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Northeast Area Monitoring and Assessment Program (NEAMAP) Mid-Atlantic Nearshore Trawl Program Pilot Survey Completion Report

Christopher F. Bonzek
Virginia Institute of Marine Science

James Gartland
Virginia Institute of Marine Science

Robert J. Latour
Virginia Institute of Marine Science

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NEAMAP Pilot Survey Final Report

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Christopher F. Bonzek, James Gartland, Robert J. Latour

NEAMAP ASMFC Progress Report

I. **Project Title:** Data collection and analysis in support of multispecies stock assessments in the mid-Atlantic: Northeast Area Monitoring and Assessment Program Nearshore Trawl Program.

II. **Grantee State and Contact Name:** Virginia/Virginia Institute of Marine Science – Christopher F. Bonzek, James Gartland, Robert J. Latour

III. **Project Period:** 1 August 2005 – 31 December 2006
Reporting Period: 31 July 2006 – 31 January 2007

IV. **Project Description:** This is a pilot study for a new fisheries-independent bottom trawl survey operating in the near coastal ocean waters of the Mid-Atlantic region. The survey is an element of the ASMFC Northeast Area Monitoring and Assessment Program (NEAMAP) and is designed to sample fishes and invertebrates from coastal waters (approximately 20-90 feet) between Montauk, New York and Cape Hatteras, North Carolina using a bottom trawl. The main objective of the survey is the estimation of biomass, length and age structures, and diet compositions of finfishes and select invertebrates inhabiting the area.

V. **Project Summary/Accomplishments:** The pilot survey was successfully completed during a research cruise between the dates of 25 September through 15 October 2006. A total of 98 stations were sampled, compared to the anticipated number of 100. About 432,000 individual fish weighing almost 19,000kg and representing 114 species (including selected invertebrates which where processed similarly to fishes). Almost 63,000 specimens were individually measured. Lab processing is proceeding on the 3,630 otoliths and 2,903 stomach samples which were saved (622 otoliths and 971 stomachs have been fully processed as of the date of this report). A full report is attached to this standard project summary.

VI. **Challenges/Changes:** Beyond completion of laboratory samples, no significant challenges remain for this contract segment.

VII. **Participants:** Program personnel remain unchanged.

VIII. **Quality Assurance:** Previous progress reports provided brief descriptions of quality assurance procedures in selecting fishing gear, conducting fishing operations, and processing the catch. These are interwoven into the attached report as well. Data collected during the survey have been processed through several data quality checks which were previously developed for other survey work and new checks developed specifically for NEAMAP.

IX. **Funding Status:** A small balance (~$5,000) remains in this project account. Those funds will be used in continued processing of samples prior to the project completion date.

X. **Future Activities:** The future of this program is dependent upon continued funding. We are awaiting instruction from ASMFC before we finalize plans for the next project segment.

XI. **Presentations/Public Outreach:** Since completion of field sampling on 15 October, presentations of survey results have been (or will be) made as follows:

- November 2006: NEAMAP Board
- December 2006: NMFS NEFSC Trawl Advisory Panel
- January 2007: NEAMAP Operations Committee
- January 2007: ASMFC Policy Board
- February 2007: New England Fishery Management Council
- February 2007: Mid-Atlantic Fishery Management Council

Northeast Area Monitoring and Assessment Program (NEAMAP)

Mid-Atlantic Nearshore Trawl Program

Pilot Survey Completion Report

31 January 2007

Submitted to:

Atlantic States Marine Fisheries Commission
Washington, DC

By:

Christopher F. Bonzek
James Gartland
Robert J. Latour, Ph.D.

Department of Fisheries Science
Virginia Institute of Marine Science
College of William and Mary
Gloucester Point, VA

Introduction

Concerns regarding the status of fishery-independent data collection from the continental shelf waters between Cape Hatteras, North Carolina and the U.S. / Canadian border led the Atlantic States Marine Fisheries Commission's (ASMFC) Management and Science Committee (MSC) to draft a resolution in 1997 calling for the formation the Northeast Area Monitoring and Assessment Program (NEAMAP) (ASMFC 2002). NEAMAP is a cooperative state-federal program modeled after the Southeast Area Monitoring and Assessment Program (SEAMAP), which had been coordinating fishery-independent data collection south of Cape Hatteras since the mid-1980s (Rester 2001). The four main goals of this new program directly address the deficiencies noted by the MSC for this region and include 1) developing fishery-independent surveys where current sampling is either inadequate or absent 2) coordinating data collection amongst existing surveys as well as any new surveys 3) providing for efficient management and dissemination of data and 4) establishing outreach programs (ASMFC 2002). The NEAMAP Memorandum of Understanding was signed by all partner agencies by July 2004.

One of the first major efforts of the NEAMAP was to design a trawl survey intended to operate in the coastal zone of the Middle Atlantic Bight (MAB - i.e., Montauk, New York to Cape Hatteras, North Carolina). While the National Marine Fisheries Service (NMFS) Northeast Fisheries Science Center's (NEFSC) bottom trawl survey has been sampling from Cape Hatteras to the U.S. / Canadian border in waters less than 91.4m since 1963, few stations are sampled in waters less than 27.4m due to the size of the sampling area and vessels (NEFSC 1988, R. Brown, NMFS, pers. comm). Further, NMFS plans to take delivery on a new, larger vessel in 2007, meaning that sampling intensity in these coastal waters will decline further, while waters less than 18.3m may no longer be sampled (R. Brown, NMFS, pers. comm.). In addition, of the six coastal states in the MAB, only New Jersey conducts a fishery-independent trawl survey in its coastal zone (Byrne 2004). This new NEAMAP Inshore Trawl Survey is intended to fill the aforementioned gap in fishery-independent survey coverage, which is consistent with the program goals.

In early 2005, the ASMFC made $250,000 of "plus-up" funds that it had received from the Atlantic Coastal Fisheries Cooperative Management Act (ACFCMA) available for some small-scale pilot work in an effort to assess the viability of the NEAMAP Inshore Trawl Survey. The Virginia Institute of Marine Science provided the sole response to the Commission's request for proposals and was awarded the funding in August 2005. This document summarizes the results of the 2006 NEAMAP Inshore Trawl Survey pilot work conducted by VIMS.

Methods

Gear Performance – Pre-Pilot Cruise

On 9-10 May 2006, a pre-pilot cruise was completed aboard the *F/V Darana R* using the 4-seam 3-bridle bottom trawl developed by the NMFS Trawl Advisory Panel (hereafter called the NEAMAP net) and size 66 Type IV Thyboron trawl doors. Prior to this cruise, this combination of net and doors had yet to be tested in the field. Previously, NMFS had tested several door types, all of which tended to overspread the net (compared to design specifications and to parameters determined to be ideal during previous flume tank testing). This short pre-pilot cruise was considered necessary for several reasons:

- To provide an opportunity for the vessel crew and scientific crew to begin operating as a cooperative single unit.
- To assure that the various electronics could be deployed correctly and would operate satisfactorily.
- To assure that the net-door-vessel combination produced satisfactory gear performance.
- To test the reaction of the gear to changes in settings and fishing conditions (e.g. varying speeds, scopes, depths, and tow directions) to establish parameter standards for the full pilot cruise.
- To allow the vessel crew to become familiar with deployment and retrieval of the gear.
- To provide the scientific crew with estimates of average catch rates which would aid in preparing for the full pilot cruise.
- To provide the science crew the opportunity to practice workup procedures and to test the layout of workstations.

Gear Performance – NMFS-NEAMAP Joint Cruise

Subsequent to the Pre-Pilot cruise it was determined that the choice of size 66 Thyboron Type IV trawl doors was appropriate for the NEAMAP net in the inshore zone of the Middle Atlantic Bight. However, it was uncertain whether the desired net parameters achieved during the cruise could have resulted from measurement difference between *Netmind* net measurement gear used by VIMS and the *Scanmar* equipment employed by NMFS in previous cruises.

A second two-day cruise was arranged during which both Netmind and Scanmar gear would measure gear performance. This cruise occurred on 29-30 June 2006 and representatives from both VIMS and the NEFSC participated. NMFS net monitoring apparatus measured door spread in addition to wingspread and headrope height. For several tows, Netmind and Scanmar gear was interchanged and the net was fished under similar conditions. Eventually, it was determined that the two systems did not interfere with one another so both sets of equipment were mounted simultaneously. For the final several tows both systems were employed, however, equipment malfunctions and computer crashes resulted in a small amount of data loss from one system or the other on some tows.

Gear Performance – Pilot Cruise

Wingspread and headrope height were measured on each tow during the pilot cruise using the VIMS Netmind system. Wingspread sensors were positioned on the middle net 'jib' in accordance with NFMS procedures. The headrope sensor was mounted at the midpoint of the headrope. A catch sensor was mounted in the cod-end, set to signal when the catch reached roughly 2,000lbs. Along with recording the net parameters every 10 to 20 seconds (with the various sensors reporting at different times) the Netmind software records GPS coordinates and vessel speed at the reporting rate of the GPS unit (every two seconds in the present case) which gives the ability to later plot tow tracks for each station. The same computer used to record Netmind readings was also employed to plot station locations (and the corners of each sampling cell) and to run the countdown clock for each tow.

Station Selection
Primary consideration in regards to survey stratification was consistency with the NMFS bottom trawl surveys. However, those surveys will be redesigned and restratified for 2008 and so restratification for the inshore NEAMAP areas was open for consideration as well.

Examination of existing strata revealed that the major divisions among survey areas (latitudinal divisions from New Jersey to the south, longitudinal divisions off Long Island) generally corresponded well with major estuarine outflow areas. Therefore these boundary definitions, with minor modifications so that regional boundaries would more closely correspond to state borders, were used for the NEAMAP pilot survey. However, examination of the current NMFS depth stratum definitions reveals that in some areas (primarily off the southern states) current stratum boundaries do not correspond well to actual depth contours. Depth stratum assignments were redrawn using depth sounding data from the National Ocean Service using depth strata 20ft.-40ft., 40ft.-60ft., and 60ft.-90ft. Finally, each stratum was subdivided into a grid pattern of potential sampling locations, with each cell measuring 1.5 x 1.5 minutes.

The number of stations (cells) selected for each region was assigned by proportional sampling according to surface area within a region. Within each region, the number of stations selected in each depth stratum was equal. This method assured that shallow areas, where there was little surface area, would be sufficiently sampled.

Species Priority Lists
During preparations for the survey, the NEAMAP Operations Committee developed a set of species priority lists. Priority ‘A’ species were to be subjected to full processing (see *Procedures at Each Station* below) at every station. Priority ‘B’ species were to be fully processed as time allowed. Priority ‘C’ species would only be fully processed if handling of A and B species would not be affected. These three categories might be summarized as ‘must have’ ‘great to have’ and ‘nice to have.’ All other species (here called Priority ‘D’) were to have gross weights recorded and all or a significant subsample to be measured. A fifth category (‘E’) was later defined, including species which required special handling. This category included sharks (other than dogfish) turtles, and sturgeon, which were measured, tagged, and released; and selected invertebrates which were processed similarly to Priority D fish species. Species included categories A-C are presented below (Table 1).

Table 1. Species priority lists (categories A-C only).

A LIST	
Black Sea Bass	***Centropristis striata***
Scup	***Stenotomus chrysops***
Bluefish	***Pomatomus saltatrix***
Striped Bass	***Morone americana***
Weakfish	***Cynoscion regalis***
Summer Flounder	***Paralychthys dentatus***
Winter Founder	***Pleuronectes americanus***
B LIST	
American Shad	***Alosa sapidissima***
Atlantic Menhaden	***Brevoortia tyrannus***
Atlantic Croaker	***Micropogonias undulatus***
Spot	***Leiostomus xanthurus***
Monkfish	***Lophius americanus***
Yellowtail Flounder	***Limanda ferruginea***
Smooth Dogfish	***Mustelus canis***
Spiny Dogfish	***Squalus acanthias***
Skate and Ray Species	
C LIST	
Alewife	***Alosa pseudoharengus***
Atlantic Herring	***Clupea harengus***
Blueback Herring	***Alosa aestivalis***
Atlantic Mackerel	***Scomber scombrus***
Black Drum	***Pogonias cromis***
Red Drum	***Sciaenops ocellatus***
Speckled Trout	***Cynoscion nebulosus***
Tautog	***Tautoga onitis***

Procedures at Each Station

All fishing operations were conducted during daylight hours. Each tow was 20 minutes in duration with a target tow speed of between 2.9 and 3.3 knots. No tows were truncated due to known hangs in the tow path, surface traffic etc.

At each station several standard parameters were recorded. These included:

- All necessary station identification parameters (date, station number, stratum, depth).
- All necessary vessel operation parameters (beginning and ending GPS position, beginning and ending tow times, compass course, engine RPMs).
- All necessary gear identification and operational parameters (net type code and net number, door type code and door numbers, amount of cable deployed).
- Atmospheric and weather data (air temperature, wind speed, wind direction, general weather state, sea state, barometric pressure).
- Hydrographic data at the surface and at the bottom (water temperature, salinity, and dissolved oxygen).

Upon arrival near a sampling cell, the Captain and Chief Scientist jointly determined the desired starting point and tow path. Flexibility was allowed with regard to these parameters such that a clear tow could be accomplished while staying within the cell boundaries and the defined cell depth stratum.

Hydrographic data were taken prior to the beginning of each tow, except rarely when taking these readings would have delayed the tow until after sunset; in these cases hydrographic data were recorded at the completion of the tow.

Vessel crew was responsible for all aspects of deployment and retrieval of the fishing gear. Due to the relatively shallow waters, 50fm. of warp was set out at all stations. One scientist was present in the wheelhouse during deployment and retrieval. The Captain signaled when the gear was fully set, at which time the Netmind software and the countdown clock were both activated. At the conclusion of each tow, the scientist signaled the Captain when the clock reached zero, at which time retrieval commenced and the Netmind recording software was stopped. Vessel crew dumped the catch into one of two enclosed locations on deck.

The catch was sorted by species and modal size group. Biomass (kg) was measured for each species-size group combination. For priority A species, and often for priority B species, a subsample from each group was selected for complete processing. At first, a species-size subsample of ten individuals per species-size class group per tow was implemented. After several stations, this number was reduced to five specimens with full stomachs, and later still for extremely common species, to three. Previous experience showed that these sampling rates would likely result in an adequate number of specimens overall, especially in consideration of the fact that in such survey work, the sampling unit is the station, not the individual specimen, and sampling large numbers of individuals at each station is not informative. These changes allowed full processing to occur for several priority B species.

Data collected from each subsampled specimen included length (to the nearest millimeter), total and eviscerated weight (measured in grams, accuracy depended upon the balance on which individuals were measured), and macroscopic sex and maturity stage (mature, immature, unknown) determination. Stomachs were removed and those containing prey items were preserved for subsequent examination. Otoliths or other appropriate ageing structures were removed from each subsampled specimen for age determination. All specimens not selected for the complete processing were enumerated, and either all or a large proportion will be measured for length, in accordance with approved subsampling procedures when necessary.

Laboratory Methods

Otoliths (or, depending upon the species, other appropriate ageing structures) were (and are being) prepared according to methodology established for other VIMS surveys. One otolith was selected and mounted on a piece of 100 weight paper with a thin layer of *Crystal Bond*. A thin transverse section was cut through the nucleus of the otolith using two *Buehler* diamond wafering blades and a low speed *Isomet* saw. The section was then mounted on a glass slide and covered with *Crystal Bond*. If necessary, the section was wet-sanded to an appropriate thickness before being covered with *Crystal Bond*. Some smaller, fragile otoliths were read whole. Both sectioned and whole otoliths were most commonly read using transmitted light under a dissecting microscope. Age was determined as the mode of the three readings.

Stomach samples were (and are being) analyzed according to standard procedures (Hyslop 1980). Prey were identified to the lowest possible taxon. Experienced laboratory personnel are able to process, on average, approximately 30 to 40 stomachs per person per day.

Analytical Methods (Abundance)
Estimates of abundance are expressed in terms of minimum trawlable number or biomass according to the formula:

$$N = \frac{cA}{a}, \qquad (2)$$

where N is the smallest number (or biomass) of fish present within the sampling area that are susceptible to the sampling gear, c is the mean number (or weight) of fish captured per tow, a is the area swept by one trawl tow, and A is the total survey area. These estimates represent the smallest number (or biomass) of fish present within the sampling area that are susceptible to the sampling gear.

This method produces estimates of abundance for each stratum, which are totaled to produce estimates for the entire survey area. As regional stratum boundaries were drawn to generally correspond with state borders, estimates of abundance (and certain other stock parameters) can be produced on a state-specific basis. While usually not biologically meaningful, for some parameters it was considered worthwhile to present results in this way due to the potential usefulness for fishery managers.

Analytical Methods (Sex Ratios)
Sex ratios were determined by summation of data from fully processed specimens. For this and several other stock parameters, data from fully processed specimens are expanded to the entire sample for parameter estimation. That is because workup procedures result in differential subsampling rates among size groups and failure to account for such factors would bias resulting stock parameter estimates. In the NEAMAP database each specimen has a calculated expansion factor associated with it which represents the number of fish that the specimen represents in the total sample for that station.

Analytical Methods (Length Frequency)
Length frequency histograms were designed using 10mm bins and the expansion factors as previously described. Length bins were identified using the bin midpoint (e.g. the 250mm bin represents individuals between 245mm and 254mm).

Analytical Methods (Length-Weight Regressions)
Power regressions for length-weight relationships were calculated and plotted for sexes combined and separately. No tests for differences in growth by sex were performed. No expansion factors were used in these calculations as they do not depend on subsampling rates.

Analytical Methods (Maturity Regressions)
Logistic regressions were calculated and plotted separately for males and females. No expansion factors were used in these calculations as they do not depend on subsampling rates.

Analytical Methods (Diets)
Diets for each species were determined by estimating the mean proportional contribution of prey type (*k*) to predator (*x*) by weight or number ($W_{k,x}$) using the following equation:

$$W_{k,x} = \frac{\sum_{i=1}^{n} M_{i,x} q_{i,k,x}}{\sum_{i=1}^{n} M_{i,x}}, \qquad (1)$$

where

$$q_{i,k,x} = \frac{w_{i,k,x}}{w_{i,x}} ,$$

(2)

where $M_{i,x}$ is the number of predator *x* captured at station *i*, $w_{i,k,x}$ is the total weight (or number) of prey type *k* encountered in the stomachs of predator *x* collected at station *i*, and $w_{i,x}$ is the total weight (or number) of all prey items encountered in these stomachs (Buckel et al. 1999). This cluster sampling estimator was used since trawl collections yield a cluster of each predator at each station.

Results

Gear Performance – Pre-Pilot Cruise
The pre-pilot cruise was successful in all respects. A total of 11 tows were completed under a variety of fishing conditions and the net performed to design specifications. Vessel speeds of 3.0-3.3 knots and relatively short scope ratios were determined to be the target parameters (Figure 1), though the shallow waters in which the NEAMAP survey is prosecuted virtually assure that the net will be 'over-scoped' compared to the 2.5:1-3:1 standard.

Further, it was determined that catch rates for a 20-minute tow were within the expected range and should provide the science crew with adequate numbers of specimens while allowing time to sample at 5-8 stations per day.

Gear Performance – NMFS-NEAMAP Joint Cruise
Simultaneous measurement of net opening by both Netmind and Scanmar monitoring gear resulted in similar dimension reports by both systems (Figure 2). The Scanmar equipment generally gave slightly smaller readings, but probably not significantly so. As a result of the two

pre-pilot cruises, NMFS determined that the Thyboron doors were an appropriate choice for initial trials aboard the *FSV Bigelow*.

Gear Performance – Pilot Cruise
Due to lessons learned during the pre-pilot cruises and during prior use on other surveys, the gear performed flawlessly and measurements were obtained for every tow. Further, due to the expertise of the Captain and crew, not a single mesh was broken during the entire cruise.

A sample wheelhouse computer 'screenshot' with the Netmind software (with no actual Netmind data plotted), charting software (with a sampling cell boundaries) and countdown clock is shown (Figure 3).

Within-tow tow-tracks and Netmind data for a straight tow (Figure 4) and a tow with a hard turn (Figure 5) are presented. Under both circumstances the gear is seen to consistently maintain the desired net openings of approximately 13m width and 5m height (random odd readings seen in both plots are edited out before calculation of average measurements for each tow).

Net opening and vessel speed averages for each tow were consistent (Figure 6A). As stations were generally both numbered and occupied from north-to-south, the order presented (x-axis) by and large is the order in which stations were completed. A slight increasing, and unexplained, trend is apparent in net width measurements. To test net performance and catch rate, one station (number 202) was executed at 3.8kt for 30 minutes (the current NMFS standard tow parameters). Both the net opening and the magnitude of catch were still within acceptable bounds.

As vessel speed during each tow was generally consistent and tow direction in relation to the current was random, tow distance and area swept were both relatively constant (Figure 6B). Notably, both parameters were nearly doubled during the tow fished at current NMFS standard speed and duration.

Stations Sampled
Compared to the goal of occupying 100 stations during the pilot cruise, 98 stations were actually sampled. This represented an average of about 6 stations per day-at-sea, though several whole or partial days were spent in transit. On days which were spent mostly or entirely conducting fishing operations, an average of a little fewer than 8 stations per day were sampled. Day-by-day vessel activities and work schedules are presented (Table 2).

Several stations in Regions 2-5 (Long Island and New York Harbor areas) in the shallow strata could not be sampled due to numerous underwater obstructions. As there were very few of these stations available in the sampling frame, no suitable alternate locations could be sampled. This may affect plans for sampling in those strata in future NEAMAP cruises. Maps comparing selected and actual stations are shown (Figure 7).

Magnitude of Catch
A major concern prior to the pilot cruise was whether the large and efficient net, coupled with a relatively small crew, would overwhelm the ability to process the catch quickly enough to accomplish the expected number of stations per day. While catches were large compared to the

previous experience of the VIMS crew, they were within the range for which the group was prepared (Figure 8). A large majority (75%) of tows caught less than 225kg and 85% of tows captured 6,000 or fewer individual fish.

Because a large portion of the time at each station is spent separating specimens by species and size group, the species-size diversity of each tow is as important as the simple magnitude of the catch. Between 1 and 46 (median 21) species and 1 and 52 (median 21) species-size classes were captured at each station (Figure 9). Due to the relatively small number of priority species defined by the NEAMAP Operations Committee for full processing (see below) this level of diversity was within acceptable bounds. For each species, the total number and biomass, the number of specimens measured, and the number of otoliths and stomachs saved for processing are shown (Table 3).

Species Data Summaries
Several graphical data summaries are shown for each species (Figures 10-108). Species are organized alphabetically within priority group.

For priority A species, most or all of the following figures are presented:

- Distribution maps showing catch ranges by number and biomass for all stations.
- Bar graphs showing the minimum trawlable number (MTN) and biomass (MTB) by state, annotated with estimates of the overall MTN and MTB and percent standard error for each.
- Histograms of sex ratio by state, annotated with the number of specimens examined.
- Length-frequency histograms annotated with the total number of specimens captured and measured and the number of otoliths removed for processing.
- Age distribution graphs shown with the total number of specimens by age if all specimens had been aged. Note that when this figure is present, the number of otoliths read is presented here rather than in the length-frequency figure. Note as well that only weakfish ageing has been completed as of the date of this report. Future updates will include age distribution figures for other species.
- Length-weight power regressions for sexes combined and separately.
- Logistic regressions for maturity, by sex, annotated with sizes at 50% and 99% maturity.
- Diet compositions by weight and number, with prey types separated into broad taxonomic groups, annotated with the number of stomachs analyzed.

These data summaries are numbered as follows:

- Black seabass – Figures 10-19.
- Bluefish – Figures 20-29.
- Scup – Figures 30-37.
- Striped bass – Figures 38-43.
- Summer flounder – Figures 44-53.
- Weakfish – Figures 54-64.
- Winter flounder – Figures 65-70.

For priority A species, at the time of report preparation, all stomachs have been analyzed and data summaries provided except for scup. As noted previously, ageing only for weakfish has been completed.

For priority B species, some or all of the following data summaries are presented:

- Distribution maps showing catch ranges by number and biomass for all stations.
- Bar graphs showing the MTN and MTB by state, annotated with estimates of the overall MTN and MTB and percent standard error for each.
- Histograms of sex ratio by state, annotated with the number of specimens examined.
- Length-frequency histograms annotated with the total number of specimens captured and measured and the number of otoliths (or vertebrae for elasmobranchs) removed for processing.
- Length-weight power regressions for sexes combined and separately.
- Logistic regressions for maturity, by sex, annotated with sizes at 50% and 99% maturity.

These data summaries are numbered as follows:

- Atlantic croaker – Figures 71-78.
- Bullnose ray – Figures 79-86.
- Clearnose skate – Figures 87-94.
- Smooth dogfish – Figures 95-100.

Several other species were captured in significant numbers as well. Data summaries for these species that are shown are:

- Distribution maps showing catch ranges by number and biomass for all stations.
- Bar graphs showing the MTN and MTB by state, annotated with estimates of the overall MTN and MTB and percent standard error for each.
- Length-frequency histograms annotated with the total number of specimens captured and measured.

These data summaries are numbered as follows:

- Butterfish – Figures 101-103.
- Silver perch – Figures 104-106.
- Southern kingfish – Figures 107-109.
- Striped anchovy – Figures 110-112.

Finally, three invertebrate species (or species groups) were captured in large enough numbers to be of note. Data summaries for these species that are shown are:

- Distribution maps showing catch ranges by number and biomass for all stations.
- Bar graphs showing the MTN and MTB by state, annotated with estimates of the overall MTN and MTB and percent standard error for each.
- Histograms of sex ratio by state, annotated with the number of specimens examined (horseshoe crab only).
- Length-frequency histograms annotated with the total number of specimens captured and measured.
- Length-weight power regressions for sexes combined and separately (horseshoe crab only).

These data summaries are numbered as follows:

- Horseshoe crab – Figures 113-118.
- Squid (all species combined) – Figures 119-121.
- Penaeid shrimp (all species combined) – Figures 122-124.

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Table 2. Summary of activities conducted during each day at sea during the NEAMAP pilot cruise.

Hours worked and stations sampled each day.																									
	Time of Day																								
Date	12:00 AM						6:00 AM						12:00 PM						6:00 PM						
25-Sep	Steaming Day - Hampton-Montauk																								0 Stations
26-Sep	Steaming Day - Hampton-Montauk																								0 Stations
27-Sep																									6 Stations
28-Sep																									9 Stations
29-Sep																									8 Stations
30-Sep																									9 Stations
1-Oct	Crew Change Day																			Cape May, NJ					5 Stations
2-Oct	Refuel/Rewater/Steam to Station																								4 Stations
3-Oct	One Station After Dark																			Steam					8 Stations
4-Oct																									8 Stations
5-Oct																									8 Stations
6-Oct											High Winds - Steam to Hampton														2 Stations
7-Oct	High Winds																								
8-Oct	High Winds																								
9-Oct	High Winds																								
10-Oct	Steam to Stations																								3 Stations
11-Oct																									7 Stations
12-Oct																									8 Stations
13-Oct	No Fishing																								
14-Oct																									7 Stations
15-Oct																									6 Stations

Table 3. Number of specimens captured and measured and number of otoliths and stomachs sampled, by species priority level.

Species	Total Number Caught	Total Species Weight (kg)	Number Measured	Number of Otoliths	Number of Stomachs
Priority A Species					
black seabass	48	10	48	40	32
bluefish	6,206	282	2,143	562	383
scup	55,889	1,417	7,635	668	578
striped bass	17	55	17	17	14
summer flounder	494	203	389	278	141
weakfish	30,826	2,328	4,783	494	366
winter flounder	22	9	22	17	7
Priority B Species					
Species	**Total Number Caught**	**Total Species Weight (kg)**	**Number Measured**	**Number of Otoliths**	**Number of Stomachs**
Atlantic croaker	26,426	2,206	2,891	275	240
Atlantic menhaden	55	11	55	27	27
Atlantic stingray	9	4	9	4	4
bluntnose stingray	72	224	72	57	50
bullnose ray	430	1,133	313	126	120
clearnose skate	708	802	708	297	286
cownose ray	60	119	60	33	23
little skate	1,815	1,106	1,690	165	160
rosette skate	5	3	5		
roughtail stingray	35	199	35	31	29
smooth butterfly ray	147	164	147	70	51
smooth dogfish	653	495	653	182	179
southern stingray	1	14	1	1	1
spiny butterfly ray	38	436	38	23	20
spot	19,829	1,354	2,345	228	158
winter skate	82	50	82	9	8
Priority C Species					
Species	**Total Number Caught**	**Total Species Weight (kg)**	**Number Measured**	**Number of Otoliths**	**Number of Stomachs**
alewife	6	0	6		
Atlantic herring	10	0	10	4	4
black drum	11	11	11	1	1
blueback herring	23	1	23	1	1
red drum	5	66	5		
spotted seatrout	6	1	6		
tautog	78	75	78	20	20

continued

Table 3. cont..

Species	Total Number Caught	Total Species Weight (kg)	Number Measured	Number of Otoliths	Number of Stomachs
Atlantic cutlassfish	377	11	375		
Atlantic moonfish	3,766	29	1,211		
Atlantic spadefish	86	3	86		
Atlantic sturgeon	2	23	2		
Atlantic thread herring	187	9	186		
Atlantic threadfin	2	0	2		
banded drum	1,154	25	574		
barrelfish	1	0	1		
bay anchovy	33,503	79	3,700		
bigeye scad	36	1	36		
blackcheek tonguefish	21	1	21		
blue runner	82	5	82		
bluespotted cornetfish	1	0	1		
butterfish	114,532	2,248	10,433		
cobia	2	0	2		
crevalle jack	19	2	19		
cunner	3	0	3		
dwarf goatfish	7	0	7		
Etropus sp.	8	0	8		
Florida pompano	3	1	3		
fourspot flounder	1	0	1		
gag	2	0	2		
guaguanche	1	0	1		
gulf kingfish	3	1	3		
harvestfish	765	42	210		
hickory shad	13	3	13		
hogchoker	77	7	77		
inshore lizardfish	149	15	149		
jellyfish spp		150			
king mackerel	2	0	2		
kingfish spp	628	110	150		
lined seahorse	25	0	5		
lookdown	2	0	2		
mackerel scad	1	0	1		
mantis shrimp	6	0	6		
northern kingfish	405	75	405		
northern pipefish	1	0	1		
northern puffer	73	4	72		
northern searobin	470	59	469		
northern sennet	65	4	65		
northern stargazer	14	12	14		

continued

Table 3. cont.

Priority D Species (continued)					
Species	Total Number Caught	Total Species Weight (kg)	Number Measured	Number of Otoliths	Number of Stomachs
pigfish	944	39	466		
pinfish	21	1	21		
planehead filefish	3	0	3		
red hake	2	0	2		
rock seabass	1	0	1		
rough scad	317	7	291		
round herring	120	3	110		
round scad	91	1	86		
sea bass spp	1	0	1		
sheepshead	10	39	10		
short bigeye	4	0	4		
silver anchovy	541	3	224		
silver hake (whiting)	228	1	188		
silver jenny	4	0	4		
silver perch	9,060	349	1,932		
silver seatrout	2	0	2		
smallmouth flounder	12	0	12		
southern kingfish	1,778	252	961		
Spanish mackerel	22	4	22		
Spanish sardine	14	1	14		
spotfin mojarra	4	0	4		
spotted hake	366	49	360		
star drum	1	0	1		
striped anchovy	47,714	582	3,983		
striped burrfish	42	14	42		
striped cusk-eel	21	1	21		
striped searobin	347	77	347		
white hake	1	0	1		
windowpane	590	92	541		

continued

Table 3. cont.

Priority E Species					
Species	Total Number Caught	Total Species Weight (kg)	Number Measured	Number of Otoliths	Number of Stomachs
American lobster	11	4	11		
Atlantic angel shark	4	22	4		
Atlantic sharpnose shark	20	83	20		
blue crab, adult female	12	1	12		
brief squid	208	2	188		
brown shrimp	757	17	569		
green turtle	1		1		
horseshoe crab	380	546	361		
loggerhead turtle	2		2		
pink shrimp	56	1	56		
sand tiger shark	4	139	4		
sandbar shark	22	75	22		
squid spp	68,135	816	9,048		
thresher shark	2	49	2		
white shrimp	408	11	299		
Total	**432,784**	**18,981**	**62,933**	**3,630**	**2,903**

Figure 1. Sample within-tow variability of net height and width at varying speeds as measured during the pre-pilot cruise.

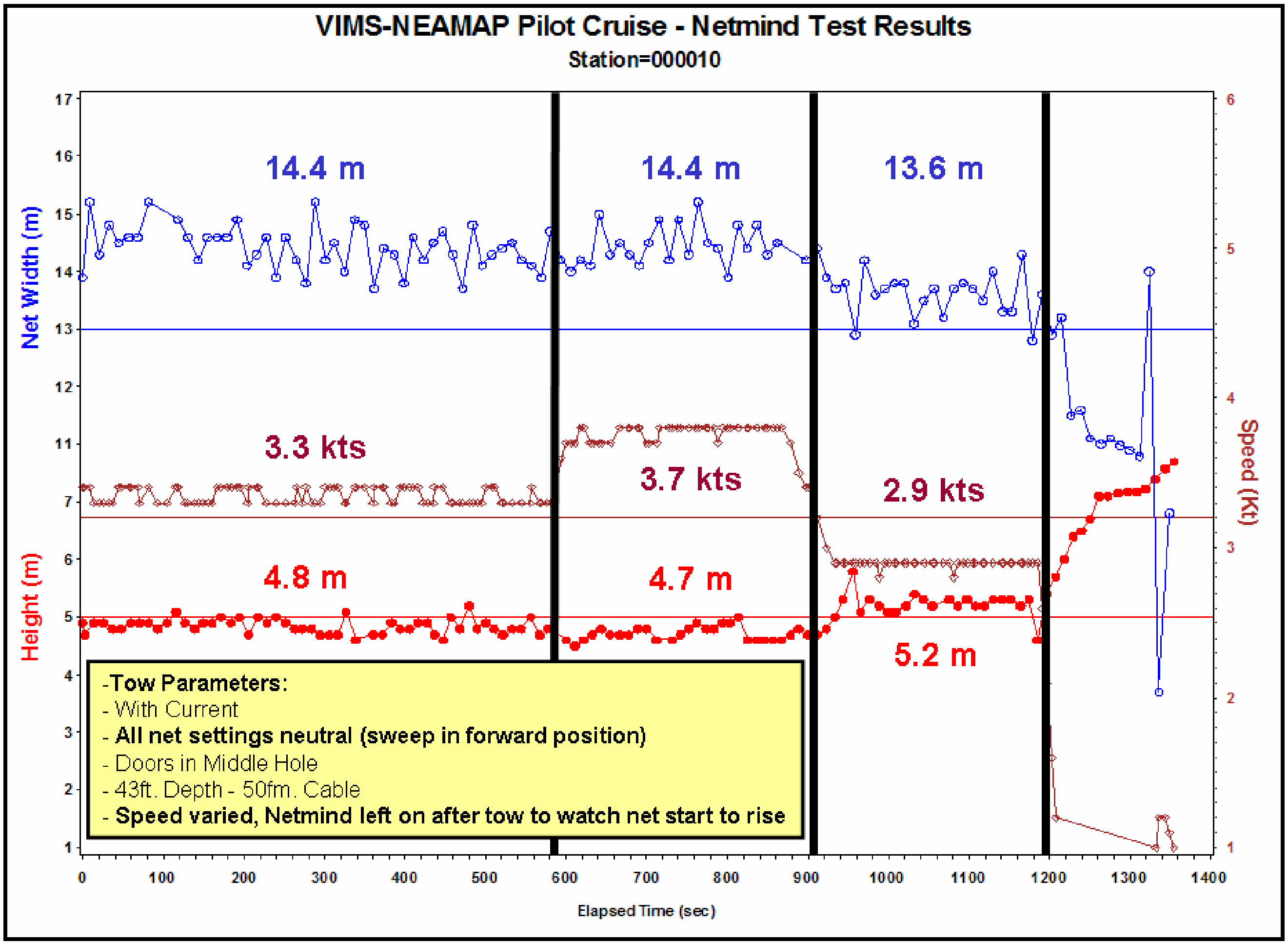
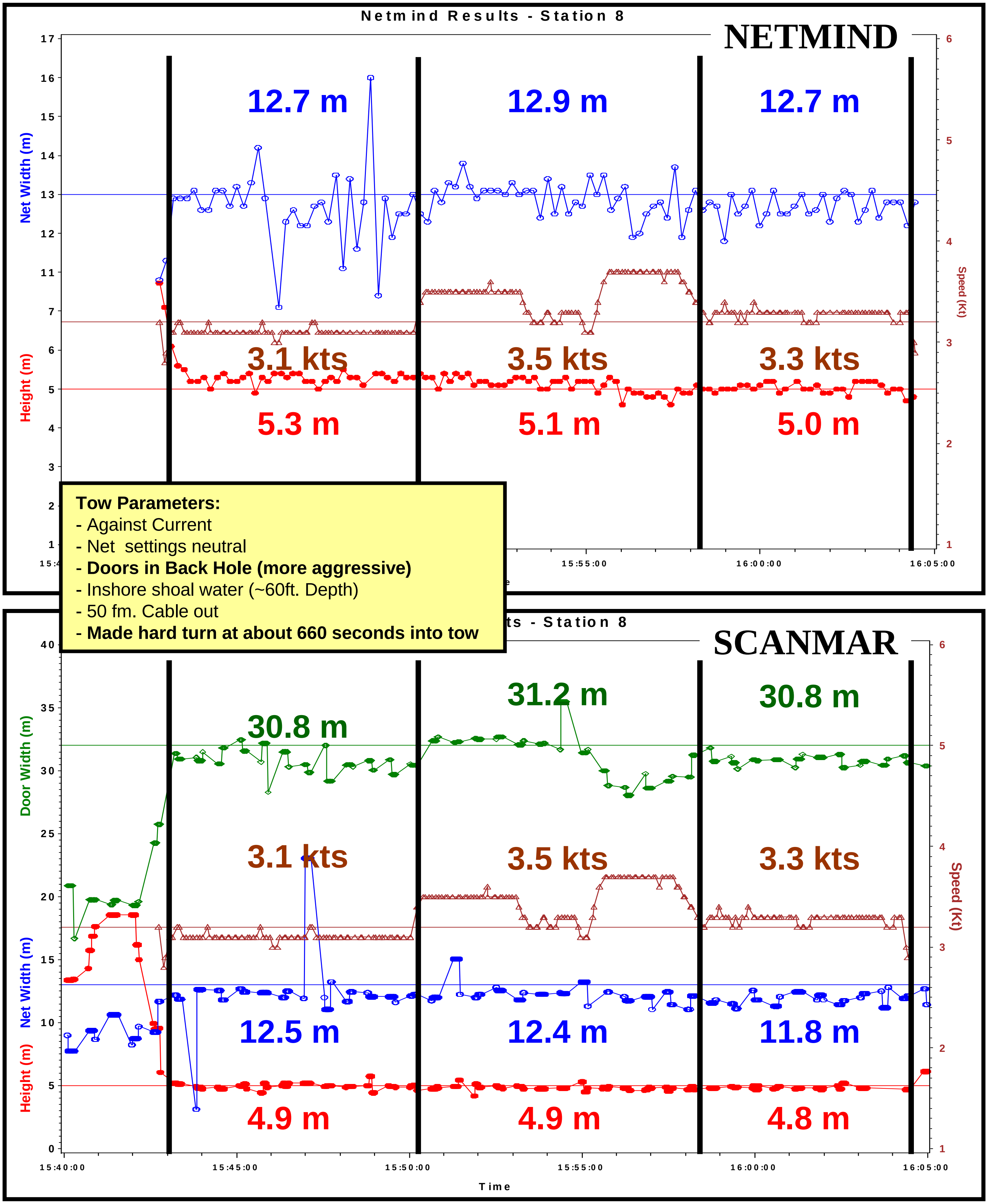


Figure 2. Sample within-tow variability of net height and width at varying speeds as measured during the NEAMAP-NMFS joint cruise.



Note: Vessel speed data taken with Netmind gear but plotted with Scanmar data for ease of interpretation.

Figure 3. Sample wheelhouse computer screenshot with Netmind software (no actual data shown), charting software with a sampling cell (blue diamonds) and countdown clock.

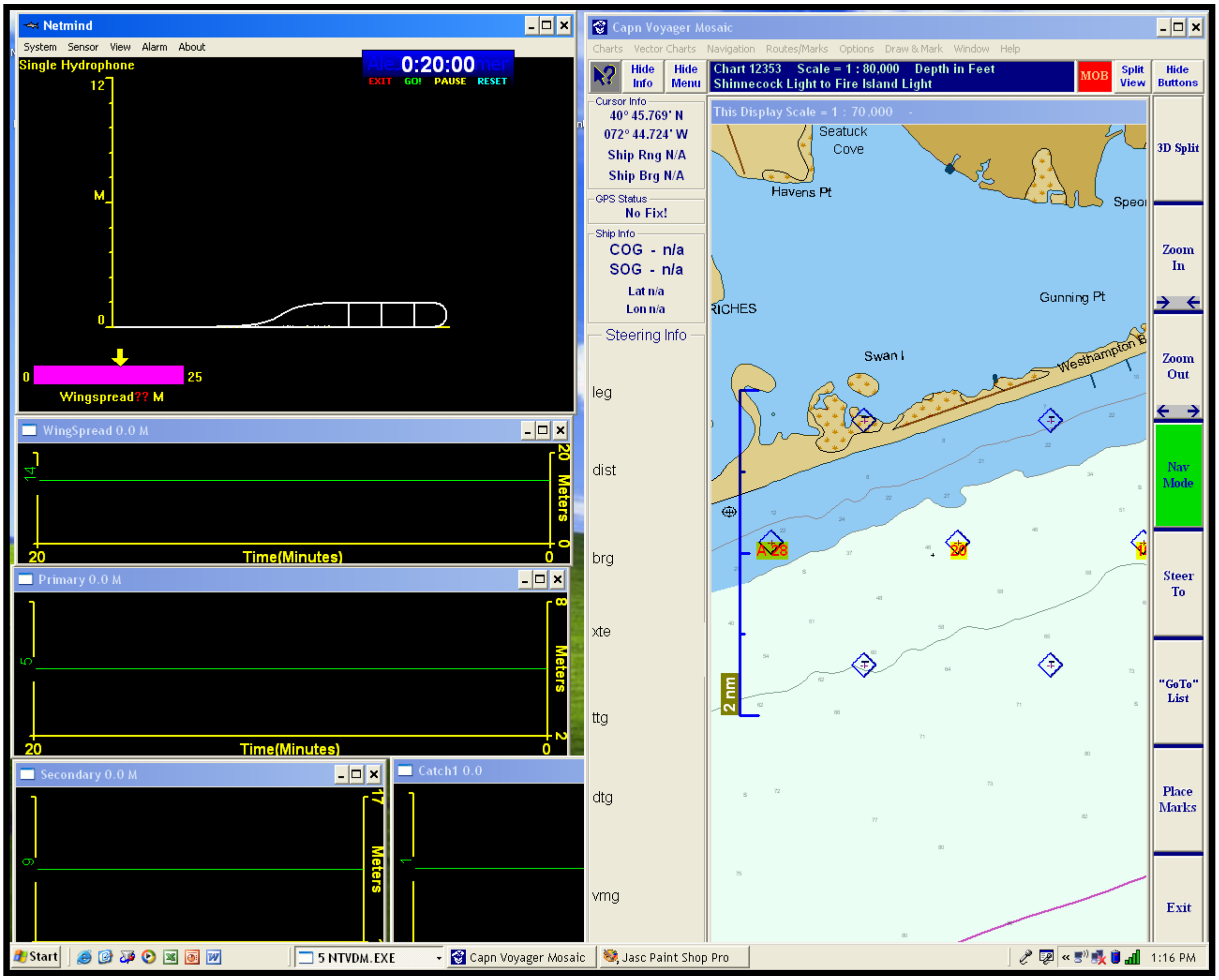


Figure 4. Sample within-tow tow-track (A) and trawl gear width, height, and vessel speed (B) during a straight tow (station 120).

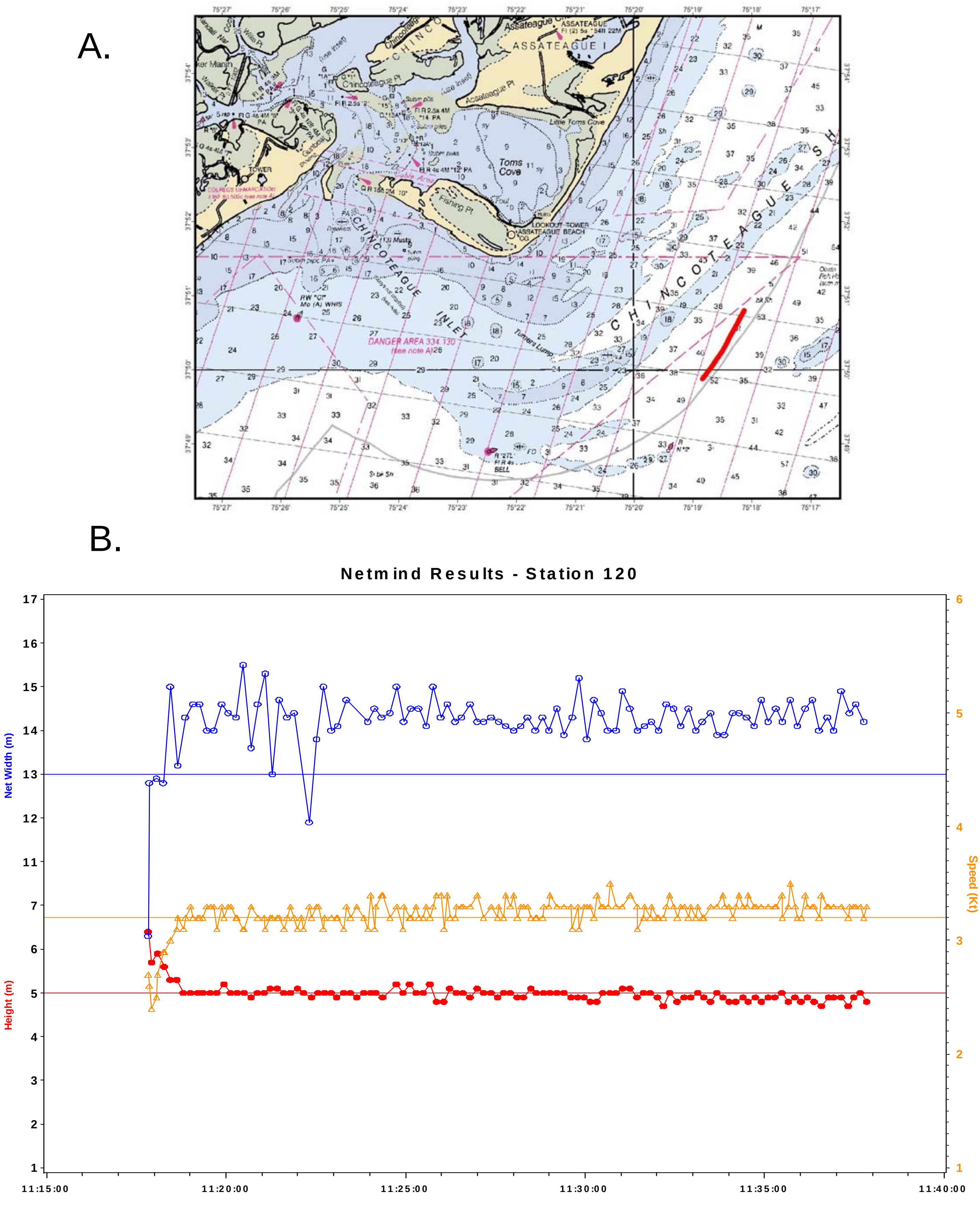
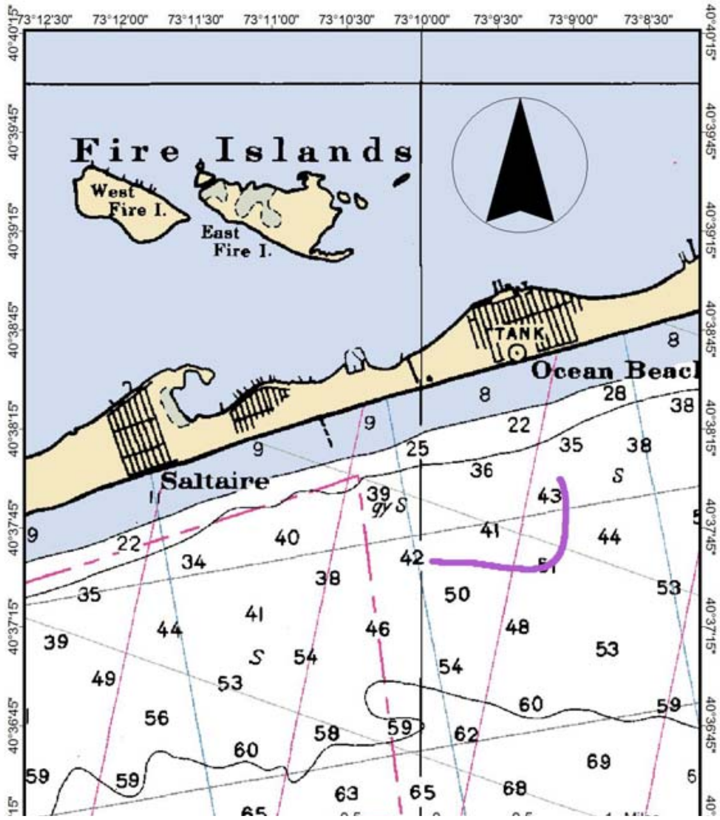


Figure 5. Sample within-tow tow-track (A) and trawl gear width, height, and vessel speed (B) during a non-straight tow (station 18).

A.



B.

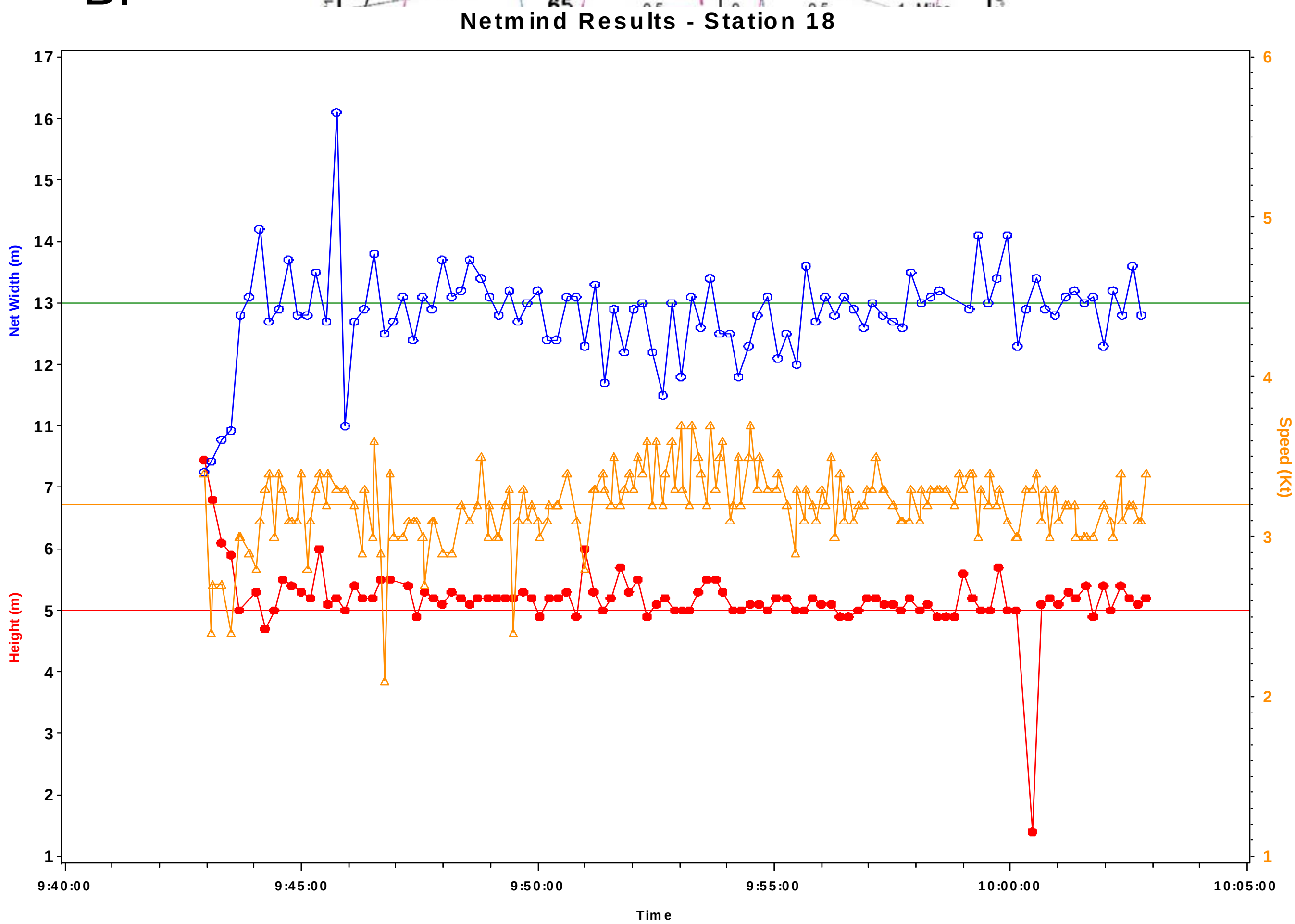
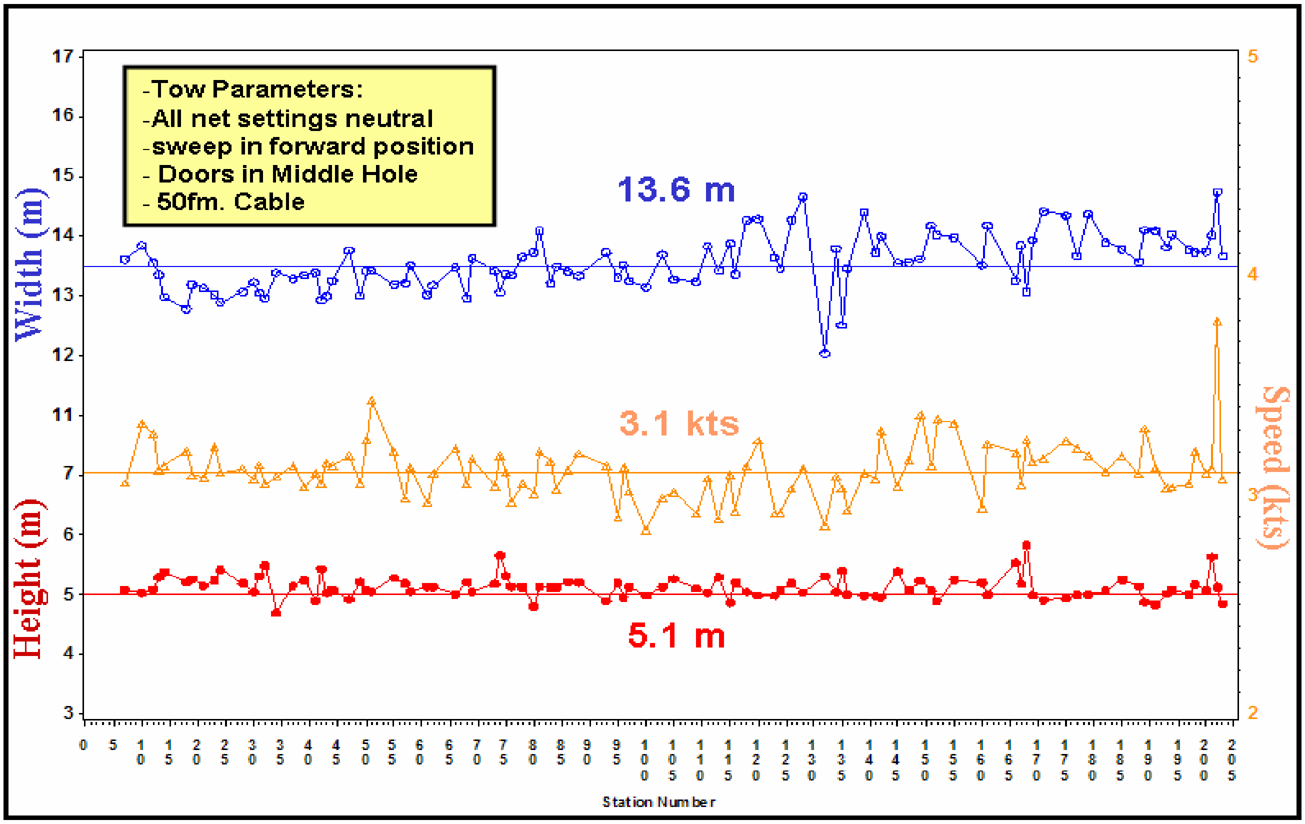


Figure 6. Tow-by-tow trawl gear width, height, and vessel speed (A), and tow distance and area swept (B), all stations.

A.



B.

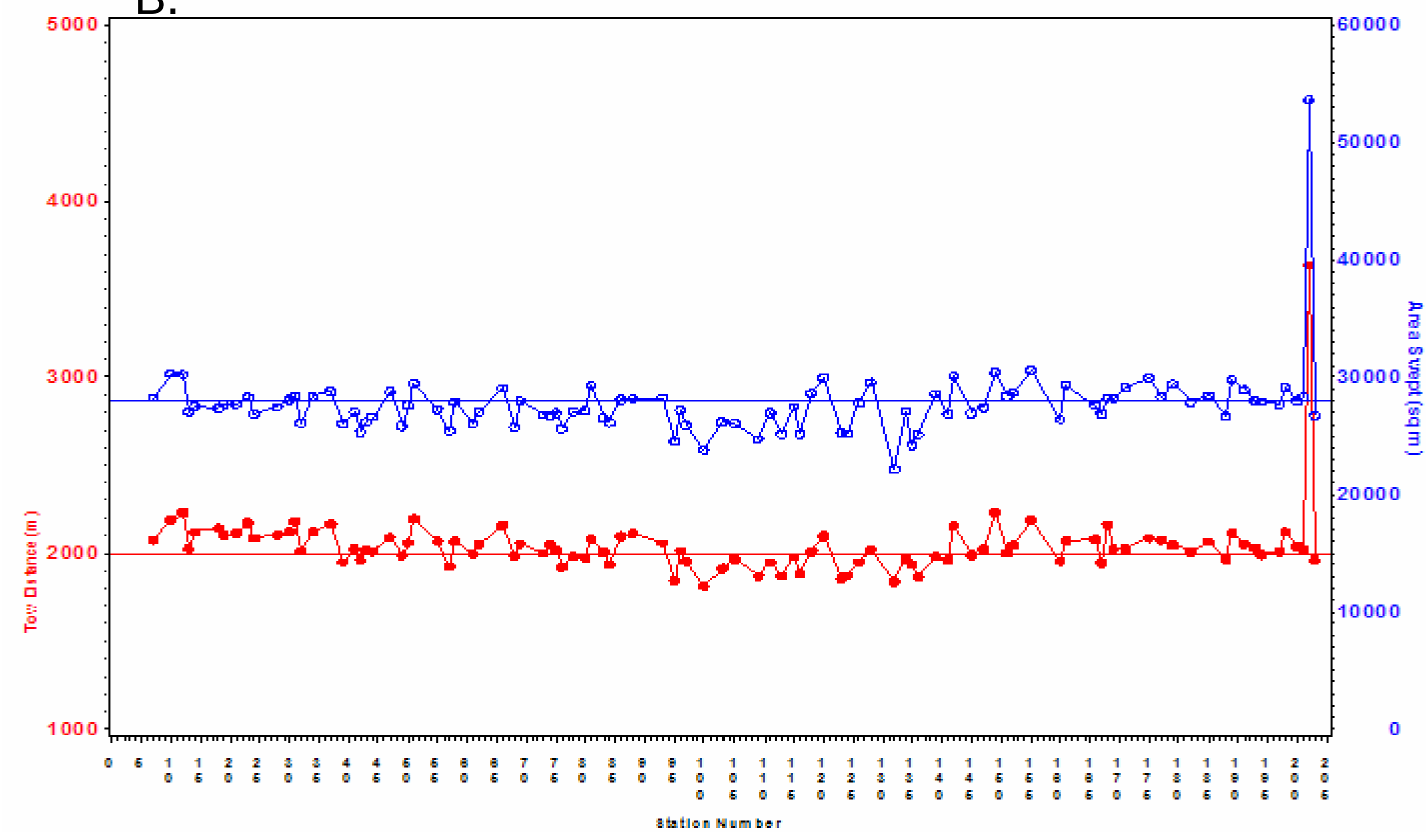
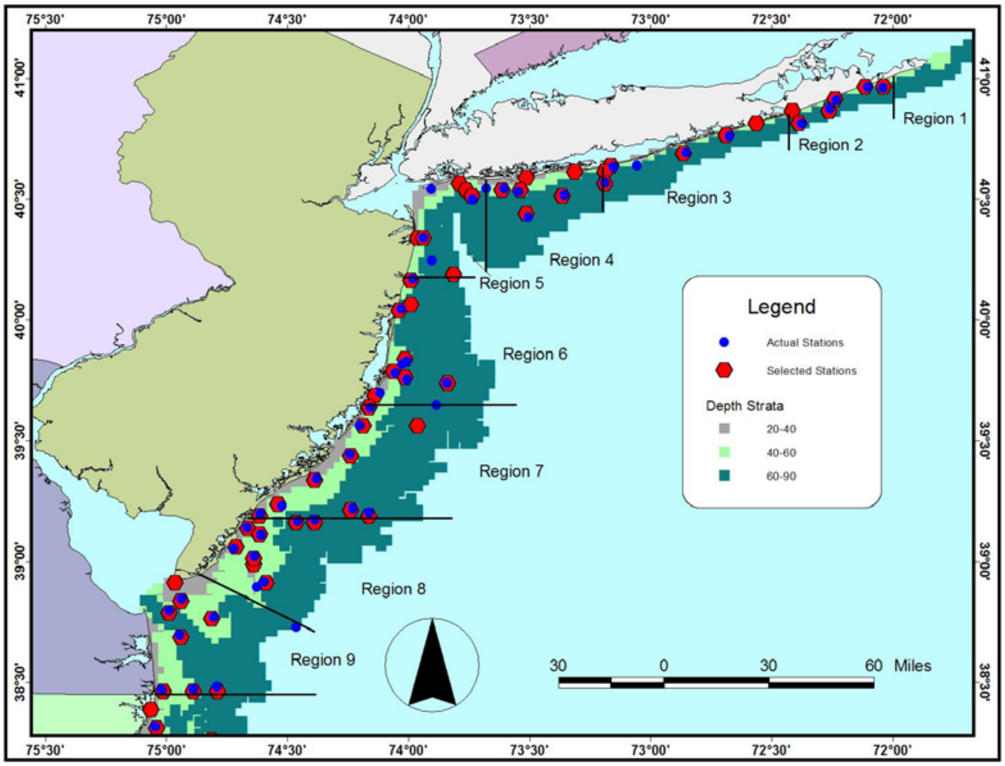


Figure 7. Comparison of stations selected for sampling and those actually occupied.



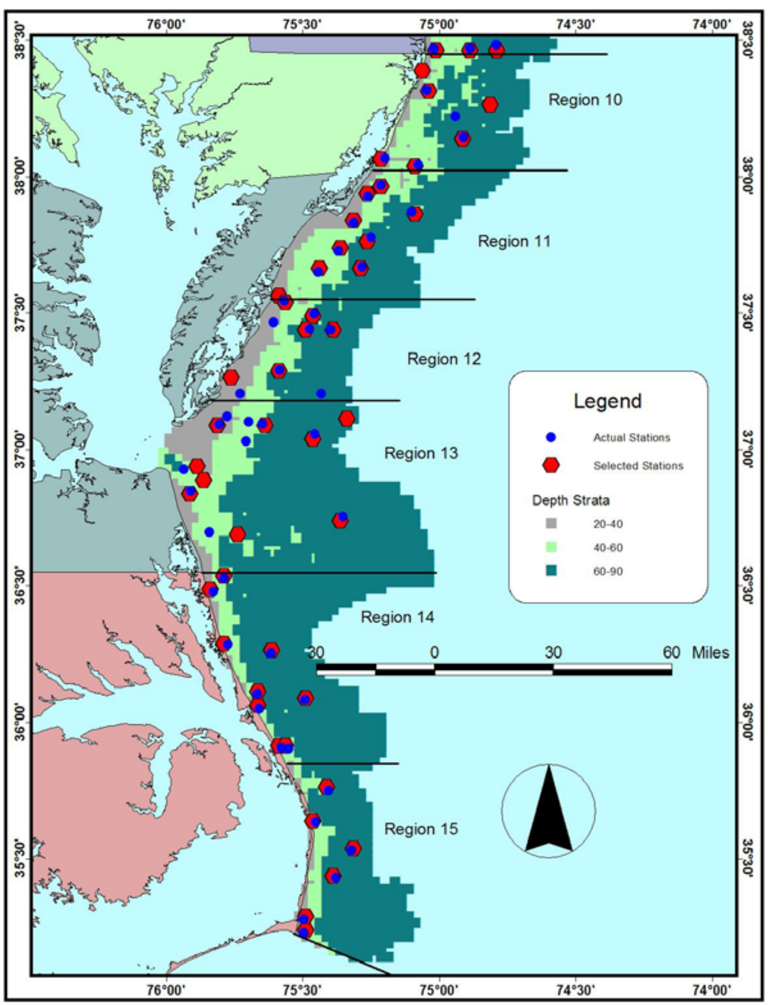
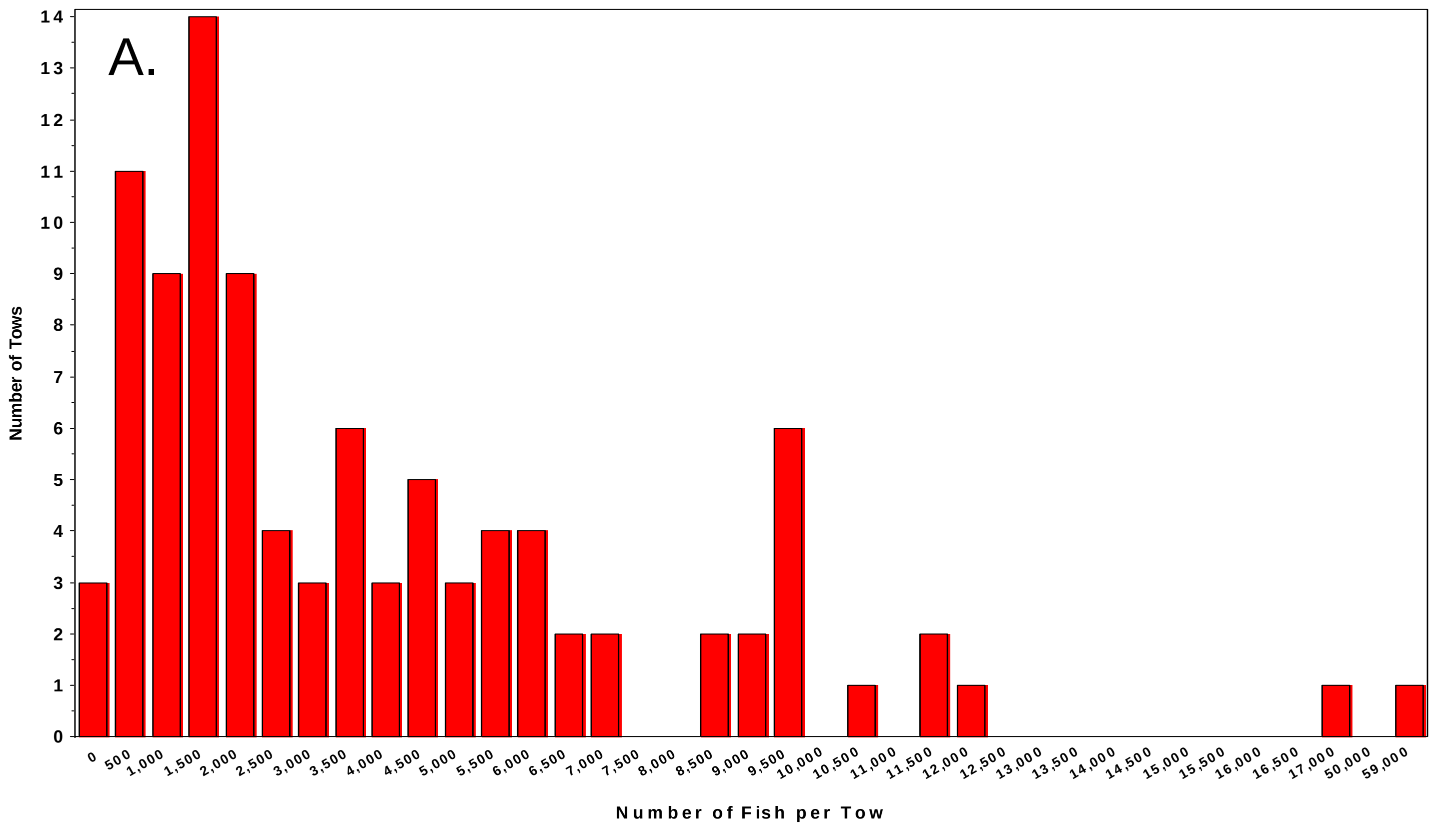


Figure 8. Frequency distributions of number (A) and biomass (B) of fish per tow.



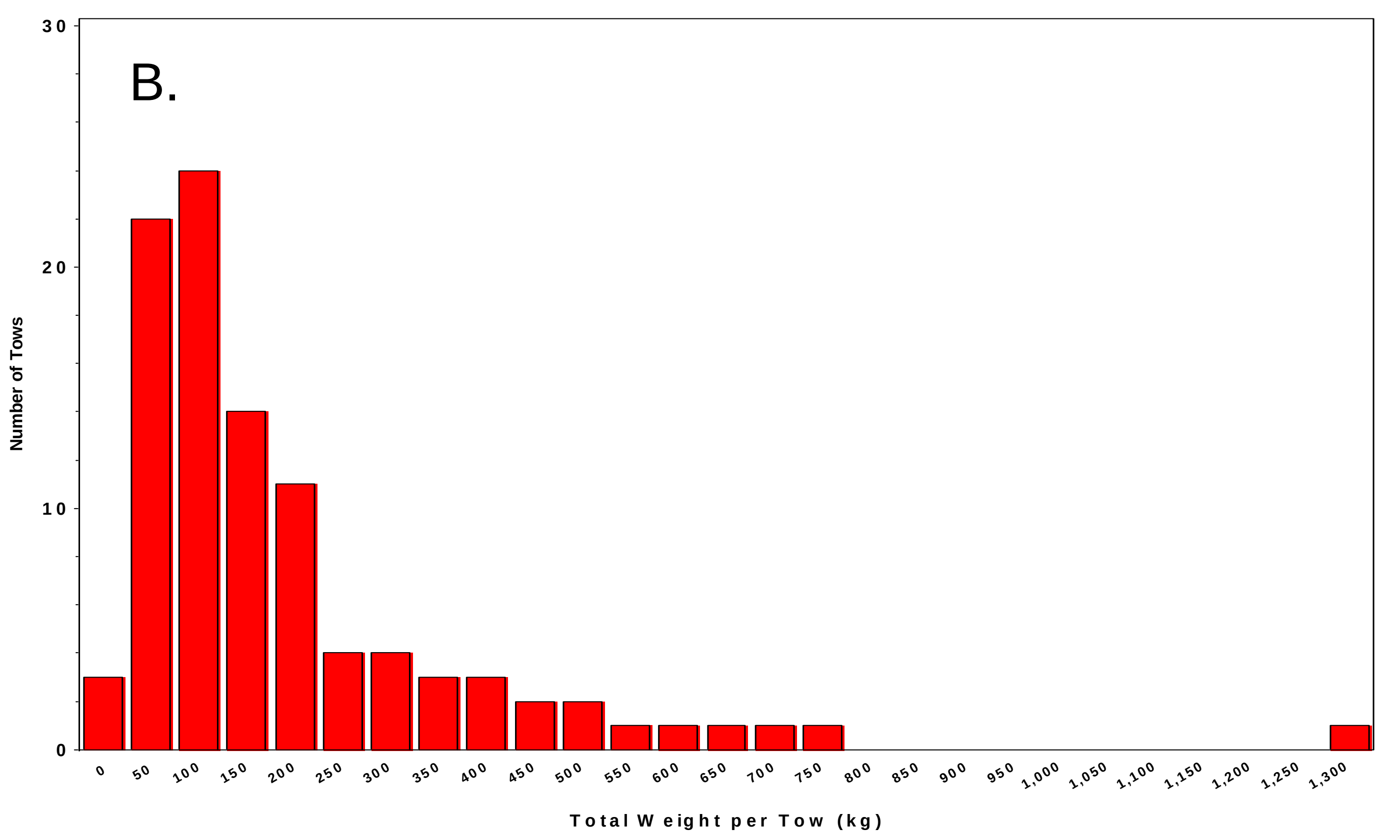
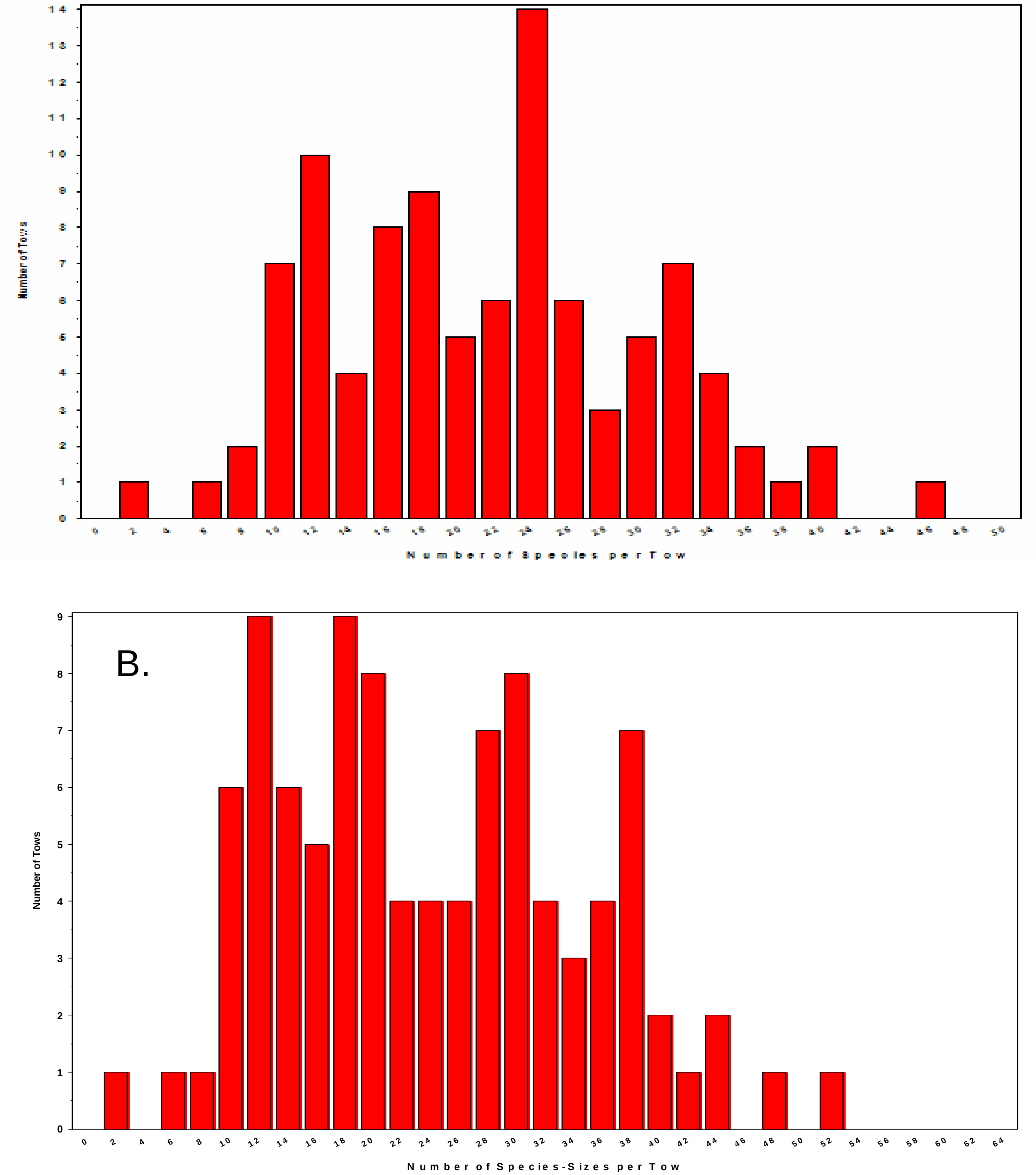
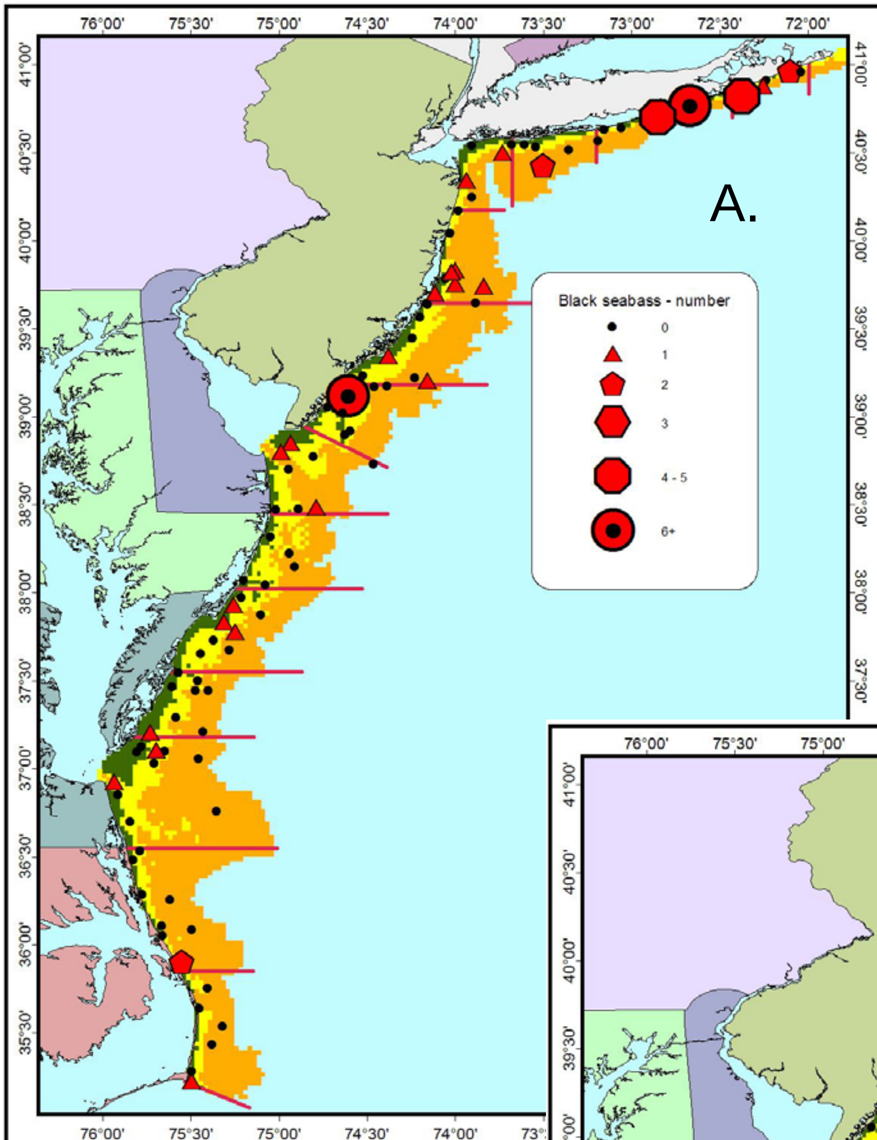


Figure 9. Frequency distributions of number of species (A) and species-size class combinations (B) per tow.

A.



Black Seabass



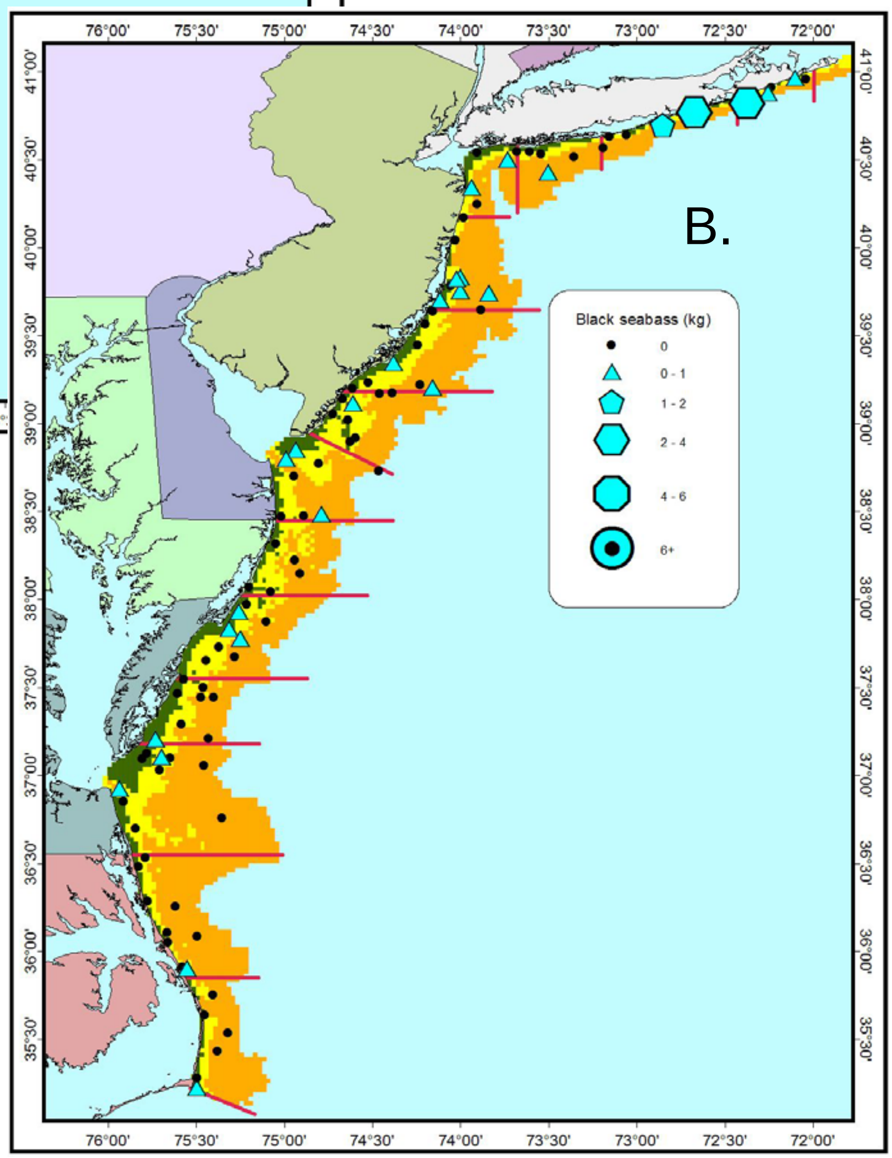


Figure 10. Number (A) and biomass (B) of specimens captured at each station for black seabass.

Figure 11. Minimum trawlable number and biomass by state for black seabass.

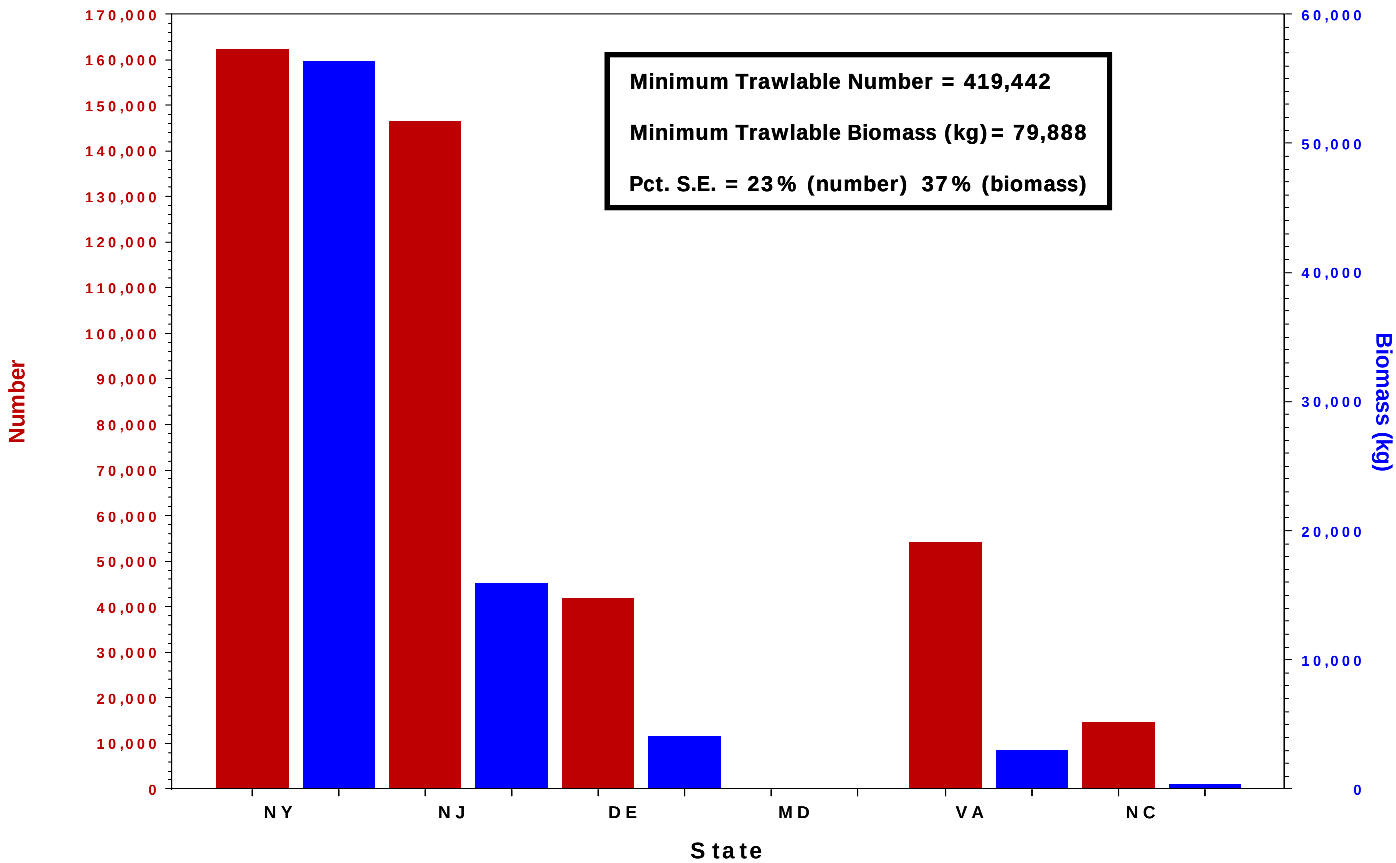


Figure 12. Sex ratios by state for black seabass.

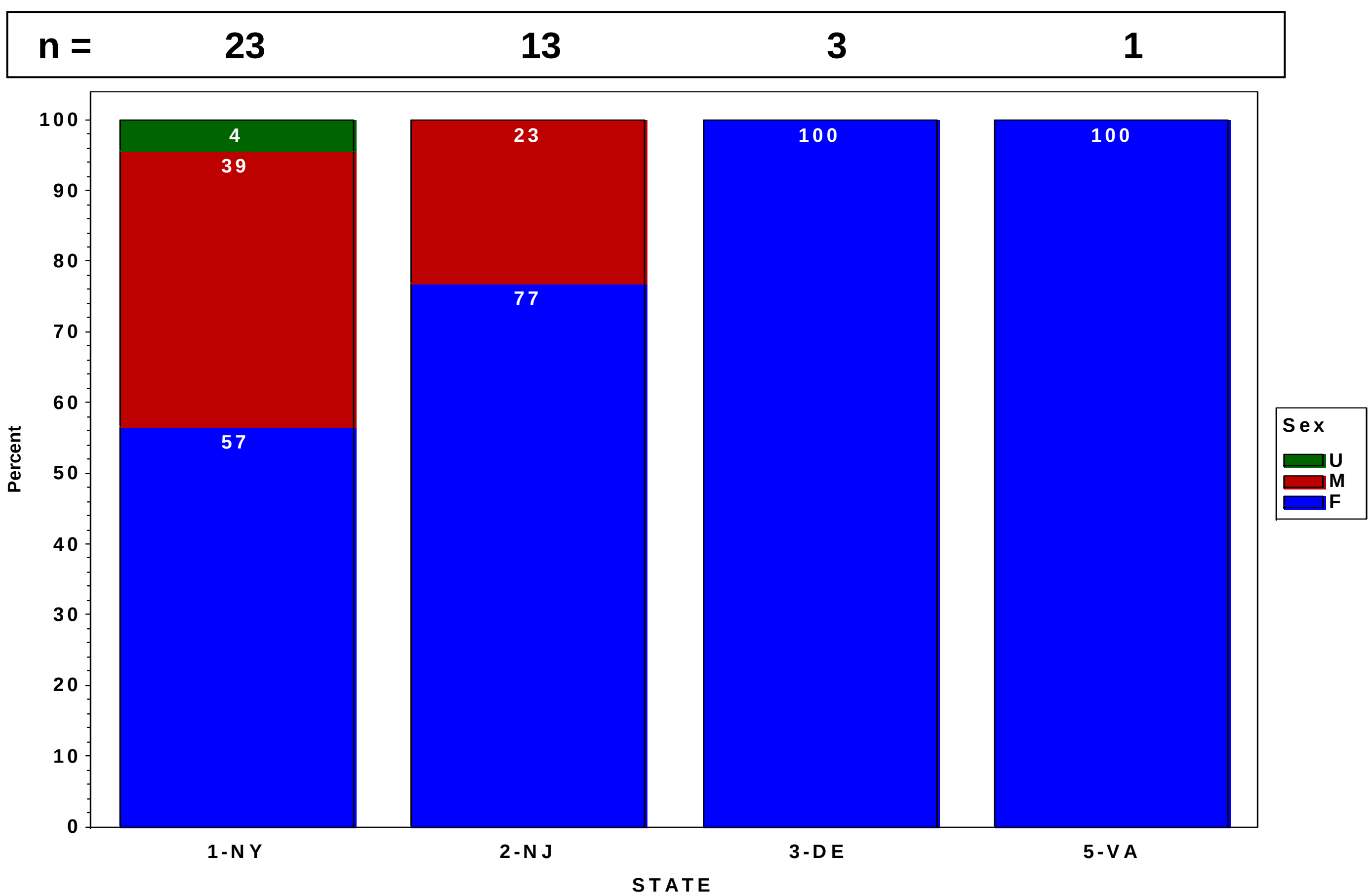


Figure 13. Length frequency for black seabass.

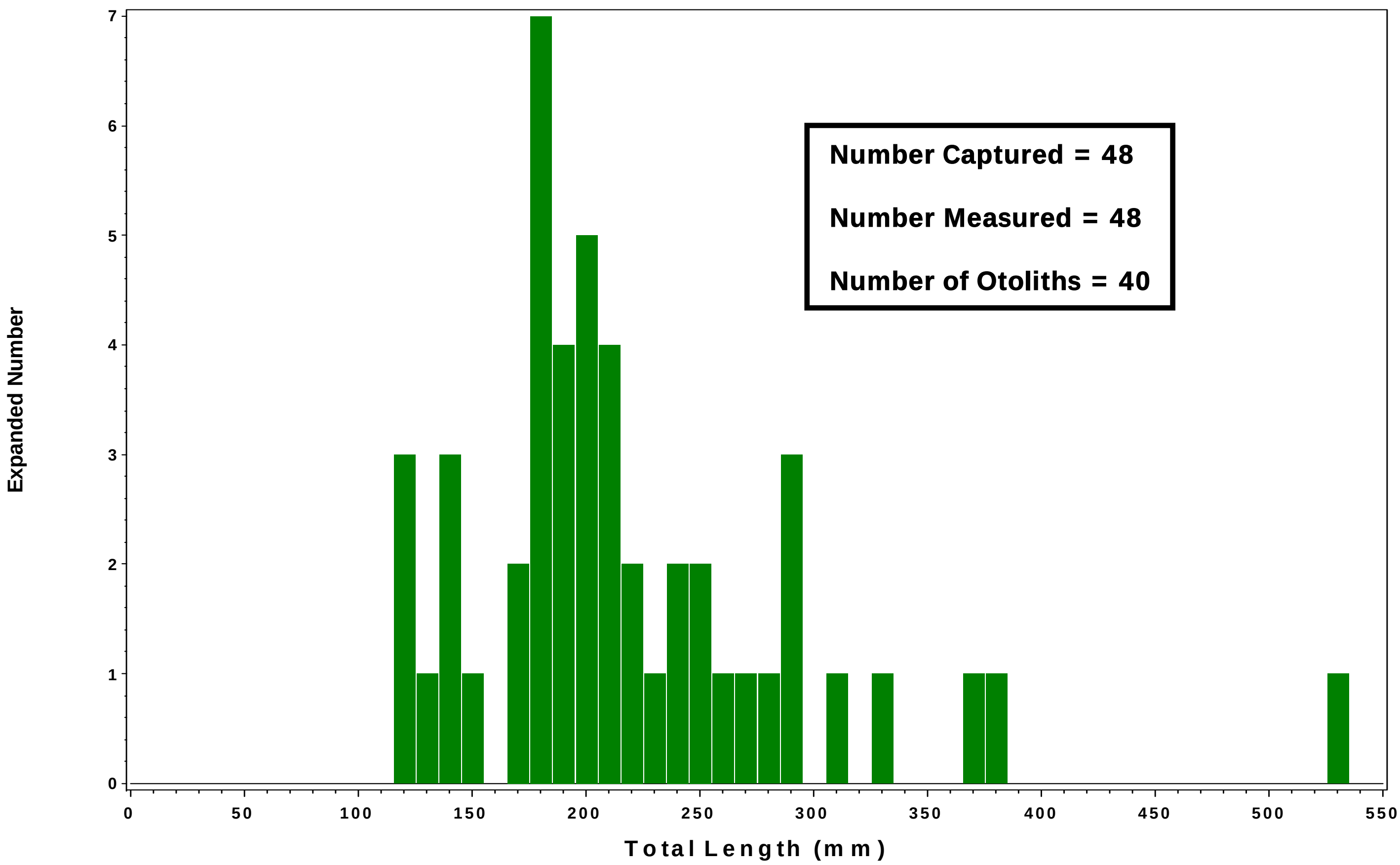


Figure 14. Length-weight regression for black seabass, sexes combined.

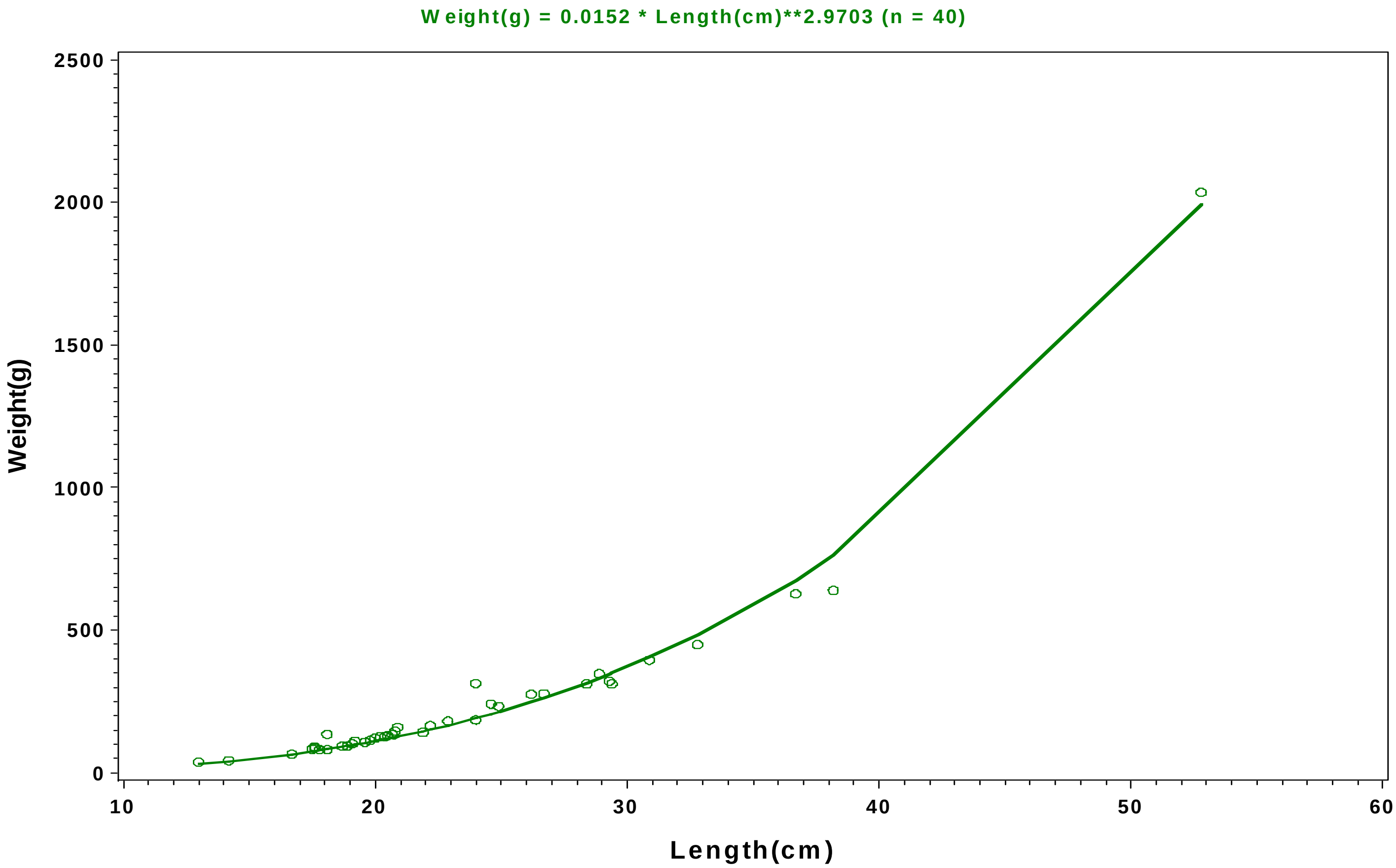


Figure 15. Length-weight regression for black seabass, by sex.

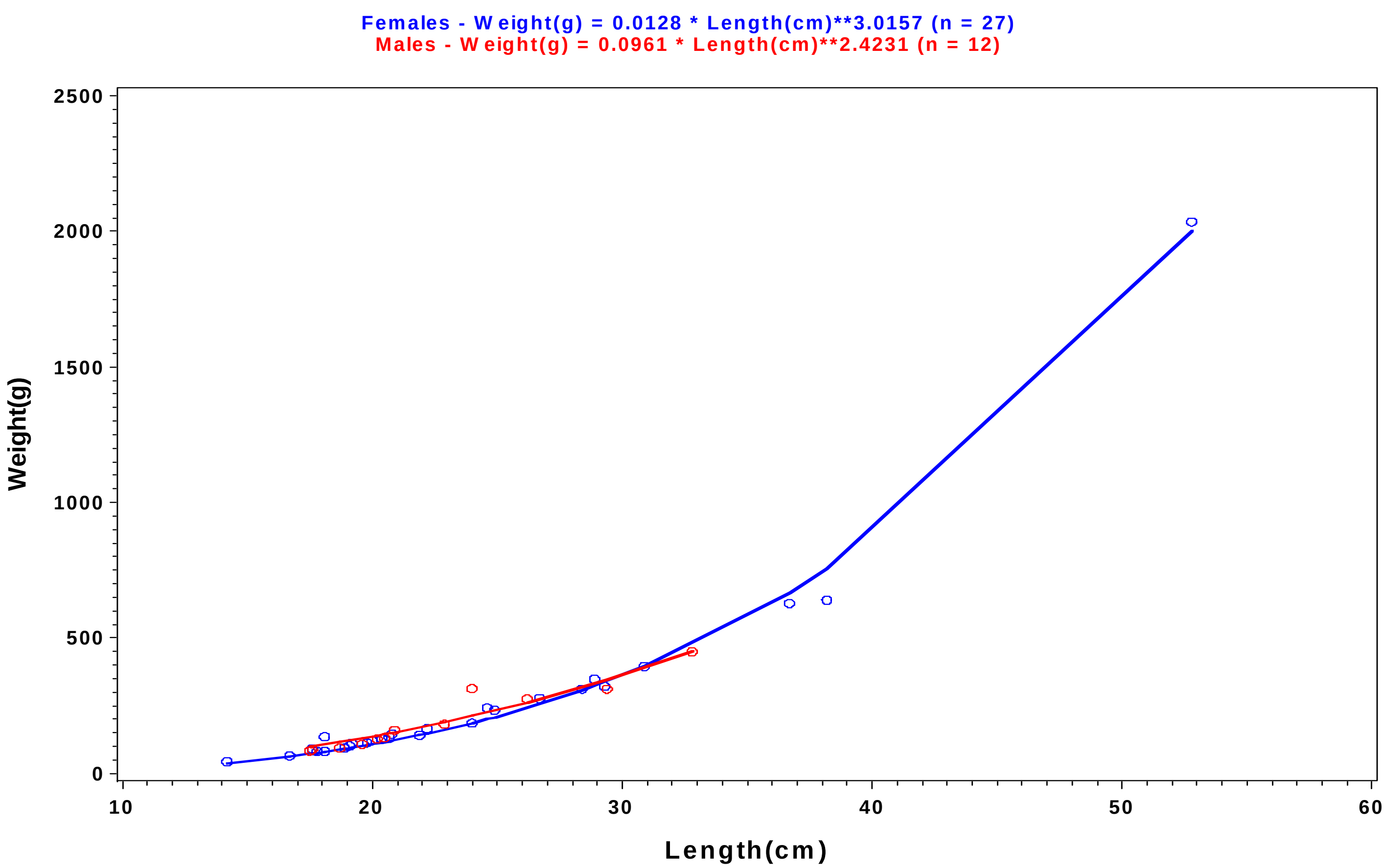


Figure 16. Maturity logistic regression for black seabass, females.

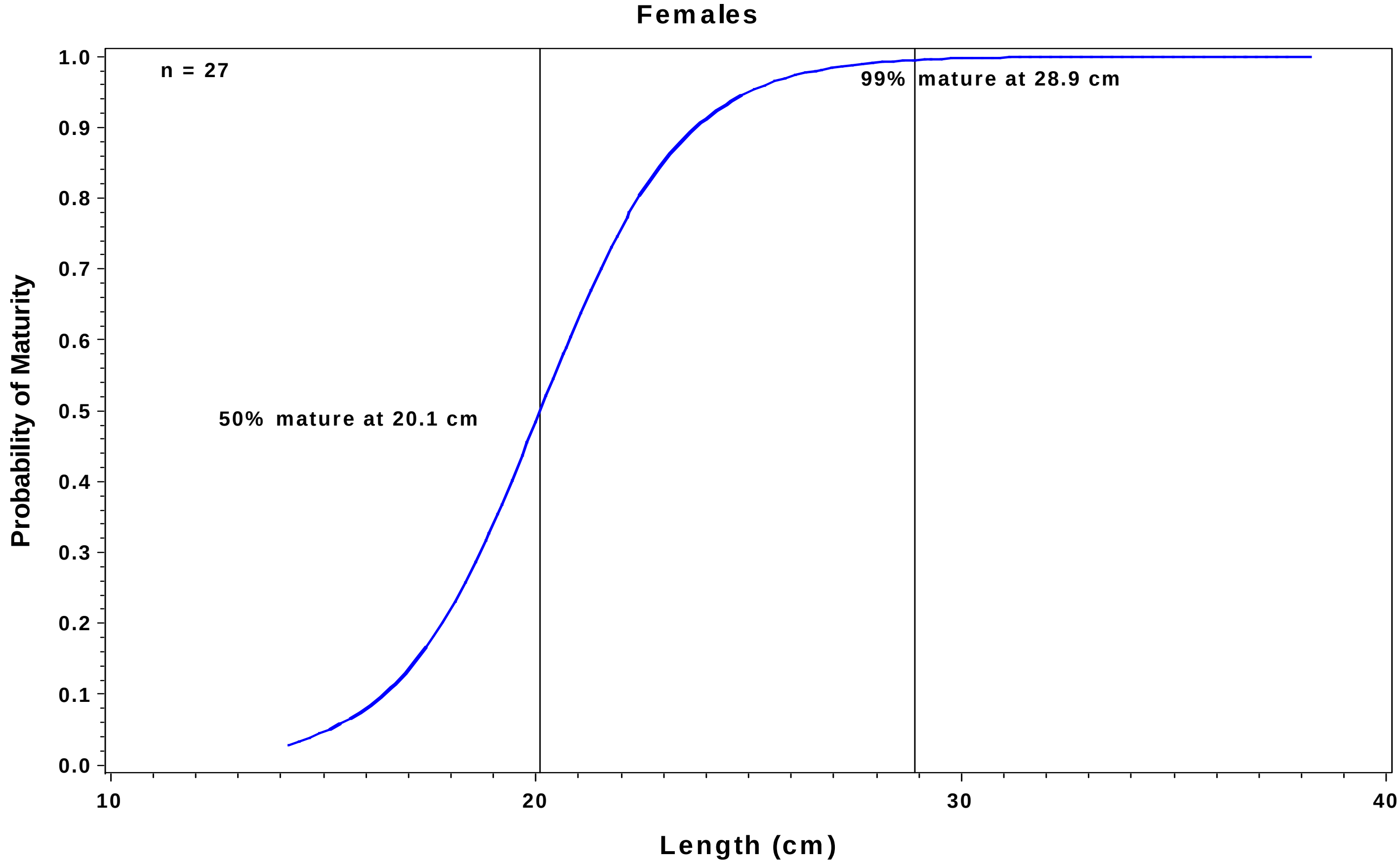


Figure 17. Maturity logistic regression for black seabass, males.

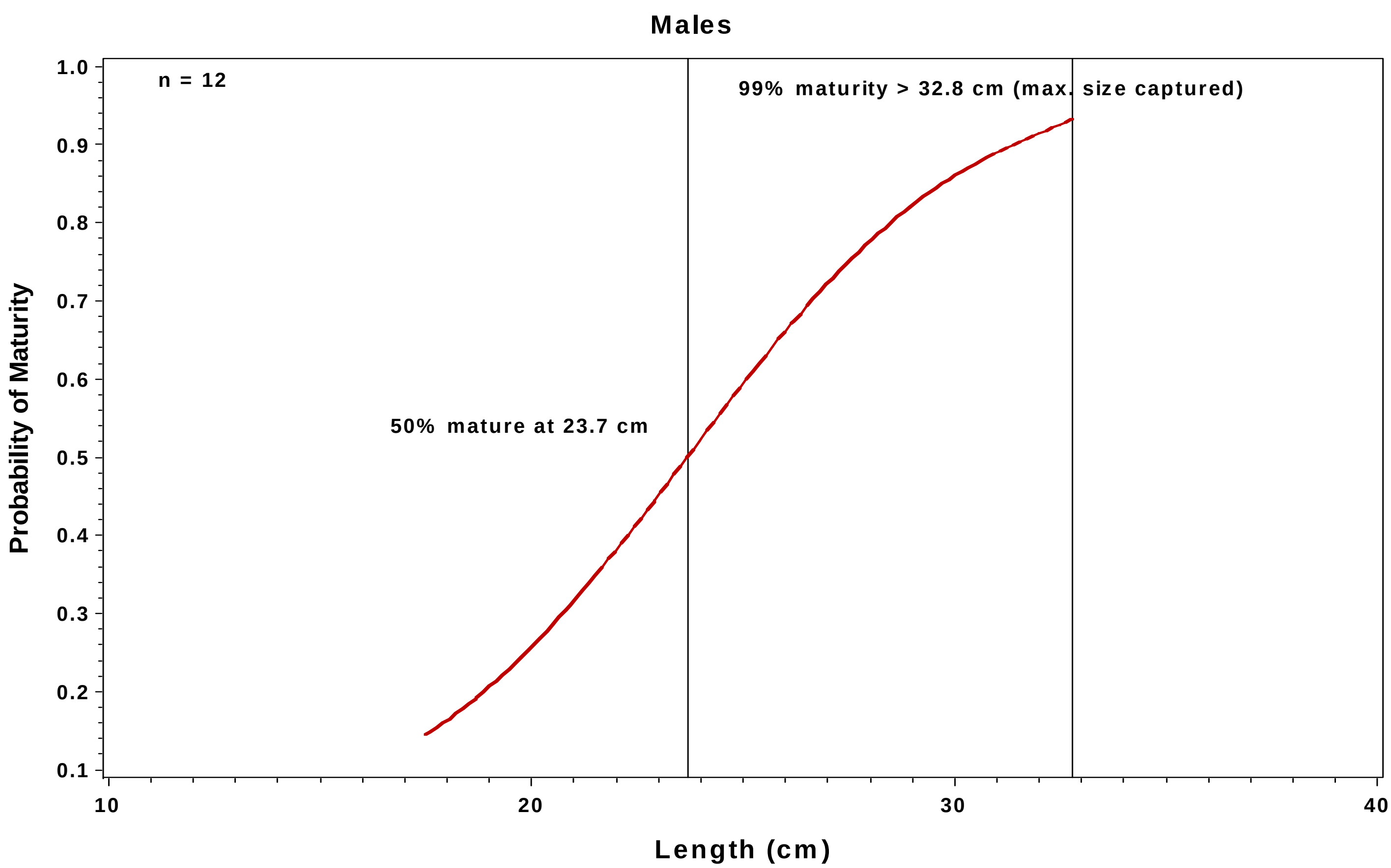


Figure 18. Diet composition by weight for black seabass.

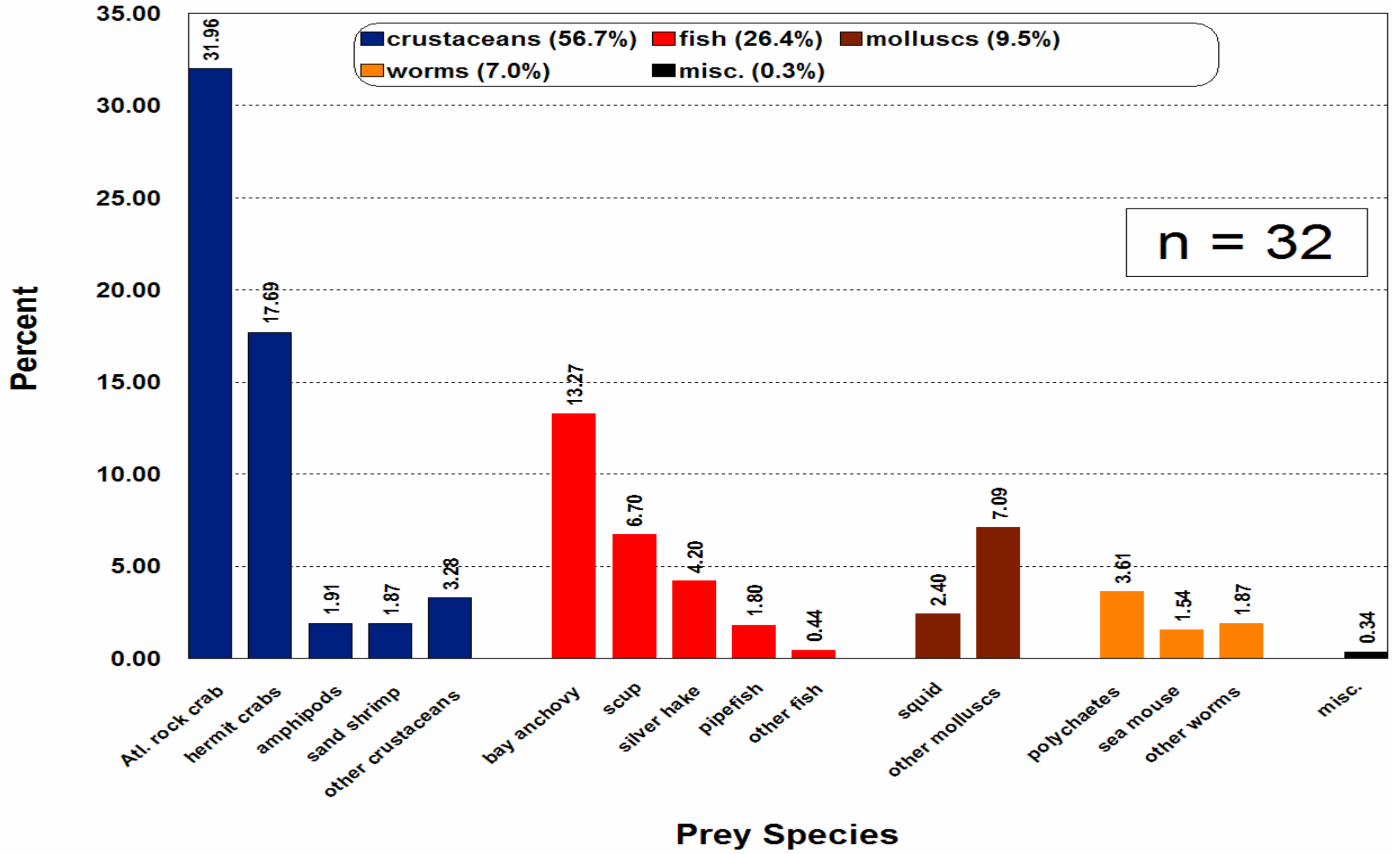
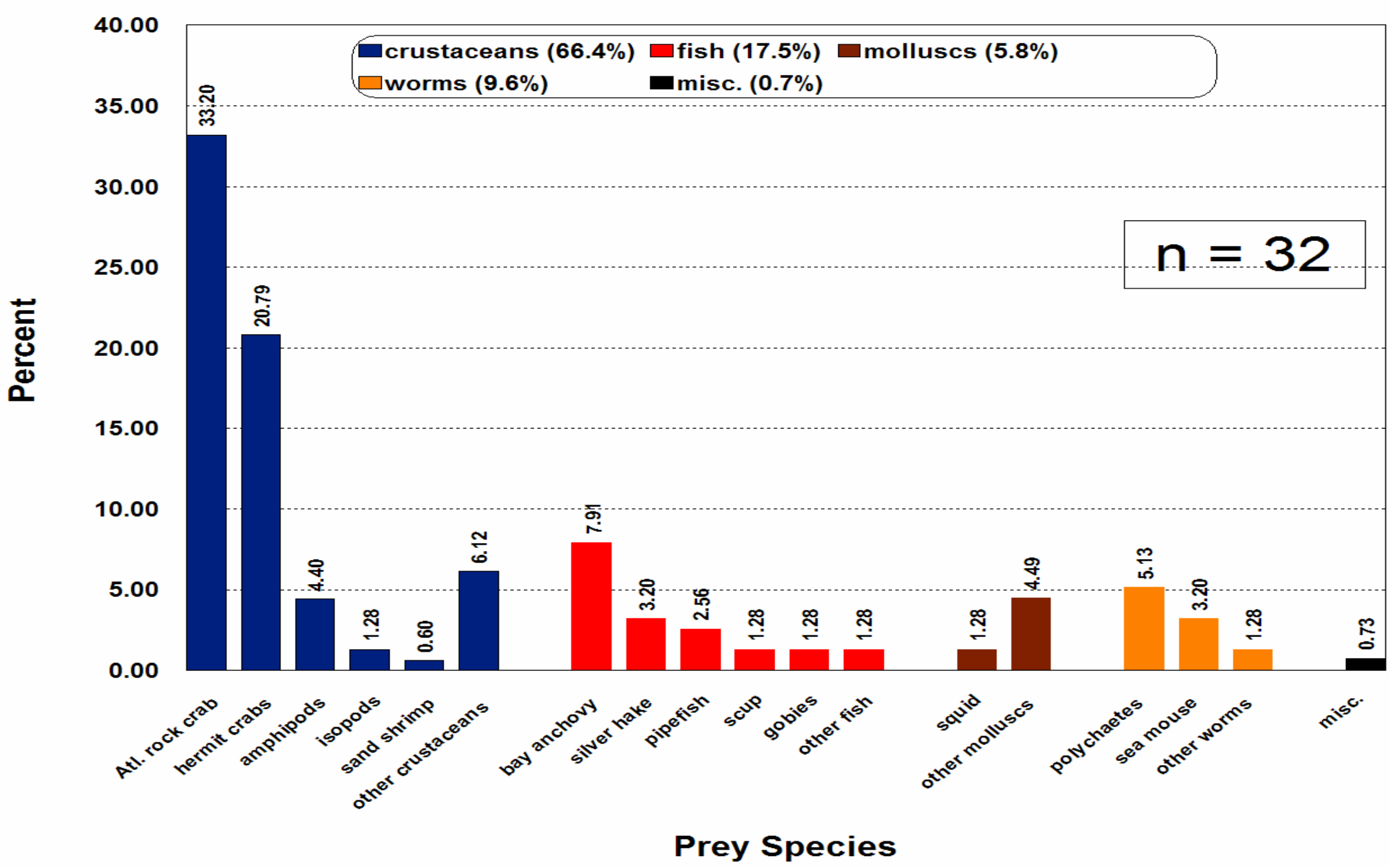
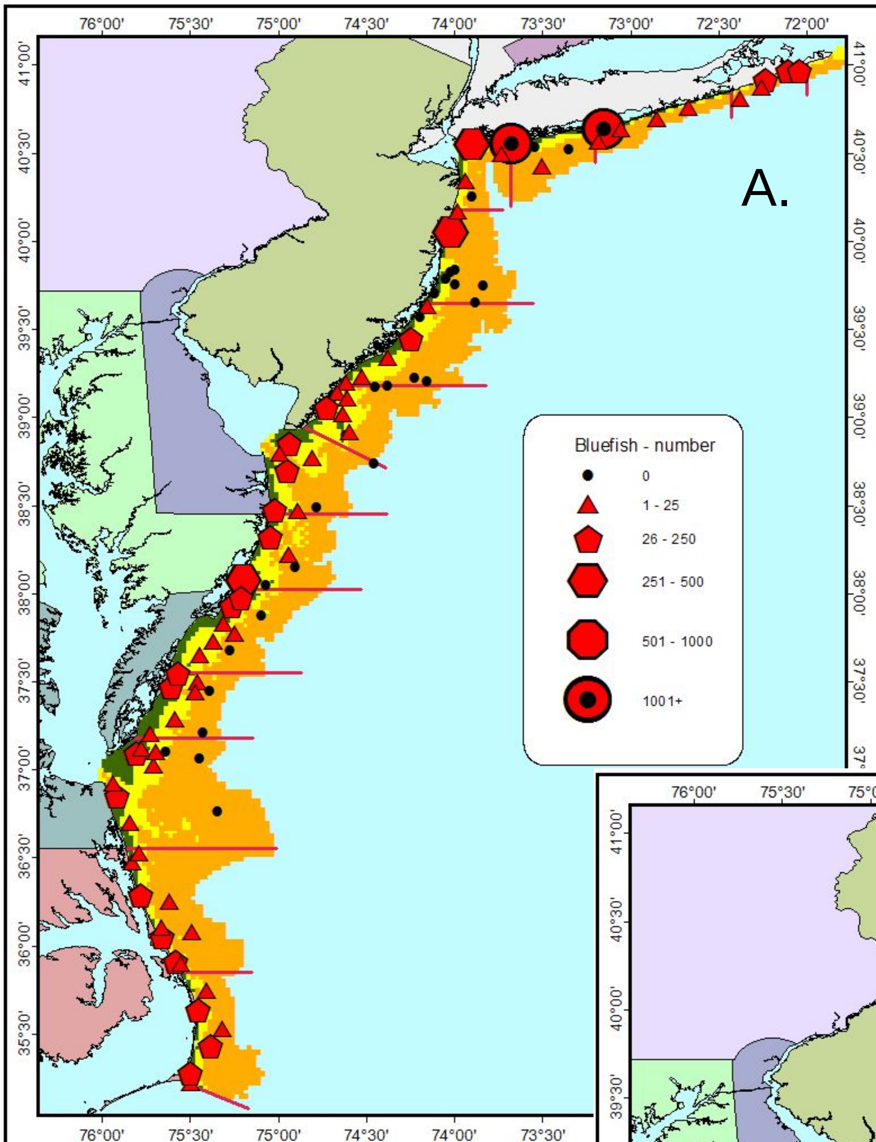


Figure 19. Diet composition by number for black seabass.



Bluefish



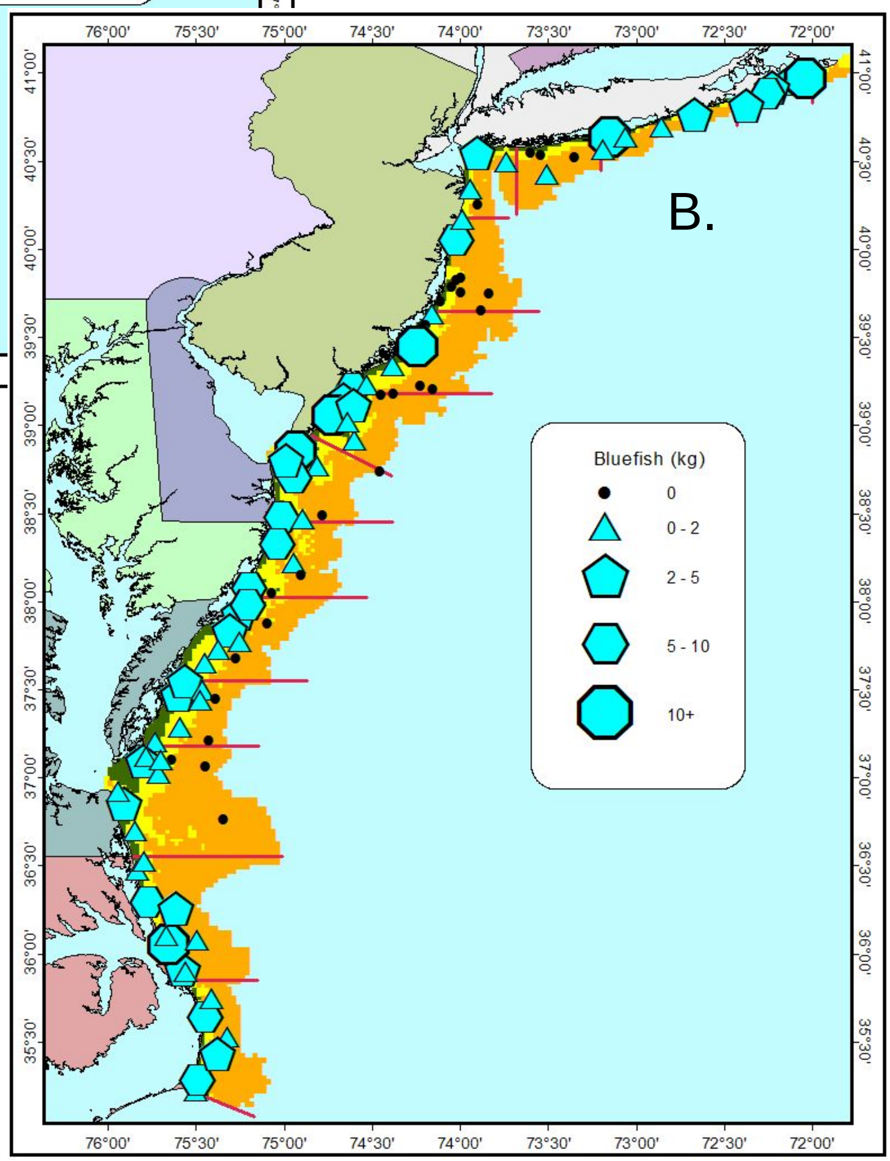


Figure 20. Number (A) and biomass (B) of specimens captured at each station for bluefish.

Figure 21. Minimum trawlable number and biomass by state for bluefish.

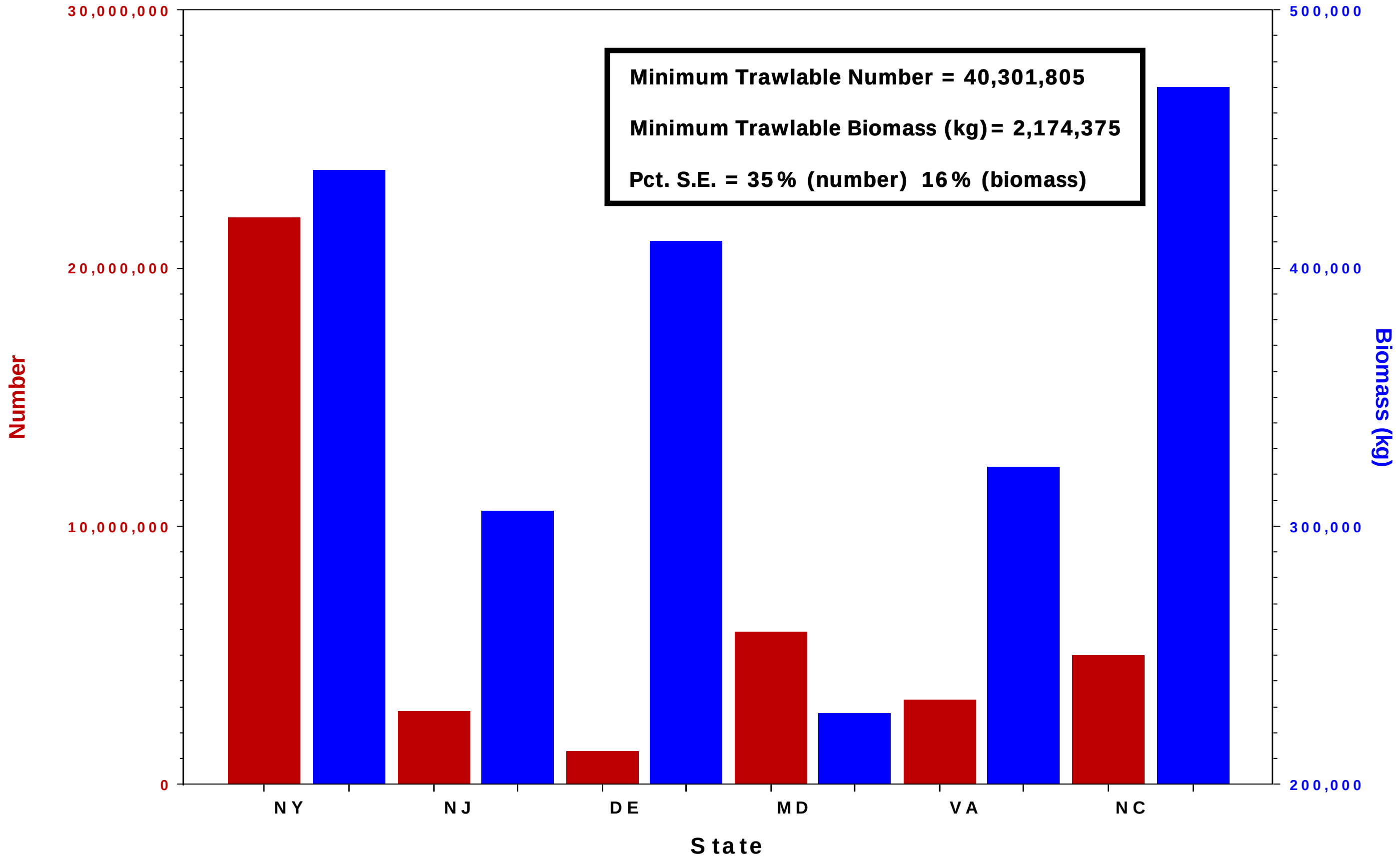


Figure 22. Sex ratios by state for bluefish.

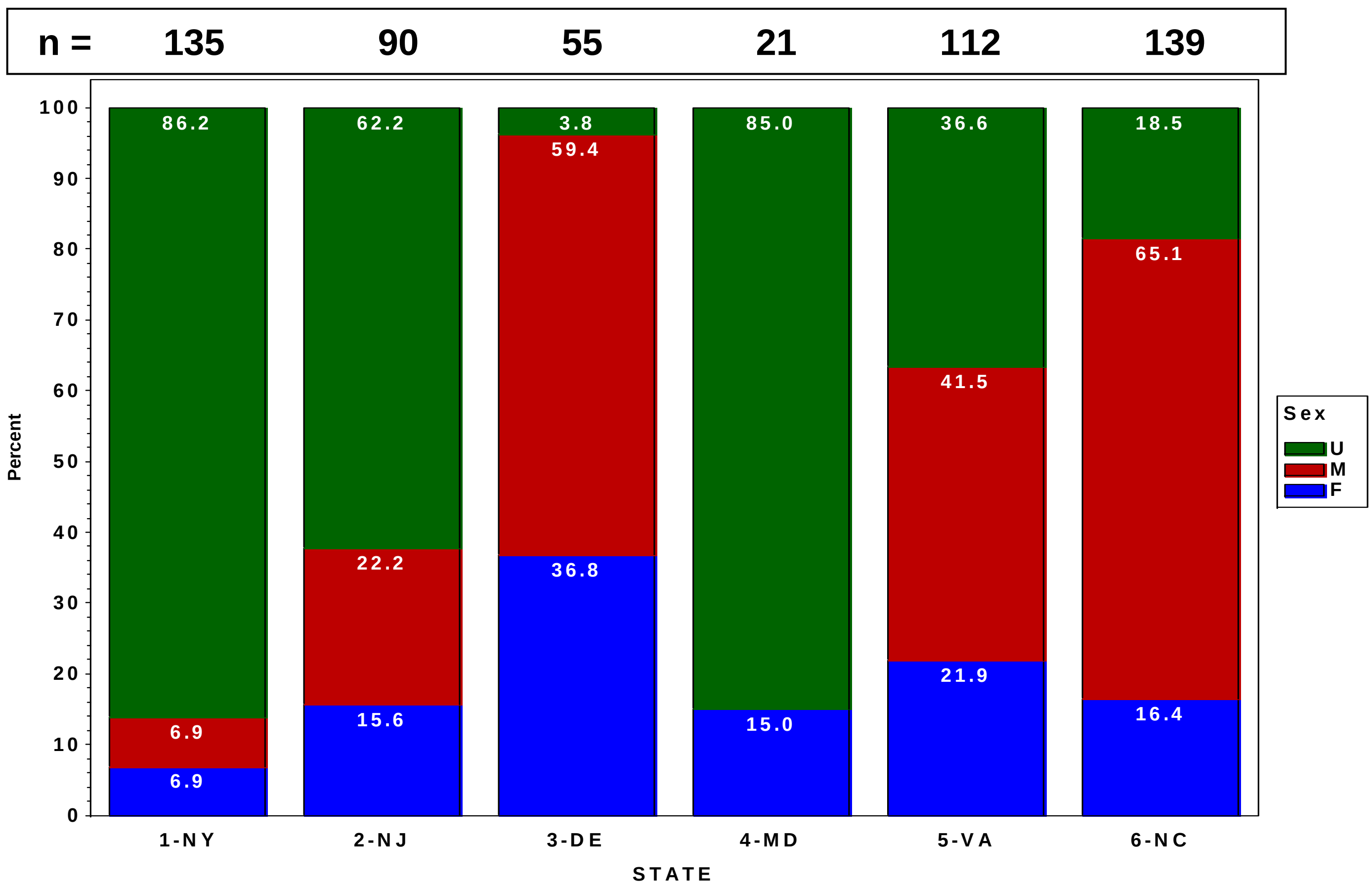


Figure 23. Length frequency for bluefish.

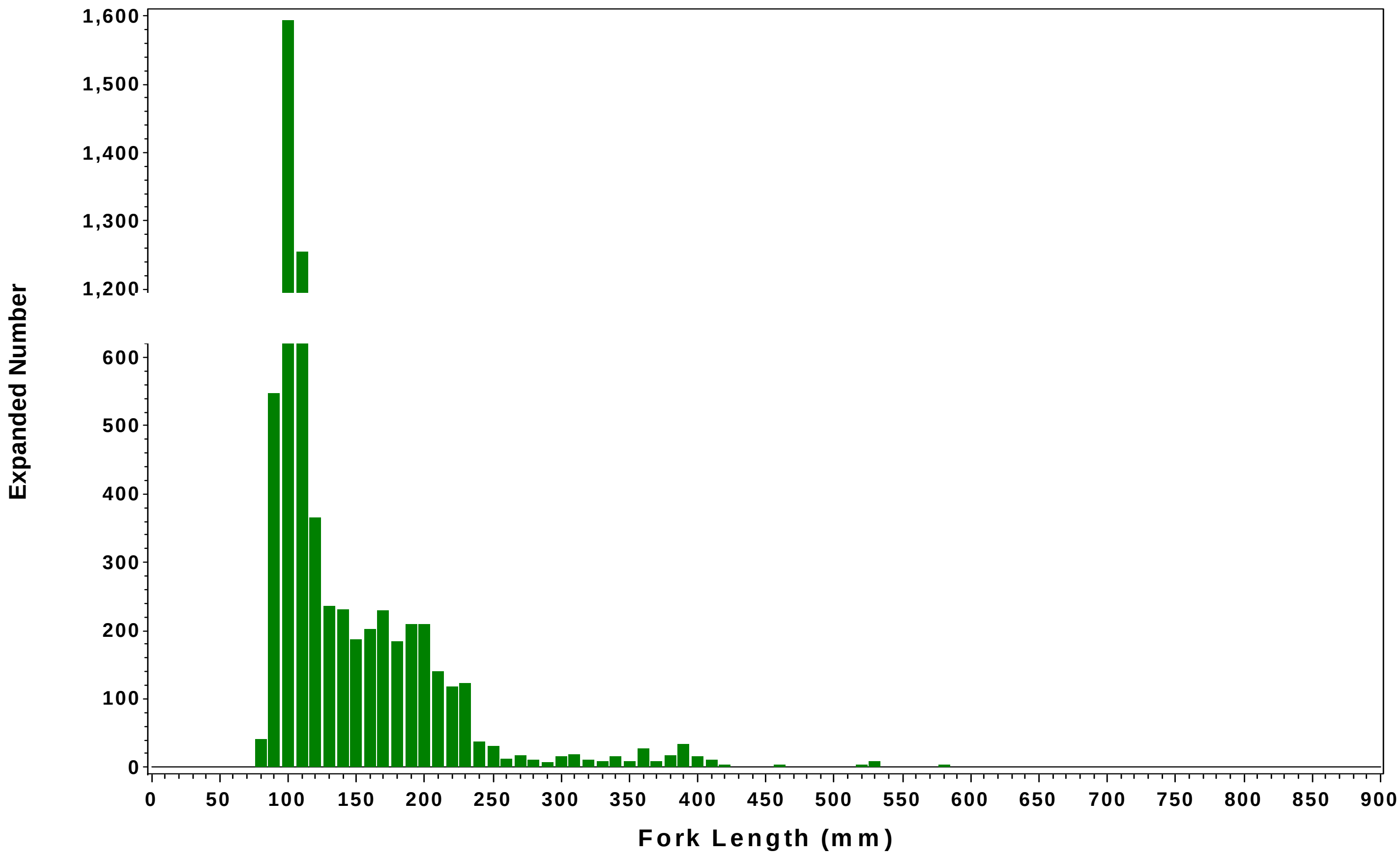


Figure 24. Length-weight regression for bluefish, sexes combined.

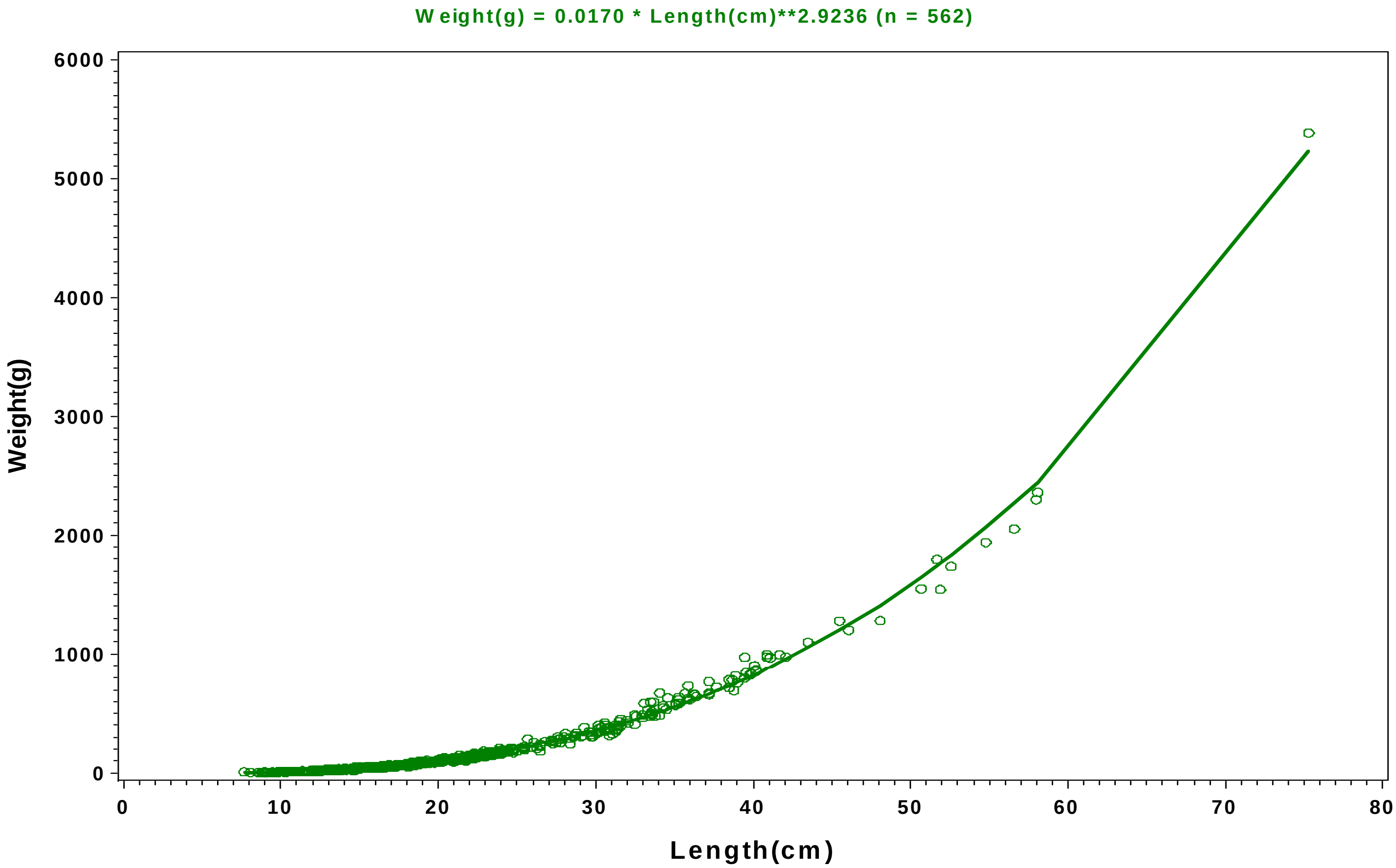


Figure 25. Length-weight regression for bluefish by sex.

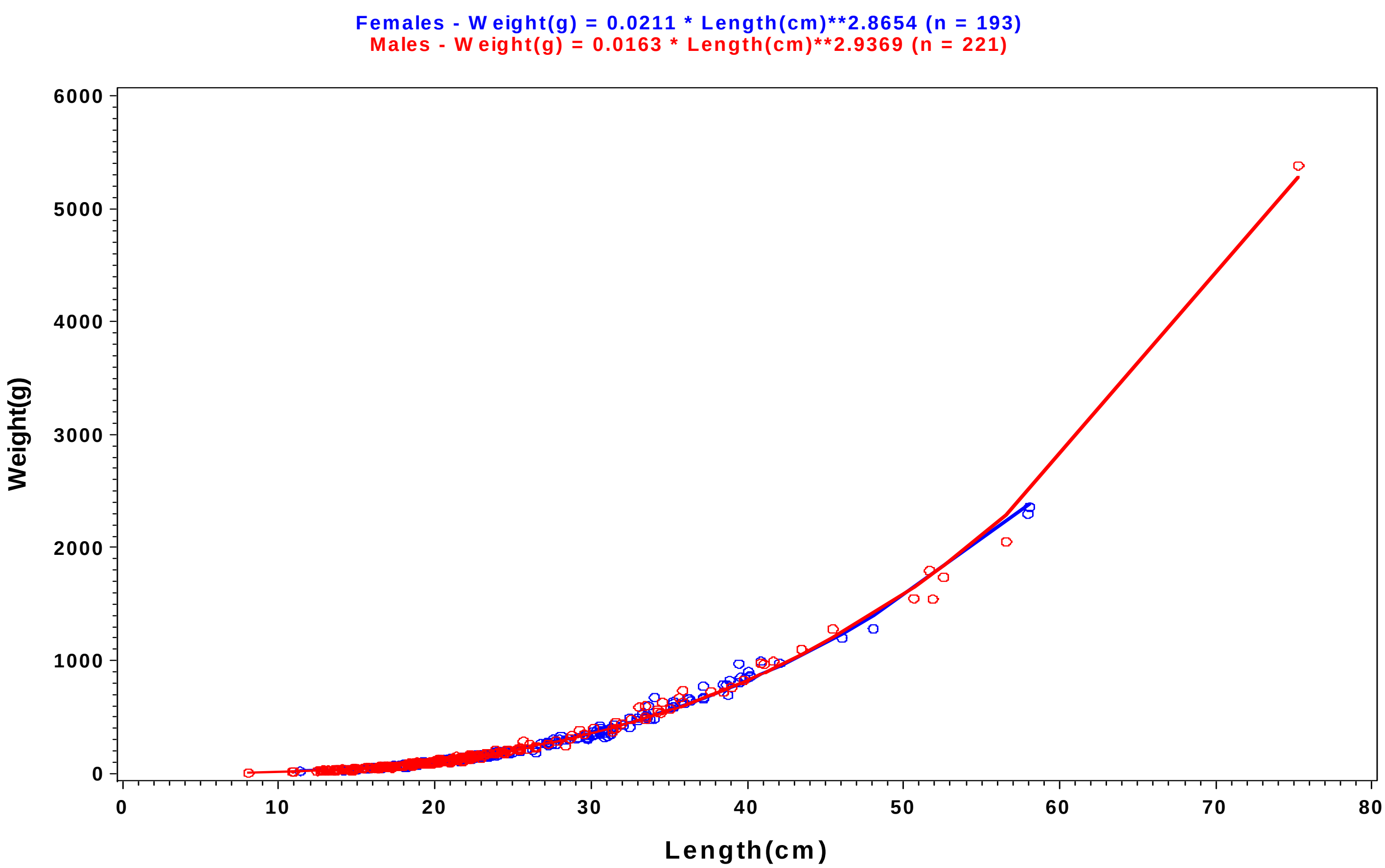


Figure 26. Maturity logistic regression for bluefish, females.

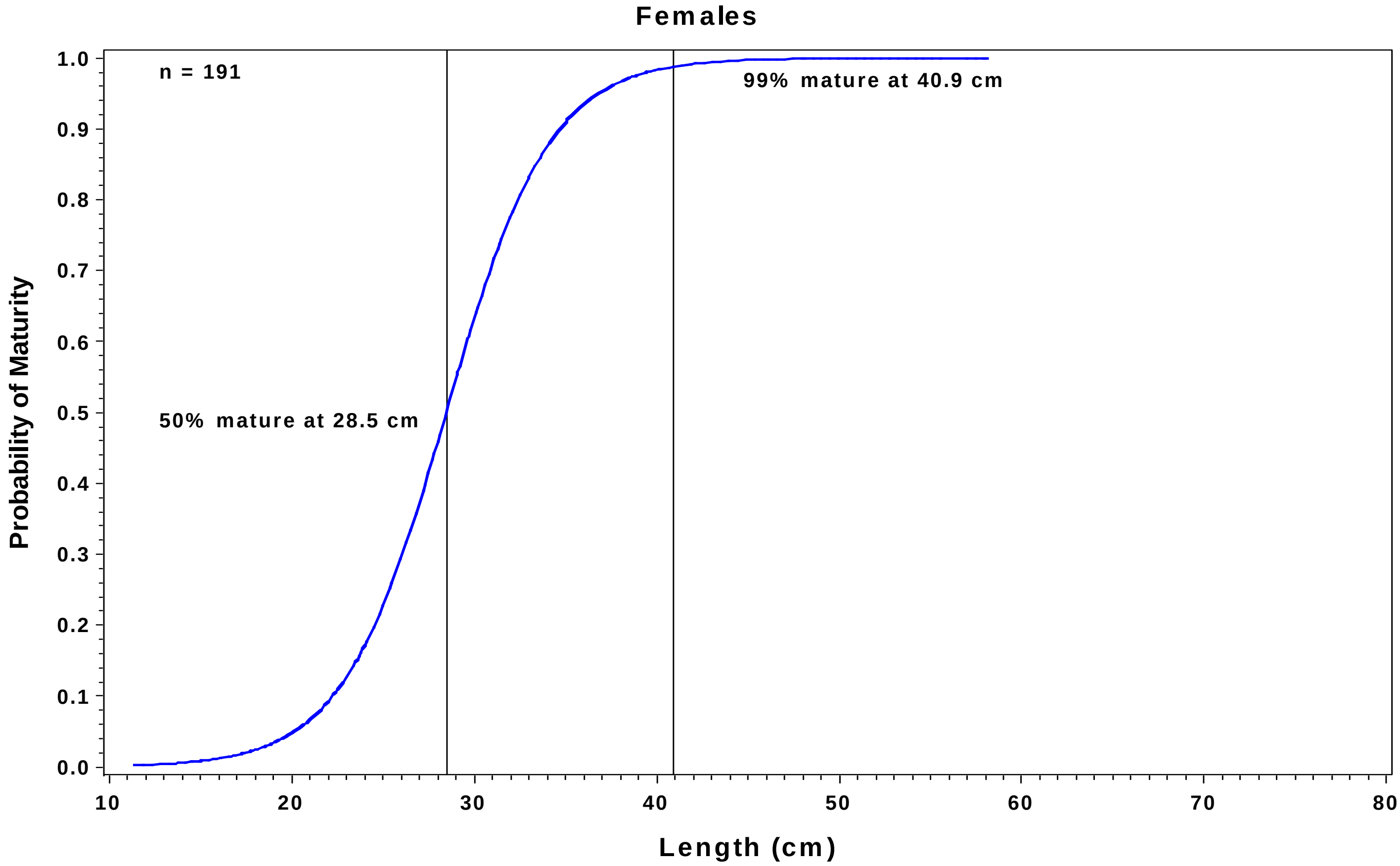


Figure 27. Maturity logistic regression for bluefish, females.

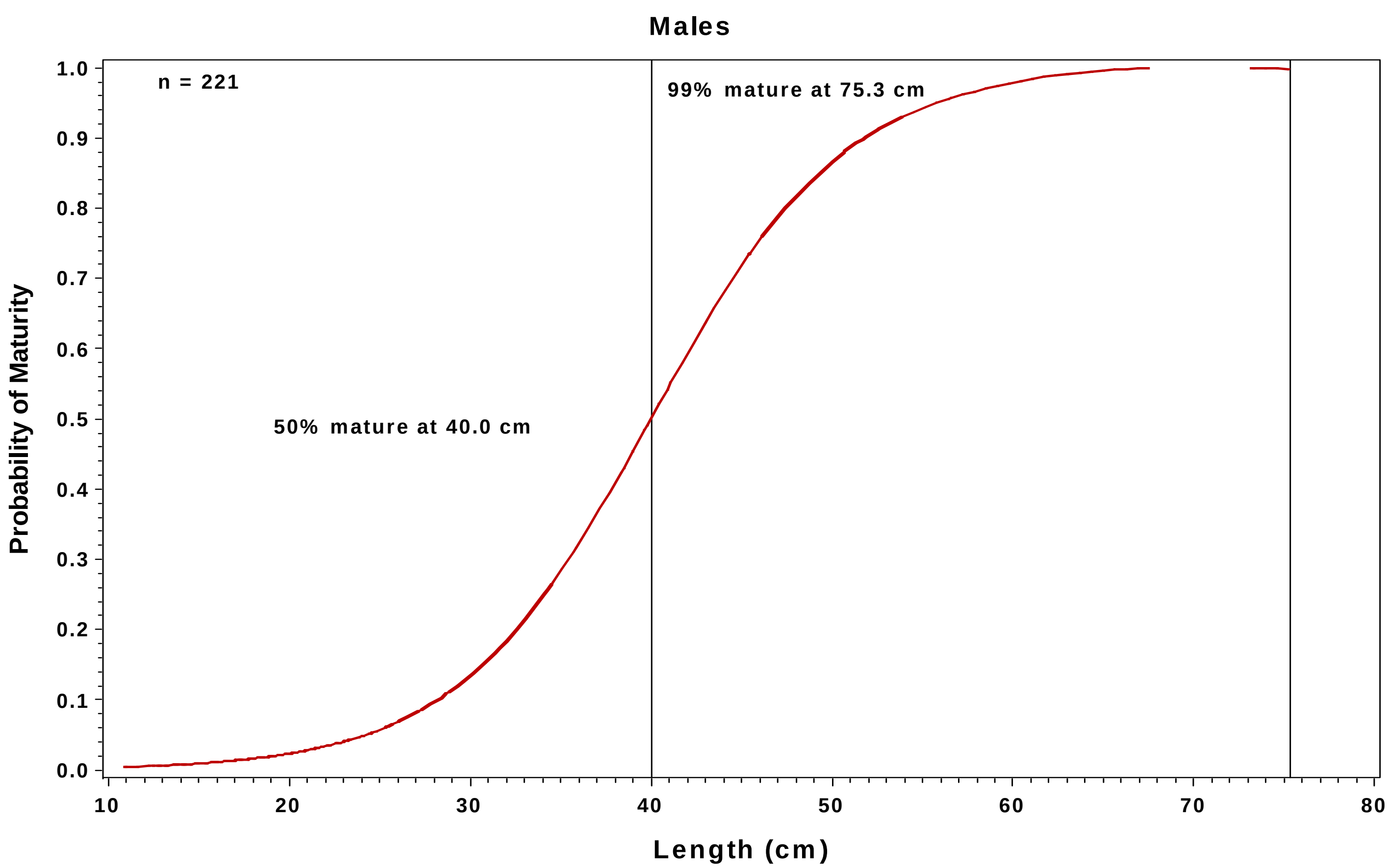


Figure 28. Diet composition by weight for bluefish.

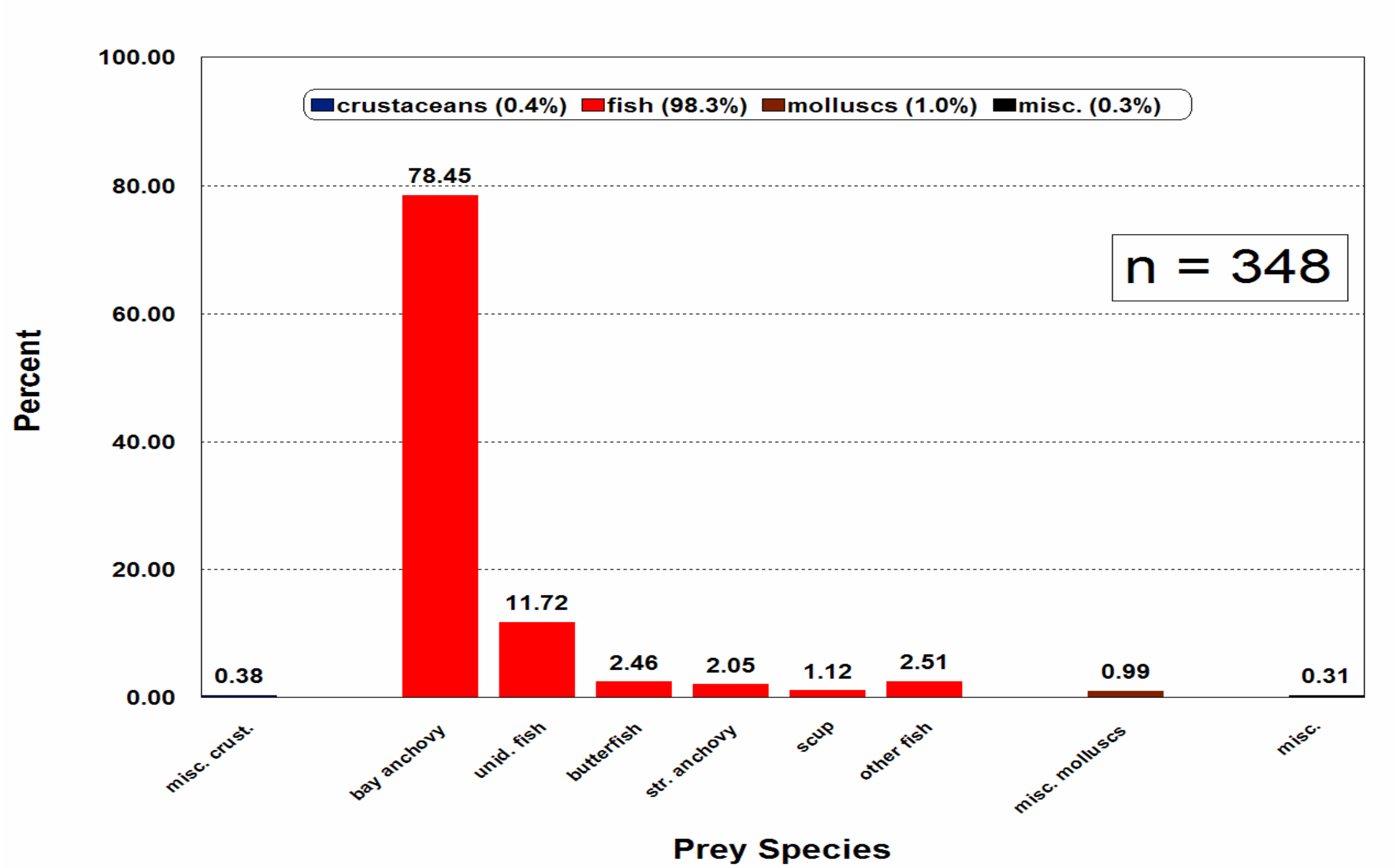
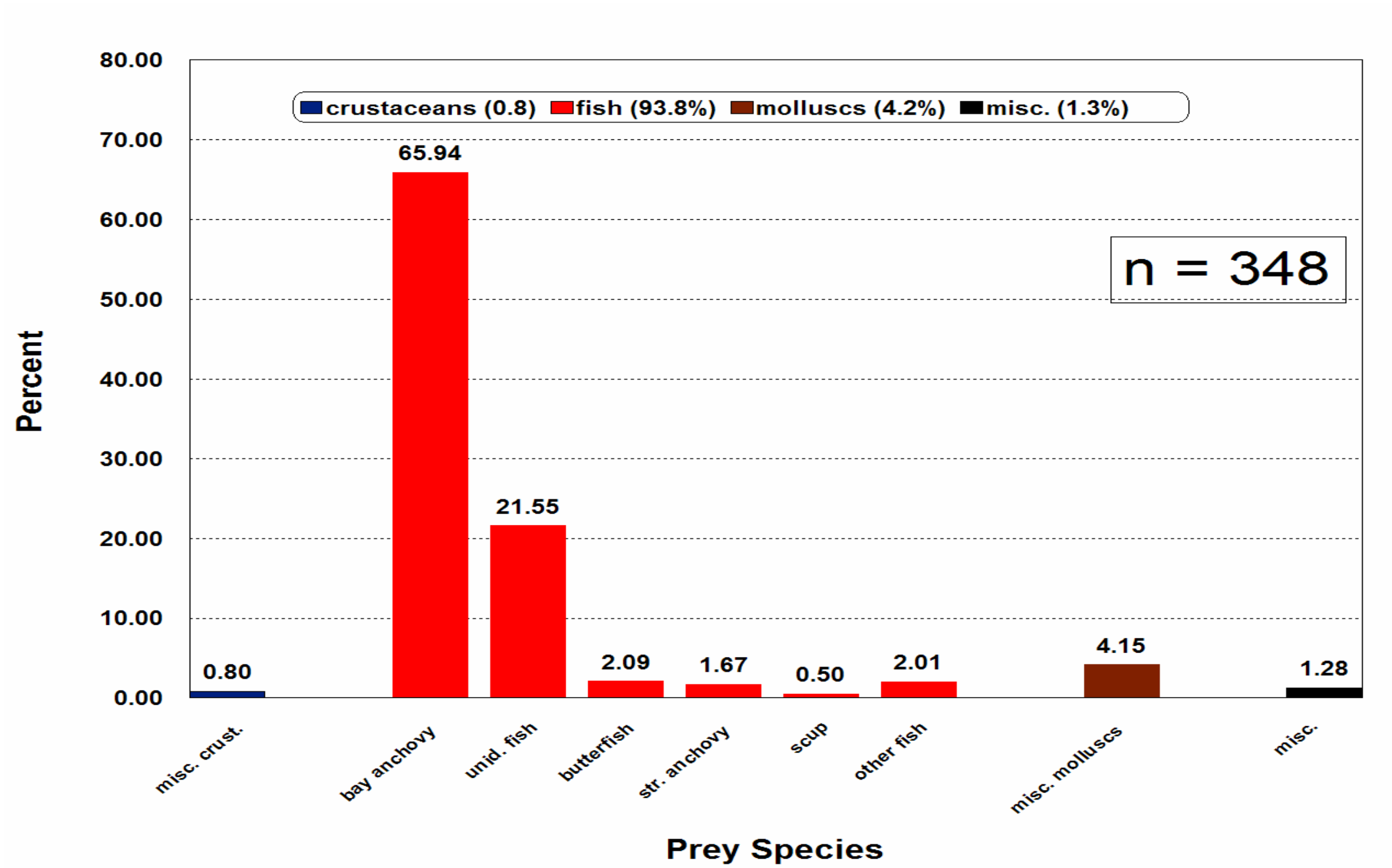
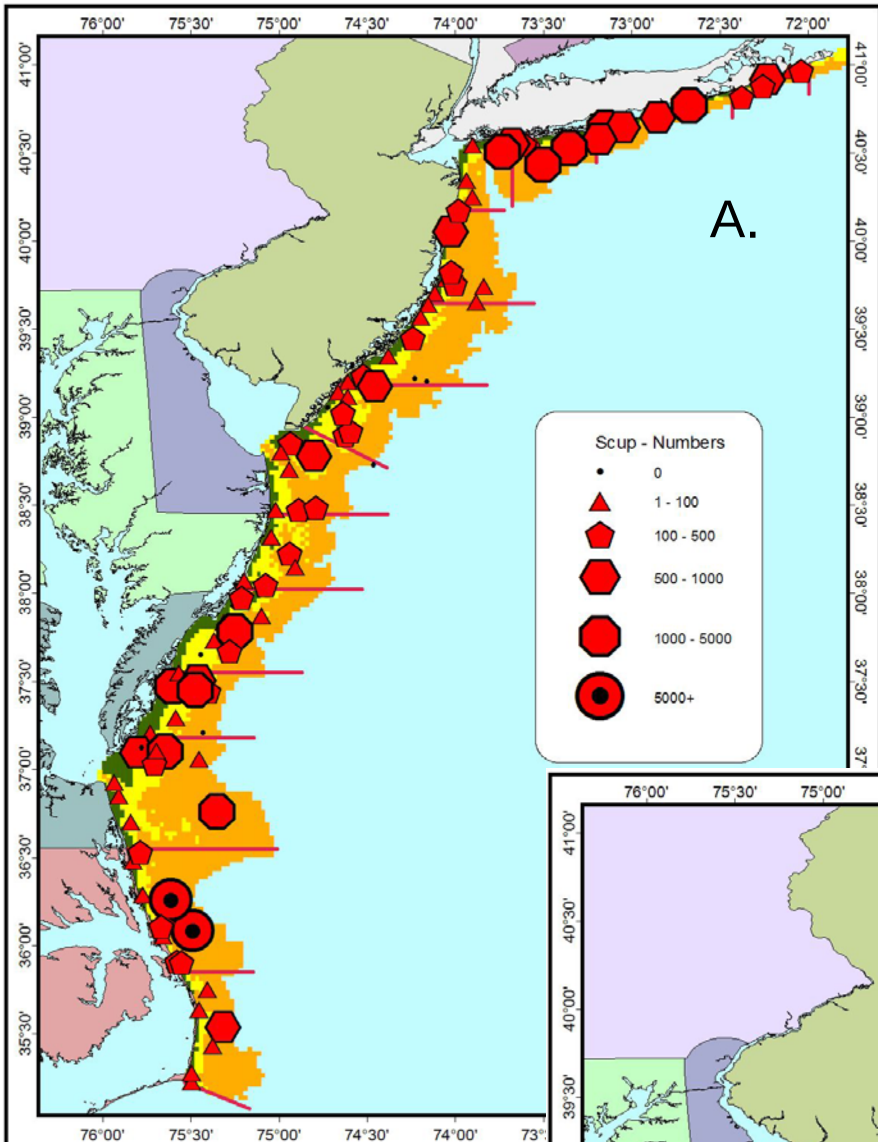


Figure 29. Diet composition by number for bluefish.



Scup



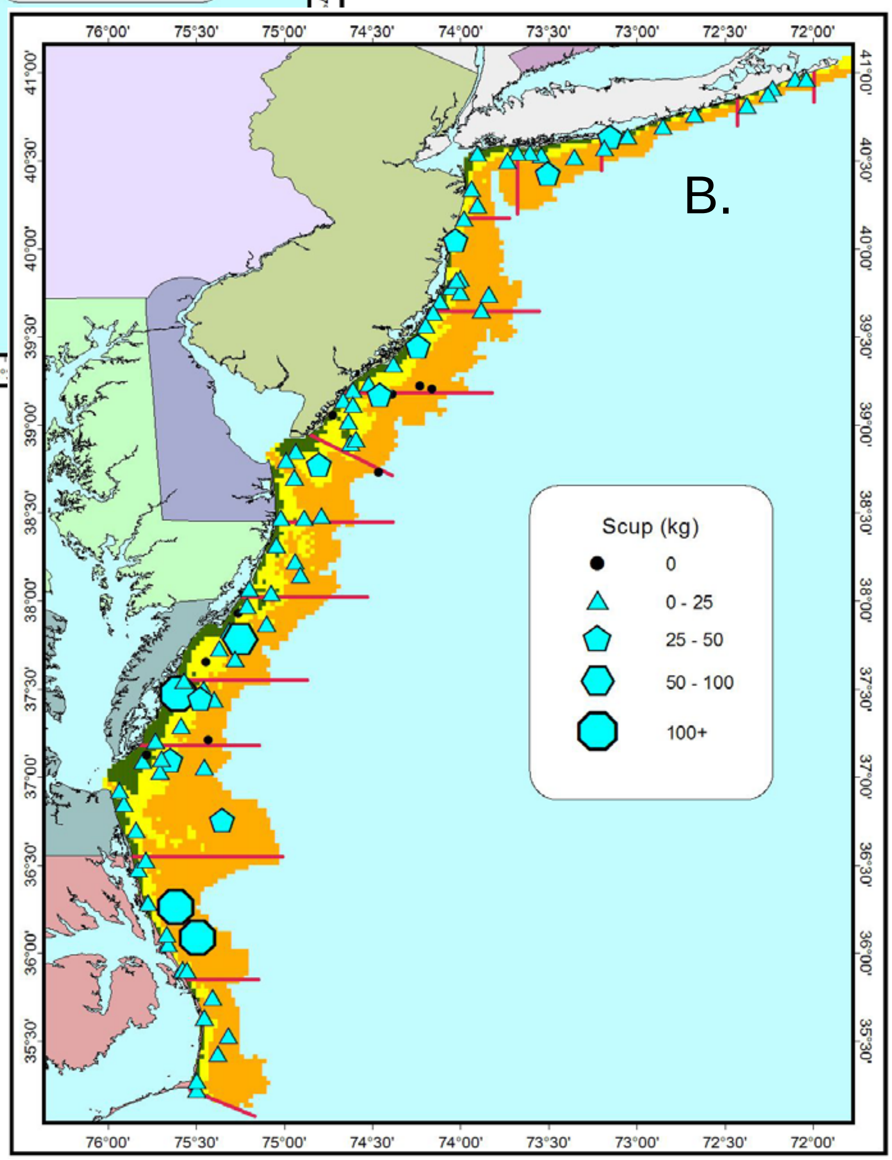


Figure 30. Number (A) and biomass (B) of specimens captured at each station for scup.

Figure 31. Minimum trawlable number and biomass by state for scup

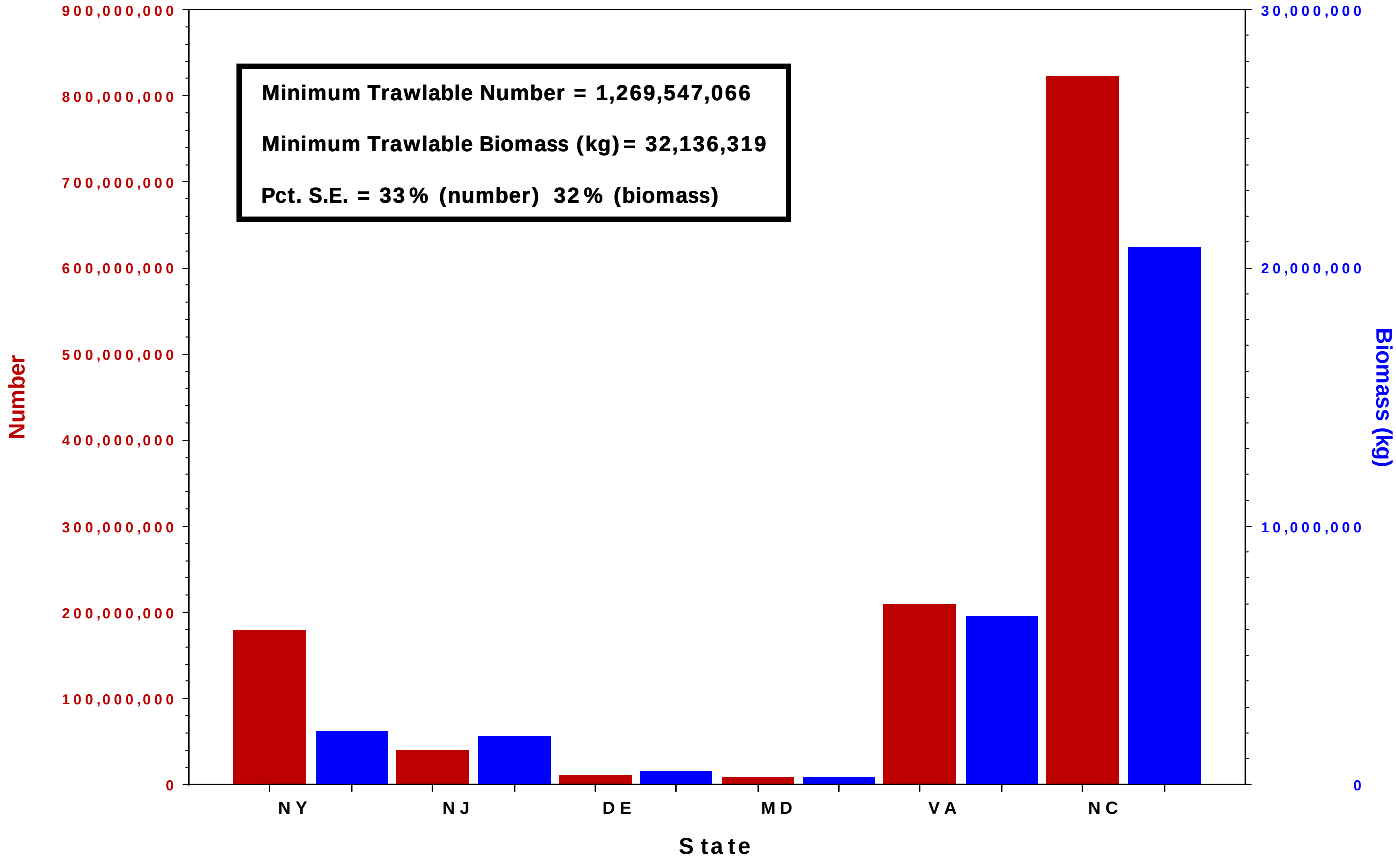


Figure 32. Sex ratios by state for scup.

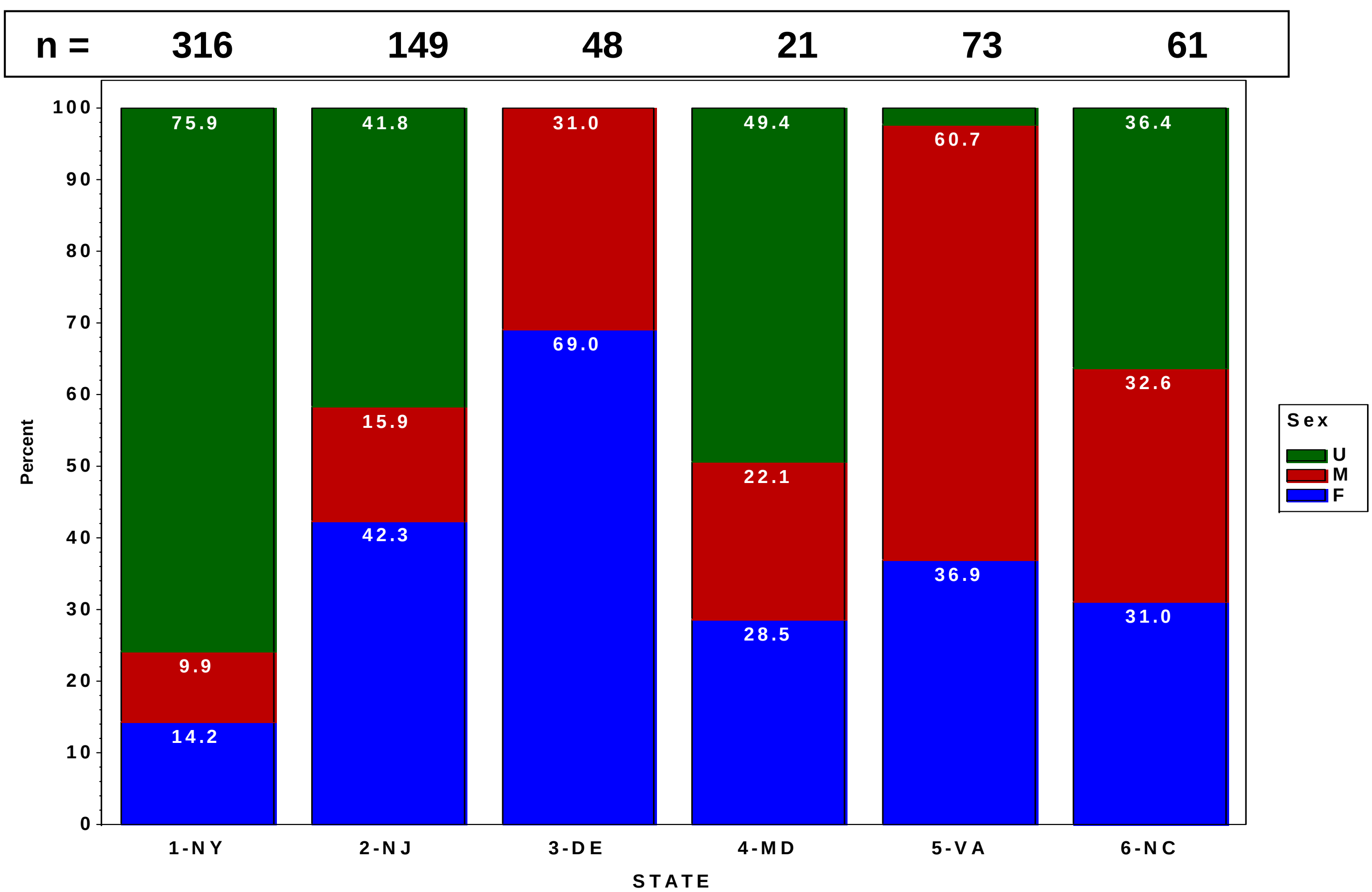


Figure 33. Length frequency for scup.

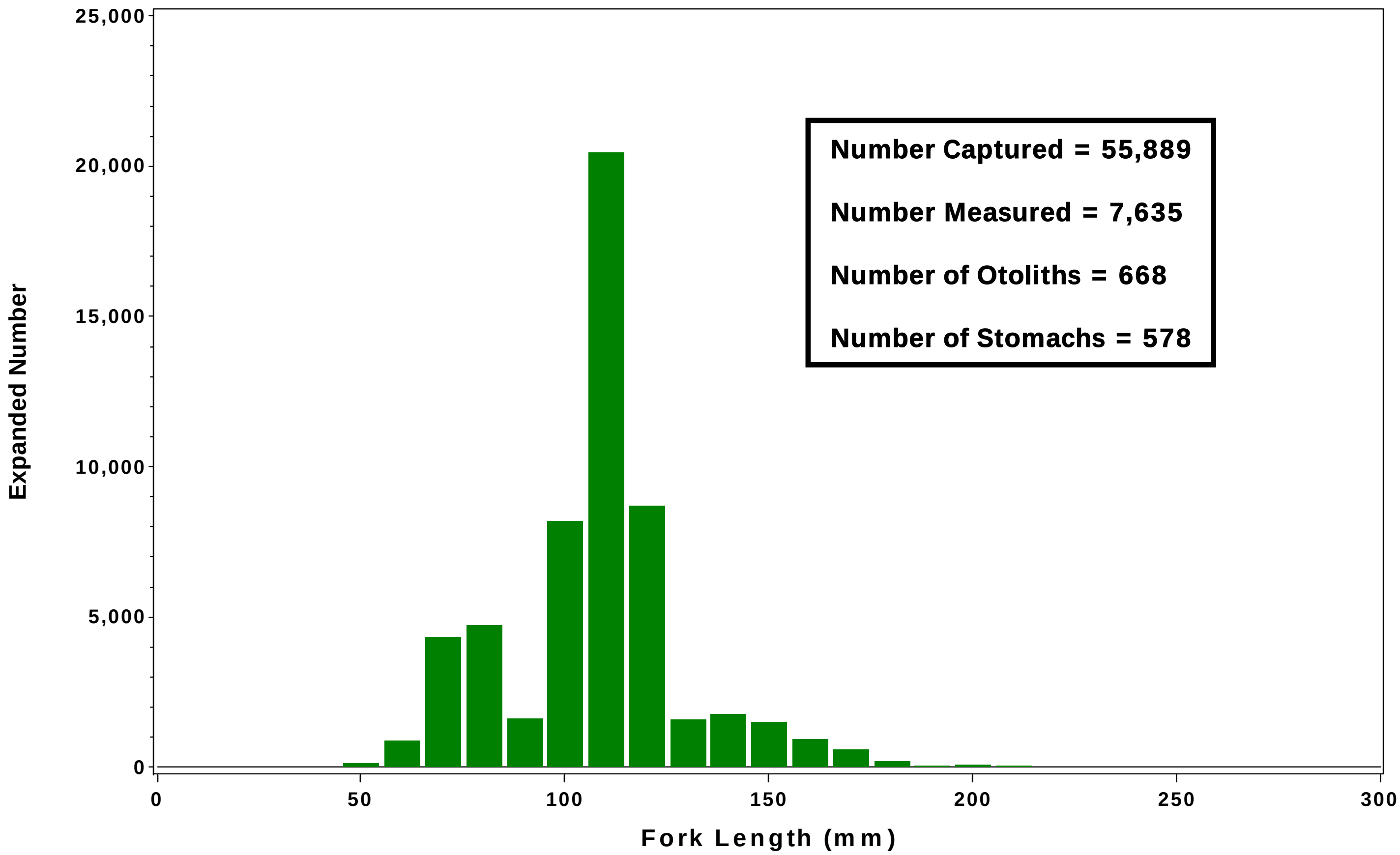


Figure 34. Length-weight regression for scup, sexes combined.

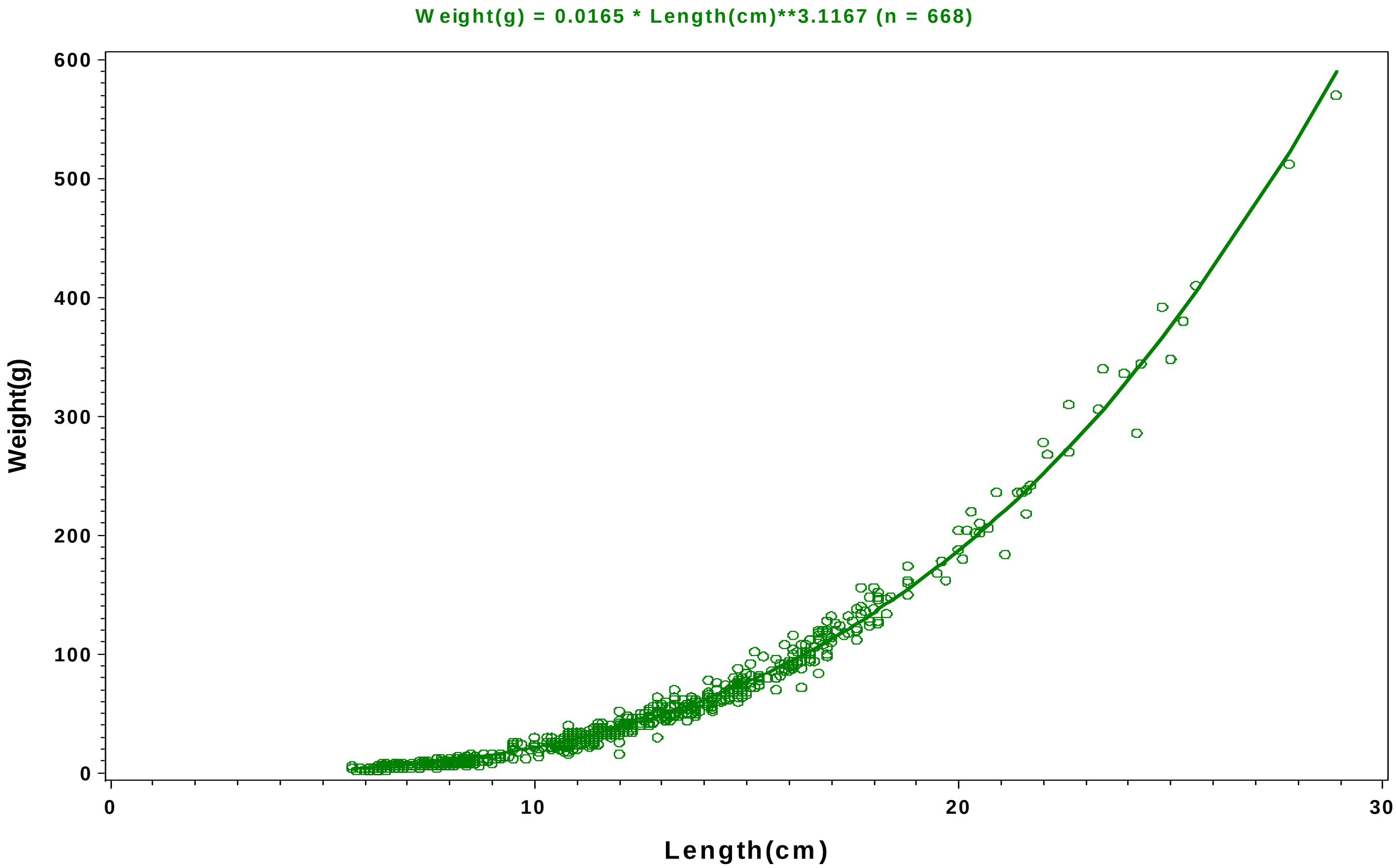


Figure 35. Length-weight regression for scup, by sex.

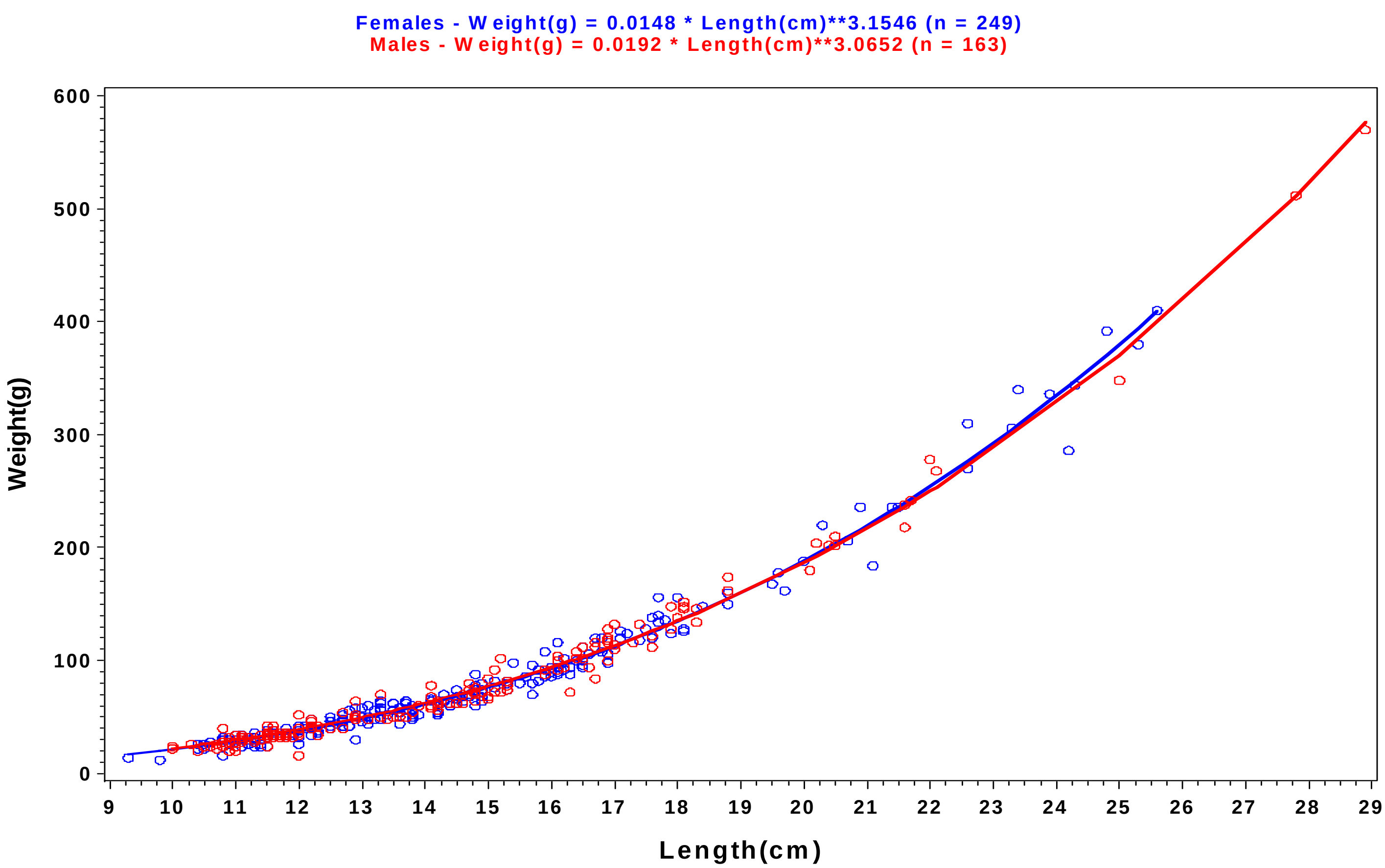


Figure 36. Maturity logistic regression for scup, females.

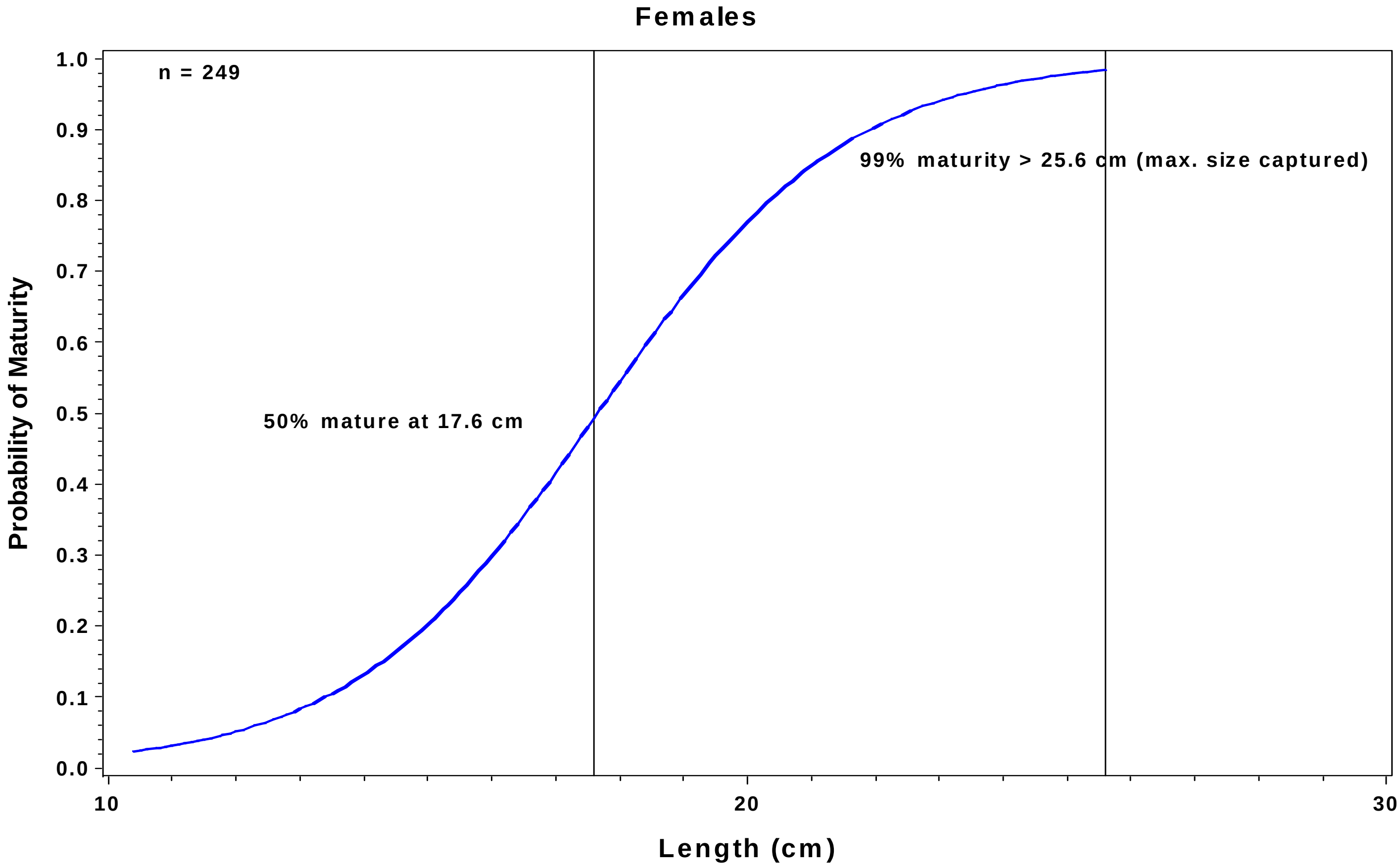
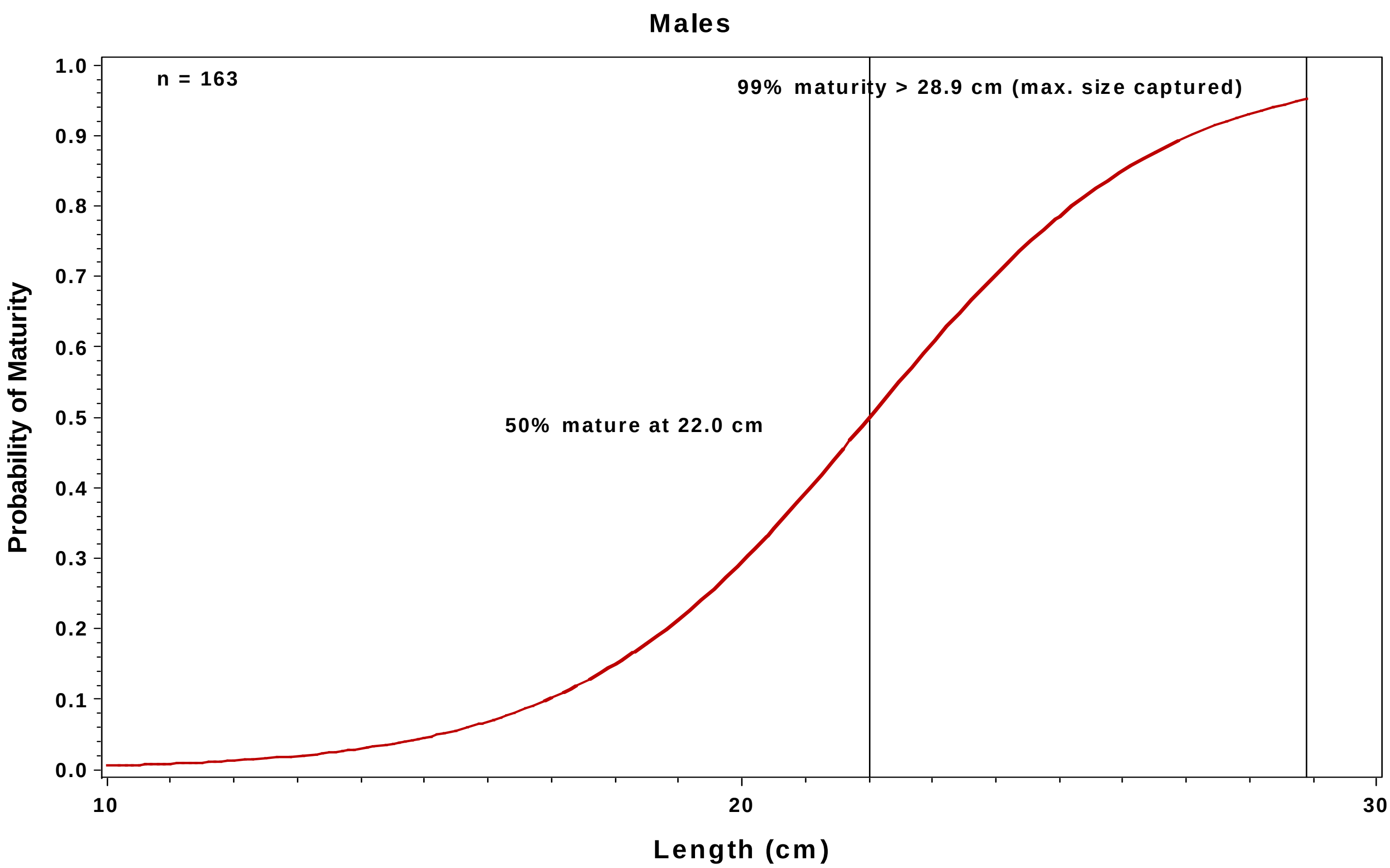
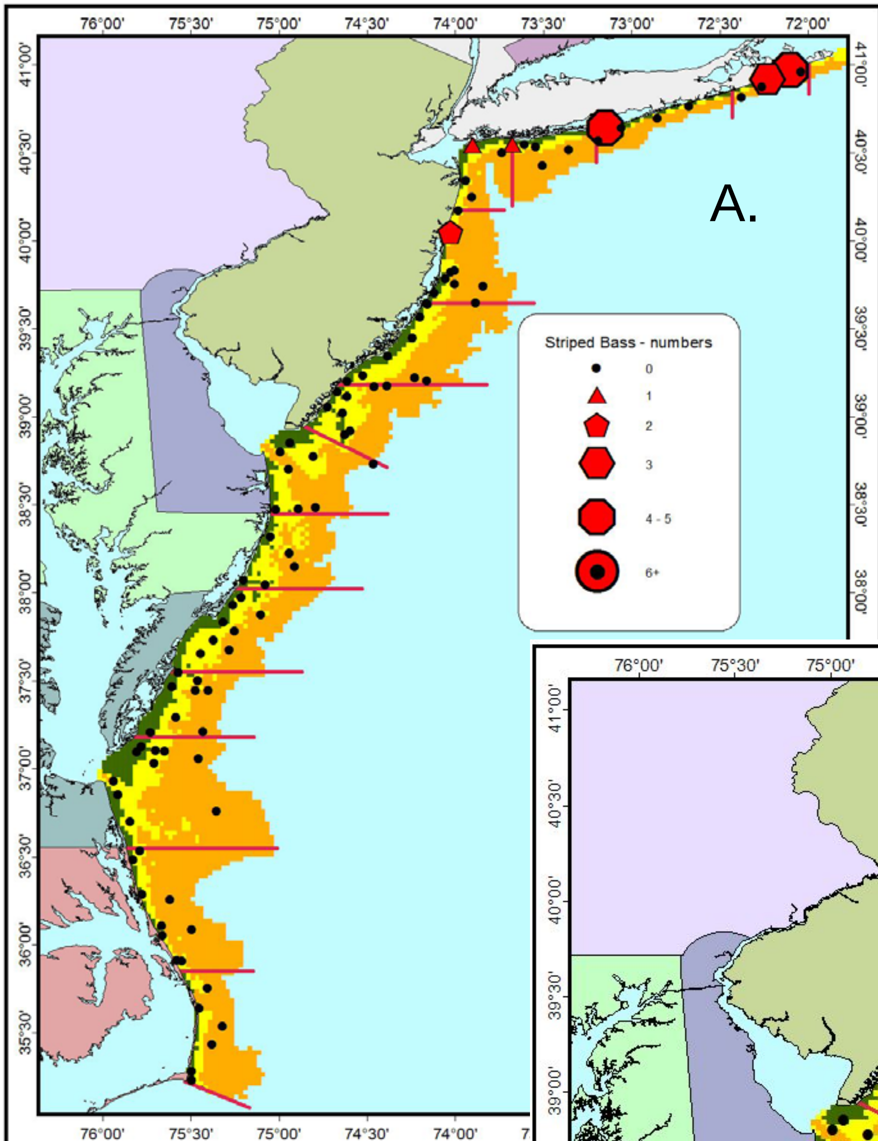


Figure 37. Maturity logistic regression for scup, males.



Striped Bass



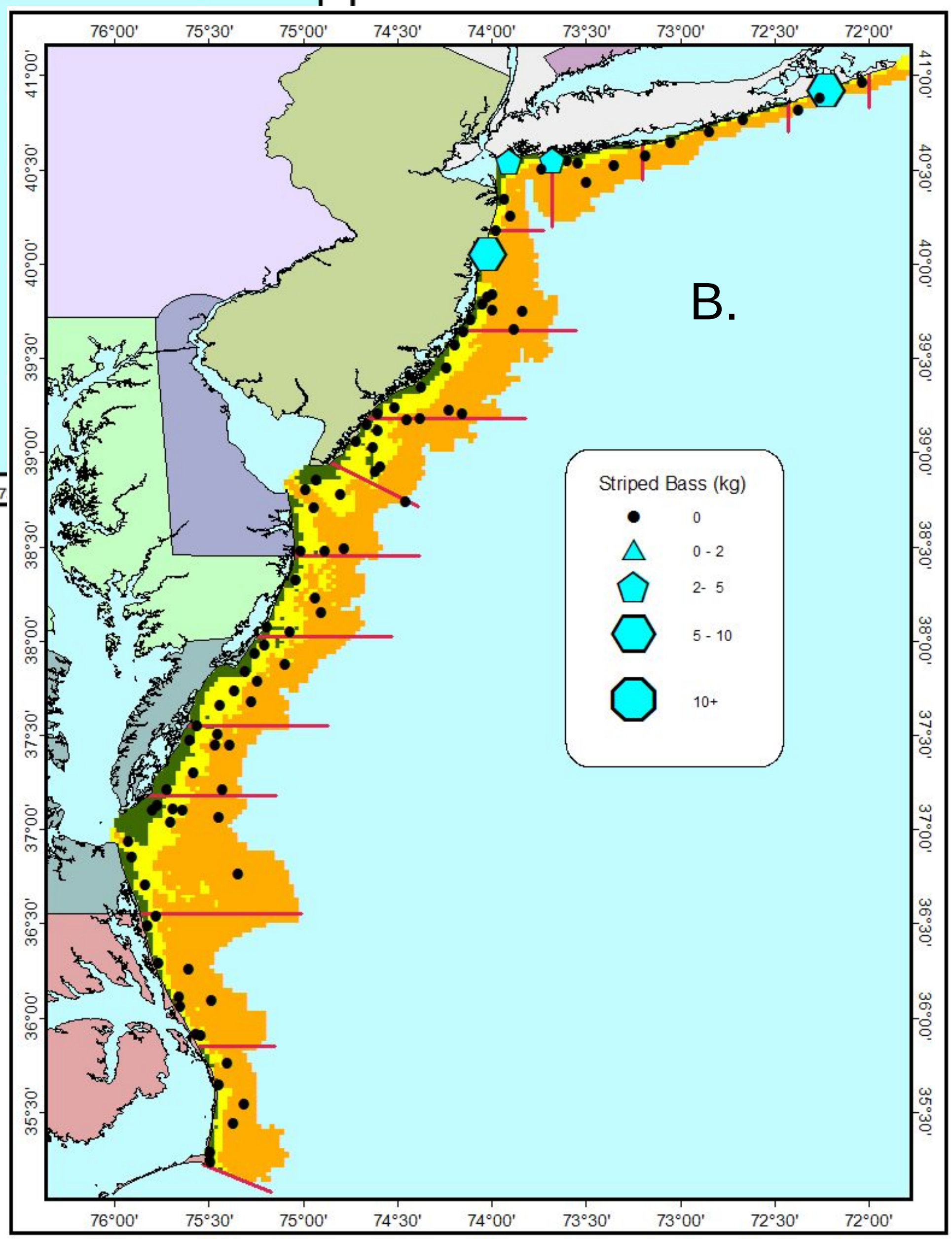


Figure 38. Number (A) and biomass (B) of specimens captured at each station for striped bass.

Figure 39. Minimum trawlable number and biomass by state for striped bass.

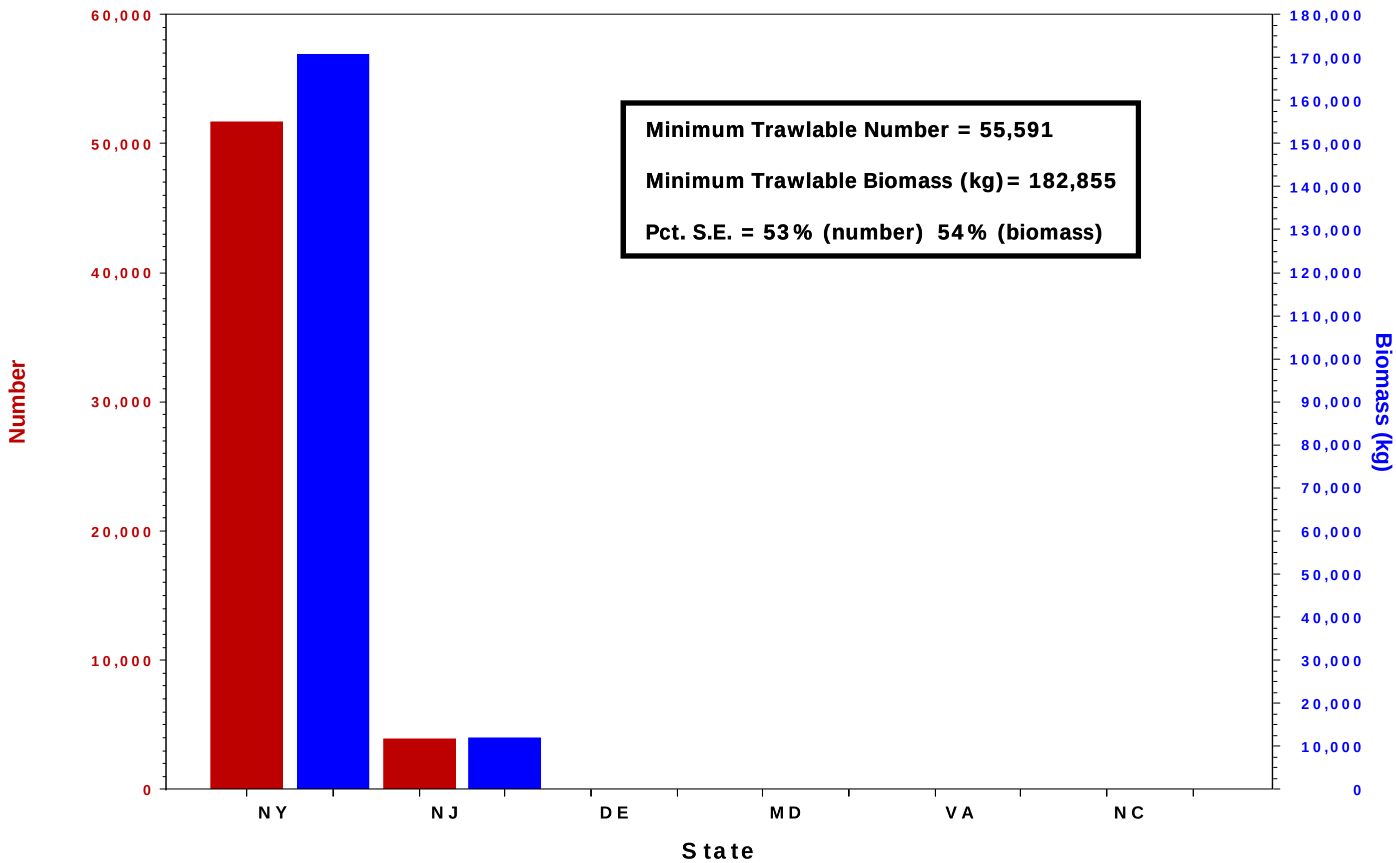


Figure 40. Sex ratios by state for striped bass.

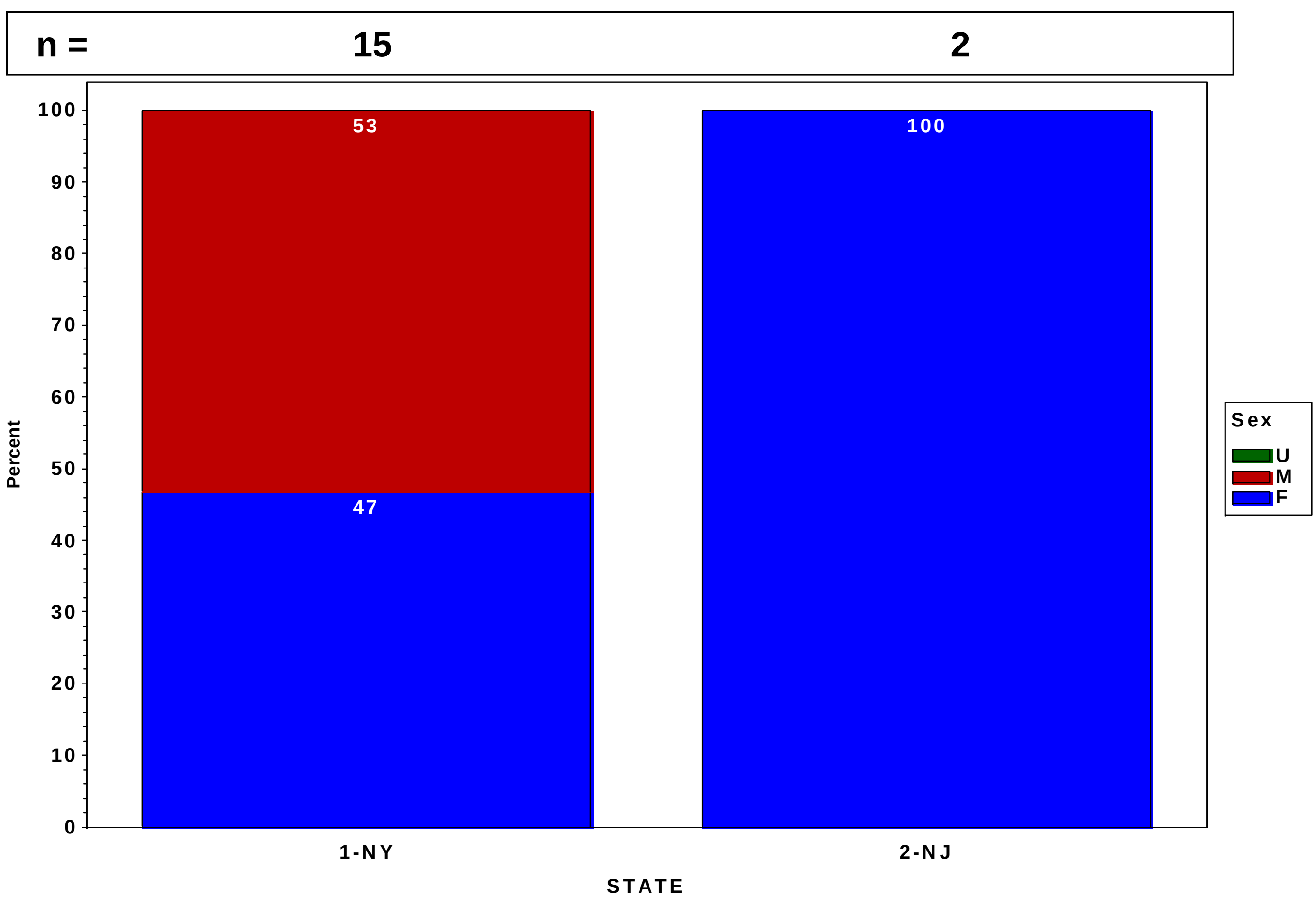


Figure 41. Length frequency for striped bass.

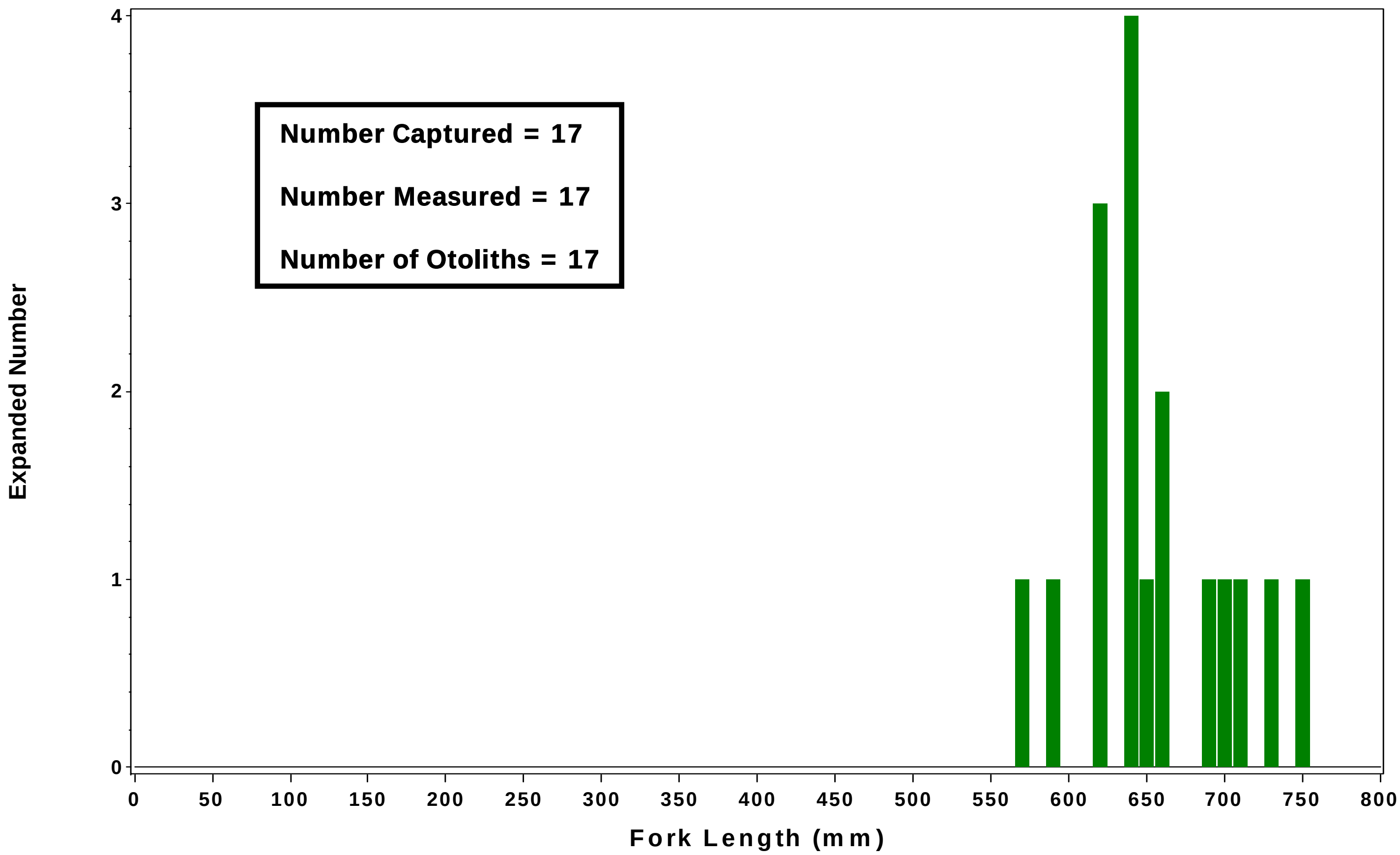


Figure 42. Diet composition by weight for striped bass.

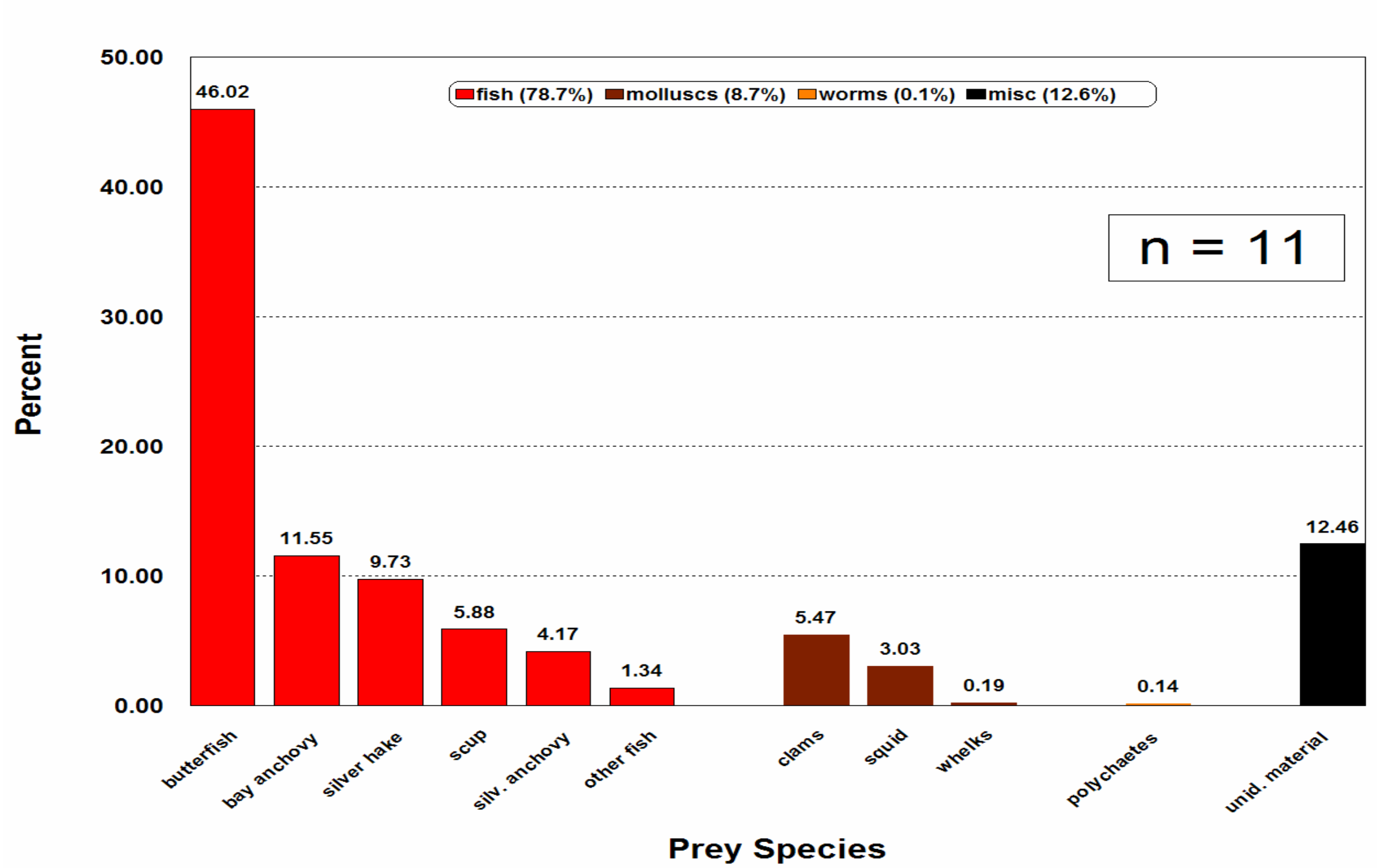
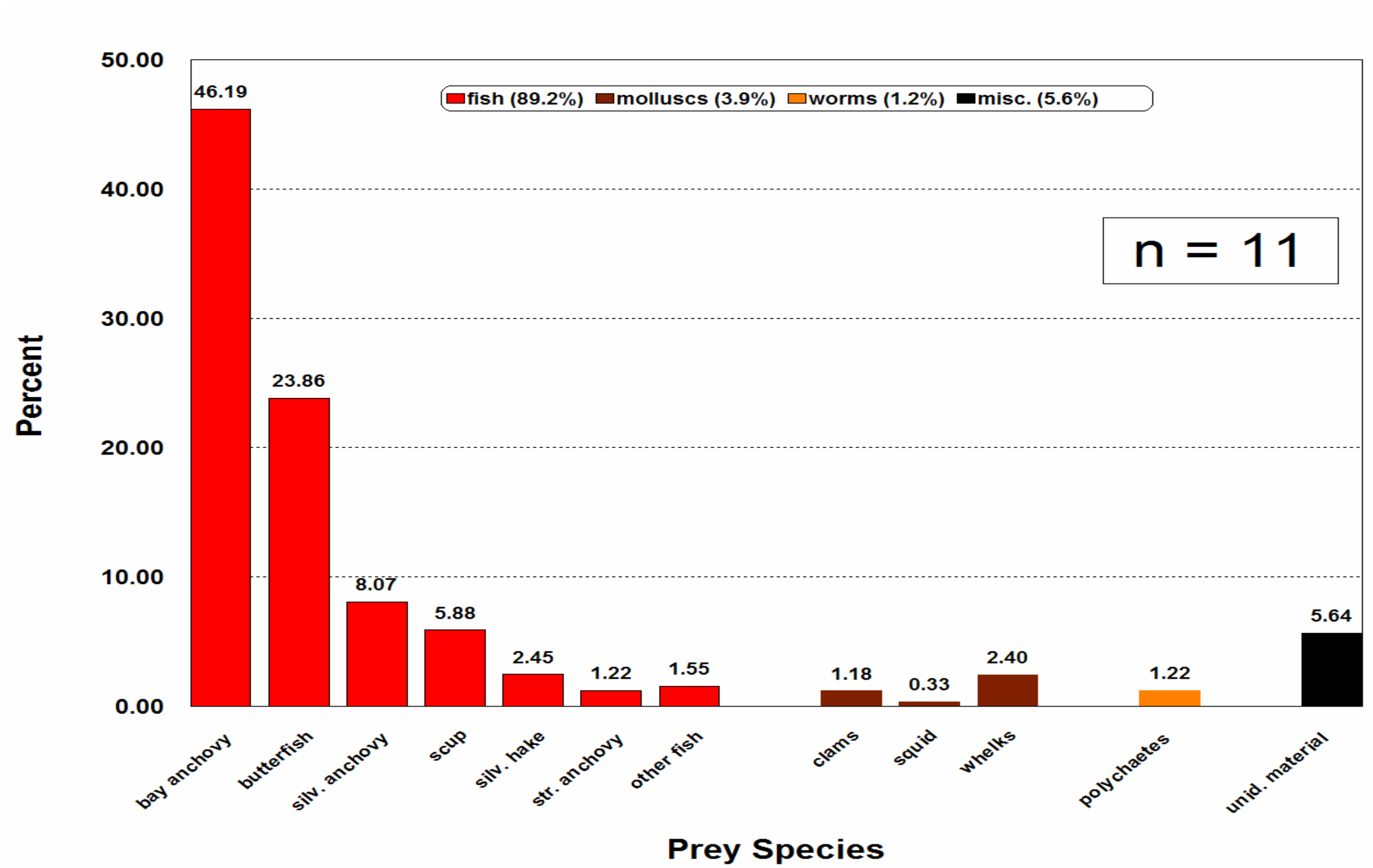
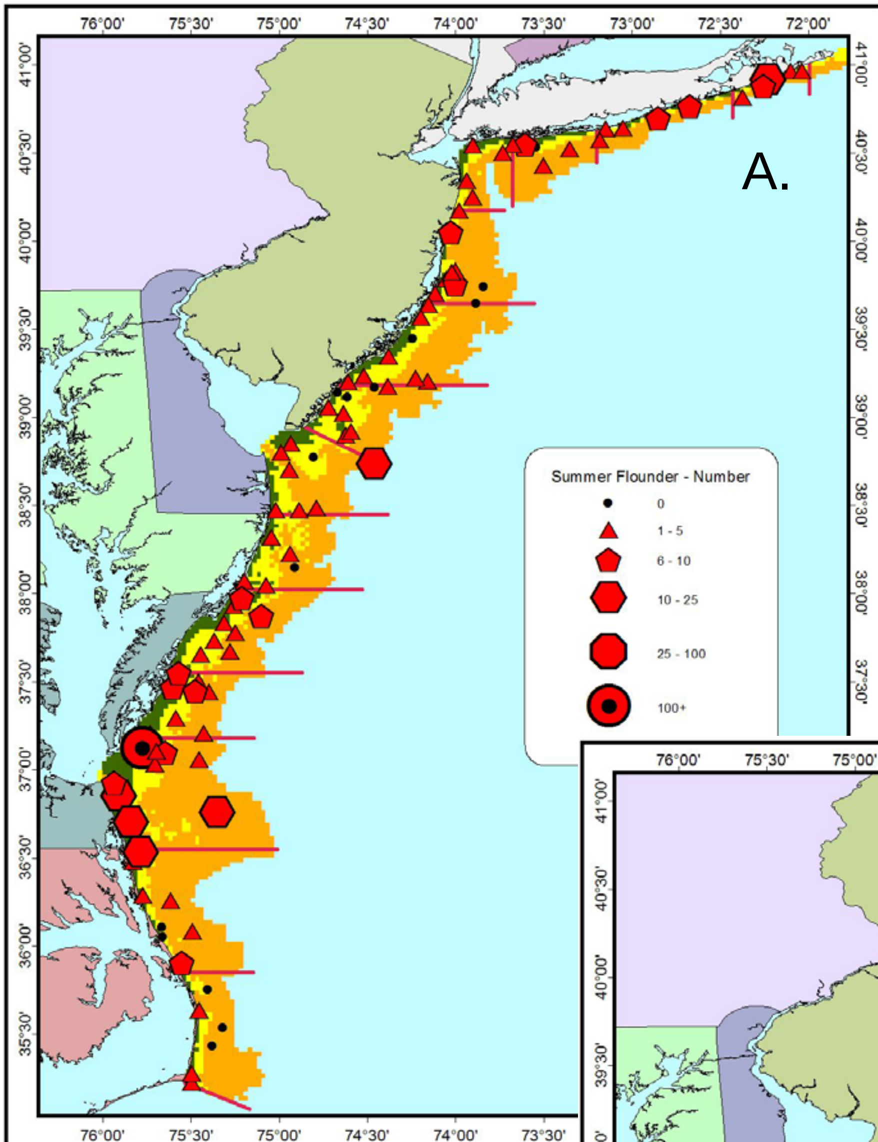


Figure 43. Diet composition by number for striped bass.



Summer Flounder



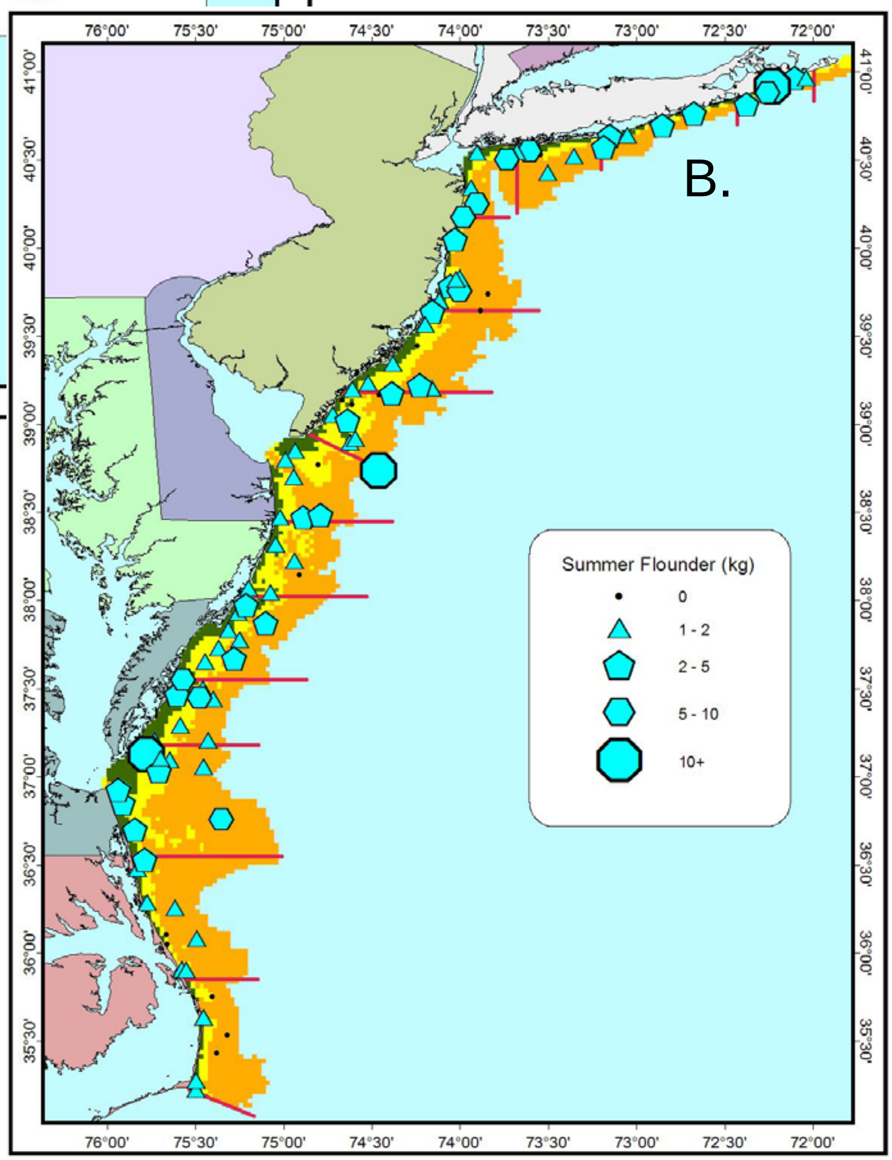


Figure 44. Number (A) and biomass (B) of specimens captured at each station for summer flounder.

Figure 45. Minimum trawlable number and biomass by state for summer flounder.

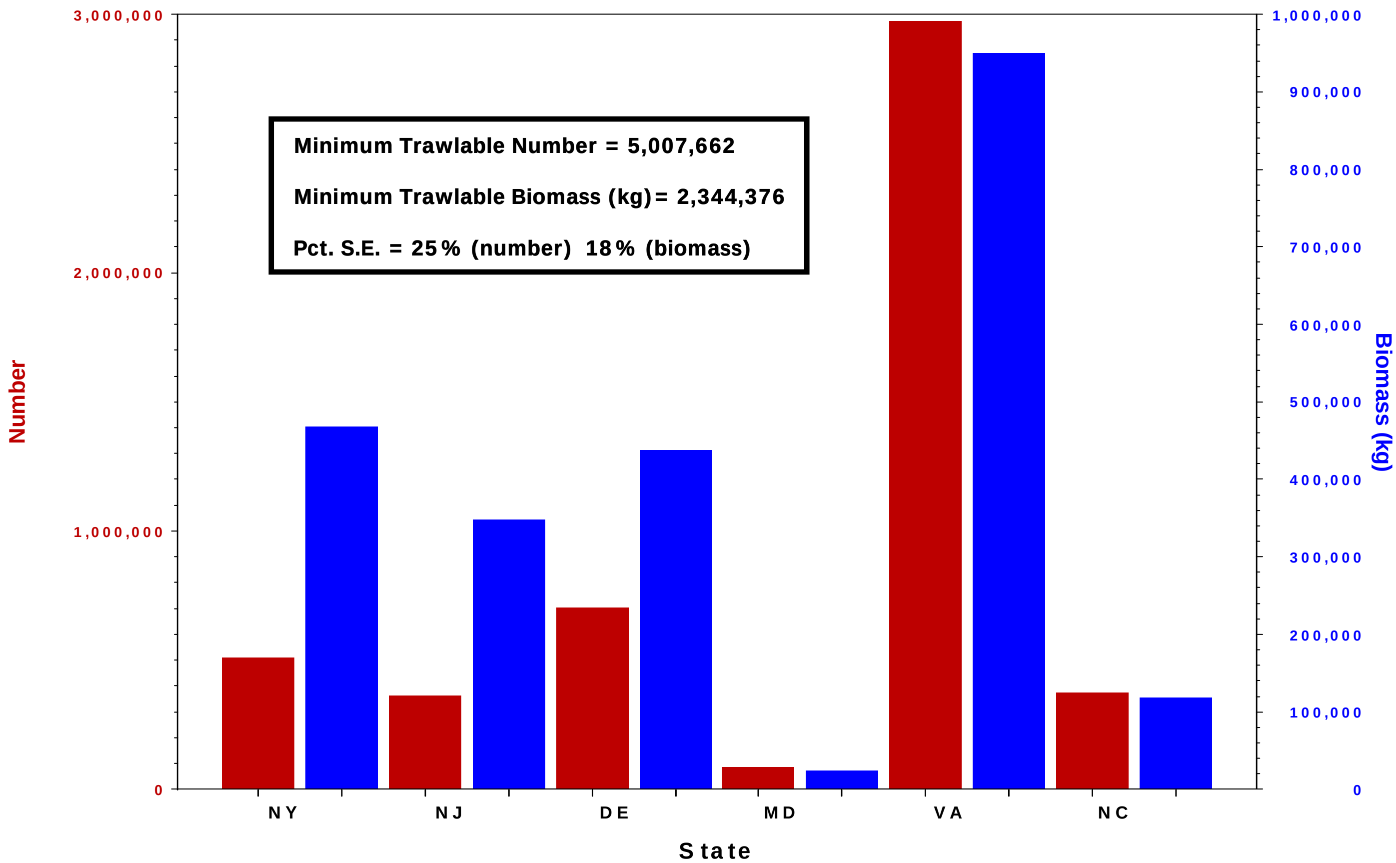


Figure 46. Sex ratios by state for summer flounder.

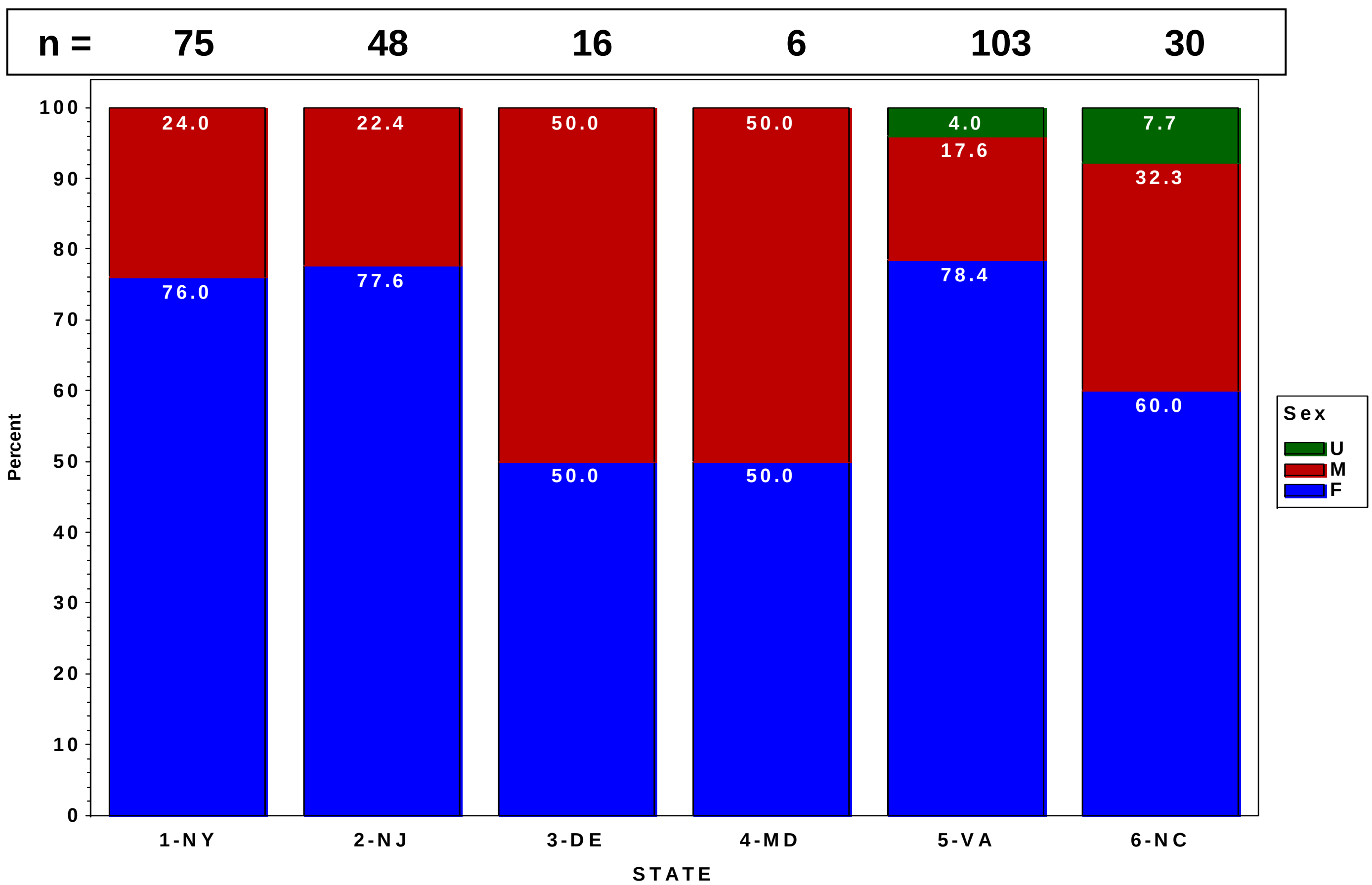


Figure 47. Length frequency for summer flounder.

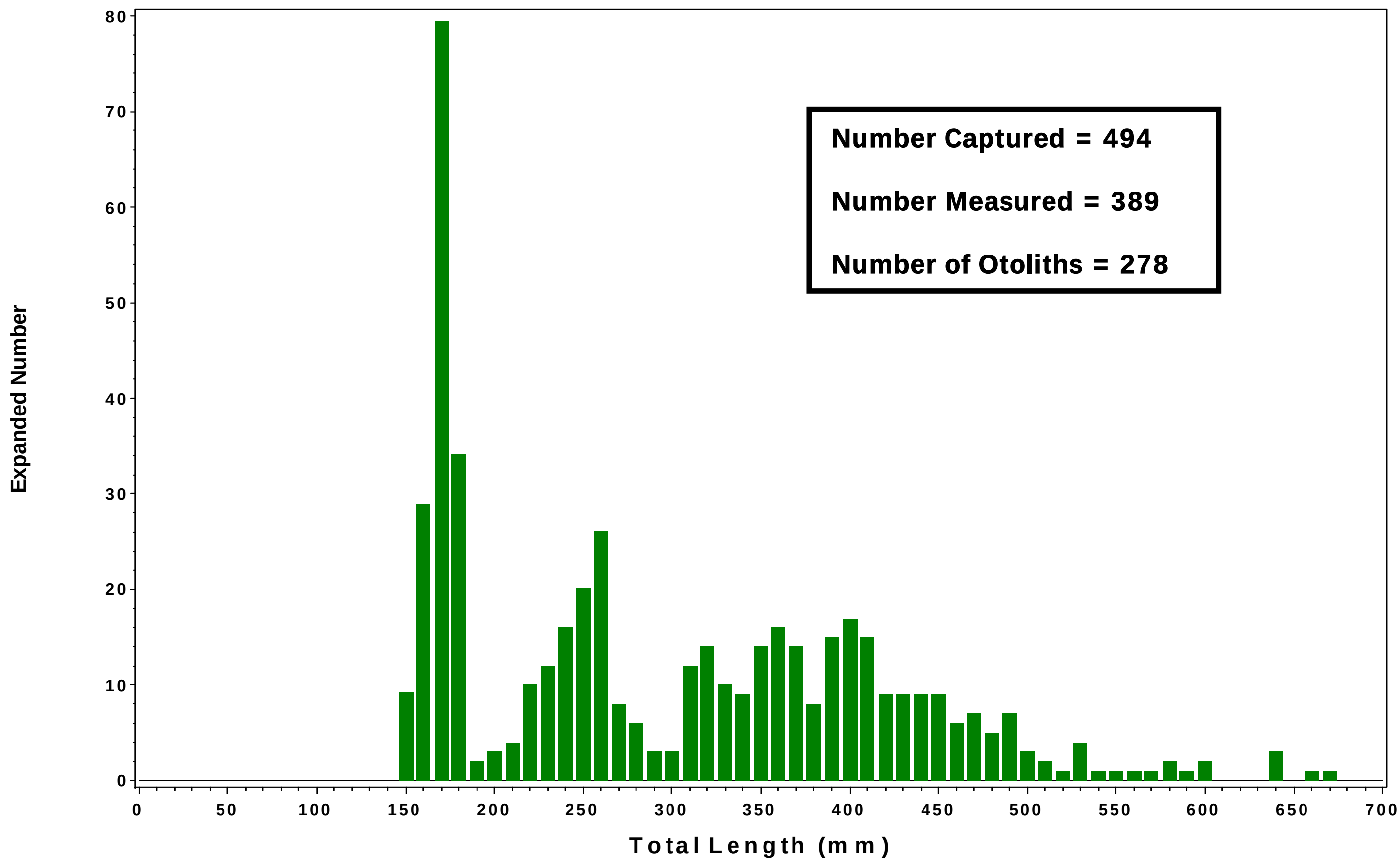


Figure 48. Length-weight regression for summer flounder, sexes combined.

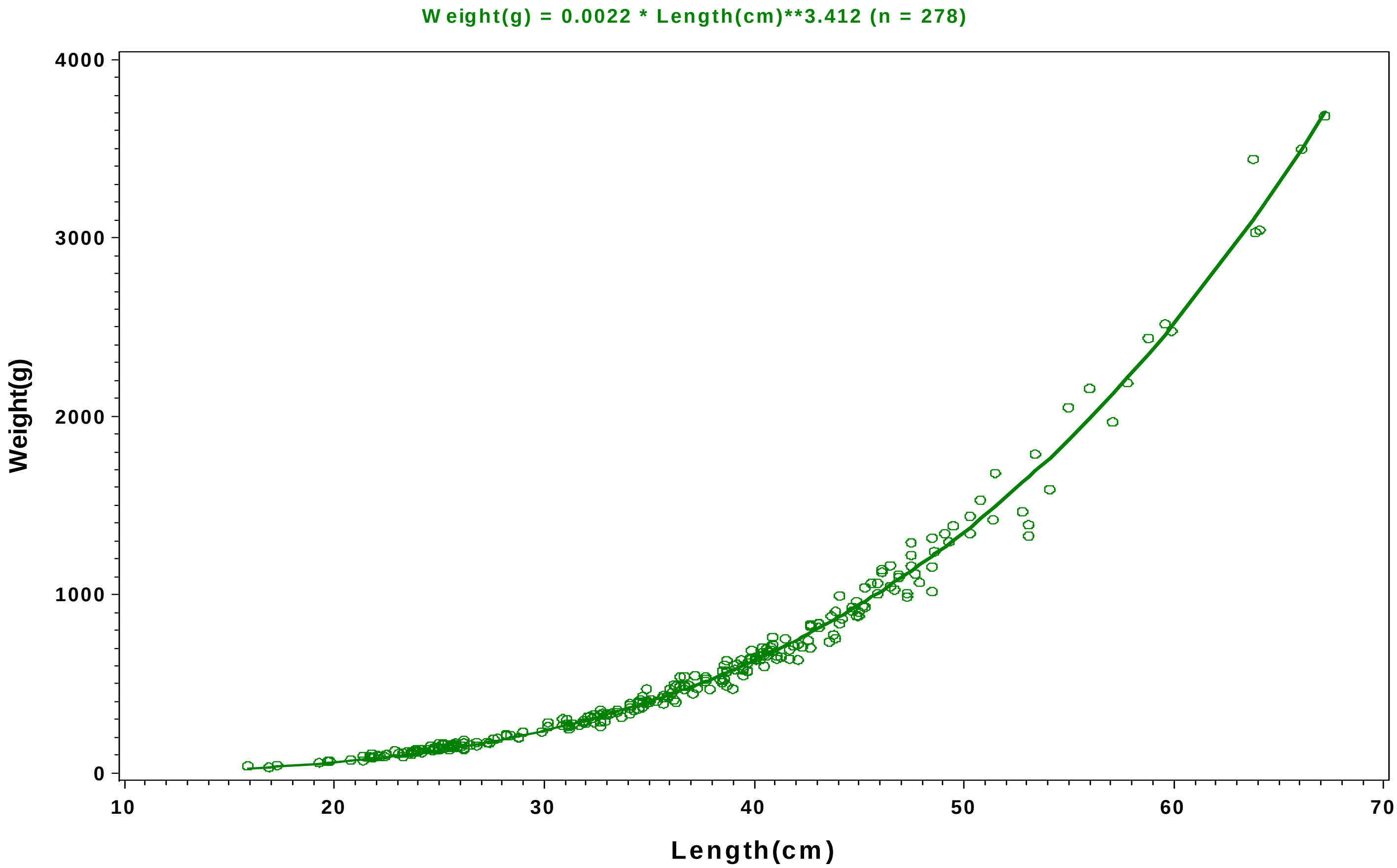


Figure 49. Length-weight regression for summer flounder, by sex.

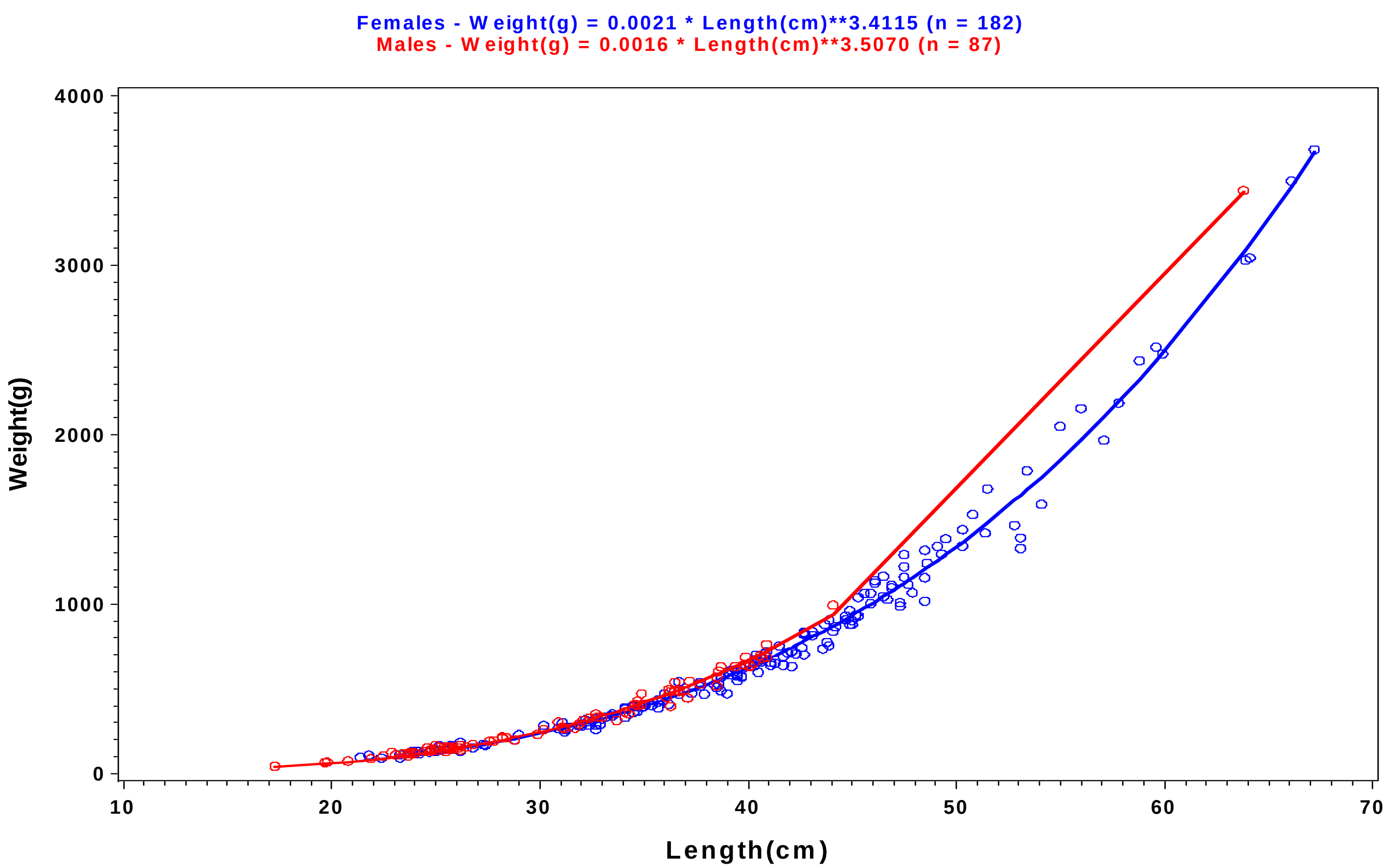


Figure 50. Maturity logistic regression for summer flounder, females.

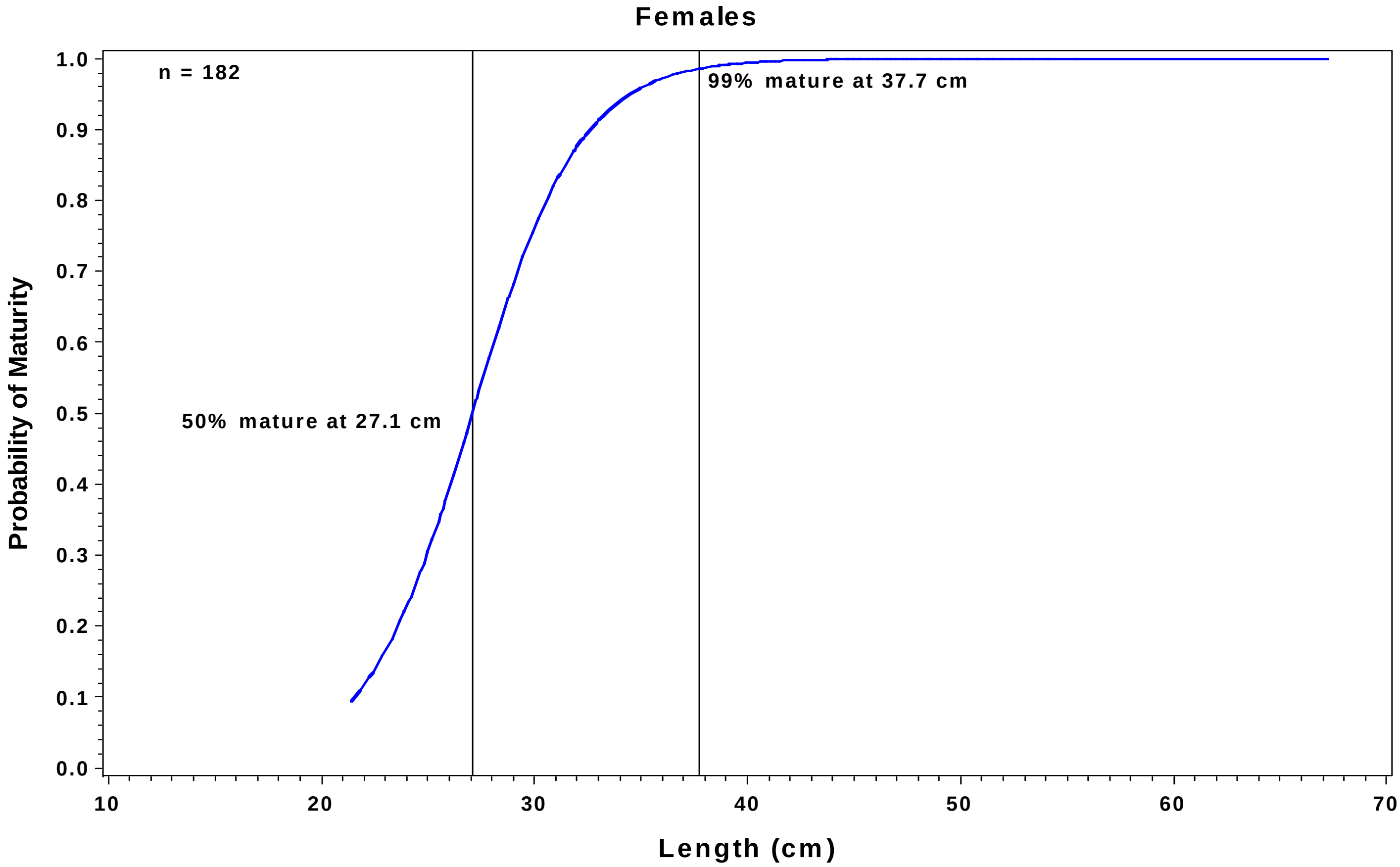


Figure 51. Maturity logistic regression for summer flounder, males.

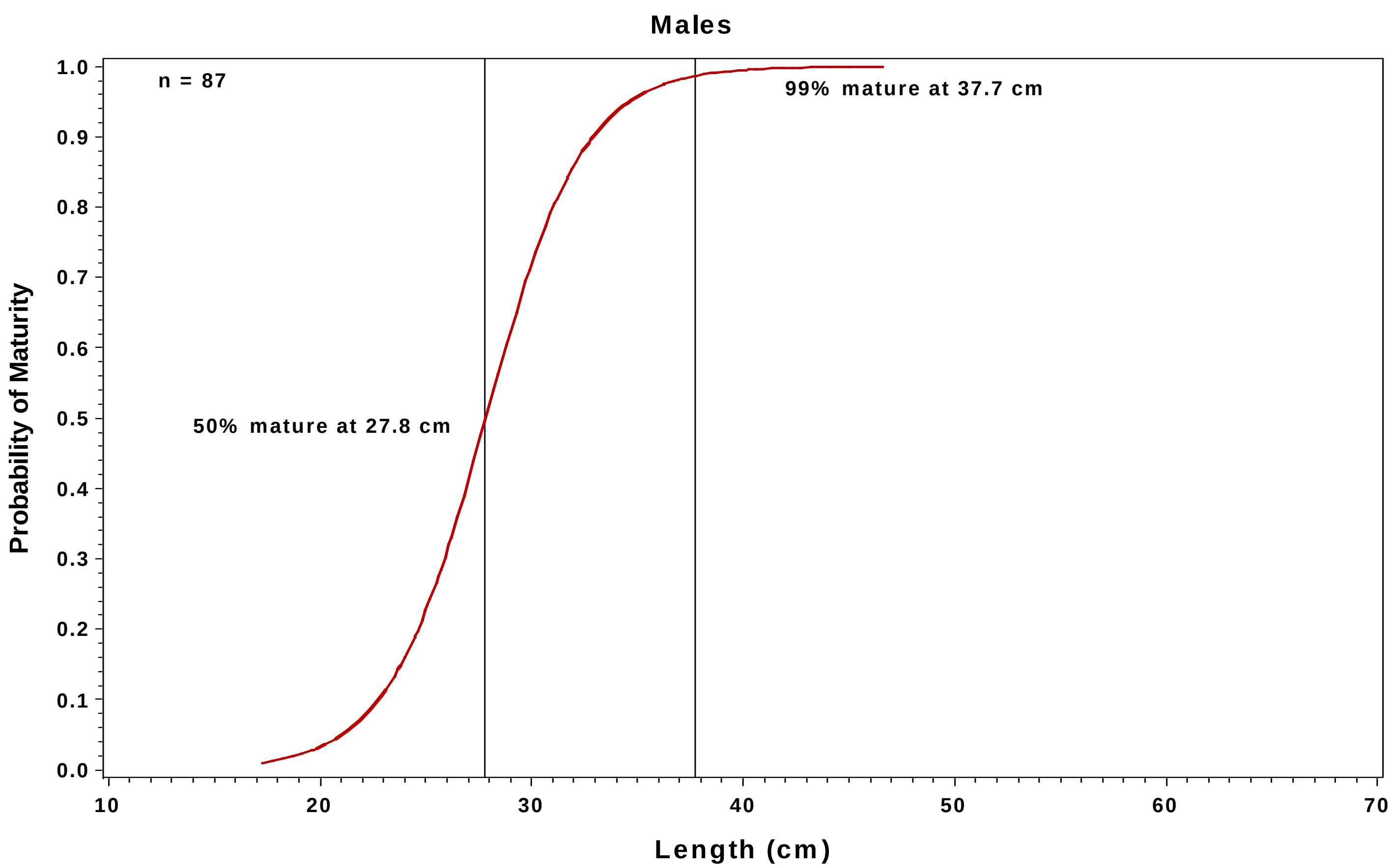


Figure 52. Diet composition by weight for summer flounder.

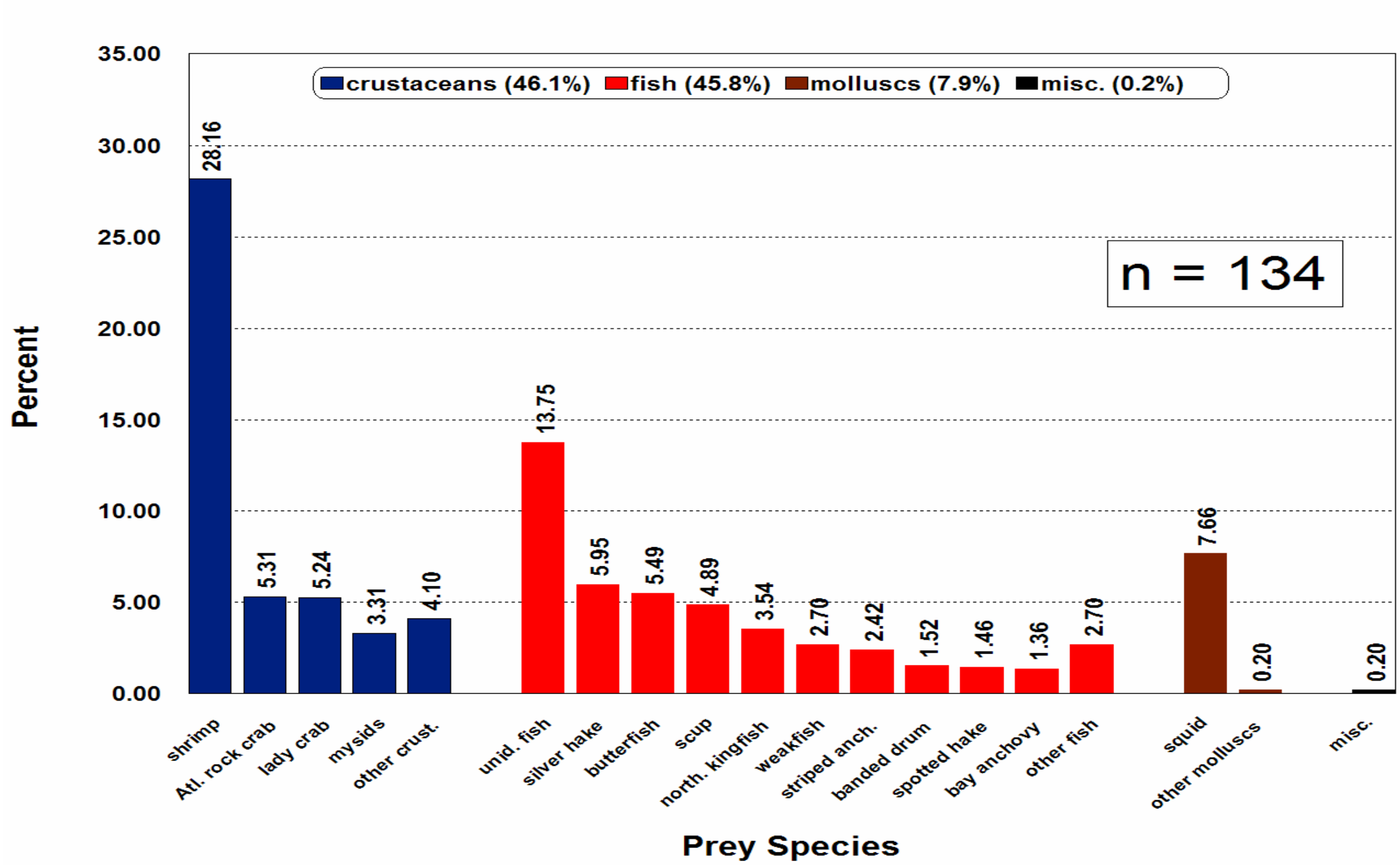
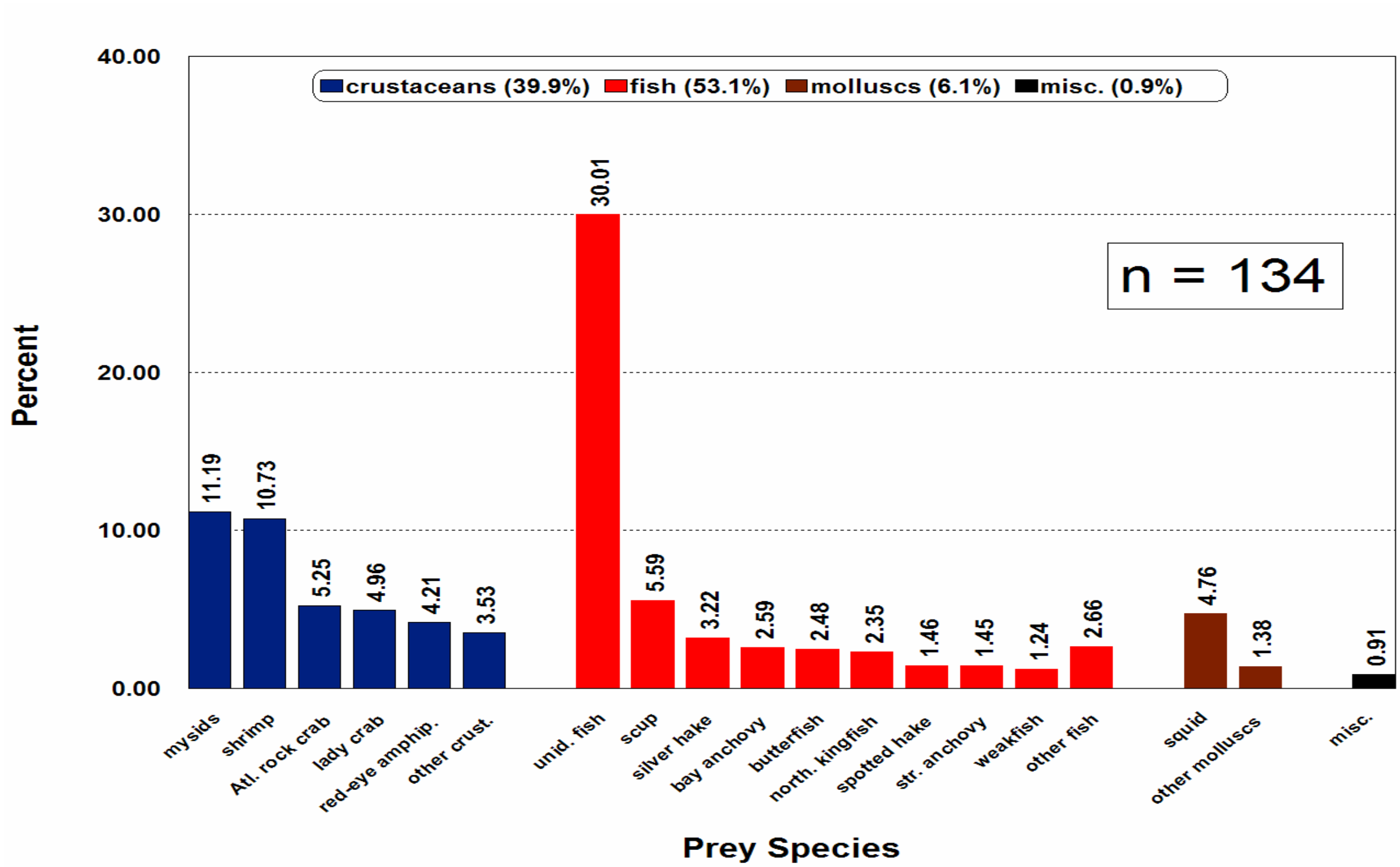
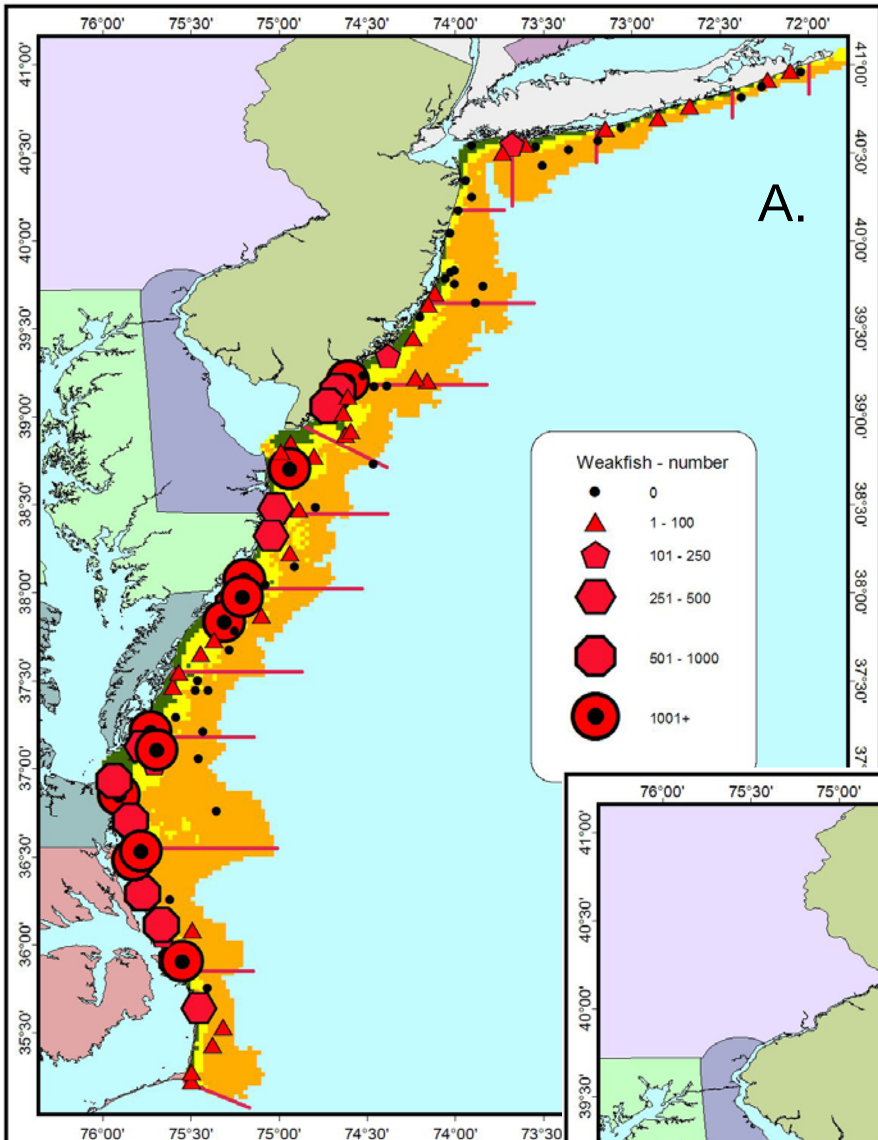


Figure 53. Diet composition by number for summer flounder.



Weakfish



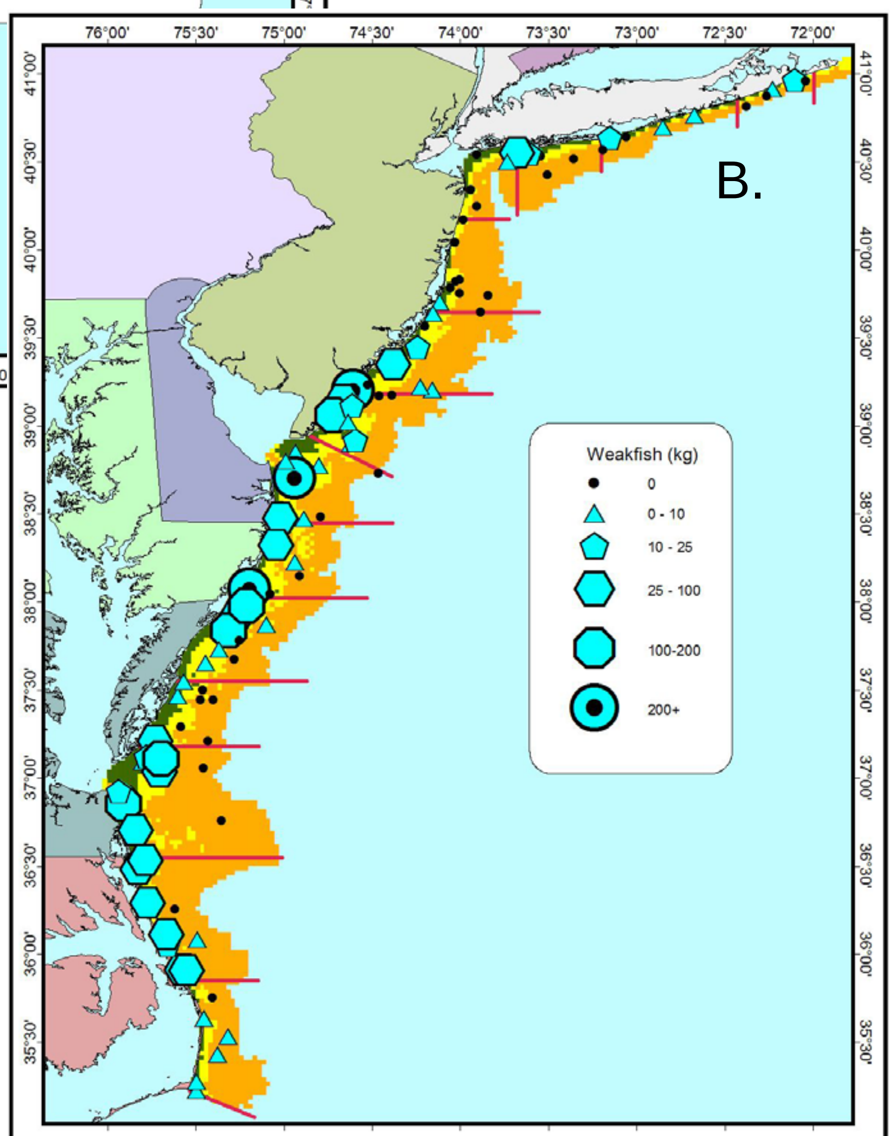


Figure 54. Number (A) and biomass (B) of specimens captured at each station for weakfish.

Figure 55. Minimum trawlable number and biomass by state for weakfish.

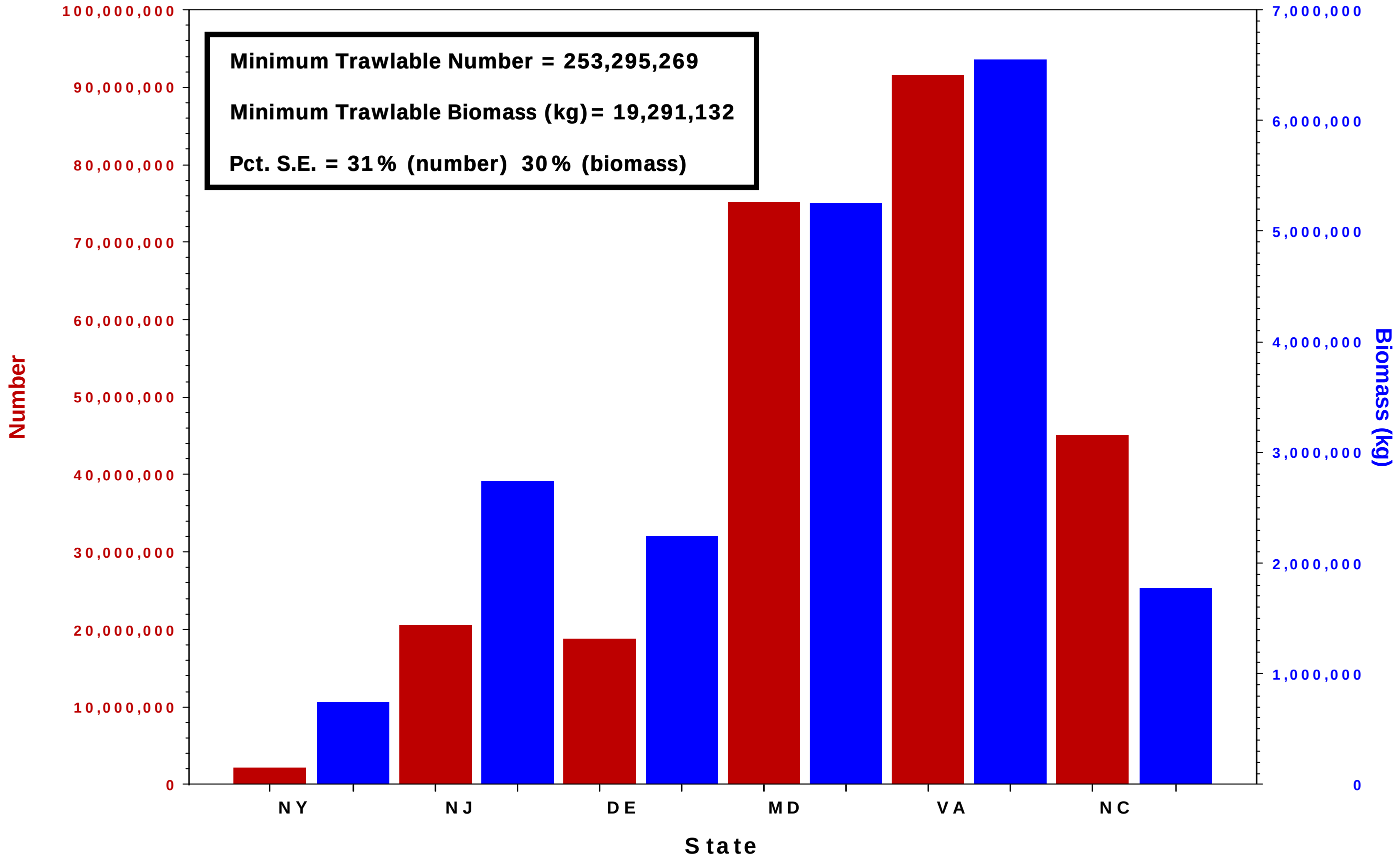


Figure 56. Sex ratios by state for weakfish.

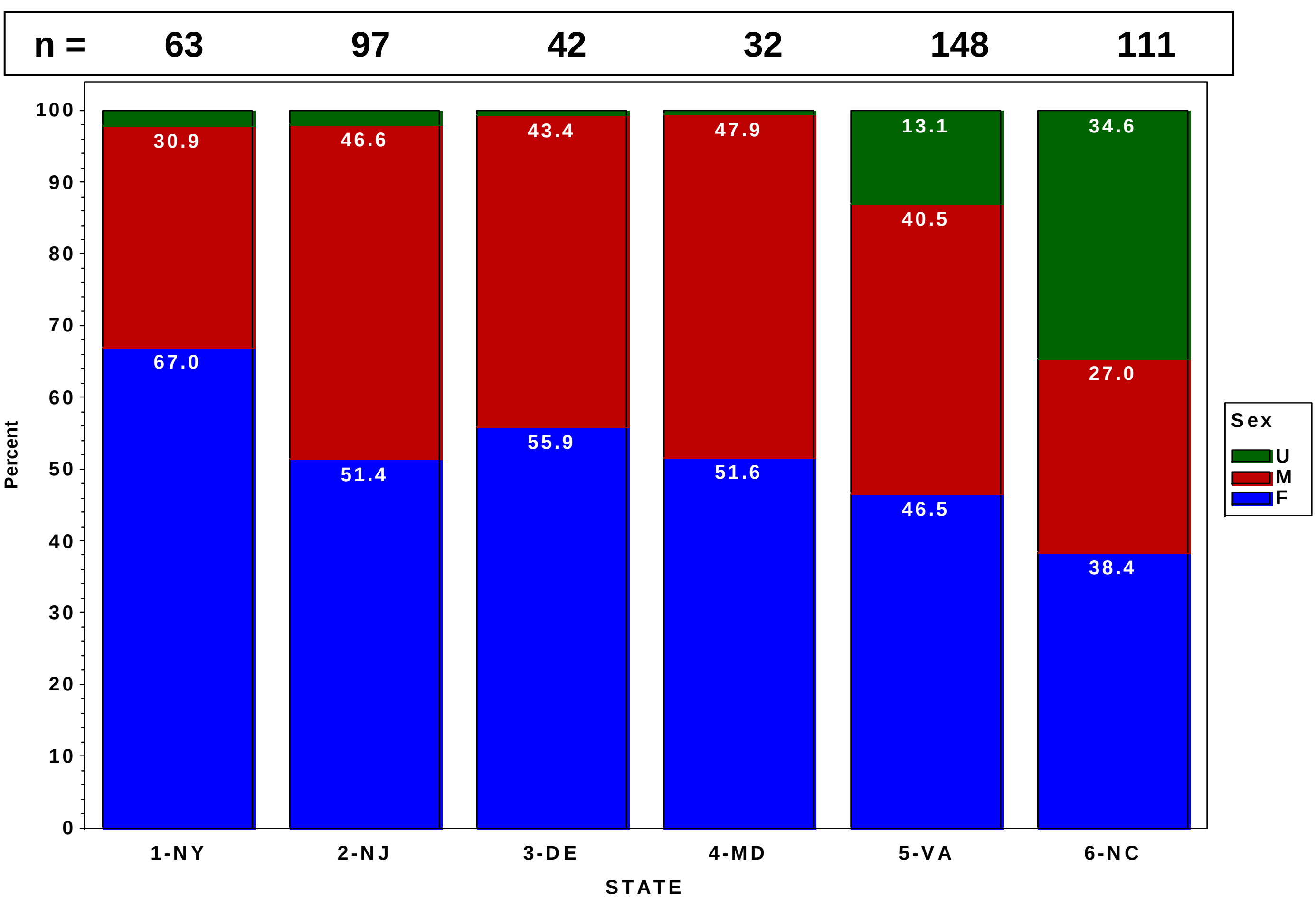


Figure 57. Length frequency for weakfish.

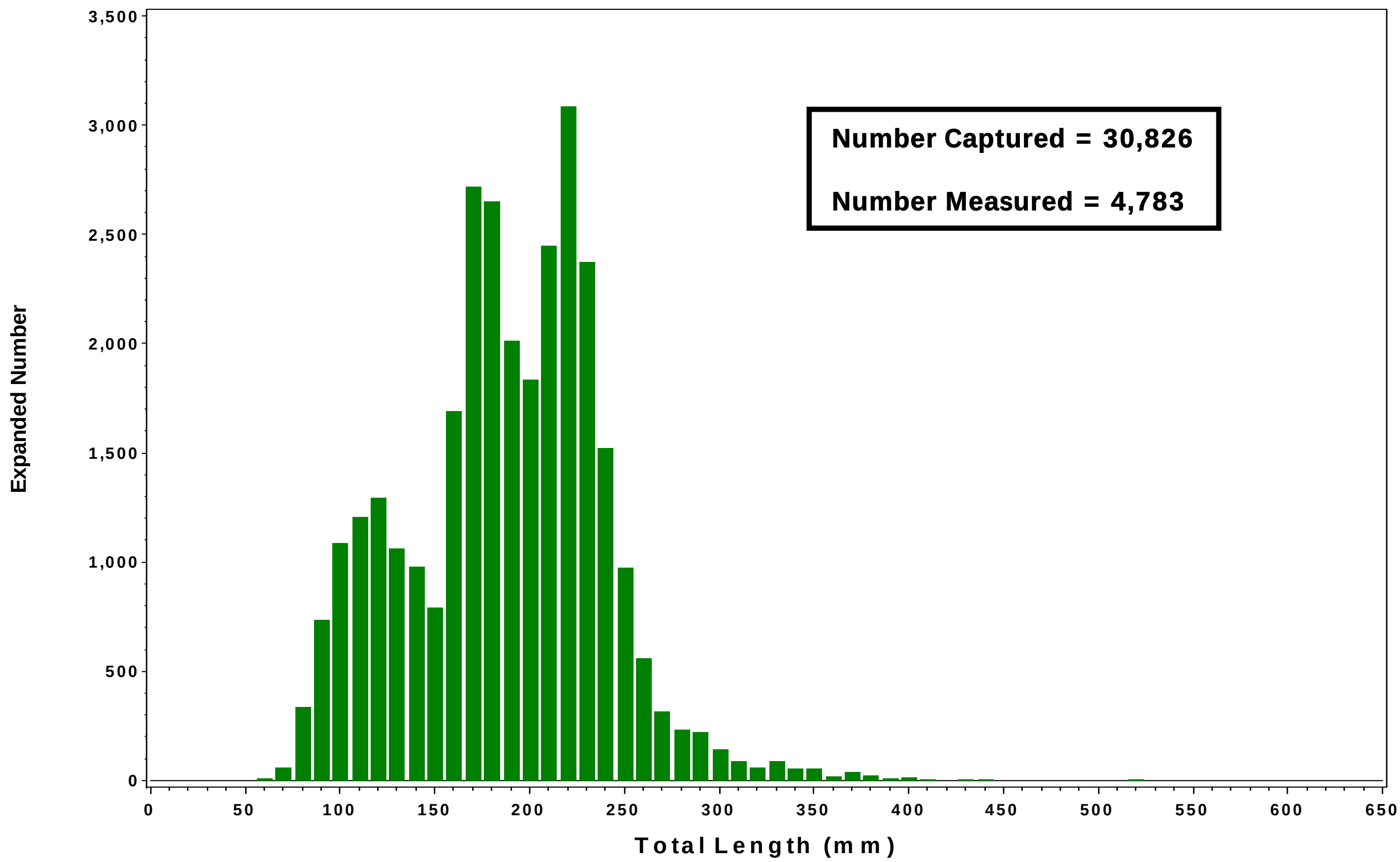


Figure 58. Age frequency for weakfish.

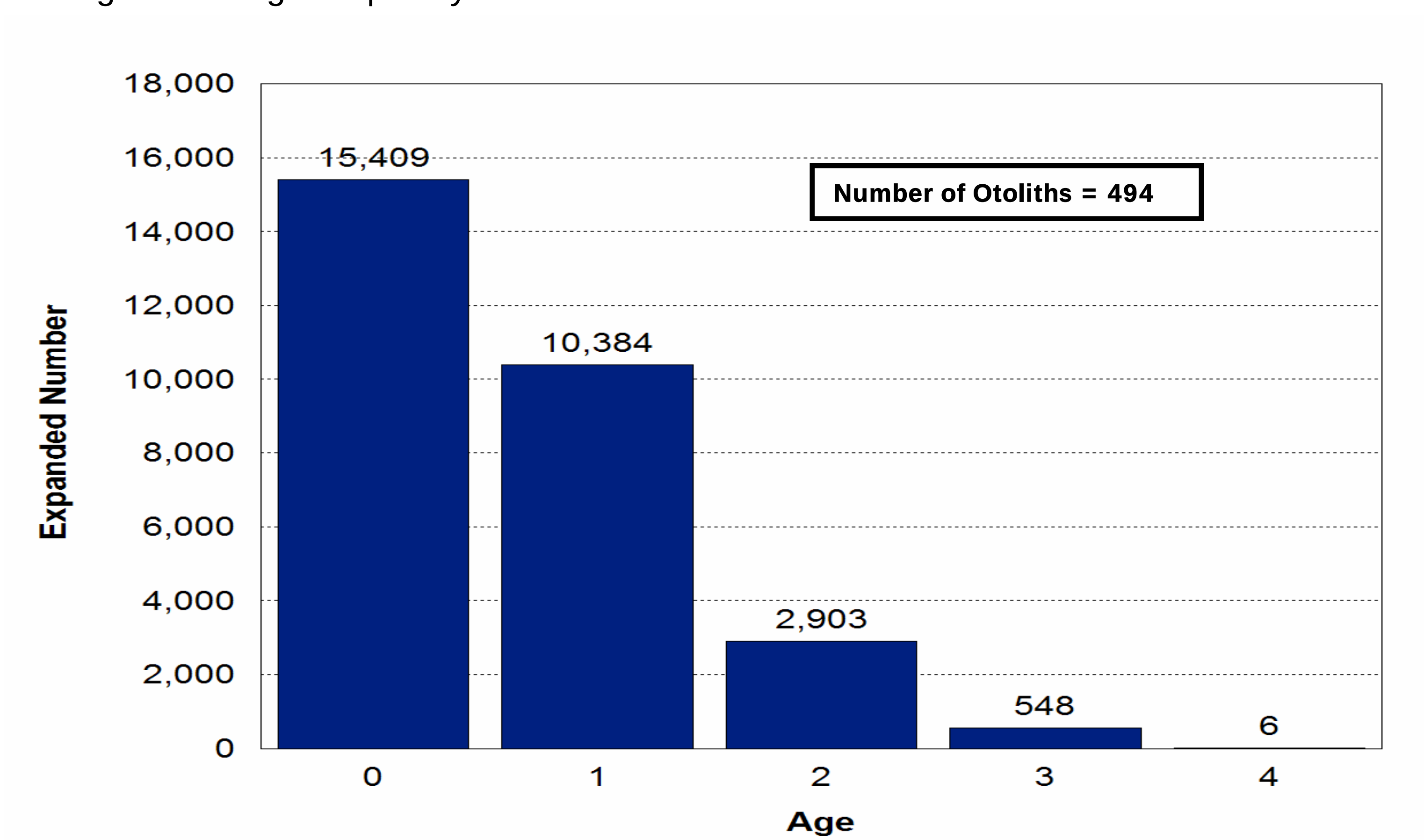


Figure 59. Length-weight regression for weakfish, sexes combined.

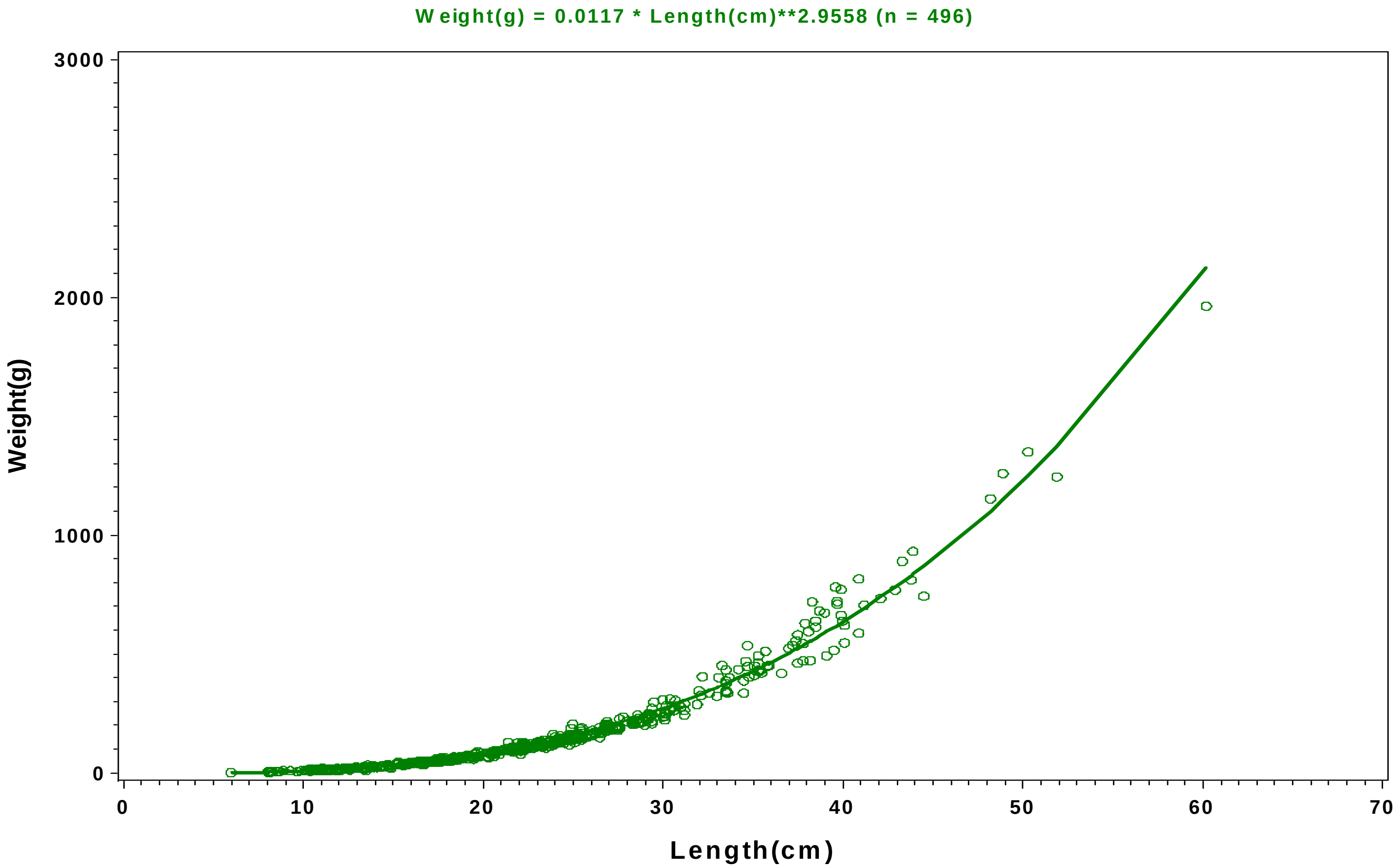


Figure 60. Length-weight regression for weakfish, by sex.

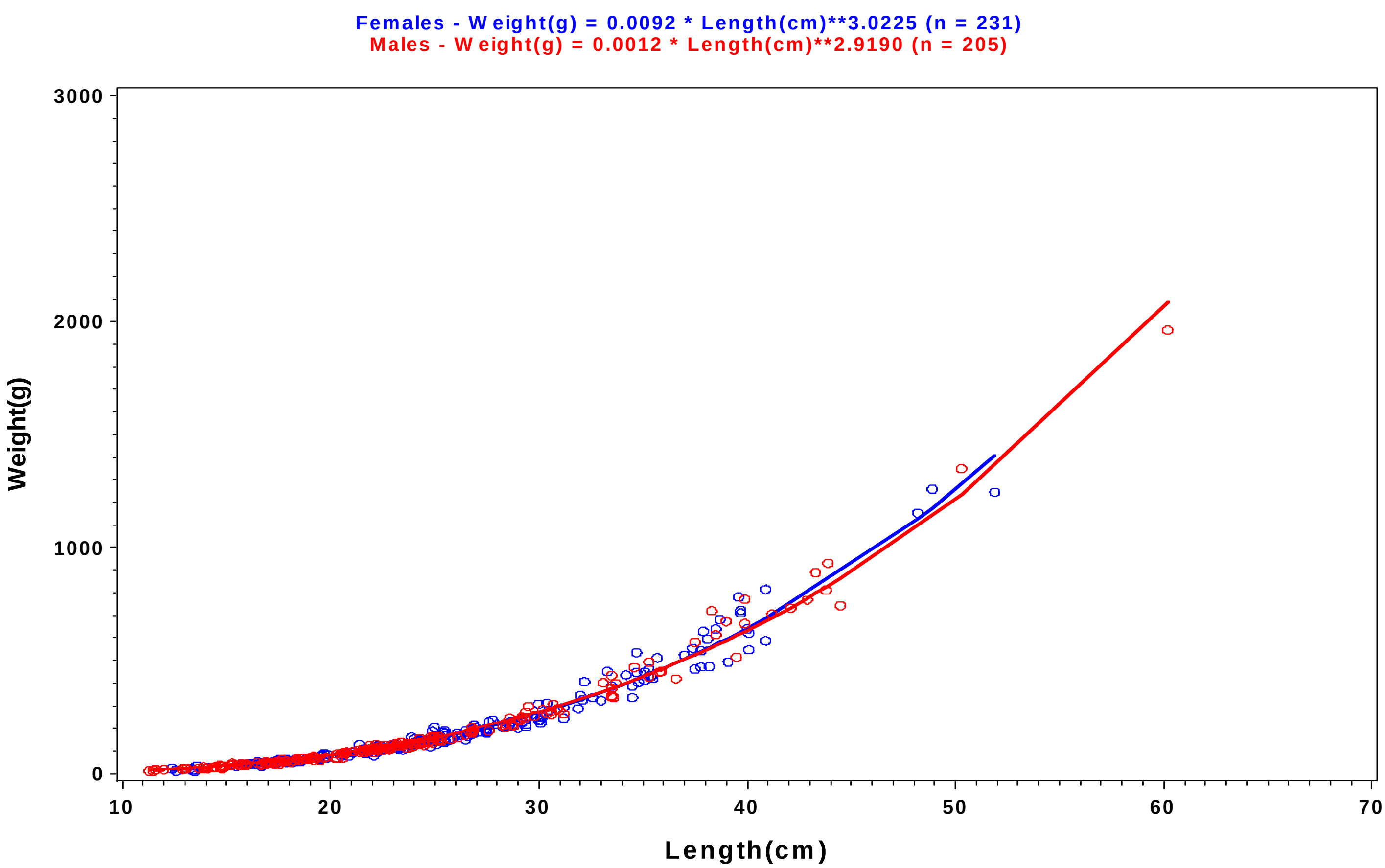


Figure 61. Maturity logistic regression for weakfish, females.

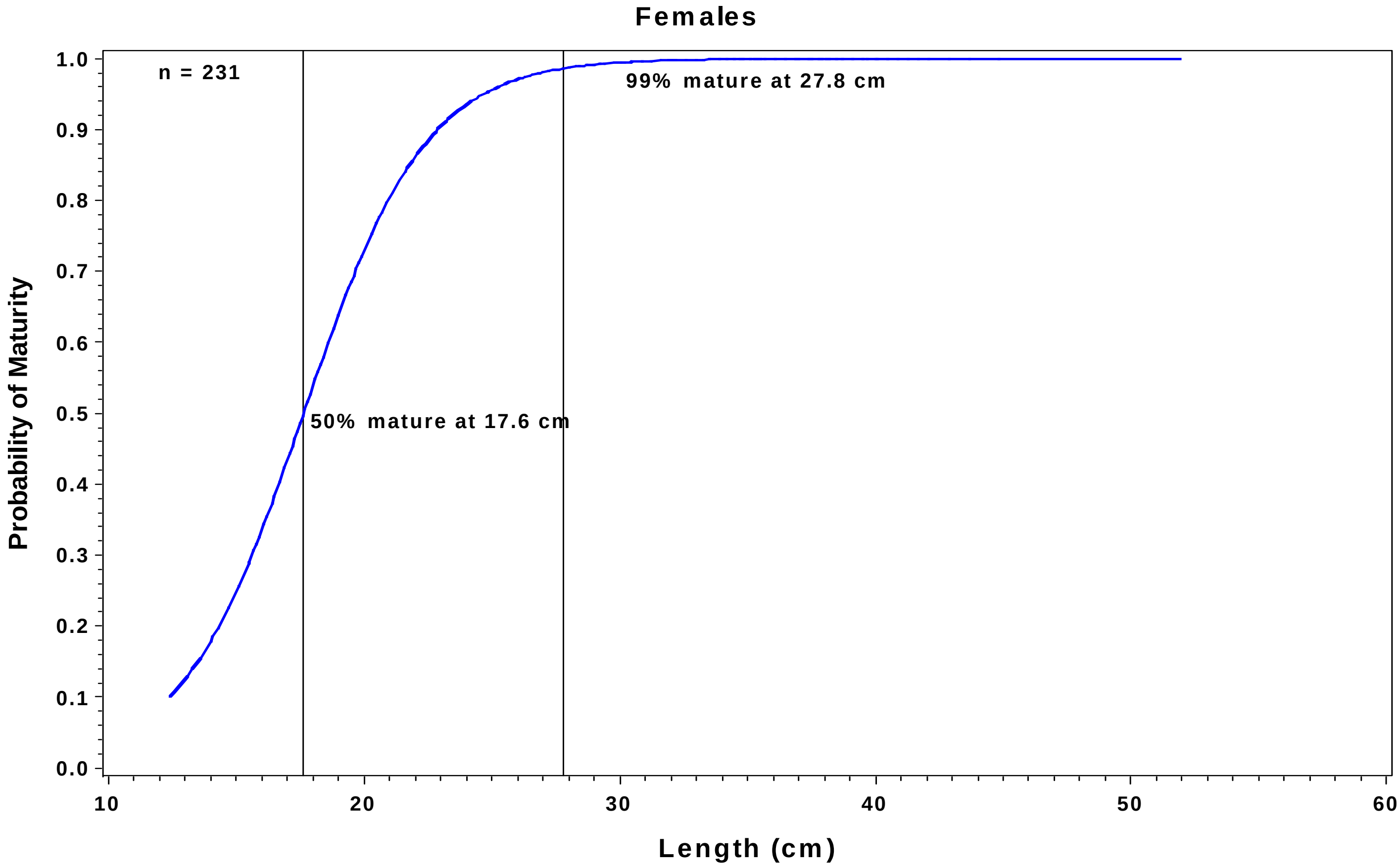


Figure 62. Maturity logistic regression for weakfish, males.

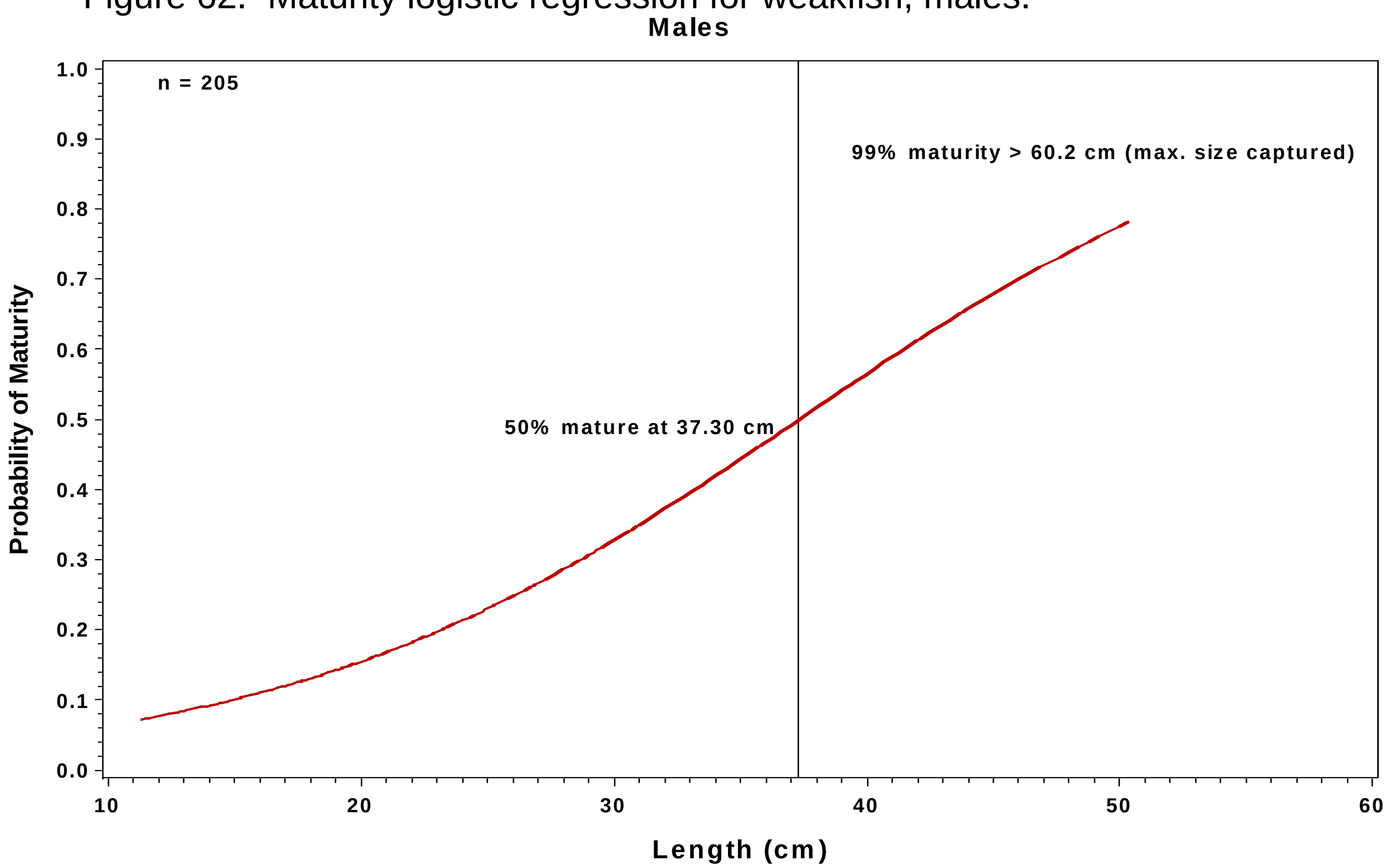


Figure 63. Diet composition by weight for weakfish.

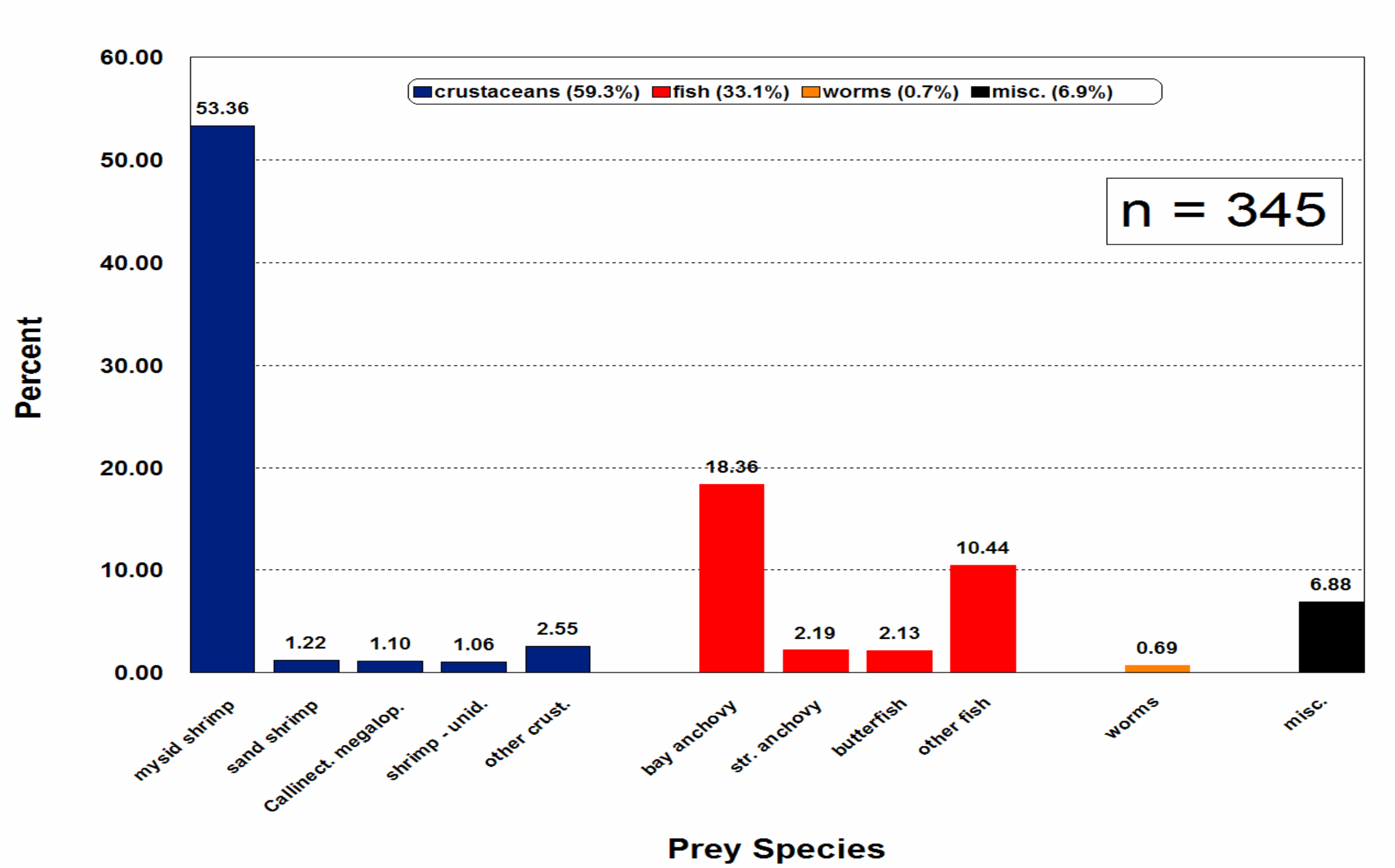
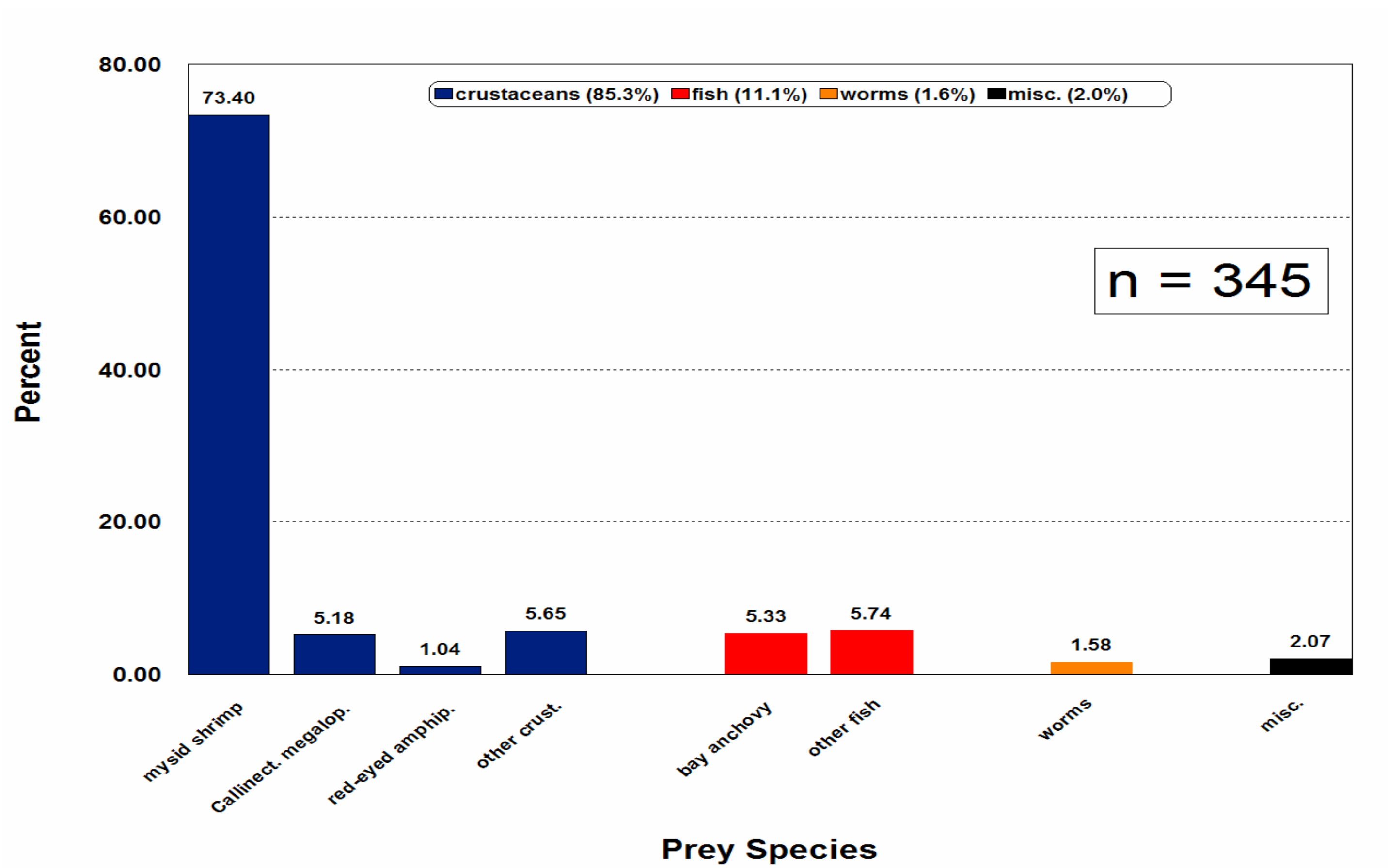
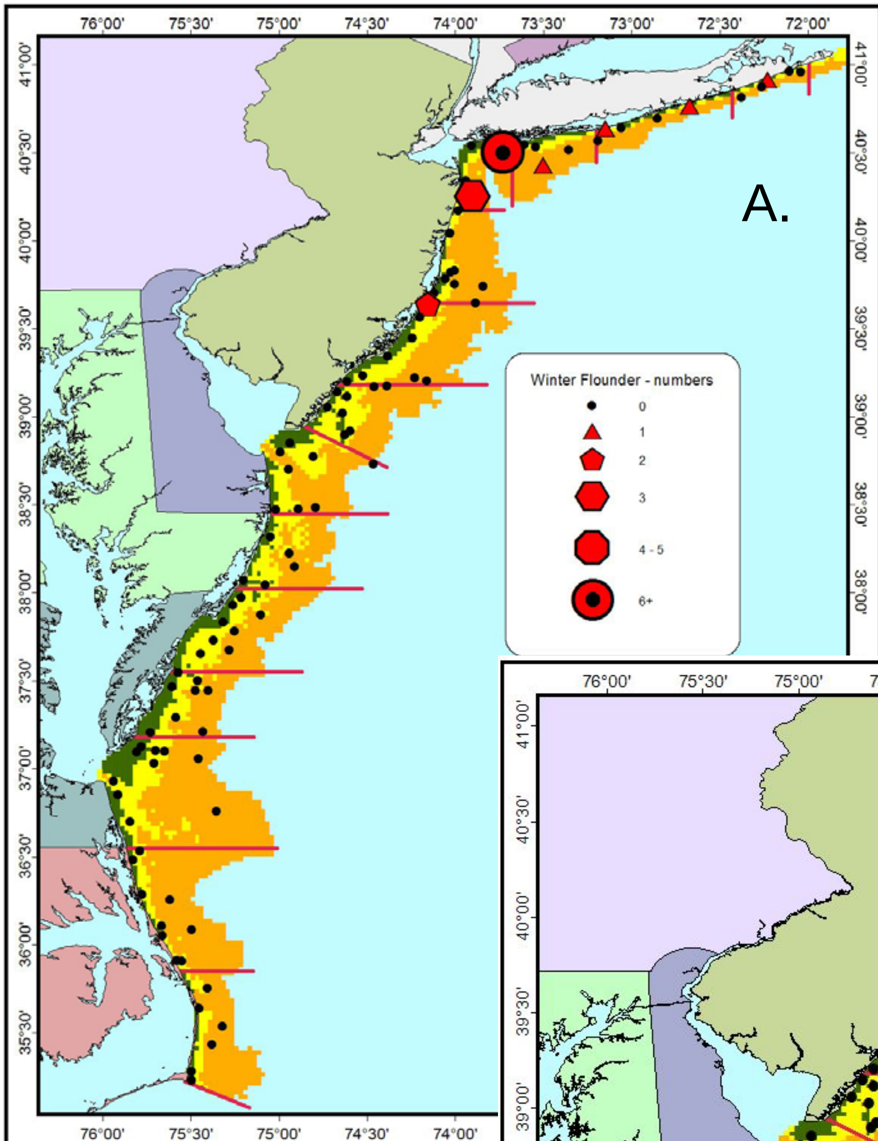


Figure 64. Diet composition by number for weakfish.



Winter Flounder



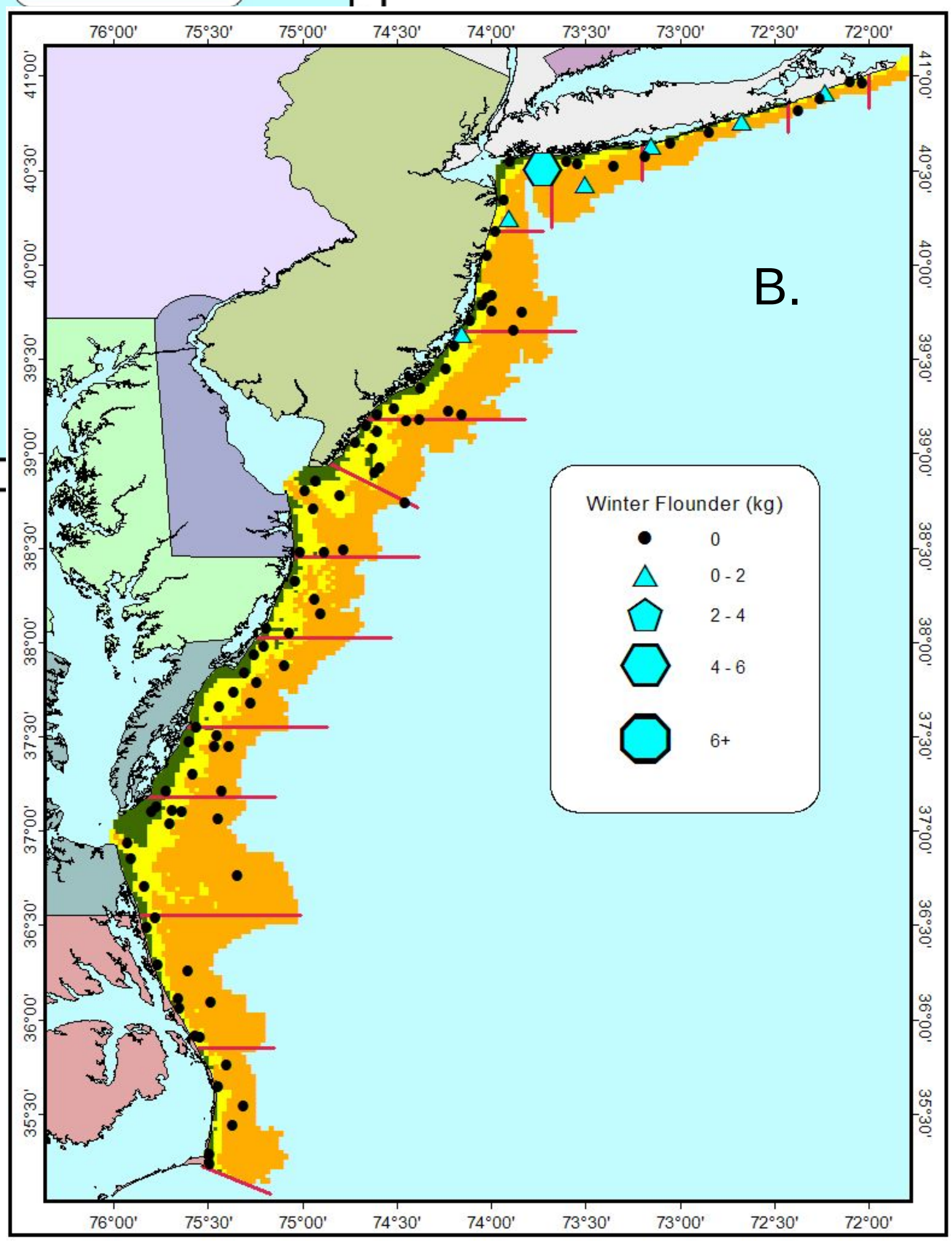


Figure 65. Number (A) and biomass (B) of specimens captured at each station for winter flounder.

Figure 66. Minimum trawlable number and biomass by state for winter flounder.

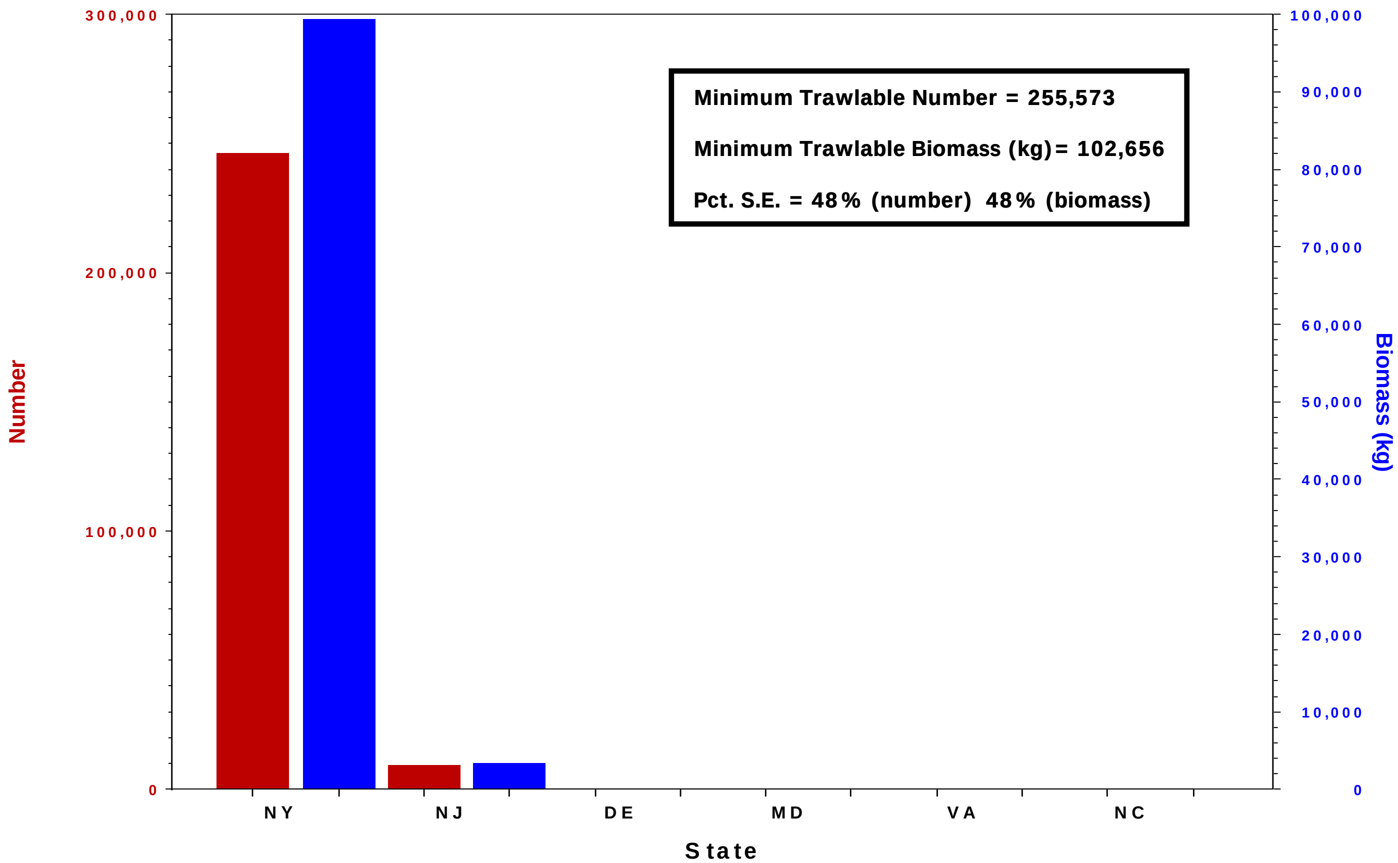


Figure 67. Sex ratios by state for winter flounder.

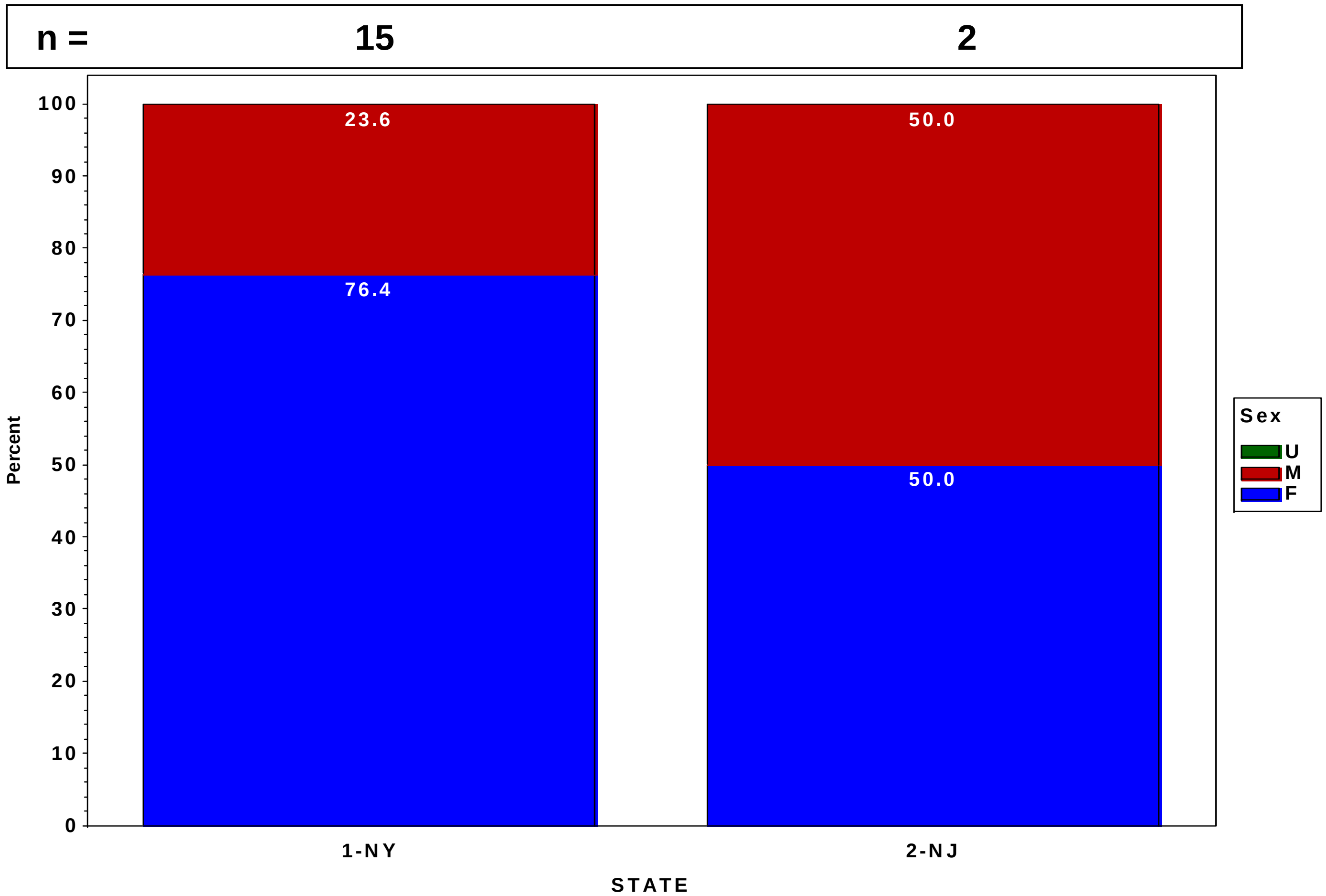


Figure 68. Length frequency for winter flounder.

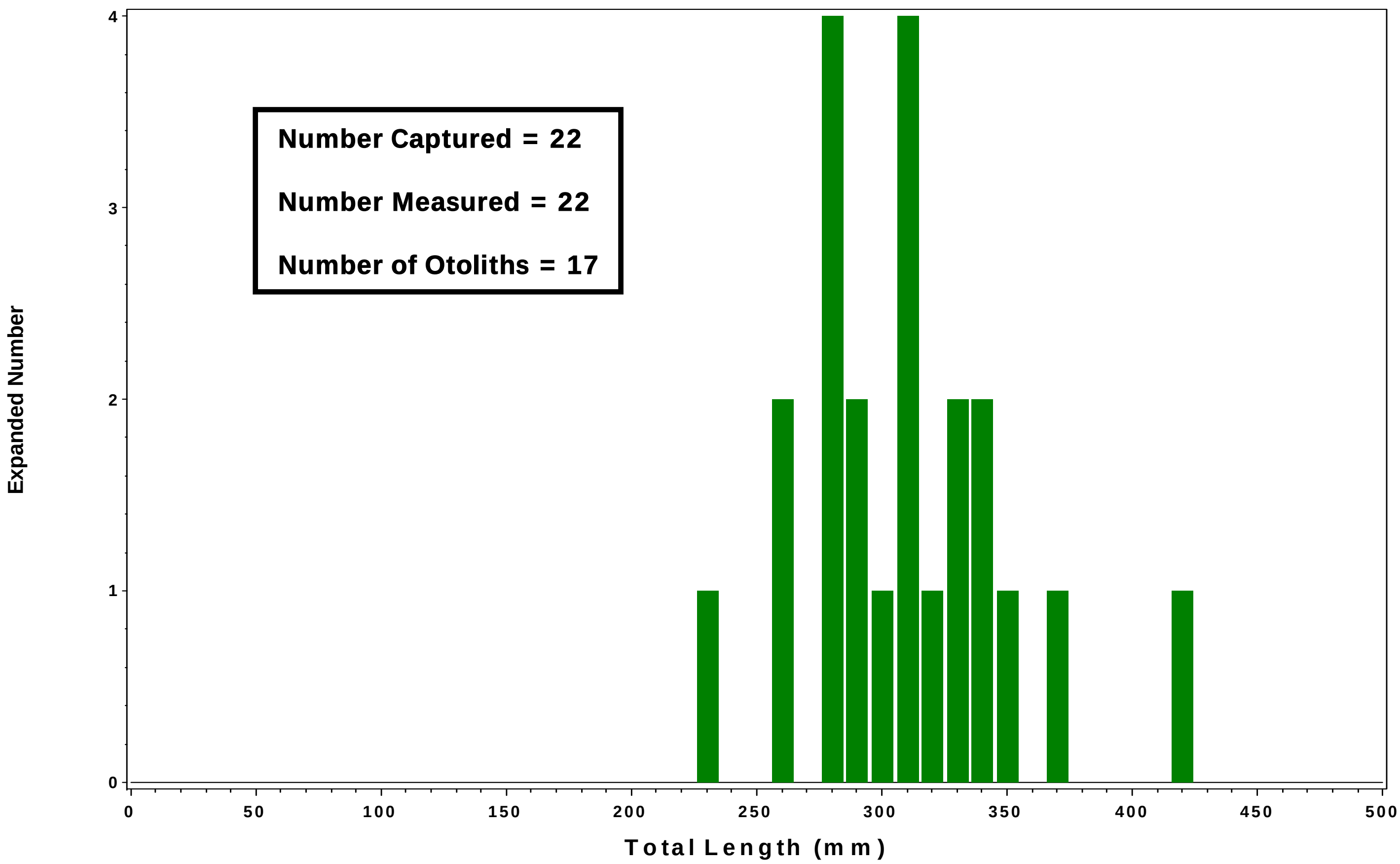


Figure 69. Diet composition by weight for winter flounder.

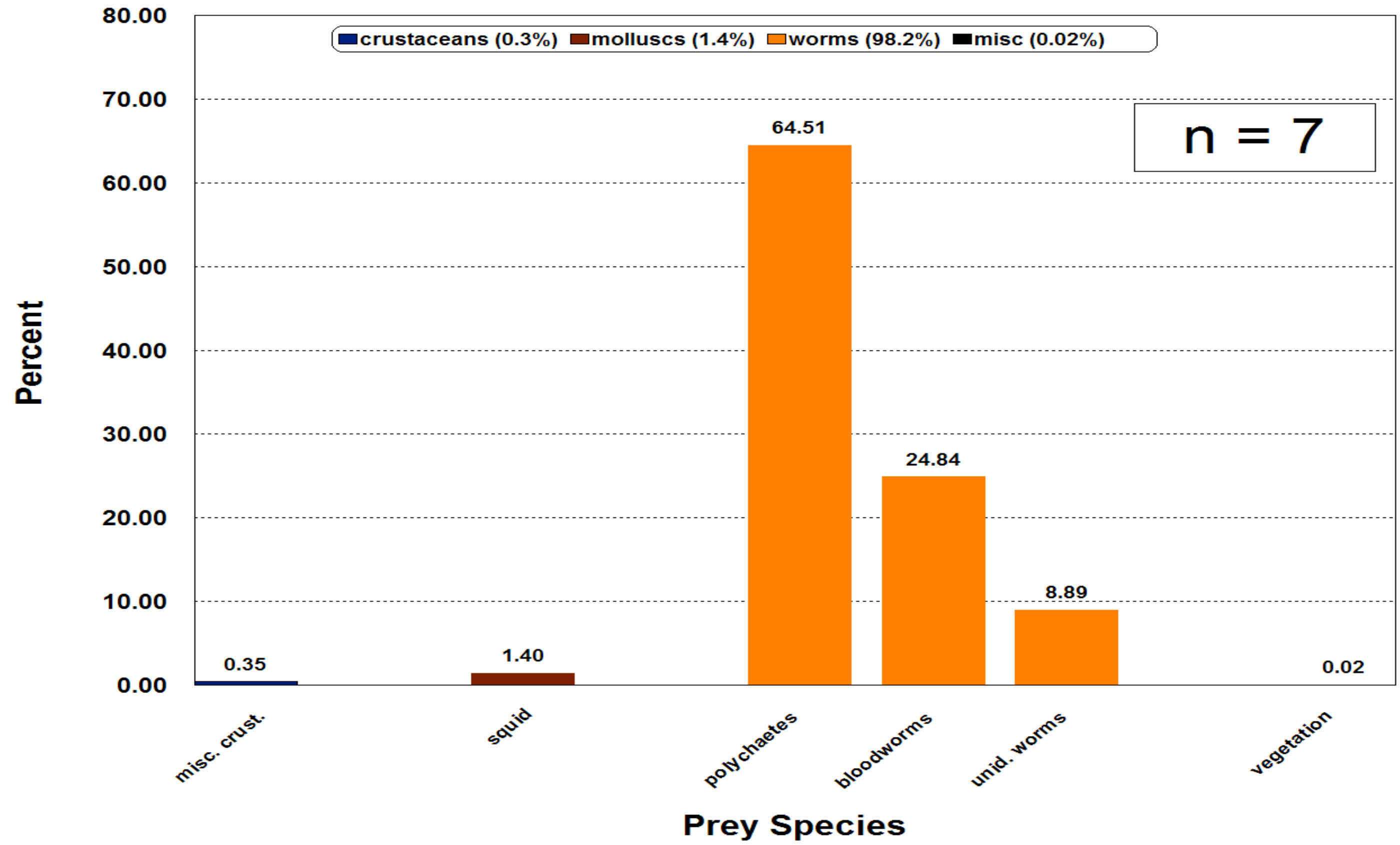
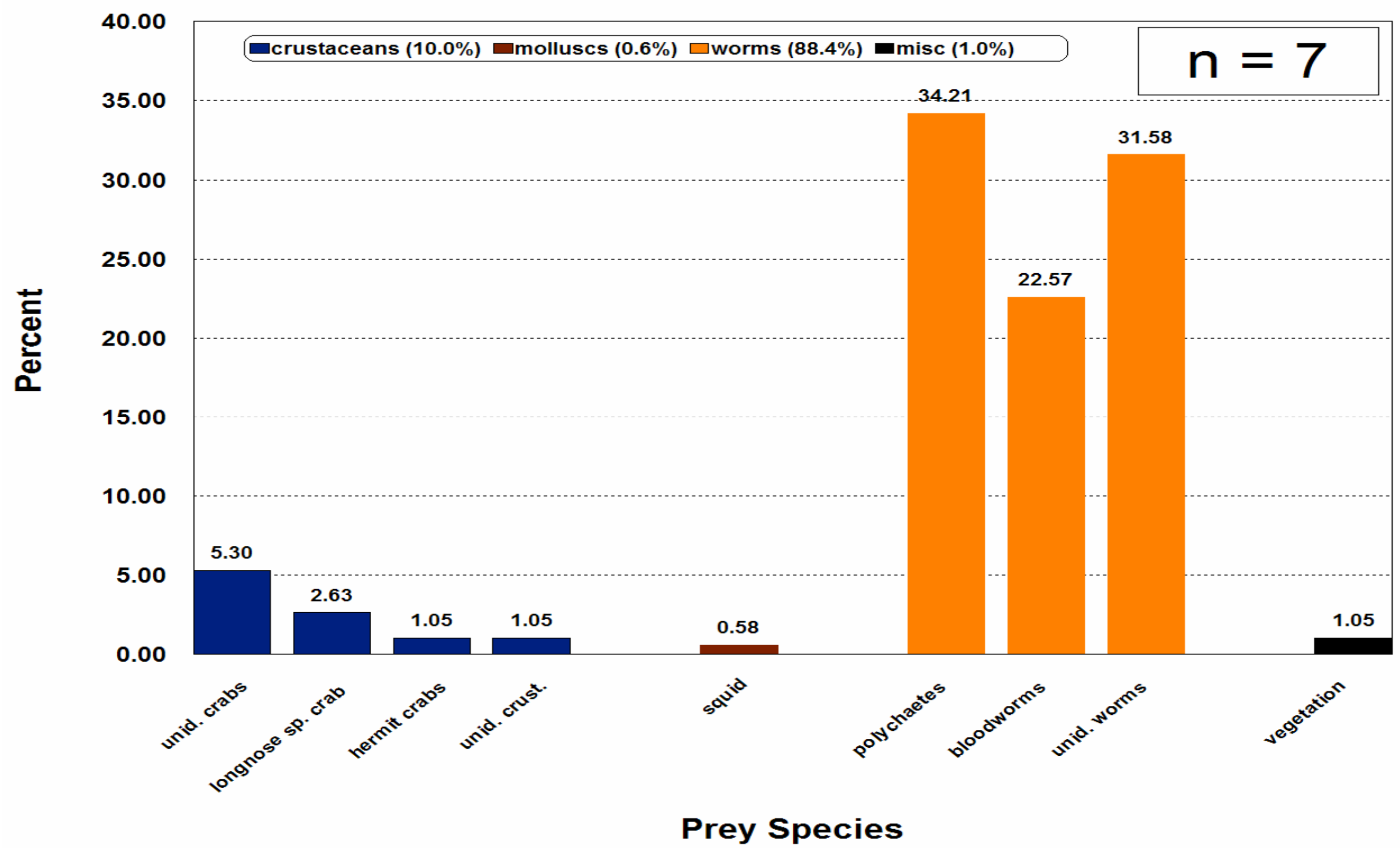
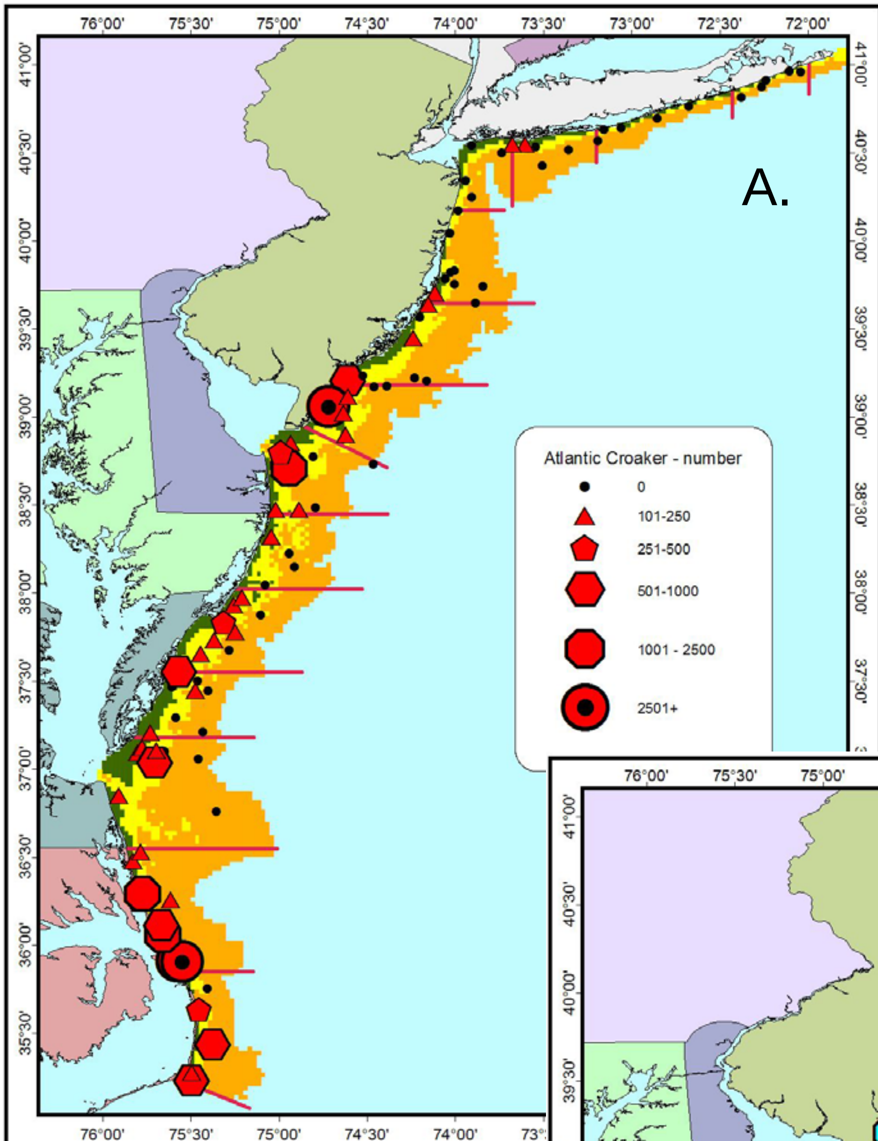


Figure 70. Diet composition by number for winter flounder.



Atlantic Croaker



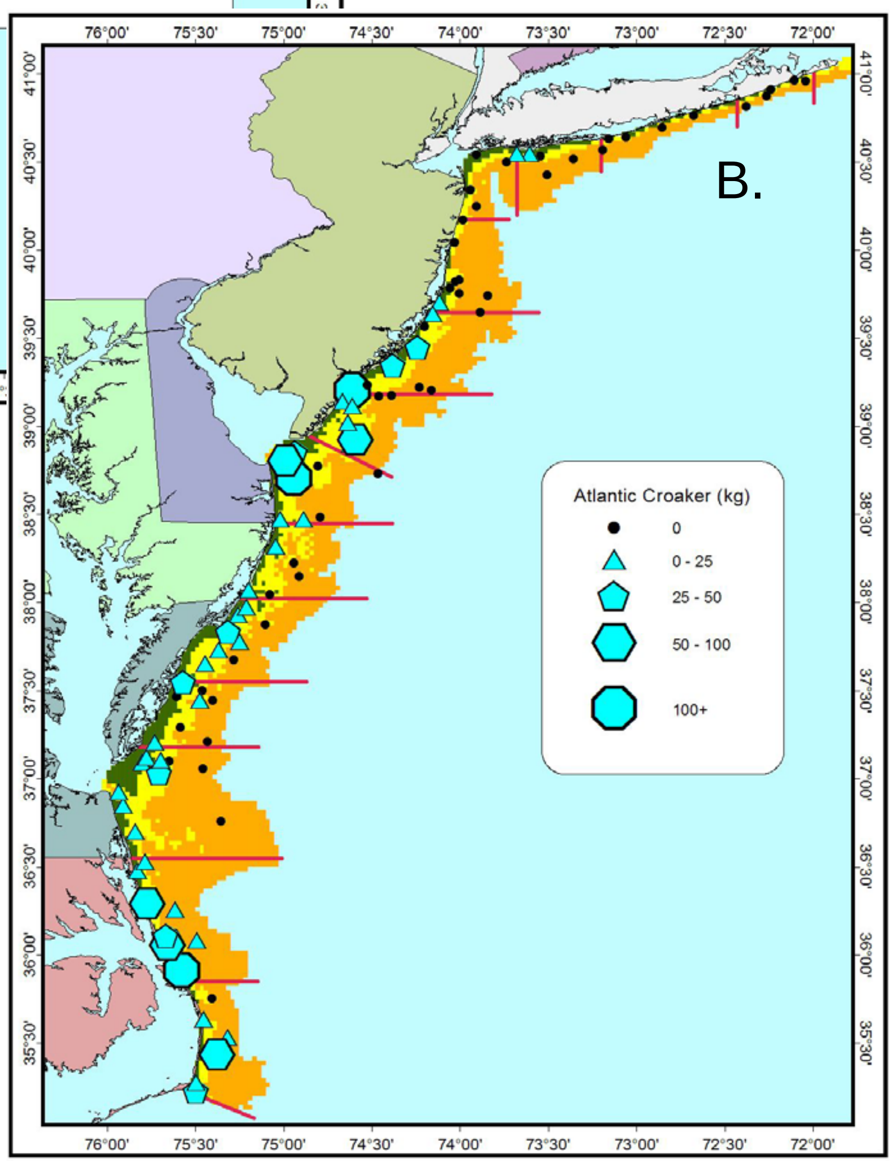


Figure 71. Number (A) and biomass (B) of specimens captured at each station for Atlantic croaker.

Figure 72. Minimum trawlable number and biomass by state for Atlantic croaker.

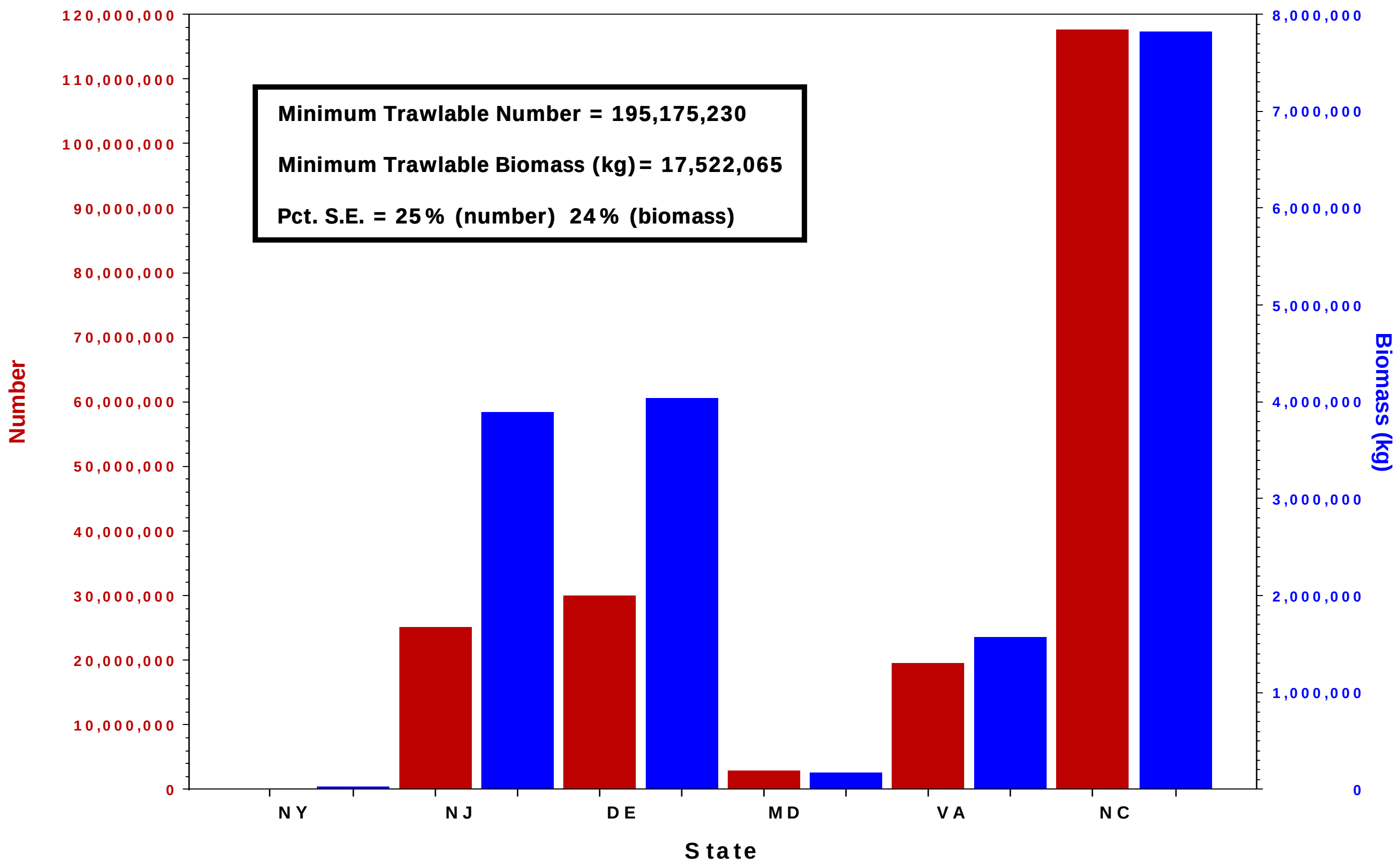


Figure 73. Sex ratios by state for Atlantic croaker.

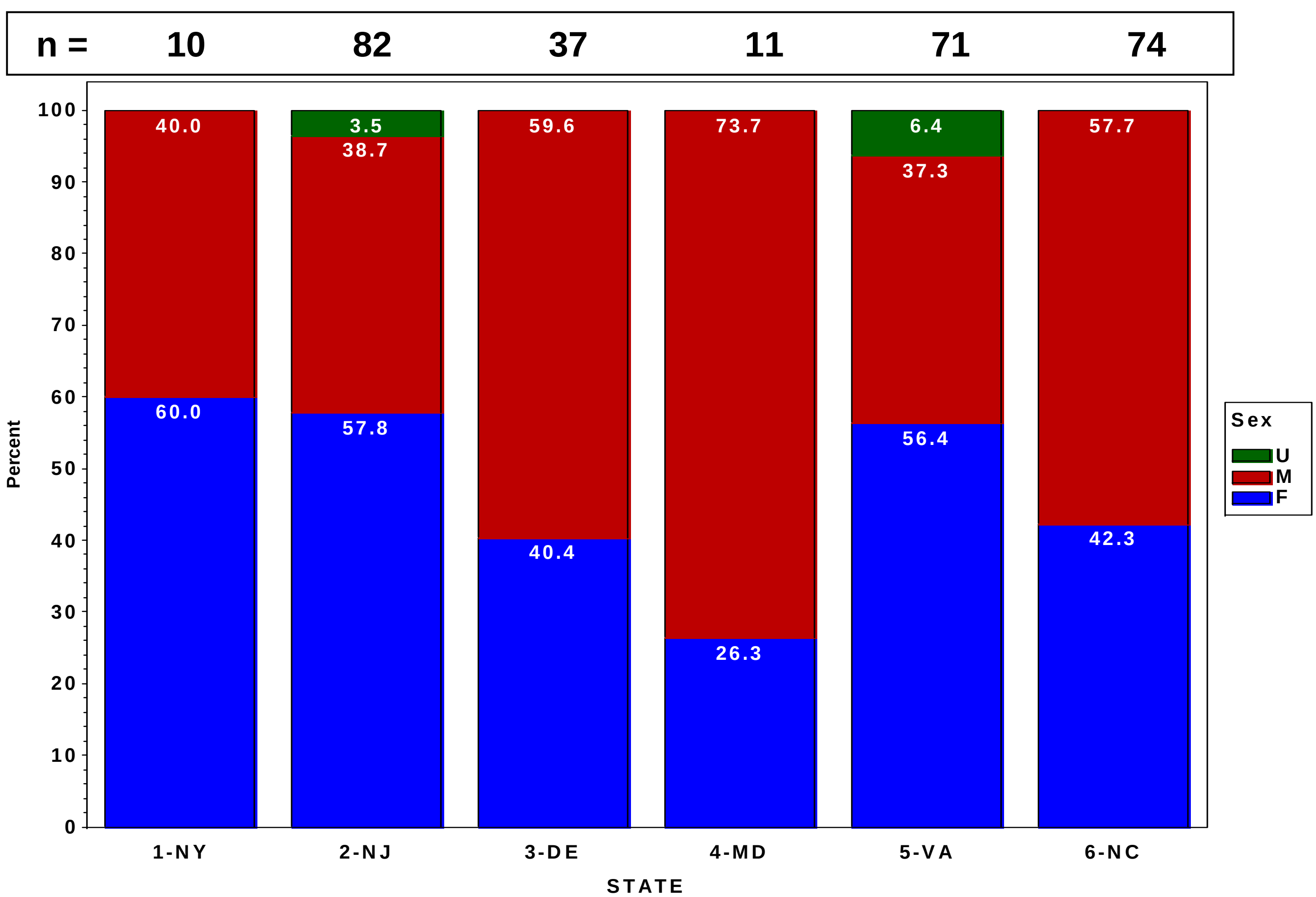


Figure 74. Length frequency for Atlantic croaker.

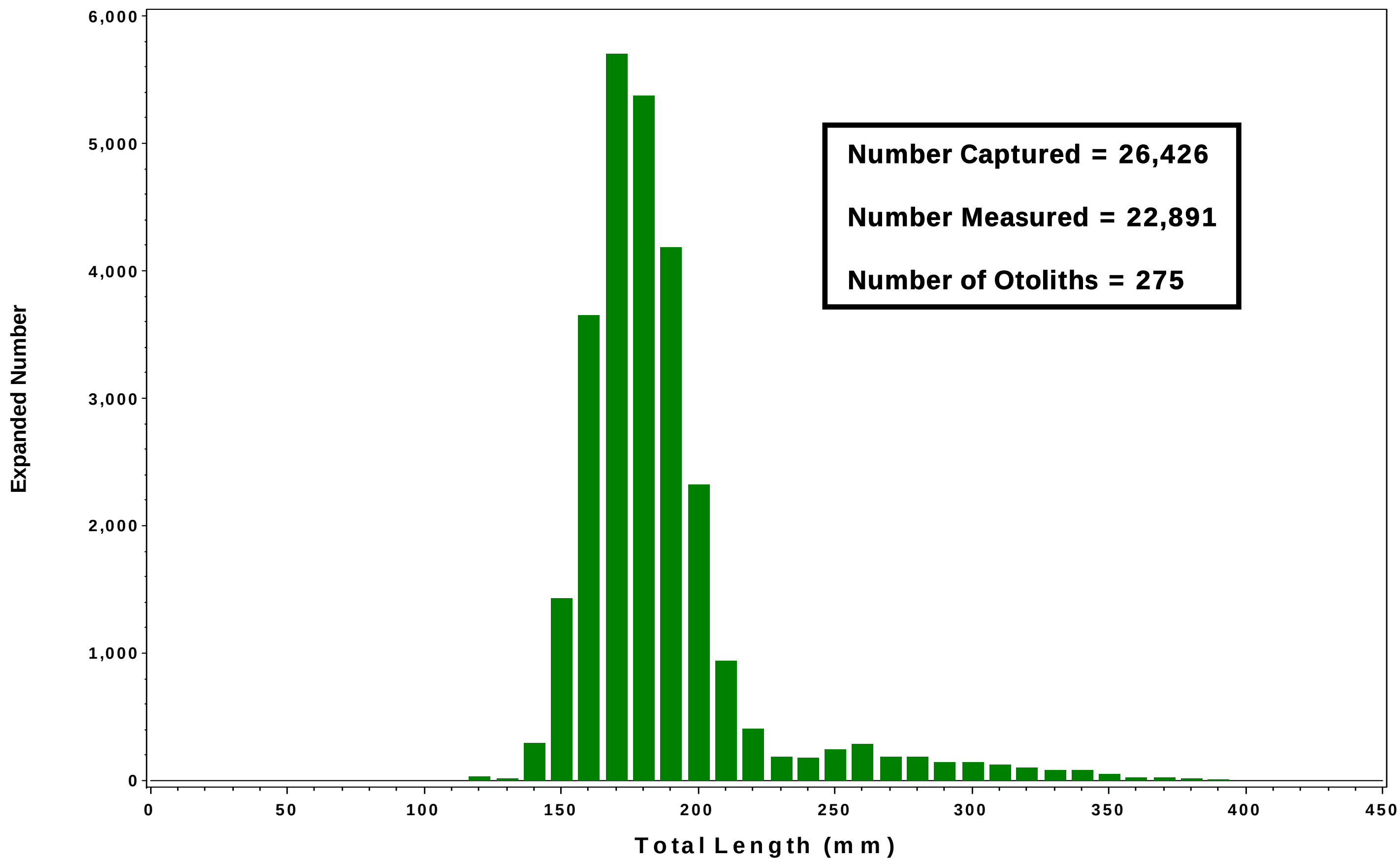


Figure 75. Length-weight regression for Atlantic croaker, sexes combined.

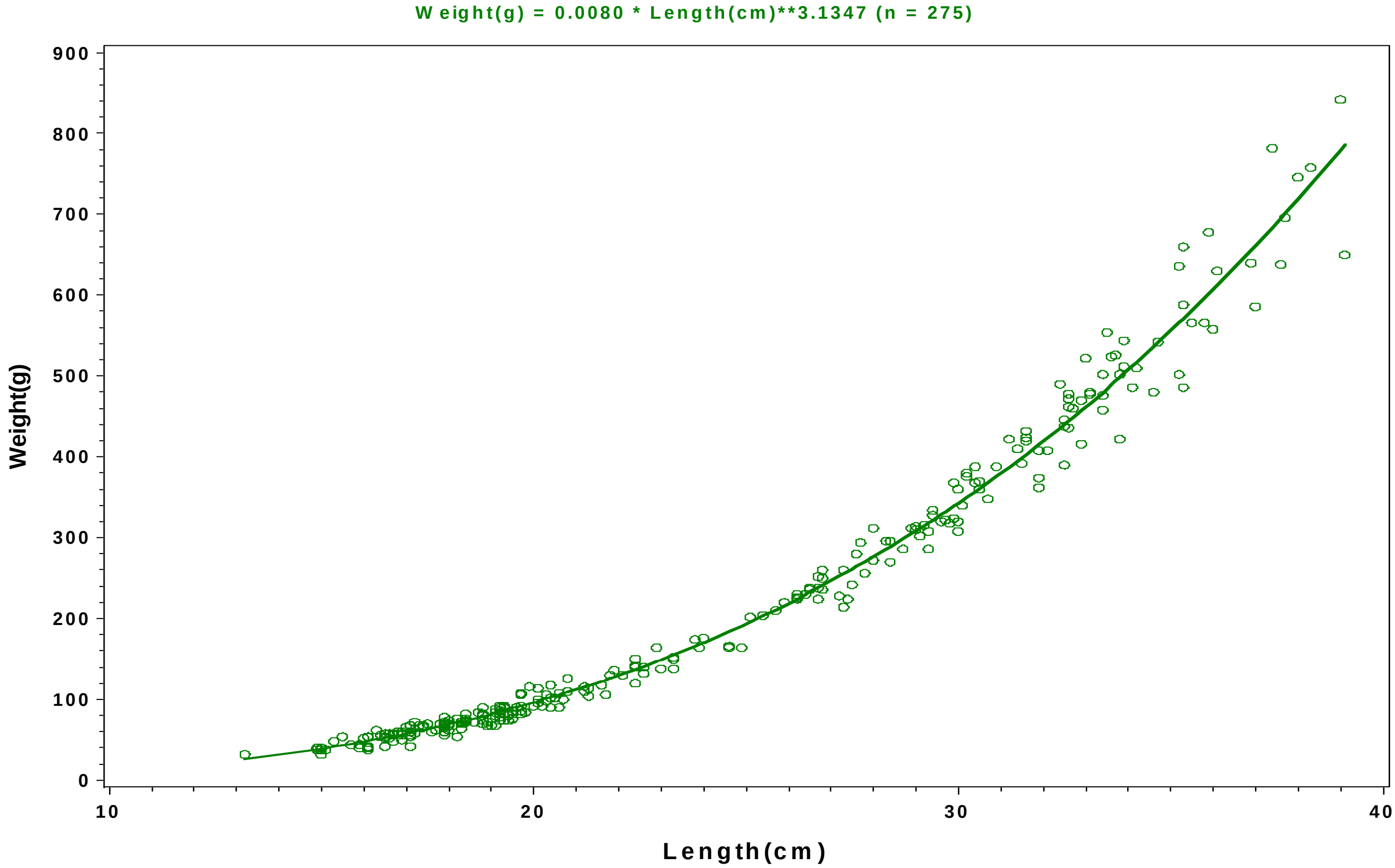


Figure 76. Length-weight regression for Atlantic croaker, by sex.

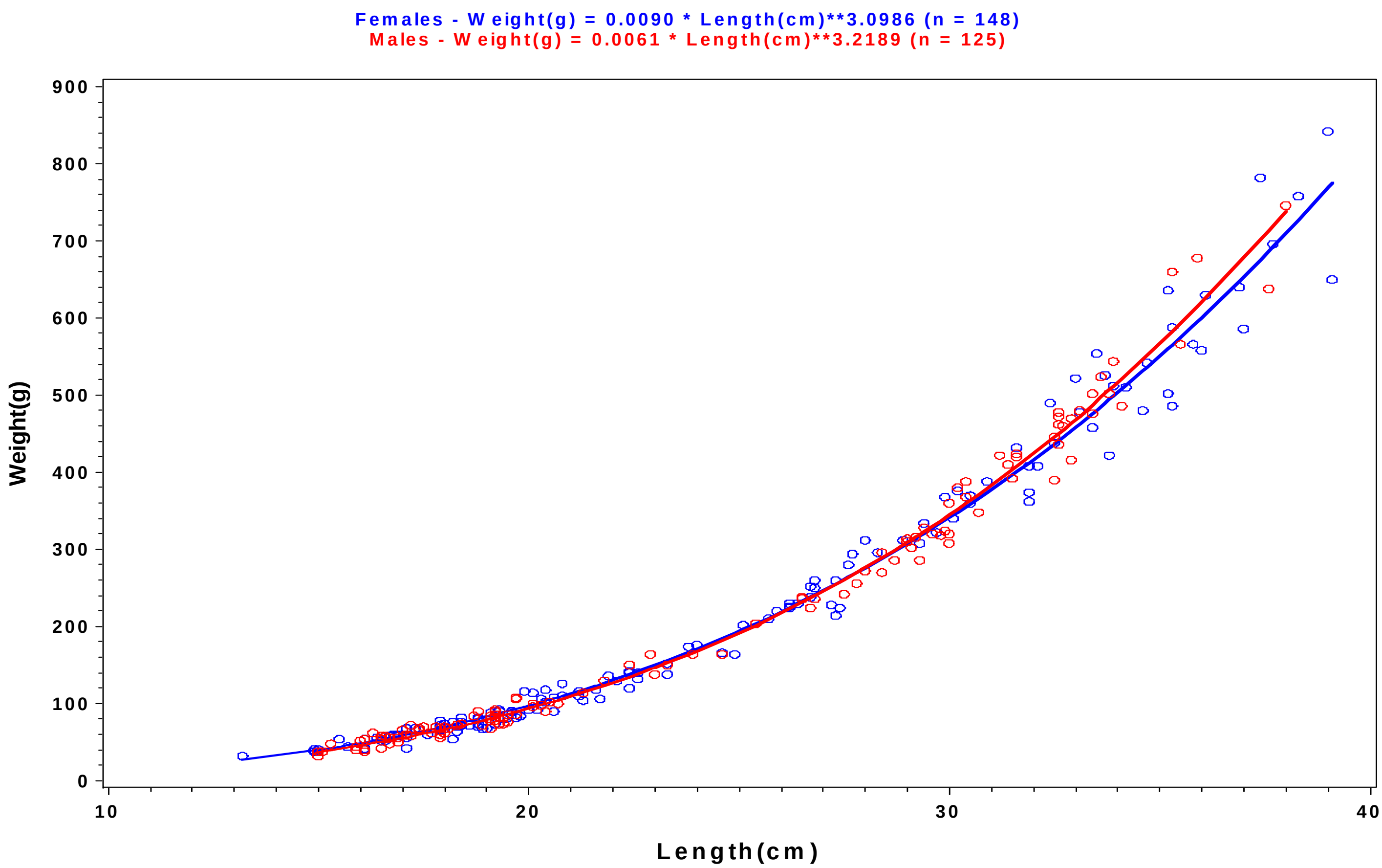


Figure 77. Maturity logistic regression for Atlantic croaker, females.

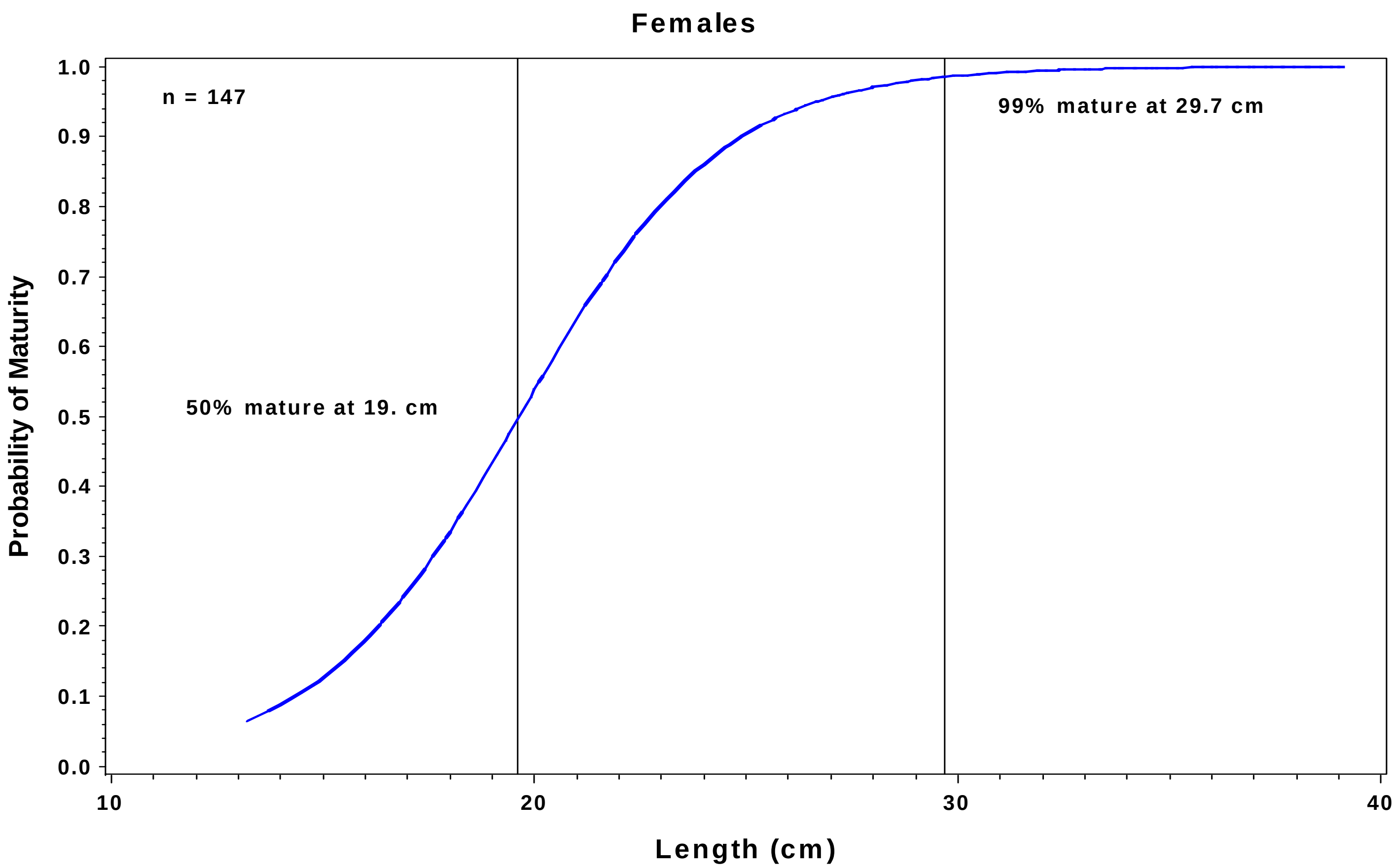
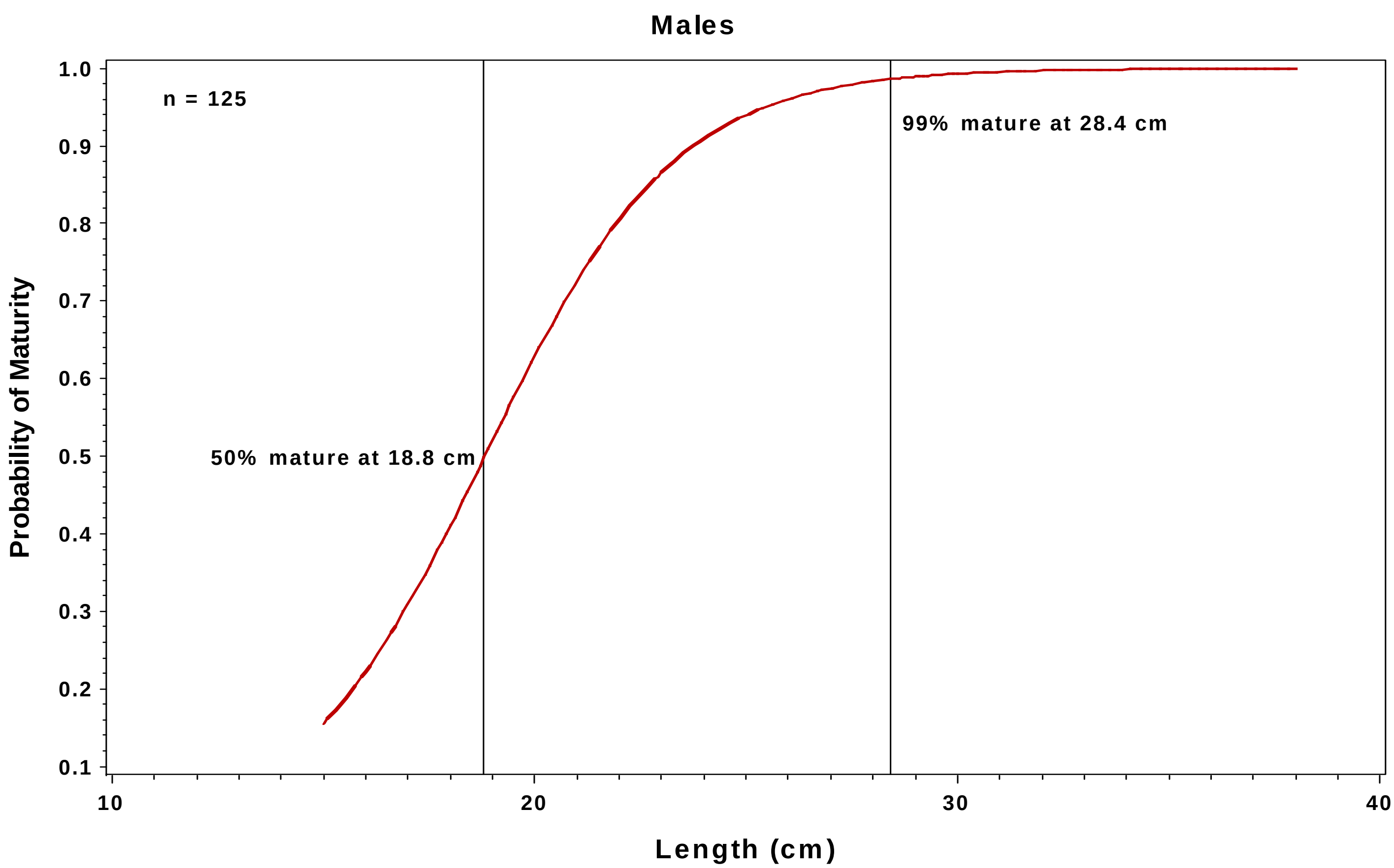
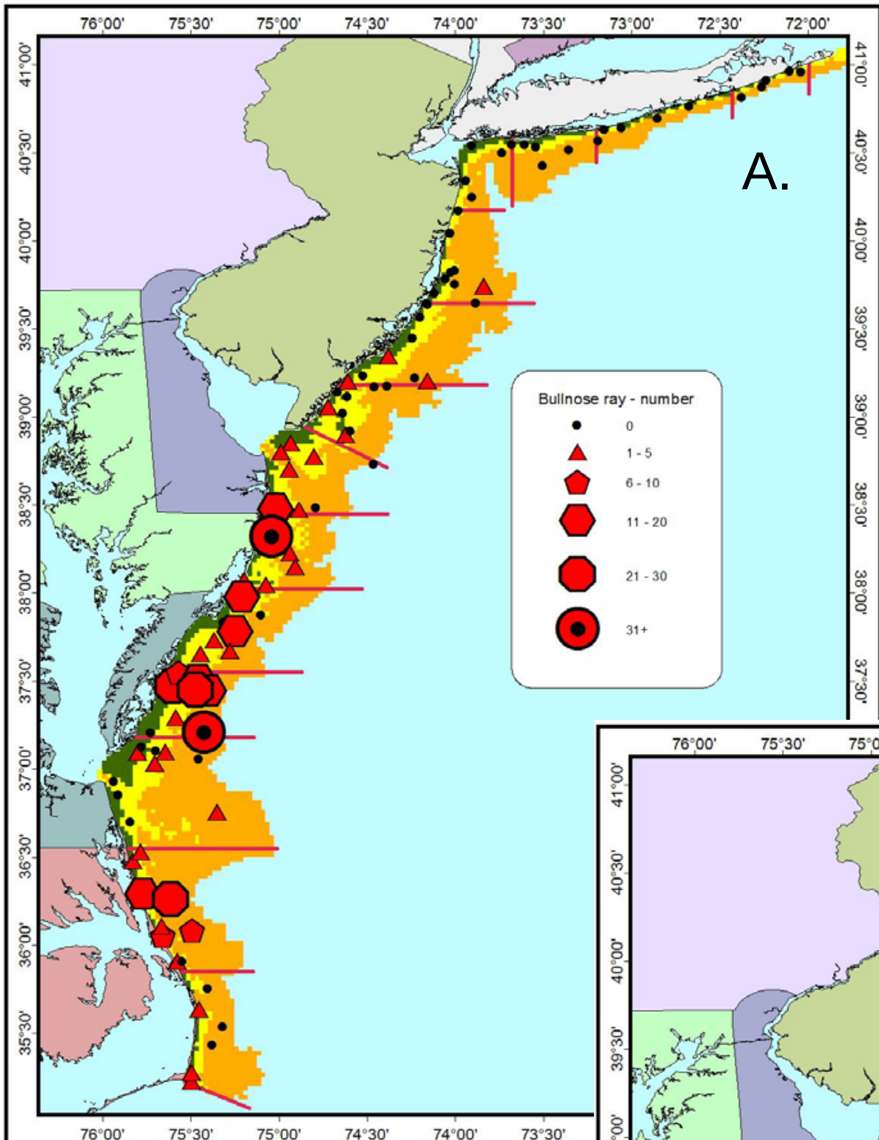


Figure 78. Maturity logistic regression for Atlantic croaker, males.



Bullnose Ray



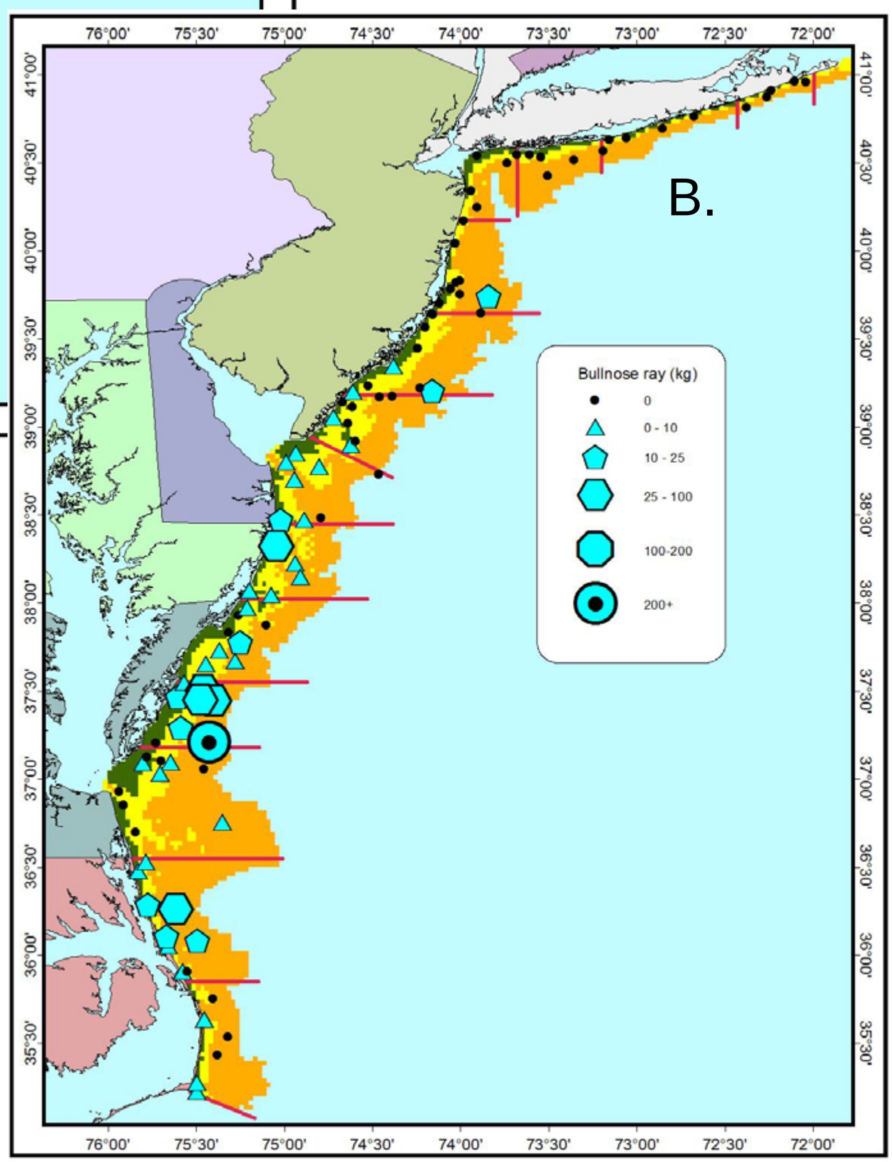


Figure 79. Number (A) and biomass (B) of specimens captured at each station for bullnose ray.

Figure 80. Minimum trawlable number and biomass by state for bullnose ray.

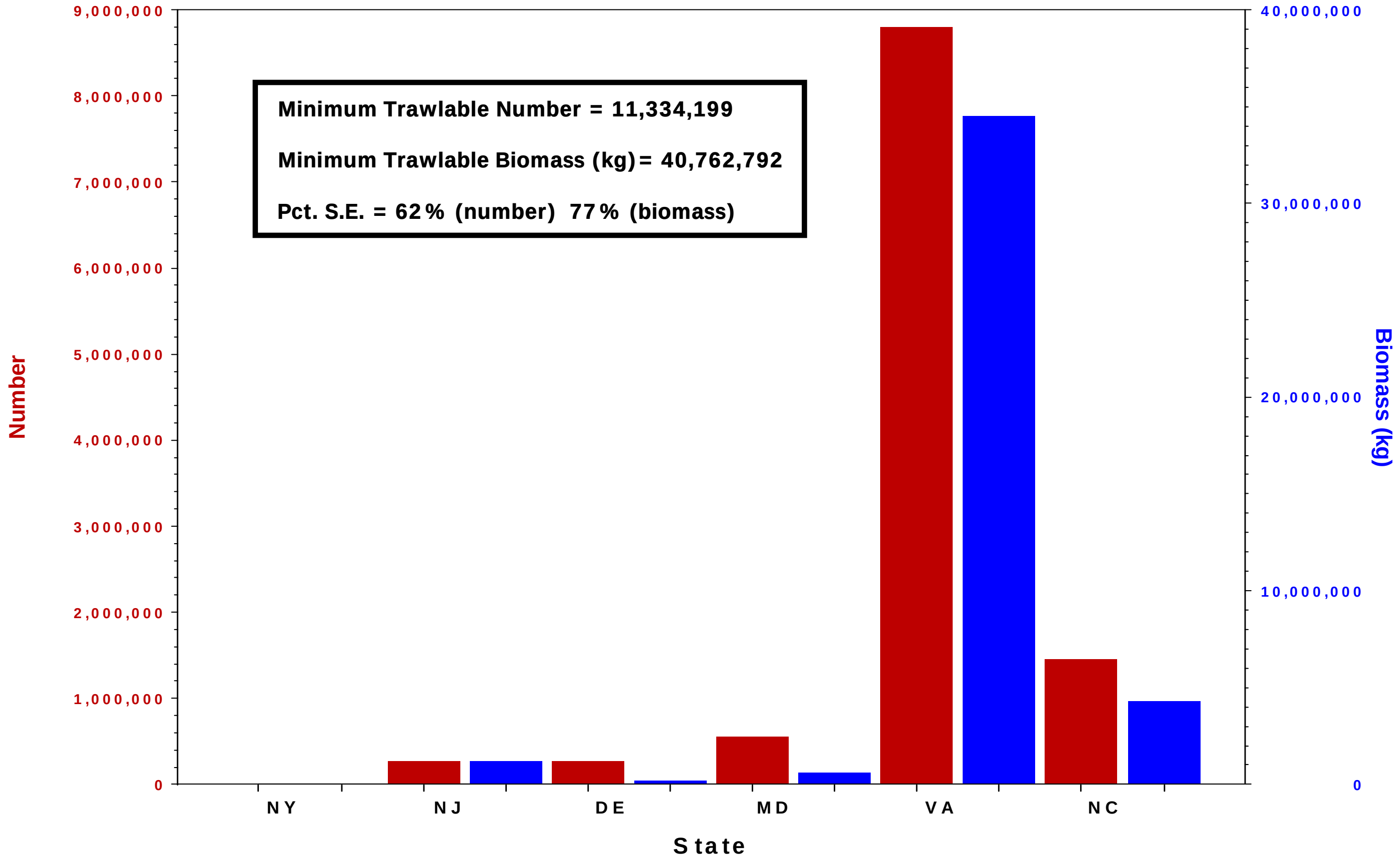


Figure 81. Sex ratios by state for bullnose ray.

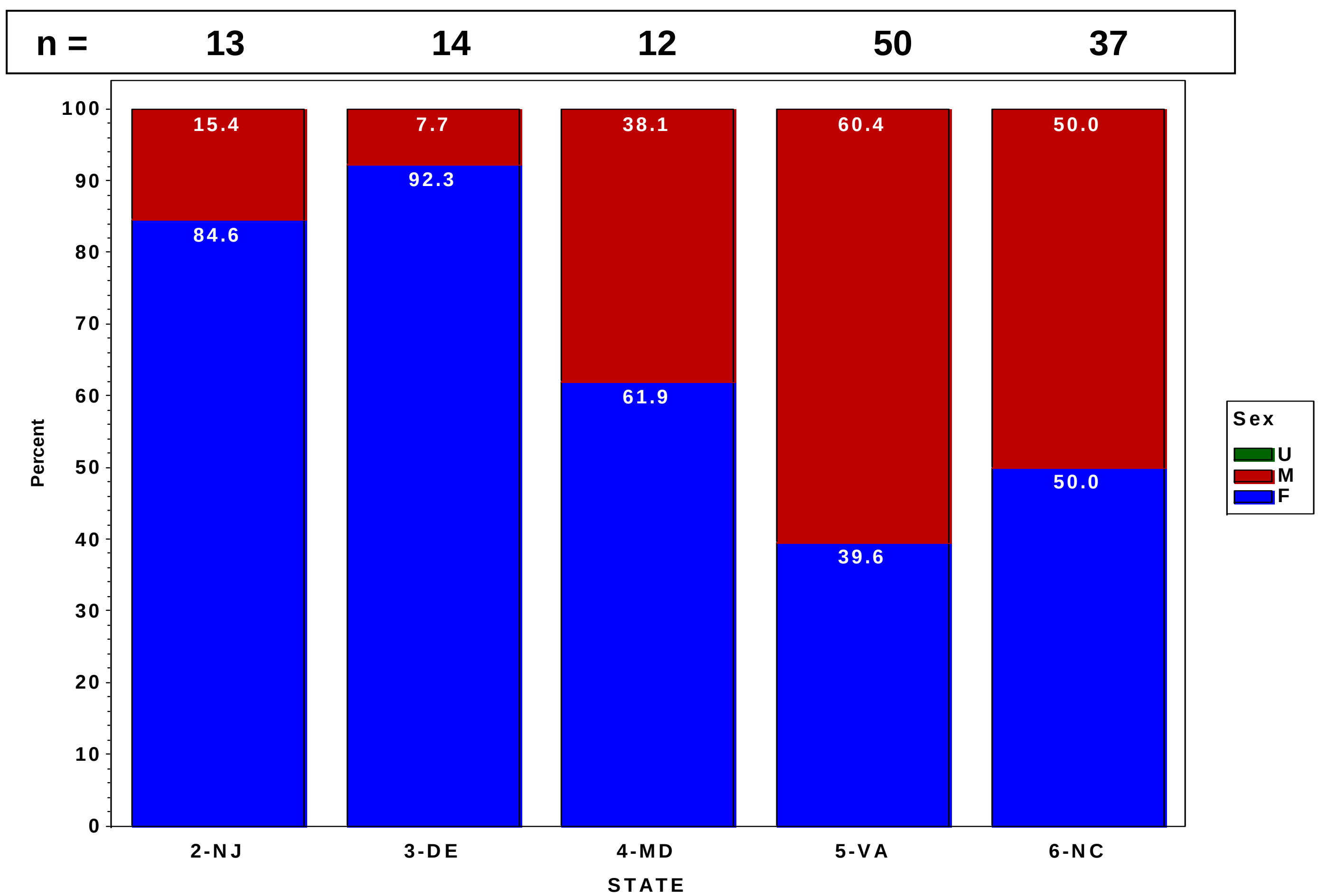


Figure 82. Length frequency for bullnose ray.

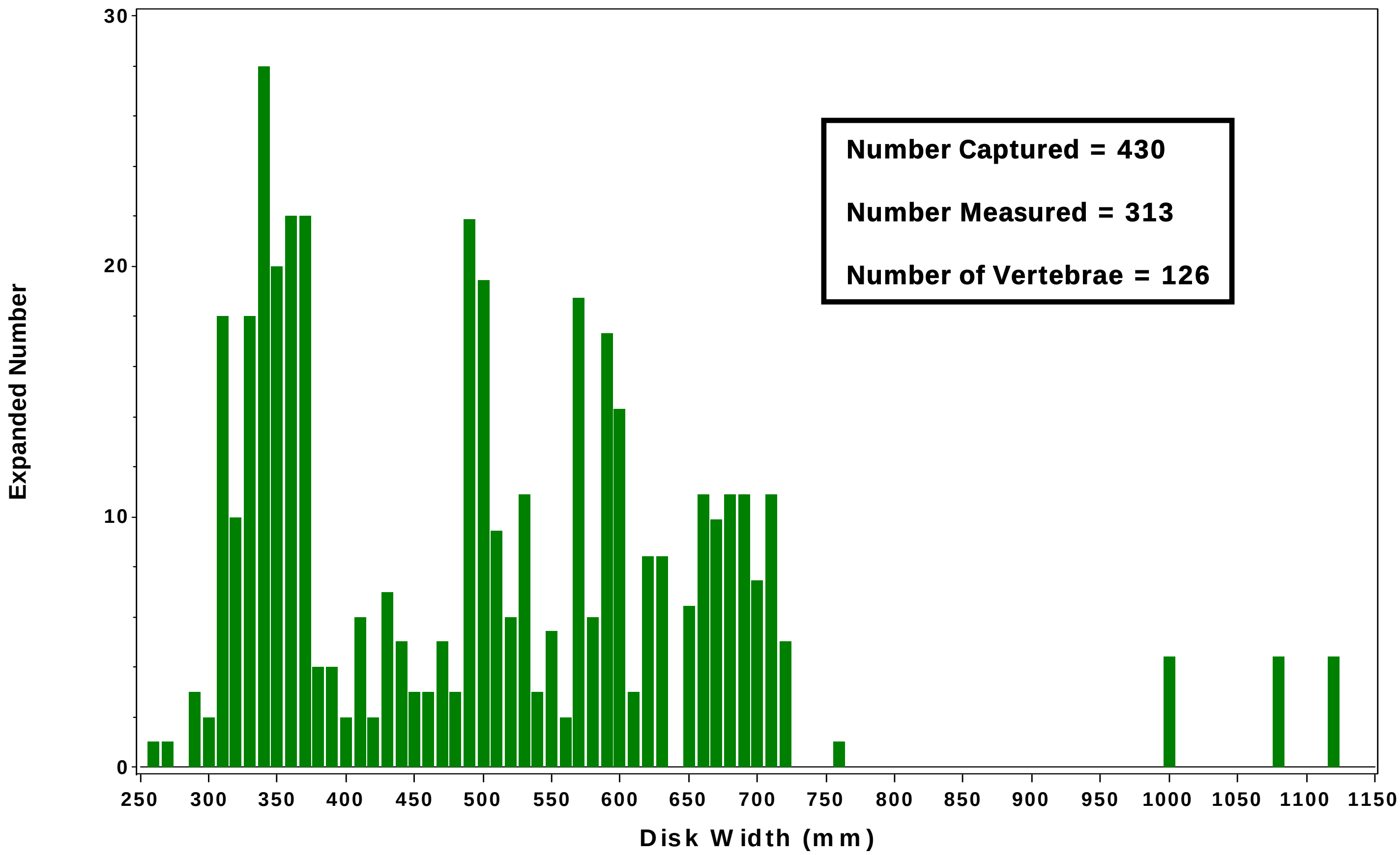


Figure 83. Length-weight regression for bullnose ray, sexes combined.

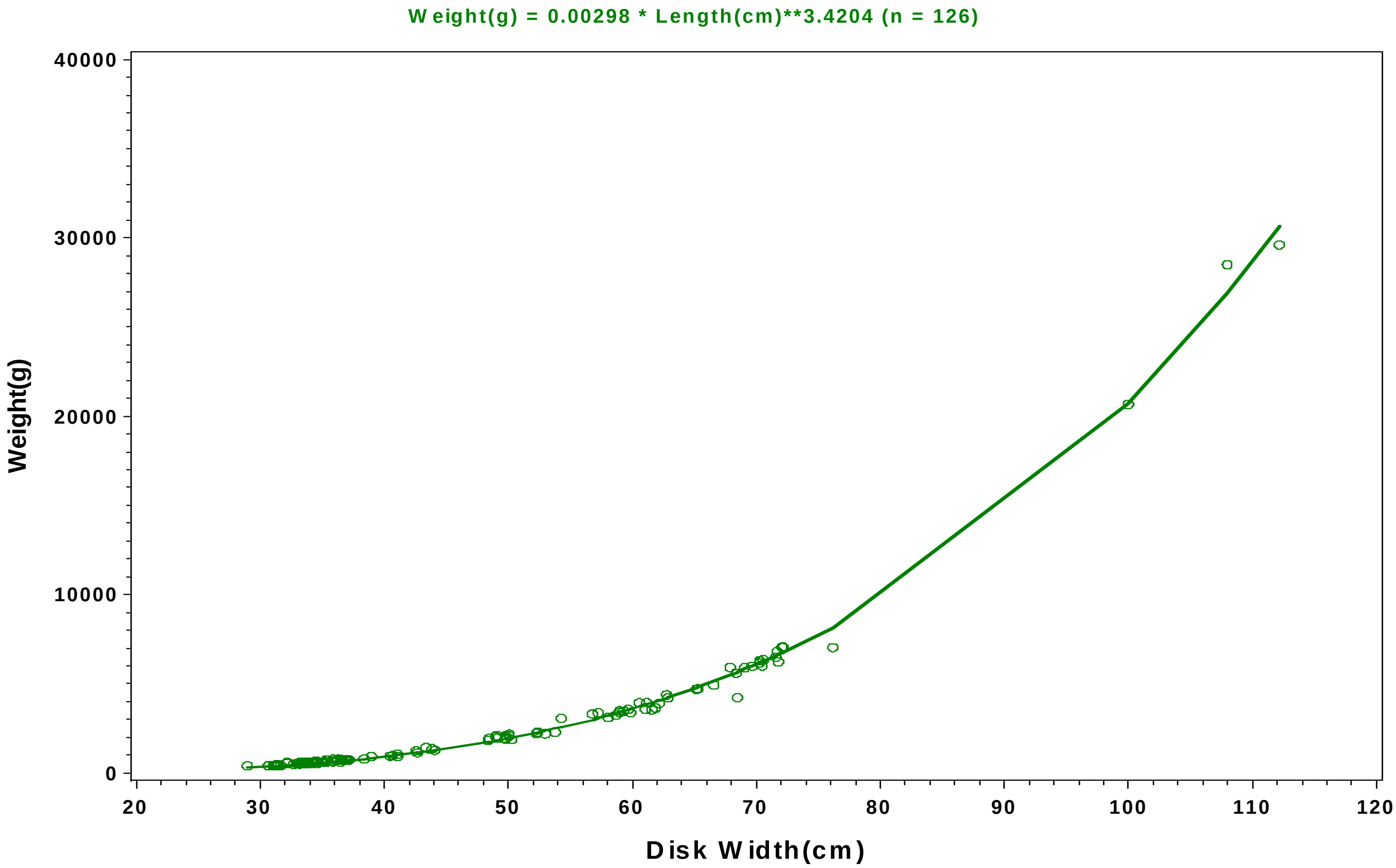


Figure 84. Length-weight regression for bullnose ray, by sex.

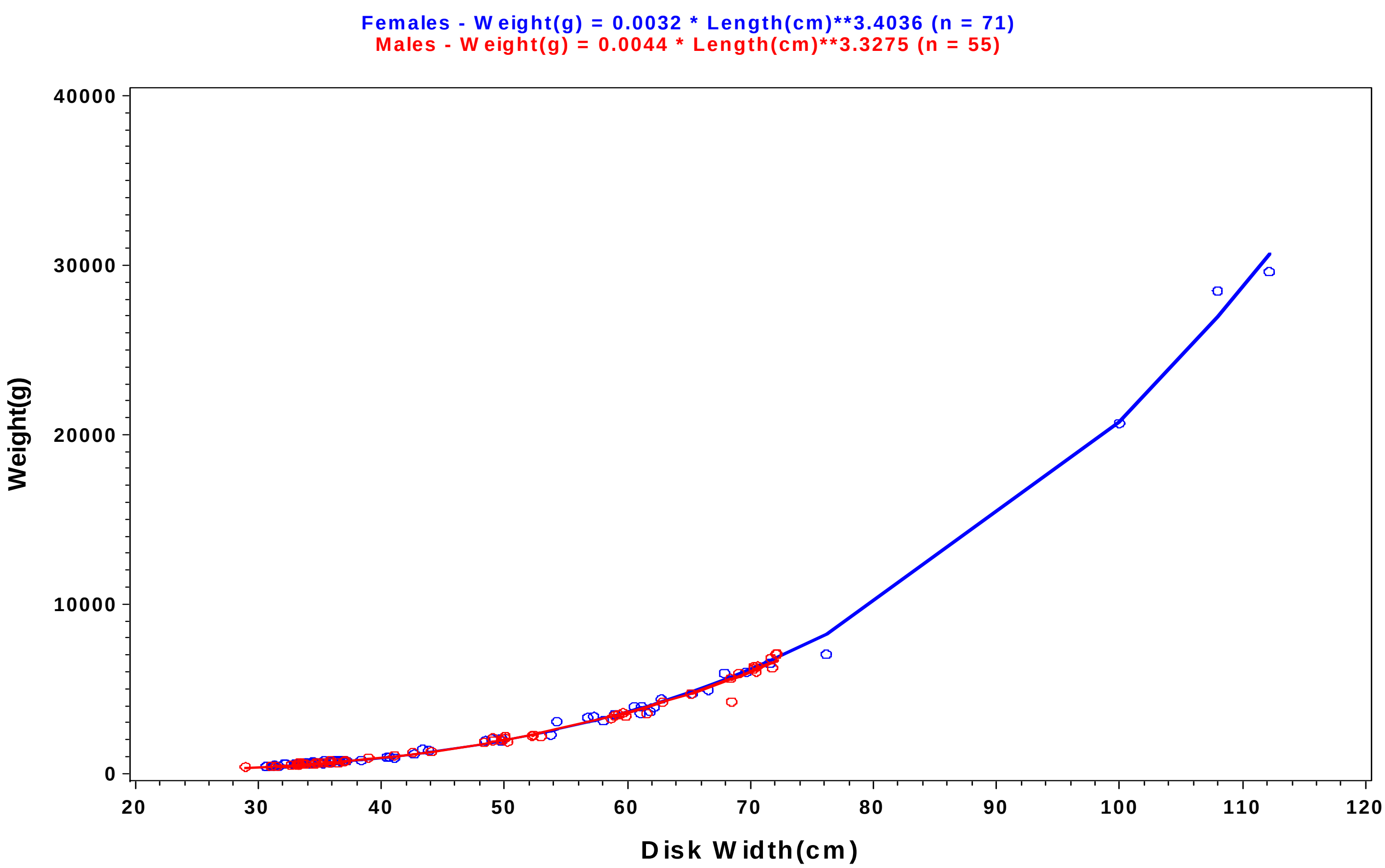


Figure 85. Maturity logistic regression for bullnose ray, females.

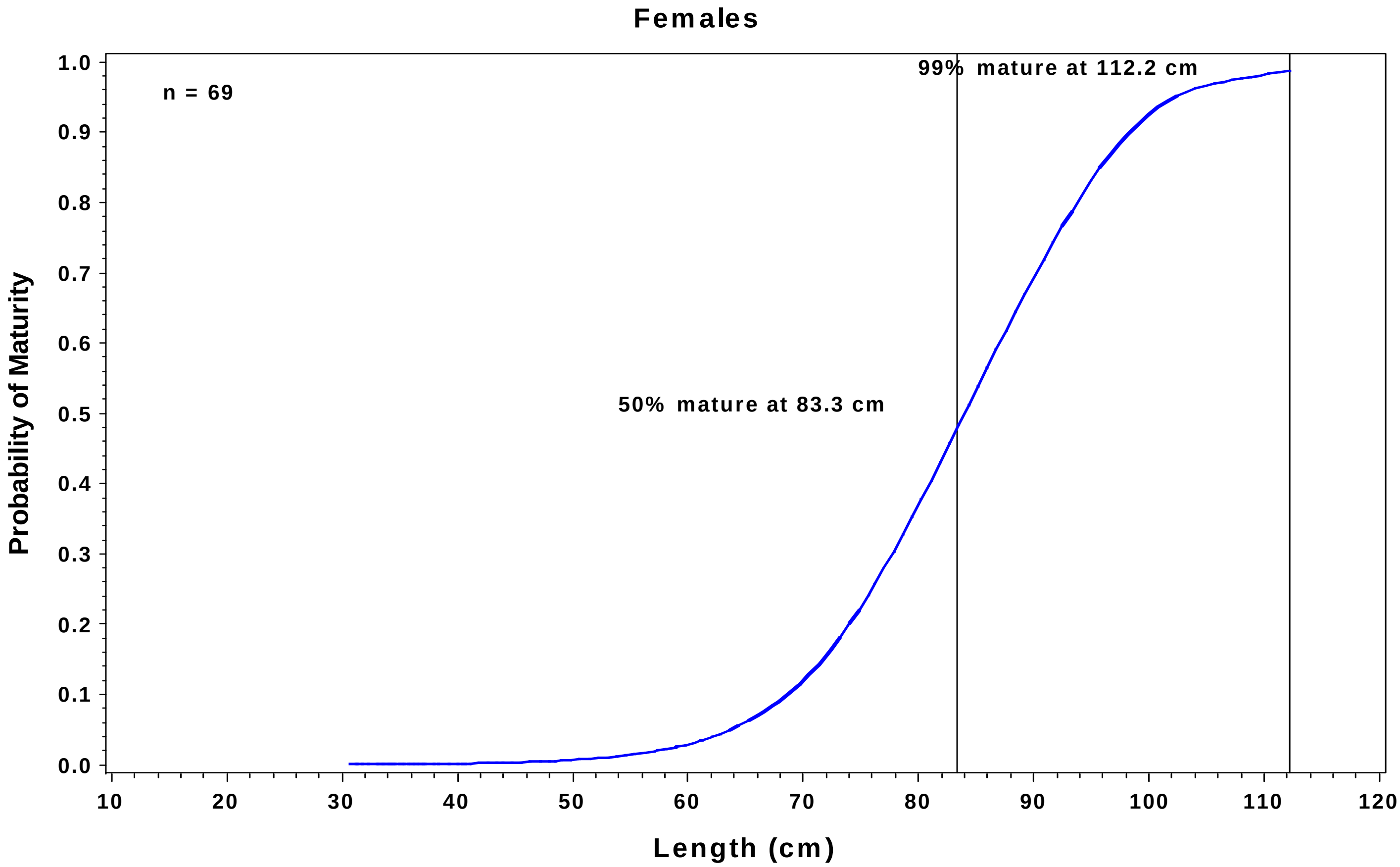
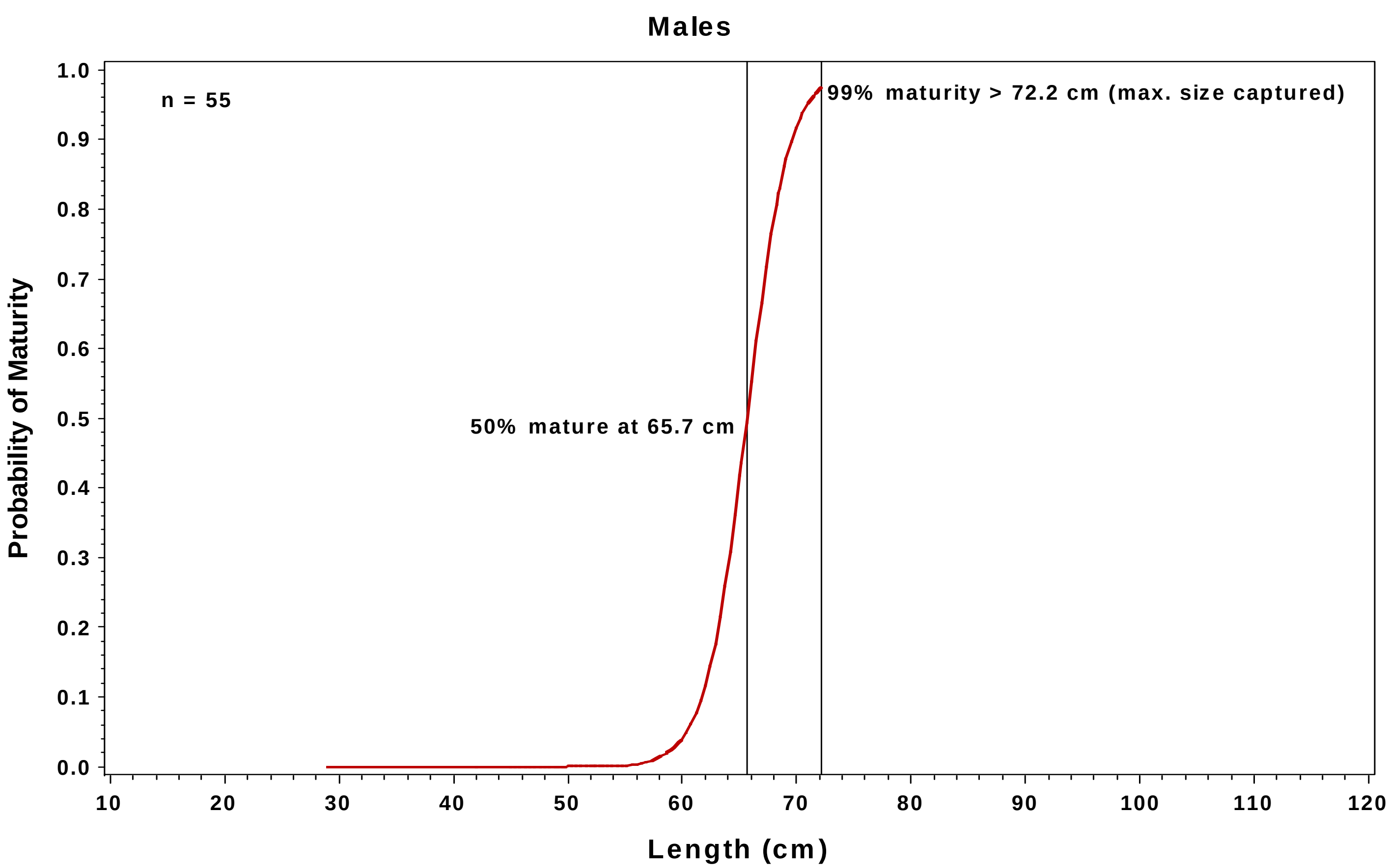
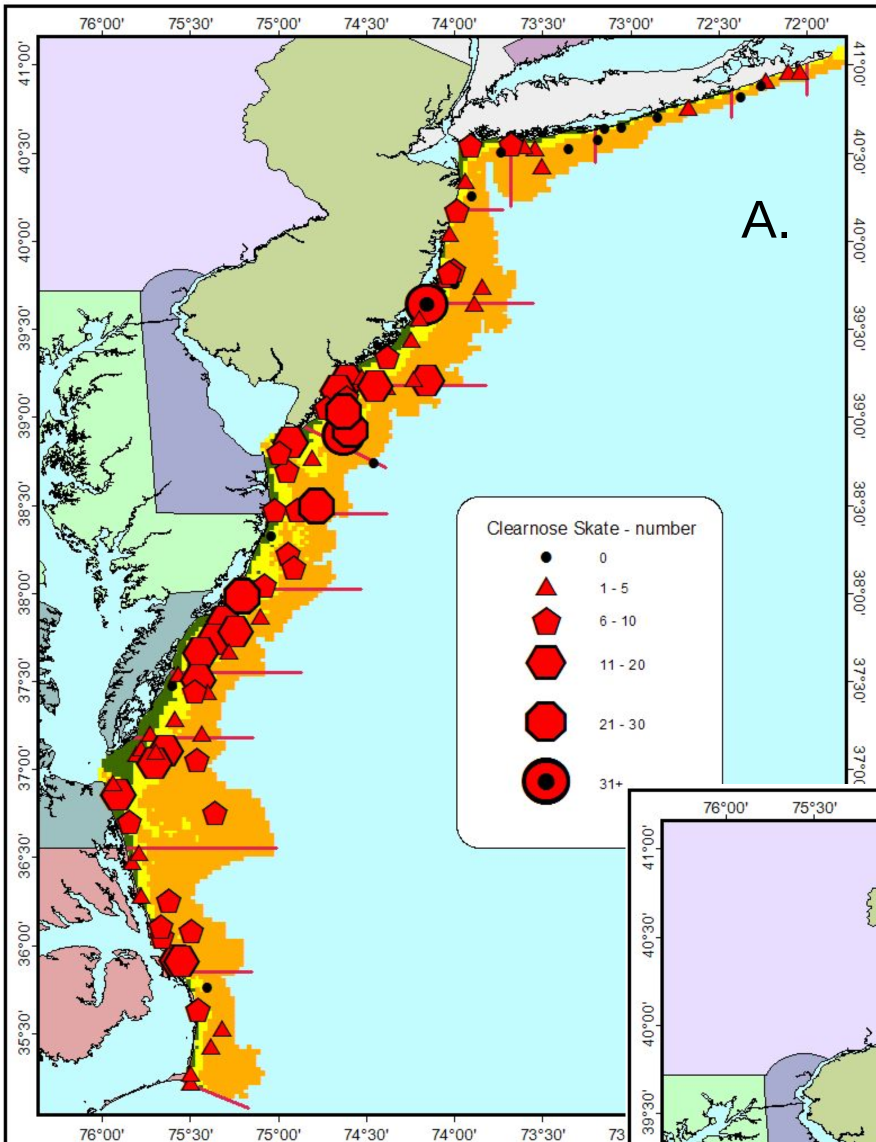


Figure 86. Maturity logistic regression for bullnose ray, males.



Clearnose Skate



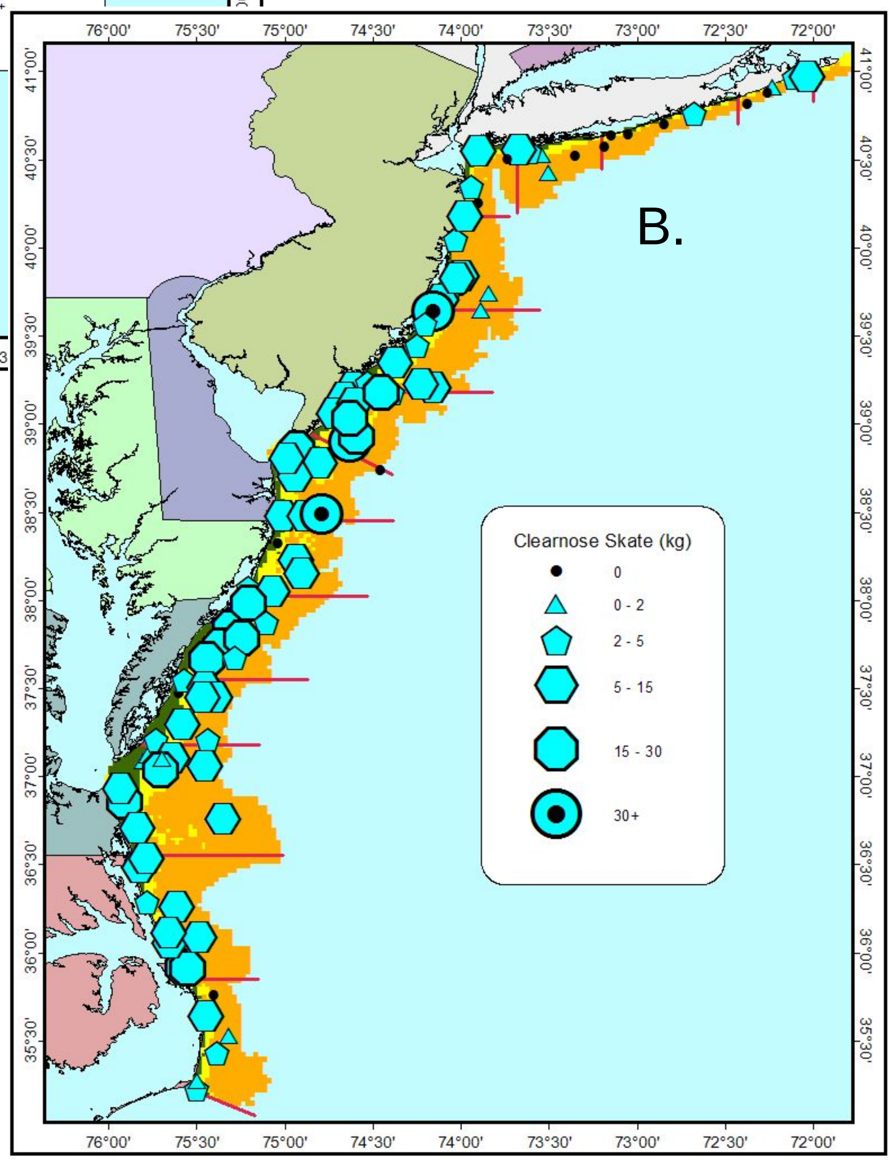


Figure 87. Number (A) and biomass (B) of specimens captured at each station for clearnose skate.

Figure 88. Minimum trawlable number and biomass by state for clearnose skate.

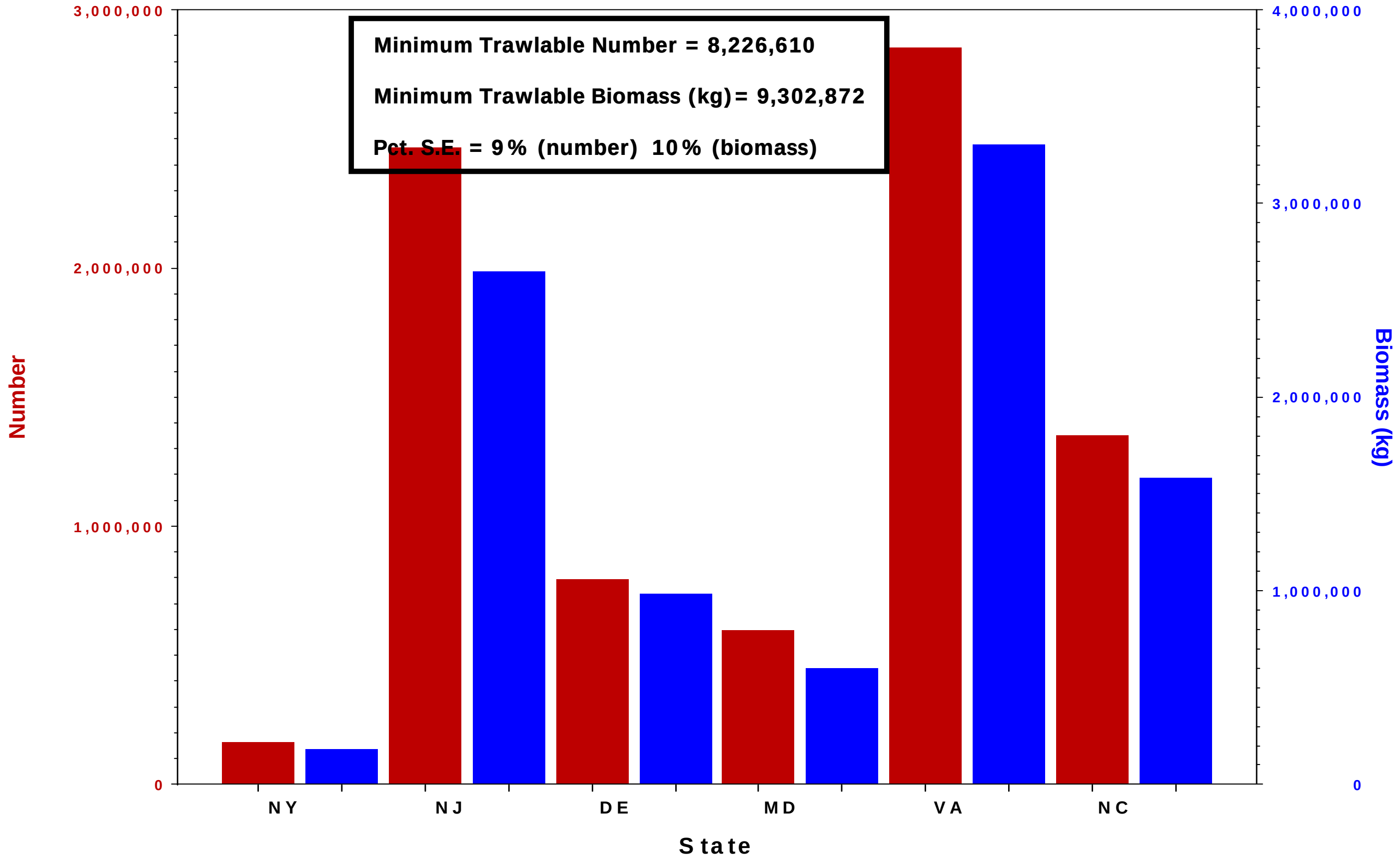


Figure 89. Sex ratios by state for clearnose skate.

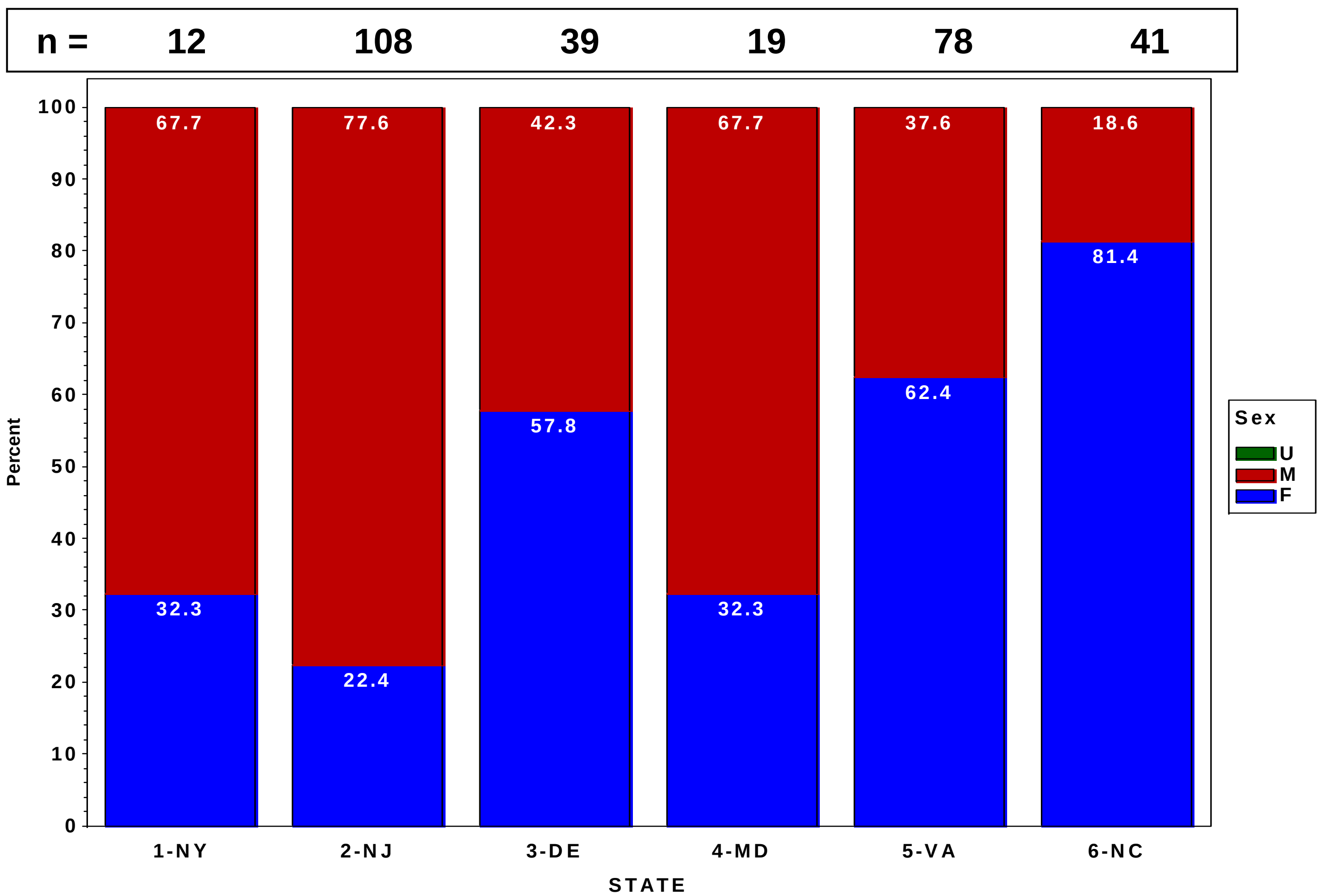


Figure 90. Length frequency for clearnose skate.

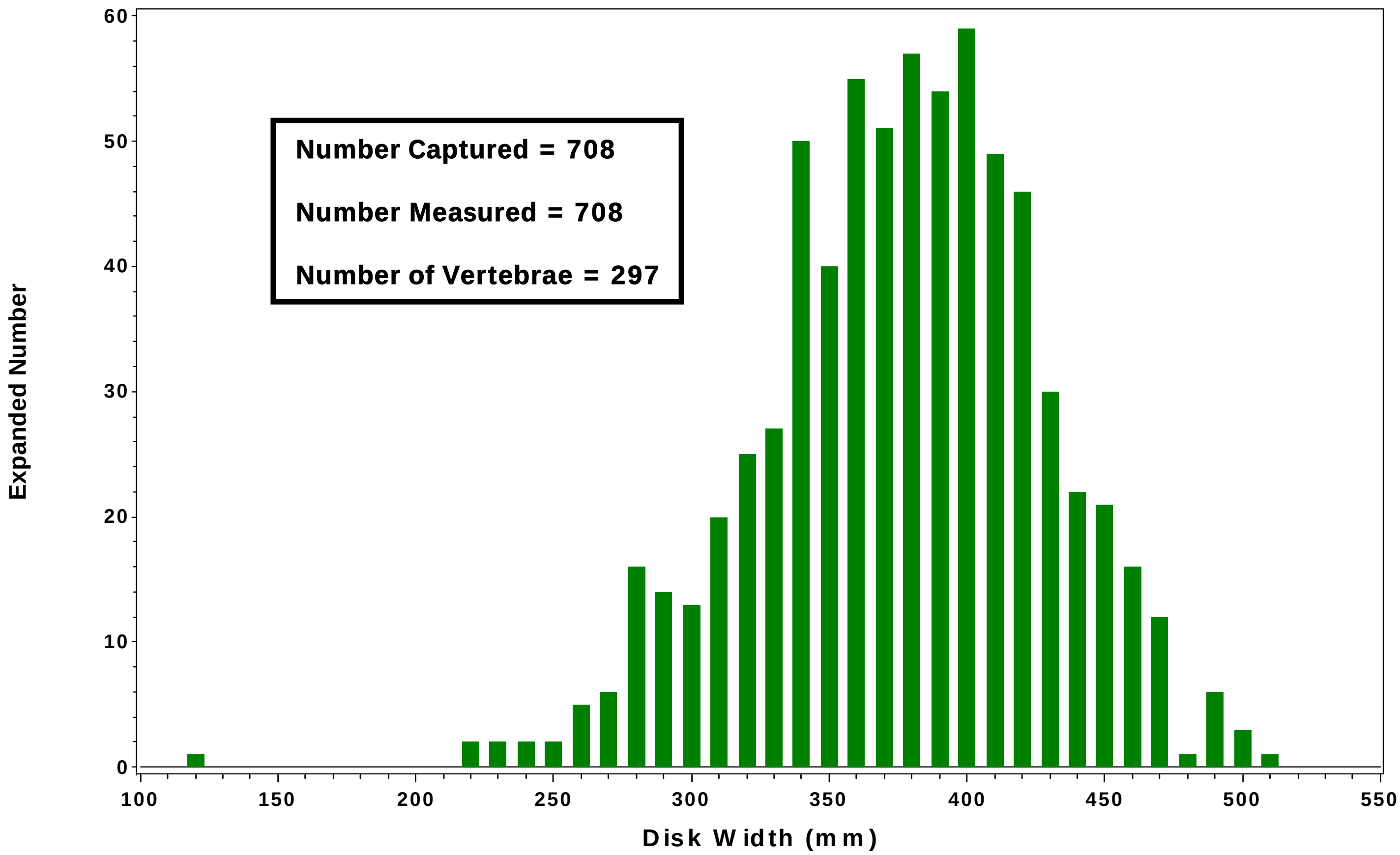


Figure 91. Length-weight regression for clearnose skate, sexes combined.

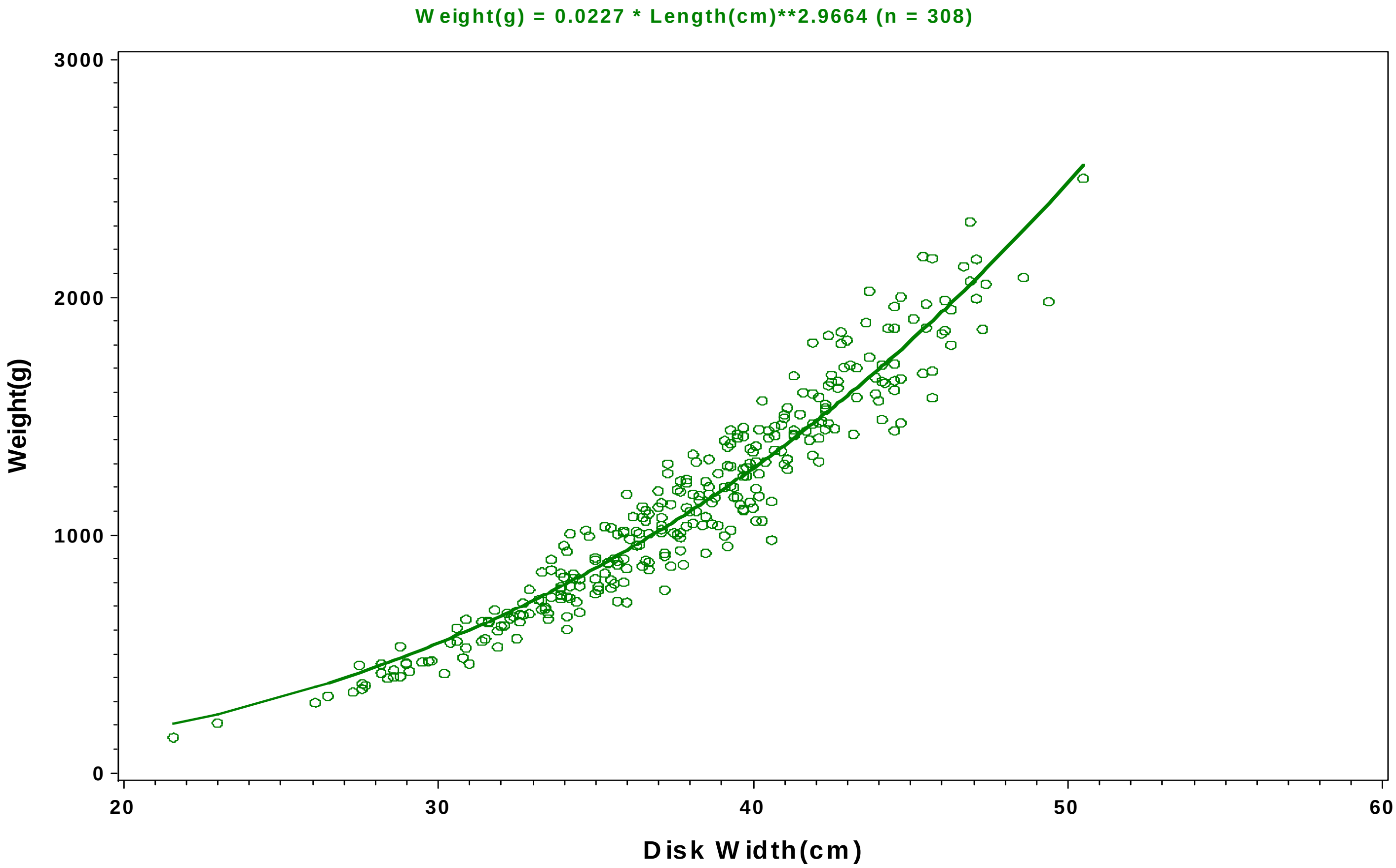


Figure 92. Length-weight regression for slearnose skate, by sex.

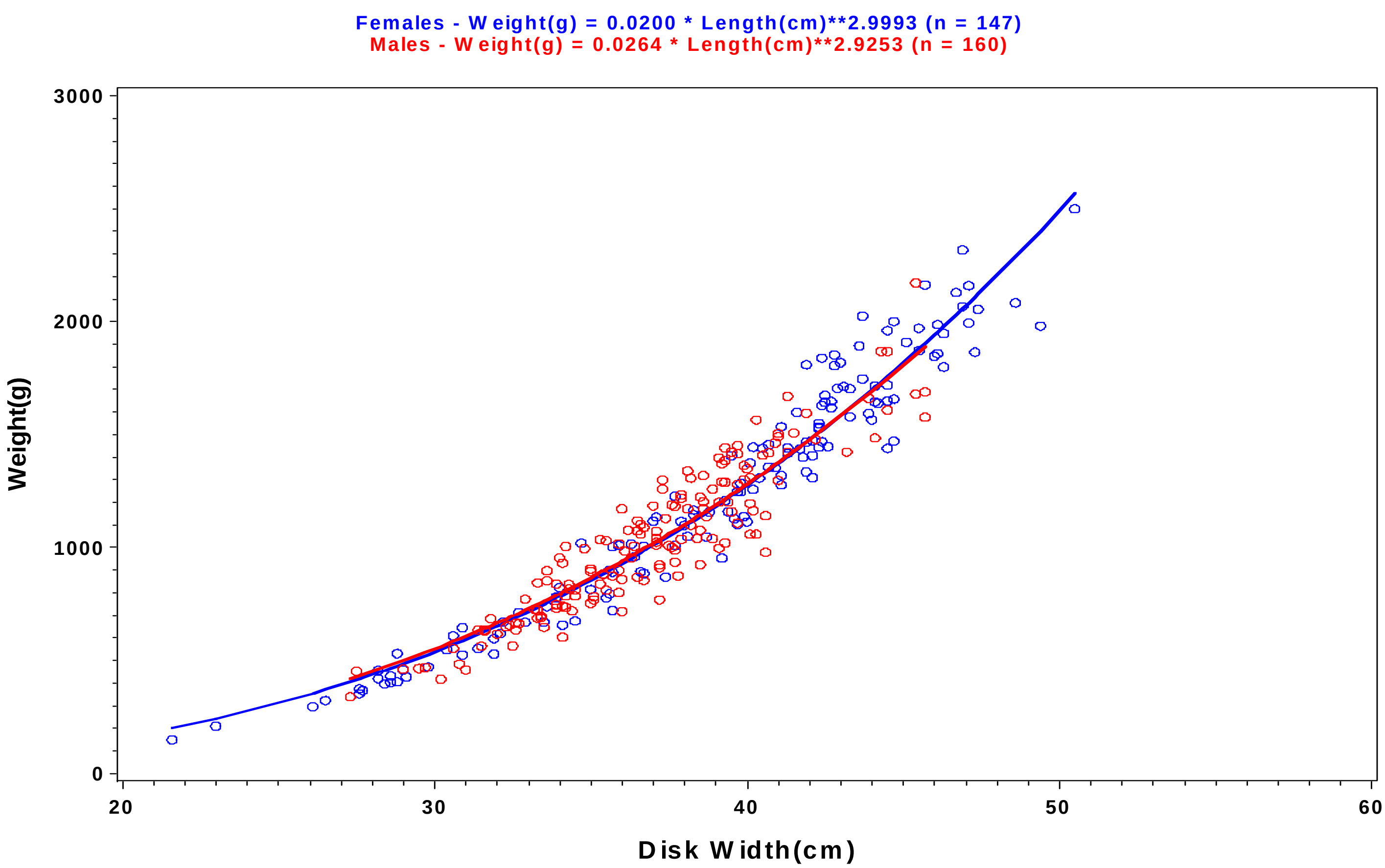


Figure 93. Maturity logistic regression for clearnose skate, females.

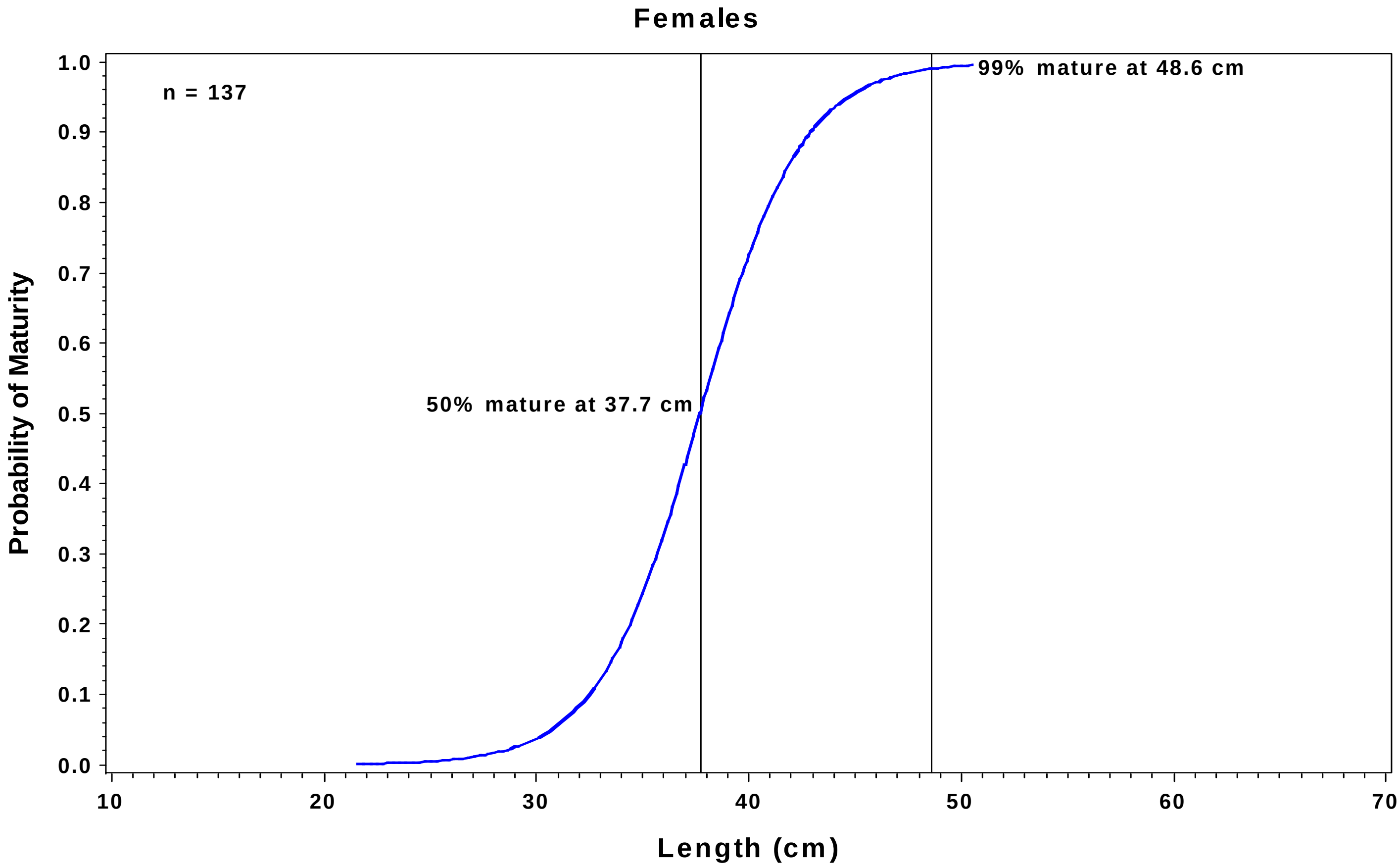
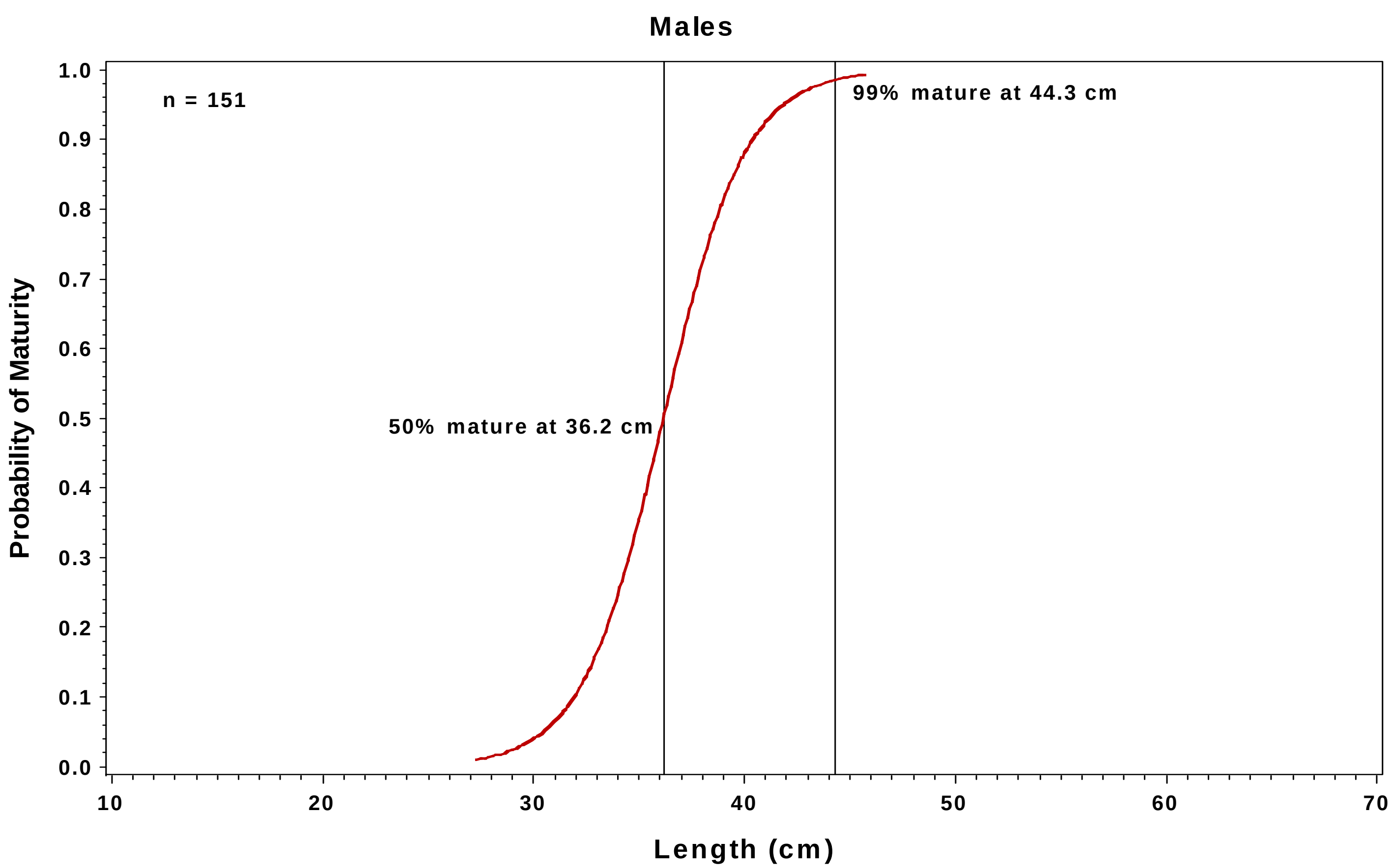
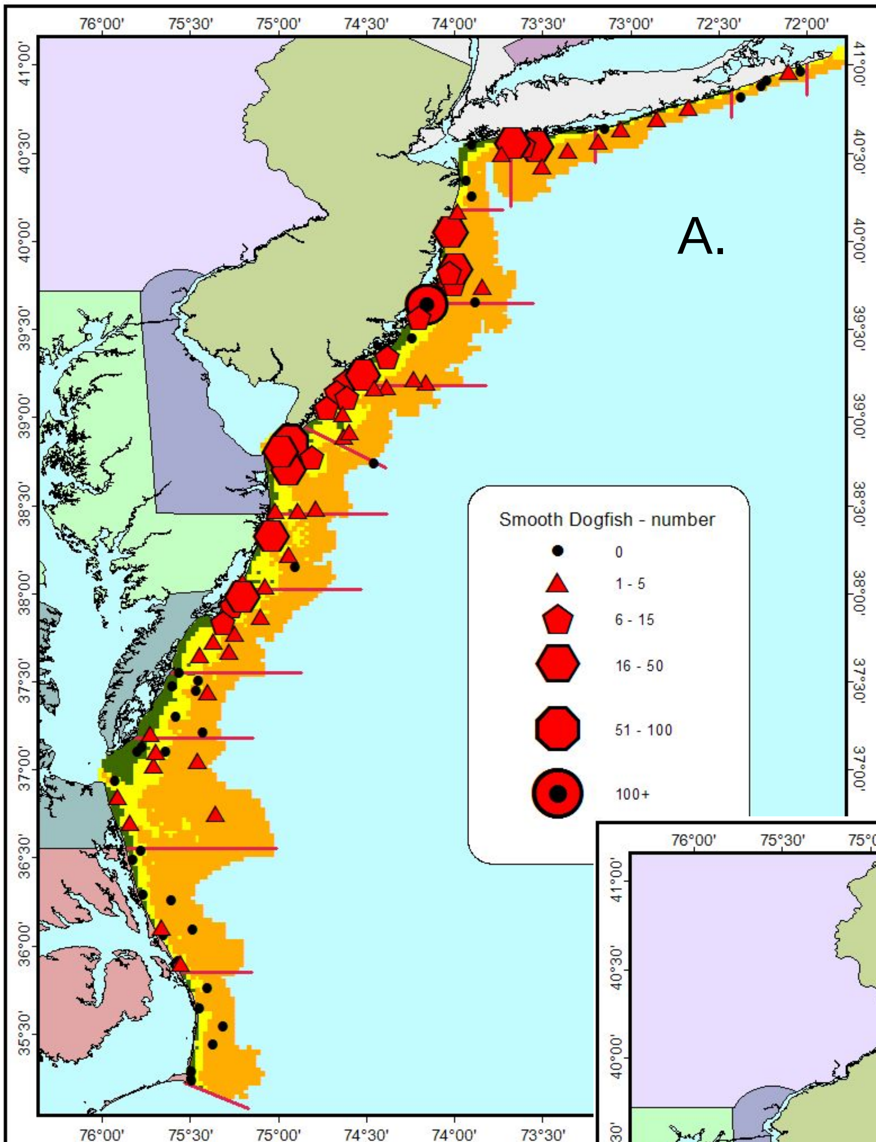


Figure 94. Maturity logistic regression for clearnose skate, males.



Smooth Dogfish



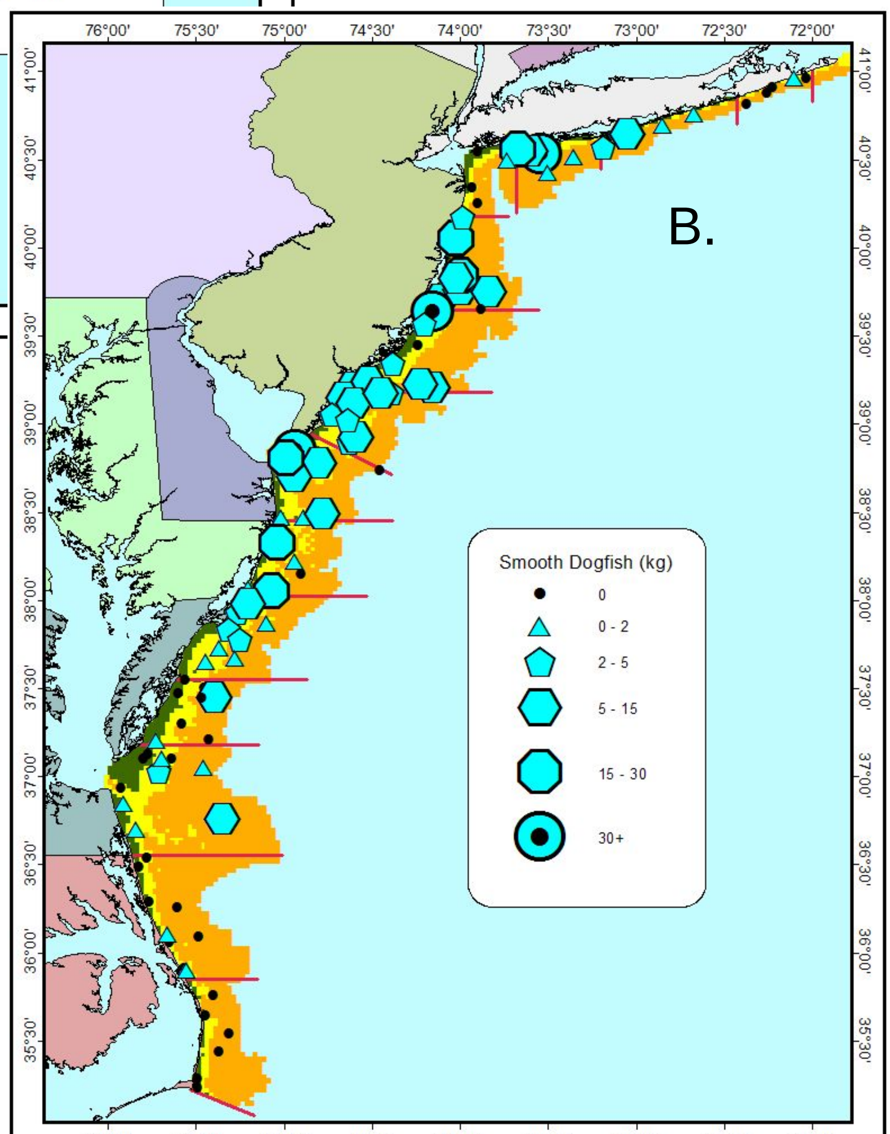


Figure 95. Number (A) and biomass (B) of specimens captured at each station for smooth dogfish.

Figure 96. Minimum trawlable number and biomass by state for smooth dogfish.

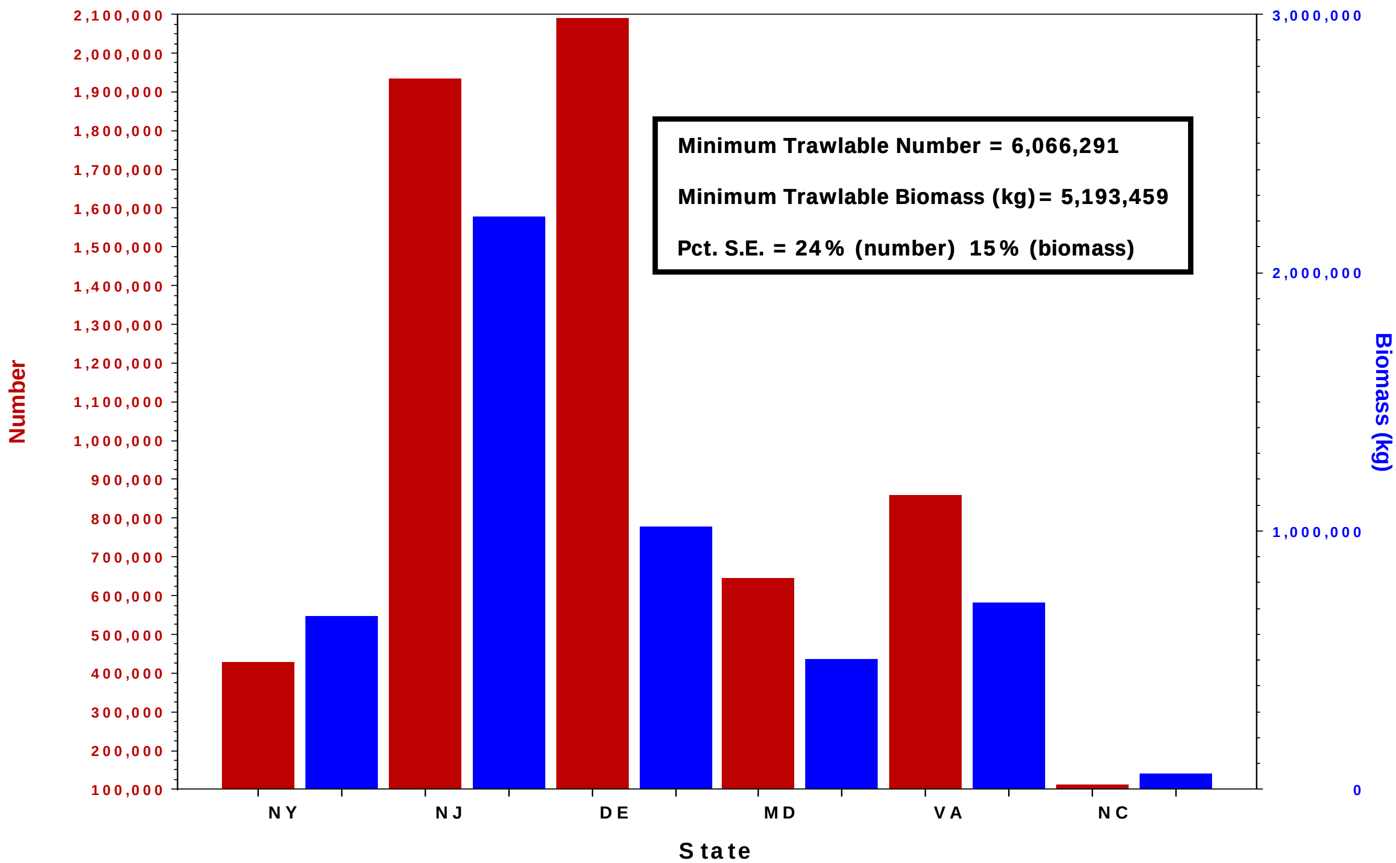


Figure 97. Sex ratios by state for smooth dogfish.

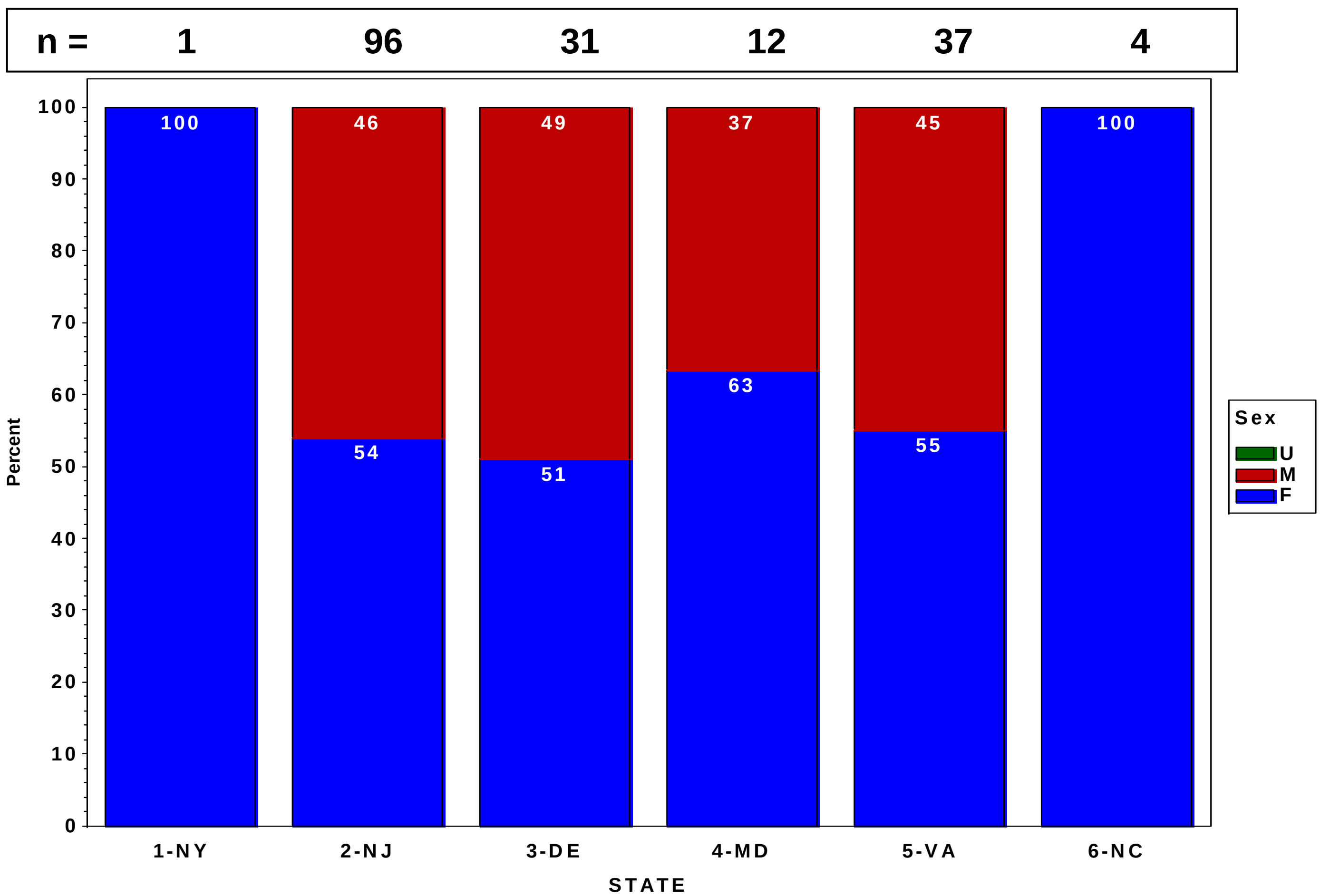


Figure 98. Length frequency for smooth dogfish.

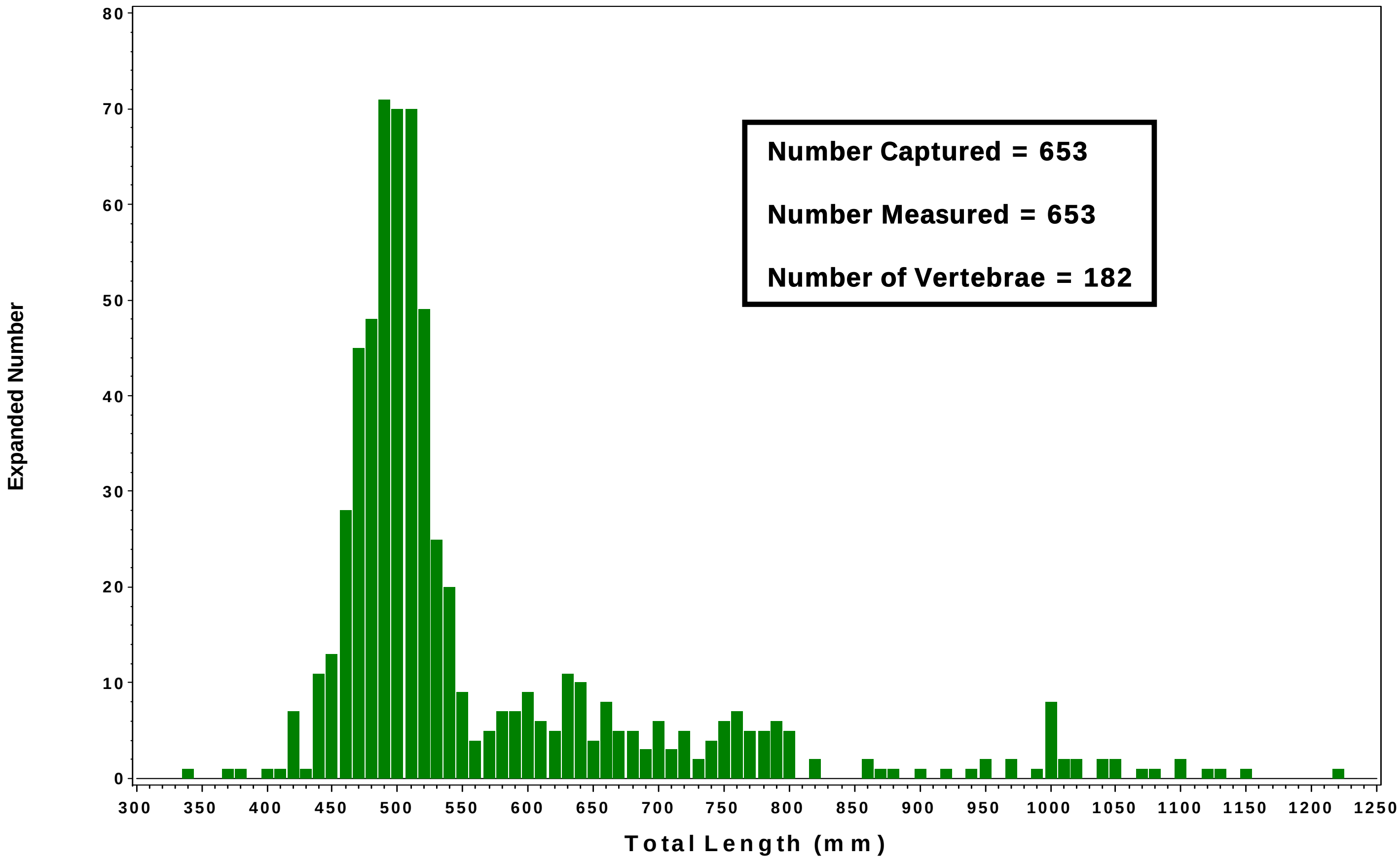


Figure 99. Length-weight regression for smooth dogfish, sexes combined.

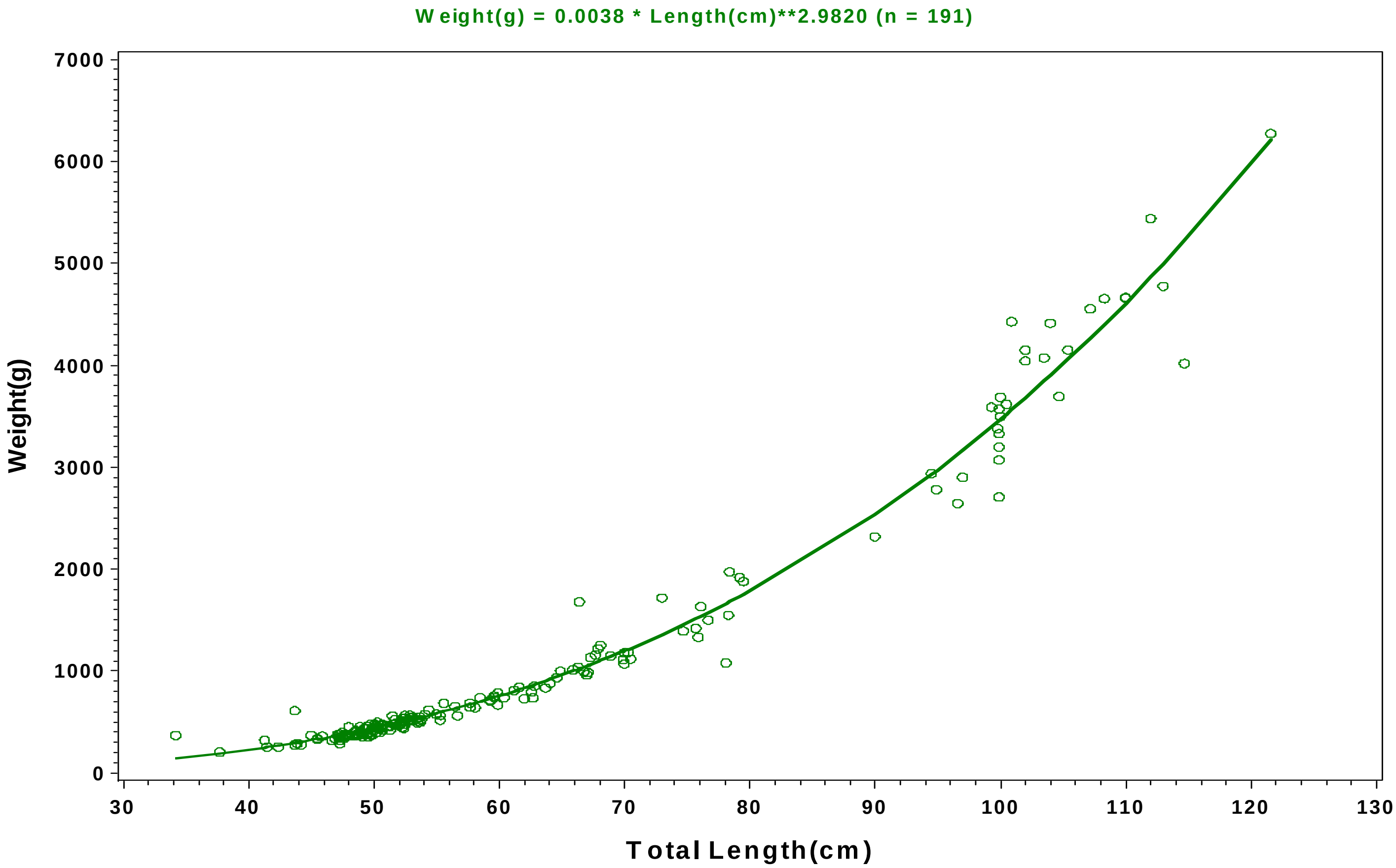
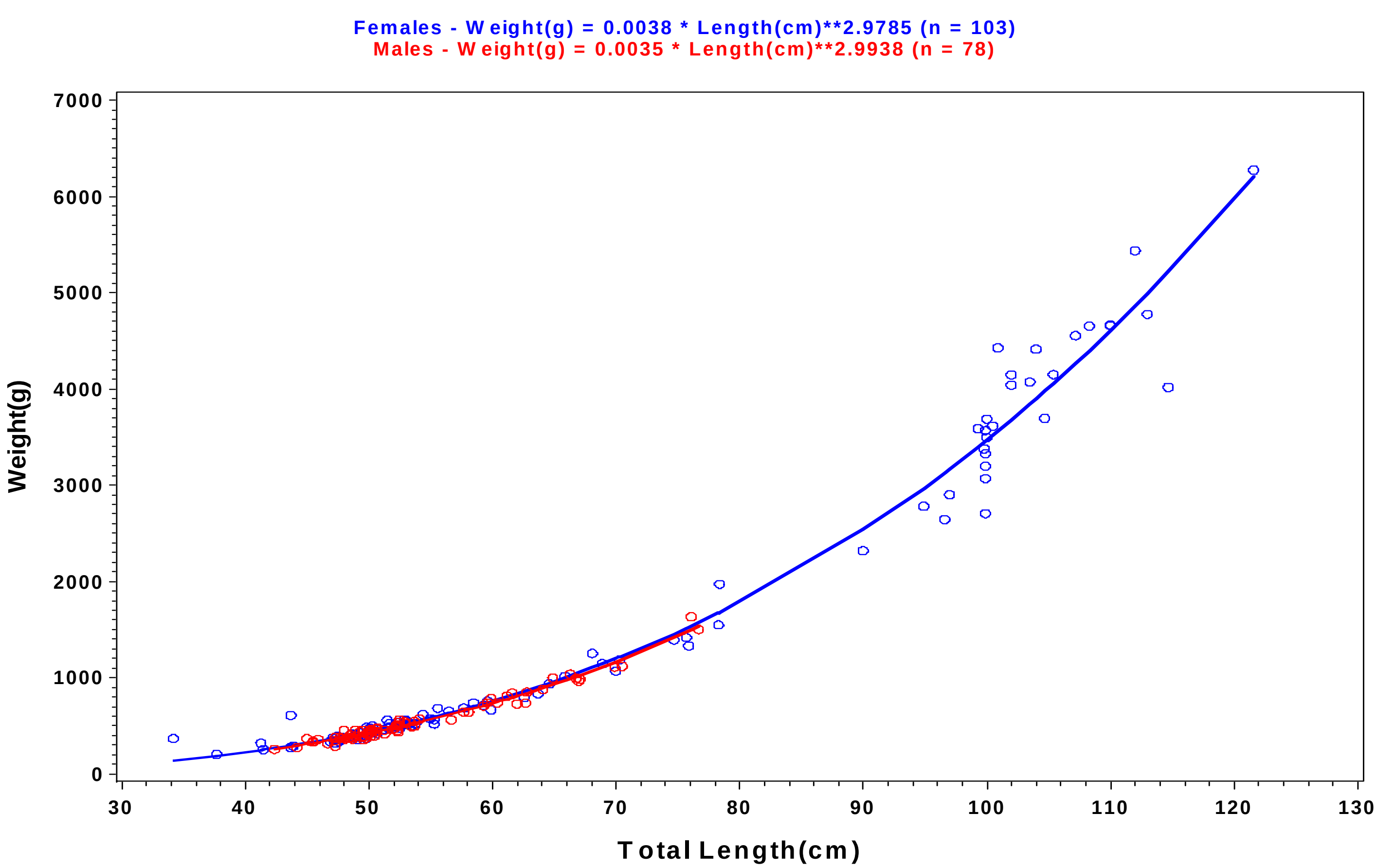
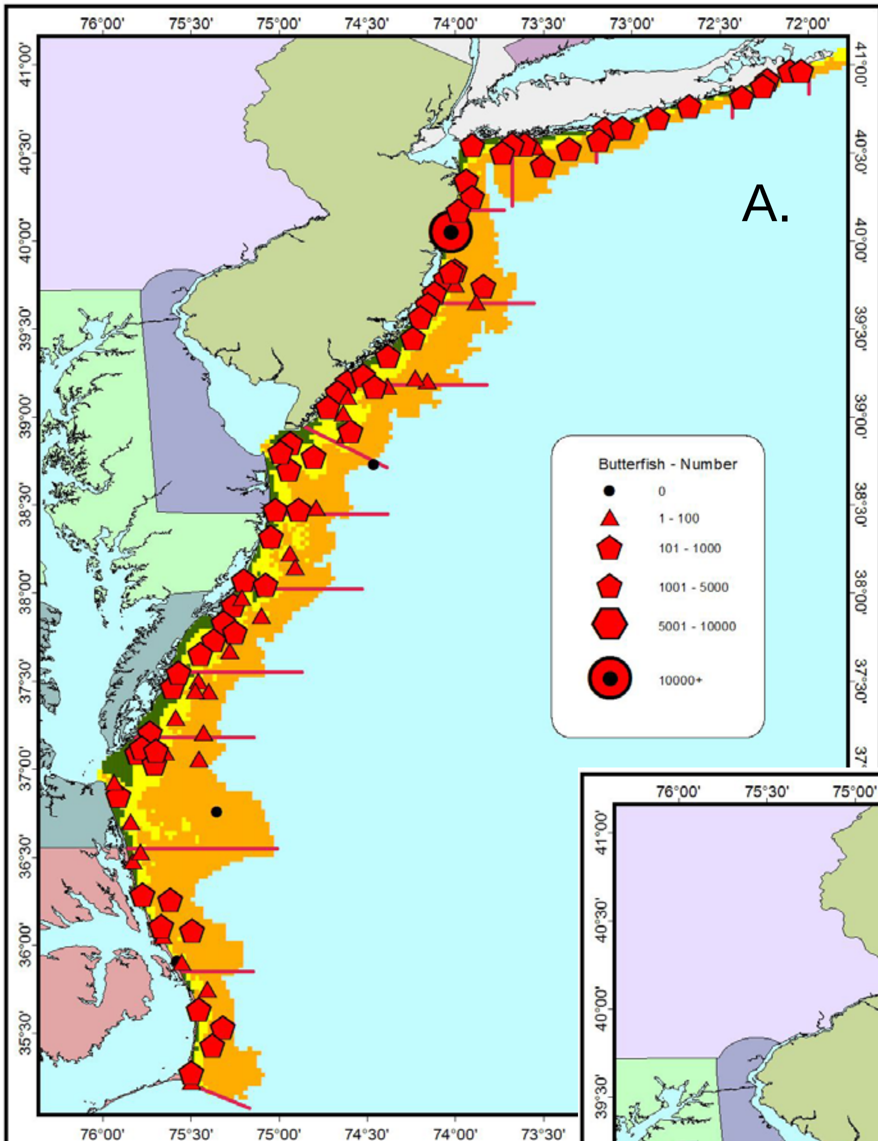


Figure 100. Length-weight regression for smooth dogfish, by sex.



Butterfish



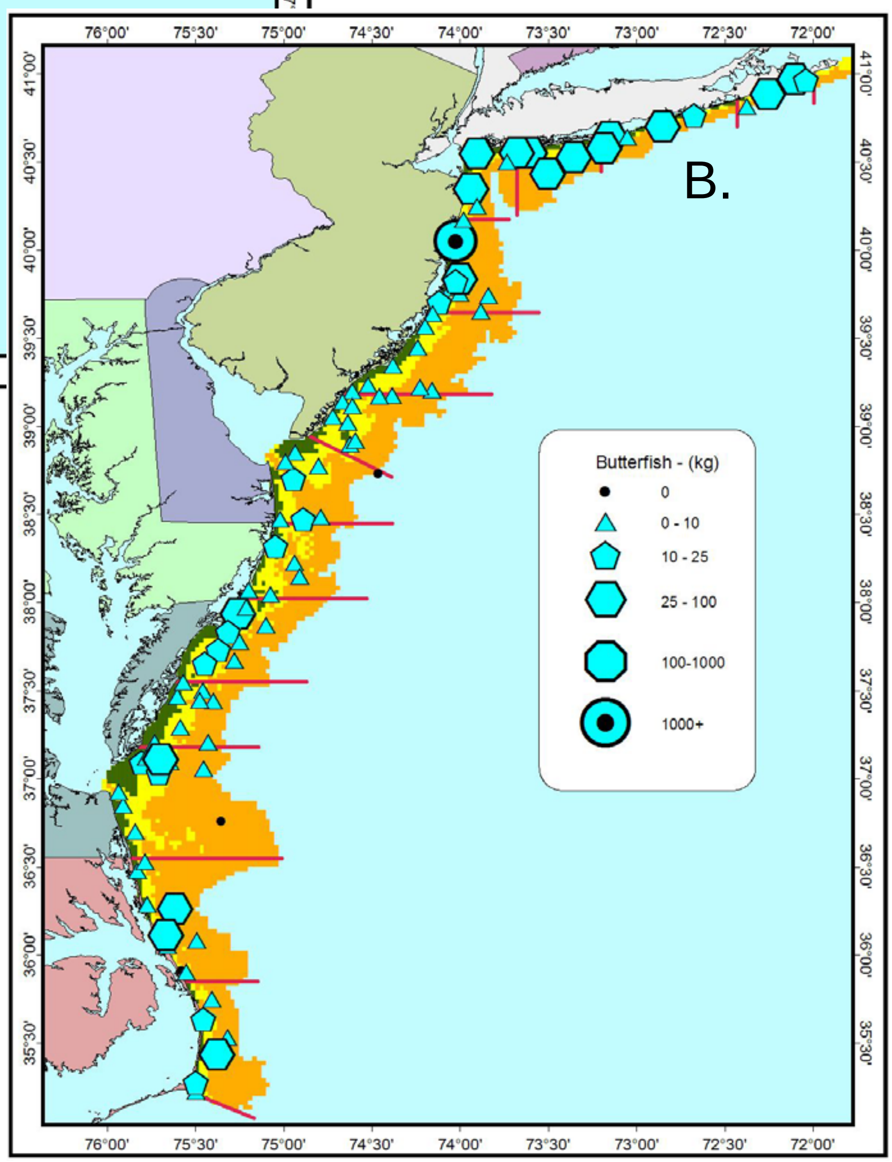


Figure 101. Number (A) and biomass (B) of specimens captured at each station for butterfish.

Figure 102. Minimum trawlable number and biomass by state for butterfish.

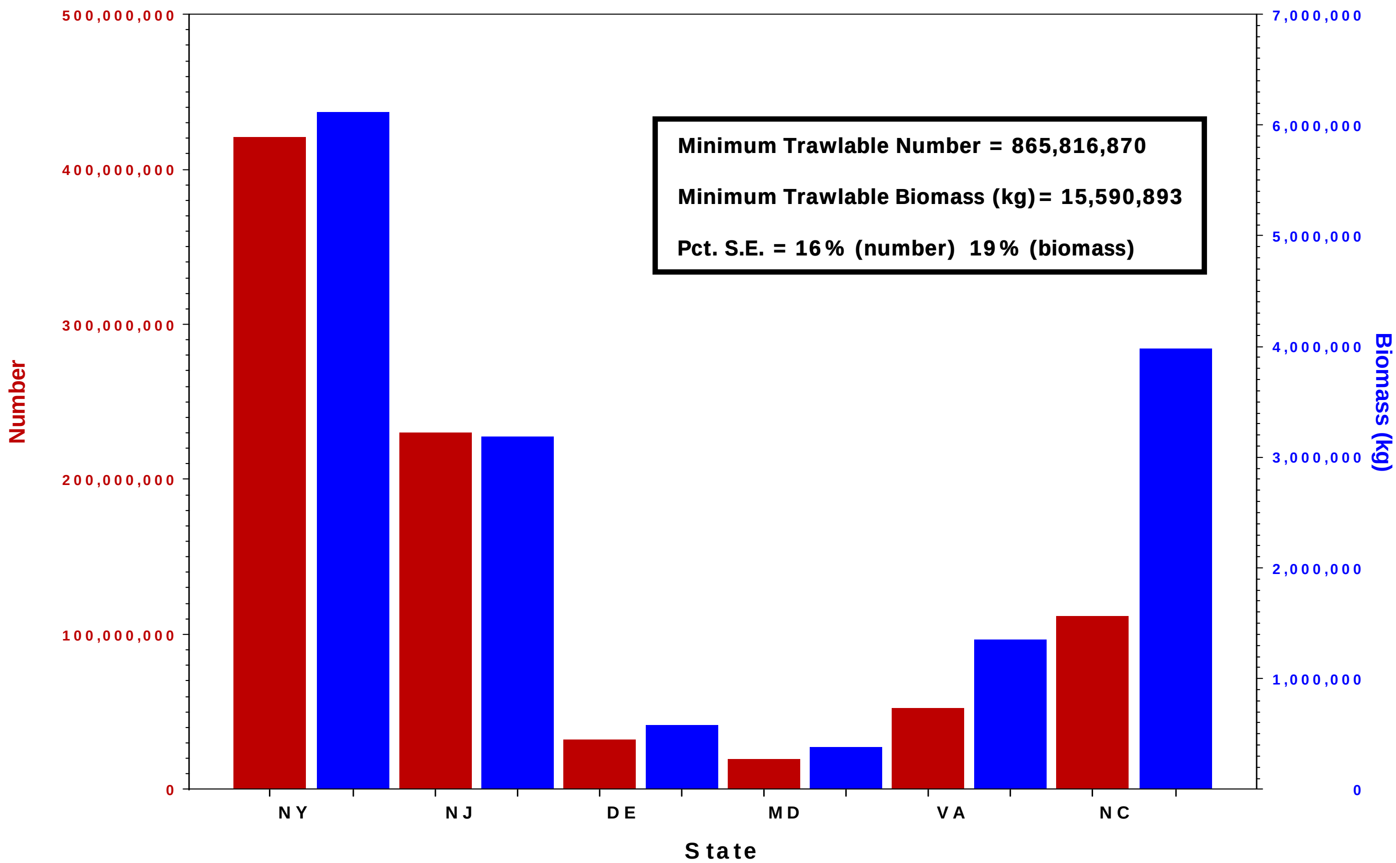
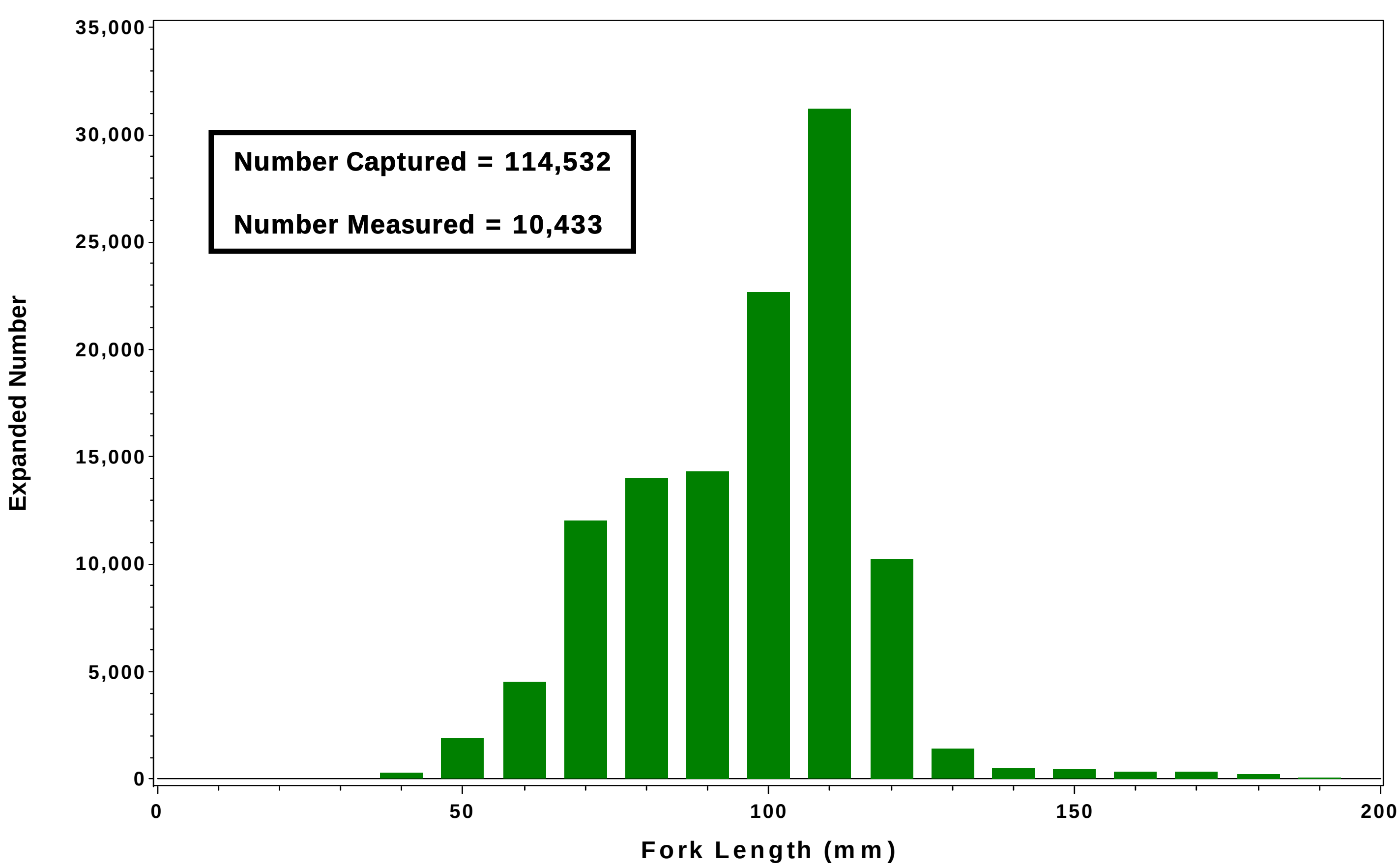
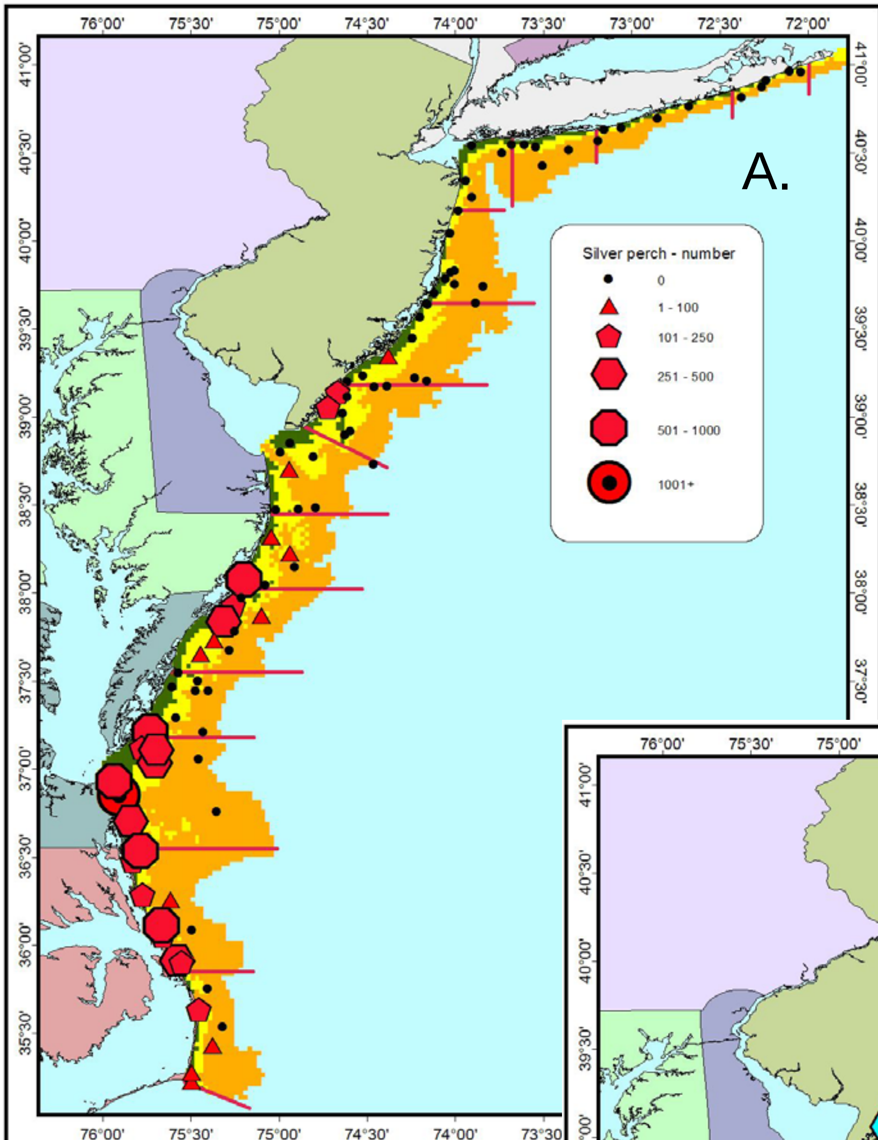


Figure 103. Length frequency for butterfish.



Silver Perch



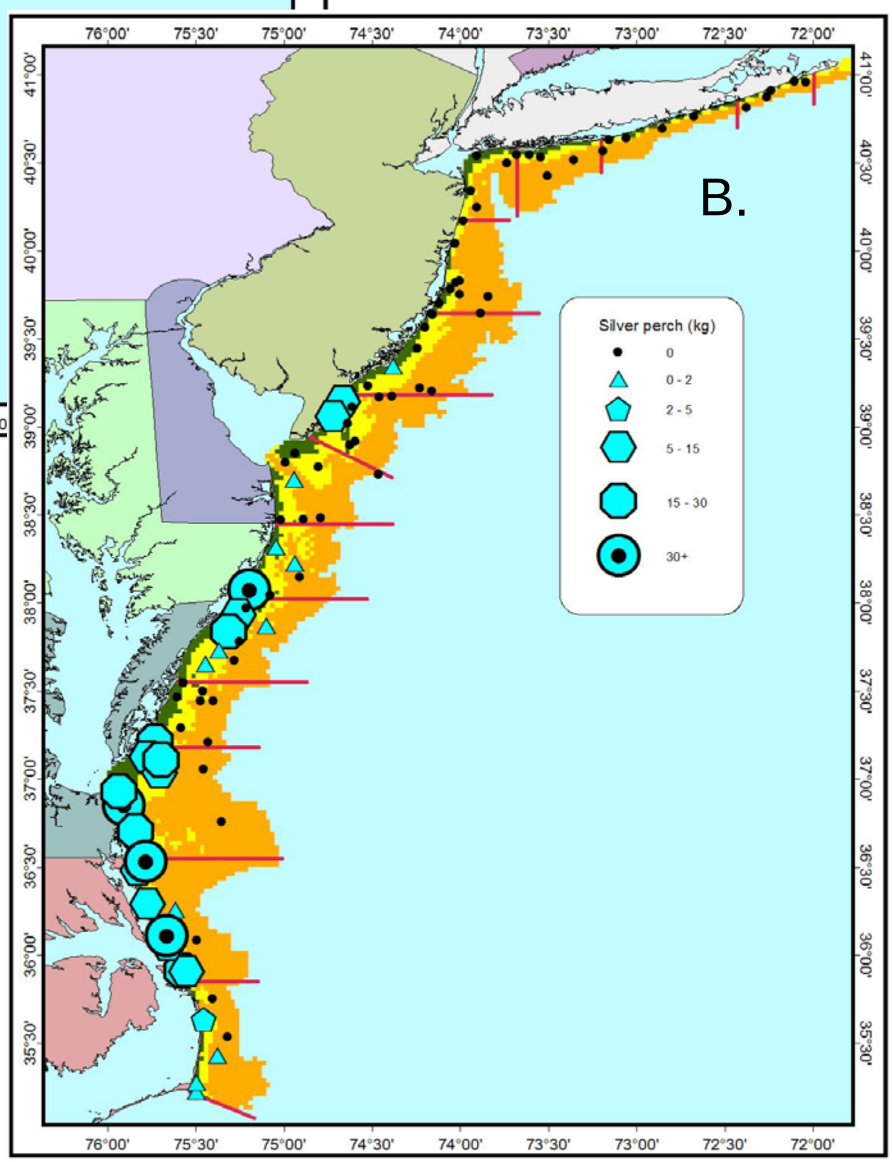


Figure 104. Number (A) and biomass (B) of specimens captured at each station for silver perch.

Figure 105. Minimum trawlable number and biomass by state for silver perch.

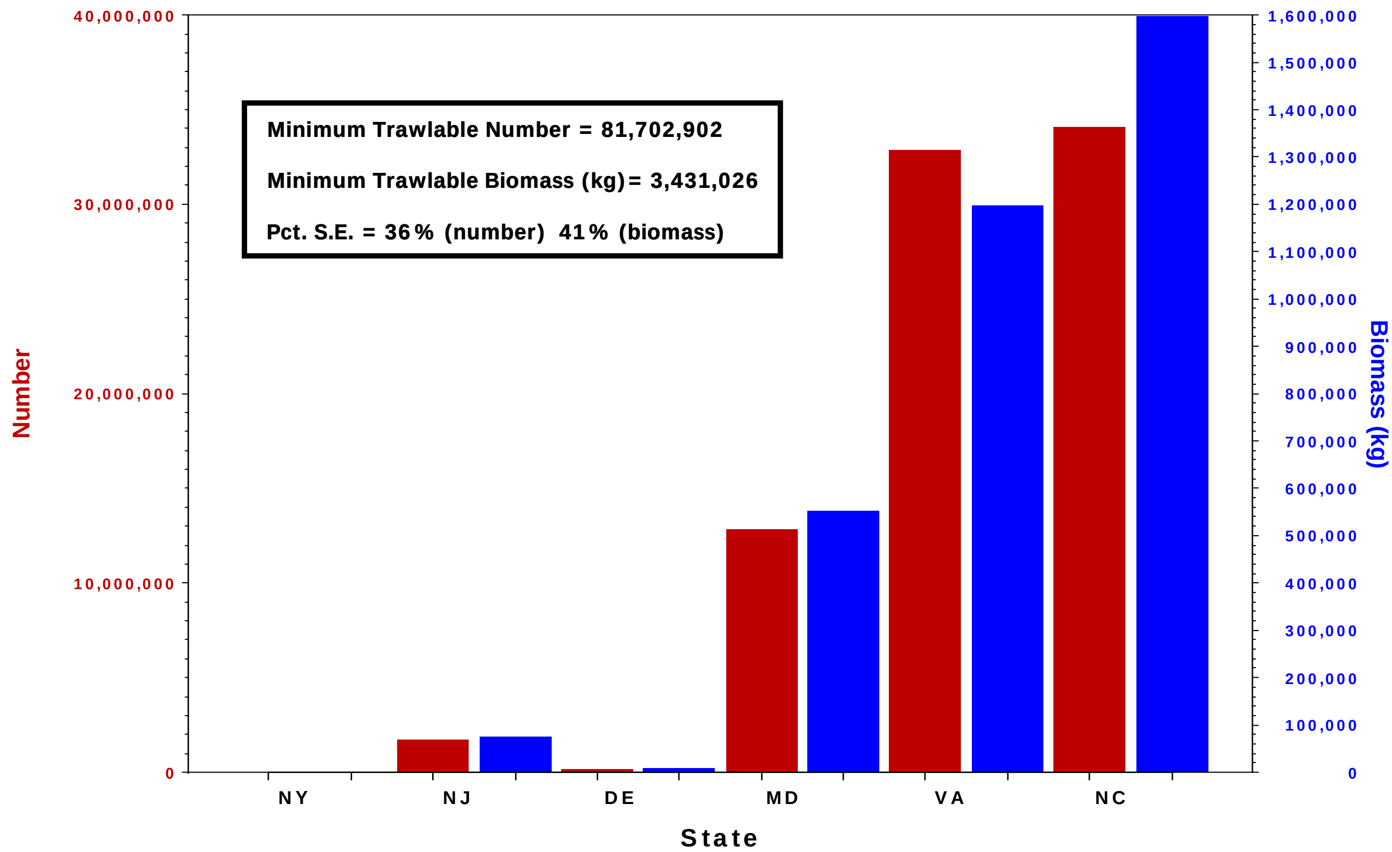
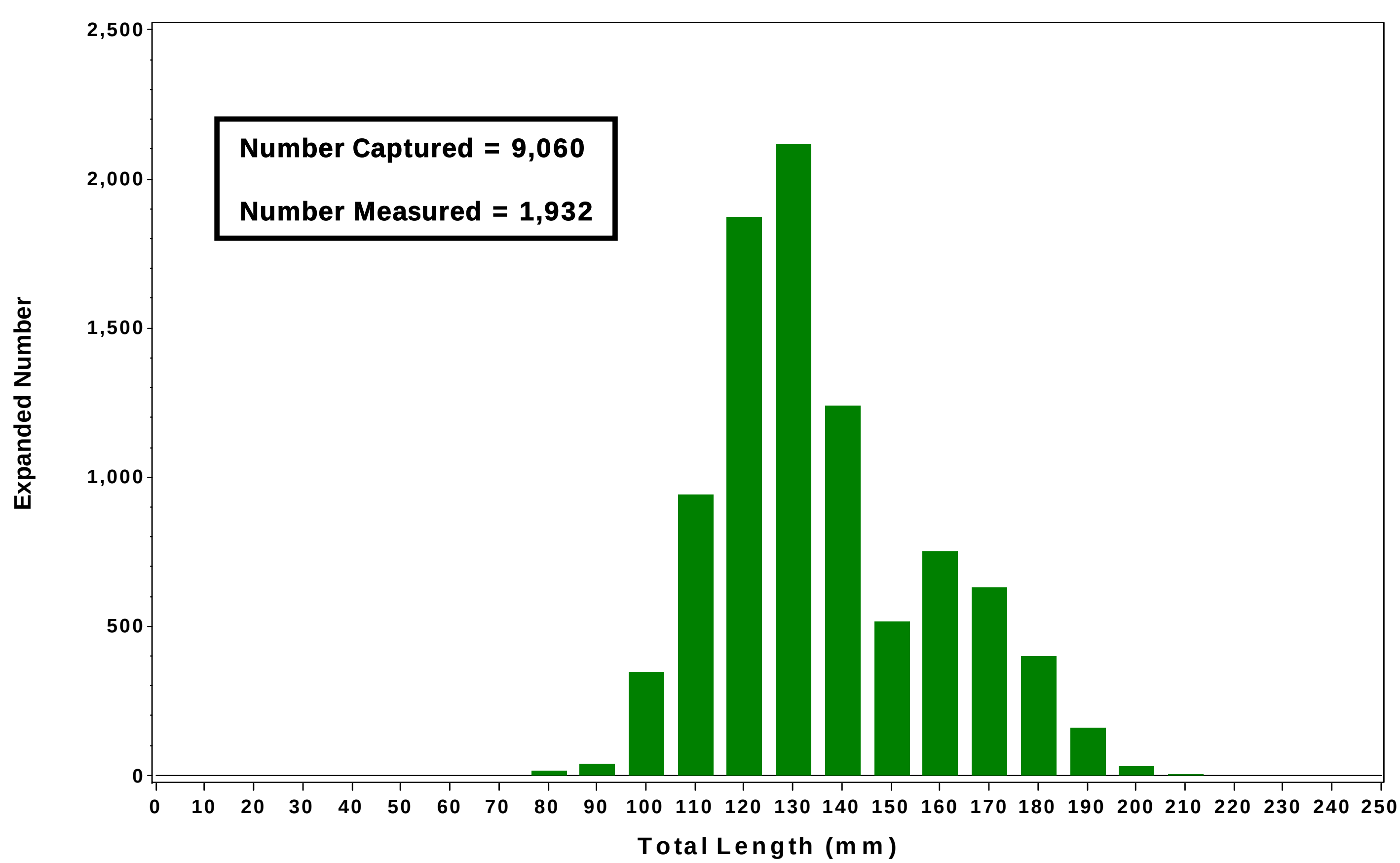
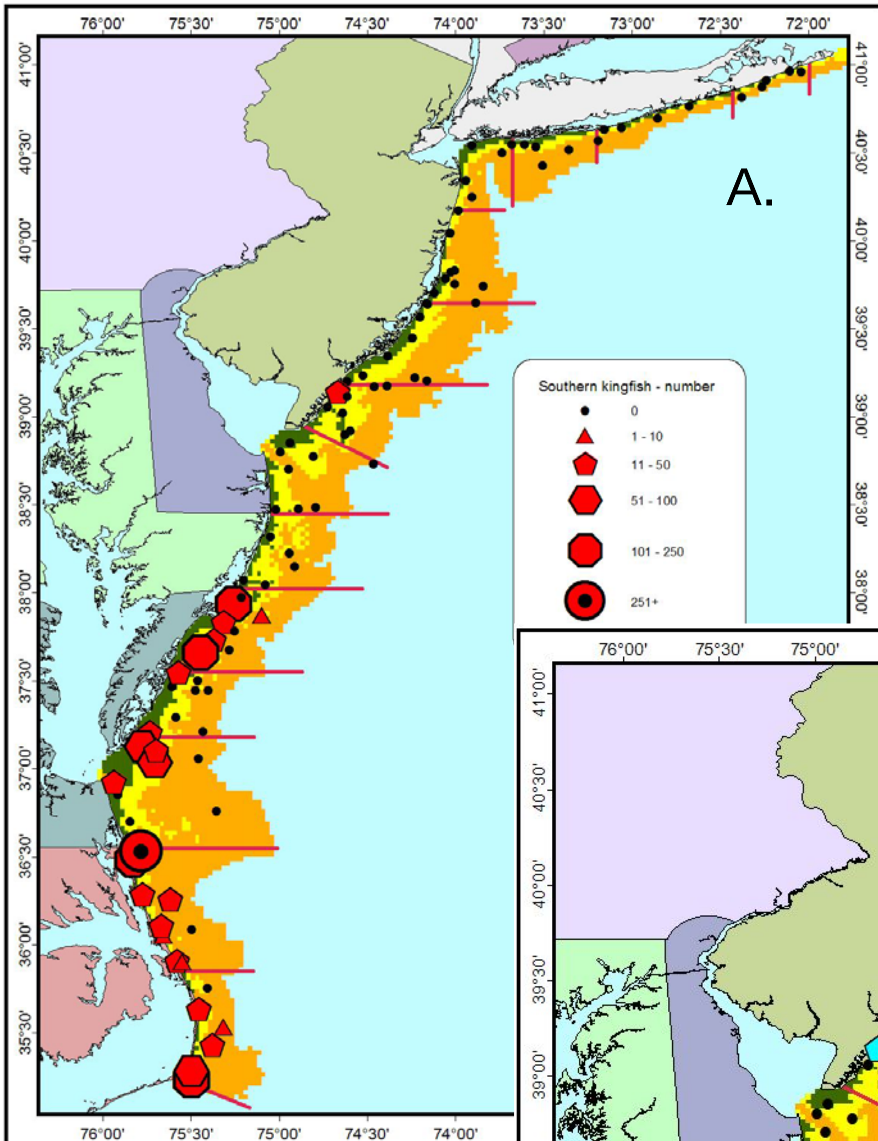


Figure 106. Length frequency for silver perch.



Southern Kingfish



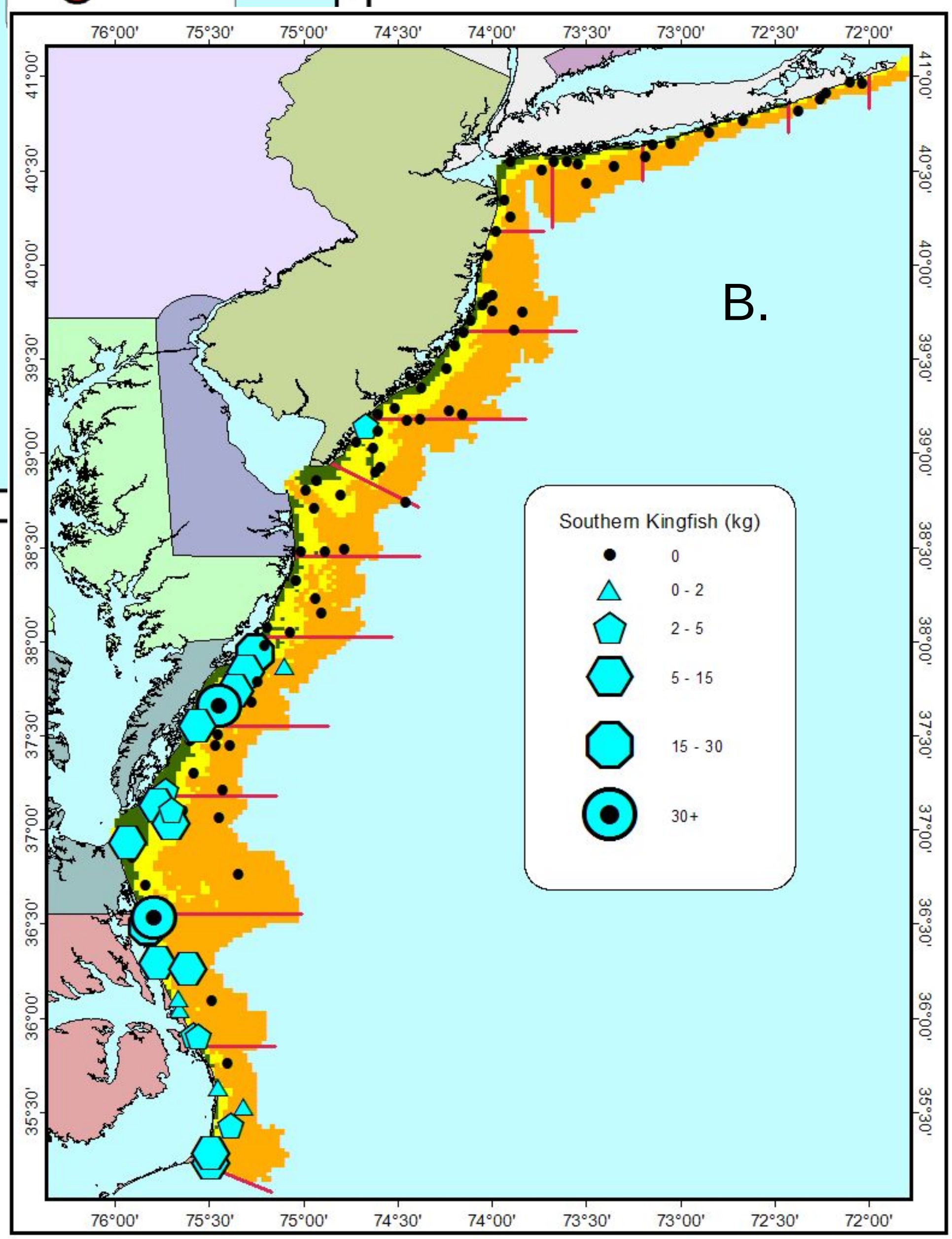


Figure 107. Number (A) and biomass (B) of specimens captured at each station for southern kingfish.

Figure 108. Minimum trawlable number and biomass by state for southern kingfish.

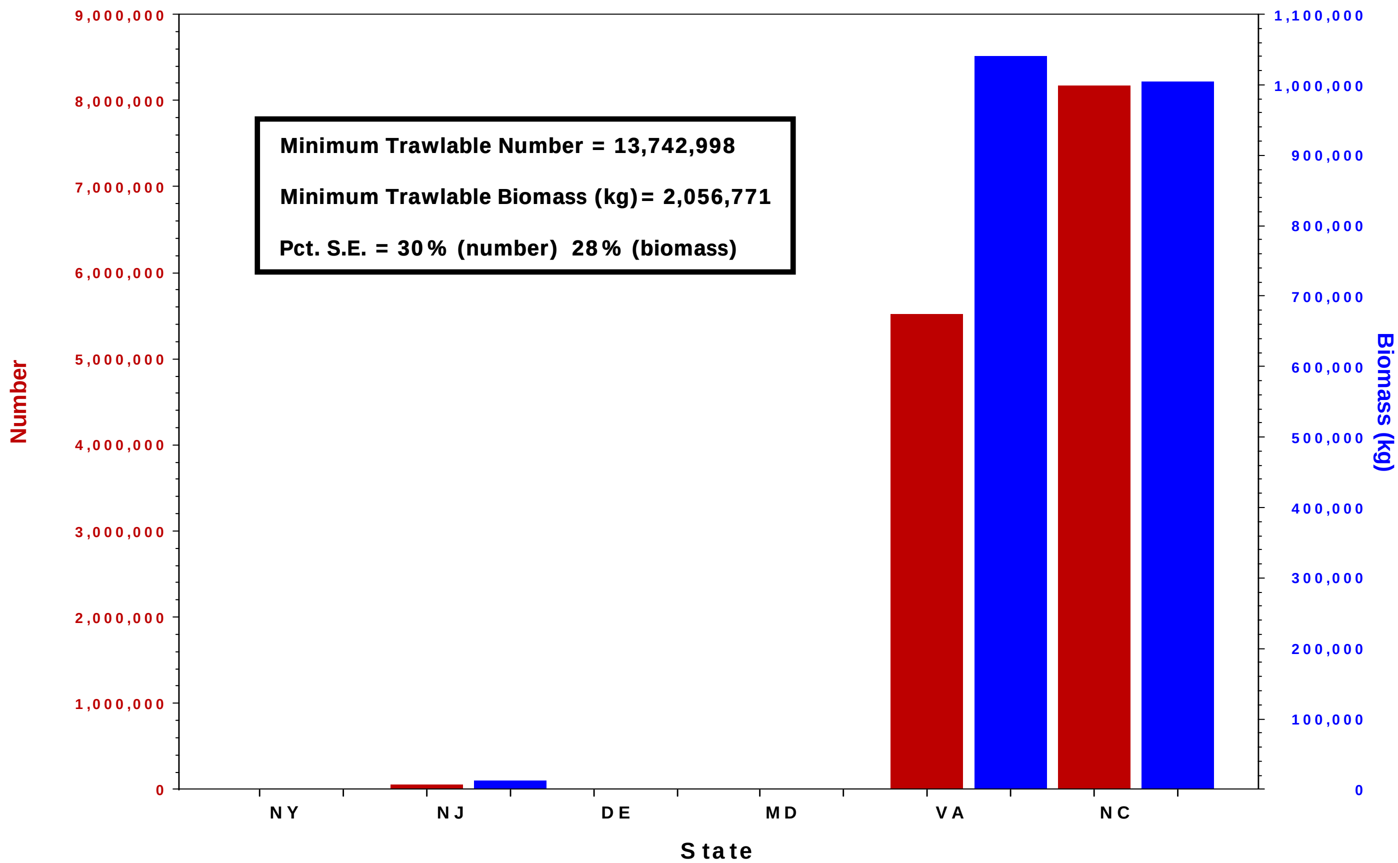
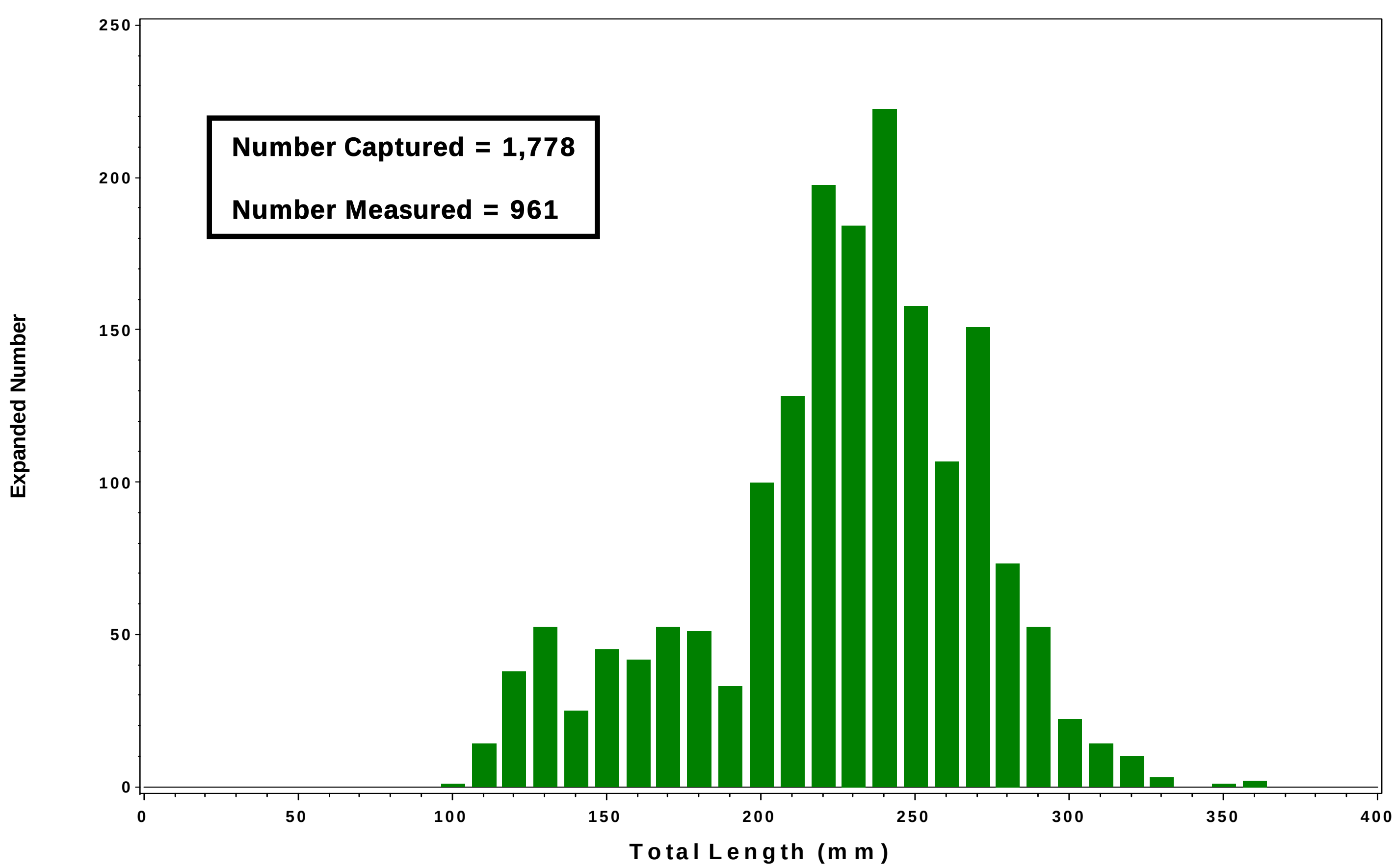
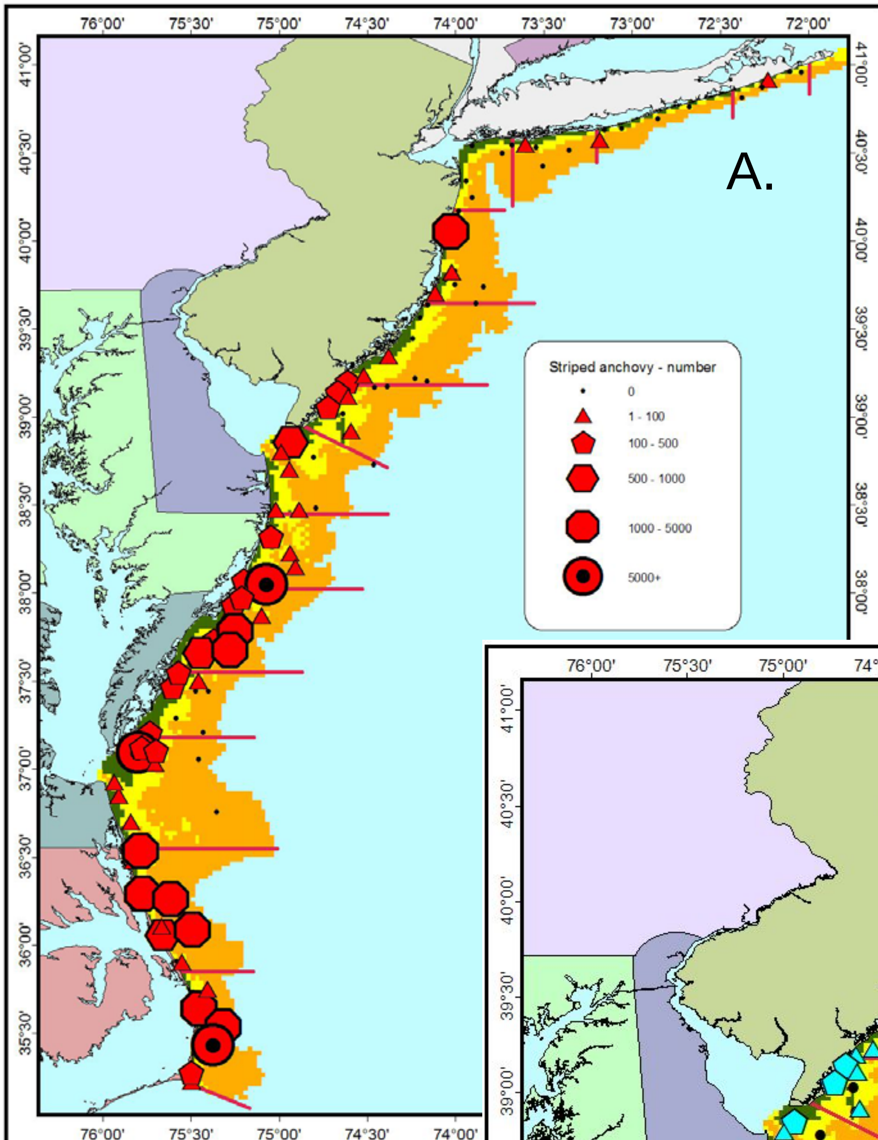


Figure 109. Length frequency for southern kingfish.



Striped Anchovy



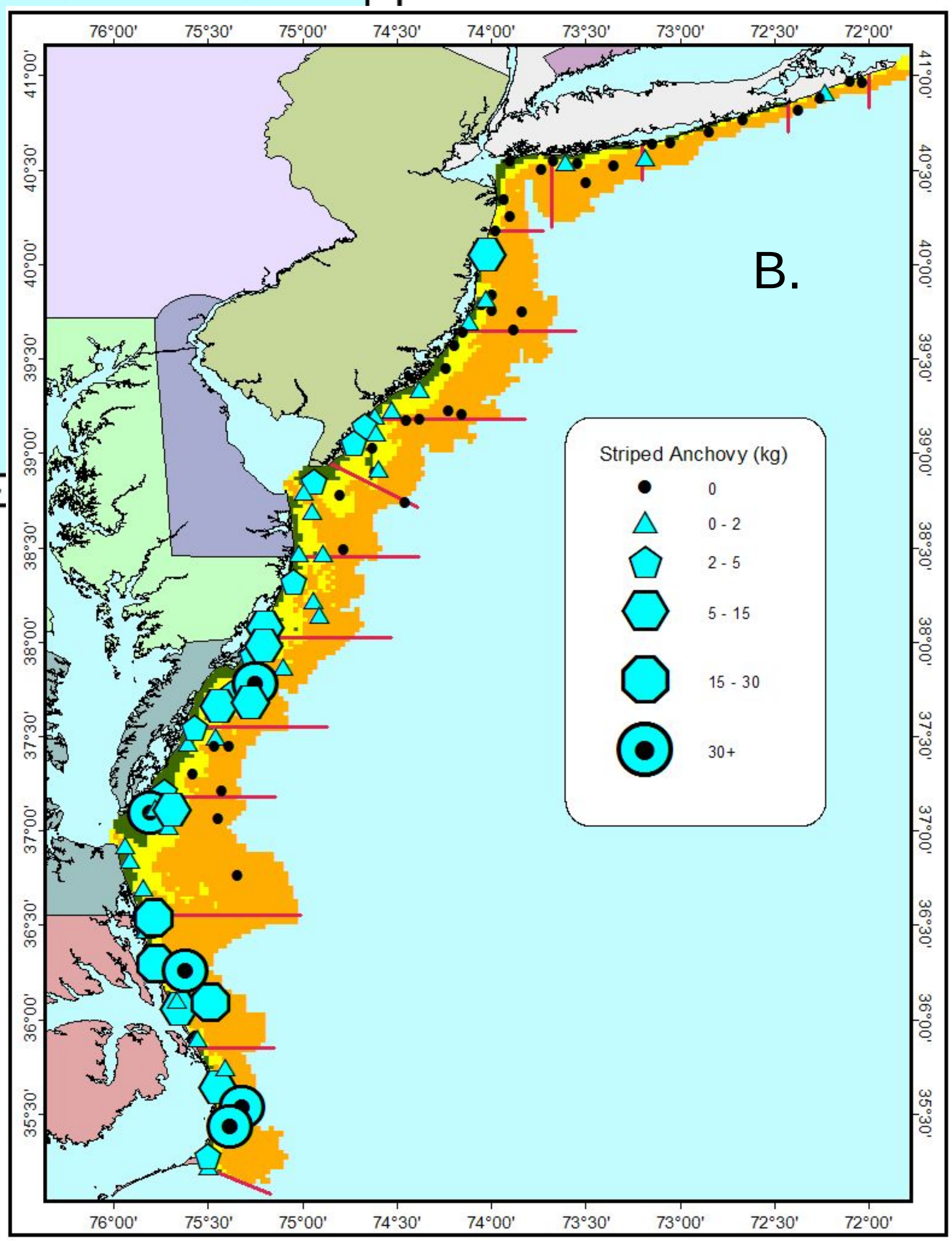


Figure 110. Number (A) and biomass (B) of specimens captured at each station for striped anchovy.

Figure 111. Minimum trawlable number and biomass by state for striped anchovy.

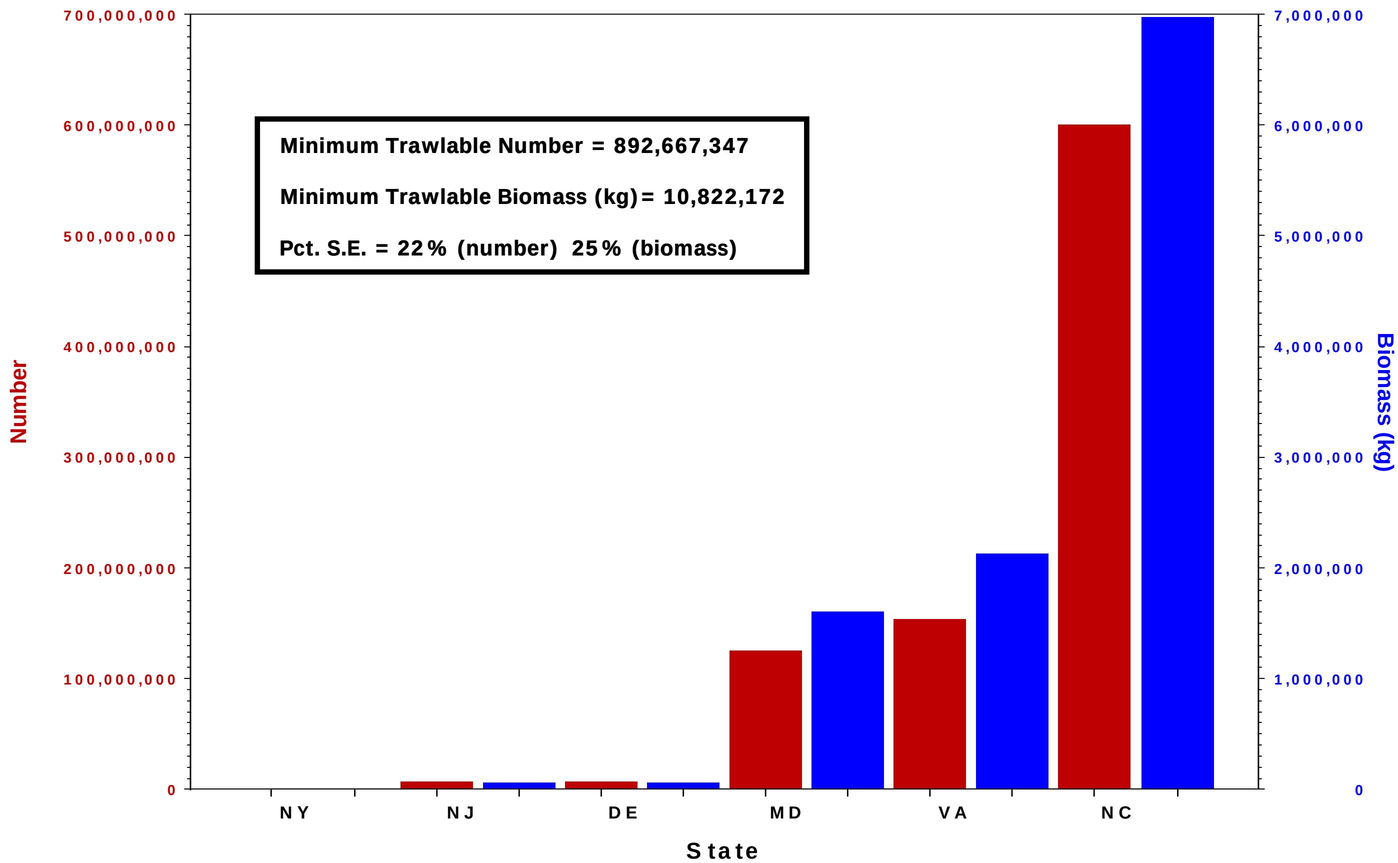
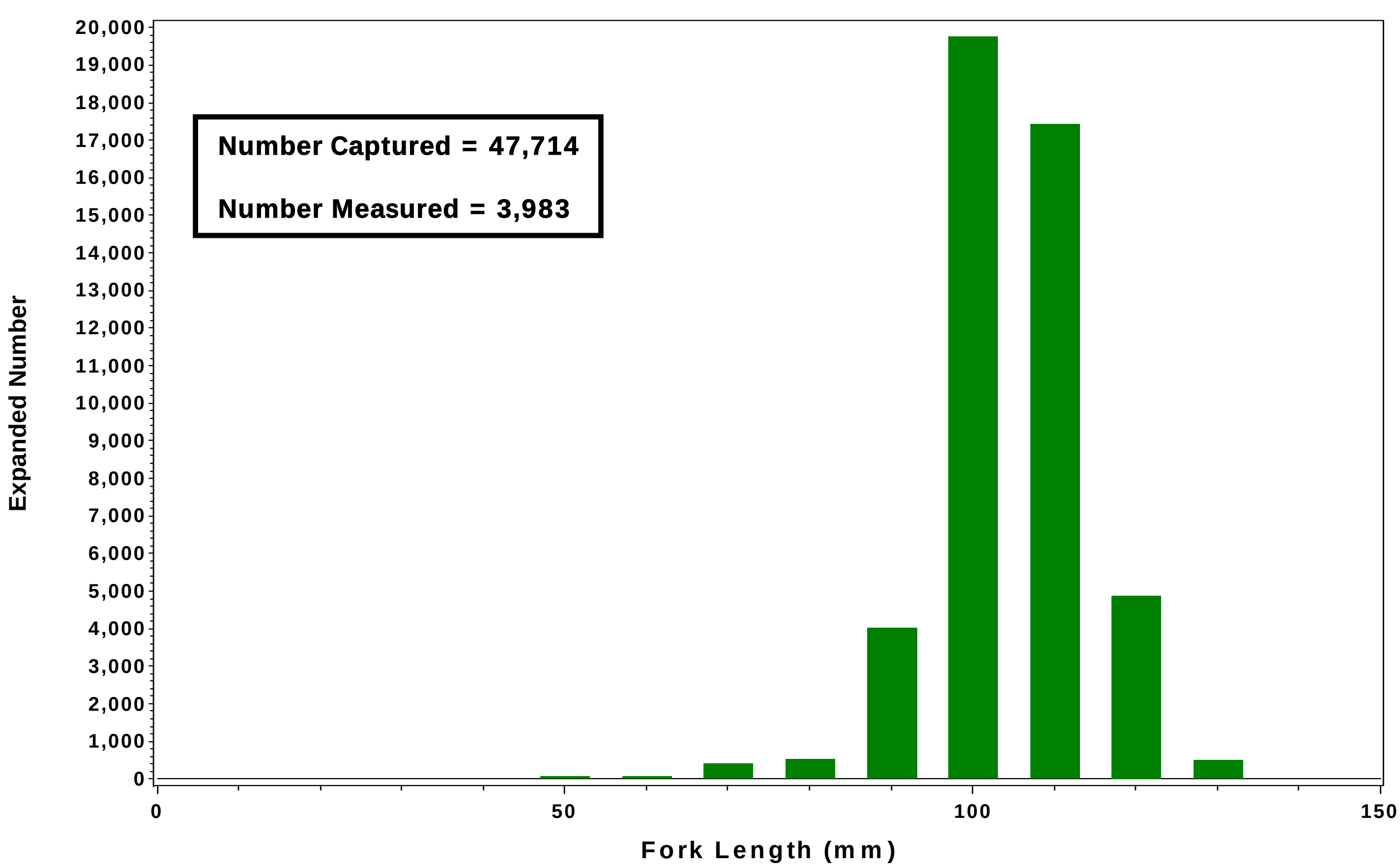
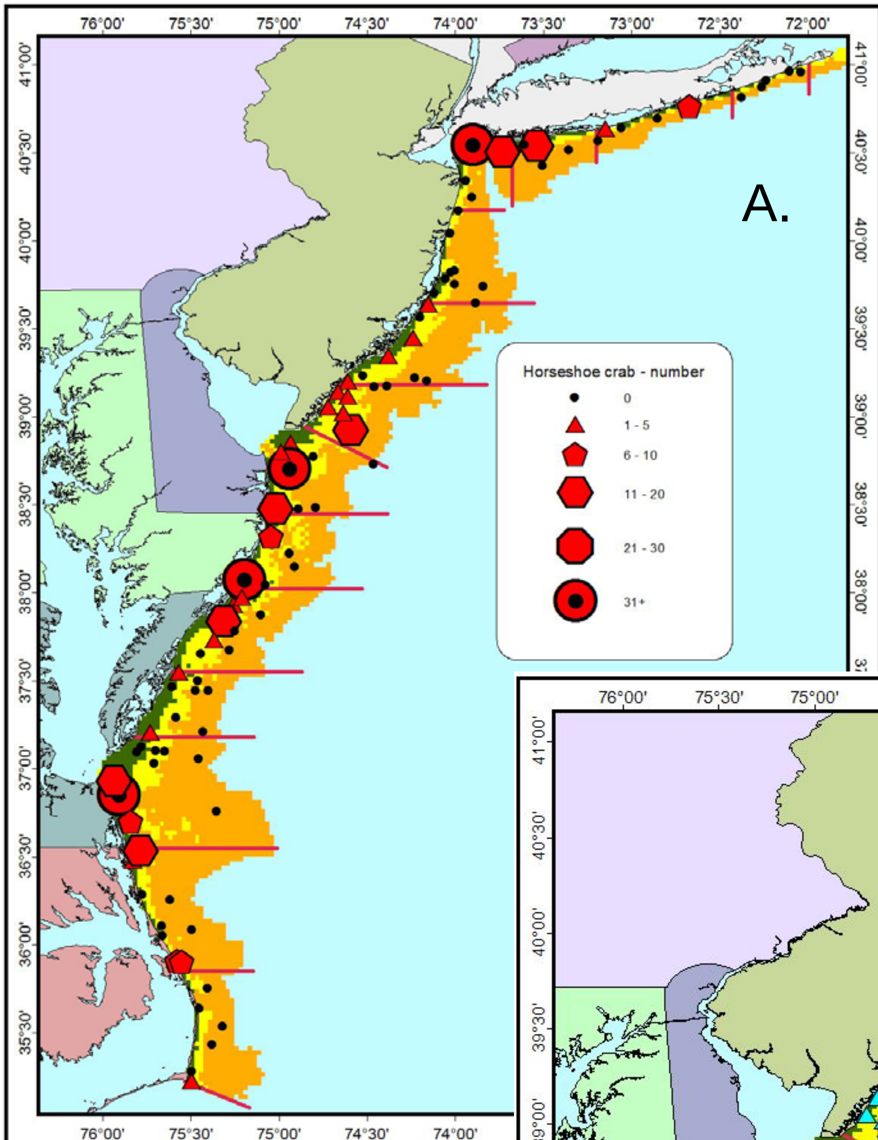


Figure 112. Length frequency for striped anchovy.



Horseshoe Crab



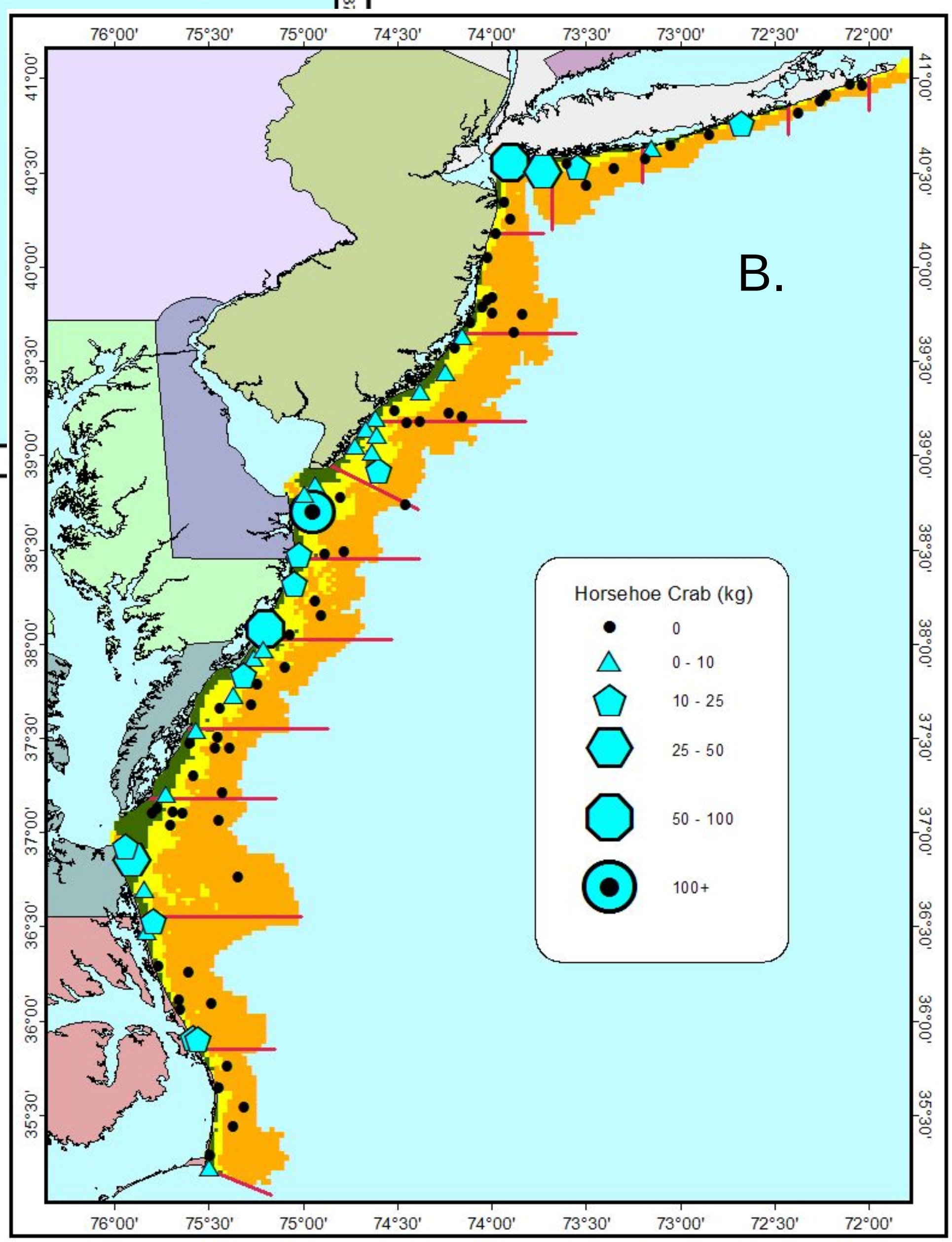


Figure 113. Number (A) and biomass (B) of specimens horseshoe crab.

Figure 114. Minimum trawlable number and biomass by state for horseshoe crab.

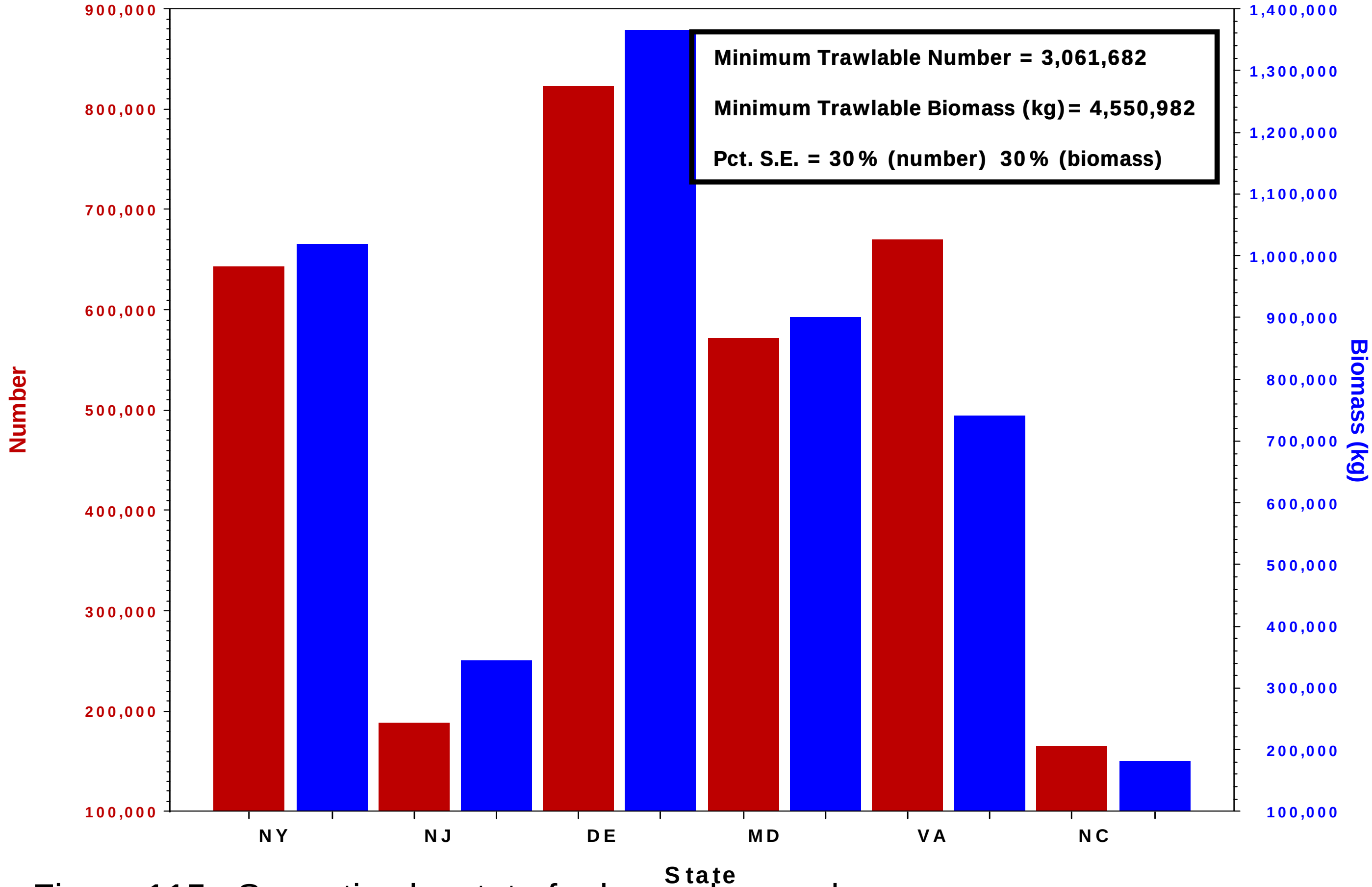


Figure 115. Sex ratios by state for horseshoe crab.

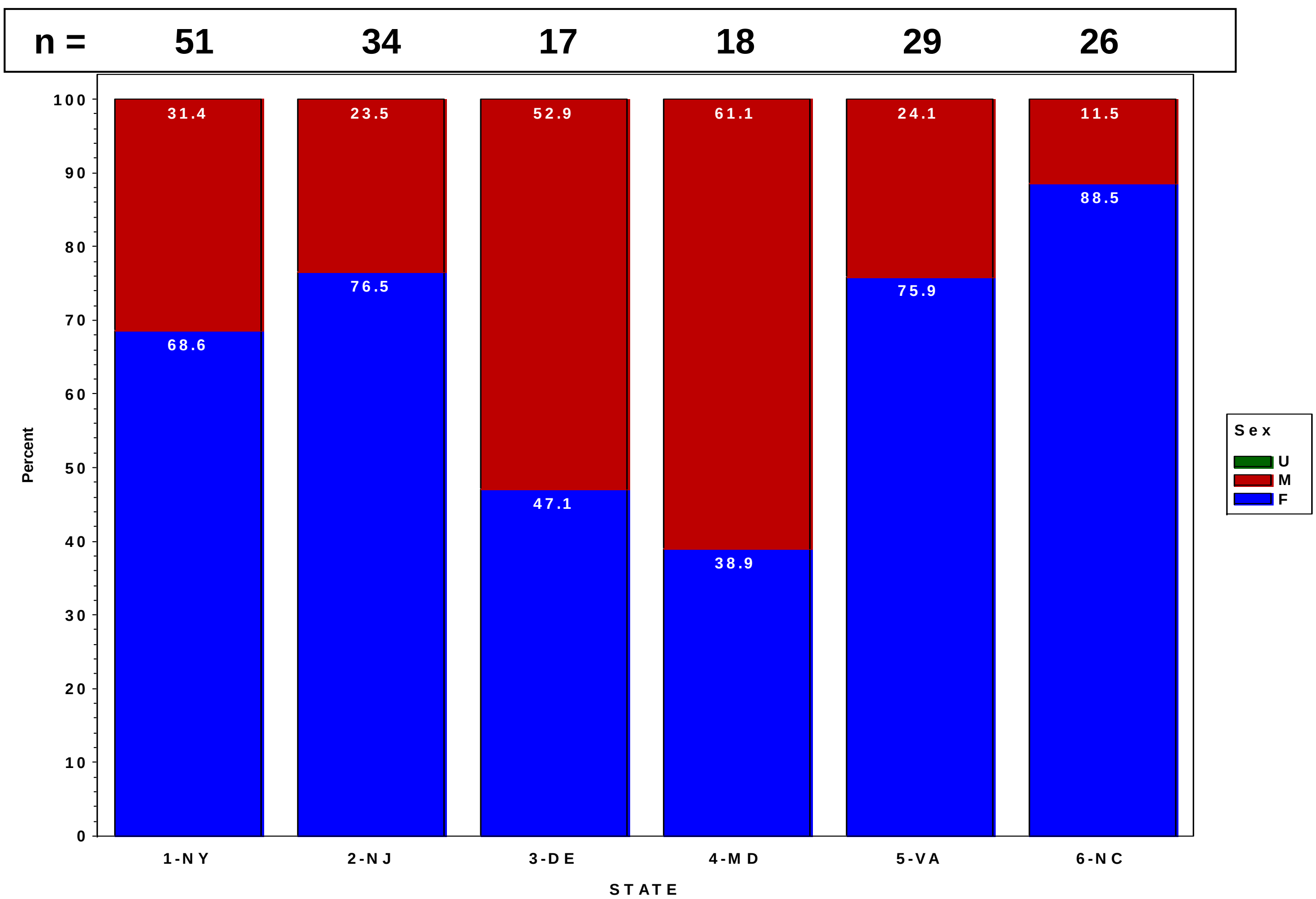


Figure 116. Width frequency for horseshoe crab.

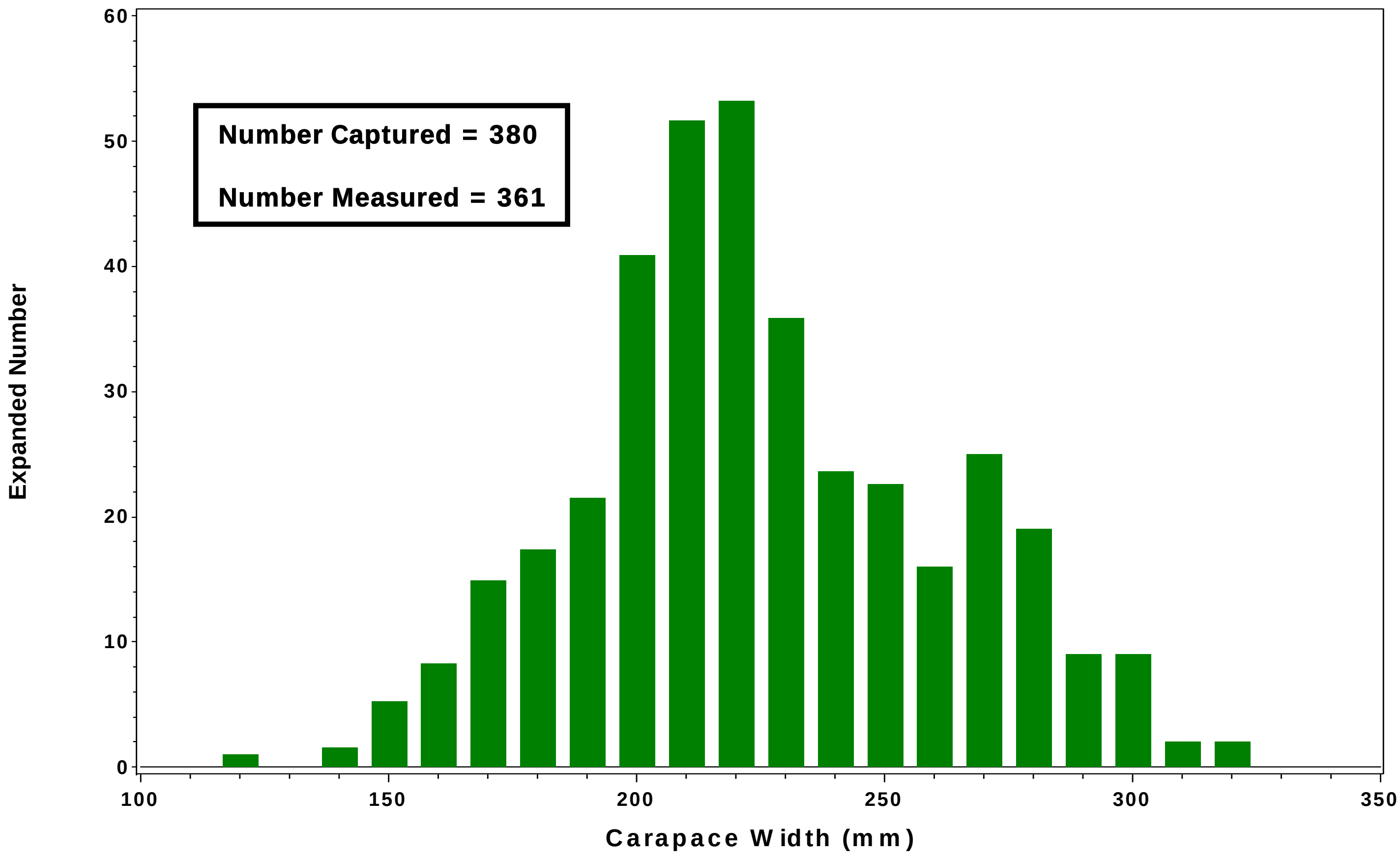


Figure 117. Length-weight regression for horseshoe crab, sexes combined.

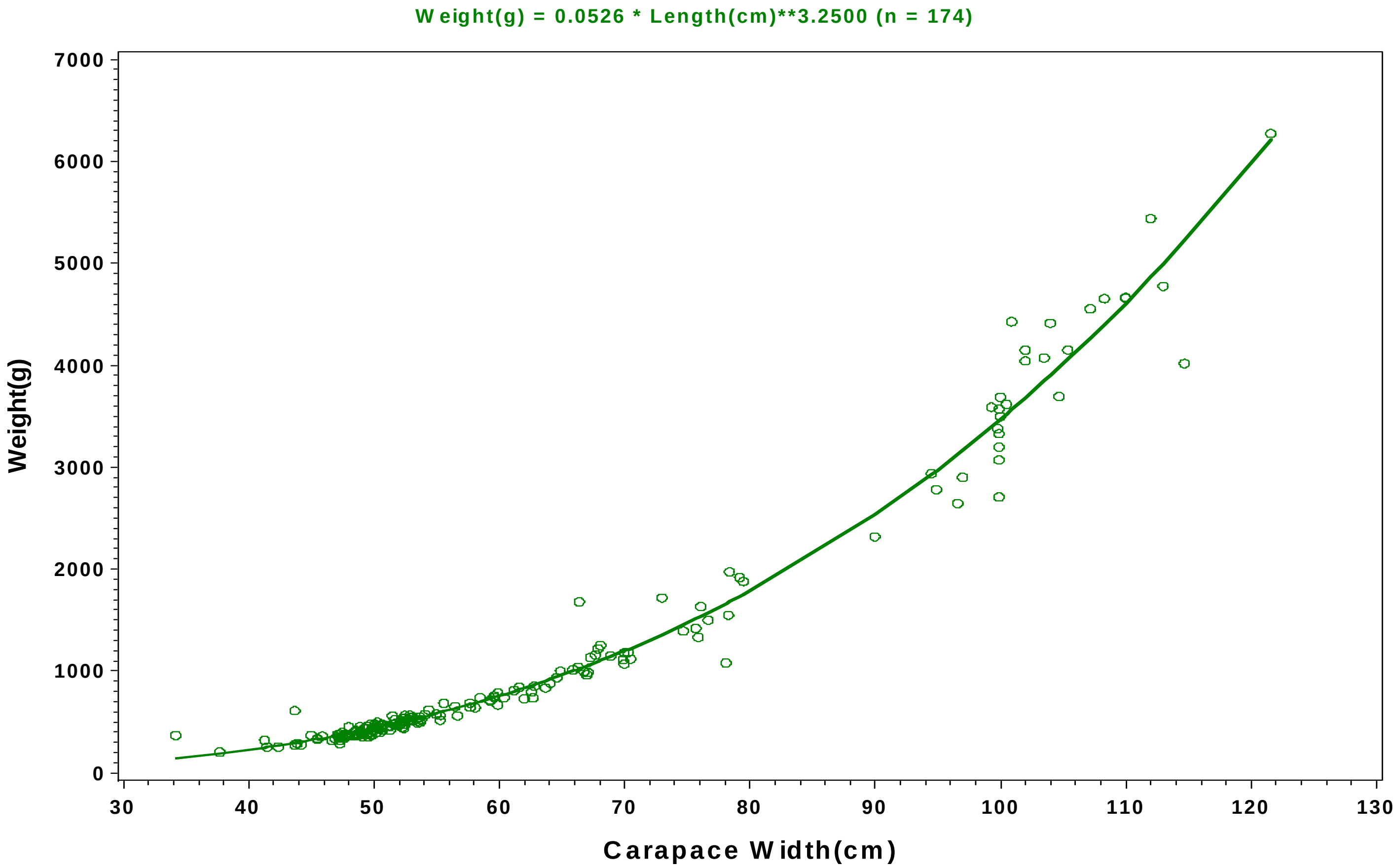
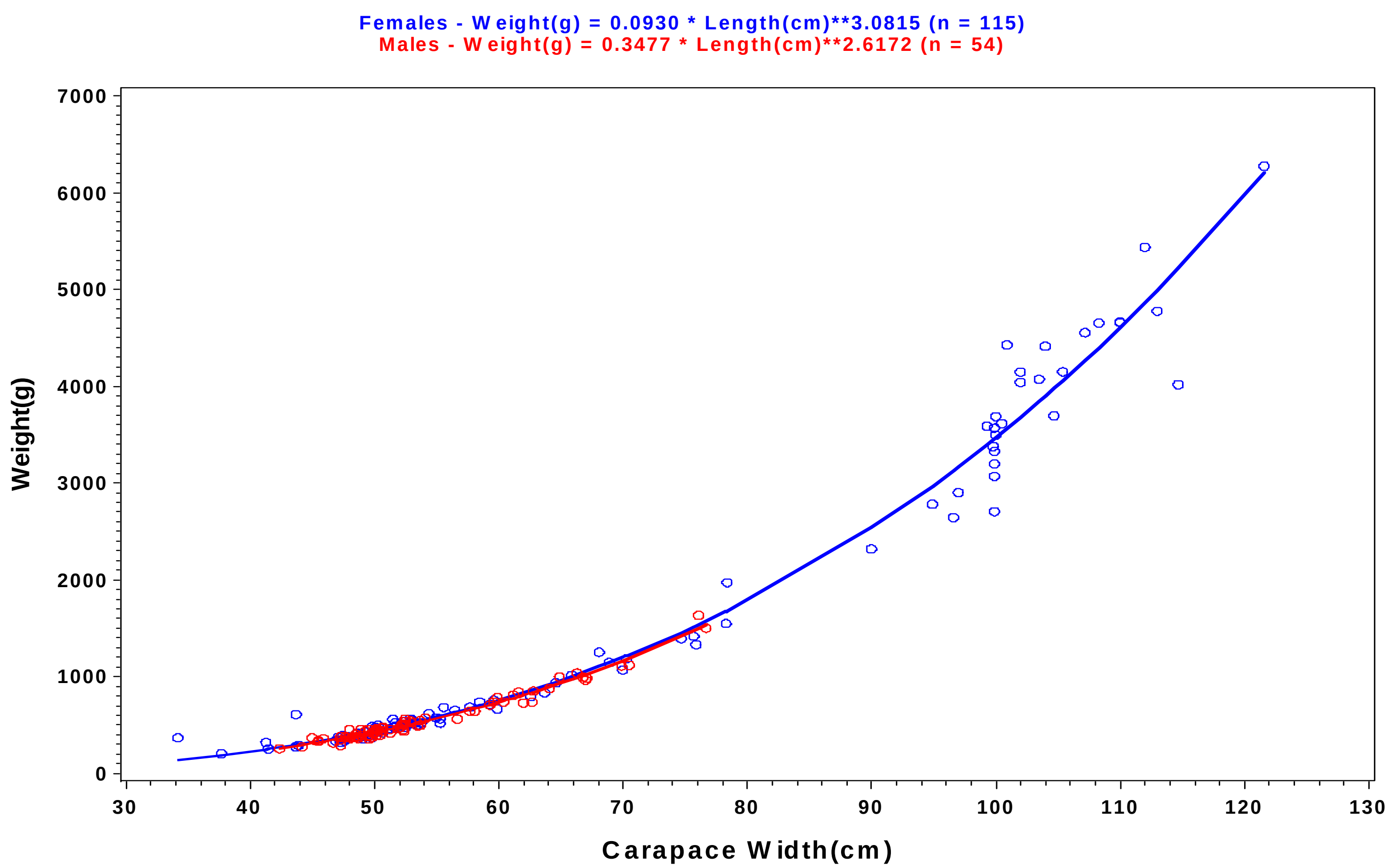
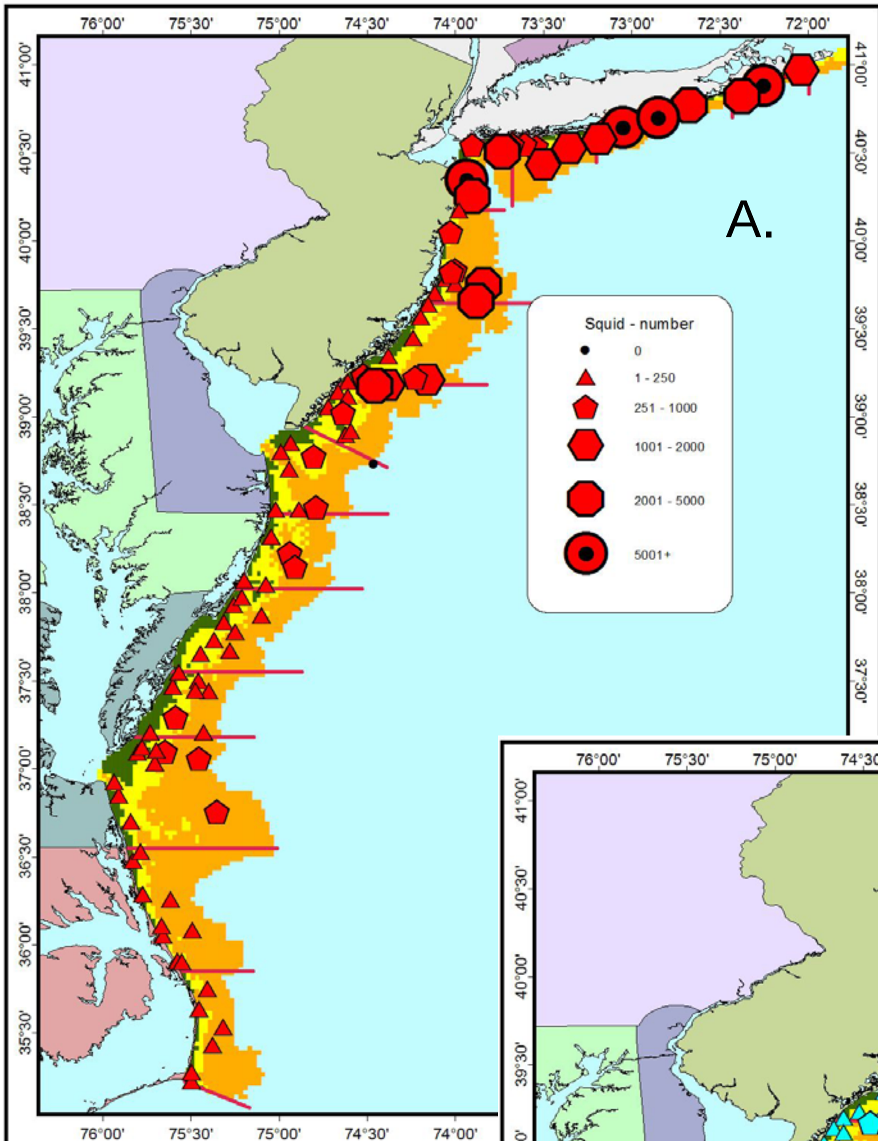


Figure 118. Length-weight regression for horseshoe crab, by sex.



Squid (*Loligo* spp.)



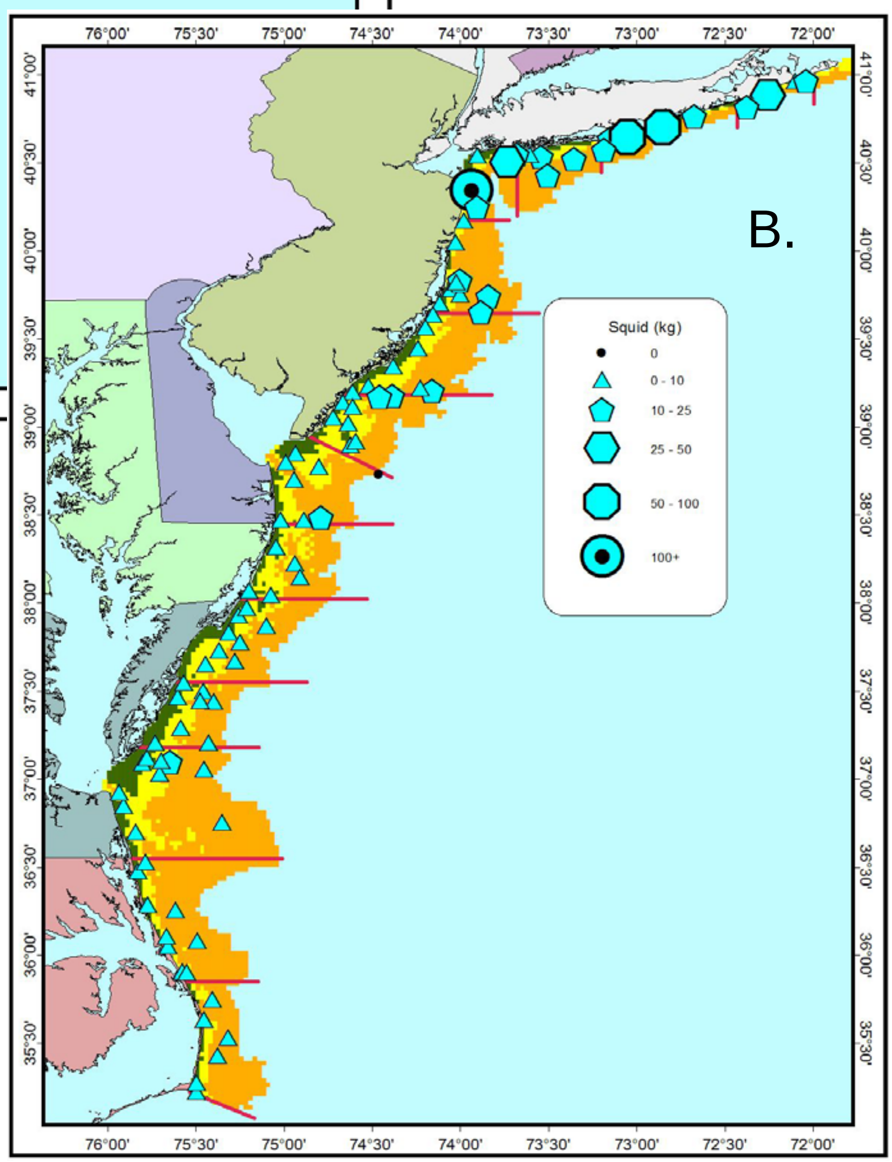


Figure 119. Number (A) and biomass (B) of specimens squid.

Figure 120. Minimum trawlable number and biomass by state for squid.

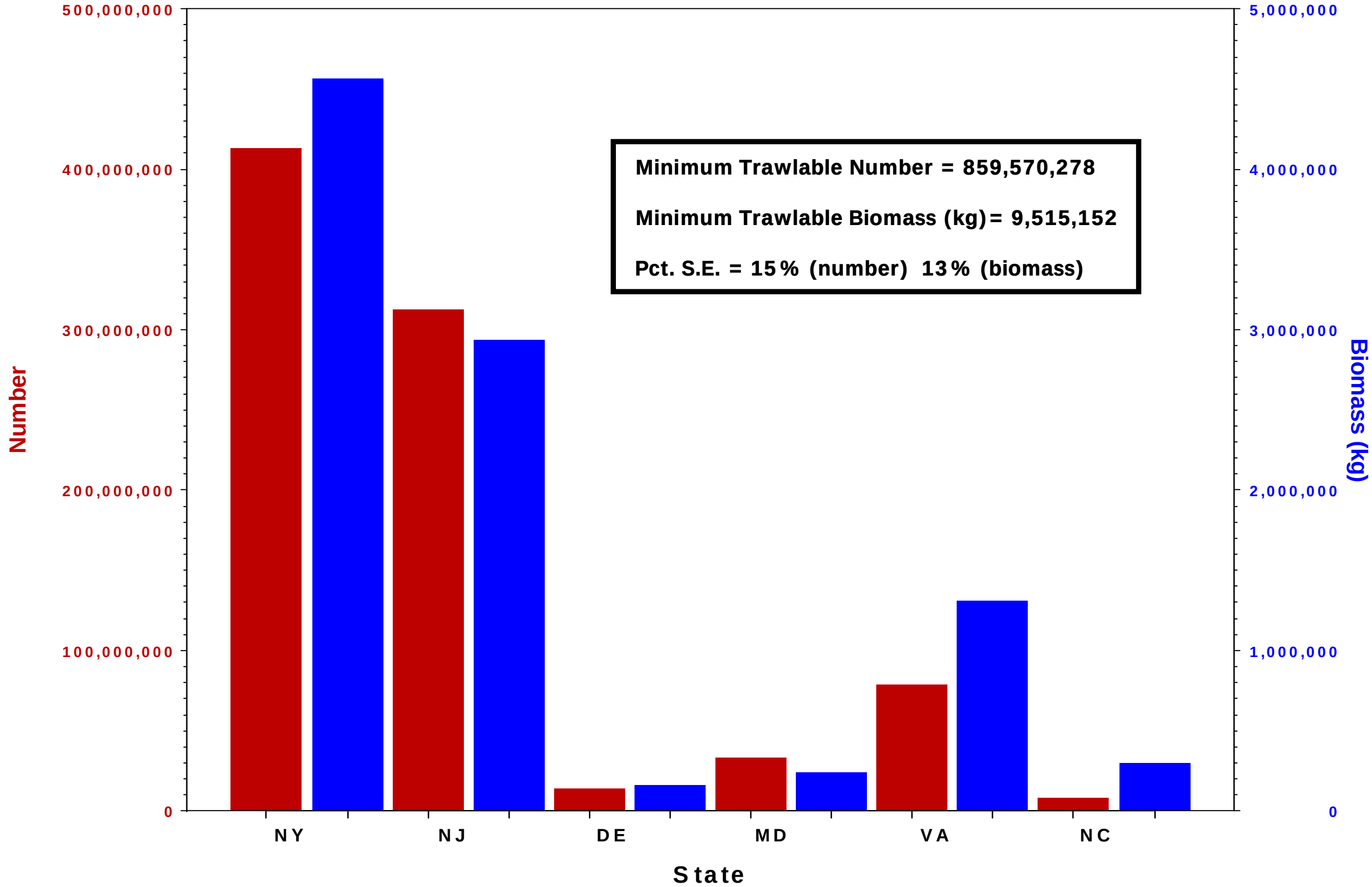
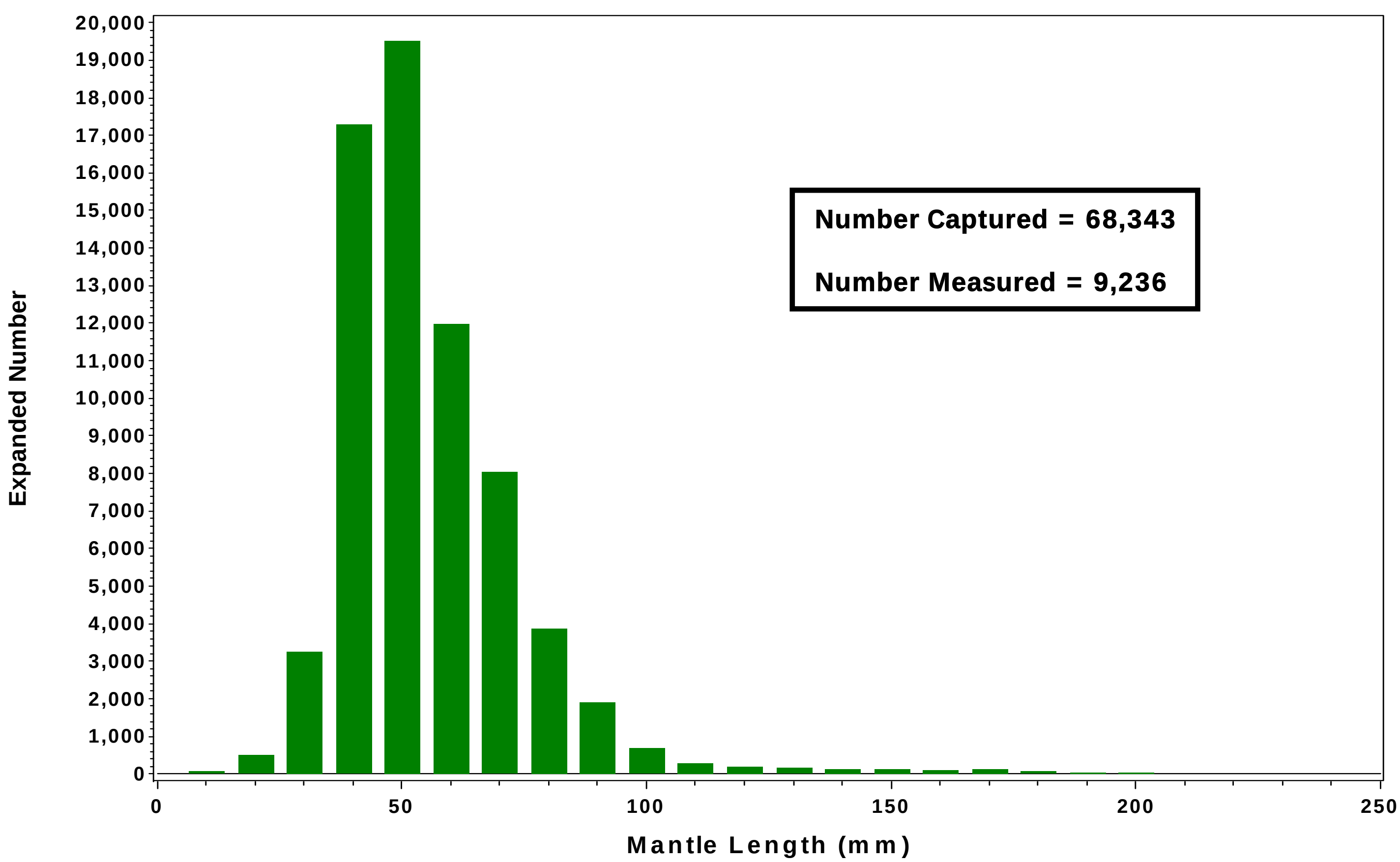
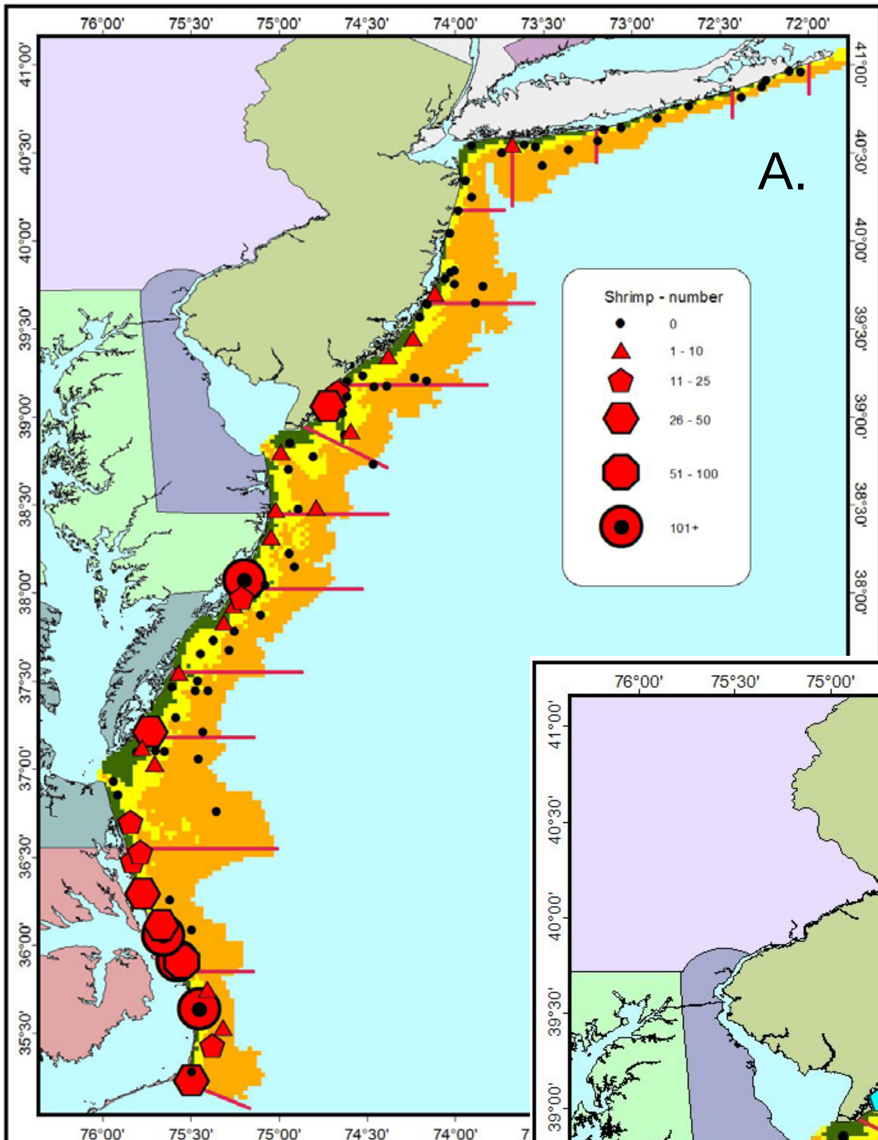


Figure 121. Length frequency for squid.



Shrimp (Penaeid)



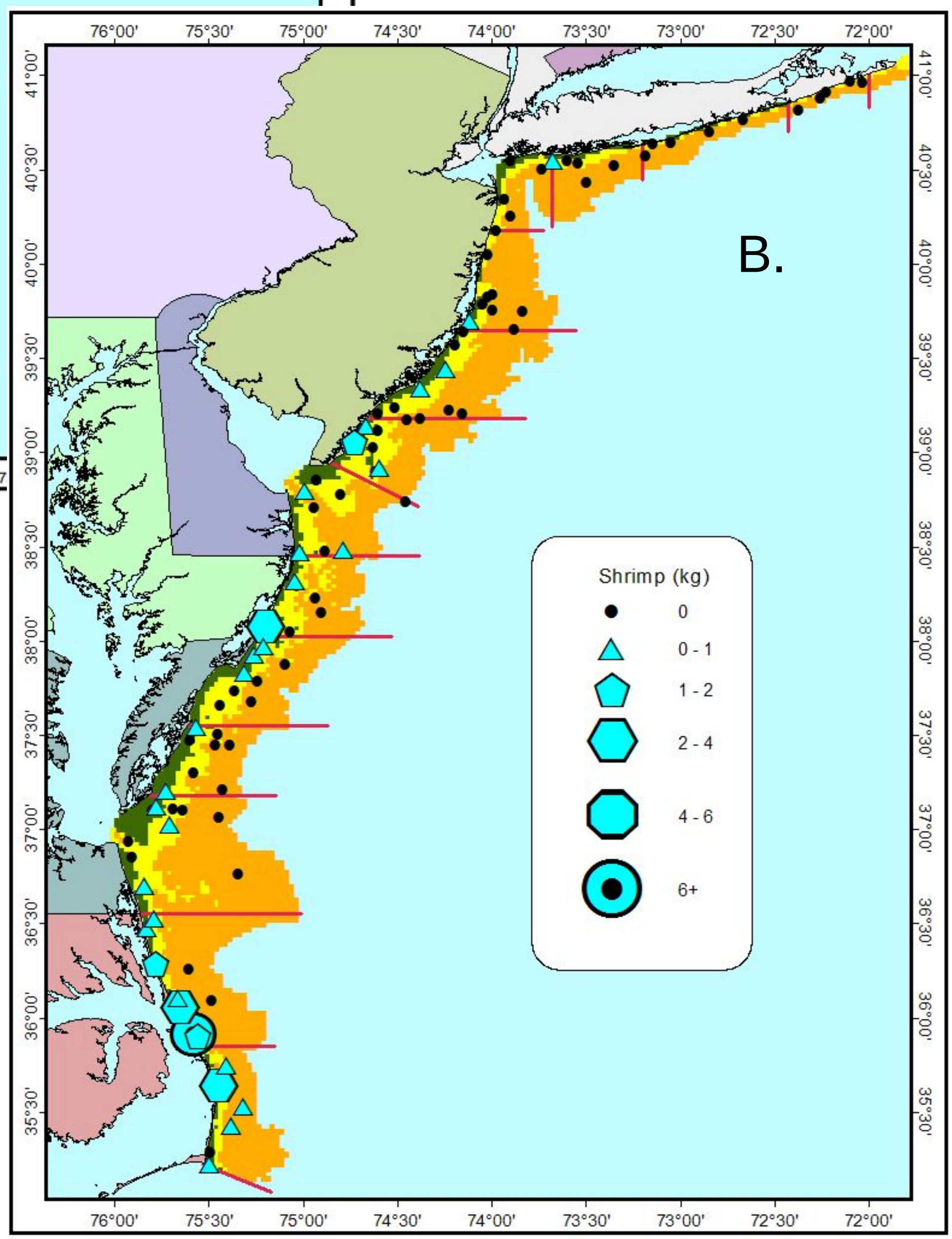


Figure 122. Number (A) and biomass (B) of specimens Penaeid shrimp (combined).

Figure 123. Minimum trawlable number and biomass by state for Penaeid shrimp.

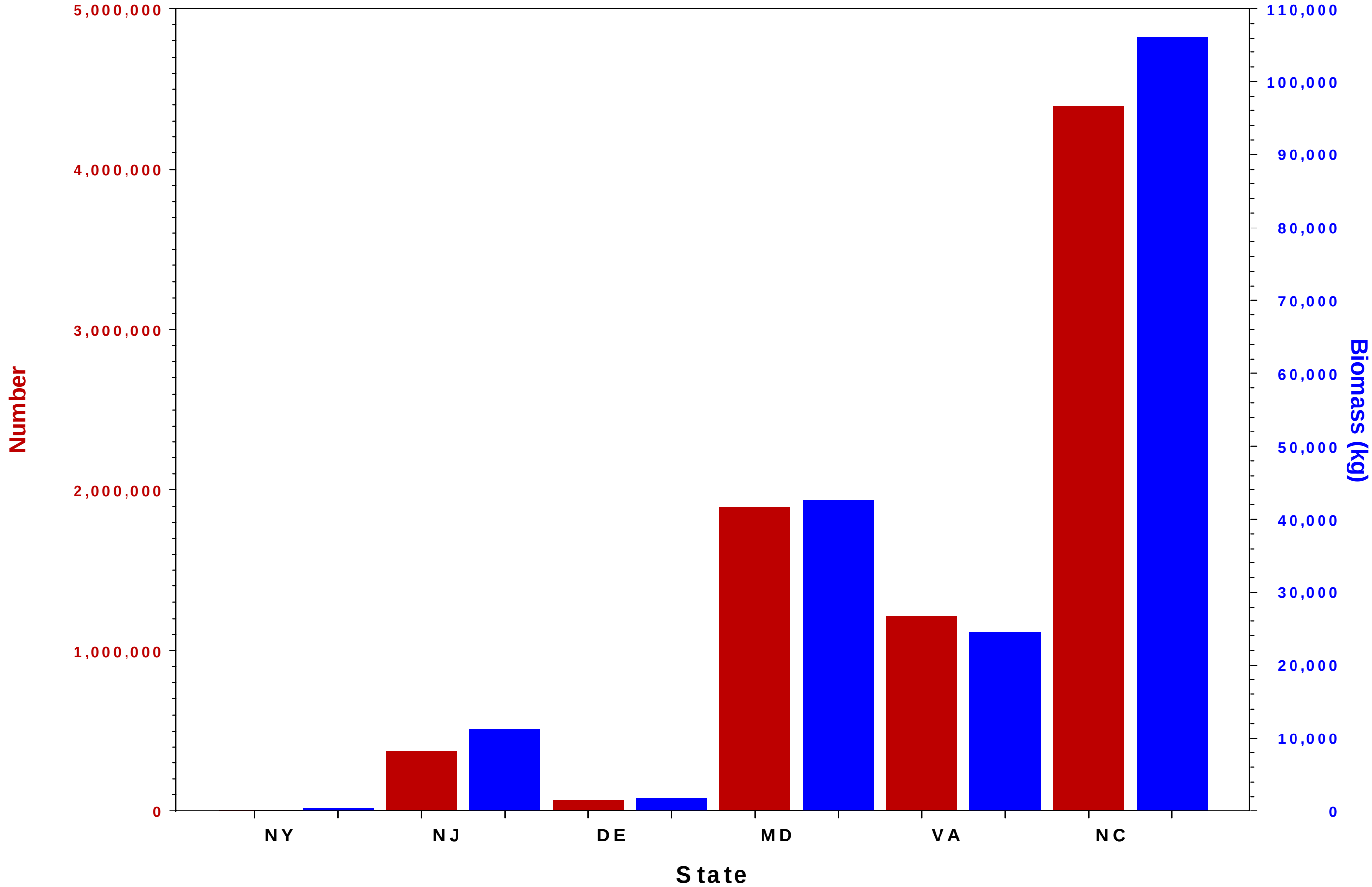


Figure 124. Length frequency for Penaeid shrimp.