sheepshead	17	606.8	43.8	475	665					
Atl.Spadefish	3	134.0	2.6	131	136					
Atl.Sturgeon	2	1715.0	63.6	1670	1760					
Bay_Anchovy	326	69.9	9.0	46	95					
Blue_Runner	9	169.7	7.8	155	178					
Blueback_Herring	10	210.0	12.9	190	239					
Bluefish	40	340.5	42.3	248	414					
Butterfish	62	127.8	37.4	50	204					
Clam,Surf						1	80.0		80	80
Crab,Blue						1	150.0		150	150
Crab,Horseshoe						181	169.4	37.8	106	281
Crab,Jonah						36	54.0	14.6	30	106
Crab,Lady						19	49.1	14.7	21	68
Crab,Mud						3	14.0	1.0	13	15
Crab,Portunid						4	34.5	3.1	30	37
Crab,Rock						30	56.3	18.3	41	118
Crab,Spider						18	55.4	13.0	30	85
Crab,Unid						3	43.0	15.4	26	56
Cubbyu	1	160.0		160	160					
Dogfish,Spiny	1216	792.6	89.2	252	1022					
Drum,Banded	2	118.0	73.5	66	170					
Drum,Black	1	594.0		594	594					
Drum,Star	4	84.8	19.6	70	113					
Eel,Cusk	2	81.5	6.4	77	86					
Flounder,Bay_Whiff	1	146.0		146	146					
Flounder,Dusky	2	258.5	23.3	242	275					
Flounder,Fourspot	3	145.3	15.5	134	163					
Flounder,Fringed	1	101.0		101	101					
Flounder,Smallmouth	28	81.8	35.9	46	183					

Flounder,Summer	57	278.1	71.4	177	547					
Flounder,Unid	25	90.2	31.2	46	135					
Flounder,Windowpane	97	217.2	72.1	67	310					
Gadidae,Unid	2	46.0	4.2	43	49					
Greater_Amberjack	1	325.0		325	325					
Grey_Triggerfish	4	188.8	67.2	116	276					
Hake,Red	39	144.8	18.9	104	183					
Hake,Silver	181	174.5	38.7	26	315					
Hake,Southern	111	157.6	72.9	47	322					
Hake,Spotted	544	161.3	69.8	33	316					
Hake,Unid	1	105.0		105	105					
Hake,White	1	221.0		221	221					
Inshore_Lizardfish	33	294.5	49.9	180	393					
Kingfish,Northern	66	223.1	41.6	97	345					
Kingfish,Southern	307	186.9	51.8	55	356					
Longspine_Porgy	215	149.8	11.0	109	217					
Pigfish	181	171.4	21.5	104	227					
Pinfish	126	141.5	18.5	111	237					
Planehead_Filefish	5	145.8	15.6	128	166					
Puffer,Northern	50	141.5	30.7	81	233					
Ray, Smooth_Butterfly						4	603.0	163.5	445	800
Ray,Bullnose						26	382.1	89.1	135	680
Ray,Spiny_Butterfly						15	1194.4	527.8	597	1955.8
Ray,Spotted_Eagle						2	765.0	63.6	720	810
Round_Herring	2	159.5	0.7	159	160					
SeaBass,Black	2	144.0	33.9	120	168					
SeaBass,Rock	1	56.0		56	56					
Searobin,Bighead	29	60.3	19.4	44	152					
Searobin,Leopard	48	150.4	56.2	55	265					
Searobin,Northern	63	79.7	36.2	30	184					
Searobin,Striped	11	181.8	123.6	57	368					
Searobin,Unid	1	40.0		40	40					
Shark,Atl._Angel	1	1012.0		1012	1012					
Shark,Atl._Sharpnose	7	924.1	59.2	860	997					
Shrimp,Brown	1	150.0		150	150					
Shrimp,Mantis	5	130.6	10.5	118	146					
Shrimp,Penaeid	6	51.3	3.9	45	55					
Shrimp,Pink	16	134.7	39.3	36	175					
Shrimp,Pink_Speckled	7	60.3	11.0	48	76					
Shrimp,Roughhead	6	75.0	10.6	63	90					
Shrimp,Roughneck	10	61.3	13.0	40	73					
Shrimp,Sand	2	36.5	0.7	36	37					

Shrimp,Trachypenaeus sp.	1	63.0		63	63					
Shrimp,Unid	1	40.0		40	40					
Shrimp,White	12	146.6	29.5	99	194					
Silver_Perch	136	123.6	15.2	78	181					
Silver_Porgy	5	172.0	24.6	130	192					
Skate,Clearnose						68	418.3	34.5	320	490
Skate,Little						162	260.4	25.6	75	335
Skate,Winter						202	392.8	76.3	90	532
Snakefish	3	179.7	77.4	114	265					
Spot	37	162.6	15.2	141	216					
Squid,Brief	2	41.0	8.5	35	47					
Stingray,Atl.	2	205.5	85.6	145	266					
Stingray,Southern	1	276.0		276	276					
Striped_Anchovy	18	113.2	10.6	78	128					
Striped_Bass	110	960.3	69.0	602	1100					
Striped_Burrfish	5	127.6	18.5	110	151					
Weakfish	342	190.0	49.4	105	364					
Whelk,Channeled	1	68.0		68	68					
Whelk,Knobbed	1	168.0		168	168					
Tot count (TL; WW; CW)	**5,365**					**779**				

Table 28. Number of Clearnose Skate females and males by size class measured during the 2013, 2015, and 2016 Cruises.

Size class	Female 2013	Male 2013	Female 2015	Male 2015	Female 2016	Male 2016	Female Total	Male Total
101-125	0	0	0	1	0	0	0	1
126-150	1	2	0	0	0	0	1	2
151-175	0	0	1	0	0	0	1	0
176-200	0	0	0	0	0	0	0	0
201-225	0	0	0	0	0	0	0	0
226-250	0	0	0	0	0	0	0	0
251-275	0	0	0	1	0	0	0	1
276-300	0	0	0	0	0	0	0	0
301-325	3	1	2	0	0	1	5	2
326-350	0	1	0	2	0	1	0	4
351-375	0	4	0	6	2	3	2	13
376-400	1	24	3	11	0	12	4	47
401-425	11	83	19	24	4	19	34	126
426-450	37	46	20	12	5	8	62	66
451-475	37	18	16	3	6	3	59	24
476-500	17	4	3	1	2	2	22	7
501-525	0	1	0	0	0	0	0	1
526-550	1	0	0	0	0	0	1	0
701-800	0	1	0	0	0	0	0	1
910	0	0	0	1	0	0	0	1
Total	108	185	64	62	19	49	191	296

Table 29. Number of Little Skate females and males by size class measured during the 2013, 2015, and 2016 Cruises.

Size class	Female 2013	Male 2013	Female 2015	Male 2015	Female 2016	Male 2016	Female Total	Male Total
<100	0	0	1	0	0	1	1	1
101-125	0	0	0	0	0	1	0	1
126-150	0	0	4	2	0	0	4	2
151-175	0	0	2	1	0	0	2	1
176-200	0	0	0	0	1	1	1	1
201-225	0	1	6	2	1	1	7	4
226-250	3	6	25	22	13	16	41	44
251-275	8	29	30	114	31	70	69	213
276-300	5	4	8	20	11	13	24	37
301-325	2	0	0	0	1	0	3	0
326-350	1	1	0	2	1	0	2	3
351-375	0	0	0	0	0	0	0	0
376-400	2	0	0	0	0	0	2	0
401-425	1	0	0	0	0	0	1	0
426-450	0	1	0	0	0	0	0	1
451-475	0	2	0	0	0	0	0	2
476-500	0	1	0	0	0	0	0	1
Total	22	45	76	163	59	103	157	311

Table 30. Number of Winter Skate females and males by size class measured during the 2013, 2015, and 2016 Cruises.

Size class	Female 2013	Male 2013	Female 2015	Male 2015	Female 2016	Male 2016	Female Total	Male Total
76-100	0	**0**	1	**0**	0	**0**	1	**0**
101-125	0	0	2	4	0	0	2	4
126-150	0	0	3	4	2	0	5	4
151-175	0	0	1	1	0	0	1	1
176-200	0	0	4	2	0	0	4	2
201-225	2	0	6	3	2	0	10	3
226-250	6	5	15	12	1	1	22	18
251-275	9	8	20	6	5	1	34	15
276-300	15	8	6	5	7	5	28	18
301-325	16	6	25	16	9	5	50	27
326-350	10	13	25	16	8	8	43	37
351-375	13	18	14	9	10	8	37	35
376-400	11	17	10	8	15	9	36	34
401-425	16	12	14	16	12	19	42	47
426-450	10	15	8	10	18	8	36	33
451-475	6	12	7	5	3	15	16	32
476-500	13	11	4	5	8	16	25	32
501-525	1	9	2	4	0	2	3	15
526-550	0	9	0	5	1	3	1	17
551-575	0	5	0	0	0	0	0	5
576-600	0	4	0	0	0	0	0	4
601-625	0	1	0	0	0	0	0	1
626-650	0	1	0	1	0	0	0	2
Total	128	154	167	132	101	100	396	386

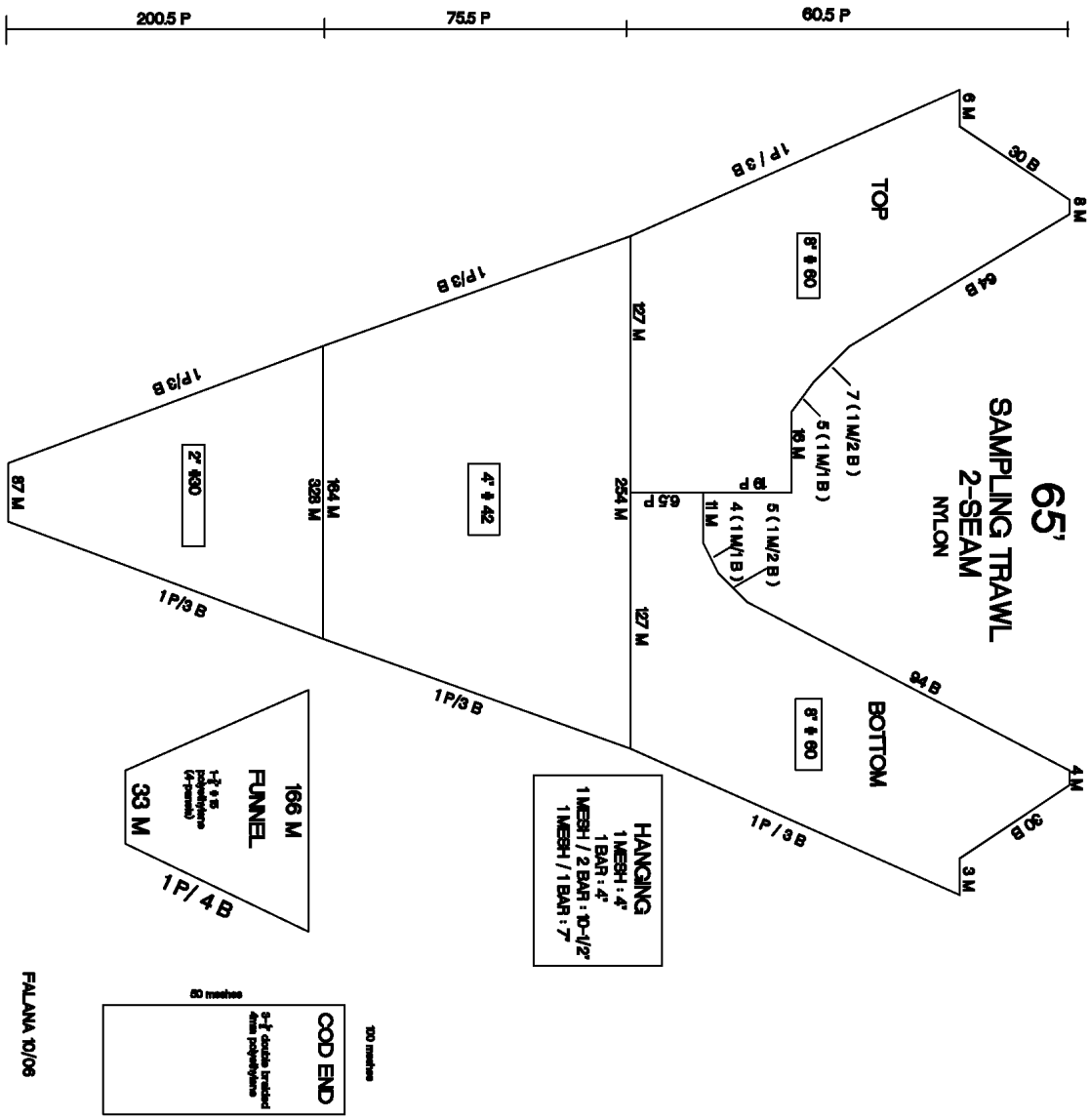
Table 31. Most abundant species co-occurring with Striped Bass in tows from the 2013, 2015, and 2016 Cruises.

Year	Number of Tows Containing Striped Bass	Number of Striped Bass Captured	Associate Species (number of co-occurring tows)	Abundance of Associate Species in Tows Containing Striped Bass
2013	78	1196	Spiny Dogfish (78)	3209
			Atlantic Herring (19)	109
			Clearnose, Winter, Little Skates (60)	146
			Summer and Windowpane Flounders (51)	363
			Butterfish (10)	58
			Hakes (11)	43
			Weakfish (13)	28
			Squid (40)	390
			Bay Anchovy (48)	--
			Horseshoe Crab, Starfish, Other Non-finfish Species (48)	--
2015	31	335	Spiny Dogfish (30)	364
			Atlantic Herring (8)	74
			Clearnose, Winter, Little Skates (28)	135
			Butterfish (9)	81
			Hakes(12)	66
			Squid (27)	292
			Horseshoe Crab, Lobster, Other Crab Species (9)	16
			Blueback Herring (8)	24
			Summer, Windowpane, and Smallmouth Flounder (10)	22
			Menhaden (4)	11
2016	13	110	Spiny Dogfish (13)	166
			Atlantic Cutlassfish (6)	21
			Atlantic Herring (4)	73
			Alewife (8)	25
			Horseshoe Crab (8)	16
			Little and Winter Skates (10)	29
			Hakes (7)	58
			Summer and Windowpane Flounders (13)	41
			Squid (13)	329
			American Lobster and Various Crab Species (7)	13

XII. APPENDICES

1. Detailed specifications of the otter trawl used for Cooperative Winter Tagging Cruise sampling.
2. NC Coastal Recreational Fishing License January 12, 2012, grant award letter from NC Division of Marine Fisheries Director Dr. Louis B. Daniel, III, to Dr. Roger A. Rulifson, East Carolina University, Greenville, NC.
3. U.S. Department of Commerce, NOAA, NMFS, Southeast Regional Office, Saltonstall-Kennedy grant March 27, 2014, award letter from Assistant Regional Administration for Operations, Management and Information Lauren B. Lugo, to Mr. Riddick Smiley, East Carolina University, Greenville, NC.
4. Letter from East Carolina University Grant and Contract Officer Kevin Mills, May 3, 2012, to Ms. Tiffany Frazier, CRFL Project Director, accepting the CRFL funding for the Cooperative Winter Tagging Cruise
5. Letter of October 10, 2013 to Martha Van Scott, ECU Office of Sponsored Programs, from Marjorie Barber, NCDENR Purchasing Agent, Purchase and Contract Section, renewing Second year of Contract for $8,000
6. Financial Assistance Award from Freddie Isaac, USDOC to Riddick Smiley, East Carolina University, Award Number NA14NMF4270042 for $194,084
7. US Fish and Wildlife Service Contribution of $8,000 to match CRFL $8,000 Second year of Funding
8. Letter to Martha Van Scott, OSP, East Carolina University from Jane Q. Smith, NCDENR Purchasing Agent, for third Year of CRFL Funding
9. Metadata documenting the list of variables used for the Cooperative Winter Tagging Cruise, the USFWS tagging data, and the master CWTC summary data files for catch summaries and measurements of species.
10. Documentation of the specimens collected during the 2013, 2015, and 2016 Cooperative winter Tagging Cruises and deposited into the collection at the North Carolina Science Museum.
11. Summary of mortality estimates, and differences in age and length frequencies between gear types

Appendix 1.
Detailed specifications of the otter trawl used for Cooperative Winter Cruise sampling.



65’

SAMPLING TRAWL

2-SEAM NYLON

WEBBING (NYLON)

-BOSOM, WINGS, AND CORNERS- 8” # 60 TWINE

-INTERMEDIATE- 4” # 42 TWINE

-EXTENSION- 2” # 30 TWINE

-CODEND- 3-1/2” DOUBLE BRAIDED 4MM POLYETHYLENE

HANGING CABLE

-HEADROPE AND FOOTROPE-9/16” DIAMETER POLYETHYLENE

- STAINLESS STEEL COMBINATION CABLE

GROUND GEAR

-5/16” GALVANIZED CHAIN W/ 8” DROPS EVERY FOUR FEET ,SET EVEN WITH THE FOOTROPE

FLOATATION

-5 – 11” HARD PLASTIC

TRAWL BOARDS

-8’ X 42” WOODEN FLAT BOARDS (900LBS PER SET)

TOWING SPEED

-2.5 KTS

BRIDLES

-50 FATHOM ½” GALVANIZED STEEL WIREROPE (6X 19 CLASSES) TO MAIN WARP

LEG LINES 20’ (17’STAINLESS 3/8” WIREROPE + 3’ TRAWL LEG)

65' 3 and 1 Trawl

Cutting Specs

Top 65.46'

Cut 64 bars, (7) 1m2b, (5) 1m1b, 16 meshes across center

Bottom 79.15'

Cut 94 bars, (5) 1m2b, (4) 1m1b, 11 meshes across center

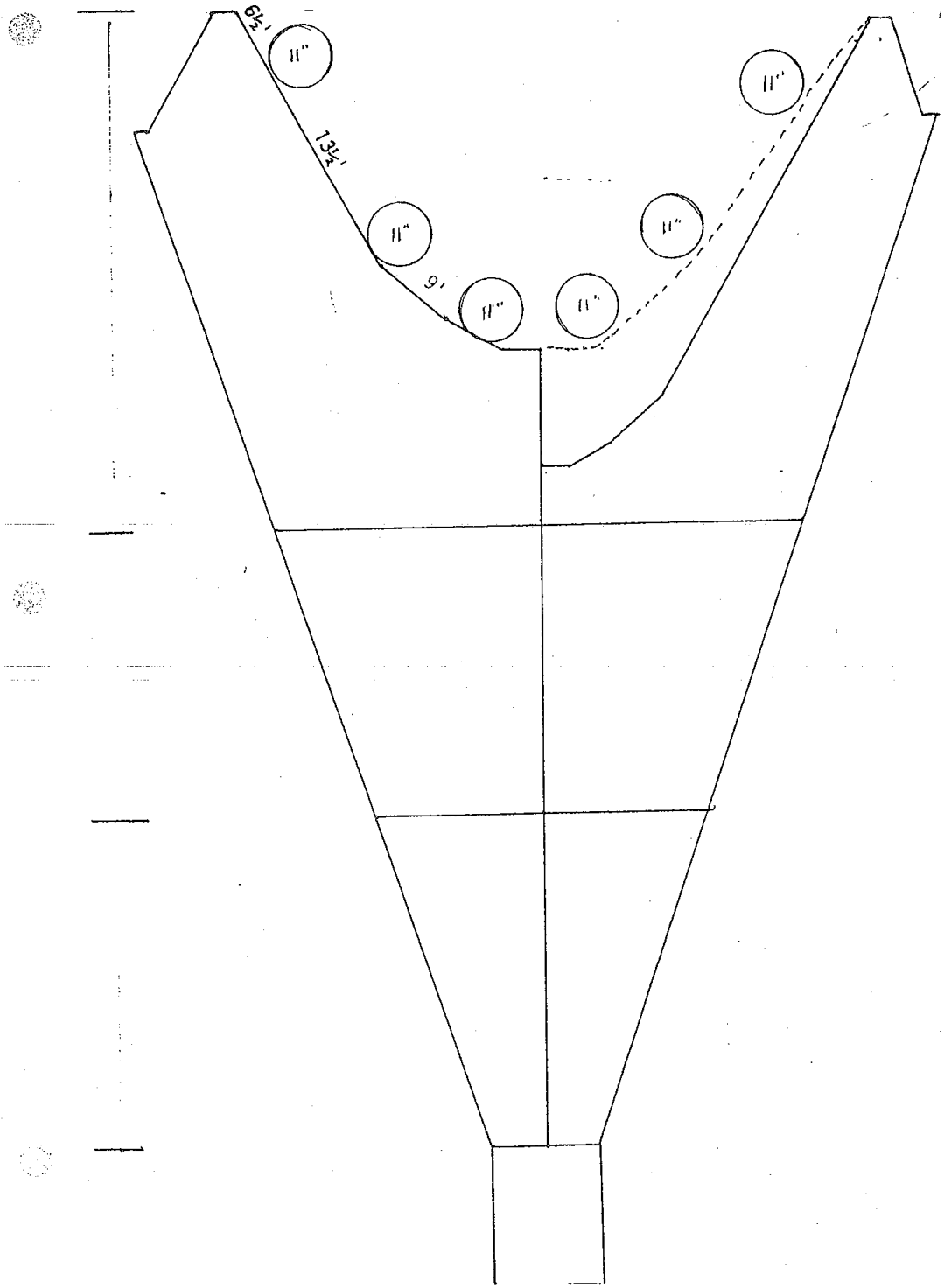
Hang: Top

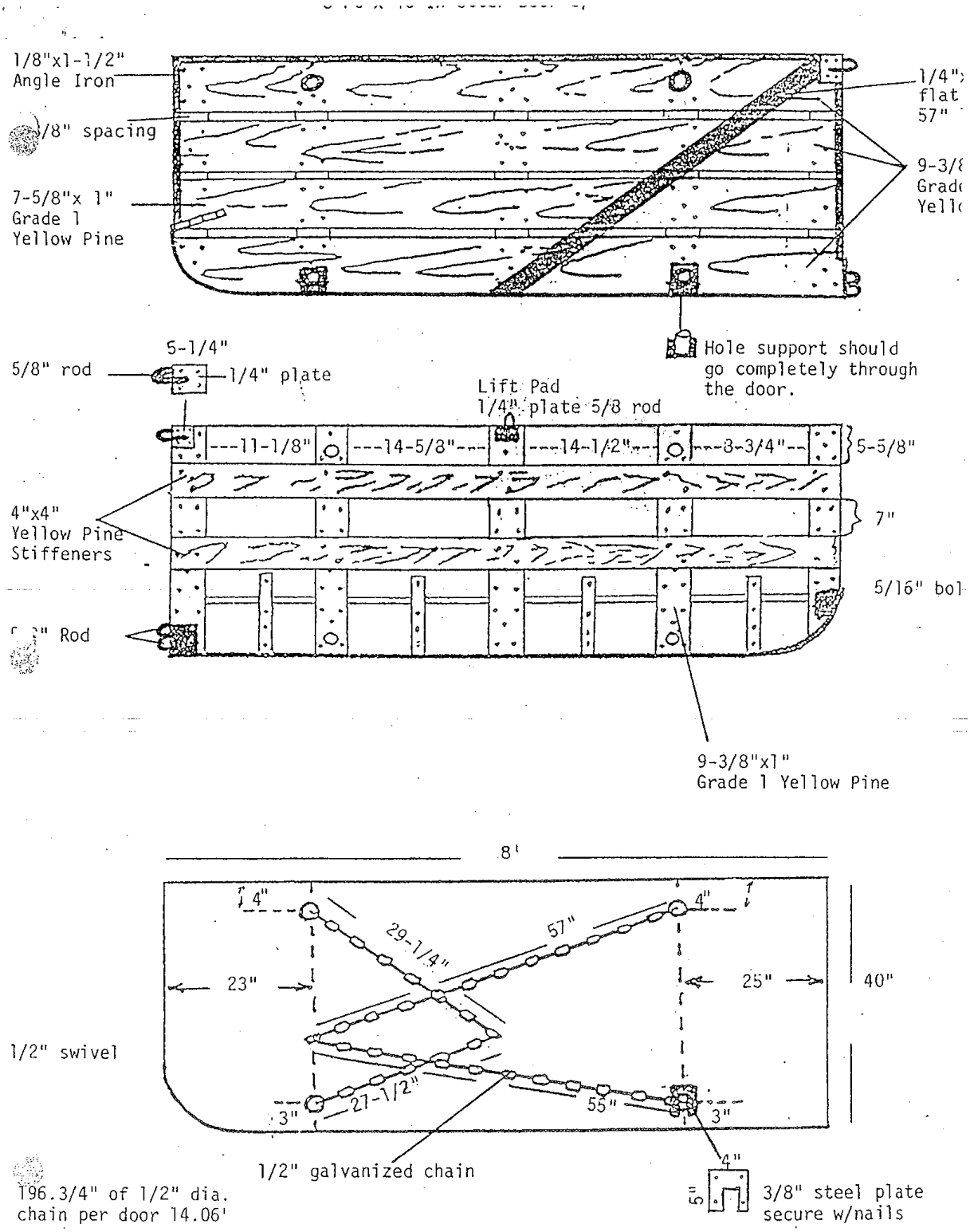
61 bars	4"	20.33' x 2
8 1m2b	10-1/2"	7' x 2
5 1m1b	7"	2.9' x 2
15 meshes	4"	5'
		65.46'

Bottom

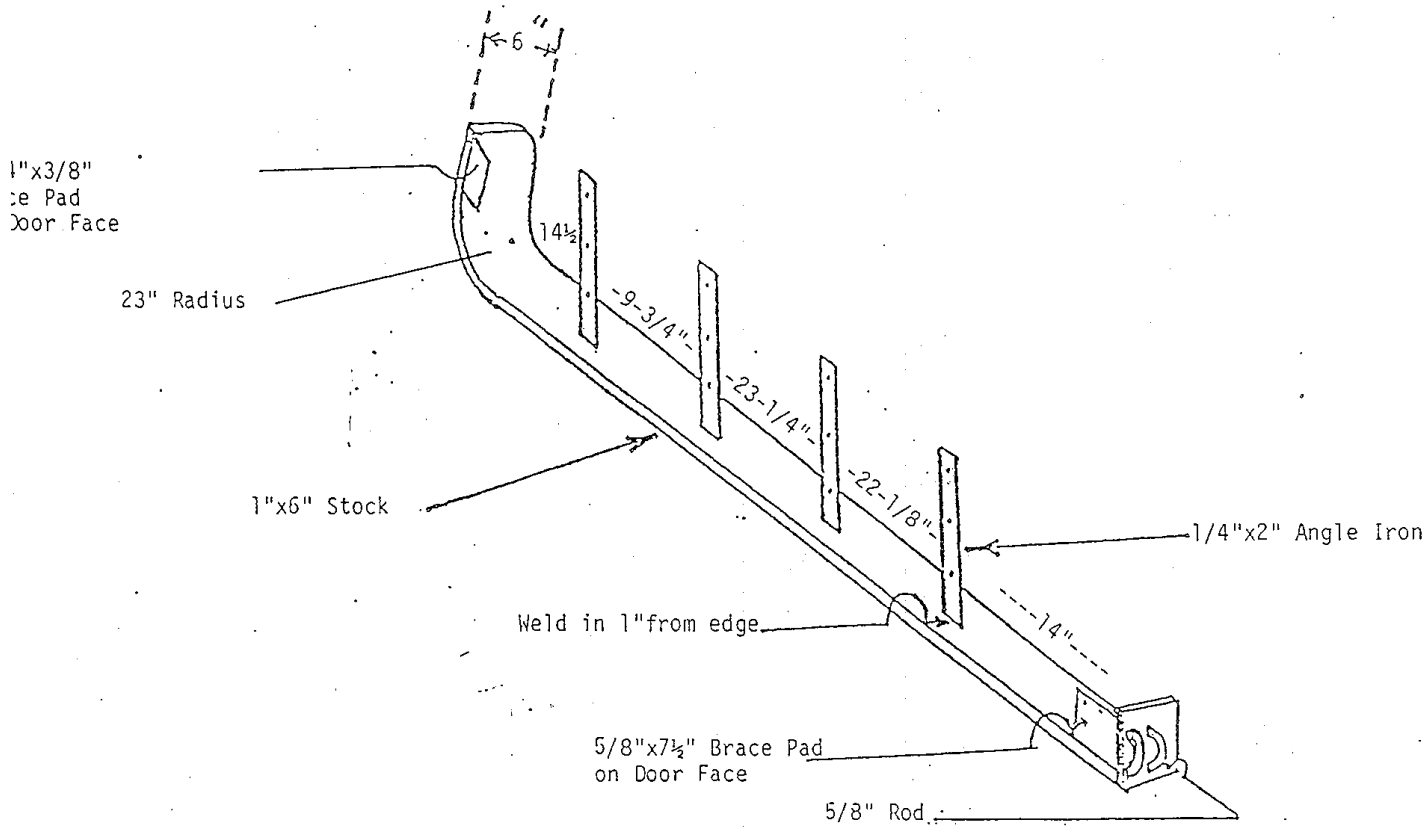
91 bars	4"	30.33' x 2
6 1m2b	10-1/2"	5.25 x 2
4 1m1b	7"	2.33 x 2
10 meshes	4"	3.33
		79.15'

Floatation Placement




1/8"x1-1/2"
Angle Iron
/8" spacing
7-5/8"x 1"
Grade 1
Yellow Pine
1/4"
flat
57"
9-3/8
Grade
Yell
Hole support should
go completely through
the door.
5-1/4"
5/8" rod
1/4" plate
Lift Pad
1/4" plate 5/8 rod
11-1/8"
14-5/8"
14-1/2"
8-3/4"
5-5/8"
4"x4"
Yellow Pine
Stiffeners
7"
5/16" bol
Rod
9-3/8"x1"
Grade 1 Yellow Pine
8'
4"
4"
29-1/4"
57"
23"
25"
40"
1/2" swivel
27-1/2"
3"
55"
3"
1/2" galvanized chain
4"
5"
3/8" steel plate
secure w/nails
196.3/4" of 1/2" dia.
chain per door 14.06'

8 Foot Door Shoe



Total weight 196.4 lb

Recommended Scope Ratio

Water Depth Fathoms	Warp Fathoms	Scope Ratio	Water Depth Fathoms	Warp Fathoms	Scope Ratio
5	35	7.0	28	116	4.1
6	35	5.8	29	118	4.1
7	35	5.0	30	120	4.0
8	40	5.0	31	124	4.0
9	45	5.0	32	128	4.0
10	50	5.0	33	132	4.0
11	55	5.0	34	136	4.0
12	60	5.0	35	140	4.0
13	65	5.0	36	144	4.0
14	70	5.0	37	148	4.0
15	75	5.0	38	152	4.0
16	80	5.0	39	156	4.0
17	85	5.0	40	160	4.0
18	90	5.0	41	164	4.0
19	95	5.0	42	168	4.0
20	100	5.0	43	172	4.0
21	102	4.9	44	176	4.0
22	104	4.7	45	180	4.0
23	106	4.6	46	184	4.0
24	108	4.5	47	188	4.0
25	110	4.4	48	192	4.0
26	112	4.3	49	196	4.0
27	114	4.2	50	200	4.0

Appendix 2.
NC Coastal Recreational Fishing License January 12, 2012, grant award letter from NC Division of Marine Fisheries Director Dr. Louis B. Daniel, III, to Dr. Roger A. Rulifson, East Carolina University, Greenville, NC.

NCDENR

North Carolina Department of Environment and Natural Resources
Division of Marine Fisheries

Beverly Eaves Perdue
Governor

Dr. Louis B. Daniel III
Director

Dee Freeman
Secretary

January 12, 2012

Dr. Roger A. Rulifson
East Carolina University
Institute for Coastal Science and Policy
Flanagan Hall 250
Greenville, NC 27858

Dear Dr. Rulifson,

Congratulations, your proposal for Cooperative Winter Tagging Cruise was chosen for funding by the Coastal Recreational Fishing License (CRFL) Fund. Your proposal in the amount of $238,836 was one of 14 selected for funding. However, the second and third year of funding will be dependent on you securing other funding sources. If additional partners can be secured, CRFL may consider funding up to 50 percent for the second and third year, but other funds have to be secured first, without reduction of work or change in objectives. This special condition will be a part of the final contract and you will need to accept this condition in addition to accepting the award. Please respond with a signed letter accepting award funding and condition stated in this award letter. Please remit to Division of Marine Fisheries, 3441 Arendell Street, Morehead City, NC 28557-0769, Attention: Tiffany D. Frazier.

The Division of Marine Fisheries will be forwarding approved proposals to our Division of Purchase and Services requesting the award of a contract. You will receive contract documents for signature within 8-10 weeks after we have received from you all necessary contract documents. Once the contract has been returned with appropriate signatures, the department will sign them and one original will be returned to you. You may begin the work defined in your contract when you have received your copy of the fully executed contract. Reporting requirements will also be specified in the contract. No work can be reimbursed unless there is a contract in place at the time the work is performed. You will not be reimbursed for any work covered in your approved proposal until the contract is fully executed.

Tiffany D. Frazier is the CRFL Project Coordinator. She will be in contact with you on your proposal and contract. Tiffany will also be your point of contact until your project is completed. Please feel free to contact her at any time. She may be reached at (252) 808-8004 or Tiffany.Frazier@ncdenr.gov.

Funding for subsequent years of multi-year projects will be contingent upon the completion of satisfactory project performance reports as required by the contract. Furthermore, the Marine Fisheries Commission and Wildlife Resources Commission will review these reports as part of their consideration for additional years of funding.

3441 Arendell Street, P.O. Box 769, Morehead City, North Carolina 28557
Phone: 252-726-7021 \ FAX: 252-726-0254 \ Internet: www.ncdmf.net

An Equal Opportunity \ Affirmative Action Employer

One NorthCarolina Naturally

Coastal Recreational Fishing License revenues will enhance recreational fishing by providing information for effective fisheries management, supporting habitat conservation and enhancement, and improving multi-use water access to the citizens of North Carolina. We greatly appreciate your interest and efforts in making this program successful.

Sincerely,

Louis B. Daniel III, Director
Division of Marine Fisheries

Appendix 3.

U.S. Department of Commerce, NOAA, NMFS, Southeast Regional Office, Saltonstall-Kennedy grant March 27, 2014, award letter from Assistant Regional Administration for Operations, Management and Information Lauren B. Lugo, to Mr. Riddick Smiley, East Carolina University, Greenville, NC.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southeast Regional Office
263 13th Avenue South
St. Petersburg, Florida 33701-5505
http://sero.nmfs.noaa.gov

March 27, 2014

Mr. Riddick Smiley
East Carolina University
MS 165
Greenville, NC 27858-4353

Dear Mr. Smiley:

Congratulations! We are pleased to inform you that your proposal entitled "East Carolina University (ECU) Cooperative Winter Tagging Cruise 2014-2015" has been reviewed favorably for funding under the National Marine Fisheries Service's Saltonstall-Kennedy Grant Program using the proposed Federal funding levels.

We will soon prepare documentation for electronic submission of your proposal to NOAA's Grants Management Division for Department of Commerce final clearance and review procedures. However, before proceeding to that step, we urge the principal investigators to examine the consolidated comments of the technical reviewers (attached), who followed the Evaluation Criteria outlined in the Federal Funding Opportunity. These comments should be viewed as constructive observations intended to strengthen the final, approved project.

The proposal has been assigned a project code 13SK036, and we request that this code be referenced in all future correspondence relating to the project. Robert (Bob) Sadler will be the Federal Program Officer for this pending award. He will be in contact with project staff to identify documentation necessary to process the award. If you have any questions, Bob can be reached at 727-551-5760 or via email at robert.sadler@noaa.gov.

Again, we offer congratulations on your proposal being recommended for funding.

Sincerely,

Robert Sadler
for Lauren B. Lugo
Assistant Regional Administrator
for Operations, Management and Information

Enclosure

cc w/enclosure: Dr. Roger Rulifson

Appendix 4.
Letter from East Carolina University Grant and Contract Officer Kevin Mills, May 3, 2012, to Ms. Tiffany Frazier, CRFL Project Director, accepting the CRFL funding for the Cooperative Winter Tagging Cruise

East Carolina University

Office of Sponsored Programs

Greenville Centre, Room 2906
2200 South Charles Boulevard
Mail Stop 165
Greenville, NC 27858-4353

Office 252-328-9540
Fax 252-328-4363
www.ecu.edu/osp

May 3, 2012

Tiffany D. Frazier
CRFL Project Coordinator
NC DENR, Division of Marine Fisheries
PO Box 769
Morehead City, NC 28557

Proposal Title:	Cooperative Winter Tagging Cruise for Atlantic Striped Bass
Lead Investigator:	Roger Rulifson, PhD
Year 1 Budget:	$238,836
Budget Period:	07/01/2012 to 06/30/2013

Dear Ms. Frazier,

East Carolina University accepts the first year of funding for the above referenced project as well as the conditions stated in the January 12, 2012 notice of funding.

The Office of Sponsored Programs is the official channel through which East Carolina University faculty conduct all business with external research sponsors. It has administrative responsibility both during the preparation and submission of proposals and throughout the duration of subsequent awards. Therefore, I would appreciate copies of correspondence with the Project Director pertaining to administrative and financial matters concerning this project.

The Office of Sponsored Programs is pleased to assist our faculty and external sponsors in any matter. Accordingly, if questions arise, please feel free to call Kevin Mills at (252) 328-9540 or e-mail millsk@ecu.edu.

Thank you for your time and attention.

Cordially,

Kevin R. Mills, M.A.Ed.
Grant and Contract Officer

Division of Research and Graduate Studies http://www.ecu.edu/rgs/
Greenville Centre Suite 1500, 2200 S Charles Blvd • Greenville, NC 27858-4353 Fax 252-328-2769
East Carolina University is a constituent institution of the University of North Carolina. An Equal Opportunity/Affirmative action Employer.

DENR TASK ORDER NO. **4485**
Task Order Amendment No.

TASK ORDER
Issued under the NC Department of Environment and Natural Resources
/University of North Carolina
Master Agreement Version 01
Between

Recipient Institution	**NC Department of Environment & Natural Resources**
1. University: East Carolina University Department: School: College: Institute: City / State: Greenville NC (See Page 2 for Contact Information)	**2. Division of:** Marine Fisheries Section: Adminsitration Unit: Grants Program City / State: Morehead City NC (See Page 2 for Contact Information)
3. Proposal / Project Title: Cooperative Winter Tagging Cruise, 2013 - 2015, for Atlantic Striped Bass and Affiliated Species (See #18 Appendices)	**4.** Source/Type of Funding: Receipts Agency: Division of Marine Fisheries Award No.: CFDA: Title: CRFL (See #18 Appendices)

5. Description / Purpose:
Grant to tag striped bass and Atlantic sturgeon in the Atlantic Ocean, and sample all species encountered, to assist in assessing fishing mortality on coastal migratory stocks of striped bass, including the Albemarle-Roanoke stock.

6. Special Funding Terms and Conditions (T&C):	**7. Funding Information**	
1. Funding is for project year one (2012- 2013)	a. Amount Funded This Action:	$238,836
	b. Previous Task Order Amount:	$
	c. New Task Order Total (7a & 7b):	$238,836
2. See Appendices for additional funding terms and conditions	d. Required Match This Action:	$
	e. Previous Required Match:	$
3.	f. New Total Required Match for Task Order:	$
	g. Other Contributions	$
4.	h. Total Task Order Amount	$238,836
	i. Task Order Start Date:	July 1, 2012
	j. Task Order End Date:	August 15, 2013

(Check below to indicate continuation of Special T&C):
[ ] Special Funding Terms & Conditions Continued under Block #20 below

In witness whereof, the parties have caused the Task Order to be executed by their authorized representatives.

RECIPIENT INSTITUTION	**NC DEPARTMENT OF ENVIRONMENT & NATURAL RESOURCES**
Signature: (Original Signature Required)	Signature: (Original Signature Required)
Name: Kathleen G. Hall Title: Director, Grants & Contracts Interim Director, Sponsored Programs East Carolina University Tel 252-328-9520 Fax 252-328-0769	Name: Michael G. Bryant Title: Director, Division of Purchase & Services
Date: 07/17/12	Date: 7/20/12
TIN/EIN: XX-XXX403	TIN/EIN: XX-XXX0372

ERB

Appendix 5.
Letter of October 10, 2013 to Martha Van Scott, ECU Office of Sponsored Programs, from Marjorie Barber, NCDENR Purchasing Agent, Purchase and Contract Section, renewing Second year of Contract for $8,000

NCDENR

North Carolina Department of Environment and Natural Resources
Financial Services Division
Rex A. Whaley, Chief Financial Officer

Pat McCrory
Governor

John E. Skvarla, III
Secretary

October 10, 2013

Martha J.S. Van Scott
Office of Sponsored Programs
East Carolina University
2200 South Charles Blvd
Greenville, NC 27858-4353

Dear Ms. Van Scott:

Enclosed is a fully executed Task Order Amendment No. 2 to DENR Task Order No. 4485 between the Department of Environment and Natural Resources and **East Carolina University** for a project titled "Cooperative Winter Tagging Cruise, 2013-2015 for Atlantic Striped Bass and Affiliated Species".

This amendment extends the contract period; the new period under this amendment is from August 16, 2013 to August 15, 2014 and adds an additional **Eight Thousand Dollars ($8,000)**. It is the intent of this amendment to address the provision(s) noted only, and in no way should this amendment be construed to further modify this contract. All other terms and conditions remain the same.

Should you have any questions regarding the contract, you may contact me at (919) 707-8539.

Sincerely,

Marjorie Barber

Purchasing Agent
Purchase and Contract Section

Enclosure

cc: Beth Govoni, DENR Division of Marine Fisheries
Jackie J. Moore, DENR Office of the Controller

RECEIVED
OCT 16 2013
By

Office of Purchase and Services
1605 Mail Service Center, Raleigh, North Carolina 27699-1605
Phone: 919-707-8525 \ FAX: 919-715-0720 \ Internet: http://portal.ncdenr.org/web/ps/
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One NorthCarolina Naturally

DENR TASK ORDER NO. 4485
Task Order Amendment No. 2

DENR - DIVISION OF PURCHASE & SERVICES
2013 OCT 8 PM 3 0

TASK ORDER

Issued under the NC Department of Environment and Natural Resources
/University of North Carolina
Master Agreement Version 01
Between

Recipient Institution	NC Department of Environment & Natural Resources
1. University: East Carolina University Department: School: College: Institute: I City / State: Greenville NC (See Page 2 for Contact Information)	**2. Division of:** Marine Fisheries Section: Administration Unit: Grants Program City / State: Morehead City NC (See Page 2 for Contact Information)
3. Proposal / Project Title: Cooperative Winter Tagging Cruise, 2013-2015, for Atlantic Striped Bass and Affiliated Species (See #18 Appendices)	**4.** Source/Type of Funding: Receipts Agency: Division of Marine Fisheries Award No.: CFDA: Title: (See #18 Appendices)

5. Description / Purpose:
Exercising renewal option, YEAR 2 funding, PO # NC10011162

6. Special Funding Terms and Conditions (T&C):	7. Funding Information	
1.	a. Amount Funded This Action:	$8,000
	b. Previous Task Order Amount:	$238,836
2.	c. New Task Order Total (7a & 7b):	$
	d. Required Match This Action:	$
3.	e. Previous Required Match:	$
	f. New Total Required Match for Task Order:	$
4.	g. Other Contributions	$
	h. Total Task Order Amount	$246,836
	i. Task Order Start Date:	July 1, 2012
	j. Task Order End Date:	August 15, 2014

(Check below to indicate continuation of Special T&C):
[ ] Special Funding Terms & Conditions Continued under Block #20 below

In witness whereof, the parties have caused the Task Order to be executed by their authorized representatives.

RECIPIENT INSTITUTION	NC DEPARTMENT OF ENVIRONMENT & NATURAL RESOURCES
Signature: Marthal S Vanscott (Original Signature Required)	Signature: (Original Signature Required)
Name: Marthal S. Vanscott, Interim Director Office of Sponsored Programs 2200 S. Charles Blvd., Suite 2906 Greenville, NC 27858-4353 Phone: 252-328-9540 Fax: 252-328-4363 Email: osp@ecu.edu	Name: Michael G. Bryant
Title:	Title: Director, Division of Purchase & Services
Date: 9/20/2013	Date: 10/09/2013
TIN/EIN: XX-XXX	TIN/EIN: XX-XXX0372

Appendix 6.
Financial Assistance Award from Freddie Isaac, USDOC to Riddick Smiley, East Carolina University, Award Number NA14NMF4270042 for $194,084

FORM CD-450 (REV 01/09) U. S. DEPARTMENT OF COMMERCE **FINANCIAL ASSISTANCE AWARD**	☒ GRANT ☐ COOPERATIVE AGREEMENT AWARD NUMBER **NA14NMF4270042**
RECIPIENT NAME East Carolina University	
STREET ADDRESS 2200 Charles Boulevard, Rm 2906	FEDERAL SHARE OF COST $194,084.00
CITY, STATE, ZIP CODE Greenville NC 27858-2463	RECIPIENT SHARE OF COST $155,267.00
AWARD PERIOD 07/01/2014-06/30/2016	TOTAL ESTIMATED COST $349,351.00
AUTHORITY 15 U.S.C. 713c-3	
CFDA NO. AND PROJECT TITLE 11.427 East Carolina University (ECU) Cooperative Winter Tagging Cruise 2014-2015	

This award offer approved by the Grants Officer constitutes an obligation of Federal funding. By accepting this award offer, the Recipient agrees to comply with the award Terms and Conditions checked below. If this was a paper issued award offer, please send two signed documents to the Grants Officer and retain one set of signed award documents for your files. If this award offer is not accepted without modification within 30 days of receipt, the Grants Officer may unilaterally withdraw this award offer and de-obligate the funds.

- ☐ Department of Commerce Financial Assistance Standard Terms and Conditions
- ☒ Government Wide Research Terms and Conditions
- ☒ Bureau Specific Administrative Standard Award Conditions
- ☒ Award Specific Special Award Conditions
- ☒ Line Item Budget
- ☒ 15 CFR Part 14, Uniform Administrative Requirements for Grants and Agreements with Institutions of Higher Education, Hospitals, Other Non-Profit, and Commercial Organizations
- ☐ 15 CFR Part 24, Uniform Administrative Requirements for Grants and Agreements to States and Local Governments
- ☒ OMB Circular A-21, Cost Principles for Educational Institutions
- ☐ OMB Circular A-87, Cost Principles for State, Local, and Indian Tribal Governments
- ☐ OMB Circular A-122, Cost Principles for Non-Profit Organizations
- ☐ 48 CFR Part 31, Contract Cost Principles and Procedures
- ☒ OMB Circular A-133, Audits of States, Local Governments, and Non-Profit Organizations
- ☒ Department of Commerce Pre-Award Notification Requirements for Grants and Cooperative Agreements REF: 77 FR 74634 (December 17, 2012)
- ☒ Other(s)
  This award is being made under competitive Federal Funding Opportunity Number NOAA-NMFS-FHQ-2013-2003834 posted at Grants.gov on 07/29/2013.

SIGNATURE OF DEPARTMENT OF COMMERCE GRANTS OFFICER	TITLE	DATE
Freddie Isaac	Grants Officer	06/30/2014
TYPE NAME AND SIGNATURE OF AUTHORIZED RECIPIENT OFFICIAL	TITLE	DATE
Mr. Riddick Smiley		07/02/2014

Submitted 8/9/17

FEDERAL FINANCIAL REPORT

(Follow form instructions)

1. Federal Agency and Organizational Element to Which Report is Submitted	2. Federal Grant or Other Identifying Number Assigned by Federal Agency (To report multiple grants, use FFR Attachment)	Page	of
Department of Commerce/NOAA	NA14NMF4270042	1	1 pages

3. Recipient Organization (Name and complete address including Zip code)
East Carolina University Grants and Contracts Suite 2900 Greenville Centre
2200 S Charles Blvd, Greenville, NC 27858-4353

4a. DUNS Number	4b. EIN	5. Recipient Account Number or Identifying Number (To report multiple grants, use FFR Attachment)	6. Report Type	7. Basis of Accounting
607579018	56-6000403	213091	Quarterly Semi-Annual ☐ Annual X Final	X Cash Accrual

8. Project/Grant Period From: (Month, Day, Year)	To: (Month, Day, Year)	9. Reporting Period End Date (Month, Day, Year)
7/1/2014	6/30/2017	6/30/2017

10. **Transactions**	Cumulative
(Use lines a-c for single or multiple grant reporting)	
Federal Cash (To report multiple grants, also use FFR Attachment):	
a. Cash Receipts	$194,084.00
b. Cash Disbursements	$194,084.00
c. Cash on Hand (line a minus b)	$0.00
(Use lines d-o for single grant reporting)	
Federal Expenditures and Unobligated Balance:	
d. Total Federal funds authorized	$194,084.00
e. Federal share of expenditures	$194,084.00
f. Federal share of unliquidated obligations	$0.00
g. Total Federal share (sum of lines e and f)	$194,084.00
h. Unobligated balance of Federal funds (line d minus g)	$0.00
Recipient Share:	
i. Total recipient share required	$155,267.00
j. Recipient share of expenditures	$155,267.00
k. Remaining recipient share to be provided (line i minus j)	$0.00
Program Income:	
l. Total Federal program income earned	
m. Program income expended in accordance with the deduction alternative	
n. Program income expended in accordance with the addition alternative	
o. Unexpended program income (line l minus line m or line n)	

	a. Type	b. Rate	c. Period From	Period To	d. Base	e. Amount Charged	f. Federal Share
11. Indirect Expense	Fixed	25%	7/1/2014	6/30/2017	155,267.20	38,816.80	38,816.80
				g. Totals:	155,267.20	38,816.80	38,816.80

12. *Remarks: Attach any explanations deemed necessary or information required by Federal sponsoring agency in compliance with governing legislation:*

13. Certification: By signing this report, I certify that it is true, complete, and accurate to the best of my knowledge. I am aware that any false, fictitious, or fraudulent information may subject me to criminal, civil, or administrative penalities. (U.S. Code, Title 218, Section 1001)

a. Typed or Printed Name and Title of Authorized Certifying Official	c. Telephone (Area code, number and extension)
Janice McGowan Financial Analyst	252-328-9529
	d. Email address mcgowanj@ecu.edu
b. Signature of Authorized Certifying Official Janice M McGowan	e. Date Report Submitted (Month, Day, Year) 7/19/2017
	14. Agency use only:

Standard Form 425
OMB Approval Number: 0348-0061
Expiration Date: 10/31/2011

Paperwork Burden Statement
According to the Paperwork Reduction Act, as amended, no persons are required to respond to a collection of information unless it displays a valid OMB Control Number. The valid OMB control number for this information collection is 0348-0061. Public reporting burden for this collection of information is estimated to average 1.5 hours per response, including time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding the burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to the Office of Management and Budget, Paperwork Reduction Project (0348-0061), Washington, DC 20503.

Grant Inception to Date FRIGITD 8.9 (PBAN) 19-JUL-2017 10:16 AM

Chart of Accounts:	E	Grant:	212533	Cooperative Winter Tagging Cruise f		Grant Year:	
Index:		Fund:	213118	Organization:	710301	☐ Include Revenue Accounts	
Program:	0000	Activity:		Location:		☐ Exclude Indirect Costs	
Account Type:		Account:		Account Summary:	All Levels	☐ Hierarchy	
Date From (MM/YY):	06 / 12	Date To (MM/YY):	07 / 17			☐ Fund Summary	
						☐ By Sponsor Account	

Account	Type		Adjusted Budget	Activity	Commitments	Available Balance
73067	E	Other Contracted Service	68,730.00	11,234.00	0.00	57,496.00
73670	E	Rental Oth Equip Boat	0.00	57,496.00	0.00	-57,496.00
73764	E	Indirect Overhead Cost	10,310.00	10,309.48	0.52	0.00
		Net Total:	79,040.00	79,039.48	0.52	0.00

match

Grant Inception to Date FRIGITD 8.9 (PBAN) 19 JUL 2017 10:17 AM

Chart of Accounts:	E	Grant:	213559 Coop. Winter Tagging Cruise 2016		Grant Year:
Index:		Fund:	213559	Organization:	☐ Include Revenue Accounts
Program:		Activity:		Location:	☐ Exclude Indirect Costs
Account Type:		Account:		Account Summary:	All Levels ☐ Hierarchy
Date From (MM/YY):	06 / 15	Date To (MM/YY):	07 / 17		☐ Fund Summary
					☐ By Sponsor Account

Account	Type		Adjusted Budget	Activity	Commitments	Available Balance
61202	L	Social Security	0.00	276.33	0.00	-276.33
61221	L	Optional Retirement	0.00	172.15	0.00	-172.15
61227	L	TIAA-CREF Optional Retirement	0.00	190.23	0.00	-190.23
61293	L	Grants Unemployment Costs	0.00	15.71	0.00	-15.71
72000	E	Supplies Budget Pool	1,000.00	0.00	0.00	1,000.00
72160	E	Noneducation Scientific Supplies	0.00	0.00	149.41	-149.41
72493	E	Other Equipment 500 to 4999	0.00	0.00	0.00	0.00
73062	E	Employee on Loan Pay	0.00	980.48	0.00	-980.48
73200	E	Travel Budget Pool	900.00	0.00	0.00	900.00
73215	E	Out of State Transportation Ground	0.00	253.64	0.00	-253.64
73235	E	Out of State Sub Lodging	0.00	356.00	0.00	-356.00
73245	E	Out of State Sub Meals	0.00	172.90	0.00	-172.90
73670	E	Rental Oth Equip Boat	78,000.00	74,898.95	0.00	3,101.05
73764	E	Indirect Overhead Cost	13,815.00	12,384.43	1,430.57	0.00
		Net Total:	105,917.00	98,301.90	1,579.98	6,035.12

match

Appendix 7.
US Fish and Wildlife Service Contribution of $8,000 to match CRFL $8,000 Second year of Funding

New Procurement

PR Title	Cape Hatteras Acoustic Array-Revised
Requesting Office	Fisheries Regional Office
Buyer	GRANTS
PR Type	Grants PR
FBMS Supervisor	Pamela Shaw

Narrative of Requirements (detailed description of this Request):

AR#FF04F00000-13-AM024, This requisition is to enter into a financial assistance agreement with East Carolina University to add to the existing grant for deployment, operation and maintenance of the Cape Hatteras Acoustic Array, conducting (in cooperation with other partners) the 2014 Cooperative Winter Tagging Cruise, hook-and-line component (see attached Scope of Work).

Delivery Date / PoP	01/07/2014	12/31/2014

Click here if you need additional Narrative space.

Line Items - Grants and Agreements PR - enter one line for every funding string!

Is this line item a bulk good or a service ("Y" or "N")? *For services and bulk goods, "Q" is always 1, and "Unit" is always AU.*

	I	Line	Line Item Text	Q	Unit	Price	Total Price	UPC
Y	D	10	Revision to CH Acoustic Arrany Grant	1	AU	8,000.00	8,000.00	411G0000
		20	Mod 1 #F11AP00593		EA			
		30	East Carolina University		EA			

Click here if you need more Lines.

Funding Detail *If you have a work order, do **not** enter a WBS, Partial Fund, or Cost Center.*

Line	%	Work Order	WBS	Partial Fund	Cost Center
10	100		FRFR48370550610		FF04FN2000

If every line will have the same funding, leave the "Line" column above blank.
Click here if you need more Funding Detail Lines.

			Date
Preparer	R. Wilson Laney, PhD.	R. Wilson Laney	8/8/2013
Supervisor	Cynthia Williams, Fish Prog.Sup	Cynthia Williams	AR Total
Funds Certifier	Pamela Shaw, Fish Prog Analyst	Pamela R. Shaw	8,000.00

Appendix 8.
Letter to Martha Van Scott, OSP, East Carolina University from Jane Q. Smith, NCDENR Purchasing Agent, for third Year of CRFL Funding

NCDENR

North Carolina Department of Environment and Natural Resources
Financial Services Division

Pat McCrory, Governor | **Rex A. Whaley, Chief Financial Officer** | John E Skvarla III, Secretary

September 12, 2014

Martha J.S. Van Scott
East Carolina University
2200 South Charles Blvd.
Greenville, NC 27858-4353

Dear Ms. Scott:

Enclosed is a fully executed copy of Amendment 3 to Task Order No. 4485 between East Carolina University and the Department of Environment and Natural Resources for the "Cooperative Winter Tagging Cruise, 2013-2015, for Atlantic Striped Bass and Affiliated Species" project. Please provide the PI for this project with a copy of this Task Order.

Invoices or matters regarding work to be performed should be directed to the DENR Task Order Administrator, Beth Govoni, as indicated on Page 2 of the task order document.

Please include Task Order No. 4485 on each invoice submitted for payment.

Should you have any questions regarding the task order, you may contact me at (919) 707-8534.

Sincerely,

Jane Q. Smith

Jane Q. Smith
Purchasing Agent
Purchase and Contract Section

Enclosure

cc: Beth Govoni, DENR Division of Marine Fisheries
Jackie J. Moore, DENR Office of the Controller

RECEIVED
SEP 22 2014
By

Office of Purchase and Services
1605 Mail Service Center, Raleigh, North Carolina 27699-1605
Phone: 919-707-8525 \ FAX: 919-715-0720

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DENR TASK ORDER NO. **4485**
Task Order Amendment No. **3**

TASK ORDER
Issued under the NC Department of Environment and Natural Resources
/University of North Carolina
Master Agreement Version 01
Between

Recipient Institution	**NC Department of Environment & Natural Resources**
1. University: East Carolina University Department: School: College: Institute: I City / State: Greenville NC (See Page 2 for Contact Information)	**2. Division of:** Marine Fisheries Section: Administration Unit: Grants Program City / State: Morehead City NC (See Page 2 for Contact Information)
3. Proposal / Project Title: Cooperative Winter Tagging Cruise, 2013-2015, for Atlantic Striped Bass and Affiliated Species (See #18 Appendices)	**4.** Source/Type of Funding: Receipts Agency: Division of Marine Fisheries Award No.: CFDA: Title: (See #18 Appendices)
5. Description / Purpose: Exercising renewal option, YEAR 3 funding, PO # NC10011162	

6. Special Funding Terms and Conditions (T&C):	**7. Funding Information**	
1.	a. Amount Funded This Action:	$79,040
	b. Previous Task Order Amount:	$246,836
2.	c. New Task Order Total (7a & 7b):	$
	d. Required Match This Action:	$79,040
3.	e. Previous Required Match:	$
	f. New Total Required Match for Task Order:	$
4.	g. Other Contributions	$
	h. Total Task Order Amount	$404,916
	i. Task Order Start Date:	July 1, 2012
	j. Task Order End Date:	June 30, 2015

(Check below to indicate continuation of Special T&C):
[ ] Special Funding Terms & Conditions Continued under Block #20 below

In witness whereof, the parties have caused the Task Order to be executed by their authorized representatives.

RECIPIENT INSTITUTION	**NC DEPARTMENT OF ENVIRONMENT & NATURAL RESOURCES**
Signature: Barbara H. Gray (Original Signature Required)	Signature: Michael G. Bryant (Original Signature Required)
Name: Barbara H. Gray Title: Director of Sponsored Programs	Name: Michael G. Bryant Title: Director, Division of Purchase & Services
Date: 09/02/2014	Date: 9/11/14
TIN/EIN: XX-XXX 56-6000403	TIN/EIN: XX-XXX0372

Task Order Award Notice - Page 1 of 4

Appendix 9.
Metadata documenting the list of variables used for the Cooperative Winter Tagging Cruise, the USFWS tagging data, and the master CWTC summary data files for catch summaries and measurements of species.

Appendix 9-1. Definition of the metadata from the CWTC and the Charter boat tag and release program.

Tagged Fish Released from All	
Relbat Batch Num	
Rel Agency	Organization or project responsible for tagging and release of the fish: NCCOOP = Cooperative Winter Tagging Cruise
Rel State	State associated with waters where fish were released after tagging
Rel Date	Date fish was released with tag (month/day/year)
Deploy Start	Start time of capture effort. For trawls, beginning of trawl deployment; for hook and line, time of lines set in the water.
Deploy End	End time of capture effort. For trawls, end of trawl deployment; for hook and line, time of lines retrieved (based on full set) from the water.
Set Soak Time	Total time of capture effort for that set.
Start Time	
End Time	
Fish Caught	Number of fish caught during capture effort: trawl = number of fish in tow; hook and line = number of fish in set.
Fish Tagged	Number of fish tagged during capture effort: trawl = number of fish in tow; hook and line = number of fish in set.
Min Tag No	First tag number for fish tagged in set.
Max Tag No	Last tag number for fish tagged in set.
Comment	
Site	Location of capture effort - generalized by area.
Latitude	Latitudinal coordinate of capture location
Longitude	Longitudinal coordinate of capture location
NOAA Code	
Surf Salin	Salinity of surface water (<10m) at time and location of capture
Water Temp	Water temperature of surface water (<10m) at time and location of capture
Air Temp	Air temperature at time and location of capture
Gear Type	H=hook and line; T=trawling
Mesh Size	N/A for hook and line; T = (codend)
Gear Depth	Depth in meters that gear was deployed at for capture effort
Gear Length	
Thread Type	
Type Fish	

Hatchery	
Relind_Batch Num	
Tag Num	Number designated on tag inserted into fish.
Tag Type	
Total Length	Total length in millimeters of tagged fish
Fork Length	Fork length in millimeters of tagged fish
Weight	Weight in kilograms of tagged fish
Sex	Gender of tagged fish: M=male; F=female; U=unidentified
Scale	Y=scales were removed and saved for aging; N = scales were not removed
Year Class	Year class of the tagged fish, determined by scale age
Other Tag	FALSE = additional tag was not place on/in fish; TRUE = additional tag was place on/in fish
Fish Examined	
Comments	
UpDate	
Recapture Data	
TagNum	Number designated on tag inserted into fish.
Event	
RepDate	Date that recapture of tagged fish was reported (day-month-year)
CapDate	Date that recapture of tagged fish occurred (day-month-year)
CapWeek	Consecutive week of the year in which fish was recaptured.
CapMonth	Consecutive month of the year in which fish was recaptured.
CapDay	Consecutive day of the month in which fish was recaptured.
CapYear	Year in which fish was recaptured.
State	State where fish was recaptured
recap.Site	Generalize description of area of fish's recapture
Region	Region where fish was recaptured
Code	
Recapturer	
recap. GearType	Gear type used by recapturer (H = hook and line; O = ; A = ; D= ; P = ; S =)
Disposition	Disposition of recaptured fish: K=killed; R=re-released; D= ; S= ; T=
Tag Removed	Y=tag was removed; N= tag was left in/on fish
Portion Removed	Both = both dart and streamer portion; Streamer = streamer only. Portion of tagged removed if 'Tag Removed' field = Y
Other Tags	Additional tags reported on fish
Length	Length in millimeters of fish when recaptured
recap. ForkLength	Fork length in millimeters of fish when recaptured
recap. Weight	Weight in kilograms of fish when recaptured
recap. Sex	Gender of fish at recapture: M=male; F=female; U=unidentified

recap. YearClass	
recap. Scale	
Tag Sent	Y= tag was returned to agency; N=tag was not returned to agency
Reporter Type	R= ; F= ; S =
Recapturer type	
BatchNum	
RelAgency	Organization or project responsible for tagging and release of the fish: NCCOOP = Cooperative Winter Tagging Cruise
RelState	State associated with waters where fish were released after tagging
RelDate	Date fish was released with tag (month/day/year)
Deploy Start	Start time of capture effort. For trawls, beginning of trawl deployment; for hook and line, time of lines set in the water.
Deploy End	End time of capture effort. For trawls, end of trawl deployment; for hook and line, time of lines retrieved (based on full set) from the water.
Set SoakTime	Total time of capture effort for that set.
Start Time	
End Time	
Fish Caught	Number of fish caught during capture effort: trawl = number of fish in tow; hook and line = number of fish in set.
Fish Tagged	Number of fish tagged during capture effort: trawl = number of fish in tow; hook and line = number of fish in set.
MinTagNo	First tag number for fish tagged in set.
MaxTagNo	Last tag number for fish tagged in set.
Relbat.Site	Location of capture effort - generalized by area.
Latitude	Latitudinal coordinate of capture location
Longitude	Longitudinal coordinate of capture location
NOAACode	
SurfSalin	Salinity of surface water (<10m) at time and location of capture
WaterTemp	Water temperature of surface water (<10m) at time and location of capture
AirTemp	Air temperature at time and location of capture
Relbat. GearType	H=hook and line; T=trawling. Gear type used to initially capture fish for tagging.
Mesh Size	N/A for hook and line; T = (codend)
Total Length	Total length in millimeters of tagged fish
Relind. ForkLength	Fork length in millimeters of tagged fish
Relind. Weight	Weight in kilograms of tagged fish
Relind. Sex	Gender of tagged fish: M=male; F=female; U=unidentified
Relind. Scale	Y=scales were removed and saved for aging; N = scales were not removed
Relind. YearClass	Year class of the tagged fish, determined by scale age
Comments	
Tag Type	

Value	
End Date	
Advertised	

Appendix 9-2. Metadata documenting the list of variables summarizing the species caught (CWTC_SumCatch_2013-2016-Final) and the species measured (CWTC_SpeciesMeasured_ 2013-2016-Final) for the Cooperative winter Tagging Cruises, 2013, 2015, and 2016. All species measurements are in millimeters (Species_Measured file only).

Variable	**Description**
Watch	"B" and "W" = 2400-0600 and 1200-1800; "A" and "J" = 0600-1200 and 1800-2400 hours.
Year	Year of study
Month	Calendar year numbered 1 (Jan), 2(Feb), etc.
Day	Day of month
Date	Complete date
Haul #	Sequential haul number
Starttime	military time, HH:MM; start time of capture = beginning of trawl deployment
Stoptime	military time, HH:MM, end of trawl capture = end of trawl deployment
S-Startlat	Latitude (decimal degrees) at start of trawl deployment
S-Startlong	Longitude (decimeal degrees) at start of trawl deployment
S-Stoplat	Latitude (decimal degrees) at end of trawl deployment
S-Stoplong	Longitude (decimeal degrees) at end of trawl deployment
MinTowspeed	Minimum tow speed throughout the tow (knots)
Maxtowspeed	Maximum tow speed throughout the tow (knots)
TOWAVG	Average tow speed (knots)
Wtemp	Water temperature, degrees Celcius
Atemp	Air temperature, degrees Celcius
Sal	Salinity, ppt
Mindepth	Minimum depth (meters) observed during trawl deployment
Maxdepth	Maximum depth (meters) observed during trawl deployment
Dogfish,Spiny-F	Count of females in the haul
Dogfish,Spiny-M	Count of males in the haul
Dogfish,Spiny-Fover	Number of female fish counted but not measured, thrown overboard
Dogfish,Spiny-Mover	Number of male fish counted but not measured, thrown overboard
Dogfish,Spiny_Tot	Total number of the species in the haul (F + Fover + M + Mover)
Striped_Bass	Number of Striped Bass in the haul
Skates,All	All skate species in the haul (Clearnose + Winter + Little)
Skate,Clearnose-M	Count of males in the haul
Skate,Clearnose-F	Count of females in the haul
Skate,Winter-M	Count of males in the haul
Skate,Winter-F	Count of females in the haul
Skate,Little-M	Count of males in the haul
Skate,Litte-F	Count of females in the haul

Clupeids,All	All clupeids in the haul (Alewife, Blueback Herring, American Shad, Hickory Shad, Atlantic Menhaden,
Sciaenids,All	All members of drum family in haul (Weakfish, N. and S. Kingfish, Spotted Trout, Atlantic Croaker, Banded Drum, Black Drum, Star Drum, Silver Perch
Weakfish	Count
Kingfish,All	Northern Kingfish + Southern Kingfish
Blueback_Herring	Count
Alewife	Count
Shad,Amer.	American Shad
Shad,Hickory	Count
Spotted_Trout	Count
Monkfish	Count
Atl.Herring	Atlantic Herring
Butterfish	Count
Pigfish	Count
Atl.Menhaden	Atlantic Menhaden
Atl.Mackerel	Atlantic Mackerel
Flounder,Summer	Count
Flounder,Southern	Count
Atl.Sturgeon	Atlantic Sturgeon
Hake,All	All Hake counted in the haul (Silver, Southern, Spotted, other unidentified)
Atl.Croaker	Atlantic Croaker
Flounder,Spotted_Whiff	Count
Flounder,Windowpane	Count
SeaRobin,Unid	Count
SeaBass,Black	Count
Amer.Lobster	American Lobster
Eel,Amer.	American Eel
Arrow_Crab	Count
Shark,Atl.sharpnose	Atlantic Sharpnose Shark
Shark,Atl.Angel	Atlantic Angel Shark
Atl.Spadefish	Atlantic Spadefish
Atl.Silverside	Atlantic Silverside
Stingray,Atl.	Atlantic Stingray
Atl.Thread_Herring	Atlantic Thread Herring
Baby's_Ear	Count
Drum,Banded	Count
Bay_Anchovy	Count
Flounder,Bay_Whiff	Count

Crab,Blue	Count
Searobin,Bighead	Count
Drum,Black	Count
Bluefish	Count
Blue_Runner	Count
Ray,Bullnose-F	Count of females in the haul
Ray,Bullnose-M	Count of males in the haul
Welk,Channeled	Count
Chiton	Count
Cobia	Count
Jelly,Comb	Count
Ray,Cownose	Count
Crab,Unid	Unidentified crab species
Cubbyu	Count
Eel,Cusk	Count
Atl.Cutlassfish	Atlantic Cutlassfish
Flounder,Dusky	Count
Etropus,Unid	Unidentified *Etropus* species
Crab,False_Blue	Count
Flounder.Unid	Unidentified flounder species
Flounder,Fringed	Count
Gadidae,Unid	Unidentified Gadidae speceis
Greater_Amberjack	Count
Grey_Triggerfish	Count
Goby,Unid	Unidentified Goby species
Crab,Hermit	Count
Crab,Horseshoe	Count
Jellies,Unid	Unidentified jellies species, not to be confused with jellyfish species
Crab,Jonah	Count
Crab,Lady	Count
Lizardfish,All	Count
Searobin,Leopard	Count
Longspine_Porgy	Count
Midshipman	Count
Jellyfish,Moon	Count
Moon_Snail	Count
Crab,Mud	Count
Kingfish,Northern	Count
Puffer,Northern	Count
Searobin,Northern	Count
Octopus	Count

Crab,Ornate_blue	Count
Pinfish	Count
Planehead_Filefish	Count
Pollock	Count
Crab,Portunid	Count
Puffer,Unid	Unidientified puffer species
Clam,Razor	Count
Crab,Rock	Count
SeaBass,Rock	Count
Stingray,Roughtail	Count
Round_Herring	Count
Shark,Sandbar	Count
Crab,Sand	Count
Sand_dollar	Count
Sheepshead	Count
Hake,Silver	Count
Silver_Perch	Count
Silver_Porgy	Count
Slippershell	Count
Flounder,Smallmouth	Count
Ray,Smooth_Butterfly-F	Count of females in the haul
Ray,Smooth_Butterfly-M	Count of males in the haul
Snakefish	Count
Hake,Southern	Count
Kingfish,Southern	Count
Stingray,Southern	Count
Spadefish	Count
Crab,Spider	Count
Ray,Spiny_Butterfly-Unid	Bufferfly, not sexed
Ray,Spiny_Butterfly -F	Count of females in the haul
Ray,Spiny_Butterfly-M	Count of males in the haul
Spinycheek_Scorpionfish	Count
Spot	Count
Flounder,Spottail	Count
Hake,Spotted	Count
Ray,Spotted_eagle	Count
Squid,Longfin	Count
Squid,Shortfin	Count
Squid,Brief	Count
Squid,Bobtail	Count
Squid_sp.	Squid species not identified

Drum,Star	Count
Starfish	Count
Striped_Anchovy	Count
Striped_Burrfish	Count
Searobin,Striped	Count
Clam,Surf	Count
Skate,Thorny	Count
Shark,Thresher	Count
Jellyfish,Unid	Unidentified jellyfish species
Whelk,Knobbed	Count
Urchin,Unid	Unidentified sea urchin
White Urchin	Count
Shrimp,Brown	Count
Shrimp,Flathead	Count
Shrimp,Roughhead	Count
Shrimp,Roughneck	Count
Shrimp,Penaeid,Unid	Count
Shrimp,*Trachypenaeu*s,Unid	*Trachypenaeus* species, not identified
Shrimp,Mantis	Count
Shrimp,Pink	Count
Shrimp,Pink_Speckled	Count
Shrimp,Sand	Count
Shrimp,White	Count
Shrimp,All	All shrimp in the haul (Brown, Flathead, Roughhead, Roughneck, Mantis, Pink, Pink Speckled, Sand, and White)
Shrimp,Unid	Shrimp counted but not identified
Whelk_sp	whelk counted but not identified to species
Jelly,Box	Count
Jellyfish	Jellyfish counted but not identified
Net Notes	Remarks

Appendix 10.
Documentation of the specimens collected during the 2013, 2015, and 2016 Cooperative winter Tagging Cruises and deposited into the collection at the North Carolina Science Museum.

Specimens colleted by RW Laney on the R/V Cape Hatteras and donated to NCSM

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Field/Locality#: **CH-13-01-001**
Cont./Ocean: Atlantic Ocean
Country: United States State: North Carolina County: Dare
Locality: Atlantic Ocean, off of North Carolina, [ca. 17.1-18.2 air miles NNE center Manteo]
Start: 36.1202° N, 75.51817° W; End: 36.14305° N, 75.52869° W (locality imprecise, lat-long approximate) Geodetic Datum: WGS84
Vessel/Cruise #/Sta. #: Cape Hatteras/13-01/001 Date Coll.: 8 January 2013 Time: 0732-0750 Accession Number: 12917
Collector(s): RW Laney et al. Gear: 65' otter trawl Depth of Capture: 25-23 m Salinity: S
Locality Remarks: None

Specimens Catalogued

NCSM Cat#	Family	Genus	Species	Common name	Total number of whole, skel/mount, cleared and stained specimens	Tissue samples in 95% ethanol
74174	Engraulidae	*Anchoa*	*mitchilli*	Bay Anchovy	1	1
74175	Stromateidae	*Peprilus*	*triacanthus*	Butterfish	1	0

Field/Locality#: **CH-13-01-002**
Cont./Ocean: Atlantic Ocean
Country: United States State: North Carolina County: Dare
Locality: Atlantic Ocean, off of North Carolina, [ca. 19.4-19.8 air miles NNE center Manteo]
Start: 36.16188° N, 75.52545° W; End: 36.17127° N, 75.53262° W (locality imprecise, lat-long approximate) Geodetic Datum: WGS84
Vessel/Cruise #/Sta. #: Cape Hatteras/13-01/002 Date Coll.: 8 January 2013 Time: 0837-0854 Accession Number: 12917
Collector(s): RW Laney et al. Gear: 65' otter trawl Depth of Capture: 25-26.1 m Salinity: S
Locality Remarks: None

Specimens Catalogued

NCSM Cat#	Family	Genus	Species	Common name	Total number of whole, skel/mount, cleared and stained specimens	Tissue samples in 95% ethanol
74178	Clupeidae	*Brevoortia*	*tyrannus*	Atlantic Menhaden	1	1
74176	Phycidae	*Urophycis*	*regia*	Spotted Hake	1	0
74177	Triglidae	*Prionotus*	*scitulus*	Leopard Searobin	1	1

Field/Locality#: **CH-13-01-003**
Cont./Ocean: Atlantic Ocean
Country: United States State: North Carolina County: Dare
Locality: Atlantic Ocean, off of North Carolina, [ca. 20.2-20.8 air miles NNE center Manteo]
Start: 36.17973° N, 75.54027° W; End: 36.19077° N, 75.54823° W (locality imprecise, lat-long approximate) Geodetic Datum: WGS84
Vessel/Cruise #/Sta. #: Cape Hatteras/13-01/003 Date Coll.: 8 January 2013 Time: 0916-0931 Accession Number: 12917
Collector(s): RW Laney et al. Gear: 65' otter trawl Depth of Capture: 22.7-25.2 m Salinity: S
Locality Remarks: None

Specimens Catalogued

NCSM Cat#	Family	Genus	Species	Common name	Total number of whole, skel/mount, cleared and stained specimens	Tissue samples in 95% ethanol
74179	Phycidae	*Urophycis*	*regia*	Spotted Hake	1	1

Field/Locality#: **CH-13-01-004**
Cont./Ocean: Atlantic Ocean
Country: United States State: Virginia County:
Locality: Atlantic Ocean, off of Virginia, [ca. 12.6-11.9 air miles ENE center Virginia Beach]
Start: 36.90875° N, 75.76213° W; End: 36.9117° N, 75.77666° W (locality imprecise, lat-long approximate) Geodetic Datum: WGS84
Vessel/Cruise #/Sta. #: Cape Hatteras/13-01/004 Date Coll.: 8 January 2013 Time: 1426-1441 Accession Number: 12917
Collector(s): RW Laney et al. Gear: 65' otter trawl Depth of Capture: 15.1-16.2 m Salinity: S
Locality Remarks: None

Specimens Catalogued

NCSM Cat#	Family	Genus	Species	Common name	Total number of whole, skel/mount, cleared and stained specimens	Tissue samples in 95% ethanol
74180	Merlucciidae	*Merluccius*	*bilinearis*	Silver Hake	1	1

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Field/Locality#: **CH-13-01-005**
Cont./Ocean: Atlantic Ocean
Country: United States State: Virginia County:
Locality: Atlantic Ocean, off of Virginia, [ca. 11.8-12.7 air miles ENE center Virginia Beach]
Start: 36.91682° N, 75.78063° W; End: 36.92238° N, 75.7658° W (locality imprecise, lat-long approximate) Geodetic Datum: WGS84
Vessel/Cruise #/Sta. #: Cape Hatteras/13-01/005 Date Coll.: 8 January 2013 Time: 1506-1521 Accession Number: 12917
Collector(s): RW Laney et al. Gear: 65' otter trawl Depth of Capture: 15.1-16.9 m Salinity: S
Locality Remarks: None

Specimens Catalogued

NCSM Cat#	Family	Genus	Species	Common name	Total number of whole, skel/mount, cleared and stained specimens	Tissue samples in 95% ethanol
74181	Scophthalmidae	*Scophthalmus*	*aquosus*	Windowpane	1	1

Field/Locality#: **CH-13-01-006**
Cont./Ocean: Atlantic Ocean
Country: United States State: Virginia County:
Locality: Atlantic Ocean, off of Virginia, [ca. 12.5-10.5 air miles ENE center Virginia Beach]
Start: 36.92253° N, 75.76942° W; End: 36.92963° N, 75.8138° W (locality imprecise, lat-long approximate) Geodetic Datum: WGS84
Vessel/Cruise #/Sta. #: Cape Hatteras/13-01/006 Date Coll.: 8 January 2013 Time: 1600-1616 Accession Number: 12917
Collector(s): RW Laney et al. Gear: 65' otter trawl Depth of Capture: 16.7-13.8 m Salinity: S
Locality Remarks: None

Specimens Catalogued

NCSM Cat#	Family	Genus	Species	Common name	Total number of whole, skel/mount, cleared and stained specimens	Tissue samples in 95% ethanol
74182	Rajidae	*Leucoraja*	*erinacea*	Little Skate	1	1

Field/Locality#: **CH-13-01-008**
Cont./Ocean: Atlantic Ocean
Country: United States State: Virginia County:
Locality: Atlantic Ocean, off of Virginia, [ca. 11.2-11.9 air miles ENE center Virginia Beach]
Start: 36.93732° N, 75.80417° W; End: 36.93945° N, 75.79107° W (locality imprecise, lat-long approximate) Geodetic Datum: WGS84
Vessel/Cruise #/Sta. #: Cape Hatteras/13-01/008 Date Coll.: 8 January 2013 Time: 1745-1800 Accession Number: 12917
Collector(s): RW Laney et al. Gear: 65' otter trawl Depth of Capture: 13.5-14.0 m Salinity: S
Locality Remarks: None

Specimens Catalogued

NCSM Cat#	Family	Genus	Species	Common name	Total number of whole, skel/mount, cleared and stained specimens	Tissue samples in 95% ethanol
74184	Clupeidae	*Clupea*	*harengus*	Atlantic Herring	1	1
74183	Scombridae	*Scomber*	*scombrus*	Atlantic Mackerel	1	1

Field/Locality#: **CH-13-01-010**
Cont./Ocean: Atlantic Ocean
Country: United States State: Virginia County:
Locality: Atlantic Ocean, off of Virginia, [ca. 13.8-13.3 air miles ENE center Virginia Beach]
Start: 36.94152° N, 75.75518° W; End: 36.94687° N, 75.76718° W (locality imprecise, lat-long approximate) Geodetic Datum: WGS84
Vessel/Cruise #/Sta. #: Cape Hatteras/13-01/010 Date Coll.: 8 January 2013 Time: 1920-1936 Accession Number: 12917
Collector(s): RW Laney et al. Gear: 65' otter trawl Depth of Capture: 16.2-14.6 m Salinity: S
Locality Remarks: None

Specimens Catalogued

NCSM Cat#	Family	Genus	Species	Common name	Total number of whole, skel/mount, cleared and stained specimens	Tissue samples in 95% ethanol
74185	Paralichthyidae	*Paralichthys*	*dentatus*	Summer Flounder	1	1

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Field/Locality#: **CH-13-01-012**
Cont./Ocean: Atlantic Ocean
Country: United States State: Virginia County:
Locality: Atlantic Ocean, off of Virginia, [ca. 13.7-12.4 air miles ENE center Virginia Beach]
Start: 36.94957° N, 75.7607° W; End: 36.9262° N, 75.77322° W (locality imprecise, lat-long approximate) Geodetic Datum: WGS84
Vessel/Cruise #/Sta. #: Cape Hatteras/13-01/012 Date Coll.: 8 January 2013 Time: 2025-2042 Accession Number: 12917
Collector(s): RW Laney et al. Gear: 65' otter trawl Depth of Capture: 15.0-14.9 m Salinity: S
Locality Remarks: None

Specimens Catalogued

NCSM Cat#	Family	Genus	Species	Common name	Total number of whole, skel/mount, cleared and stained specimens	Tissue samples in 95% ethanol
74186	Sciaenidae	*Cynoscion*	*regalis*	Weakfish	1	1
74187	Paralichthyidae	*Etropus*	*microstomus*	Smallmouth Flounder	1	1

Field/Locality#: **CH-13-01-015**
Cont./Ocean: Atlantic Ocean
Country: United States State: Virginia County: Virginia Beach City
Locality: Atlantic Ocean, off of Virginia, [ca. 10.5-9.5 air miles ENE center Virginia Beach]
Start: 36.90488° N, 75.80016° W; End: 36.90388° N, 75.81886° W (locality imprecise, lat-long approximate) Geodetic Datum: WGS84
Vessel/Cruise #/Sta. #: Cape Hatteras/13-01/015 Date Coll.: 8 January 2013 Time: 2218-2239 Accession Number: 12917
Collector(s): RW Laney et al. Gear: 65' otter trawl Depth of Capture: 14.3-13.0 m Salinity: S
Locality Remarks: None

Specimens Catalogued

NCSM Cat#	Family	Genus	Species	Common name	Total number of whole, skel/mount, cleared and stained specimens	Tissue samples in 95% ethanol
74188	Sciaenidae	*Leiostomus*	*xanthurus*	Spot	1	1

Field/Locality#: **CH-13-01-030**
Cont./Ocean: Atlantic Ocean
Country: United States State: Virginia County:
Locality: Atlantic Ocean, off of Virginia, [ca. 17.5-16.8 air miles ENE center Virginia Beach]
Start: 36.90443° N, 75.66949° W; End: 36.91567° N, 75.68478° W (locality imprecise, lat-long approximate) Geodetic Datum: WGS84
Vessel/Cruise #/Sta. #: Cape Hatteras/13-01/030 Date Coll.: 9 January 2013 Time: 0938-0949 Accession Number: 12917
Collector(s): RW Laney et al. Gear: 65' otter trawl Depth of Capture: 21.4-19.6 m Salinity: S
Locality Remarks: None

Specimens Catalogued

NCSM Cat#	Family	Genus	Species	Common name	Total number of whole, skel/mount, cleared and stained specimens	Tissue samples in 95% ethanol
74189	Stromateidae	*Peprilus*	*triacanthus*	Butterfish	1	1

Field/Locality#: **CH-13-01-054**
Cont./Ocean: Atlantic Ocean
Country: United States State: Virginia County:
Locality: Atlantic Ocean, off of Virginia, [ca. 20.7-21.1 air miles ENE center Virginia Beach]
Start: 36.97198° N, 75.6343° W; End: 36.98615° N, 75.63375° W (locality imprecise, lat-long approximate) Geodetic Datum: WGS84
Vessel/Cruise #/Sta. #: Cape Hatteras/13-01/054 Date Coll.: 10 January 2013 Time: 0452-0510 Accession Number: 12917
Collector(s): RW Laney et al. Gear: 65' otter trawl Depth of Capture: 22.7-25.2 m Salinity: S
Locality Remarks: None

Specimens Catalogued

NCSM Cat#	Family	Genus	Species	Common name	Total number of whole, skel/mount, cleared and stained specimens	Tissue samples in 95% ethanol
74190	Serranidae	*Centropristis*	*striata*	Black Sea Bass	1	1

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Field/Locality#: **CH-13-01-055**
Cont./Ocean: Atlantic Ocean
Country: United States State: Virginia County:
Locality: Atlantic Ocean, off of Virginia, [ca. 21.0-19.8 air miles ENE center Virginia Beach]
Start: 36.98768° N, 75.63692° W; End: 36.97797° N, 75.65514° W (locality imprecise, lat-long approximate) Geodetic Datum: WGS84
Vessel/Cruise #/Sta. #: Cape Hatteras/13-01/055 Date Coll.: 10 January 2013 Time: 0527-0548 Accession Number: 12917
Collector(s): RW Laney et al. Gear: 65' otter trawl Depth of Capture: 23.8-23.2 m Salinity: S
Locality Remarks: None

Specimens Catalogued

NCSM Cat#	Family	Genus	Species	Common name	Total number of whole, skel/mount, cleared and stained specimens	Tissue samples in 95% ethanol
74199	Trichiuridae	*Trichiurus*	*lepturus*	Atlantic Cutlassfish	1	1

Field/Locality#: **CH-13-01-105**
Cont./Ocean: Atlantic Ocean
Country: United States State: Virginia County:
Locality: Atlantic Ocean, off of Virginia, [ca. 11.7-11.0 air miles ENE center Virginia Beach]
Start: 36.93196° N, 75.79128° W; End: 36.91507° N, 75.79504° W (locality imprecise, lat-long approximate) Geodetic Datum: WGS84
Vessel/Cruise #/Sta. #: Cape Hatteras/13-01/105 Date Coll.: 11 January 2013 Time: 1726-1746 Accession Number: 12917
Collector(s): RW Laney et al. Gear: 65' otter trawl Depth of Capture: 15.1-15.4 m Salinity: S
Locality Remarks: None

Specimens Catalogued

NCSM Cat#	Family	Genus	Species	Common name	Total number of whole, skel/mount, cleared and stained specimens	Tissue samples in 95% ethanol
74198	Clupeidae	*Alosa*	*mediocris*	Hickory Shad	1	1

Field/Locality#: **CH-13-01-178**
Cont./Ocean: Atlantic Ocean
Country: United States State: Virginia County:
Locality: Atlantic Ocean, off of Virginia, [ca. 14.7-13.7 air miles ENE center Virginia Beach]
Start: 36.9171° N, 75.72594° W; End: 36.91208° N, 75.7416° W (locality imprecise, lat-long approximate) Geodetic Datum: WGS84
Vessel/Cruise #/Sta. #: Cape Hatteras/13-01/178 Date Coll.: 14 January 2013 Time: 0102-0132 Accession Number: 12917
Collector(s): RW Laney et al. Gear: 65' otter trawl Depth of Capture: 17.2-14.6 m Salinity: S
Locality Remarks: None

Specimens Catalogued

NCSM Cat#	Family	Genus	Species	Common name	Total number of whole, skel/mount, cleared and stained specimens	Tissue samples in 95% ethanol
74194	Rajidae	*Amblyraja*	*radiata*	Thorny Skate	1	1

Field/Locality#: **CH-13-01-200**
Cont./Ocean: Atlantic Ocean
Country: United States State: Virginia County:
Locality: Atlantic Ocean, off of Virginia, [ca. 14.2-13.8 air miles ENE center Virginia Beach]
Start: 36.91133° N, 75.73296° W; End: 36.92465° N, 75.74532° W (locality imprecise, lat-long approximate) Geodetic Datum: WGS84
Vessel/Cruise #/Sta. #: Cape Hatteras/13-01/200 Date Coll.: 14 January 2013 Time: 1711-1731 Accession Number: 12917
Collector(s): RW Laney et al. Gear: 65' otter trawl Depth of Capture: 18.0-16.0 m Salinity: S
Locality Remarks: None

Specimens Catalogued

NCSM Cat#	Family	Genus	Species	Common name	Total number of whole, skel/mount, cleared and stained specimens	Tissue samples in 95% ethanol
74200	Rajidae	*Leucoraja*	*ocellata*	Winter Skate	1	1

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Field/Locality#: **CH-13-01-204**
Cont./Ocean: Atlantic Ocean
Country: United States State: Virginia County:
Locality: Atlantic Ocean, off of Virginia, [ca. 15.9-15.2 air miles ENE center Virginia Beach]
Start: 36.91936° N, 75.70348° W; End: 36.93343° N, 75.72321° W (locality imprecise, lat-long approximate) Geodetic Datum: WGS84
Vessel/Cruise #/Sta. #: Cape Hatteras/13-01/204 Date Coll.: 14 January 2013 Time: 2004-2034 Accession Number: 12917
Collector(s): RW Laney et al. Gear: 65' otter trawl Depth of Capture: 17.5-17.8 m Salinity: S
Locality Remarks: None

Specimens Catalogued

NCSM Cat#	Family	Genus	Species	Common name	Total number of whole, skel/mount, cleared and stained specimens	Tissue samples in 95% ethanol
74191	Squalidae	*Squalus*	*acanthias*	Spiny Dogfish	1	1

Field/Locality#: **CH-13-01-216**
Cont./Ocean: Atlantic Ocean
Country: United States State: Virginia County: Virginia Beach City
Locality: Atlantic Ocean, off of Virginia, [ca. 4.3-4.7 air miles E-ESE center Virginia Beach]
Start: 36.85187° N, 75.90208° W; End: 36.83555° N, 75.89906° W (locality imprecise, lat-long approximate) Geodetic Datum: WGS84
Vessel/Cruise #/Sta. #: Cape Hatteras/13-01/216 Date Coll.: 15 January 2013 Time: 1221-1241 Accession Number: 12917
Collector(s): RW Laney et al. Gear: 65' otter trawl Depth of Capture: 13.0-13.5 m Salinity: S
Locality Remarks: None

Specimens Catalogued

NCSM Cat#	Family	Genus	Species	Common name	Total number of whole, skel/mount, cleared and stained specimens	Tissue samples in 95% ethanol
74197	Sciaenidae	*Bairdiella*	*chrysoura*	Silver Perch	1	1

Field/Locality#: **CH-13-01-218**
Cont./Ocean: Atlantic Ocean
Country: United States State: Virginia County: Virginia Beach City
Locality: Atlantic Ocean, off of Virginia, [ca.10.7-11.5 air miles SE center Virginia Beach]
Start: 36.73715° N, 75.85555° W; End: 36.7261° N, 75.85087° W (locality imprecise, lat-long approximate) Geodetic Datum: WGS84
Vessel/Cruise #/Sta. #: Cape Hatteras/13-01/218 Date Coll.: 15 January 2013 Time: 1418-1433 Accession Number: 12917
Collector(s): RW Laney et al. Gear: 65' otter trawl Depth of Capture: 14.0-13.7 m Salinity: S
Locality Remarks: None

Specimens Catalogued

NCSM Cat#	Family	Genus	Species	Common name	Total number of whole, skel/mount, cleared and stained specimens	Tissue samples in 95% ethanol
74195	Sciaenidae	*Micropogonias*	*undulatus*	Atlantic Croaker	1	1

Field/Locality#: **CH-13-01-244**
Cont./Ocean: Atlantic Ocean
Country: United States State: North Carolina County: Dare
Locality: Atlantic Ocean, off of North Carolina, [ca.13.9-14.1 air miles ESE center Manteo]
Start: 35.8013° N, 75.46603° W; End: 35.81653° N, 75.45197° W (locality imprecise, lat-long approximate) Geodetic Datum: WGS84
Vessel/Cruise #/Sta. #: Cape Hatteras/13-01/244 Date Coll.: 16 January 2013 Time: 1200-1215 Accession Number: 12917
Collector(s): RW Laney et al. Gear: 65' otter trawl Depth of Capture: 17.3-15.8 m Salinity: S
Locality Remarks: None

Specimens Catalogued

NCSM Cat#	Family	Genus	Species	Common name	Total number of whole, skel/mount, cleared and stained specimens	Tissue samples in 95% ethanol
74196	Sciaenidae	*Menticirrhus*	*americanus*	Southern Kingfish	1	1

Specimens colleted by RW Laney on the R/V Cape Hatteras and donated to NCSM

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Field/Locality#: **CH-13-01-245**

Cont./Ocean: Atlantic Ocean

Country: United States State: North Carolina County: Dare
Locality: Atlantic Ocean, off of North Carolina, [ca.15.6-16.3 air miles ESE center Manteo]

Start: 35.79313° N, 75.43633° W; End: 35.78025° N, 75.43095° W (locality imprecise, lat-long approximate) Geodetic Datum: WGS84
Vessel/Cruise #/Sta. #: Cape Hatteras/13-01/245 Date Coll.: 16 January 2013 Time: 1232-1247 Accession Number: 12917

Collector(s): RW Laney et al. Gear: 65' otter trawl Depth of Capture: 24.5-21.4 m Salinity: S

Locality Remarks: None

Specimens Catalogued

NCSM Cat#	Family	Genus	Species	Common name	Total number of whole, skel/mount, cleared and stained specimens	Tissue samples in 95% ethanol
74193	Haemulidae	*Orthopristis*	*chrysoptera*	Pigfish	1	1
74192	Sparidae	*Lagodon*	*rhomboides*	Pinfish	1	1

Specimens donated by RW Laney from the 2015 Cooperative Winter Tagging Cruise

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Field/Locality#: **SAV-15-01-005**

Cont./Ocean: Atlantic Ocean

Country: United States State: North Carolina County:
Locality: Atlantic Ocean [off of North Carolina], [ca. 29.5-30.5 km ESE center Buxton]

Start: 35.18776° N, 75.2329° W; End: 35.2044° N, 75.2164° W (locality imprecise, lat-long approximate) Geodetic Datum: WGS84
Vessel/Cruise #/Sta. #: Savannah/15-01/005 Date Coll.: 11 January 2015 Time: 0246-0306 Accession Number: 13180

Collector(s): RW Laney et al. Gear: Otter trawl (65 ft headrope, 3.2 kts tow speed) Depth of Capture: 21.9-24.3 m Salinity: S

Locality Remarks: 2015 Cooperative Winter Tagging Cruise; surface water temperature: 20.3° C; air temperature: 9.6° C; surface salinity: 36.3

Specimens Catalogued

NCSM Cat#	Family	Genus	Species	Common name	Total number of whole, skel/mount, cleared and stained specimens	Tissue samples in 95% ethanol
76377	Paralichthyidae	*Syacium*	*papillosum*	Dusky Flounder	1	1

Field/Locality#: **SAV-15-01-006**

Cont./Ocean: Atlantic Ocean

Country: United States State: North Carolina County: Dare
Locality: Atlantic Ocean [off of North Carolina], [ca. 7.9-8.4 km ENE center Avon]

Start: 35.3819° N, 75.432° W; End: 35.3922° N, 75.4321° W (locality imprecise, lat-long approximate) Geodetic Datum: WGS84 Vessel/Cruise #/Sta. #: Savannah/15-01/006 Date Coll.: 11 January 2015 Time: 0545-0555 Accession Number: 13180

Collector(s): RW Laney et al. Gear: Otter trawl (65 ft headrope, 3.2 kts tow speed) Depth of Capture: 13.0-16.4 m Salinity: S

Locality Remarks: 2015 Cooperative Winter Tagging Cruise; surface water temperature: 16.7° C; air temperature: 8.0° C; surface salinity: 36.0

Specimens Catalogued

NCSM Cat#	Family	Genus	Species	Common name	Total number of whole, skel/mount, cleared and stained specimens	Tissue samples in 95% ethanol
76376	Trichiuridae	*Trichiurus*	*lepturus*	Atlantic Cutlassfish	1	1

Field/Locality#: **SAV-15-01-009**

Cont./Ocean: Atlantic Ocean

Country: United States State: North Carolina County: Dare
Locality: Atlantic Ocean, on Platt Shoals off of Oregon Inlet, [ca. 24.1-23.6 km ESE center Wanchese]

Start: 35.7333° N, 75.408° W; End: 35.7459° N, 75.4052° W (locality imprecise, lat-long approximate) Geodetic Datum: WGS84 Vessel/Cruise #/Sta. #: Savannah/15-01/009 Date Coll.: 11 January 2015 Time: 1105-1120 Accession Number: 13180

Collector(s): RW Laney et al. Gear: Otter trawl (65 ft headrope, 3.0 kts tow speed) Depth of Capture: 20.6-21.0 m Salinity: S

Locality Remarks: 2015 Cooperative Winter Tagging Cruise; surface water temperature: 13.7° C; air temperature: 10.7° C; surface salinity: 34.2

Specimens Catalogued

NCSM Cat#	Family	Genus	Species	Common name	Total number of whole, skel/mount, cleared and stained specimens	Tissue samples in 95% ethanol
76375	Alopiidae	*Alopias*	*vulpinus*	Thresher Shark	2	2

Field/Locality#: **SAV-15-01-015**

Cont./Ocean: Atlantic Ocean

Country: United States State: North Carolina County: Dare
Locality: Atlantic Ocean [off of North Carolina], [ca. 28.9-29.8 km NNW center Manteo]

Start: 36.1642° N, 75.7289° W; End: 36.1725° N, 75.7309° W (locality imprecise, lat-long approximate) Geodetic Datum: WGS84 Vessel/Cruise #/Sta. #: Savannah/15-01/015 Date Coll.: 11 January 2015 Time: 2000-2010 Accession Number: 13180

Collector(s): RW Laney et al. Gear: Otter trawl (65 ft headrope, 3.2 kts tow speed) Depth of Capture: 30.9-33.5 ft Salinity: S

Locality Remarks: 2015 Cooperative Winter Tagging Cruise; surface water temperature: 7.7° C; air temperature: 7.8° C; surface salinity: 31.6

Specimens Catalogued

NCSM Cat#	Family	Genus	Species	Common name	Total number of whole, skel/mount, cleared and stained specimens	Tissue samples in 95% ethanol
76374	Sciaenidae	*Larimus*	*fasciatus*	Banded Drum	1	1

Specimens donated by RW Laney from the 2015 Cooperative Winter Tagging Cruise

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Field/Locality#: **SAV-15-01-054**

Cont./Ocean: Atlantic Ocean

Country: United States State: Virginia County:
Locality: Atlantic Ocean [off of Virginia], [ca. 40.7-41.5 km ENE center Exmore]

Start: 37.6374° N, 75.3809° W; End: 37.6572° N, 75.374° W (locality imprecise, lat-long approximate) Geodetic Datum: WGS84 Vessel/Cruise #/Sta. #: Savannah/15-01/054 Date Coll.: 13 January 2015 Time: 0135-0155 Accession Number: 13180

Collector(s): RW Laney et al. Gear: Otter trawl (65 ft headrope, 3.2-3.3 kts tow speed) Depth of Capture: 55.5-58.5 ft Salinity: S

Locality Remarks: 2015 Cooperative Winter Tagging Cruise; surface water temperature: 6.9° C; air temperature: 4.9° C; surface salinity: 33.0

Specimens Catalogued

NCSM Cat#	Family	Genus	Species	Common name	Total number of whole, skel/mount, cleared and stained specimens	Tissue samples in 95% ethanol
76378	Rajidae	*Leucoraja*	*erinacea*	Little Skate	1	1

Field/Locality#: **SAV-15-01-071**

Cont./Ocean: Atlantic Ocean

Country: United States State: Virginia County:
Locality: Atlantic Ocean [off of Virginia], [ca. 73.3-72.0 km ENE center Exmore]

Start: 37.8378° N, 75.0849° W; End: 37.848° N, 75.1096° W (locality imprecise, lat-long approximate) Geodetic Datum: WGS84 Vessel/Cruise #/Sta. #: Savannah/15-01/071 Date Coll.: 15 January 2015 Time: 1553-1613 Accession Number: 13180

Collector(s): RW Laney et al. Gear: Otter trawl (65 ft headrope, 3.2 kts tow speed) Depth of Capture: 76.4-97.1 ft Salinity: S

Locality Remarks: 2015 Cooperative Winter Tagging Cruise; surface water temperature: 6.4° C; air temperature: 3.4° C; surface salinity: 32.9

Specimens Catalogued

NCSM Cat#	Family	Genus	Species	Common name	Total number of whole, skel/mount, cleared and stained specimens	Tissue samples in 95% ethanol
76373	Rajidae	*Leucoraja*	*erinacea*	Little Skate	1	1

Accession Number: 13268 **25 Jan 2016**

RECORD of ACCESSION
North Carolina Museum of Natural Sciences
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Donated by: R. Wilson Laney
US Fish and Wildlife Service
South Atlantic Fisheries Coordination
POB 33683
Raleigh, NC 27636
USA

Accepted by: Gabriela M. Hogue
Form Completed Date: 25 January 2016
Date Received: 2016
Location: Research Lab
Disposition: Research
Type of Accession: Gift

Materials Received: Misc. fish and invertebrate specimens
Where Obtained: various
Date Coll: 2016
Collector(s): R. Wilson Laney et al.
This is a blanket accession for specimens donated and/or collected in 2016.

AGREEMENT: I, the undersigned, hereby donate the above listed object(s) to the North Carolina State Museum of Natural Sciences as a gift to be used, allocated or disposed of in the best interests of the museum and its programs as determined by officials of the institution. I understand that with this agreement the said object(s) become(s) sole property of the North Carolina State Museum of Natural Sciences, and that I have no further claim to its (their) ownership, usage or disposition.

Signed: _____ **Date:** 2-18-2016

PLEASE SIGN AND RETURN ONE COPY

Specimens donated by RW Laney from the 2016 Cooperative Winter Tagging Cruise

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Field/Locality#: **SAV-16-01-05**

Cont./Ocean: Atlantic Ocean

Country: United States State: North Carolina County:
Locality: [Atlantic Ocean, off of North Carolina, ca. 15.2-15.3 kilometers E center Corolla]

Start: 36.3696° N, 75.66431° W; End: 36.39059° N, 75.66258° W Geodetic Datum: WGS84 Vessel/Cruise #/Sta. #: Savannah/16-01/05 Date Coll.: 12 January 2016 Time: 1923-1946 Accession Number: 13268

Collector(s): R. Wilson Laney, et al. (Cooperative Winter Tagging Cruise) Gear: 65' otter trawl Depth of Capture: 22.1-22.6 meters Salinity: S

Locality Remarks: Water temperature: 11.9°C

Specimens Catalogued

NCSM Cat#	Family	Genus	Species	Common name	Total number of whole, skel/mount, cleared and stained specimens	Tissue samples in 95% ethanol
83115	Paralichthyidae	*Etropus*	*microstomus*	Smallmouth Flounder	3	1

Field/Locality#: **SAV-16-01-11**

Cont./Ocean: Atlantic Ocean

Country: United States State: North Carolina County:
Locality: Atlantic Ocean, [off of] North Carolina, [ca, 12.1-10.1 kilometers NNE center Corolla]

Start: 36.47306° N, 75.76003° W; End: 36.4526° N, 75.76284° W Geodetic Datum: WGS84 Vessel/Cruise #/Sta. #: Savannah/16-01/11 Date Coll.: 12-13 January 2016 Time: 2345-0015 Accession Number: 13268

Collector(s): R. Wilson Laney, et al. (Cooperative Winter Tagging Cruise) Gear: 65' otter trawl Depth of Capture: 20.1-20.6 meters Salinity: S

Locality Remarks: Water temperature: 11.2°C

Specimens Catalogued

NCSM Cat#	Family	Genus	Species	Common name	Total number of whole, skel/mount, cleared and stained specimens	Tissue samples in 95% ethanol
83012	Phycidae	*Urophycis*	*floridana*	Southern Hake	0	3
82999	Phycidae	*Urophycis*	*regia*	Spotted Hake	2	2
83000	Triglidae	*Prionotus*	*scitulus*	Leopard Searobin	1	1

Field/Locality#: **SAV-16-01-12**

Cont./Ocean: Atlantic Ocean

Country: United States State: North Carolina County:
Locality: Atlantic Ocean, off North Carolina, [ca. 8.0-6.2 kilometers NE center Corolla]

Start: 36.43785° N, 75.77774° W; End: 36.42384° N, 75.78854° W Geodetic Datum: WGS84 Vessel/Cruise #/Sta. #: Savannah/16-01/12 Date Coll.: 13 January 2016 Time: 0042-0105 Accession Number: 13268

Collector(s): R. Wilson Laney, et al. (Cooperative Winter Tagging Cruise) Gear: 65' otter trawl Depth of Capture: 17.1-19.0 meters Salinity: S

Locality Remarks: Water temperature: 11.1°C

Specimens Catalogued

NCSM Cat#	Family	Genus	Species	Common name	Total number of whole, skel/mount, cleared and stained specimens	Tissue samples in 95% ethanol
82979	Engraulidae	*Anchoa*	*mitchilli*	Bay Anchovy	1	1
83009	Phycidae	*Urophycis*	*regia*	Spotted Hake	1	1
83010	Merlucciidae	*Merluccius*	*bilinearis*	Silver Hake	1	1
82980	Sciaenidae	*Bairdiella*	*chrysoura*	Silver Perch	2	2
83011	Paralichthyidae	*Etropus*	*microstomus*	Smallmouth Flounder	2	2

Specimens donated by RW Laney from the 2016 Cooperative Winter Tagging Cruise

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Field/Locality#: **FISH8-2895**

Cont./Ocean: Atlantic Ocean

Country: United States State: North Carolina County: Dare
Locality: [Manns Harbor, ca. 7.5 kilometers WSW center Manteo]

Lat/Long: 35.89018° N, 75.75615° W Geodetic Datum: WGS84 Vessel/Cruise #/Sta. #: n/a Date Coll.: n/k February 2016 Time: n/k
Accession Number: 13268

Collector(s): John Ellis Gear: Hook and line Depth of Capture: n/k Salinity: S

Locality Remarks: Collected on fishing vessel "Midnight Sun".

Specimens Catalogued

NCSM Cat#	Family	Genus	Species	Common name	Total number of whole, skel/mount, cleared and stained specimens	Tissue samples in 95% ethanol
83018	Petromyzontidae	*Petromyzon*	*marinus*	Sea Lamprey	1	1

Field/Locality#: **SAV-16-01-02**

Cont./Ocean: Atlantic Ocean

Country: United States State: North Carolina County:
Locality: Atlantic Ocean, offshore North Carolina, [ca. 38.5-40.7 kilometers NNE center Manteo]

Start: 36.24375° N, 75.56977° W; End: 36.26232° N, 75.56043° W Geodetic Datum: WGS84 Vessel/Cruise #/Sta. #: Savannah/16-01/02
Date Coll.: 12 January 2016 Time: 1608-1633 Accession Number: 13268

Collector(s): R. Wilson Laney, et al. (Cooperative Winter Tagging Cruise) Gear: 65' otter trawl Depth of Capture: 26.3-26.5 meters Salinity: S

Locality Remarks: Water temperature: 12.1°C.

Specimens Catalogued

NCSM Cat#	Family	Genus	Species	Common name	Total number of whole, skel/mount, cleared and stained specimens	Tissue samples in 95% ethanol
82993	Stromateidae	*Peprilus*	*triacanthus*	Butterfish	1	1

Field/Locality#: **SAV-16-01-03**

Cont./Ocean: Atlantic Ocean

Country: United States State: North Carolina County:
Locality: [Atlantic Ocean, off of North Carolina, ca. 14.6-14.5 kilometers ESE center Corolla]

Start: 36.31318° N, 75.69398° W; End: 36.32491° N, 75.68667° W Geodetic Datum: WGS84 Vessel/Cruise #/Sta. #: Savannah/16-01/03
Date Coll.: 12 January 2016 Time: 1822-1837 Accession Number: 13268

Collector(s): R. Wilson Laney, et al. (Cooperative Winter Tagging Cruise) Gear: 65' otter trawl Depth of Capture: 21.1-21.7 meters Salinity: S

Locality Remarks: Water temperature: 11.7°C

Specimens Catalogued

NCSM Cat#	Family	Genus	Species	Common name	Total number of whole, skel/mount, cleared and stained specimens	Tissue samples in 95% ethanol
83015	Triglidae	*Prionotus*	*sp.*		1	1
83113	Paralichthyidae	*Etropus*	*microstomus*	Smallmouth Flounder	1	1

Field/Locality#: **SAV-16-01-04**

Cont./Ocean: Atlantic Ocean

Country: United States State: North Carolina County:
Locality: [Atlantic Ocean, off of North Carolina, ca. 14.6-14.9 kilometers ESE-E center Corolla]

Start: 36.33925° N, 75.67854° W; End: 36.35781° N, 75.66876° W Geodetic Datum: WGS84 Vessel/Cruise #/Sta. #: Savannah/16-01/04
Date Coll.: 12 January 2016 Time: 1851-1913 Accession Number: 13268

Collector(s): R. Wilson Laney, et al. (Cooperative Winter Tagging Cruise) Gear: 65' otter trawl Depth of Capture: 19.3-22.7 meters Salinity: S

Locality Remarks: Water temperature: 11.6°C

Specimens Catalogued

NCSM Cat#	Family	Genus	Species	Common name	Total number of whole, skel/mount, cleared and stained specimens	Tissue samples in 95% ethanol
83112	Paralichthyidae	*Etropus*	*microstomus*	Smallmouth Flounder	3	1

Specimens donated by RW Laney from the 2016 Cooperative Winter Tagging Cruise

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Field/Locality#: **SAV-16-01-15**
Cont./Ocean: Atlantic Ocean
Country: United States State: North Carolina County:
Locality: Atlantic Ocean, off North Carolina, [ca. 7.1-8.8 kilometers NNE center Corolla]
Start: 36.43479° N, 75.79058° W; End: 36.45405° N, 75.79427° W Geodetic Datum: WGS84 Vessel/Cruise #/Sta. #: Savannah/16-01/15
Date Coll.: 13 January 2016 Time: 0338-0402 Accession Number: 13268
Collector(s): R. Wilson Laney, et al. (Cooperative Winter Tagging Cruise) Gear: 65' Otter trawl Depth of Capture: 17.2-17.6 meters Salinity: S
Locality Remarks: Water temperature: 10.9°C

Specimens Catalogued

NCSM Cat#	Family	Genus	Species	Common name	Total number of whole, skel/mount, cleared and stained specimens	Tissue samples in 95% ethanol
82992	Phycidae	*Urophycis*	*floridana*	Southern Hake	2	2

Field/Locality#: **SAV-16-01-16**
Cont./Ocean: Atlantic Ocean
Country: United States State: North Carolina County:
Locality: Atlantic Ocean, [off of] North Carolina, [ca. 13.6-15.6 kilometers NNE center Corolla]
Start: 36.49929° N, 75.79242° W; End: 36.51551° N, 75.78137° W Geodetic Datum: WGS84 Vessel/Cruise #/Sta. #: Savannah/16-01/16
Date Coll.: 13 January 2016 Time: 0442-0506 Accession Number: 13268
Collector(s): R. Wilson Laney, et al. (Cooperative Winter Tagging Cruise) Gear: 65' otter trawl Depth of Capture: 18.1-19.3 meters Salinity: S
Locality Remarks: Water temperature: 10.9°C

Specimens Catalogued

NCSM Cat#	Family	Genus	Species	Common name	Total number of whole, skel/mount, cleared and stained specimens	Tissue samples in 95% ethanol
82991	Clupeidae	*Clupea*	*harengus*	Atlantic Herring	1	1

Field/Locality#: **SAV-16-01-19**
Cont./Ocean: Atlantic Ocean
Country: United States State: County:
Locality: Atlantic Ocean, off Virginia coast, [ca. 28.5-30.0 kilometers ENE center Virginia Beach]
Start: 36.9445° N, 75.67952° W; End: 36.96109° N, 75.66961° W Geodetic Datum: WGS84 Vessel/Cruise #/Sta. #: Savannah/16-01/19 Date Coll.: 13 January 2016 Time: 1121-1145 Accession Number: 13268
Collector(s): R. Wilson Laney, et al. (Cooperative Winter Tagging Cruise) Gear: 65' otter trawl Depth of Capture: 17.9-20.5 meters Salinity: S
Locality Remarks: Water temperature: 10.7°C

Specimens Catalogued

NCSM Cat#	Family	Genus	Species	Common name	Total number of whole, skel/mount, cleared and stained specimens	Tissue samples in 95% ethanol
82998	Sciaenidae	*Bairdiella*	*chrysoura*	Silver Perch	1	1
83104	Paralichthyidae	*Etropus*	*microstomus*	Smallmouth Flounder	1	1

Field/Locality#: **SAV-16-01-21**
Cont./Ocean: Atlantic Ocean
Country: United States State: Virginia County:
Locality: Atlantic Ocean, off Virginia coast, [ca. 34.2-34.8 kilometers NE center Virginia Beach]
Start: 37.05471° N, 75.68608° W; End: 37.07018° N, 75.69429° W Geodetic Datum: WGS84 Vessel/Cruise #/Sta. #: Savannah/16-01/21
Date Coll.: 13 January 2016 Time: 1321-1343 Accession Number: 13268
Collector(s): R. Wilson Laney, et al. (Cooperative Winter Tagging Cruise) Gear: 65' Otter trawl Depth of Capture: 15.5-17.9 meters Salinity: S
Locality Remarks: Water temperature: 10.5°C

Specimens Catalogued

NCSM Cat#	Family	Genus	Species	Common name	Total number of whole, skel/mount, cleared and stained specimens	Tissue samples in 95% ethanol
82997	Merlucciidae	*Merluccius*	*bilinearis*	Silver Hake	1	1

Specimens donated by RW Laney from the 2016 Cooperative Winter Tagging Cruise

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Field/Locality#: **SAV-16-01-22**
Cont./Ocean: Atlantic Ocean
Country: United States State: Virginia County:
Locality: Atlantic Ocean, off Virginia coast, [ca. 34.3-33.7 kilometers NE center Virginia Beach]
Start: 37.07268° N, 75.70419° W; End: 37.07935° N, 75.72407° W Geodetic Datum: WGS84 Vessel/Cruise #/Sta. #: Savannah/16-01/22
Date Coll.: 13 January 2016 Time: 1358-1420 Accession Number: 13268
Collector(s): R. Wilson Laney, et al. (Cooperative Winter Tagging Cruise) Gear: 65' otter trawl Depth of Capture: 14.7-15.5 meters Salinity: S
Locality Remarks: Water temperature: 10.1°C

Specimens Catalogued

NCSM Cat#	Family	Genus	Species	Common name	Total number of whole, skel/mount, cleared and stained specimens	Tissue samples in 95% ethanol
82984	Clupeidae	*Clupea*	*harengus*	Atlantic Herring	5	5
82985	Trichiuridae	*Trichiurus*	*lepturus*	Atlantic Cutlassfish	2	2
82986	Scophthalmidae	*Scophthalmus*	*aquosus*	Windowpane	1	1

Field/Locality#: **SAV-16-01-28**
Cont./Ocean: Atlantic Ocean
Country: United States State: Virginia County:
Locality: [Atlantic Ocean, off of Virginia, ca. 27.9-29.0 kilometers ESE-E center Accomac]
Start: 37.66379° N, 75.35612° W; End: 37.68022° N, 75.34033° W Geodetic Datum: WGS84 Vessel/Cruise #/Sta. #: Savannah/16-01/28
Date Coll.: 13 January 2016 Time: 2245-2308 Accession Number: 13268
Collector(s): R. Wilson Laney, et al. (Cooperative Winter Tagging Cruise) Gear: 65' otter trawl Depth of Capture: 14.4-16.5 meters Salinity: S
Locality Remarks: Water temperature: 9.4°C

Specimens Catalogued

NCSM Cat#	Family	Genus	Species	Common name	Total number of whole, skel/mount, cleared and stained specimens	Tissue samples in 95% ethanol
83110	Paralichthyidae	*Etropus*	*microstomus*	Smallmouth Flounder	1	1

Field/Locality#: **SAV-16-01-30**
Cont./Ocean: Atlantic Ocean
Country: United States State: Virginia County:
Locality: Atlantic Ocean, offshore Virginia, [ca. 32.8-34.4 kilometers E center Accomac]
Start: 37.73294° N, 75.29301° W; End: 37.74885° N, 75.27611° W Geodetic Datum: WGS84 Vessel/Cruise #/Sta. #: Savannah/16-01/30
Date Coll.: 13-14 January 2016 Time: 2358-0022 Accession Number: 13268
Collector(s): R. Wilson Laney, et al. (Cooperative Winter Tagging Cruise) Gear: 65' otter trawl Depth of Capture: 21.0-22.3 meters Salinity: S
Locality Remarks: Water temperature: 9.6°C

Specimens Catalogued

NCSM Cat#	Family	Genus	Species	Common name	Total number of whole, skel/mount, cleared and stained specimens	Tissue samples in 95% ethanol
82994	Merlucciidae	*Merluccius*	*bilinearis*	Silver Hake	2	2
82995	Triglidae	*Prionotus*	*scitulus*	Leopard Searobin	3	3
82996	Paralichthyidae	*Etropus*	*microstomus*	Smallmouth Flounder	2	2

Specimens donated by RW Laney from the 2016 Cooperative Winter Tagging Cruise

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Field/Locality#: **SAV-16-01-31**
Cont./Ocean: Atlantic Ocean
Country: United States State: Virginia County:
Locality: Atlantic Ocean, offshore of Virginia, [ca. 35.5-37.3 kilometers ENE center Accomac]
Start: 37.77158° N, 75.26712° W; End: 37.79298° N, 75.25148° W Geodetic Datum: WGS84 Vessel/Cruise #/Sta. #: Savannah/16-01/31
Date Coll.: 14 January 2016 Time: 0048-0115 Accession Number: 13268
Collector(s): R. Wilson Laney, et al. (Cooperative Winter Tagging Cruise) Gear: 65' otter trawl Depth of Capture: 19.0-21.9 meters Salinity: S
Locality Remarks: Water temperature: 9.5°C

Specimens Catalogued

NCSM Cat#	Family	Genus	Species	Common name	Total number of whole, skel/mount, cleared and stained specimens	Tissue samples in 95% ethanol
82987	Triglidae	*Prionotus*	*scitulus*	Leopard Searobin	1	1
83117	Paralichthyidae	*Etropus*	*microstomus*	Smallmouth Flounder	7	0

Field/Locality#: **SAV-16-01-50**
Cont./Ocean: Atlantic Ocean
Country: United States State: Maryland County:
Locality: [Atlantic Ocean, off of Maryland, ca. 33.0-33.2 kilometers ESE center Snow Hill]
Start: 38.07385° N, 75.03862° W; End: 38.09198° N, 75.02882° W Geodetic Datum: WGS84 Vessel/Cruise #/Sta. #: Savannah/16-01/50
Date Coll.: 14 January 2016 Time: 1755-1817 Accession Number: 13268
Collector(s): R. Wilson Laney, et al. (Cooperative Winter Tagging Cruise) Gear: 65' otter trawl Depth of Capture: 13.1-15.3 meters Salinity: S
Locality Remarks: Water temperature: 8.9°C

Specimens Catalogued

NCSM Cat#	Family	Genus	Species	Common name	Total number of whole, skel/mount, cleared and stained specimens	Tissue samples in 95% ethanol
83102	Paralichthyidae	*Etropus*	*microstomus*	Smallmouth Flounder	1	1

Field/Locality#: **SAV-16-01-51**
Cont./Ocean: Atlantic Ocean
Country: United States State: Maryland County:
Locality: [Atlantic Ocean, off of Maryland, ca. 33.3-31.5 kilometers ESE center Snow Hill]
Start: 38.10445° N, 75.02288° W; End: 38.09931° N, 75.04601° W Geodetic Datum: WGS84 Vessel/Cruise #/Sta. #: Savannah/16-01/51
Date Coll.: 14 January 2016 Time: 1831-1854 Accession Number: 13268
Collector(s): R. Wilson Laney, et al. (Cooperative Winter Tagging Cruise) Gear: 65' otter trawl Depth of Capture: 13.1-15.8 meters Salinity: S
Locality Remarks: Water temperature: 8.7°C

Specimens Catalogued

NCSM Cat#	Family	Genus	Species	Common name	Total number of whole, skel/mount, cleared and stained specimens	Tissue samples in 95% ethanol
83108	Paralichthyidae	*Etropus*	*microstomus*	Smallmouth Flounder	2	1

Field/Locality#: **SAV-16-01-53**
Cont./Ocean: Atlantic Ocean
Country: United States State: Maryland County:
Locality: [Atlantic Ocean, off of Maryland, ca. 30.0-29.1 kilometers ESE center Snow Hill]
Start: 38.08455° N, 75.07011° W; End: 38.0599° N, 75.09582° W Geodetic Datum: WGS84 Vessel/Cruise #/Sta. #: Savannah/16-01/53 Date Coll.: 14 January 2016 Time: 1921-2002 Accession Number: 13268
Collector(s): R. Wilson Laney, et al. (Cooperative Winter Tagging Cruise) Gear: 65' otter trawl Depth of Capture: 11.1-16 meters Salinity: S
Locality Remarks: Water temperature: 8.7°C

Specimens Catalogued

NCSM Cat#	Family	Genus	Species	Common name	Total number of whole, skel/mount, cleared and stained specimens	Tissue samples in 95% ethanol
83116	Paralichthyidae	*Etropus*	*microstomus*	Smallmouth Flounder	6	2

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Field/Locality#: **SAV-16-01-54**
Cont./Ocean: Atlantic Ocean
Country: United States State: Maryland County:
Locality: [Atlantic Ocean, off of Maryland, ca. 27.1-26.3 kilometers SE center Snow Hill]
Start: 38.04457° N, 75.13282° W; End: 38.03647° N, 75.15158° W Geodetic Datum: WGS84 Vessel/Cruise #/Sta. #: Savannah/16-01/54
Date Coll.: 14 January 2016 Time: 2026-2050 Accession Number: 13268
Collector(s): R. Wilson Laney, et al. (Cooperative Winter Tagging Cruise) Gear: 65' otter trawl Depth of Capture: 9.8-17.6 meters Salinity: S
Locality Remarks: Water temperature: 8.6°C

Specimens Catalogued

NCSM Cat#	Family	Genus	Species	Common name	Total number of whole, skel/mount, cleared and stained specimens	Tissue samples in 95% ethanol
83114	Paralichthyidae	*Etropus*	*microstomus*	Smallmouth Flounder	4	1

Field/Locality#: **SAV-16-01-55**
Cont./Ocean: Atlantic Ocean
Country: United States State: Maryland County:
Locality: Atlantic Ocean, offshore Assateague [Island], [ca. 20.8-21.1 kilometers E center Stockton]
Start: 38.04583° N, 75.17259° W; End: 38.06712° N, 75.17015° W Geodetic Datum: WGS84 Vessel/Cruise #/Sta. #: Savannah/16-01/55
Date Coll.: 14 January 2016 Time: 2108-2132 Accession Number: 13268
Collector(s): R. Wilson Laney, et al. (Cooperative Winter Tagging Cruise) Gear: 65' otter trawl Depth of Capture: 13.5-14.7 meters Salinity: S
Locality Remarks: Water temperature: 8.4°C

Specimens Catalogued

NCSM Cat#	Family	Genus	Species	Common name	Total number of whole, skel/mount, cleared and stained specimens	Tissue samples in 95% ethanol
83111	Paralichthyidae	*Etropus*	*microstomus*	Smallmouth Flounder	0	1

Field/Locality#: **SAV-16-01-56**
Cont./Ocean: Atlantic Ocean
Country: United States State: Maryland County:
Locality: [Atlantic Ocean, off of Maryland, ca. 22.3-22.5 kilometers ESE-E center Snow Hill]
Start: 38.13149° N, 75.14482° W; End: 38.15375° N, 75.13675° W Geodetic Datum: WGS84 Vessel/Cruise #/Sta. #: Savannah/16-01/56
Date Coll.: 14 January 2016 Time: 2219-2245 Accession Number: 13268
Collector(s): R. Wilson Laney, et al. (Cooperative Winter Tagging Cruise) Gear: 65' otter trawl Depth of Capture: 15.4-15.7 meters Salinity: S
Locality Remarks: Water temperature: 7.5°C

Specimens Catalogued

NCSM Cat#	Family	Genus	Species	Common name	Total number of whole, skel/mount, cleared and stained specimens	Tissue samples in 95% ethanol
83109	Paralichthyidae	*Etropus*	*microstomus*	Smallmouth Flounder	1	1

Field/Locality#: **SAV-16-01-63**
Cont./Ocean: Atlantic Ocean
Country: United States State: Virginia County:
Locality: [Atlantic Ocean, off of Virginia, ca. 37.2-34.7 kilometers ENE center Accomac]
Start: 37.82159° N, 75.26218° W; End: 37.8106° N, 75.28775° W Geodetic Datum: WGS84 Vessel/Cruise #/Sta. #: Savannah/16-01/63 Date Coll.: 15 January 2016 Time: 1953-2018 Accession Number: 13268
Collector(s): R. Wilson Laney, et al. (Cooperative Winter Tagging Cruise) Gear: 65' otter trawl Depth of Capture: 9.07-9.17 meters Salinity: S
Locality Remarks: Water temperature: 9.1°C

Specimens Catalogued

NCSM Cat#	Family	Genus	Species	Common name	Total number of whole, skel/mount, cleared and stained specimens	Tissue samples in 95% ethanol
83107	Paralichthyidae	*Etropus*	*microstomus*	Smallmouth Flounder	1	1

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Field/Locality#: **SAV-16-01-65**
Cont./Ocean: Atlantic Ocean
Country: United States State: Virginia County:
Locality: Atlantic Ocean, off Virginia, [ca. 16.5-14.9 kilometers E-ESE center Accomac]
Start: 37.6988° N, 75.48039° W; End: 37.68906° N, 75.50111° W Geodetic Datum: WGS84 Vessel/Cruise #/Sta. #: Savannah/16-01/65 Date Coll.: 16 January 2016 Time: 1350-1412 Accession Number: 13268
Collector(s): R. Wilson Laney, et al. (Cooperative Winter Tagging Cruise) Gear: 65' otter trawl Depth of Capture: 16.7-17 meters Salinity: S
Locality Remarks: Water temperature: 9.1°C

Specimens Catalogued

NCSM Cat#	Family	Genus	Species	Common name	Total number of whole, skel/mount, cleared and stained specimens	Tissue samples in 95% ethanol
82988	Sciaenidae	*Stellifer*	*lanceolatus*	Star Drum	1	1

Field/Locality#: **SAV-16-01-66**
Cont./Ocean: Atlantic Ocean
Country: United States State: Virginia County:
Locality: Atlantic Ocean, off Virginia, [ca. 13.6-14.9 kilometers SE center Accomac]
Start: 37.63856° N, 75.54998° W; End: 37.62094° N, 75.5503° W Geodetic Datum: WGS84 Vessel/Cruise #/Sta. #: Savannah/16-01/66 Date Coll.: 16 January 2016 Time: 1455-1515 Accession Number: 13268
Collector(s): R. Wilson Laney, et al. (Cooperative Winter Tagging Cruise) Gear: 65' otter trawl Depth of Capture: 12.4-12.6 meters Salinity: S
Locality Remarks: Water temperature: 8.8°C

Specimens Catalogued

NCSM Cat#	Family	Genus	Species	Common name	Total number of whole, skel/mount, cleared and stained specimens	Tissue samples in 95% ethanol
82990	Triglidae	*Prionotus*	*tribulus*	Bighead Searobin	1	1
82989	Sciaenidae	*Stellifer*	*lanceolatus*	Star Drum	1	1

Field/Locality#: **SAV-16-01-70**
Cont./Ocean: Atlantic Ocean
Country: United States State: Virginia County:
Locality: Atlantic Ocean, off Virginia, [ca. 35.0-37.0 kilometers SSE center Accomac]
Start: 37.41661° N, 75.55766° W; End: 37.39666° N, 75.5625° W Geodetic Datum: WGS84 Vessel/Cruise #/Sta. #: Savannah/16-01/70 Date Coll.: 16 January 2016 Time: 1831-1856 Accession Number: 13268
Collector(s): R. Wilson Laney, et al. (Cooperative Winter Tagging Cruise) Gear: 65' otter trawl Depth of Capture: 18.4-18.6 meters Salinity: S
Locality Remarks: Water temperature: 9.3°C

Specimens Catalogued

NCSM Cat#	Family	Genus	Species	Common name	Total number of whole, skel/mount, cleared and stained specimens	Tissue samples in 95% ethanol
83013	Phycidae	*Urophycis*	*chuss*	Red Hake	3	3
83105	Paralichthyidae	*Etropus*	*microstomus*	Smallmouth Flounder	1	1

Field/Locality#: **SAV-16-01-73**
Cont./Ocean: Atlantic Ocean
Country: United States State: County:
Locality: [Atlantic Ocean, off of Virginia, [ca. 70.7-68.3 kilometers NE center Virginia Beach]
Start: 37.27603° N, 75.38154° W; End: 37.25486° N, 75.39384° W Geodetic Datum: WGS84 Vessel/Cruise #/Sta. #: Savannah/16-01/73 Date Coll.: 16 January 2016 Time: 2213-2240 Accession Number: 13268
Collector(s): R. Wilson Laney, et al. (Cooperative Winter Tagging Cruise) Gear: 65' otter trawl Depth of Capture: 27.5-29.4 meters Salinity: S
Locality Remarks: Water temperature: 10.9°C

Specimens Catalogued

NCSM Cat#	Family	Genus	Species	Common name	Total number of whole, skel/mount, cleared and stained specimens	Tissue samples in 95% ethanol
83103	Paralichthyidae	*Etropus*	*microstomus*	Smallmouth Flounder	6	2

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Field/Locality#: **SAV-16-01-75**
Cont./Ocean: Atlantic Ocean
Country: United States State: County:
Locality: Atlantic Ocean, off Virginia shore, [ca. 61.7-59.6 kilometers ENE center Virginia Beach]
Start: 37.1623° N, 75.40028° W; End: 37.14026° N, 75.41061° W Geodetic Datum: WGS84 Vessel/Cruise #/Sta. #: Savannah/16-01/75 Date Coll.: 17 January 2016 Time: 0043-0111 Accession Number: 13268
Collector(s): R. Wilson Laney, et al. (Cooperative Winter Tagging Cruise) Gear: 65' otter trawl Depth of Capture: 29.8-30.5 meters Salinity: S
Locality Remarks: Water temperature: 11.3°C

Specimens Catalogued

NCSM Cat#	Family	Genus	Species	Common name	Total number of whole, skel/mount, cleared and stained specimens	Tissue samples in 95% ethanol
83118	Serranidae	*Centropristis*	*striata*	Black Sea Bass	1	1

Field/Locality#: **SAV-16-01-77**
Cont./Ocean: Atlantic Ocean
Country: United States State: County:
Locality: Atlantic Ocean, offshore Virginia, [ca. 51.0-49.4 kilometers ENE center Virginia Beach]
Start: 37.04583° N, 75.45716° W; End: 37.02527° N, 75.46636° W Geodetic Datum: WGS84 Vessel/Cruise #/Sta. #: Savannah/16-01/77 Date Coll.: 17 January 2016 Time: 0235-0300 Accession Number: 13268
Collector(s): R. Wilson Laney, et al. (Cooperative Winter Tagging Cruise) Gear: 65' Otter trawl Depth of Capture: 31.2-31.5 meters Salinity: S
Locality Remarks: Water temperature: 11.3°C

Specimens Catalogued

NCSM Cat#	Family	Genus	Species	Common name	Total number of whole, skel/mount, cleared and stained specimens	Tissue samples in 95% ethanol
82982	Scombridae	*Scomber*	*scombrus*	Atlantic Mackerel	1	1
82981	Diodontidae	*Chilomycterus*	*schoepfii*	Striped Burrfish	1	1

Field/Locality#: **SAV-16-01-83**
Cont./Ocean: Atlantic Ocean
Country: United States State: County:
Locality: [Atlantic Ocean, off of Virginia, ca. 26.3-24.7 kilometers E center Virginia Beach]
Start: 36.86584° N, 75.68442° W; End: 36.85939° N, 75.70234° W Geodetic Datum: WGS84 Vessel/Cruise #/Sta. #: Savannah/16-01/83 Date Coll.: 17 January 2016 Time: 1019-1044 Accession Number: 13268
Collector(s): R. Wilson Laney, et al. (Cooperative Winter Tagging Cruise) Gear: 65' otter trawl Depth of Capture: 23.9-24.1 meters Salinity: S
Locality Remarks: Water temperature: 10.3°C

Specimens Catalogued

NCSM Cat#	Family	Genus	Species	Common name	Total number of whole, skel/mount, cleared and stained specimens	Tissue samples in 95% ethanol
83106	Paralichthyidae	*Etropus*	*microstomus*	Smallmouth Flounder	1	1

Field/Locality#: **SAV-16-01-85**
Cont./Ocean: Atlantic Ocean
Country: United States State: North Carolina County:
Locality: Atlantic Ocean, offshore of Hatteras, [ca. 67.9-67.7 kilometers ENE center Beaufort]
Start: 35.01647° N, 76.01467° W; End: 35.02587° N, 76.02406° W Geodetic Datum: WGS84 Vessel/Cruise #/Sta. #: Savannah/16-01/85 Date Coll.: 18 January 2016 Time: 0819-0839 Accession Number: 13268
Collector(s): R. Wilson Laney, et al. (Cooperative Winter Tagging Cruise) Gear: 65' otter trawl Depth of Capture: 13.8-15.7 meters Salinity: S
Locality Remarks: Water temperature: 16.7°C

Specimens Catalogued

NCSM Cat#	Family	Genus	Species	Common name	Total number of whole, skel/mount, cleared and stained specimens	Tissue samples in 95% ethanol
83004	Gymnuridae	*Gymnura*	*micrura*	Smooth Butterfly Ray	1	1

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Field/Locality#: **SAV-16-01-88**
Cont./Ocean: Atlantic Ocean
Country: United States State: North Carolina County:
Locality: Atlantic Ocean, off of North Carolina, [ca. 53.9-53.2 kilometers ENE center Beaufort]
Start: 34.96058° N, 76.15305° W; End: 34.95591° N, 76.15807° W Geodetic Datum: WGS84 Vessel/Cruise #/Sta. #: Savannah/16-01/88
Date Coll.: 18 January 2016 Time: 1055-1109 Accession Number: 13268
Collector(s): R. Wilson Laney, et al. (Cooperative Winter Tagging Cruise) Gear: 65' otter trawl Depth of Capture: 7.5-7.6 meters Salinity: S
Locality Remarks: Water temperature: 15.1°C

Specimens Catalogued

NCSM Cat#	Family	Genus	Species	Common name	Total number of whole, skel/mount, cleared and stained specimens	Tissue samples in 95% ethanol
83002	Sciaenidae	*Pareques*	*umbrosus*	Cubbyu	1	1

Field/Locality#: **SAV-16-01-89**
Cont./Ocean: Atlantic Ocean
Country: United States State: North Carolina County:
Locality: Atlantic Ocean, off Core Banks, [ca. 46.2-44.3 kilometers ENE center Beaufort]
Start: 34.89993° N, 76.209° W; End: 34.89045° N, 76.22663° W Geodetic Datum: WGS84 Vessel/Cruise #/Sta. #: Savannah/16-01/89 Date Coll.: 18 January 2016 Time: 1405-1427 Accession Number: 13268
Collector(s): R. Wilson Laney, et al. (Cooperative Winter Tagging Cruise) Gear: 65' otter trawl Depth of Capture: 14.2-14.4 meters Salinity: S
Locality Remarks: Water temperature: 15.3°C

Specimens Catalogued

NCSM Cat#	Family	Genus	Species	Common name	Total number of whole, skel/mount, cleared and stained specimens	Tissue samples in 95% ethanol
83005	Myliobatidae	*Myliobatis*	*freminvillii*	Bullnose Ray	0	1
83001	Sparidae	*Stenotomus*	*caprinus*	Longspine Porgy	3	3

Field/Locality#: **SAV-16-01-90**
Cont./Ocean: Atlantic Ocean
Country: United States State: North Carolina County:
Locality: Atlantic Ocean, off Core Banks, [ca. 41.6-39.5 kilometers ENE center Beaufort]
Start: 34.88159° N, 76.25467° W; End: 34.87047° N, 76.27306° W Geodetic Datum: WGS84 Vessel/Cruise #/Sta. #: Savannah/16-01/90
Date Coll.: 18 January 2016 Time: 1446-1509 Accession Number: 13268
Collector(s): R. Wilson Laney, et al. (Cooperative Winter Tagging Cruise) Gear: 65' otter trawl Depth of Capture: 15.14-15.38 meters Salinity: S
Locality Remarks: Water temperature: 15.3°C

Specimens Catalogued

NCSM Cat#	Family	Genus	Species	Common name	Total number of whole, skel/mount, cleared and stained specimens	Tissue samples in 95% ethanol
83006	Carangidae	*Seriola*	*dumerili*	Greater Amberjack	0	1

Field/Locality#: **SAV-16-01-91**
Cont./Ocean: Atlantic Ocean
Country: United States State: North Carolina County:
Locality: Atlantic Ocean, [off of] North Carolina, [ca. 37.3-38.1 kilometers ENE center Beaufort]
Start: 34.85265° N, 76.28965° W; End: 34.85521° N, 76.28222° W Geodetic Datum: WGS84 Vessel/Cruise #/Sta. #: Savannah/16-01/91
Date Coll.: 18 January 2016 Time: 1540-1552 Accession Number: 13268
Collector(s): R. Wilson Laney, et al. (Cooperative Winter Tagging Cruise) Gear: 65' otter trawl Depth of Capture: 12.1-12.3 meters Salinity: S
Locality Remarks: Water temperature: 15.3°C

Specimens Catalogued

NCSM Cat#	Family	Genus	Species	Common name	Total number of whole, skel/mount, cleared and stained specimens	Tissue samples in 95% ethanol
83003	Carangidae	*Caranx*	*crysos*	Blue Runner	4	4
83007	Sparidae	*Archosargus*	*probatocephalus*	Sheepshead	0	4

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Field/Locality#: **SAV-16-01-94**
Cont./Ocean: Atlantic Ocean
Country: United States State: North Carolina County:
Locality: [Atlantic Ocean, off of North Carolina, ca. 27.6-28.0 kilometers E center Beaufort]
Start: 34.73613° N, 76.36322° W; End: 34.71799° N, 76.35751° W Geodetic Datum: WGS84 Vessel/Cruise #/Sta. #: Savannah/16-01/94
Date Coll.: 18 January 2016 Time: 1805-1827 Accession Number: 13268
Collector(s): R. Wilson Laney, et al. (Cooperative Winter Tagging Cruise) Gear: 65' Otter trawl Depth of Capture: 18.6-18.8 meters Salinity: S
Locality Remarks: Water temperature: 18.6°C

Specimens Catalogued

NCSM Cat#	Family	Genus	Species	Common name	Total number of whole, skel/mount, cleared and stained specimens	Tissue samples in 95% ethanol
83016	Batrachoididae	*Porichthys*	*plectrodon*	Atlantic Midshipman	1	0

Field/Locality#: **SAV-16-01-97**
Cont./Ocean: Atlantic Ocean
Country: United States State: North Carolina County:
Locality: [Atlantic Ocean, off of North Carolina, ca. 30.5-30.0 kilometers ESE center Beaufort]
Start: 34.65007° N, 76.34066° W; End: 34.63132° N, 76.35312° W Geodetic Datum: WGS84 Vessel/Cruise #/Sta. #: Savannah/16-01/97
Date Coll.: 18 January 2016 Time: 1947-2012 Accession Number: 13268
Collector(s): R. Wilson Laney, et al. (Cooperative Winter Tagging Cruise) Gear: 65' otter trawl Depth of Capture: 20.9-23.0 meters Salinity: S
Locality Remarks: Water temperature: 18.6°C

Specimens Catalogued

NCSM Cat#	Family	Genus	Species	Common name	Total number of whole, skel/mount, cleared and stained specimens	Tissue samples in 95% ethanol
83014	Balistidae	*Balistes*	*capriscus*	Gray Triggerfish	1	0

Field/Locality#: **SAV-16-01-E**
Cont./Ocean: Atlantic Ocean
Country: United States State: County:
Locality: Atlantic Ocean, offshore Maryland-Virginia, [no further localiy data available]
Lat/Long: ° , ° Vessel/Cruise #/Sta. #: Savannah/16-06/n/k Date Coll.: 15 January 2016 Time: 1000 Accession Number: 13268
Collector(s): R. Wilson Laney, et al. (Cooperative Winter Tagging Cruise) Gear: 65' otter trawl Depth of Capture: n/k Salinity: S
Locality Remarks: Found in net while docked in Ocean City, Maryland.

Specimens Catalogued

NCSM Cat#	Family	Genus	Species	Common name	Total number of whole, skel/mount, cleared and stained specimens	Tissue samples in 95% ethanol
86214	Ophichthidae	*Ophichthidae*	*n/k*		1	0

Field/Locality#: **SAV-16-01-HL1**
Cont./Ocean: Atlantic Ocean
Country: United States State: County:
Locality: Atlantic Ocean, off North Carolina, [ca. 56.5 kilometers E center Beaufort]
Lat/Long: 34.68541° N, 76.04727° W Geodetic Datum: WGS84 Vessel/Cruise #/Sta. #: Savannah/16-01/HL-1 Date Coll.: 11 January 2016
Time: 1440 Accession Number: 13268
Collector(s): R. Wilson Laney, John E. Ellis, et al. (Cooperative Winter Tagging Cruise) Gear: Hook and line Depth of Capture: 33 meters
Salinity: S
Locality Remarks: None

Specimens Catalogued

NCSM Cat#	Family	Genus	Species	Common name	Total number of whole, skel/mount, cleared and stained specimens	Tissue samples in 95% ethanol
83008	Scombridae	*Euthynnus*	*alletteratus*	Little Tunny	0	1

Specimens donated by RW Laney from the 2016 Cooperative Winter Tagging Cruise

Gabriela M. Hogue, Collections Manager of Fishes
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Field/Locality#: **SAV-16-01-M1**

Cont./Ocean: Atlantic Ocean

Country: United States State: County:
Locality: Atlantic Ocean, off North Carolina, [ca. 65.1 kilometers ENE center Manteo]

Lat/Long: 36.18466° N, 75.03803° W Geodetic Datum: WGS84 Vessel/Cruise #/Sta. #: Savannah/16-01/M-1 Date Coll.: 12 January 2016
Time: 0840 Accession Number: 13268

Collector(s): R. Wilson Laney, John E. Ellis, et al. (Cooperative Winter Tagging Cruise) Gear: n/k Depth of Capture: 80 feet Salinity: S

Locality Remarks: None

Specimens Catalogued

NCSM Cat#	Family	Genus	Species	Common name	Total number of whole, skel/mount, cleared and stained specimens	Tissue samples in 95% ethanol
82983	Gobiesocidae	*Gobiesox*	*sp.*		1	1

Appendix 11.
Summary of Mortality Estimates, and Differences in Age and Length Frequencies between Gear Types

Dr. Stuart Welsh of West Virginia University did the following analyses using the USFWS recovery data for Striped Bass tagged and released at >710 mm from 1988 through 2017, and also analyzed for differences between hook-and-line tagged, versus trawl-tagged, fish from the 2013, 2015 and 2016 Cruises. This is an update of what he sent previously, as the current analysis includes recovery year 2017.

Objective 3: Estimate fishing mortality (F) of the coastal migratory Striped Bass stock:

Estimates of fishing mortality (F) and total mortality (Z) were calculated using Seber models in Program MARK, and estimated fishing mortality (F), natural mortality (M), and total mortality (Z) was calculated using instantaneous rates. The analysis was done with the IRCR program of Gary Nelson (Massachusetts Division of Marine Fisheries). Full description of the above analyses, as well as the catch rate analysis below, can be found in the following ASMFC report: http://www.asmfc.org/uploads/file/2011StripedBassAssmtUpdate.pdf.

There were no significant differences ($p > 0.05$) in estimates of fishing mortality, natural mortality, or total mortality between the two gear types and estimates of F, M, and Z were nearly identical for the two groups. For hook and line-caught Striped Bass, F ranges for the study period were 0.121-0.126, the estimated M was 0.332, and Z ranges were 0.453-0.459 (Appendix Table 11-1). For trawl-caught Striped Bass, F ranges were 0.120-0.125, M was assigned 0.331, and Z ranges were 0.452-0.457.

Appendix Table 11-1. Instantaneous rates estimates of fishing mortality (F), natural mortality (M), and total mortality (Z) for hook- and trawl-released Striped Bass for years 2013-2016.

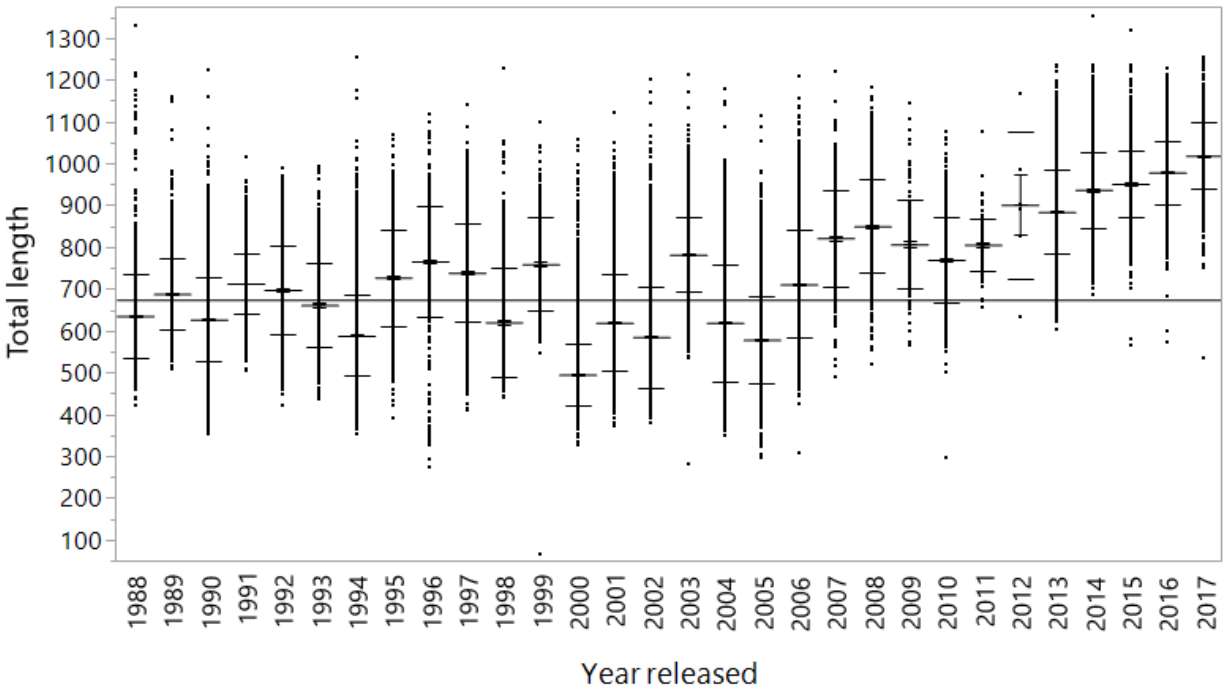
		Fishing mortality			Natural mortality			
Gear	Year	F	SE	Adj SE	M	SE	Adj SE	Z
Hook								
	2013	0.12458	0.01096	0.01167	0.33216	0.04933	0.04983	0.45674642
	2014	0.12637	0.01096	0.01182	0.33216	0.04933	0.04983	0.45853622
	2015	0.12054	0.0111	0.01188	0.33216	0.04933	0.04983	0.45269883
	2016	0.12225	0.01126	0.01171	0.33216	0.04933	0.04983	0.45441155
Trawl								
	2013	0.12391	0.01086	0.01147	0.33149	0.04931	0.04975	0.45539949
	2014	0.12544	0.01085	0.01157	0.33149	0.04931	0.04975	0.45693152
	2015	0.12025	0.01103	0.01174	0.33149	0.04931	0.04975	0.4517393
	2016	0.12189	0.01118	0.0116	0.33149	0.04931	0.04975	0.45338222

Only one year – 2013 – showed differences in the estimated first-year catch rates between hook-caught and trawl-caught Striped Bass. For the analysis, an adjusted reporting rate of 0.43 was used, and a 95% rate was used for profile likelihood confidence intervals (LCI and UCI). In 2013 the trawl-tagged Striped Bass had a slightly higher estimated catch rate than that of hook-and-line tagged fish, but rates between the two groups were similar for 2015 and 2016 (Appendix Table 11-2).

Appendix Table 11-2. Estimated catch rates of tagged Striped Bass reported for two sampling gear types (Hook and Trawl). Analysis is based on first year recoveries and a reporting rate of 0.43. LCI and UCI are 95% profile likelihood confidence intervals.

Year	Gear	Number released	Recaps killed	Recaps released	Estimated catch rate	LCI	UCI
2013	Hook	1114	53	19	0.150	0.13	0.172
	Trawl	893	51	26	0.201	0.175	0.228
2014	Hook	921	49	16	0.164	0.141	0.189
	Trawl	0	0	0			
2015	Hook	1042	50	25	0.167	0.145	0.19
	Trawl	333	17	9	0.182	0.141	0.224
2016	Hook	1241	59	26	0.159	0.14	0.181
	Trawl	110	7	1	0.169	0.11	0.25

An examination of fish size for the study period clearly indicated that the average total length of Striped Bass collected was larger for the study period than for earlier years within the time series. The series grand mean lies between 650-700 mm TL, and since 2006 the average mean size has been larger than the grand mean (Appendix Figure 11-1; Appendix Table 11-3). Larger Striped Bass were tagged and released during recent years of the time series.



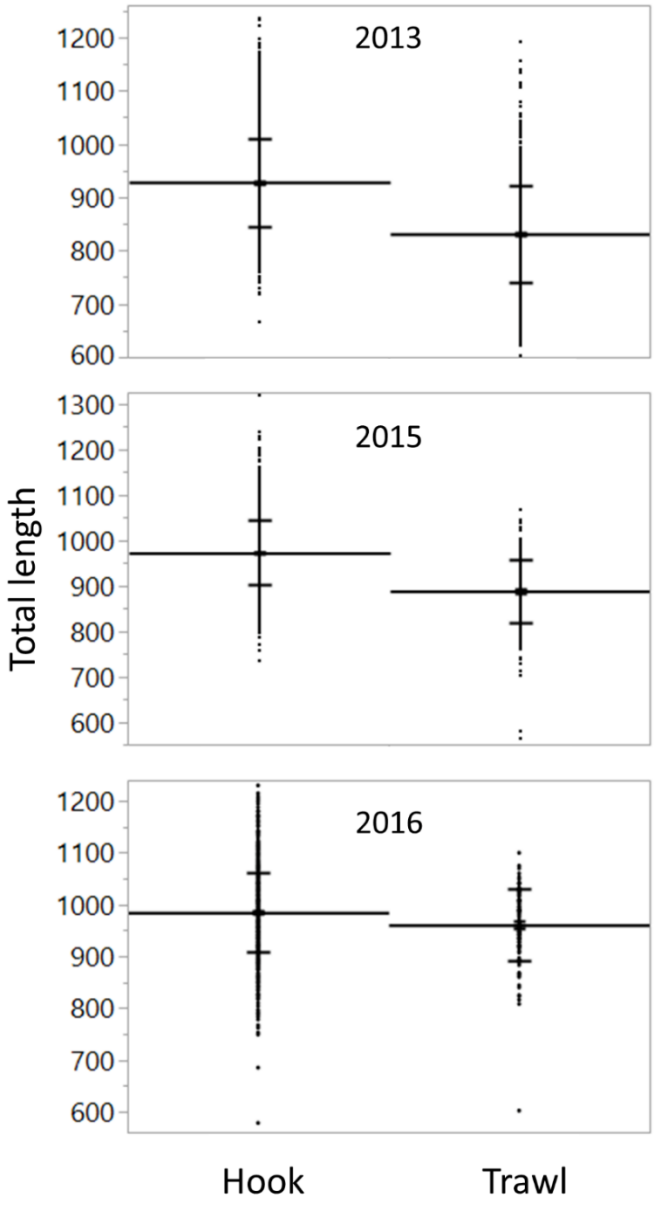
Appendix Figure 11-1. Mean lengths and associated standard errors and standard deviations of Striped Bass tagged from 1988 through 2017. Horizontal bar is grand mean.

Appendix Table 11-3. Mean lengths and associated standard deviations (SD), standard errors (SE), and lower and upper 95% confidence intervals (LCI, UCI) of Striped Bass tagged from 1988 through 2017.

Year	Count	Mean	SD	SE	LCI	UCI
1988	1336	639.4	99.4	2.7	634.0	644.7
1989	1156	692.1	84.6	2.5	687.2	696.9
1990	2010	631.0	98.8	2.2	626.7	635.4
1991	1779	716.5	71.0	1.7	713.1	719.8
1992	1016	701.2	106.6	3.3	694.7	707.8
1993	530	665.4	100.7	4.4	656.8	674.0
1994	4631	592.2	96.2	1.4	589.4	595.0
1995	644	730.8	115.9	4.6	721.8	739.7
1996	698	769.8	131.9	5.0	760.0	779.6
1997	1355	742.4	117.6	3.2	736.1	748.7
1998	462	624.4	130.1	6.1	612.5	636.2
1999	272	763.3	111.7	6.8	749.9	776.6
2000	6231	498.8	75.1	1.0	496.9	500.6
2001	2446	622.7	115.6	2.3	618.2	627.3
2002	4079	589.0	121.5	1.9	585.3	592.8
2003	1907	785.7	88.5	2.0	781.7	789.7
2004	2707	622.9	140.5	2.7	617.6	628.2
2005	4262	582.0	104.8	1.6	578.9	585.2
2006	4459	714.7	129.0	1.9	710.9	718.5
2007	370	825.2	115.8	6.0	813.3	837.0
2008	1033	853.6	111.1	3.5	846.8	860.4
2009	146	810.3	105.6	8.7	793.1	827.6
2010	567	773.1	102.8	4.3	764.6	781.6
2011	107	809.6	63.5	6.1	797.5	821.8
2012	6	904.7	176.9	72.2	719.0	1090.3
2013	2006	887.7	99.3	2.2	883.3	892.0
2014	920	940.7	91.0	3.0	934.9	946.6
2015	1375	954.8	79.2	2.1	950.6	959.0
2016	1348	982.3	75.8	2.1	978.3	986.4
2017	881	1022.1	78.7	2.7	1016.9	1027.3

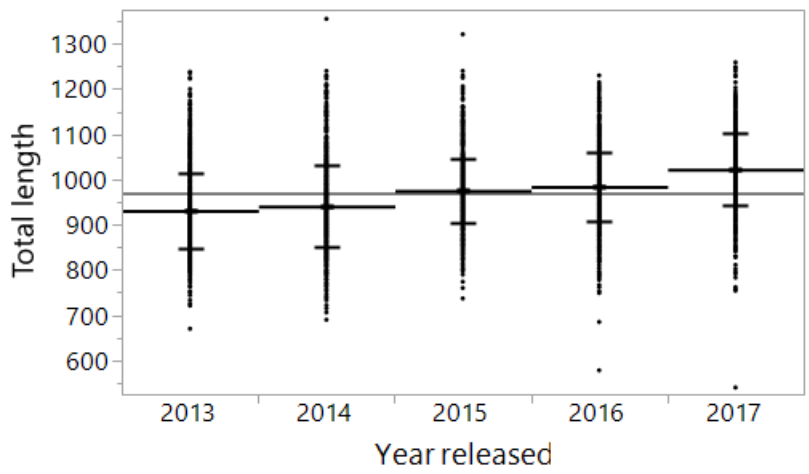
There were also significant differences in fish size between gear types. Results of a comparison between the two gear types showed that hook-caught Striped Bass were of a larger size than trawl-caught fish for all three years of the study (Appendix Figure 11-2). For this analysis, the total length data were log-transformed and analyzed using a Welch's t-test for unequal variances.

The total lengths of hook-and-line tagged fish were significantly greater ($p < 0.05$) than those of trawl-tagged fish for all years of comparison (2013, 2015, and 2016).



Appendix Figure 11-2. Hook and line vs. trawl comparison of total lengths (mm) of Striped Bass tagged and released during 2013, 2015, and 2016, including mean values, standard errors, and standard deviations.

Hook and line-caught Striped Bass also increased in size during the hook study. The hook-and-line data were inclusive for years 2013 through 2017. The average size of Striped Bass tagged and released increased in each year (Appendix Figure 11-3; Table 11-4).

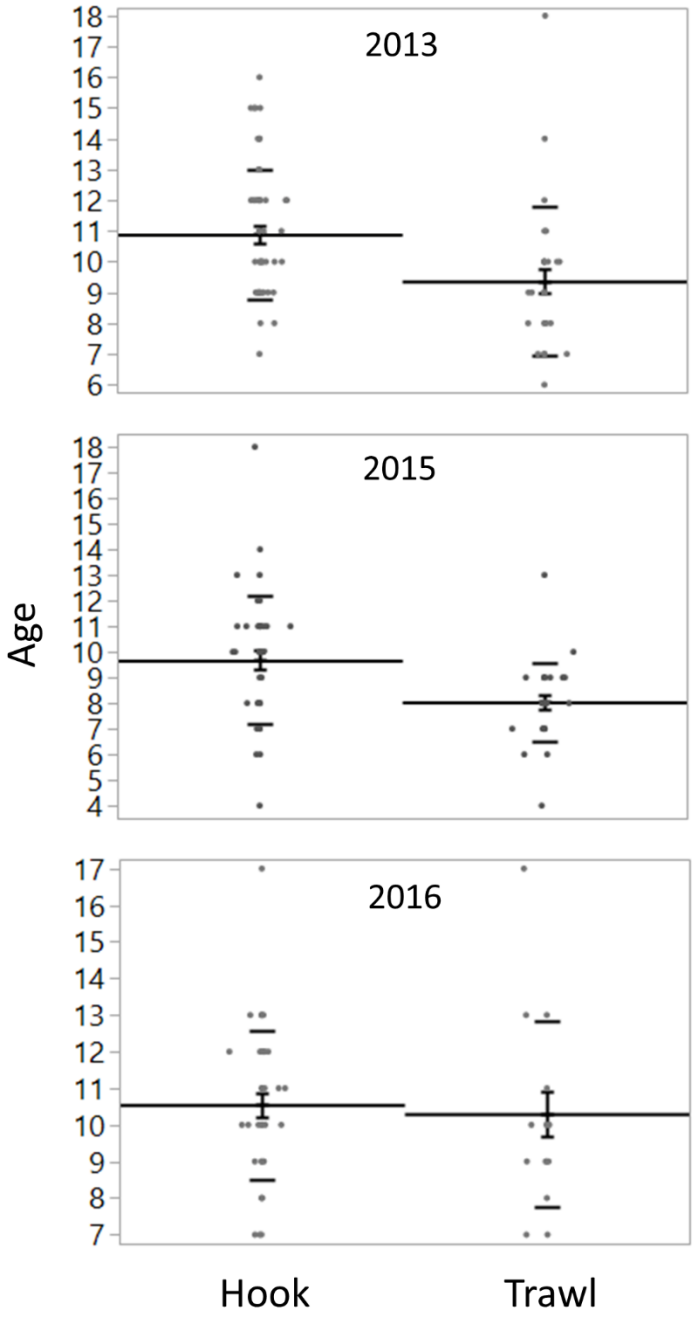


Appendix Figure 11-3. Comparison of lengths (means, standard error bars, and standard deviations) for hook-and-line tagged fish from 2013-2017. Continuous bar is grand mean.

Appendix Table 11-4. Comparison of lengths for hook-and-line tagged fish from 2013-2017.

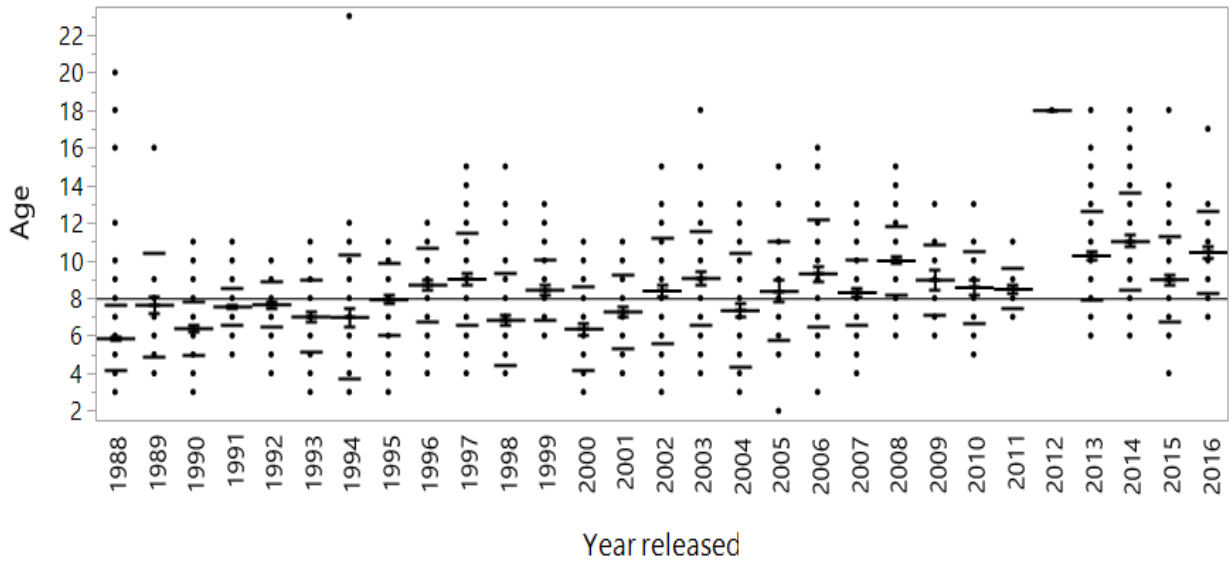
Year	Number	Mean	SD	SE	LCI	UCI
2013	1113	930.8	82.9	2.5	925.9	935.6
2014	920	940.7	91.0	3.0	934.9	946.6
2015	1042	975.3	70.4	2.2	971.0	979.5
2016	1238	984.3	76.1	2.2	980.1	988.5
2017	881	1022.1	78.7	2.7	1016.9	1027.3

Average size increases were related to increases in the age distribution of the sampled population. For this analysis the age information available in the database for years 2013, 2015, and 2016 were used. Age was log-transformed and used as a continuous variable. A Welch's t-test for unequal variances compared ages of hook-and-line and trawl tagged fish. The ages of hook-and-line tagged fish were significantly greater ($p < 0.05$) than those of trawl-tagged fish for 2013 ($t = 3.5588$; $p = 0.0007$) and 2015 ($t = 3.1012$; $p = 0.0028$), but not statistically different ($t = 0.5089$; $p = 0.6150$) for 2016.



Appendix Figure 11-4. Hook and line vs. trawl comparison of ages (years) of Striped Bass tagged and released during 2013, 2015, and 2016, including mean values, standard errors, and standard deviations. Points are jittered to prevent hidden values.

A comparison of the age distributions across the time series indicates that in recent years tagged Striped Bass have been older. Data from both gear types were combined for the recent study period, and plotted (Appendix Figure 11-5) and tabulated (Appendix Table 11-5).



Appendix Figure 11-5. Mean ages and associated standard errors and standard deviations of Striped Bass tagged from 1988 through 2016. Data for 2017 were unavailable at time of analysis. Horizontal bar is grand mean.

Appendix Table 11-5. Mean ages and associated standard deviations (SD), standard errors (SE), and lower and upper 95% confidence intervals (LCI, UCI) of Striped Bass tagged from 1988 through 2016.

Year	Count	Mean	SD	SE	LCI	UCI
1988	325	5.9	0.1	5.7	6.1	6.1
1989	37	7.6	0.3	7.0	8.3	8.3
1990	74	6.4	0.2	5.9	6.9	6.9
1991	163	7.6	0.2	7.2	7.9	7.9
1992	55	7.7	0.3	7.1	8.2	8.2
1993	58	7.0	0.3	6.5	7.6	7.6
1994	43	7.0	0.3	6.4	7.6	7.6
1995	77	7.9	0.2	7.5	8.4	8.4
1996	58	8.7	0.3	8.2	9.3	9.3
1997	71	9.0	0.2	8.6	9.5	9.5
1998	77	6.9	0.2	6.4	7.3	7.3
1999	46	8.5	0.3	7.9	9.1	9.1
2000	52	6.4	0.3	5.8	7.0	7.0
2001	65	7.3	0.3	6.8	7.8	7.8
2002	62	8.4	0.3	7.9	8.9	8.9
2003	51	9.1	0.3	8.5	9.7	9.7
2004	61	7.4	0.3	6.9	7.9	7.9
2005	23	8.4	0.4	7.5	9.2	9.2
2006	50	9.3	0.3	8.7	9.9	9.9
2007	70	8.3	0.2	7.8	8.8	8.8
2008	114	10.0	0.2	9.6	10.4	10.4
2009	13	9.0	0.6	7.9	10.1	10.1
2010	25	8.6	0.4	7.8	9.4	9.4
2011	24	8.5	0.4	7.7	9.3	9.3
2012	1	18.0	2.1	13.9	22.1	22.1
2013	98	10.3	0.2	9.9	10.7	10.7
2014	70	11.0	0.2	10.6	11.5	11.5
2015	75	9.0	0.2	8.5	9.5	9.5
2016	55	10.5	0.3	9.9	11.0	11.0