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ANNUAL REPORT - 2012 Data collection and analysis in support of single and multispecies stock assessments in Chesapeake Bay:The Chesapeake Bay Multispecies Monitoring and Assessment Program

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ChesMMAP

THE CHESAPEAKE BAY MULTISPECIES MONITORING AND ASSESSMENT PROGRAM

ANNUAL REPORT - JUNE 2013

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Data collection and analysis in support of single and multispecies stock assessments in Chesapeake Bay:

The Chesapeake Bay Multispecies Monitoring and Assessment Program

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Table of Contents

Introduction

Historically, fisheries management has been based on the results of single-species stock assessment models that focus on the interplay between exploitation level and sustainability. There currently exists a suite of standard and accepted analytical frameworks (e.g., virtual population analysis (VPA), biomass dynamic production modeling, delay difference models, etc.) for assessing the stocks, projecting future stock size, evaluating recovery schedules and rebuilding strategies for overfished stocks, setting allowable catches, and estimating fishing mortality or exploitation rates. A variety of methods also exist to integrate the biological system and the fisheries resource system, thereby enabling the evaluation of alternative management strategies on stock status and fishery performance. These well-established approaches have specific data requirements involving biological (life history), fisheries-dependent, and fisheries-independent data (Table 1). From these, there are two classes of stock assessment or modeling approaches used in fisheries: partial assessment based solely on understanding the biology of a species, and full analytical assessment including both biological and fisheries data.

Table 1. Summary of biological, fisheries-dependent and fisheries-independent data requirements for single-species analytical stock assessment models.

Data Category	Assessment Type	Data Description
Biological / Life History	Partial	Growth (length / weight)
		Maturity schedule
		Fecundity
		Partial recruitment schedules
		Longevity
		Life history strategies (reproductive and behavioral)
Fishery-Dependent Data	Analytical	Catch, landings, and effort
		Biological characterization of the harvest (size, sex, age)
		Gear selectivity
		Discards/bycatch
Fishery-Independent Data	Analytical	Biological characterization of the population (size, sex, age)
		Mortality rates
		Estimates of annual juvenile recruitment

Although single-species assessment models are valuable and informative, a primary shortcoming is that they generally fail to consider the ecology of the species under management (e.g., habitat requirements, response to environmental change), ecological interactions (e.g., predation, competition), and technical interactions (e.g., discards, bycatch) (NMFS 1999, Link 2002a,b). Inclusion of ecological processes into fisheries management plans is now strongly recommended (NMFS 1999) and in some cases even mandated (NOAA 1996). Multispecies assessment models have been developed to move towards an ecosystem-based approach to fisheries management (Hollowed et al. 2000, Whipple et al. 2000, Link 2002a,b). Although such models are still designed to yield information about sustainability, they are structured to do so by incorporating the effects of ecological processes among interacting populations.

Over the past decade, the number and type of multispecies models designed to provide insight about fisheries questions has grown significantly (Hollowed et al. 2000, Whipple et al. 2000). While this growth has been fueled primarily by the need to better inform fisheries policy makers and managers, recent concerns about effects of fishing on the structure of ecosystems have also prompted research activities on multispecies modeling and the predator-prey relationships that are implied. From a theoretical perspective, basing fisheries stock assessments on multispecies rather than single-species models certainly appears to be more appropriate, since multispecies approaches allow a greater number of the processes that govern population abundance to be modeled. However, this increase in realism leads to an increased number of model parameters, which in turn, creates the need for additional types of data.

In the Chesapeake Bay region, there has been a growing interest in ecosystem-based fisheries management, as evidenced by the recent development of fisheries steering groups (e.g., ASMFC multispecies committee), the convening of technical workshops (Miller et al. 1996, Houde et al. 1998), and the goals for ecosystem-based fisheries management set by the Chesapeake Bay 2000 (C2K) Agreement. In many respects, it can be argued that the ecosystem-based fisheries mandates inherent to the C2K Agreement constitute the driving force behind this growing awareness. The exact language of the C2K agreement, as it pertains to multispecies fisheries management, reads as follows:

1. By 2004, assess the effects of different population levels of filter feeders such as menhaden, oysters and clams on bay water quality and habitat.

2. By 2005, develop ecosystem-based multispecies management plans for targeted species.

3. By 2007, revise and implement existing fisheries management plans to incorporate ecological, social and economic considerations, multispecies fisheries management and ecosystem approaches.

If either single-species or ecosystem-based management plans are to be developed, they must be based on sound stock assessments. In the Chesapeake Bay region, however, the data needed to perform single and multispecies assessments has been either partially available or nonexistent.

The Chesapeake Bay Multispecies Monitoring and Assessment Program (ChesMMAP) was developed to assist in filling these data gaps, and ultimately to support bay-specific stock assessment modeling activities at both single and multispecies scales. While no single gear or monitoring program can collect all of the data necessary for both types of assessments, ChesMMAP was designed to maximize the biological and ecological information collected for several recreationally, commercially, and ecologically important species in the bay.

In general, ChesMMAP is fishery-independent monitoring survey that uses a large-mesh bottom trawl to sample late juvenile-to-adult fishes in the mainstem of Chesapeake Bay. This program currently provides data on relative abundance, length, weight, sex ratio, maturity, age, and trophic interactions for several important fish species that inhabit the bay seasonally. This report summarizes the data generated from the field and laboratory components of this project.

Among the research agencies in the Chesapeake Bay region, only VIMS has a program focused on multispecies issues involving the late juvenile and adult (i.e., harvested) components of the exploited fish species that seasonally inhabit the bay. The Multispecies Research Group (MRG) is also responsible for executing the nearshore trawl survey for the Northeast Area Monitoring and Assessment Program (NEAMAP), as well as the VIMS elasmobranch longline survey. In this report, we summarize the ChesMMAP field, laboratory, and data analysis activities through the 2012 sampling year.

A new ChesMMAP task included during recent segments was initial evaluation of a potential new sampling gear system. This system includes a one-half size (200 x 12cm fishing circle) version of the same trawl net in use for the NEFSC and NEAMAP surveys (400 x 12cm fishing circle). Scale model flume tank testing occurred during an earlier segment, initial field testing took place during 2009-2010 and the first comparative (to the existing gear) field trials took place in 2010-2011. Due to previously unanticipated upgrades and replacement plans for the *R/V Bay Eagle* it was determined that the most prudent course of action was to delay further testing during the current segment (fully explained in Methods below).

The MRG has been attempting to steadily improve its online presence and provide stakeholders, scientists, and managers with ready access to significant parts of the ChesMMAP (and other monitoring surveys conducted by the group) data bases. Three elements of particular significance have been made accessible during the past year:

- Abundance Indices – All measures of relative abundance presented in this report are also available online at www.vims.edu/fisheries/chesmmapindices/index.php
- Food Habits Summaries – A variety of user-selectable summarizations of fish diet information, from either the predator or the prey point of view, are available at http://www.vims.edu/fisheries/fishfood.
- Station-Specific Catches – GIS style representations of tow-specific catch information for ChesMMAP (and other) data with user-selected data filters are at: www.vims.edu/fisheries/fao/index.php.

These links as well as much more information about ChesMMAP and other programs conducted by the MRG are available at http://www.vims.edu/fisheries/mrg.

The following Tasks are addressed in this report:

- Task 1 – Conduct research cruises
- Task 2 – Synthesize data for single species analyses
- Task 3 – Quantify trophic interactions for multispecies analyses
- Task 4 – Estimate abundance
- Task 5 – Continue evaluation of alternative sampling gear.

Methods

Task 1 – Conduct research cruises

The timing of the cruises was chosen so as to coincide with the seasonal abundances of fishes in the bay. In calendar year 2012, five bimonthly (~80 station) research cruises were planned between March to November in the mainstem of Chesapeake Bay. However, due to required engine and hydraulic system replacement on the research vessel *R/V Bay Eagle*, the March cruise could not be conducted. While it is very unfortunate to lose an entire research cruise, these necessary vessel changes were timed to assure the minimum possible disruption to the several research programs for which this vessel is used. These upgrades will provide a more reliable vessel and will extend its life by several years and will assure its availability to conduct calibration experiments when the replacement vessel is acquired in 2015 or 2016.

The *R/V Bay Eagle*, a 19.8 m aluminum hull, twin diesel vessel owned and operated by VIMS, served as the sampling platform for this survey. Fishes (and select invertebrates) were collected using a 13.7 m (headrope length), two-bridle, four-seam bottom trawl manufactured by *Reidar's Manufacturing Inc.* of New Bedford, MA. The top belly, bottom belly, and side panels of the net are constructed of 15.2 cm stretch mesh (2.6 mm diameter twine), and the codend is constructed of 7.6cm stretch mesh (1.6 mm diameter twine). The bridles (legs) of the net are 6.1 m and connected directly to 1.3 m x 0.8 m steel-V trawl doors weighing 71.8 kg each. The trawl net is deployed with a single-warp system using 9.5 mm (dia.) steel main cable and a 37.6 m bridle constructed of 7.9 mm stainless steel wire rope.

For each cruise, the goal was to sample 80 sites throughout the mainstem of Chesapeake Bay. Sampling sites were selected using a stratified random design. The bay was stratified by dividing the mainstem into five regions of 30 latitudinal minutes each (the upper and lower regions being slightly smaller and larger than 30 minutes, respectively). For easy reference, regions are numbered 1 through 5 from north to south. Regions 1-3 coincide with the Maryland portion of the bay and regions 4-5 correspond with Virginia waters. Within each region, three depth strata ranging from 3.0 m-9.1 m, 9.1 m-15.2 m, and >15.2 m were defined. A grid of 1.9 km^2 cells was superimposed over the mainstem, where each cell represented a potential sampling location. The number of stations sampled in each region and in each stratum was proportional to the surface area of water represented. Stations were sampled without replacement and those north of Pooles Island (latitude 39^o 17') have not been sampled since July 2002 due to repeated loss of gear. In the future, we plan to use sidescan sonar to identify potential sampling locations in this area.

Tows were normally conducted in the same general direction as the tidal current (pilot work conducted using the net monitoring gear in November 2001 indicated that the survey gear performed most consistently when towed with the current rather than against the current). The net was generally deployed at a 4:1 scope, which refers to the cable length: water depth ratio. For shallow stations, however, bridle wires were always fully deployed, implying that the scope ratio could be quite high in these particular situations. The target tow speed was 3.0 kts but occasionally varied depending on wind and tidal conditions. Based on data collected from the net monitoring gear, tow speed and scope were adjusted occasionally to ensure that the net maintained expected geometry. Tows were 20 minutes in duration, unless obstructions or other logistical issues forced a tow to be shortened (if the duration of a tow was at least 10 minutes, it was considered valid). Computer software was used to record data from the net monitoring gear (i.e., wingspread and headrope height) as well as a continuous GPS stream during each tow. On occasions when the monitoring gear failed or was not deployed, the trawl geometry was assumed to follow cruise averages and beginning and ending tow coordinates were recorded by hand from the vessel's GPS system.

Task 2 – Synthesize data for single species analyses

Once onboard, the catch from each tow was sorted and measured by species and size-class if distinct classes within a particular species were evident. A subsample of each species/size-class was further processed for individual weight determination, stomach contents, ageing, and determination of sex and maturity stage. In addition to these biological data, water temperature, salinity, and dissolved oxygen readings were recorded at each sampling location. During 2010, acquisition of a new water quality instrument which takes near instantaneous readings of all parameters (temperature, salinity, dissolved oxygen) allowed measurement of these parameters throughout the water column rather than only at the surface and near bottom as had previously been practiced. At each location, water quality parameters were electronically recorded approximately at 1m, 2m, and at 2m intervals until the instrument reaches the bottom. Complete ChesMMAP water column profiles for each Region are presented here for the first time.

Single-species assessment models typically require information on (among others) age-, length-, and weight-structure, sex ratio, and maturity stage. Data were synthesized to characterize annual length- and age-frequency distributions. Analytical computer programs to characterize each of the assessment-related data elements (length, weight, age, sex, maturity) were developed to allow for the summarization of these characteristics across a variety of spatial and temporal scales (e.g., by year, season, or region of the bay) for each species.

Task 3 – Quantify trophic interactions for multispecies analyses

In addition to the population-level information described under Task 2, multispecies assessment models require information on predator-prey interactions across broad seasonal and spatial scales. In general, these procedures involve examining the stomach contents of predators and identifying each prey item to the lowest possible taxonomic level. As such, stomach samples were collected and preserved in the field and were processed at VIMS following standard diet analysis procedures (Hyslop 1980). Several diet indices were calculated to identify the main prey types for each species sampled by the ChesMMAP Survey: percent weight, percent number, and percent frequency-of-occurrence.

Both percent weight and percent number are offered in this report. In the food habits figures presented for each species, prey types are ordered first in decreasing percentage (by weight) order by major taxa (e.g. fish, crustaceans, molluscs, etc.) and within each taxon by decreasing percentage for each species or subgroup. To make comparisons between percent by weight vs. by number readily accomplished, the same color scheme of major taxa is maintained in the succeeding percent by number figure though the taxa order (again by by decreasing percentage), as well as species or subgroup order within each taxon are allowed to vary.

These indices can be coupled with the information generated from Task 2 and age-, length-, and sex-specific diet characterizations can be developed for each species. Characterizing spatial and temporal variability in these diets is also possible using ChesMMAP data.

As noted above, several diet index values were calculated to identify the main prey in the diet of predators in the mainstem Chesapeake Bay. Since trawl collections essentially yield a cluster of fish at each sampling location, these indices were calculated using a cluster sampling estimator (Buckel et al. 1999).

Specifically, the contribution of each prey type to the diet by weight ($\%Q_k$) is given by:

$$\%Q_k = \frac{\sum_{i=1}^{n} M_i q_{ik}}{\sum_{i=1}^{n} M_i} ,$$

where

$$q_{ik} = \frac{w_{ik}}{w_i} * 100 ,$$

and where *n* is the number of clusters (species/size-class combinations) of the predator of interest sampled, M_i is the number of individuals of this predator species represented in cluster *i*, w_i is the total weight of all prey items encountered in the stomachs of that predator sampled from cluster *i*, and w_{ik} is the total weight of prey type *k* in those stomachs.

Task 4 – Estimate abundance

Time-series of abundance information are standard products developed from the basic catch data of a fishery independent monitoring survey. For each species sampled by the ChesMMAP Survey, a variety of relative abundance trends can be generated according to year, season, and location within Chesapeake Bay.

Absolute abundance estimates can be generated for each species by combining abundance data with area swept by the trawl and gear efficiency. Area swept was calculated for each tow by multiplying tow distance (provided by GPS) by average wingspread (provided by net monitoring gear). Gear efficiency estimates, gained through hydroacoustic data collection as described in previous project reports, have been estimated for two species common in ChesMMAP catches (Atlantic croaker and white perch) and results were recently published (Hoffman et al. 2009). Though calculated for previous annual reports these absolute abundance estimates are not presented for this current segment.

While minimum total or absolute abundance estimates are important for certain bioenergetics and ecosystem level analyses, fishery assessments typically depend upon relative abundance indices from surveys as important indicators of abundance. Previous ChesMMAP progress reports have presented an evolving series of relative and absolute abundance estimates. Still another new step in the evolution of those indices was introduced in the 2011 report. Specifically, for species for which identifiable (from analysis of hard parts) age cohorts are present in ChesMMAP samples, age-specific indices of abundance based on ChesMMAP-developed age-length keys (ALK) were offered and those estimates are presented again this year, based on improved ALKs.

Development of ChesMMAP-specific ALKs was required due to the multiple annual sampling events (i.e. bi-monthly cruises) and inter-cruise growth. Such specific growth information has not been previously available for most species in Chesapeake Bay and could only be accomplished now as ChesMMAP sample sizes became large enough after several years of field sampling and laboratory ageing efforts.

To develop these ALKs the following procedure was followed for each appropriate species:

- For aged specimens, each fish was assigned into 1cm length bins.
- The proportion of aged fish belonging to each age-class within each length bin was calculated.
- Within each age-class and for each appropriate cruise (i.e. only those cruises used in calculating abundance indices for a species) these proportions were run through a loess-based smoothing algorithm. This process tended to remove spikes (positive or negative) in the raw proportions that occur due to small sample sizes of aged specimens within some length bins and to specimens with abnormally slow or fast growth. This smoothing however did mean that typically the sum of the proportions across all age classes within a length bin did not add to exactly 1.0.
- Small adjustments were made to the loess-smoothed proportions such that within each month (cruise) the sum of all proportional values at a length increment was equal to 1.0.
- For species for which there is still an insufficient sample size of aged specimens to calculate ChesMMAP-specific ALKs, data from the most appropriate NEAMAP cruises were substituted. This includes black sea bass, bluefish, butterfish, and scup.

Once the ALKs were established for each index month, all measured specimens were similarly assigned to length bins, the total number of specimens captured within each length bin (within each cruise) was summed and the cruise-specific age-at-length proportions applied to those sums, thereby estimating the total number of age-x fish captured within each cruise. That number was then fed into the index calculation algorithm (below). For age-specific biomass indices, the average weight of specimens within each length bin with each age-class was calculated, then multiplied by the calculated (as above) number within the length bin to estimate total weight. Similarly, that figure was then processed through the index calculation algorithm. This method to calculate age-specific abundance differs somewhat from that employed by analysts at the Northeast Fisheries Science Center in which the proportion-at-age is applied to the overall index for each year. The methodology employed in this report has a slight disadvantage in that due primarily to the transformations and back-transformations the sum of the age-specific indices is not equal to the overall abundance index. It has the advantage however that it allows normal calculation of confidence limits on the age-specific indices.

For this report, only geometric mean abundance indices are presented. Arithmetic indices as offered in previous reports are rarely statistically valid. Delta-lognormal indices as introduced in our previous segment report (Bonzek et al. 2011) are still considered likely to be the most valid computational method but the programming to calculate these indices on an age-specific basis has not been completed. Description of the delta-lognormal calculation however is still described below.

Abundance index calculations presented here are calculated according to:

1. Raw catch data used for each species index are restricted by month, region, and depth strata such that only those strata with maximum catch-per-unit-effort for that species are used. The methods used to determine these species-specific restrictions were described in a previous progress report (Bonzek et al. 2009). For a small number of species these limiting parameters were updated in the previous segment report.

2. Delta Lognormal Mean: This data treatment (Shimizu, 1988) is becoming more common for calculation of abundance estimates from fishery surveys as a means of dealing with the odd statistical properties of catch data from such surveys.

   Examination of the raw catch-per-tow data for each species within specific strata indicated presence of a high proportion of zero catches, or alternatively, a low proportion of tows where at least one individual of the species of interest was captured. Zero catches can arise for many reasons, and it was reasoned that the use of an active sampling gear combined with the schooling nature of most fishes was the likely cause. Although a variety of strategies can be used to deal with zero catches, we elected to apply the delta-lognormal distribution where the mean catch-per-unit-effort for the ith stratum (CPUEi) was modeled as the product of probability of obtaining a zero catch (pi) with the lognormal mean CPUEi derived from the non-zero tows (Aitchison 1955). Therefore, the estimator for the mean abundance within each stratum (, expressed either as number or biomass) was calculated as:

   $$\overline{Y_i} = \hat{p} \cdot e^{\left(\log_e\left(\frac{1}{t_i}\sum_{i=1}^{t_i} CPUE_i\right) + 0.5 \cdot \mathrm{var}(\log_e(CPUE_i))\right)}.$$

   The overall mean relative abundance for species s was then calculated as:

$$\overline{Y}_s = \sum_{i=1}^{n} w_i \overline{Y}_i,$$

where wi represents the weighting term (expressed as a proportion) associated with the ith stratum. All calculations were completed using the software package R, version 2.11.0 (R Development Core Team, 2010).

3. Geometric Mean: Using the restricted data, annual geometric mean catch per area swept indices for each species for all ages combined, were calculated according to the formula:

$$\mathbf{I} = \mathbf{exp}\left\{\sum_{i=1}^{n}\left(\log\left(\frac{C}{a} + \mathbf{1}\right)\right) \times w\right\} - \mathbf{1}$$

where: I = Index

C = number or biomass caught at a station
a = area swept at a station
i = ith stratum
n = number of strata
w = stratum weight

<u>*Task 5 – Continue evaluation of alternative sampling gear*</u>

As discussed in previous project reports, personnel associated with the ChesMMAP Trawl Survey worked in conjunction with *Reidar's Manufacturing, Inc.* to design a survey trawl that could serve as a replacement for the sampling net currently used by this program. Specifically, a three-bridle, four-seam, 200 x 12cm (fishing circle) bottom trawl had been developed. This net is identical in design to that used to sample the near shore coastal ocean by the NEAMAP Trawl Survey, and is nearly-identical to that used by the Northeast Fisheries Science Center's (NEFSC) Bottom Trawl Survey. Because the survey vessel used by ChesMMAP is appreciably smaller than those used by NEAMAP and by the NEFSC, however, the three-bridle, four-seam net developed for this program is half of the size of those used by the latter two (i.e., 200 x 12cm fishing circle net for ChesMMAP vs. 400 x 12 cm fishing circle net for NEAMAP and NEFSC). Again, flume trials conducted on model trawls in December 2009 indicated that the 200 x 12cm net may be a more appropriate sampling gear than the current two-bridle four-seam, semi-balloon bottom trawl used by ChesMMAP, as the optimal configuration and performance consistency of the alternate net appeared to be superior to that of the current gear.

In an effort to begin to document and evaluate the performance of the 200 x 12cm trawl in the field, ChesMMAP purchased a single net, along with all associated rigging hardware, from *Reidar's* during the summer of 2010. With respect to matching a set of trawl doors to this net, several options were available. Senior project personnel worked closely with trawl door specialists at *Trawlworks Inc.* in Narragansett, Rhode Island to identify those that were most likely capable of consistently providing the optimal wingspread for the 200 x 12cm net (i.e., 6.5m, as defined by the flume trials). It was determined that the doors currently used by ChesMMAP, a set of $1m^2$ steel-vee doors, could not generate the necessary spreading power. Three alternative options were therefore identified; namely, #2 Bison doors ($0.86m^2$ surface area), 44" Thyboron Type IV doors ($0.88m^2$), and 0.6 Patriot doors ($0.67m^2$).

Calculations showed that the Patriot doors would be able to provide sufficient spreading power. These doors, while they are the smallest, are the heaviest of the three and would therefore likely be the most difficult to handle onboard the vessel. As such, these doors were eliminated from consideration. The Thyboron doors also had more than sufficient spreading power to achieve optimal wingspread for the 200 x 12cm trawl, and these doors weigh approximately half that of the Patriots. The Bison doors were by far the lightest, although it was determined that nearly the full spreading power of these doors would be needed to achieve the optimal configuration of the trawl. In the end, project personnel decided to begin field testing of this alternate net using the #2 Bison doors as they theoretically should provide sufficient spreading power, were the lightest and therefore easiest to handle, and were already on hand (VIMS owned a set of #2 Bison doors from a previous experiment, representing a potential time and cost savings to the project) All hardware replacement and rigging necessary to match the #2 Bison doors with the 200 x 12cm trawl took place in the summer of 2010.

Following the plan outlined in the 2010 project proposal, all field-testing of this alternate survey gear package took place in the late summer and fall. This period was chosen as both the abundance and diversity of fishes typically reaches a maximum in Chesapeake Bay during this time, meaning that conducting trials during this season would most likely provide the best indication of the ability of this trawl to sample fishes. Further, normally very few days are lost to the weather during these months, so delays due to poor conditions were likely to be minimized by completing the sea trials during this time. As such, field experimentation with this 200 x 12cm trawl/#2 Bison door combination began on September 5, 2010, and tows were conducted approximately 2nm west of Kiptopeake, VA. Unfortunately, the gear was hung on the bottom partway through the second tow and suffered extensive damage in the port wing and first bottom belly. Survey personnel were able to repair the trawl and the field trials of this gear configuration resumed on November 16 & 18, 2010 in the York River and around York Spit; all tows were completed without incident.

Again, as presented in the 2010 project proposal, these gear trials began with a series of rigging and towing (e.g., vessel speed, warp length, tow direction relative to the current, etc.) adjustments in an attempt to identify protocols that would consistently yield the theoretical optimal configuration of this net. These experiments were followed by a series of 're-tows', where sampling sites occupied earlier during regular survey operations (using the two-bridle, four-seam, semi-balloon bottom trawl) were towed again with the new net/door combination using standard sampling protocols in an effort to compare catch rates and compositions. A full detailing of the rigging and towing adjustments made and their associated outcomes, along with a description of catches under standard sampling conditions, is given in the results section below.

The ChesMMAP project proposal for 2011-2012 outlined plans for further testing (two days) of the 200x12 fishing system. This testing was deferred until future segments however due to two separate vessel-related issues.

- First, as described earlier, the Bison trawl doors were determined to be barely adequate for use with the new net and that the Thyboron doors were the proper match. However, the winch and the associated hydraulic system on the *R/V Bay Eagle* are not sufficient to provide the necessary pulling power for the entire fishing system with the Thyboron doors. So, a new and larger winch was procured but still the vessel hydraulics were inadequate. Midway through 2011 however, VIMS acquired funds that were necessary to replace the vessel's well-past-life-expectancy engines as well as the hydraulic system. These improvements were scheduled for early spring 2012 (unfortunately resulting in the loss of the vessel's availability for the March 2012 ChesMMAP cruise). ChesMMAP investigators chose not to experiment further with the new net paired with the Bison doors when we would soon have available a fishing platform which would allow us to evaluate what is anticipated to be a superior net/door pairing.

- Second, early in 2012 the Virginia General Assembly unexpectedly provided sufficient funds in the next biennial budget for VIMS to design and purchase an entirely new research vessel to replace the *R/V Bay Eagle*. The design and construction of the vessel will take place over several years. However, at the end of that time, ChesMMAP will have in place the ability to conduct full-scale old vessel/old net vs. new vessel/new net experiments. By waiting for the new vessel to come online to implement the new fishing system we can accomplish a one-step conversion. This has the unfortunate effect of delaying implementation of the new fishing gear but ChesMMAP investigators believe the wait will be worth it.

Results

Task 1 – Conduct Research Cruises

Cruise dates and the numbers of stations completed during each survey since 2002 are shown in Table 2. For years 2002-2004 the target number of stations per cruise was 90 and since 2005 that target number has been 80 (extensive analyses of data collected through 2004 revealed that the target number could be decreased by 10 stations per cruise with little effect on survey precision, but that decreases below 80 do have a significant negative effect on precision). Examination of the data presented in Table 2 reveals that as experience has been gained and survey procedures improved, the number of calendar days per cruise has decreased from an average of 11-13 days down to 9-11 (or even fewer days if we are fortunate to have a good weather window). Likewise, the number of actual work days has decreased from a range of 8-10 down to 7-8. As the survey only pays vessel costs on days actually worked, this increased efficiency has resulted in significant cost savings (note however that some of these efficiencies have likely resulted from an overall decrease in the number of fish caught, described below).

In mid-2008 we gained the ability to plot previous successful tow tracks onto electronically displayed overlays of selected sampling cells for each cruise. In difficult trawling areas, which are very common in Chesapeake Bay, by approximately retracing a successful tow track it becomes much less likely that the trawl gear will 'hang up' and/or be significantly damaged. This has resulted both in a further increase in efficiency (much less time is spent retrieving 'hung' gear so more time is spent sampling) and a decrease in the number of nets requiring major repair or replacement. Both of these elements offer further cost savings.

After reaching a maximum during the third survey year (2004), the total number of specimens sampled annually has steadily declined (Table 3). Total samples collected and processed reached a time series low in 2011 (which represented a 55% decrease in total catch compared to 2004, with comparable levels of total sampling effort) and then another low in 2012, though without a March 2012 cruise. However, even if the March cruise yielded catch rates comparable to other recent years, the total number of specimens captured in 2012 would still be a time series low value.

Table 2. Cruise dates and number of stations completed during ChesMMAP cruises 2002-2012

Year	Cruise	Begin Date	End Date	Stations Completed	Calendar Days	Work Days
2002	March	3/29/2002	4/16/2002	50	19	8
	May	5/20/2002	5/28/2002	80	9	8
	July	7/8/2002	7/16/2002	77	9	8
	September	9/13/2002	9/22/2002	76	10	10
	November	10/28/2002	11/10/2002	74	14	9
2003	March	3/24/2003	4/4/2003	69	12	8
	May	5/20/2003	5/23/2003	29	4	4
	July	6/30/2003	7/10/2003	87	11	8
	September	9/30/2003	10/8/2003	73	9	8
	November	10/28/2003	11/5/2003	76	9	9
2004	March	3/20/2004	3/31/2004	90	12	8
	May	5/17/2004	5/26/2004	90	10	10
	July	7/1/2004	7/10/2004	59	10	7
	September	9/2/2004	9/15/2004	80	14	8
	November	10/28/2004	11/10/2004	86	14	10
2005	March	3/16/2005	3/25/2005	80	10	8
	May	5/2/2005	5/10/2005	80	9	8
	July	7/1/2005	7/12/2005	80	12	8
	September	9/8/2005	9/18/2005	76	11	8
	November	10/31/2005	11/9/2005	80	10	9
2006	March	3/23/2006	3/31/2006	80	9	8
	May	5/15/2006	5/25/2006	80	11	8
	July	6/28/2006	7/13/2006	73	16	7
	September	8/30/2006	9/13/2006	70	15	8
	November	10/30/2006	11/7/2006	74	9	8
2007	March	3/13/2007	3/23/2007	77	11	8
	May	5/9/2007	5/23/2007	77	15	9
	July	7/2/2007	7/10/2007	78	9	9
	September			0	0	0
	November	10/30/2007	11/12/2007	77	14	8
2008	March	3/17/2008	3/26/2008	80	10	8
	May	5/20/2008	5/27/2008	78	8	8
	July	6/28/2008	7/7/2008	80	10	7
	September	9/2/2008	9/11/2008	80	10	7
	November	10/30/2008	11/11/2008	80	13	8
2009	March	3/16/2009	3/26/2009	80	11	7
	May			0	0	0
	July	7/14/2009	7/20/2009	80	7	7
	September	9/2/2009	9/12/2009	80	11	8
	November	11/3/2009	11/10/2009	78	8	7
2010	March	3/22/2010	3/31/2010	79	10	7
	May	5/22/2010	5/28/2010	79	7	7
	July	7/6/2010	7/9/2010	45	4	4
	September	8/31/2010	9/11/2010	80	12	8
	November	11/2/2010	11/15/2010	79	14	8
2011	March	3/22/2011	3/30/2011	80	9	7
	May	5/26/2011	6/1/2011	79	7	7
	July	7/7/2011	7/13/2011	79	7	7
	September	9/1/2011	9/8/2011	79	8	8
	November	11/2/2011	11/10/2011	78	9	8
2012	March	No cruise due to vessel repowering.				
	May	5/26/2012	6/2/2012	80	8	8
	July	7/9/2012	7/16/2012	79	8	8
	September	9/3/2012	9/11/2012	80	9	8
	November	11/9/2012	11/17/2012	72	9	8

Table 3. Number of specimens collected, measured and processed for age determination and diet composition information from ChesMMAP, 2002 – 2012.

Year	Fish collected	Fish measured	Otoliths collected	Otoliths processed	Stomachs collected	Stomachs processed
2002	32,018	23,606	5,489	4,494	4,562	3,020
2003	30,924	20,829	3,913	3,055	3,250	2,417
2004	47,622	31,245	5,169	4,290	4,272	3,330
2005	45,204	36,909	6,065	5,006	5,067	3,432
2006	43,957	31,243	5,413	4,229	4,402	3,504
2007	30,893	22,124	4,282	3,275	3,671	2,869
2008	26,299	19,597	4,207	3,048	3,678	3,429
2009	22,050	15,694	3,227	2,246	2,729	2,643
2010	26,337	20,566	4,003	2,676	3,424	3,236
2011	21,185	16,397	3,429	2,010	2,742	2,525
2012	17,329	14,955	2,497	675	2,015	1,734

Concerns as to whether this decrease in catch is due to actual changes in species abundance or is an artifact of unknown sampling effects were examined in the previous segment reports (Bonzek et al., 2010 and 2011). Those analyses revealed that much of the decrease in total catch can be attributed to declines in measured abundance of a single species, Atlantic croaker. Catch rates of other commonly abundance species, (e.g. spot, weakfish, March white perch) have also declined when compared to the mid-2000s. There is still some uncertainty in the investigators' minds as to whether these declines represent real biological abundance in Chesapeake Bay or are a sampling artifact. Future sampling with the new three-bridle, four-seam, 200x12 net may aid in this determination.

Except for the most recent sampling year, the vast majority of ageing structures (i.e. otoliths, opercles, etc.) and stomach samples preserved have been analyzed (Table 3). Currently, most of the otolith and stomach samples that remain to be processed represent species which are either of relatively minor management interest (e.g. oyster toadfish otoliths), which involve significantly different preparation and analysis techniques (e.g. elasmobranch vertebrae), which are particularly difficult to analyze (e.g. Atlantic menhaden stomachs), or which currently have no accepted processing protocols (e.g., butterfish sampled from inshore waters). Due in large measure to a restructuring of personnel assignments within the MRG, what had been a growing backlog of samples to be processed has been largely eliminated.

Tasks 2-4 – Data Summaries

The data summaries in this report represent a subset of the biological and ecological analyses which could be calculated from the ChesMMAP data set. For those species which are well-sampled by the survey, overall abundance estimates are presented. Estimates of 'minimum trawlable abundance' as presented in segment reports through 2010 are not included here and likely will not be in future reports. These estimates are useful in certain bioenergetics analyses and represented a first step in development of ChesMMAP abundance indices but are not typically useful in a management context.

Relative abundance index calculations were based on limiting the data used for each species to the months, regions, and depth strata of maximum abundance over all years (Table 4). Those limiting parameters have been updated for some species based on subsequent analyses conducted during 2010 and 2012 (but not presented here).

Table 4. Selected months, regions, and depth strata data used for abundance indices for each species (modified in comparison to previous segment reports).

Species	Sp. Code	Month					Region					Depth		
		03	05	07	09	11	01	02	03	04	05	01	02	03
Atlantic croaker	0005		x	x	x					x	x		x	x
black seabass	0002			x	x	x				x	x	x	x	x
bluefish	0009				x	x				x	x	x	x	x
butterfish	0004				x	x				x	x		x	
kingfish sp.	0013		x	x	x	x					x	x	x	x
northern puffer	0050				x	x					x	x	x	
scup	0001			x	x	x					x	x	x	
spot	0033			x	x	x	x	x	x	x	x	x	x	x
striped bass (March)	0031	x					x	x				x	x	
striped bass (November)	0031					x	x	x				x	x	
summer flounder	0003				x	x				x	x	x	x	x
weakfish	0007				x	x				x	x		x	x
white perch (March)	0032	x					x	x				x	x	
white perch (November)	0032					x	x	x				x	x	
Additional species														
blue crab - ad. female	6143					x				x	x	x	x	x
blue crab - male	6141				x	x	x	x				x	x	x
clearnose skate	0170		x	x	x	x					x	x	x	x

For species for which age-specific indices can be calculated, those indices along with the ALKs in both graphical and tabular formats are shown. Both the tabular and graphical representations present only the loess-smoothed/adjusted proportions of age-at-length.

Length-frequency (for sexes combined and sex-specific for most species), age-frequency (for those species for which ageing has been substantially completed) and overall diet summaries (for data through 2011) are also presented. Age-frequency figures are given both in histogram format showing the ‘raw’ number at age expanded to the total catch (i.e. as if every specimen captured had been aged) and in standardized bubble plot format with the ‘raw’ figures standardized to 800 trawl minutes (the total number of minutes towed in a full ChesMMAP year if each of the 5 cruises consisted of 80 stations at 20 minutes each). The bubble plots allow a representation of the age-specific abundance for all years simultaneously and can sometimes make it easier for the reader to follow large and small year classes diagonally through the population.

Some analyses (e.g. sex ratios, length-weight relationships, growth equations) presented in previous project reports are not included. It is assumed that, when needed, assessment scientists and managers will request specific analyses of these data types which could not be fully anticipated in this report. Therefore, only those general data summaries of the most universal possible use are included. The profiles that follow are organized first by species and then by type of analysis (‘Task’). Each Task element (single-species stock parameter summarizations, trophic interaction summaries, and estimates of abundance) is included but is not labeled with a Task number and is not necessarily shown in Task number order (note also that not all analysis types are available for all species).

For each species, the following data summaries are presented (note that some data/analyses may not be available for all species):

1) A series of GIS figures showing total abundance at each sampling site overlaid on the survey depth strata, for each cruise during the year (Note that in the 2009 ChesMMAP report these figures were presented for all survey years. To compare results in 2010 through 2012 to prior years refer to these previous project reports – e.g. Bonzek et al. 2009, Bonzek et al. 2010).
2) Figures and tables presenting overall and age-specific (for appropriate species) area-swept-corrected abundance indices by number and biomass, calculated using geometric means.
3) ALKs for each month used in developing abundance indices, presented with the key overlaid on aggregate length-frequency histograms and in tabular form.
4) Length-frequency data by year, for sexes combined and separately.
5) Age-frequency distributions by year (for those species where appreciable numbers have been captured and otoliths have been processed).
6) Age-frequency distributions by month, summed over all years, in both histogram and bubble plot format, as described above.
7) Diet analyses by weight and number, using all data collected and analyzed 2002-2011. For this report (and for presentation elsewhere), standardized categories of prey types (Fishes, Crustaceans, Molluscs, Worms, Misc.) have been developed for all ChesMMAP species. In each figure for each predator species, these categories are presented in decreasing order of importance and within each broad category specific prey types are shown also in decreasing order. Only those specific prey types greater than or equal to 1.0% of the overall diet are shown (unless the entire category is less than 1.0%). All other specific prey are lumped into a category called 'other x' (x = fishes, molluscs, etc.) which is distinct from unidentified prey types within the category. For the reader's convenience, the color scheme used for all species (e.g. red = crustaceans, light blue = fishes, etc.) is the same. This makes it relatively easy to compare figures across predator species or by weight/number within a species.

<u>Species Data Summaries</u>

***Atlantic Croaker* (*Micropogonias undulatus*)**

<u>Abundance:</u> Atlantic croaker is typically among the most abundant species in ChesMMAP survey catches, especially during the mid-year. The majority of fish are captured in regions 4 and 5 (Virginia) but specimens are regularly captured in all survey regions. Catches decline in September and November as this summer resident species leaves bay waters (Figure 1).

Relative abundance indices (Table 5, Figure 2) for all ages combined both in numbers and biomass reveal low values in 2002 and 2003 that were followed by a period of high abundance throughout 2004-2007 then low abundances from 2008 through 2012. Anecdotal information suggests that the low abundance for this species throughout 2008-2012 ChesMMAP samples is representative of a coastwide phenomenon and may be related to cyclical abundances that have been observed in the past. Age-specific abundances are shown for ages 0 through 4+ (all ages equal to or greater than 4 combined). For ages 2 and older the pattern of abundance generally follows that for overall abundance which indicates that to some extent at least, availability of this species to the ChesMMAP survey area (i.e. the proportion of the coastal stock that invades the bay during warm months) may play at least some role in determining abundance as estimated by ChesMMAP.

Age-Length: Monthly (for May, July, and September) proportions of aged fish for each 1cm length bin for ages 0 through 4+ are given (Figure 3). Very few age-0 specimens are ever captured during May cruises so age-0 data from that yearly cruise is omitted from all age-specific analyses. With the exception of a few specimens (which can be reexamined) the patterns of ages and bi-monthly growth is regular and without anomalies.

Length and Age: Specimens between 14mm and 499mm in total length (Figure 4) and between age 0 and 17 (Figures 5, Figure6) appear in survey data; most individuals range between 150mm and 350mm and ages 1-5. No particular pattern of differences in sex-specific length frequencies was observed.

The length distribution of this species changes considerably year-to-year as year- classes of either extremely high or extremely low abundance move through the stock. For example, a highly abundant 2002 year class was seen as a peak in the length-frequency histograms between 2003 and 2007 and as a distinctly abundant year class in the age-frequency figures even into 2008. There appears to be evidence of mildly to highly successful year class in 2006 which was still abundant in 2007 and 2008 but was not found in appreciable numbers in 2009. Conversely, the 2007 year class appears to have been nearly absent in Chesapeake Bay and similarly was not abundant in 2008. In 2009 these two-year-old fish were the most abundant age class but the number captured was very low compared with other years.

Croakers to age 8 are not uncommon for this survey. During 2008, program personnel attended an Atlantic croaker ageing workshop sponsored by the Atlantic States Marine Fisheries Commission. The consensus report from that workshop set a birth date of 1 January each year, as that date is the approximate mid-point of spawning in the southern portion (i.e., south of Cape Hatteras) of the species' range. Spawning north of Hatteras, including Virginia's waters, occurs several months earlier, and is often complete by early December. As a result, all croaker ages in the ChesMMAP data base were adjusted down one year and it is now possible to capture age-negative 1 fish in the survey. This occurs when fish spawned in late summer and autumn of a given year are collected during the September or November cruises of that year. Those fish are not considered age-0 (or young-of-the year) until that upcoming January, so to place them in the correct year-class, they are assigned an age-negative 1.

Standardized age distribution bubble plots allow certain year classes to be followed as they progress through yearly ChesMMAP surveys (Figure 6). For example, the largest number of age-0 specimens was captured in 2002 and this year class became more abundant in ChesMMAP catches in 2003 and 2004 as more specimens recruited to the gear. Following this year class down (and diagonally) through the plot shows that it was abundant all the way through 2007 and still present in 2010. Similarly in 2007 an exceptionally large number of age-1 specimens were captured and this year class (2006) was still relatively abundant in 2008, was mostly gone by 2009, though it was still present in small numbers as age-5 fish in 2011.

Compared to other survey years, a relatively large number of age-negative 1 fish were captured in the fall of 2011. If these specimens represented a stronger year class which survived the winter of 2011-2012 they would be likely to present themselves as age-1s fully recruited to the survey gear in 2013.

Histogram and bubble plots of monthly age distributions with data combined over all available survey years within each month, reveals the typical annual pattern of invasion of and retreat from Chesapeake Bay waters by this species (Figure 7). Early in the year, abundance builds to a July peak, and then declines through September and November. Within any given month, a regular pattern of age distributions appears, with croaker being fully recruited to the survey gear by age-1 or age-2 and with each succeeding age-class declining in abundance. As the full complement of ages occurs during each month, it does not appear that there is differential migration (in or out) among age classes.

Diet: Miscellaneous polychaetes (17.9% by weight (W) and 17.1% by number (N)) represent the largest single prey type in the diet of Atlantic croaker and all worms combined (42.2% W, 32.3% N) represent the largest taxonomic group. Miscellaneous prey items (primarily unidentifiable material) are the second most important prey category by weight (24.7%) and third by number (24.9%). This unidentified material is likely made up largely of worms and soft-bodied molluscs. Small bodied crustaceans (e.g. mysids) constitute the third major prey category totaling 16.7% by weight and 30.3% by number. Several clam and mussel prey types contribute 14.4% and 11.4% of croaker diets by weight and number respectively with fishes constituting very minor amounts (2.0% W, 1.2% N) (Figure 8).

Figure 1. Abundance (kg per hectare swept) of Atlantic croaker in Chesapeake Bay, 2012.

Table 5. Atlantic croaker geometric mean indices of abundance, by number and biomass, overall and by age-class.

Figure 2. Atlantic croaker geometric mean indices of abundance, by number and biomass, for all ages combined and by age-class.

Figure 3. Atlantic croaker ALKs for all May, July, and September cruises, showing loess smoothed proportions at each 1cm length bin, overlaid on month-specific length frequencies pooled over all years. ALK proportions are adjusted such that the sums of values for each length bin within each month are forced to 1.0

Figure 4. Atlantic croaker length-frequency in Chesapeake Bay 2002-2012, overall (A) and by sex (B).

Figure 5. Atlantic croaker age-frequency by year, 2002-2011.

Figure 6. Atlantic croaker age-frequency by year, 2002-2011 standardized to 8,000 annual trawl minutes.

Figure 7. Atlantic croaker age-frequency by cruise month, 2002-2011 combined, actual (A) and standardized to 8,000 total annual trawl minutes (B).

Figure 8. Diet composition, expressed as percent by weight (A) and percent by number (B) of Atlantic croaker collected during ChesMMAP cruises in 2002-2011 combined.

Black Sea Bass **(*Centropristis striata*)**

Abundance: The ChesMMAP survey gear and sampling methodology are not considered particularly effective for this structure-oriented species (locations of known complex bottom structures and other ‘hangs’ are purposely avoided). However, enough individuals are captured for a certain amount of information to be extracted from survey samples. Catches are typically highest during the July, September and November cruises and are concentrated in regions 4 and 5 but are not uncommon in region 3 (Figure 9). Significant differences in catch rates among depth strata were not observed (Bonzek et al., 2009).

Overall relative abundance indices expressed either in numbers or biomass exhibit nearly identical inter-annual patterns, indicating that the sizes of captured specimens is relatively constant year to year. A steady decline in measured abundances between 2002 and 2006 was followed by a period of fluctuating high and low values, until 2011 when the index was in the middle range of the time series. However, in 2012 very few black sea bass were captured and the indices found new time-series lows for both number and biomass (Table 6, Figure 10). Age-specific abundance indices follow a similar general downward trend, with occasional single-year upward ticks. As catch rates for this species are low and inconsistent confidence limits on the abundance estimates are comparatively broad.

Comparisons of abundance estimates between this and other surveys has not yet been accomplished but may give insight as to the reliability of data from this and other programs.

Age-Length: Capture rates and distribution of lengths (ages) are both insufficient to develop ChesMMAP-specific ALKs. So, in order to provide age-specific abundance indices, the ALKs developed from the NEAMAP spring and fall surveys data were applied to ChesMMAP length data for the months of July (NEAMAP spring survey data), September and November (NEAMAP fall survey data for both months). While the key provides for age-class separation to age 4+, the ChesMMAP black sea bass length-distributions only allow for calculation of indices for ages 0,1, and 2 (Figure 11).

Length and Age: Specimens captured in the survey tend to be relatively small (<250mm) and young (age-0 and age-1) though individuals up to 270mm total length have been sampled (Figure 12). Due to the small sizes of most individuals captured by ChesMMAP, the majority of specimens observed of this protogynous hermaphroditic species have been females. During 2012 the previous backlog of otolith samples was cleared and all specimens collected through 2011 have now been assigned ages. Age-frequencies reveal that in most years the survey catches are dominated by either age-0 or age-1 specimens (Figure 13, Figure 14). Monthly age-frequency plots do not exhibit any annual inward or outward age-specific migration patterns, indicating the young specimens captured by ChesMMAP are likely using Chesapeake Bay as a nursery area which they have mostly left by age-2 and completely by age-3 (Figure 15).

The MRG is has conducted a scale/otolith comparison study for black sea bass and preliminary results indicate significant differences in assigned ages between the two structures. These results will be examined at a black sea bass ageing workshop sponsored by ASMFC during July 2013.

Diet: Though the sample size is relatively small (218 specimens, 139 clusters) and the size range of samples is limited, the diet data is probably the most valuable ChesMMAP contribution for this species. Crustaceans (71.0% W, 80.4% N), dominated by mysids (15.4% W, 34.9% N), mud crabs (10.5% W, 6.6% N), and amphipods (6.3% W, 11.8% N) contribute the highest portion of the diet, by weight of identifiable prey. Fishes constitute 9.2% of the diet by weight and 6.4% by number with bay anchovy (2.8% W, 1.2% N) the largest component among identifiable species. A variety of worms (4.8% W, 3.0% N) molluscs (4.4% W, 1.6% N) and other less prominent or unidentifiable taxa comprise the remainder of the diet (Figure 16).

Figure 9. Abundance (kg per hectare swept) of black sea bass in Chesapeake Bay, 2012.

Table 6. Black sea bass geometric mean indices of abundance, by number and biomass, overall and by age-class.

Figure 10. Black sea bass geometric mean indices of abundance, by number and biomass, for all ages combined and by age-class.

Figure 11. Black sea bass ALKs for all NEAMAP fall cruises, showing loess smoothed proportions at each 1cm length bin, overlaid on month-specific length frequencies pooled over all years. ALK proportions are adjusted such that the sums of values for each length bin within each month are forced to 1.0. Only used for ages 0, 1, and 2 for this report.

Figure 12. Black sea bass length-frequency in Chesapeake Bay 2002-2012, overall (A) and by sex (B).

Figure 13. Black sea bass age-frequency by year, 2002-2011.

Figure 14. Black sea bass age-frequency by year, 2002-2011 standardized to 8,000 annual trawl minutes.

Figure 15. Black sea bass age-frequency by cruise month, 2002-2011 combined, actual (A) and standardized to 8,000 total annual trawl minutes (B).

Figure 16. Diet composition, expressed as percent by weight (A) and percent by number (B) of black seabass collected during ChesMMAP cruises in 2002-2011 combined.

***Bluefish* (*Pomatomus saltatrix*)**

Abundance: Due to the fast-swimming and pelagic nature of bluefish, this species also is not considered to be well sampled by ChesMMAP, though some useful assessment-related information can be generated from these survey data. When captured, typically between one and five specimens occur in a tow (Figure 17) though as many as 42 have been collected in a single sampling event. Bluefish are usually captured in either the shallow (10’-30’) or mid-depth (30’-50’) strata. Catches are typically highest late in the year, presumably as the young-of-the year fish are moving into deeper waters in preparation for outmigration from the bay.
Abundance is normally highest in regions 4 and 5 but notable exceptions occur such as a single capture of 26 specimens in Region 1 during the September 2008 cruise (Bonzek et al. 2009).

Abundance indices for all ages of bluefish combined alternated between low and high values from 2002 to 2007 but have been consistently at time series lows for the past five years (Table 7, Figure 18). Patterns between indices by number and weight are very similar. As nearly all specimens captured are young-of-year fish, the age-0 index closely follows the pattern for the overall index.

Age-Length: As with black sea bass, capture rates and distribution of lengths (ages) are both insufficient to develop ChesMMAP-specific ALKs. So, in order to provide age-specific abundance indices, the ALKs developed from the NEAMAP fall survey data were applied to ChesMMAP length data for the months of September and November. While the key provides for age-class separation to age 2+, the ChesMMAP bluefish length-distributions only allow for calculation of indices for age 0 (Figure 19).

Length and Age: Most individuals sampled in the survey are less than 350mm fork length and, due to the small number of specimens captured and protracted spawning season of this species, it is difficult to differentiate cohorts in length frequencies (Figure 20). No pattern of sexual differentiation by size has been observed. Nearly all ChesMMAP bluefish are either age-0 or age-1 and in most years the majority of specimens captured are age-0 (Figure 21, Figure 22, Figure 23).

Diet: Diet data presented here are consistent with previous studies in showing that bluefish are highly piscivorous (Figure 24). For the 242 specimens examined, which represent 140 clusters, bay anchovy constitute 39.9% of the diet by weight and 45.7% by number, while spot (18.7% W, 11.8% N) and Atlantic menhaden (9.3% W, 8.5% N) are the other major identifiable fish prey, and all fish species together represent 87.7% by weight and 84.7% by number. Crustaceans (mainly mysids) at 8.8% W and 9.5% N, represent most of the remainder. Small amounts of *Loliguncula* (Atlantic brief) squid (1.4% W, 1.3% N) were present in the diet of observed fish.

Figure 17. Abundance (kg per hectare swept) of bluefish in Chesapeake Bay, 2012.

Table 7. Bluefish geometric mean indices of abundance, by number and biomass, overall and age-0.

Figure 18. Bluefish geometric mean indices of abundance, by number and biomass, for all ages combined and for age-0.

Figure 19. Bluefish ALK for all NEAMAP fall cruises, showing loess smoothed proportions at each 1cm length bin, overlaid on month-specific length frequencies pooled over all years. ALK proportions are adjusted such that the sums of values for each length bin within each month are forced to 1.0. Only used for age 0 for this report.

Figure 20. Bluefish length-frequency in Chesapeake Bay 2002-2012, overall (A) and by sex (B).

Figure 21. Bluefish age-frequency by year, 2002-2011.

Figure 22. Bluefish age-frequency by year, 2002-2011 standardized to 8,000 annual trawl minutes.

Figure 23. Bluefish age-frequency by cruise month, 2002-2011 combined, actual (A) and standardized to 8,000 total annual trawl minutes (B).

Figure 24. Diet composition, expressed as percent by weight (A) and percent by number (B) of bluefish collected during ChesMMAP cruises in 2002-2011 combined.

***Butterfish* (*Peprilus triacanthus*)**

Abundance: Butterfish abundance follows a generally predictable annual pattern, building from near-zero during March, increasing abundance (albeit low) through the spring and summer, and reaching a maximum generally during the September and November cruises (Figure 25).

Abundance indices generally varied without trend between 2002 and 2009 but have remained low from 2010 through 2012s (Table 8, Figure 26). Abundance as measured in other surveys has been increasing so whether the recent low ChesMMAP values represent natural survey variation or a change in availability within Chesapeake Bay will bear future observation.

Age-Length: Experience gained by MRG staff while attempting to assign ages to butterfish collected by ChesMMAP during earlier years, and confirmed by ageing personnel at NEFSC, led to the conclusion that butterfish collected in areas such as Chesapeake Bay cannot generally be aged. Butterfish otoliths have not been regularly collected on ChesMMAP cruises since 2005. Thus, to provide age-specific abundance indices, the ALKs developed from the NEAMAP fall survey data were applied to ChesMMAP length data for the months of September and November (Figure 27). However, it is reasonable to assume that growth rates may differ for specimens captured in Chesapeake Bay compared to the near shore Atlantic, so care must be taken in interpreting these data.

Length and Age: As stated above,this program (and others) has found butterfish extremely difficult to age. We are still investigating methods to obtain accurate age determinations from otolith samples. Yearly length frequency diagrams (Figure 28) appear to reveal at least two year classes of varying strength present in the Chesapeake Bay fish during any given year, however this will require further analysis.

Diet: Analyses of butterfish stomachs from early program years revealed a high percentage of generally unidentifiable gelatinous zooplankton and other unidentifiable items. It was determined that further analyses of butterfish diets was not an efficient use of resources and the decision was made to discontinue preservation and analysis of butterfish stomachs.

Figure 25. Abundance (kg per hectare swept) of butterfish in Chesapeake Bay, 2012.

Table 8. Butterfish geometric mean indices of abundance, by number and biomass, overall and by age-class.

Figure 26. Butterfish geometric mean indices of abundance, by number and biomass, for all ages combined and by age-class.

Figure 27. Butterfish ALK for all NEAMAP fall cruises, showing loess smoothed proportions at each 1cm length bin, overlaid on month-specific length frequencies pooled over all years. ALK proportions are adjusted such that the sums of values for each length bin within each month are forced to 1.0.

Figure 28. Butterfish length-frequency in Chesapeake Bay 2002-2012, overall.

***Kingfish* (*Menticirrhus spp.*)**

The ranges of three closely related species, the northern kingfish (*Menticirrhus saxatilis*), the southern kingfish (*Menticirrhus americanus*), and the gulf kingfish kingfish (*Menticirrhus littoralis*) overlap in Chesapeake Bay. While some specimens are easily separable in the field, many are not. We have therefore adopted the practice of combining all of these specimens into a single category of kingfish (*Menticirrhus spp.*). This practice is consistent with the manner in which these species are landed and reported in the fishery as well.

Abundance: ChesMMAP catches for this species are almost exclusively in regions 4 and 5 (lower bay) and occur throughout the warm weather months and are often high even in November (Figure 29).

Until 2012 it appeared that kingfish had been on a nearly consistent increasing abundance trend throughout the survey years. However, 2012 saw a nearly seven-fold decline in the indices. Geometric means expressed either numerically or in biomass units show the same trend. Age-specific ChesMMAP indices follow similar patterns with generally lower values through 2007, an increasing trend through 2011, with a sharp decrease in 2012 (Table 9, Figure 30).

Age-Length: Preliminary analyses (not presented) revealed that for the purpose of constructing ALKs, data from May and July, and then from September and November cruises could be combined. ChesMMAP captures specimens over a broad enough size/age range that keys (and therefore abundance indices) can be constructed for ages 0 through3+. Very few or no age-0 specimens are captured in May or July so these data are excluded from all analyses, including calculation of indices (Figure 31).

Length and Age: Due to the relatively small number of specimens captured during early survey years and to the overlapping sizes-at-age, it is difficult to interpret length frequencies, though at least two cohorts are apparent in many years (Figure 32). No differential growth patterns between male and female kingfish have been observed.

Specimens between ages 0 and 7 have been captured with most being age-4 or less. Year-classes of high (e.g. 2002) and low (e.g. 2004) abundance do seem to track through the stock from year to year, which indicates consistent survey sampling and otolith analysis. Relatively large numbers of age-0 and age-2 specimens were captured in 2009 but the number of age-3-and-older fish was very small. It is apparent that this species does not fully recruit to the ChesMMAP sampling gear until at least age-1 and perhaps even age-2 (Figure 33, Figure 34).

As stated above, age-0 kingfish generally do not recruit to the survey gear until September and are most abundant in November cruises. Specimens from all age classes are captured during every survey month except March (Figure 35).

Diet: The largest taxa of prey items in kingfish stomachs are crustaceans (44.1% W, 46.6% N), primarily small shrimps and crabs. Molluscs and worms constitute the next largest portions (28.4% W, 26.1%N and 12.2% W, 14.9% N respectively) of the diet, with fishes and several other categories completing the diet (Figure 36).

Figure 29. Abundance (kg per hectare swept) of kingfish in Chesapeake Bay, 2012.

Table 9. Kingfish geometric mean indices of abundance, by number and biomass, overall and by age-class.

Figure 30. Kingfish geometric mean indices of abundance, by number and biomass, for all ages combined and by age-class.

Figure 31. Kingfish ALK for all May/July, and September/Novembers cruises, showing loess smoothed proportions at each 1cm length bin, overlaid on month-specific length frequencies pooled over all years. ALK proportions are adjusted such that the sums of values for each length bin within each month are forced to 1.0

Figure 32. Kingfish length-frequency in Chesapeake Bay 2002-2012, overall (A) and by sex (B).

Figure 33. Kingfish age-frequency by year, 2002-2011.

Figure 34. Kingfish age-frequency by year, 2002-2011 standardized to 8,000 annual trawl minutes.

Figure 35. Kingfish age-frequency by cruise month, 2002-2011 combined, actual (A) and standardized to 8,000 total annual trawl minutes (B).

Figure 36. Diet composition, expressed as percent by weight (A) and percent by number (B) of kingfish collected during ChesMMAP cruises in 2002-2011 combined.

***Northern Puffer* (*Sphoeroides maculatus*)**

Abundance: Typical patterns of abundance for this species in the survey are minimal numbers in spring and early summer, and a peak in abundance during the September and/or November cruises, perhaps as the summer residents are migrating toward offshore wintering grounds. Catches are consistently greatest in regions 4 and 5, though the species is common into region 3 (Figure 37). As catches in the survey are spotty, estimates of abundance for this species are of unknown reliability.

Relative abundance indices from survey data have (both in numbers and biomass) varied without trend between 2002 and 2010, then reached time series high values in 2011 and fell back to time-series low values in 2012 (Table 10, Figure 38).

Length and Age: Specimens between approximately 50mm and 270mm total length have been captured, though most individuals measured between 100mm and 250mm. The length composition varies year to year, likely as a result of varying year-classes entering and leaving the bay stock (Figure 39). However, as this is not a high priority species, ageing has not been completed. The largest individuals captured have generally been females but there appears to be no overall pattern of differential growth between sexes.

Diet: Crustaceans (32.0% W, 34.5% N), primarily small crab species, molluscs (27.5% W, 22.7% N), and worms (7.5% W, 8.2% N), constitute the majority of identifiable items in the stomachs of this species. Unidentifiable material (which makes up most of the 'miscellaneous category) constitutes an appreciable (16.9% W, 20.0% N) portion of prey items examined (Figure 40).

Figure 37. Abundance (kg per hectare swept) of northern puffer in Chesapeake Bay, 2012.

Table 10. Northern puffer geometric mean indices of abundance, by number and biomass, overall.

Figure 38. Northern puffer geometric mean indices of abundance, by number and biomass, for all ages combined.

Figure 39. Northern puffer length-frequency in Chesapeake Bay 2002-2012, overall (A) and by sex (B).

Figure 40. Diet composition, expressed as percent by weight (A) and percent by number (B) of northern puffer collected during ChesMMAP cruises in 2002-2011 combined.

***Scup* (*Stenotomus chrysops*)**

Abundance: Survey catches of scup are typically rare during spring through early summer and nearly always reach a peak in September before declining again in November as fish leave bay waters (Figure

41). The species is most abundant in region 5 and is rarely captured north of region 4. It is important to note that 2007 data are limited due to cancellation of the September cruise. Scup are typically most abundant in shallow strata (10’-30’) and mid-depth strata (30’-50’) and are rarely captured in waters over 50’.

Discerning trends over the time series is problematic due to the difficulty in interpreting 2007 data when the September cruise was cancelled resulting from a budget shortfall. Geometric mean indices for both number and biomass indicate moderate abundance through 2007 then a sharp decline in 2008 followed by a two year upward trend toward a time series high in 2010 followed by another sharp decrease to time series low values in 2011 and 2012 (Table 11, Figure 42).

As nearly all specimens captured by ChesMMAP are either age-0 or age-1, age-specific indices have been developed for only those two age classes (i.e. there is no ‘age-x+’ category). The annual patterns of these indices closely follow those for overall abundance.

Age-Length: Capture rates and distribution of lengths (ages) are both insufficient to develop ChesMMAP-specific ALKs. So, in order to provide age-specific abundance indices, the ALKs developed from the NEAMAP spring and fall surveys data were applied to ChesMMAP length data for the months of July (NEAMAP spring survey data), September and November (NEAMAP fall survey data for both months). While the key provides for age-class separation to age 2+, the ChesMMAP black sea bass length-distributions only allow for calculation of indices for ages 0 and 1 (Figure 43).

Length and Age: Most specimens captured in the survey are less than 200mm fork length and at least two year classes are apparent in length data (Figure 44). Due to the small size and sexual immaturity of the majority of scup sampled by ChesMMAP, sex cannot be determined in the field for large numbers of specimens so sex-specific length frequencies do not display any discernible pattern of differences in sex ratios at size.

Nearly all specimens captured are either age-0 or age-1, so it is difficult to discern whether year-class abundance can be followed through time in age frequency figures (Figure 45, Figure 46). Most research groups that generate age data for this species use scales rather than the otoliths used by ChesMMAP, so scale/otolith comparisons must be completed in coming years. The MRG at VIMS intends to complete scale/otolith comparisons in 2013; sample collections occurred between 2010 and 2012 and ageing of both scales and otoliths has been completed.

Monthly age frequency distributions reveal the patterns of in-migration in spring and out-migration in fall, as well as recruitment of age-0 specimens to the gear beginning in September (Figure 47).

Diet: By weight, worm species constitute a near majority (49.9%) of identifiable items in scup stomachs and represent 25.1% of prey by number (Figure 48). Unidentifiable prey (likely largely constituted of worms and other soft-bodied prey – listed as ‘misc. other’) also make up a large portion (28.2% W, 27.5% N). At 14.6% by weight, crustaceans (primarily mysids and amphipods) are also a major prey source, and at 38.5% represent the largest single taxon in scup diets when measured by number.

Figure 41. Abundance (kg per hectare swept) of scup in Chesapeake Bay, 2012.

Table 11. Scup geometric mean indices of abundance, by number and biomass, overall and by age-class.

Figure 42. Scup geometric mean indices of abundance, by number and biomass, for all ages combined and by age-class .

Figure 43. Scup ALK for all NEAMAP fall cruises, showing loess smoothed proportions at each 1cm length bin, overlaid on month-specific length frequencies pooled over all years. ALK proportions are adjusted such that the sums of values for each length bin within each month are forced to 1.0. Only used for ages 0 and 1 for this report.

Figure 44. Scup length-frequency in Chesapeake Bay 2002-2012, overall (A) and by sex (B).

Figure 45. Scup age-frequency by year, 2002-2007.

Figure 46. Scup age-frequency by year, 2002-2007 standardized to 8,000 annual trawl minutes.

Figure 47. Scup age-frequency by cruise month, 2002-2007 combined, actual (A) and standardized to 8,000 total annual trawl minutes (B).

Figure 48. Diet composition, expressed as percent by weight (A) and percent by number (B) of scup collected during ChesMMAP cruises in 2002-2011 combined.

***Spot* (*Leiostomus xanthurus*)**

Abundance: Spot are typically among the most abundant species in the survey during all cruises except March. Likewise this species is well distributed throughout the bay, though concentrations are highest in regions 4 and 5. Spot appear to invade the bay earlier and remain abundant later in the fall during recent years compared to earlier survey years (Figure 49). Whether this is environmentally driven or a result of other factors is unknown.

Overall abundances for the time series were on a generally rising trend between 2002 and 2006 and have declined sharply since, reaching time-series low values in 2012 (Table 12, Figure 50).

Age-specific indices are given for ages 0 through 2+ though since relatively few specimens older than age-1 are captured, the age-2+ index is of unknown reliability. These indices largely follow the same pattern as described for all ages combined except that the age-1 index reached its peak in 2007 rather than 2006 indicating that the large 2006 year class was still abundant one year later.

Age-Length: Monthly (for July, September, and November) proportions of aged fish for each 1cm length bin for ages 0 through 4+ are given (Figure 51). Very few large age-2 specimens are ever captured during November cruises so for specimens larger than 22cm, age-2 data from September are substituted. During July and September there is broad overlap in size at age for specimens between about 140mm and 200mm. November catches are dominated by age-0 specimens as the older fish have apparently migrated offshore by that time of year.

Length and Age: Individuals between 100mm and 250mm are most common in the survey, with a smaller number of specimens up to 300mm occasionally captured (Figure 52). The largest individuals are most often captured in regions 2 or 3. No pattern of differential growth rates between the sexes is apparent.

Nearly all fish in the survey are either age-0 or age-1 with the oldest fish (5 total specimens) captured at age-4 (Figure 53, Figure 54). As discussed above, even though the age distribution of this species in Chesapeake Bay is not wide, the relative numbers of smaller vs. larger specimens can vary significantly year to year. This likely represents both changes in relative year class strength and the numbers and sizes of specimens invading the bay each year.

Month-specific age frequencies for all years combined reveal the same annual migration patterns described above (Figure 55).

Diet: Not surprisingly, given the bottom-feeding habit of this species, the largest single prey type is 'misc. other' (42.7% W, 42.7% N) which is primarily constituted by unidentified material, followed by worms (31.8% W, 24.3% N) which for the most part were not identifiable to specific taxa. Molluscs (primarily clams) at 12.8% by weight and 10.4% by number, and crustaceans (7.6% W, 18.1% N), principally mysids and amphipods, were also major portions of the diet for spot (Figure 56).

Figure 49. Abundance (kg per hectare swept) of spot in Chesapeake Bay, 2012.

Table 12. Spot geometric mean indices of abundance, by number and biomass, overall and by age-class.

Figure 50. Spot geometric mean indices of abundance, by number and biomass, for all ages combined and by age-class.

Figure 51. Spot ALK for all July, September and Novembers cruises, showing loess smoothed proportions at each 1cm length bin, overlaid on month-specific length frequencies pooled over all years. ALK proportions are adjusted such that the sums of values for each length bin within each month are forced to 1.0

Figure 52. Spot length-frequency in Chesapeake Bay 2002-2012, overall (A) and by sex (B).

Figure 53. Spot age-frequency by year, 2002-2011.

Figure 54. Spot age-frequency by year, 2002-2011 standardized to 8,000 annual trawl minutes.

Figure 55. Spot age-frequency by cruise month, 2002-2011 combined, actual (A) and standardized to 8,000 total annual trawl minutes (B).

Figure 56. Diet composition, expressed as percent by weight (A) and percent by number (B) of spot collected during ChesMMAP cruises in 2002-2011 combined.

***Striped Bass* (*Morone saxatilis*)**

Abundance: Intra-annual patterns of abundance for striped bass typically follow a consistent pattern. Large numbers of spawning migrants are captured during the March cruise, followed by lower numbers in May as the spawners leave the bay. Fewer captures occur in July and September, and higher numbers are encountered again in November as fish school before leaving the bay for offshore wintering grounds. Most striped bass are captured in regions 1 – 3 (Maryland waters) but the species occurs regularly in samples from all bay locations. In March, catches are high in all depth strata, but in other survey months catch rates are greatest in waters less than 50' (Figure 57).

Two sets of abundance indices have been calculated for this species: one using data from the March cruise which assesses abundance of the spring spawning stock, and one using data from November which characterizes the number of summer residents as they school together in the fall.

March abundance for all ages combined, as measured both by number and biomass, was highest in 2004 and 2008, otherwise varying within a fairly narrow range. This pattern generally held for age-specific abundance as well except that for age-1 and age-2 fish 2003 was also a year of high abundance. As most of the specimens captured in March are assumed to be reproductive migrants, it is logical that in years of high overall abundance that all age classes would be present. Spawner abundance has been at low values during 2009 through 2012 (Table 13, Figure 58).

Mean November abundance indices (summer residents) show high values in 2004 (more so in numbers than in biomass) and 2006. In 2011 and 2012 abundance turned upwards to mid-level values after a brief decline over the preceding two years. Again the same general pattern is seen in age-specific indices though variations do exist. The uptick in 2011 and 2012 appears to be due mainly to a larger number of age-2, and to a lesser degree age-1, specimens captured (Table 14, Figure 59).

Age-Length: Monthly (for March and November) proportions of aged fish for each 1cm length bin for ages 1 through 4+ are given (Figure 60). Relatively few age-1 specimens are ever captured during March cruises, likely due both to their absence from the survey area and to their failure to recruit to the survey gear. In the middle of the size range other age classes overlap substantially but length-frequency peaks tend to coincide with peaks in the ALKs.

Length and Age: Most specimens captured in the survey are about 600mm fork length or less (ages 1 – 7). The largest individuals approach 1000mm and are captured during spring spawning. Due to the relatively long-lived nature of this species, the varying life history scenarios for different portions of the stock and associated variable growth rates, along with variable young-of-year recruitment, it is difficult to differentiate year-classes within length-frequency histograms (Figure 61). However, age distribution figures (Figure 62, Figure 63) readily reveal year-class strength (high peaks during one year tend to follow into succeeding years, as do low abundances) and this phenomenon is being used in an attempt to validate results of young-of-year seine surveys. The largest fish captured tend to be migrating females and many ‘resident’ male fish are captured up to about 50cm. The oldest specimens yet sampled by the survey, both age-20 were captured in 2008 and 2010 (1988 and 1990 year classes, respectively). Age-frequencies by cruise month reveal the typical pattern of higher survey catch rates in March and November and lower, but still appreciable, catches in between. The oldest fish are typically captured during the March spawning season. Striped bass appear to be fully recruited to the survey gear by age-1 (Figure 64).

Diet: Results of diet analyses from this study differ appreciably from previous studies using specimens from Chesapeake Bay (Figure 65). Fish comprise the largest taxonomic group in the diet by weight (42.6%), but rank second to crustaceans by number (29.1% W vs. 45.5% N) due to consumption of a large number of small bodied mysids and amphipods. Among fish species, this survey consistently finds that bay anchovy contributes the highest proportion by weight (16.9%) with Atlantic menhaden second (9.5%). Mysids and amphipods combined constitute 22.4% by weight and 37.8% by number, a sharp contrast to previous studies; and worms make up the only other major prey type (15.8% W, 11.7% N). These differences from previous diet studies are likely the result both of sampling methodological differences (the broad temporal and geographic scale of ChesMMAP as well as the trawl gear used compared to many studies which were limited in temporal or geographical scale or which use capture methodologies which yield a narrower size range) and analytical/mathematical differences in calculating percentages in the diet. In brief, this study calculates fish diets using cluster-sampling theory and analytical methods whereas previous studies are thought to have used the assumption of simple random sampling of fish. The cluster method moderates the effect of a relatively small number of large predator specimens with large prey in the stomachs (e.g. Atlantic menhaden) as compared to a large number of smaller specimens with a significantly different diet.

Figure 57. Abundance (kg per hectare swept) of striped bass in Chesapeake Bay, 2012.

Table 13. Striped bass (March) geometric mean indices of abundance, by number and biomass, overall and by age-class.

Figure 58. Striped bass (March) geometric mean indices of abundance, by number and biomass, for all ages combined and by age-class.

Table 14. Striped bass (November) geometric mean indices of abundance, by number and biomass, overall and by age-class.

Figure 59. Striped bass (November) geometric mean indices of abundance, by number and biomass, for all ages combined and by age-class.

Figure 60. Striped bass ALK for all March and Novembers cruises, showing loess smoothed proportions at each 1cm length bin, overlaid on month-specific length frequencies pooled over all years. ALK proportions are adjusted such that the sums of values for each length bin within each month are forced to 1.0

Figure 61. Striped bass length-frequency in Chesapeake Bay 2002-2012, overall (A) and by sex (B).

Figure 62. Striped bass total age-frequency, 2002-2012.

Figure 63. Striped bass age-frequency by year, 2002-2012 standardized to 8,000 annual trawl minutes.

Figure 64. Striped bass age-frequency by cruise month, 2002-2012 combined, actual (A) and standardized to 8,000 total annual trawl minutes (B).

Figure 65. Diet composition, expressed as percent by weight (A) and percent by number (B) of striped bass collected during ChesMMAP cruises in 2002-2011 combined.

***Summer Flounder* (*Paralichthys dentatus*)**

Abundance: The typical intra-annual pattern of numerical abundance for summer flounder shows catches increasing monthly throughout the sample year, with highest catches in September and/or November (Figure 66). Summer flounder are most abundant in regions 4 and 5 but are common in regions 2 and 3 as well. A slightly higher catch rate is exhibited for mid-depth (30' – 50') and deep (>50') stations than in shallow (10' – 30') waters. The highest catches of summer flounder often occur along the eastern portions of regions 4 and 5 but this is not an absolute.

Abundance indices have varied considerably over the time but exhibit a consistent downward trend since 2006, reaching a time series low in 2012. This is in contrast to what is thought to be a generally increasing stock size coastwide and so ChesMMAP catches may reflect a varying pattern of migrations (Table 15, Figure 67).

Age-specific indices were calculated for ages 0 through 4+. The coastal stock assessment currently uses data for ages 0 through 7+ but as ChesMMAP captures relatively few individuals older than age-4 or age-5, the 4+ group has been used here. Age-0 fish reached time series high values in 2006 and 2007 while most other year classes were most abundant one or two years earlier. As these abundant young of year do not seem to result in higher abundance one or two years later perhaps specific individuals of this species do not reinvade the Chesapeake Bay each year.

Age-Length: Monthly (for September and November) proportions of aged fish for each 1cm length bin for ages 1 through 4+ are given (Figure 68). Comparing monthly length-frequencies to the ALKs reveals that the largest share of summer flounder in Chesapeake Bay are age-0. This is especially true in November when most of the older fish have apparently migrated offshore. Large measures of size overlap among age classes are apparent. These keys are in good agreement with similar estimates published elsewhere (e.g. http://www.odu.edu/sci/cqfe/Research/Chesapeake%20Bay/Summer%20flounder/Summer%20flounder.htm).

Length and Age: Fish which measure between approximately 200mm and 500mm total length are most prevalent in survey samples though fish as large as 760mm have been captured (Figure 69). In several years a large number of fish under 300mm (mostly age-0) can be differentiated in length-frequency graphs. This species is known to exhibit sexually dimorphic growth patterns (Dery 1981) and this is demonstrated in the sex-specific length plots. The vast majority of ChesMMAP specimens larger than 35cm and nearly all individuals larger than 40cm are females.

Most fish in the survey are age-5 and under, and the oldest fish yet captured are three specimens at age-12. In age classes older than age-2 it appears to be more difficult, compared to other species, to follow abundance trends of particular year classes in successive years (Figure 70, Figure 71). This could be the result of differential migration patterns among different sized fish or of fishery preferences and/or regulations.

Monthly age-frequency figures reveal the aforementioned pattern of age-0 summer flounder increasingly recruiting to the survey gear throughout the year, reaching peak abundance in November (Figure 72). Other age classes are generally present throughout the survey year, though as previously described, older/larger individuals tend to disappear from the survey area in November.

Diet: As measured by percent weight, fish comprise a slight majority (52.4%) of summer flounder diets in the survey, with the primary prey being bay anchovy (17.6%), weakfish (9.5%), and spot (8.2%) (Figure 73) with crustaceans (43.8%) only slightly lower; as measured by number, crustaceans constitute nearly two-thirds of the diet (63.3%) with the main prey types being mysids (47.2%), sand shrimp (6.9%), and mantis shrimp (4.9%). The high prevalence of fish in summer flounder stomachs, especially for larger individuals, leads to the conclusion that this species should be considered a top predator in Chesapeake Bay along with striped bass, bluefish, and weakfish (Latour et al. 2008). It is noteworthy that by percent weight as measured by this survey, in Chesapeake Bay summer flounder are more highly piscivorous than are striped bass and are nearly on par with weakfish in this characteristic.

Figure 66. Abundance (kg per hectare swept) of striped bass in Chesapeake Bay, 2012.

Table 15. Summer flounder geometric mean indices of abundance, by number and biomass, overall and by age-class.

Figure 67. Summer flounder geometric mean indices of abundance, by number and biomass, for all ages combined and by age-class.

Figure 68. Summer flounder ALK for all September and Novembers cruises, showing loess smoothed proportions at each 1cm length bin, overlaid on month-specific length frequencies pooled over all years. ALK proportions are adjusted such that the sums of values for each length bin within each month are forced to 1.0

Figure 69. Summer flounder length-frequency in Chesapeake Bay 2002-2012, overall (A) and by sex (B).

Figure 70. Summer flounder total age-frequency, 2002-2012.

Figure 71. Summer flounder age-frequency by year, 2002-2012 standardized to 8,000 annual trawl minutes.

Figure 72. Summer flounder age-frequency by cruise month, 2002-2012 combined, actual (A) and standardized to 8,000 total annual trawl minutes (B).

Figure 73. Diet composition, expressed as percent by weight (A) and percent by number (B) of striped bass collected during ChesMMAP cruises in 2002-2011 combined.

Weakfish (Cynoscion regalis)

Abundance: Weakfish is among the most abundant species in survey samples over most seasons and locations. Catches are typically low in March but by May fish have begun to migrate into the bay and remain abundant in the survey throughout the rest of the year. Peak catches are usually in September and decline somewhat in November as fish begin their late fall migration out of the bay (Figure 74). Catches are typically higher in mid-depth (30' – 50') and deep (>50') stations than at shallow ones (10' – 30').

Consistent with recent coast wide trends (ASMFC Weakfish Technical Committee, 2009), overall abundance for this species increased between 2002 and 2005 and then steadily declined over the next several years. However, after reaching a time series low in 2008 a slight upward tick was found in the successive two years but a sharp decline was seen again in 2011 and 2012 (Table 16, Figure 75). As the vast majority of weakfish sampled by ChesMMAP (and presumably present in the bay) in recent years have been either age-0 or age-1, the age specific abundances for these age classes tends to follow the same pattern as the overall indices.

Age-Length: Monthly (for September and November) proportions of aged fish for each 1cm length bin for ages 1 through 2+ are given (Figure 76). Peaks in length frequencies are generally in good agreement with the ALKs, especially for age-0 fish. Age-1 and older weakfish seem to be displaying atypical accelerated growth patterns, perhaps to fill a void left by the consistent lack in older/larger fish over several consecutive years. This lack of older/larger specimens is of serious concern to managers

Length and Age: Most weakfish captured by the survey are between 100mm and 350mm total length. Minimum and maximum sizes found during the survey are 23mm and 616mm respectively (Figure 77). With only a few exceptions, most fish captured over 400mm were sampled during the first two years of the survey (2002 and 2003). Likewise, the age structure of Chesapeake Bay weakfish has compressed over the past several years, with few individuals older than age-2 captured in recent years and almost none older than age-3 (Figure 78, Figure 79). In this survey, and others, each sampling year seems to result in (what appear to be) reasonable numbers of young fish but very few of these specimens are captured in successive years as older fish.

Few weakfish are captured during March cruises but in other survey months each age class (in this age-compressed stock) seem to be well represented in survey tows. Age-0 weakfish appear to recruit to the survey gear during September and November (Figure 80).

Diet: Fish (57.9%), primarily bay anchovy (35.5%), comprise a majority of prey types in the weakfish diet as measured by biomass ingested (Figure 81). Notably, weakfish account for 4.2% of prey in the diet of weakfish, by weight. Similar to summer flounder, as measured by number, crustaceans dominate the diet of weakfish in Chesapeake Bay (62.5%), dominated by mysids at 53.5%. Bay anchovy are 20.5% of the diet by number. The relatively low percent of Atlantic menhaden seen in the survey stomach samples (2.7% W, 1.2% N), when compared to earlier studies, may be due to the truncation of the size range of weakfish in Chesapeake Bay as well as the broad geographic and temporal scale of this survey and due to the cluster sampling analytical methodology as explained for striped bass above.

Figure 74. Abundance (kg per hectare swept) of weakfish in Chesapeake Bay, 2012.

Table 16. Weakfish geometric mean indices of abundance, by number and biomass, overall and by age-class.

Figure 75. Weakfish geometric mean indices of abundance, by number and biomass, for all ages combined and by age-class.

Figure 76. Weakfish ALK for all September and Novembers cruises, showing loess smoothed proportions at each 1cm length bin, overlaid on month-specific length frequencies pooled over all years. ALK proportions are adjusted such that the sums of values for each length bin within each month are forced to 1.0

Figure 77. Weakfish length-frequency in Chesapeake Bay 2002-2012, overall (A) and by sex (B).

Figure 78. Weakfish total age-frequency, 2002-2012.

Figure 79. Weakfish age-frequency by year, 2002-2012 standardized to 8,000 annual trawl minutes.

Figure 80. Weakfish age-frequency by cruise month, 2002-2012 combined, actual (A) and standardized to 8,000 total annual trawl minutes (B).

Figure 81. Diet composition, expressed as percent by weight (A) and percent by number (B) of weakfish collected during ChesMMAP cruises in 2002-2011 combined.

White Perch (Morone americana)

Abundance: White perch are extremely abundant in survey samples throughout each year in regions 1 and 2 and are common into region 3 (Figure 82). Due to this species' concentration in the shallow waters of region 1, catches are highest in the shallowest strata (10' – 30'), followed by the mid-depth strata (30' – 50'), with this species rarely seen in samples from the deepest stations (>50'). Interpretation of abundance indices for this species must account for the fact that ChesMMAP samples only a portion of the range of the species and catches can be significantly influenced by salinity.

As with striped bass, indices of abundance are presented for both the spring (March) spawning population and for the fall (November) when fish again school together. Interestingly, these two sets of indices show nearly opposing trends in abundance. The March indices (Table 17, Figure 83), measured either by number or biomass, show relatively flat abundance in all years except for peak values (about 4-5 times higher than other values) in 2007 and 2008. Meanwhile, the November indices (Table 18, Figure 84) fluctuate without trend through 2006, and then reach time series lows in 2007 and 2008, followed by a steady upward trend with a distinct decline in 2012. If it is assumed that the peaks in March abundance in 2007 and 2008 reflected a high abundance of spawners then it could well make sense that the stock increased for several of the following years.

Age-Length: While a number of white perch age classes are sampled by ChesMMAP, age-specific abundances have not been calculated for this segment report. The large number of overlapping age-classes at any given size makes development of ALKs computationally challenging (i.e. the loess smoothing algorithm cannot converge on a solution). ChesMMAP investigators hope to address this issue for future reports.

Length and Age: All white perch of sizes greater than approximately 150mm fork length are well sampled in the survey (Figure 85). Due to the relatively small maximum size, long life, and slow growth rates it is difficult to separate year-classes of this species using length-frequency. The peak of abundance in 2007 and 2008 samples was at a smaller size than during previous years. It appears that more females are sampled by ChesMMAP than are males and that females reach a slightly larger maximum size than to males.

This species is not well sampled by the survey until approximately age-2 or 3 (Figure 86, Figure 87); however past that age the survey appears to adequately represent all age classes. Specimens as old as 18 years have been captured. The species age distribution appears to be regulated by the relative success of each year-class. Year-class specific peaks in abundance can be easily followed during successive years in survey samples (e.g., 1993, 1996, 2000, 2003 year-classes).

As would typically be expected, monthly age frequency plots for several species presented in this report show a generally declining number of specimens at each age class within any given month (e.g Atlantic croaker as shown in Figure 7B). Presumably due to their longevity and to highly variable year-class strength, this pattern is not present for white perch (Figure 88). The number of specimens captured at each age class within any given cruise month generally displays no particular pattern. All age-classes are present in survey catches during each cruise month, with younger/smaller evidently recruiting to the gear as each year progresses.

Diet: While unidentified material (which largely constitutes the 'misc' prey category) represents the largest single prey category by weight in white perch stomachs, crustaceans (32.2% W, 46.4% N) constitute the largest identifiable taxon with amphipods (15.7% W, 26.0% N) as the primary prey, followed by a number of other small crustacean prey. Worms (25.2% W, 16.9% N), primarily *Nereis* clam worms (13.7% W, 9.0% N) and other polychaetes (10.2% W, 7.0% N), are the second most abundant prey, followed by a variety of mollusc species, primarily bivalves (15.4% W, 13.2% N). Notably, a small number of bay anchovy (3.2% W, 2.1% N) are present in white perch stomachs (Figure 89).

Figure 82. Abundance (kg per hectare swept) of white perch in Chesapeake Bay, 2012.

Table 17. White perch (March) geometric mean indices of abundance, by number and biomass, overall.

Figure 83. White perch (March) geometric mean indices of abundance, by number and biomass, for all ages combined and by age-class.

Table 18. White perch (November) geometric mean indices of abundance, by number and biomass, overall.

Figure 84. White perch (November) geometric mean indices of abundance, by number and biomass, for all ages combined and by age-class.

Figure 85. White perch length-frequency in Chesapeake Bay 2002-2012, overall (A) and by sex (B).

Figure 86. White perch total age-frequency, 2002-2011.

Figure 87. White perch age-frequency by year, 2002-2011 standardized to 8,000 annual trawl minutes.

Figure 88. White perch age-frequency by cruise month, 2002-2011 combined, actual (A) and standardized to 8,000 total annual trawl minutes (B).

Figure 89. Diet composition, expressed as percent by weight (A) and percent by number (B) of white perch collected during ChesMMAP cruises in 2002-2011 combined.

<u>Water Quality</u>

Figure 90. Interpolated bottom water temperatures in Chesapeake Bay, by cruise, for 2012 (A), and deviations from averages for all previous monthly cruises (B).

Figure 91. Interpolated bottom salinities in Chesapeake Bay, by cruise, for 2012 (A), and deviations from averages for all previous monthly cruises (B).

Figure 92. Interpolated bottom dissolved oxygen in Chesapeake Bay, by cruise, for 2012 (A), and deviations from averages for all previous monthly cruises (B).

Figure 93. Interpolated bi-monthly water temperature profiles in Chesapeake Bay, 2012 (no March cruise).

Figure 94. Interpolated bi-monthly salinity profiles in Chesapeake Bay, 2012 (no March cruise).

Figure 95. Interpolated bi-monthly dissolved oxygen profiles in Chesapeake Bay, 2012 (no March cruise, no November data due to equipment malfunction).

Task 5 – Continue evaluation of alternative sampling gear

As noted in the 'Methods' section above, field trials of the 200 x 12cm trawl/#2 Bison door combination began on September 5, 2010 in the lower Chesapeake Bay, approximately 2nm west of Kiptopeake, VA. However, due to the circumstances already previously explained (Methods, Task 5), the two days of further testing that was scheduled during this segment was deferred due to significant vessel-related issues. ChesMMAP investigators still plan to change to the half-size 'NEAMAP style' net and that change now has a clear path towards implementation.

Appendix

Abundance data summaries for a selection of common species which are not considered as recreational species for funding and management purposes are provided in the Appendix. The species are blue crab – males and mature females separately, and clearnose skate

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Figure 1. Abundance (kg per hectare swept) of Atlantic croaker in Chesapeake Bay, 2012.

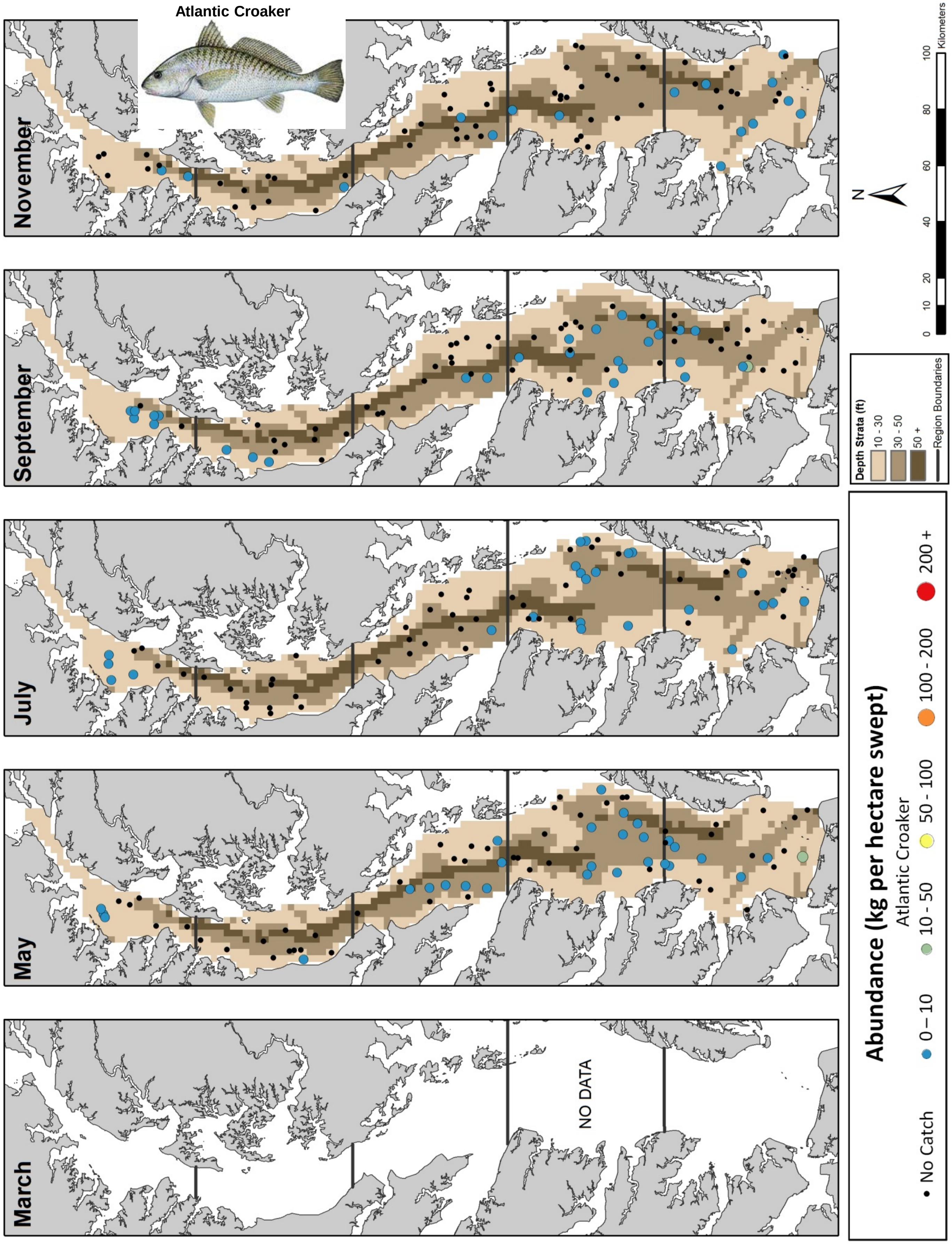


Table 5. Atlantic croaker geometric mean indices of abundance, by number and biomass, overall and by age-class.

Year	Age	n	Numerical Index			Biomass Index		
			LCI	**Index**	UCI	LCI	**Index**	UCI
2002	All	70	91.6	**243.5**	644.7	17.8	**34.1**	64.5
2003		48	191.2	**512.0**	1,367.9	27.6	**49.4**	87.8
2004		77	1,441.4	**2,687.7**	5,011.0	105.6	**154.8**	226.7
2005		77	751.0	**1,488.4**	2,949.0	57.6	**89.7**	139.5
2006		74	521.4	**1,143.3**	2,505.4	149.7	**293.4**	574.4
2007		52	789.1	**2,074.0**	5,448.3	179.9	**412.2**	942.4
2008		76	44.7	**108.0**	258.9	12.9	**25.1**	48.2
2009		52	230.3	**557.1**	1,345.3	42.9	**85.6**	169.5
2010		78	47.4	**104.8**	230.5	11.6	**21.4**	38.6
2011		78	55.1	**124.6**	280.4	13.2	**24.9**	46.5
2012		78	14.3	**34.3**	80.6	3.8	**7.2**	13.1
2013								
2014								
2015								
2016								
2002	0	70	4.8	**12.0**	27.9	1.1	**2.2**	3.7
2003		48	7.9	**15.4**	29.4	0.7	**1.1**	1.7
2004		77	4.4	**9.5**	19.4	0.8	**1.5**	2.3
2005		77	10.7	**23.5**	50.6	1.0	**1.7**	2.7
2006		74	16.0	**34.4**	73.1	4.2	**7.6**	13.5
2007		52	18.4	**41.8**	93.6	4.3	**8.3**	15.4
2008		76	10.3	**24.1**	54.4	2.8	**5.2**	9.1
2009		52	62.6	**141.3**	317.7	11.5	**20.7**	36.7
2010		78	12.5	**26.0**	53.0	3.2	**5.5**	9.1
2011		78	18.8	**38.8**	79.1	4.4	**7.6**	12.7
2012		78	9.4	**22.3**	51.1	2.3	**4.4**	7.8
2013								
2014								
2015								
2016								
2002	1	70	22.4	**49.7**	108.6	3.4	**5.4**	8.4
2003		48	66.8	**169.4**	427.1	8.0	**13.0**	20.7
2004		77	144.8	**262.1**	473.7	6.7	**9.1**	12.3
2005		77	66.1	**140.0**	295.4	4.8	**7.5**	11.5
2006		74	95.2	**196.1**	402.7	23.3	**41.3**	72.8
2007		52	204.2	**586.6**	1,682.1	45.3	**107.0**	250.9
2008		76	15.1	**31.9**	66.0	4.3	**7.7**	13.4
2009		52	71.8	**169.2**	396.9	14.3	**28.7**	56.5
2010		78	24.4	**50.4**	103.2	5.8	**10.3**	17.8
2011		78	26.9	**58.0**	123.6	6.7	**12.3**	21.7
2012		78	4.1	**8.8**	17.7	1.1	**2.2**	3.7
2013								
2014								
2015								
2016								

Year	Age	n	Numerical Index			Biomass Index		
			LCI	**Index**	UCI	LCI	**Index**	UCI
2002	2	70	30.1	**67.0**	148.0	5.2	**8.6**	13.8
2003		48	52.5	**125.9**	300.1	6.5	**10.1**	15.3
2004		77	270.1	**508.7**	957.3	15.8	**21.8**	29.9
2005		77	125.9	**234.7**	436.5	8.2	**11.5**	15.8
2006		74	95.7	**188.0**	368.5	25.7	**45.9**	81.2
2007		52	200.5	**511.7**	1,303.2	44.8	**99.0**	217.5
2008		76	9.4	**18.7**	36.2	2.9	**5.3**	9.1
2009		52	28.7	**63.8**	140.5	7.3	**13.9**	25.8
2010		78	11.1	**21.4**	40.5	3.0	**5.2**	8.7
2011		78	12.9	**25.5**	49.4	3.4	**6.0**	10.1
2012		78	1.7	**3.5**	6.5	0.6	**1.1**	1.9
2013								
2014								
2015								
2016								
2002	3	70	22.4	**51.3**	115.5	5.4	**9.3**	15.7
2003		48	40.4	**94.6**	220.0	5.7	**8.9**	13.6
2004		77	239.7	**461.7**	888.4	20.2	**28.5**	40.2
2005		77	119.5	**225.7**	425.3	11.2	**16.3**	23.4
2006		74	67.2	**139.5**	288.1	24.1	**45.5**	85.2
2007		52	142.7	**341.1**	813.4	36.4	**77.3**	162.8
2008		76	4.8	**9.7**	18.6	1.9	**3.7**	6.4
2009		52	14.6	**29.6**	59.1	4.3	**7.9**	13.9
2010		78	5.2	**9.8**	17.8	1.8	**3.1**	4.9
2011		78	5.6	**10.8**	20.0	1.7	**3.1**	5.2
2012		78	0.9	**1.9**	3.5	0.4	**0.8**	1.3
2013								
2014								
2015								
2016								
2002	4+	70	20.8	**48.6**	111.7	6.3	**11.7**	21.2
2003		48	30.7	**74.1**	176.5	6.1	**11.3**	20.0
2004		77	308.7	**594.9**	1,145.8	43.7	**68.6**	107.6
2005		77	170.3	**331.1**	642.8	26.2	**41.8**	66.4
2006		74	70.1	**154.7**	340.0	30.2	**62.5**	128.2
2007		52	103.0	**243.7**	574.7	35.7	**75.6**	158.8
2008		76	3.4	**6.9**	13.2	1.6	**3.1**	5.5
2009		52	6.7	**13.5**	26.2	2.3	**4.5**	8.0
2010		78	2.8	**5.0**	8.6	1.1	**1.9**	2.9
2011		78	2.3	**4.4**	8.0	0.8	**1.6**	2.7
2012		78	0.6	**1.3**	2.2	0.3	**0.5**	0.8
2013								
2014								
2015								
2016								

Figure 2. Atlantic croaker geometric mean indices of abundance, by number and biomass, for all ages combined and by age-class.

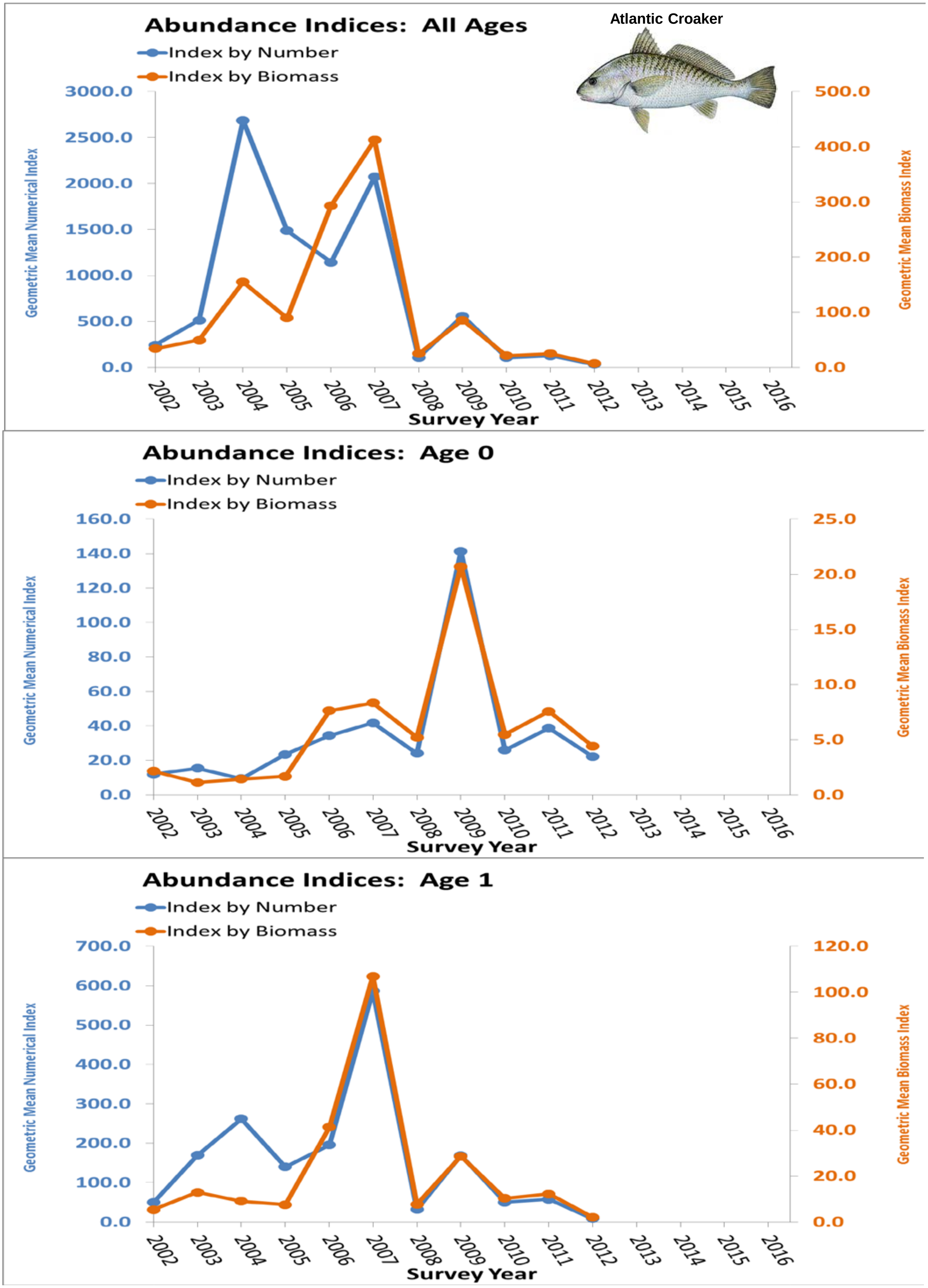


Figure 2. cont.

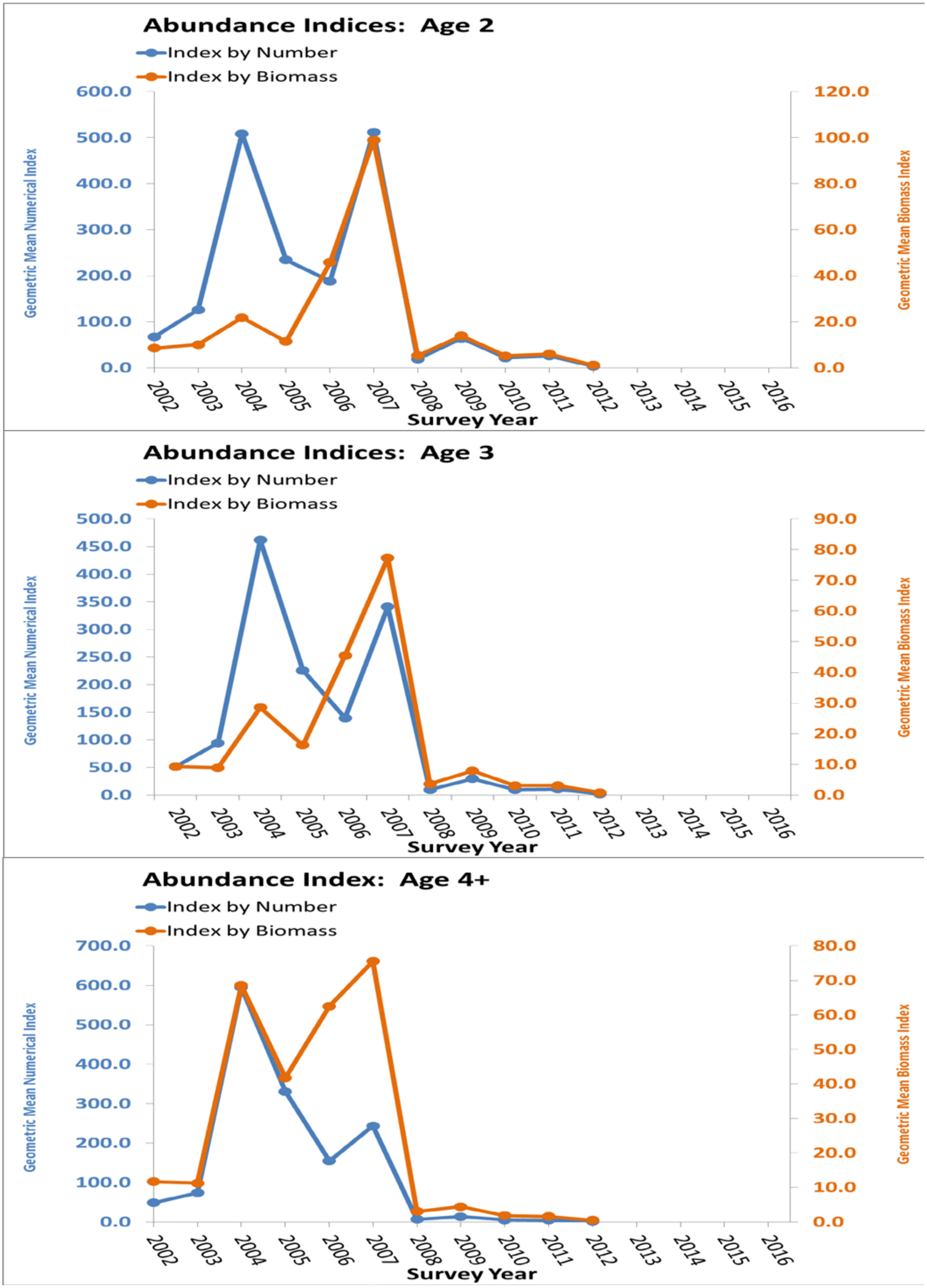
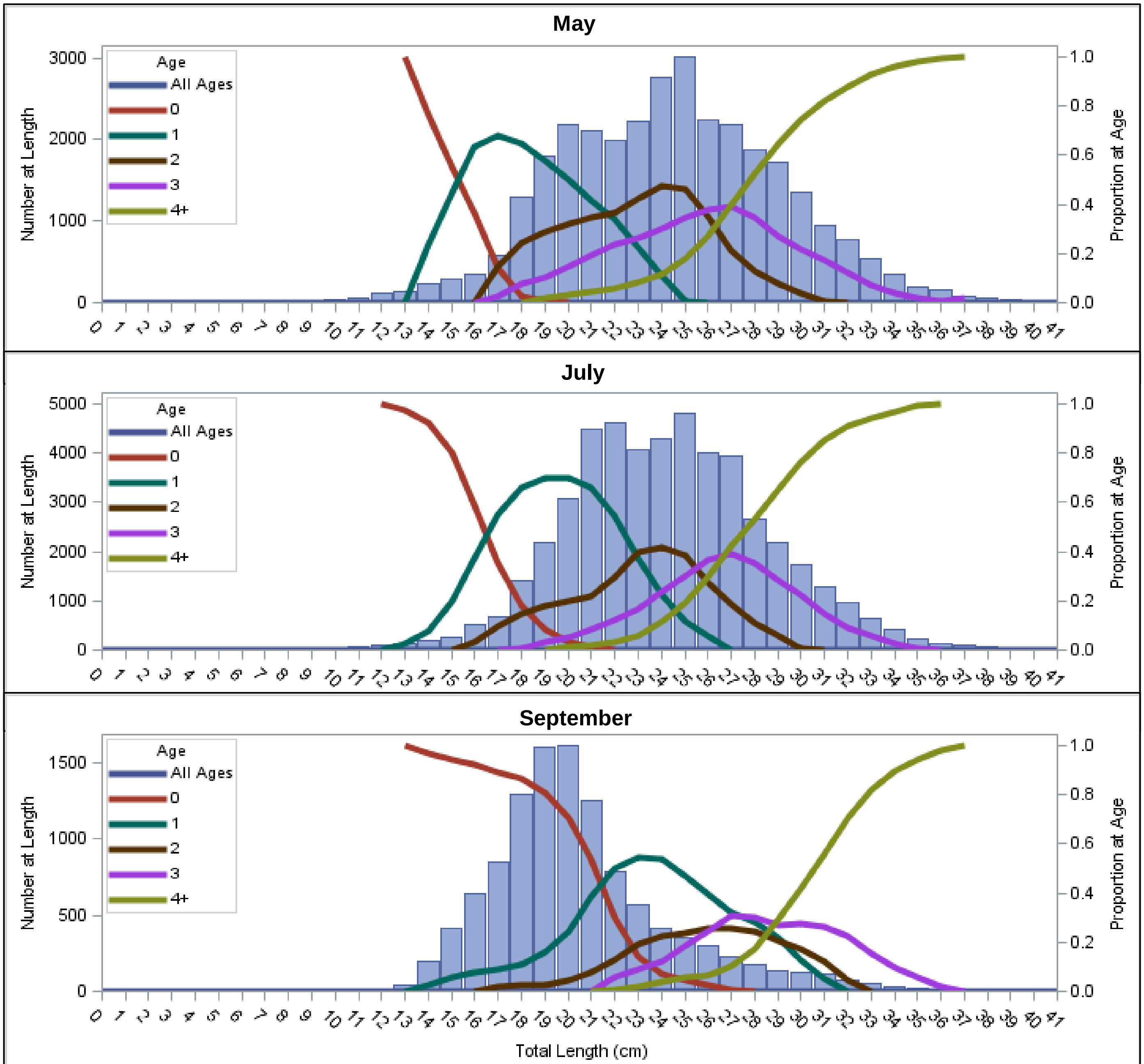


Figure 3. Atlantic croaker ALK for all May, July, and September cruises, showing loess smoothed proportions at each 1cm length bin, overlaid on month-specific length frequencies pooled over all years. ALK proportions are adjusted such that the sums of values for each length bin within each month are forced to 1.0



May						
Length (cm)	Age-0	Age-1	Age-2	Age-3	Age-4+	Sum
10						
11						
12						
13	1.000	0.000				1.000
14	0.763	0.237				1.000
15	0.550	0.450				1.000
16	0.364	0.636	0.000	0.000		1.000
17	0.140	0.680	0.150	0.030		1.000
18	0.030	0.650	0.245	0.075	0.000	1.000
19	0.007	0.575	0.292	0.106	0.019	1.000
20	0.000	0.501	0.319	0.147	0.033	1.000
21		0.415	0.344	0.193	0.047	1.000
22		0.340	0.363	0.235	0.062	1.000
23		0.227	0.425	0.265	0.083	1.000
24		0.108	0.474	0.301	0.117	1.000
25		0.010	0.463	0.347	0.181	1.000
26		0.000	0.350	0.380	0.270	1.000
27			0.210	0.391	0.399	1.000
28			0.132	0.344	0.524	1.000
29			0.080	0.270	0.650	1.000
30			0.038	0.220	0.742	1.000
31			0.010	0.173	0.817	1.000
32			0.000	0.120	0.880	1.000
33				0.074	0.926	1.000
34				0.041	0.959	1.000
35				0.021	0.979	1.000
36				0.010	0.990	1.000
37				0.000	1.000	1.000
38						
39						
40						

July						
Length (cm)	Age-0	Age-1	Age-2	Age-3	Age-4+	Sum
10						
11						
12	1.000	0.000				1.000
13	0.975	0.025				1.000
14	0.925	0.075				1.000
15	0.801	0.199	0.000			1.000
16	0.593	0.374	0.033			1.000
17	0.351	0.552	0.097	0.000		1.000
18	0.179	0.662	0.149	0.010		1.000
19	0.085	0.700	0.180	0.035	0.000	1.000
20	0.032	0.700	0.200	0.054	0.015	1.000
21	0.017	0.663	0.218	0.082	0.020	1.000
22	0.000	0.547	0.293	0.125	0.035	1.000
23		0.372	0.397	0.169	0.062	1.000
24		0.227	0.419	0.238	0.116	1.000
25		0.117	0.386	0.303	0.193	1.000
26		0.060	0.275	0.369	0.296	1.000
27		0.000	0.188	0.390	0.422	1.000
28			0.113	0.355	0.532	1.000
29			0.059	0.285	0.656	1.000
30			0.010	0.227	0.763	1.000
31			0.000	0.151	0.849	1.000
32				0.090	0.910	1.000
33				0.060	0.940	1.000
34				0.030	0.970	1.000
35				0.010	0.990	1.000
36				0.000	1.000	1.000
37						
38						
39						
40						

September						
Length (cm)	Age-0	Age-1	Age-2	Age-3	Age-4+	Sum
10						
11						
12						
13	1.000	0.000				1.000
14	0.970	0.030				1.000
15	0.944	0.056				1.000
16	0.921	0.079	0.000			1.000
17	0.888	0.089	0.023			1.000
18	0.863	0.111	0.026			1.000
19	0.809	0.161	0.030			1.000
20	0.708	0.244	0.048			1.000
21	0.538	0.383	0.079	0.000	0.000	1.000
22	0.305	0.498	0.131	0.056	0.010	1.000
23	0.145	0.547	0.191	0.093	0.023	1.000
24	0.072	0.541	0.223	0.126	0.037	1.000
25	0.046	0.467	0.240	0.190	0.058	1.000
26	0.030	0.400	0.256	0.247	0.067	1.000
27	0.009	0.324	0.258	0.306	0.103	1.000
28	0.000	0.280	0.244	0.301	0.174	1.000
29		0.220	0.209	0.273	0.298	1.000
30		0.130	0.176	0.274	0.420	1.000
31		0.052	0.124	0.266	0.557	1.000
32		0.000	0.068	0.228	0.704	1.000
33			0.020	0.157	0.823	1.000
34			0.000	0.100	0.900	1.000
35				0.060	0.940	1.000
36				0.020	0.980	1.000
37				0.000	1.000	1.000
38						
39						
40						

Figure 4. Atlantic croaker length-frequency in Chesapeake Bay 2002-2012, overall (A) and by sex (B).

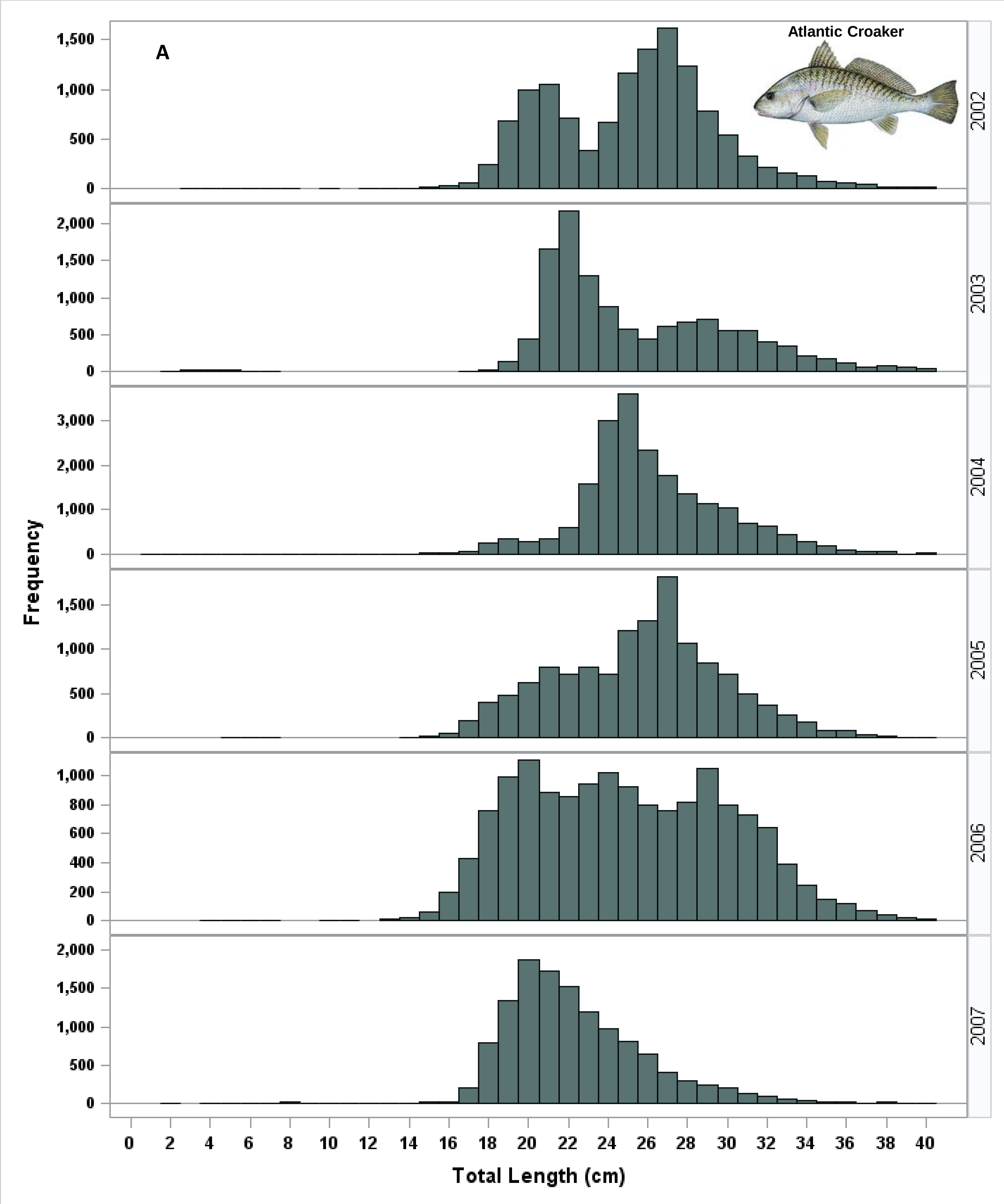


Figure 4. continued.

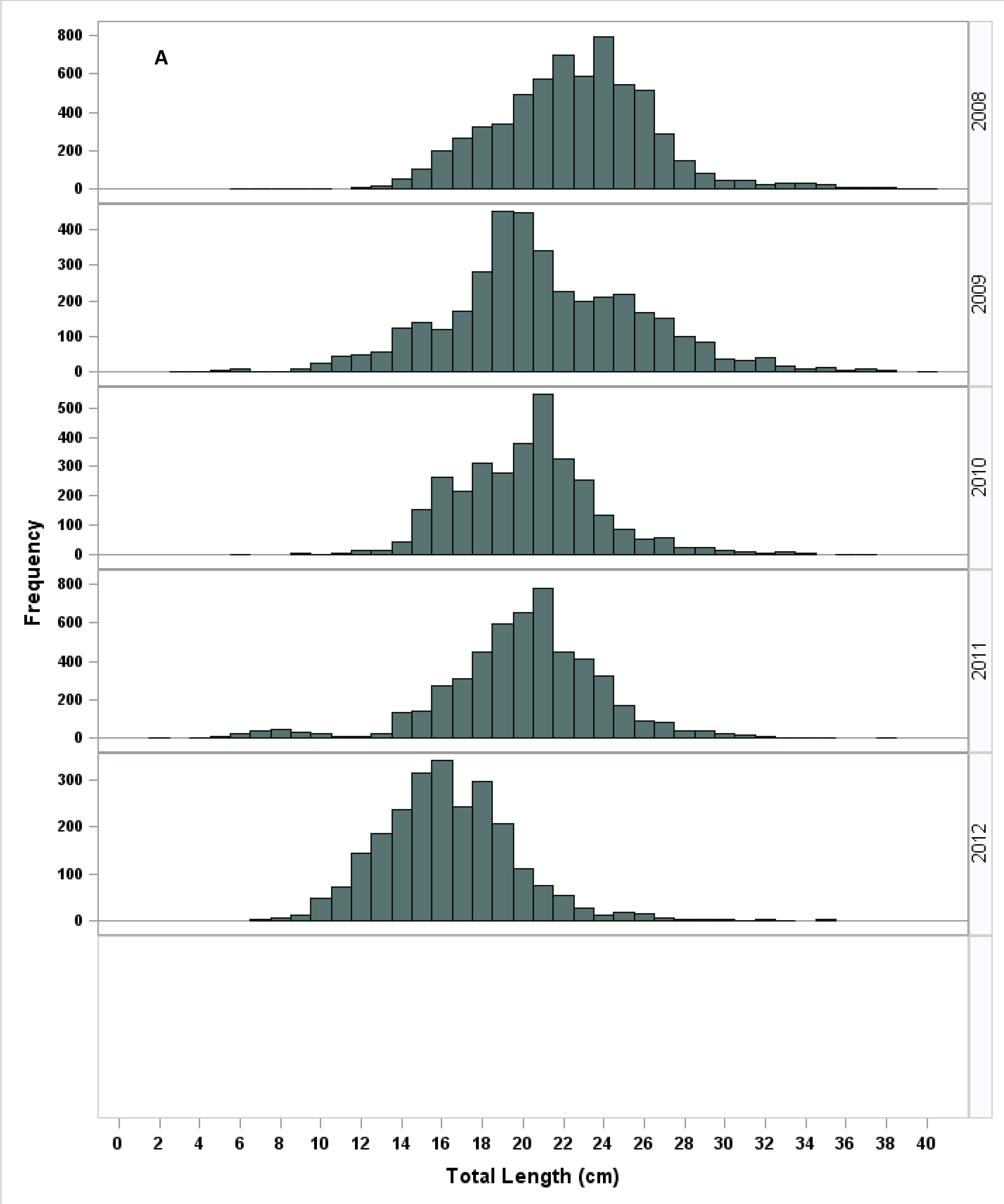
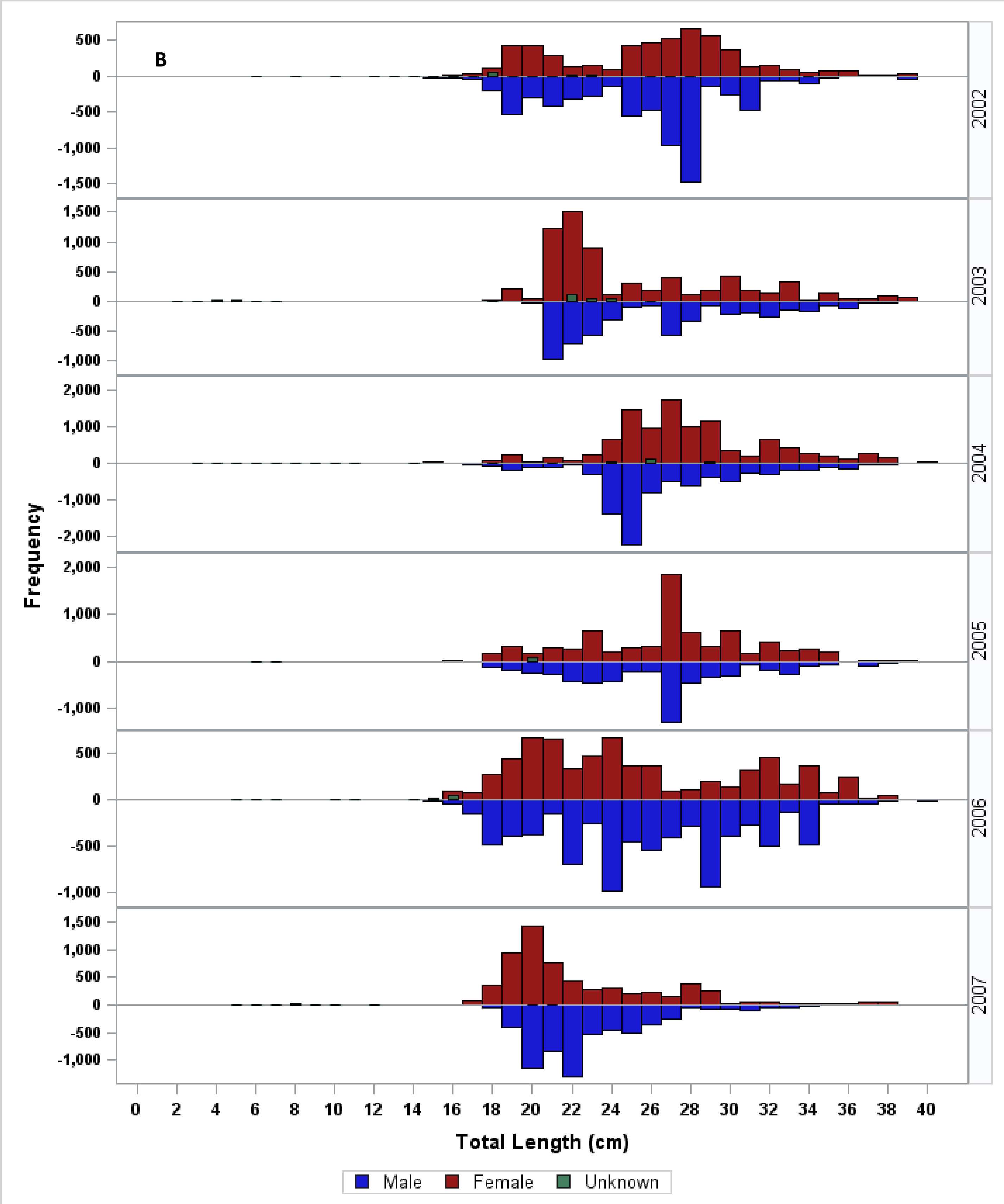


Figure 4. continued.



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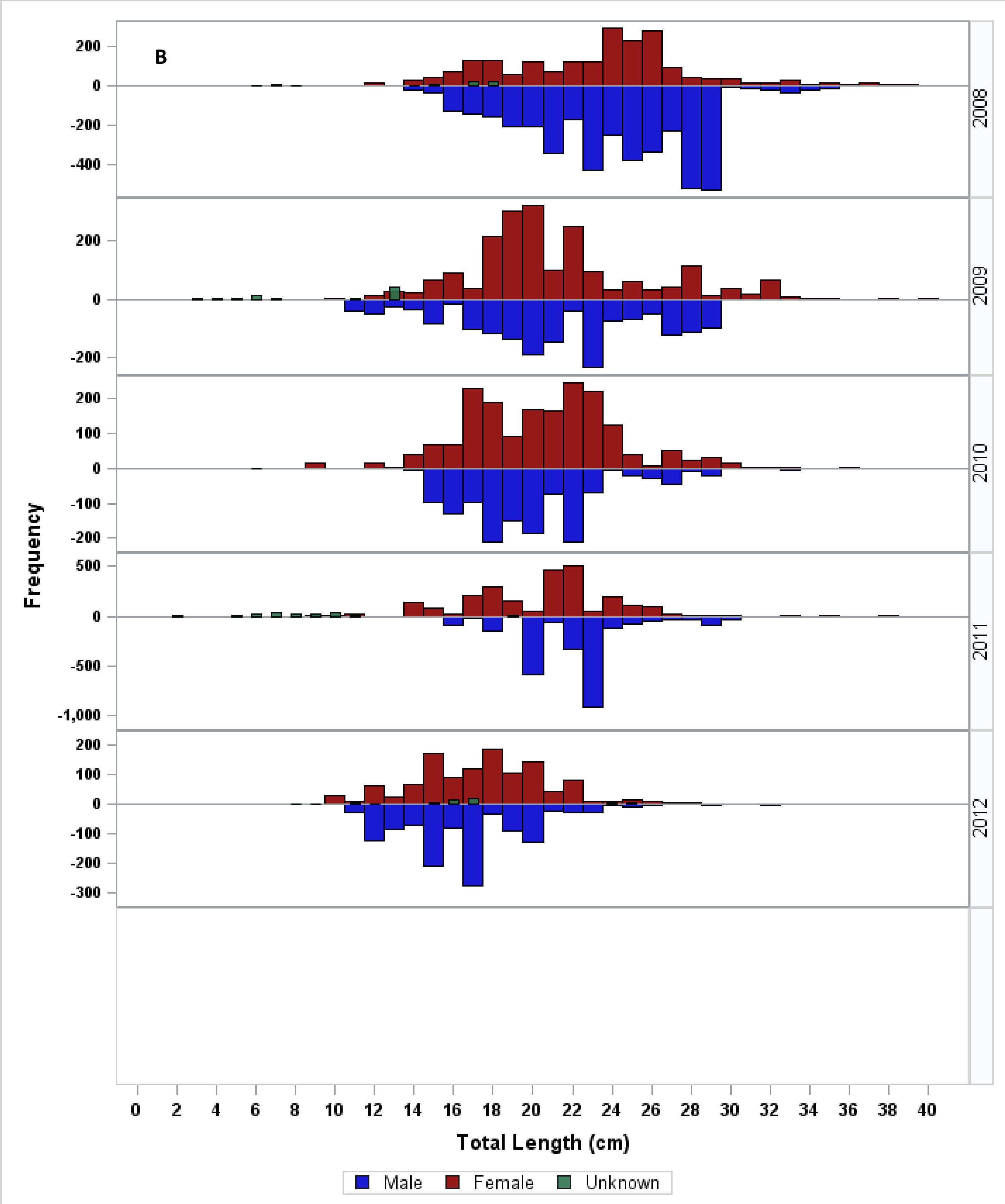


Figure 5. Atlantic croaker age-frequency by year, 2002-2011.

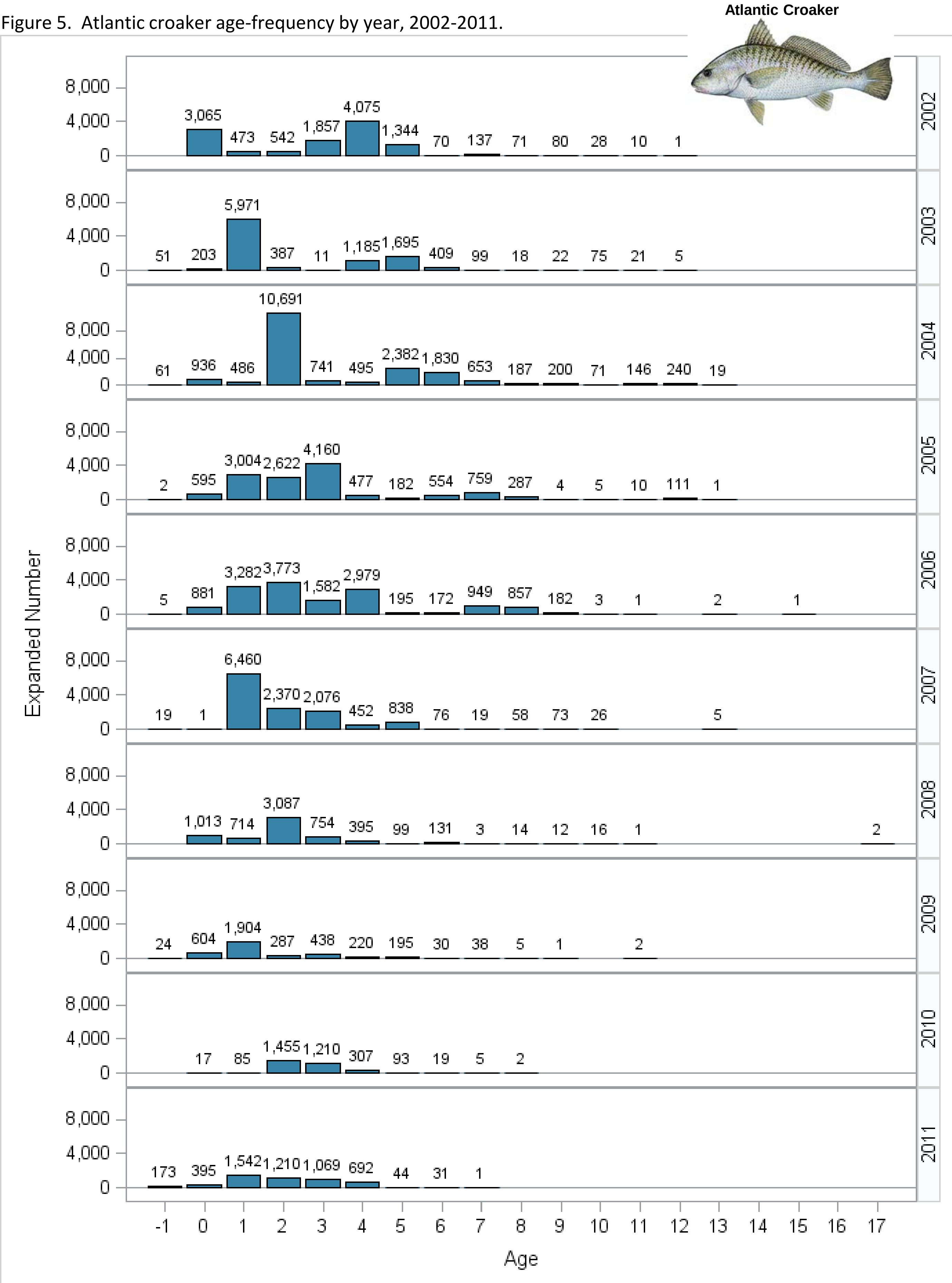


Figure 6. Atlantic croaker age-frequency by year, 2002-2011 standardized to 8,000 annual trawl minutes.

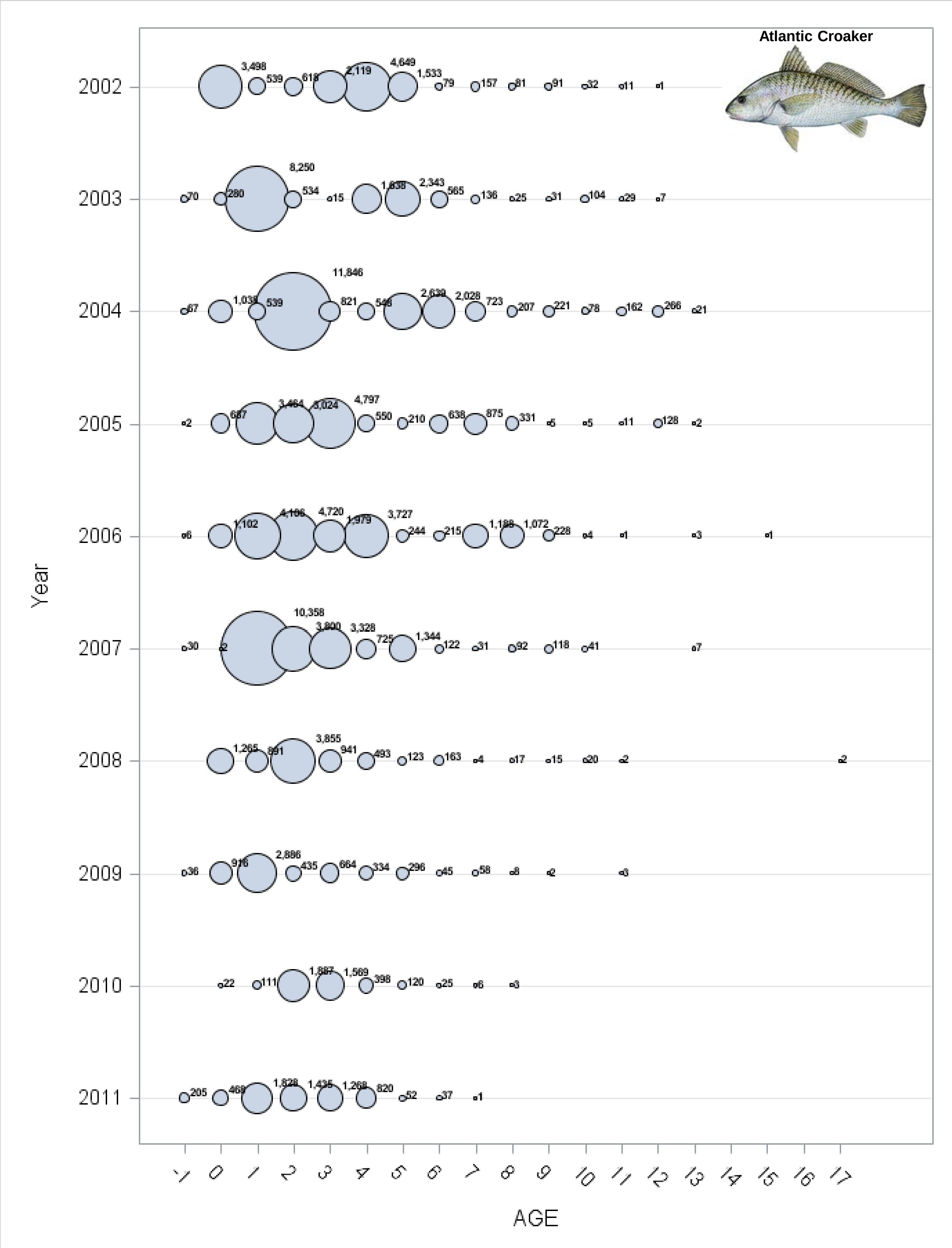


Figure 7. Atlantic croaker age-frequency by cruise month, 2002-2011 combined, actual (A) and standardized to 8,000 total annual trawl minutes (B).

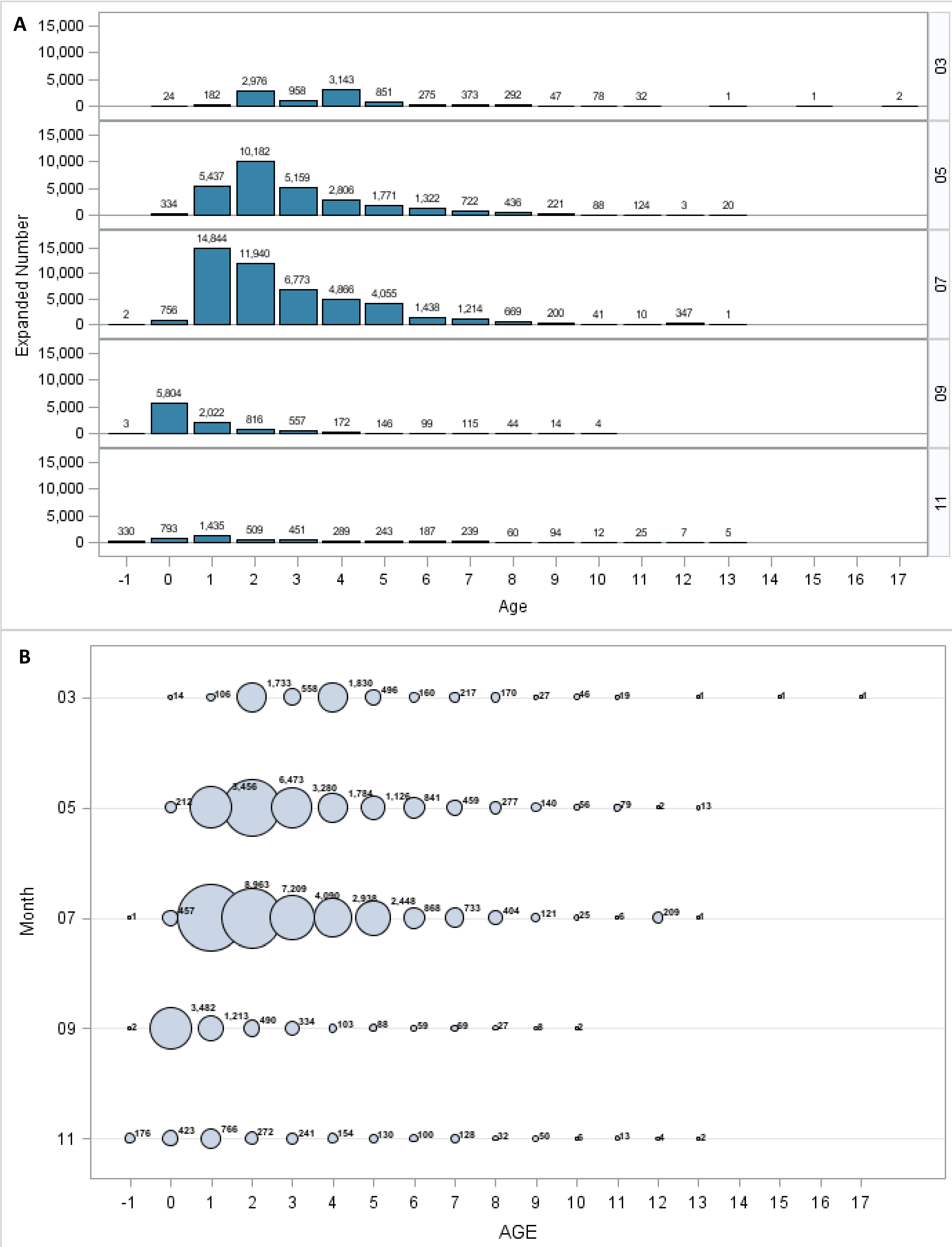


Figure 8. Diet composition, expressed as percent by weight (A) and percent by number (B) of Atlantic croaker collected during ChesMMAP cruises in 2002-2011 combined.

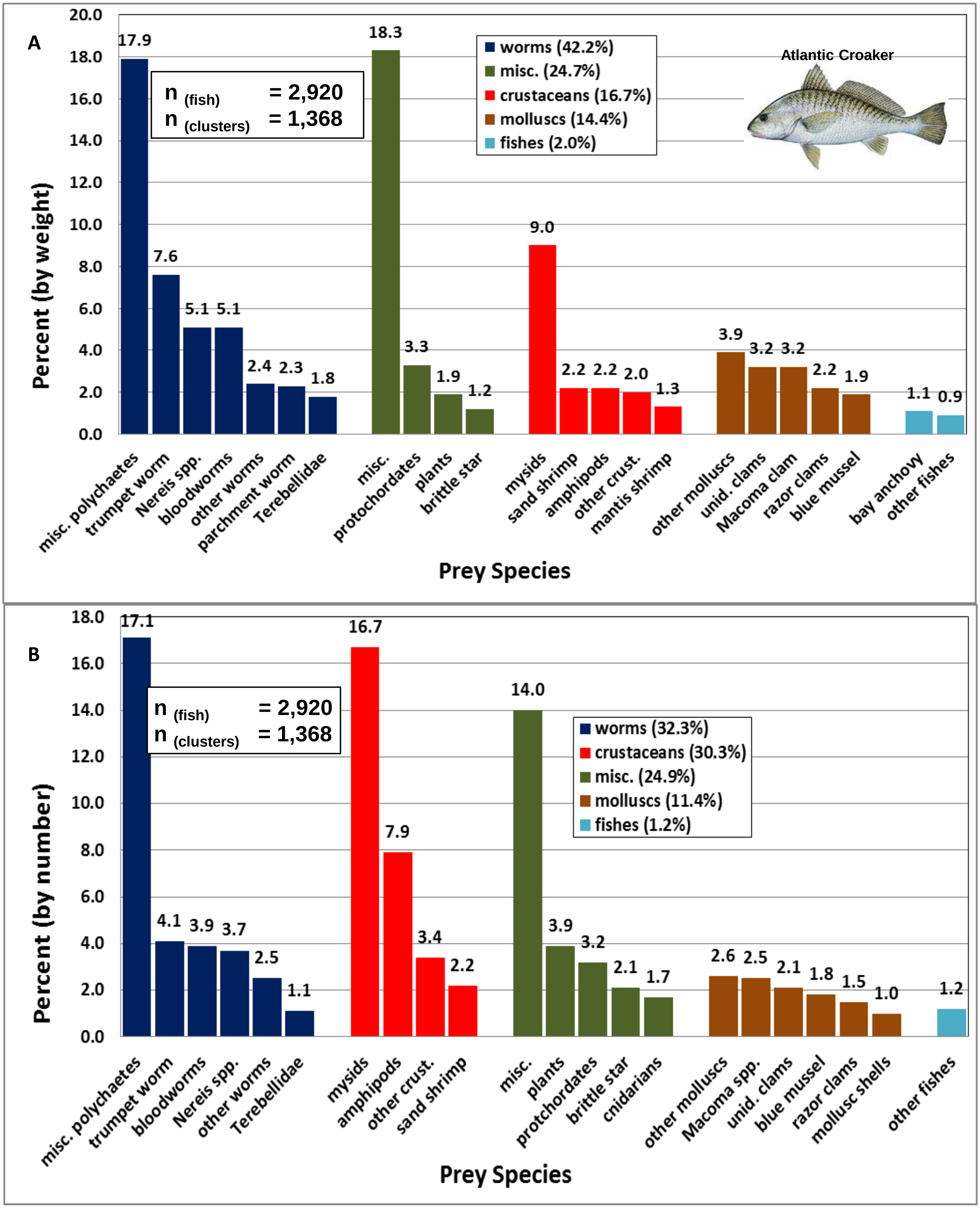


Figure 9. Abundance (kg per hectare swept) of black sea bass in Chesapeake Bay, 2012.

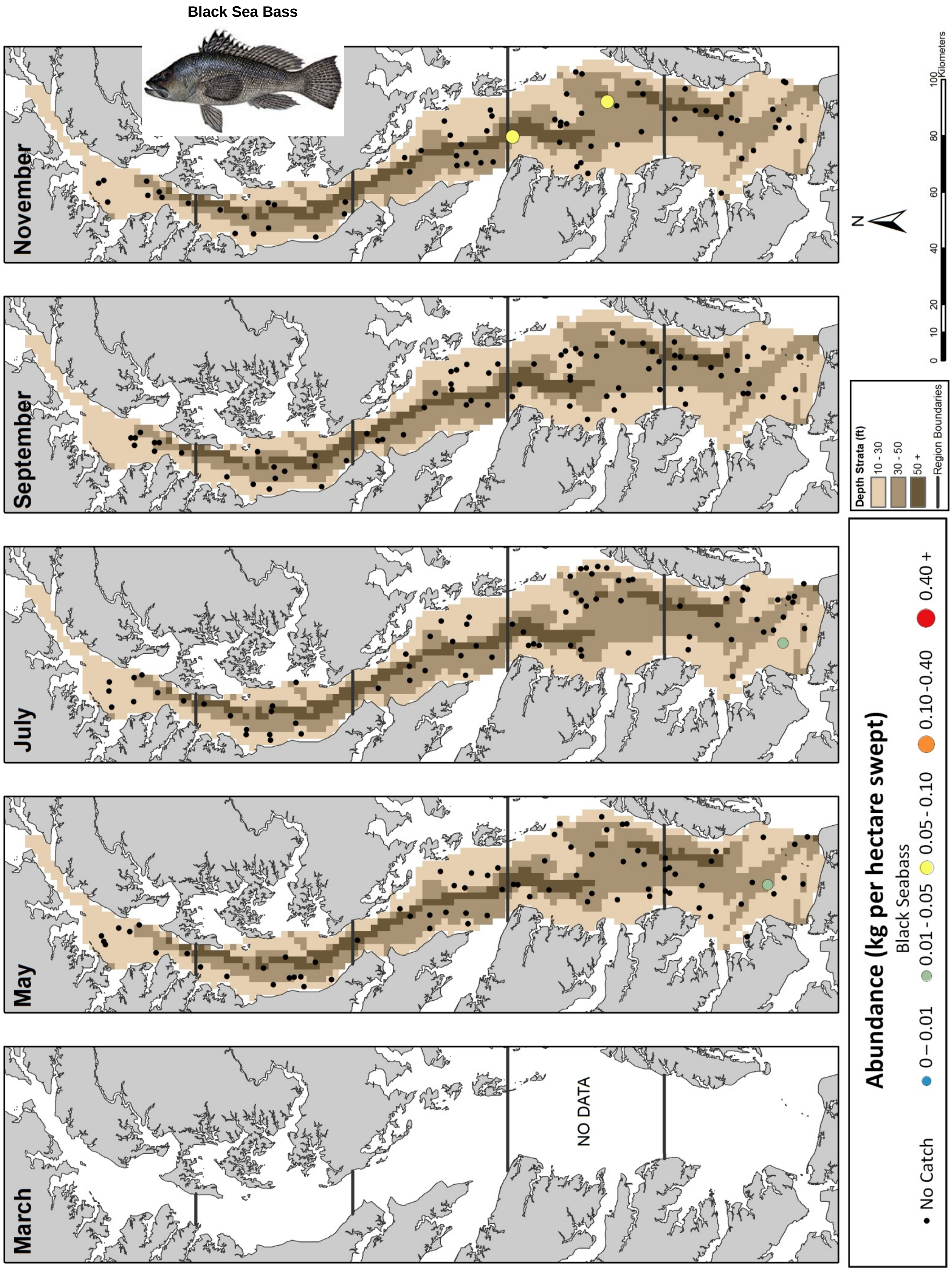


Table 6. Black sea bass geometric mean indices of abundance, by number and biomass, overall and by age-class.

Year	Age	n	Numerical Index LCI	Numerical Index Index	Numerical Index UCI	Biomass Index LCI	Biomass Index Index	Biomass Index UCI
2002	All	122	0.46	0.96	1.62	0.18	0.34	0.53
2003		149	0.50	0.97	1.59	0.11	0.25	0.41
2004		127	0.15	0.44	0.79	0.08	0.23	0.40
2005		131	0.07	0.29	0.56	0.03	0.15	0.27
2006		120	0.09	0.36	0.70	0.02	0.14	0.27
2007		88	0.33	0.92	1.76	0.12	0.31	0.54
2008		135	0.07	0.29	0.54	0.02	0.11	0.21
2009		135	0.45	0.93	1.56	0.14	0.29	0.46
2010		135	0.20	0.52	0.93	0.06	0.15	0.25
2011		134	0.24	0.57	0.98	0.07	0.18	0.29
2012		129	0.00	0.11	0.27	0.00	0.04	0.10
2013								
2014								
2015								
2016								
2002	0	122	0.13	0.32	0.53	0.04	0.11	0.17
2003		149	0.34	0.64	1.01	0.05	0.14	0.22
2004		127	0.08	0.23	0.41	0.03	0.10	0.17
2005		131	0.03	0.18	0.35	0.01	0.07	0.14
2006		120	0.05	0.25	0.49	0.00	0.07	0.15
2007		88	0.17	0.49	0.89	0.04	0.13	0.23
2008		135	0.04	0.19	0.36	0.00	0.05	0.11
2009		135	0.31	0.62	1.01	0.07	0.15	0.24
2010		135	0.07	0.26	0.48	0.01	0.06	0.10
2011		134	0.17	0.40	0.68	0.03	0.09	0.15
2012		129	0.00	0.08	0.19	0.00	0.02	0.05
2013								
2014								
2015								
2016								

Year	Age	n	Numerical Index LCI	Numerical Index Index	Numerical Index UCI	Biomass Index LCI	Biomass Index Index	Biomass Index UCI
2002	1	122	0.41	0.84	1.40	0.14	0.27	0.42
2003		149	0.42	0.80	1.28	0.08	0.19	0.31
2004		127	0.13	0.37	0.67	0.06	0.18	0.31
2005		131	0.06	0.25	0.47	0.02	0.11	0.21
2006		120	0.07	0.31	0.59	0.01	0.11	0.21
2007		88	0.30	0.82	1.54	0.10	0.25	0.43
2008		135	0.06	0.24	0.44	0.01	0.08	0.15
2009		135	0.35	0.73	1.21	0.10	0.21	0.34
2010		135	0.17	0.45	0.78	0.04	0.11	0.18
2011		134	0.20	0.47	0.80	0.04	0.12	0.21
2012		129	0.00	0.10	0.23	0.00	0.03	0.08
2013								
2014								
2015								
2016								
2002	2	122	0.26	0.51	0.81	0.06	0.13	0.21
2003		149	0.21	0.40	0.63	0.03	0.09	0.15
2004		127	0.10	0.27	0.47	0.04	0.11	0.20
2005		131	0.04	0.17	0.32	0.01	0.06	0.12
2006		120	0.02	0.15	0.29	0.00	0.05	0.10
2007		88	0.18	0.47	0.82	0.03	0.10	0.17
2008		135	0.04	0.15	0.28	0.00	0.04	0.09
2009		135	0.17	0.36	0.58	0.02	0.08	0.15
2010		135	0.08	0.22	0.38	0.01	0.03	0.05
2011		134	0.10	0.24	0.39	0.00	0.05	0.10
2012		129	0.00	0.05	0.11	0.00	0.01	0.03
2013								
2014								
2015								
2016								

Figure 10. Black sea bass geometric mean indices of abundance, by number and biomass, for all ages combined and by age-class.

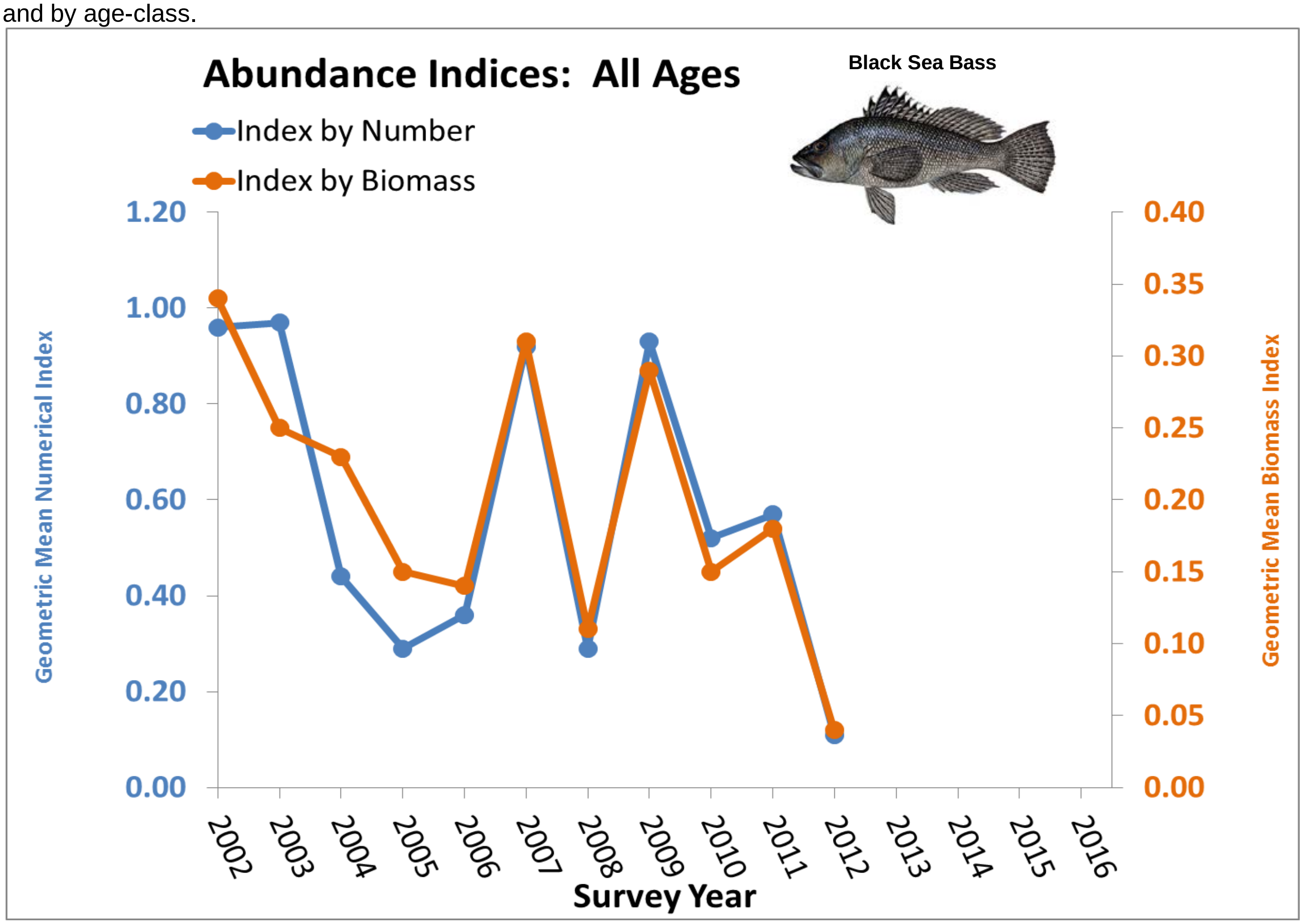
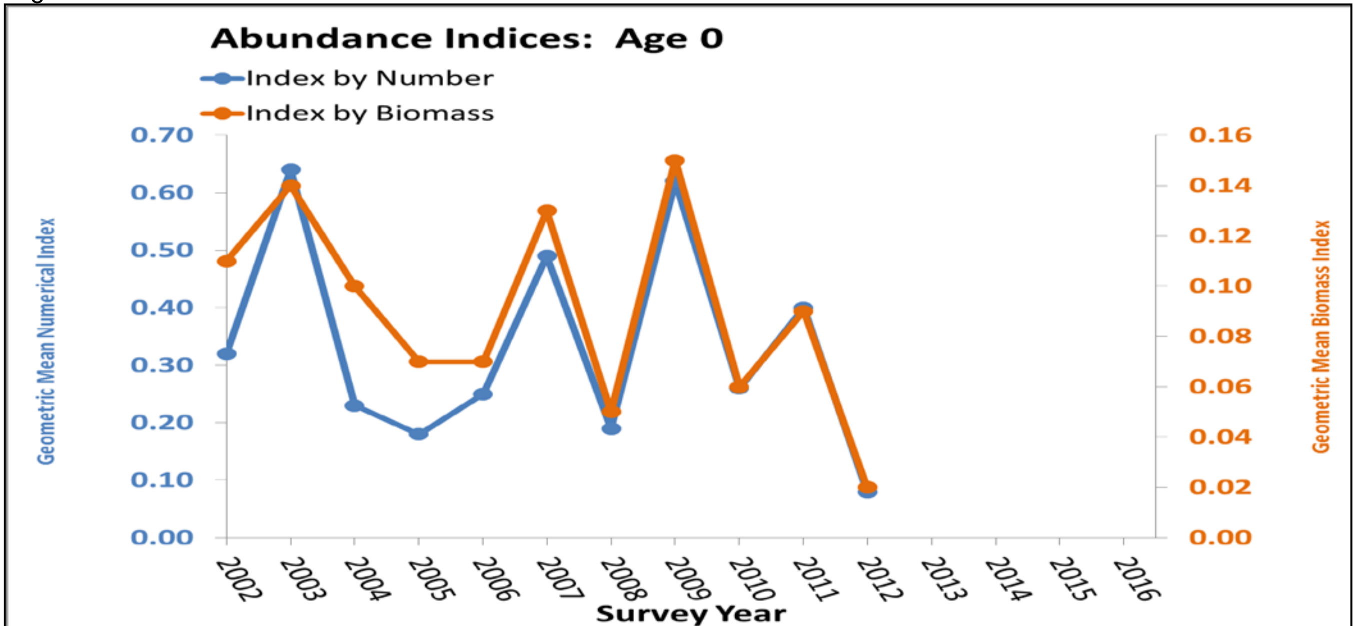
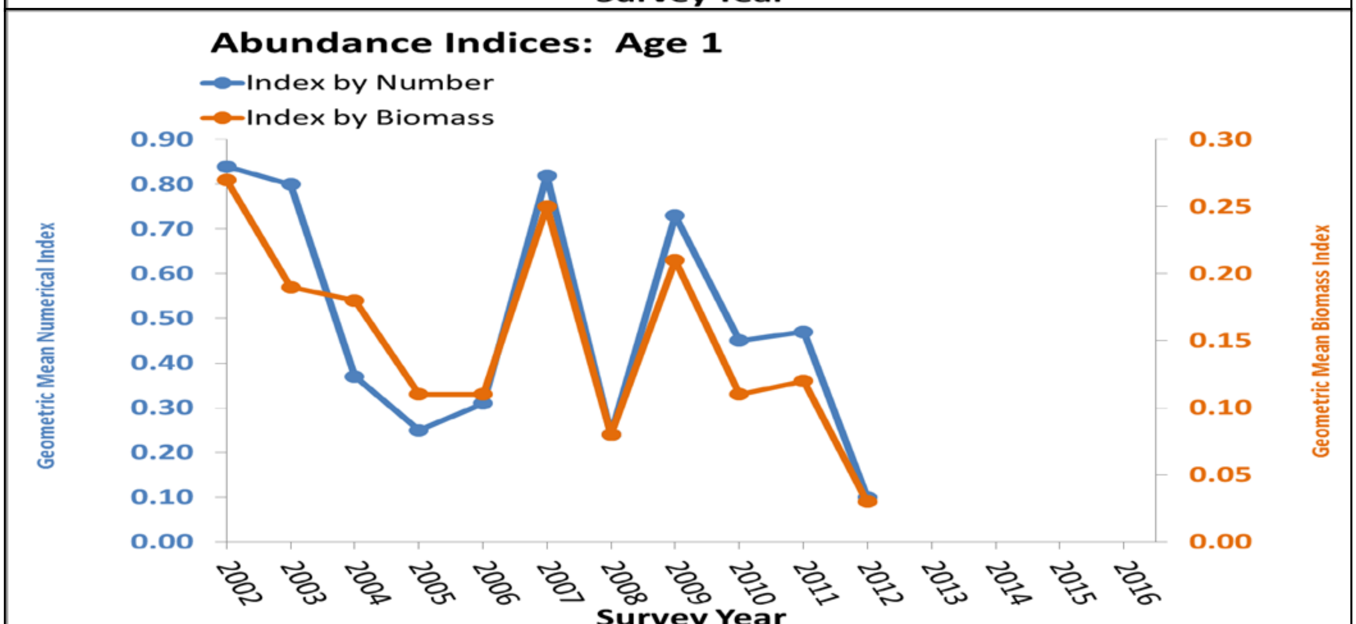


Figure 10. cont.





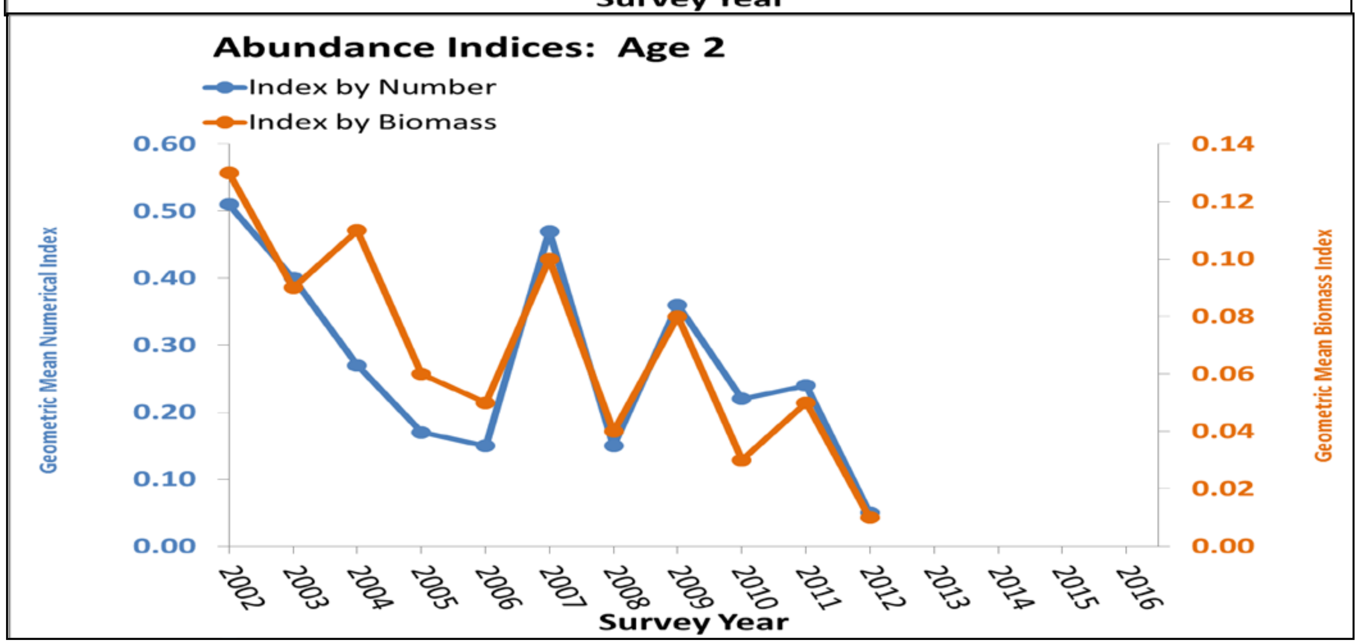
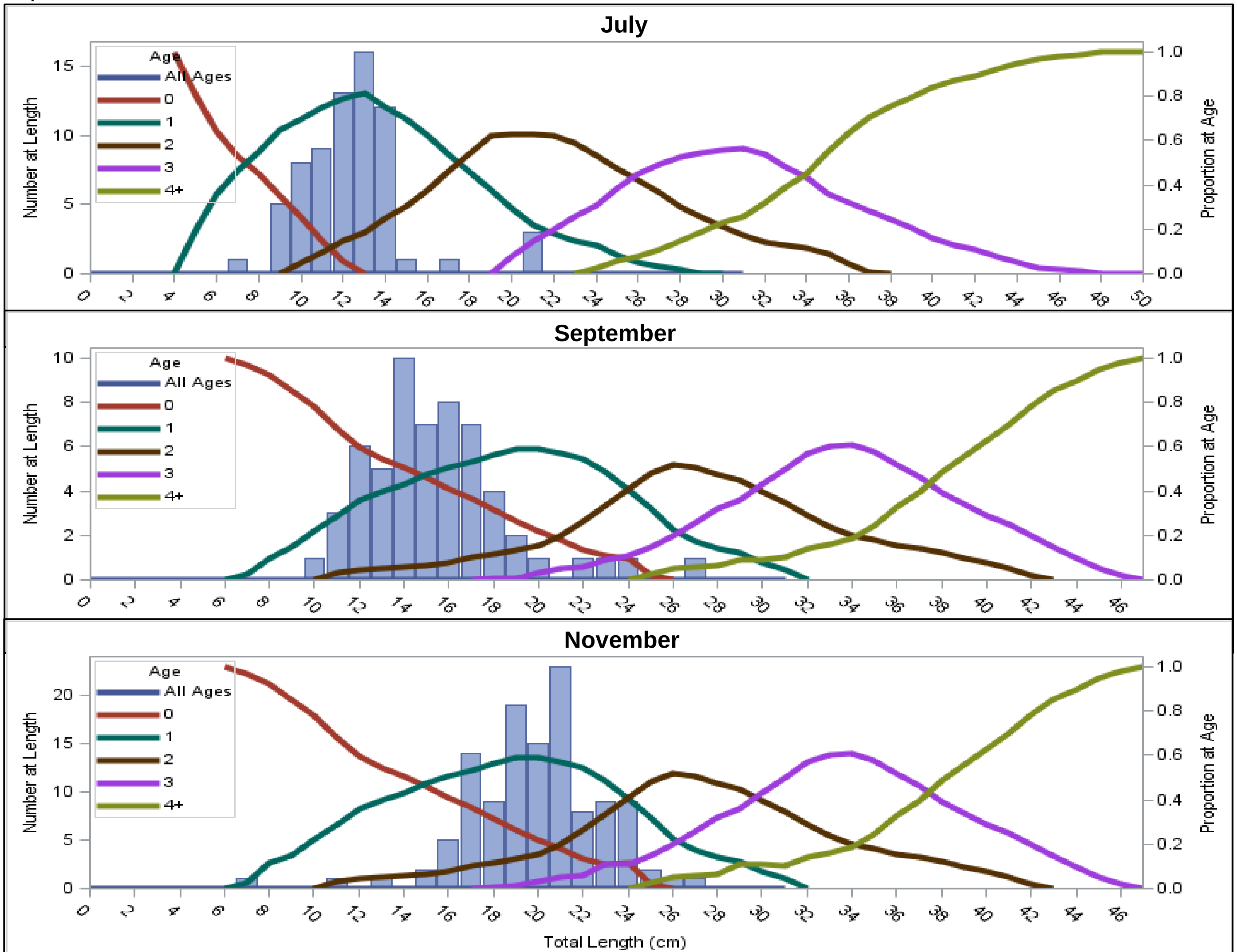


Figure 11. Black sea bass ALK for all NEAMAP fall cruises, showing loess smoothed proportions at each 1cm length bin, overlaid on month-specific length frequencies pooled over all years. ALK proportions are adjusted such that the sums of values for each length bin within each month are forced to 1.0. Only used for ages 0, 1, and 2 for this report.



	Spring							Fall					
Length (cm)	Age-0	Age-1	Age-2	Age-3	Age-4+	Sum	Length (cm)	Age-0	Age-1	Age-2	Age-3	Age-4+	Sum
4	1.000	0.000				1.000	4	1.000					1.000
5	0.800	0.200				1.000	5	1.000					1.000
6	0.640	0.360				1.000	6	1.000	0.000				1.000
7	0.535	0.465				1.000	7	0.970	0.030				1.000
8	0.450	0.550				1.000	8	0.923	0.077				1.000
9	0.350	0.650	0.000			1.000	9	0.853	0.148				1.000
10	0.250	0.700	0.050			1.000	10	0.779	0.221	0.000			1.000
11	0.150	0.750	0.100			1.000	11	0.679	0.288	0.033			1.000
12	0.060	0.790	0.150			1.000	12	0.599	0.357	0.045			1.000
13	0.000	0.812	0.188			1.000	13	0.547	0.401	0.052			1.000
14		0.750	0.250			1.000	14	0.508	0.433	0.059			1.000
15		0.700	0.300			1.000	15	0.460	0.472	0.068			1.000
16		0.620	0.380			1.000	16	0.413	0.505	0.081			1.000
17		0.539	0.461			1.000	17	0.368	0.530	0.102	0.000		1.000
18		0.460	0.540			1.000	18	0.314	0.566	0.114	0.005		1.000
19		0.380	0.620	0.000		1.000	19	0.265	0.593	0.135	0.007		1.000
20		0.295	0.630	0.075		1.000	20	0.220	0.590	0.155	0.035		1.000
21		0.220	0.630	0.150		1.000	21	0.180	0.570	0.200	0.050		1.000
22		0.180	0.620	0.200		1.000	22	0.138	0.542	0.261	0.060		1.000
23		0.150	0.590	0.260	0.000	1.000	23	0.111	0.485	0.334	0.070		1.000
24		0.130	0.530	0.311	0.029	1.000	24	0.075	0.405	0.410	0.110	0.000	1.000
25		0.085	0.473	0.382	0.060	1.000	25	0.020	0.320	0.480	0.150	0.030	1.000
26		0.050	0.424	0.446	0.080	1.000	26	0.000	0.228	0.520	0.200	0.052	1.000
27		0.035	0.363	0.492	0.110	1.000	27		0.175	0.506	0.260	0.060	1.000
28		0.018	0.305	0.527	0.150	1.000	28		0.140	0.475	0.320	0.065	1.000
29		0.003	0.260	0.547	0.190	1.000	29		0.120	0.450	0.360	0.070	1.000
30		0.000	0.210	0.560	0.230	1.000	30		0.080	0.400	0.430	0.090	1.000
31			0.175	0.565	0.260	1.000	31		0.046	0.346	0.503	0.105	1.000
32			0.140	0.540	0.320	1.000	32		0.000	0.292	0.568	0.140	1.000
33			0.130	0.480	0.390	1.000	33			0.240	0.600	0.160	1.000
34			0.116	0.434	0.450	1.000	34			0.200	0.610	0.190	1.000
35			0.090	0.360	0.550	1.000	35			0.180	0.576	0.244	1.000
36			0.047	0.320	0.633	1.000	36			0.155	0.520	0.325	1.000
37			0.010	0.284	0.706	1.000	37			0.140	0.460	0.400	1.000
38			0.000	0.242	0.758	1.000	38			0.120	0.390	0.490	1.000
39				0.203	0.797	1.000	39			0.100	0.340	0.560	1.000
40				0.163	0.837	1.000	40			0.080	0.290	0.630	1.000
41				0.129	0.871	1.000	41			0.050	0.250	0.700	1.000
42				0.109	0.891	1.000	42			0.020	0.200	0.780	1.000
43				0.080	0.920	1.000	43			0.000	0.150	0.850	1.000
44				0.050	0.950	1.000	44				0.100	0.900	1.000
45				0.030	0.970	1.000	45				0.050	0.950	1.000
46				0.020	0.980	1.000	46				0.020	0.980	1.000
47				0.012	0.988	1.000	47				0.000	1.000	1.000
48				0.002	0.998	1.000	48						0.000
49				0.001	0.999	1.000	49						0.000
50				0.000	1.000	1.000	50						0.000

Figure 12. Black sea bass length-frequency in Chesapeake Bay 2002-2012, overall (A) and by sex (B).

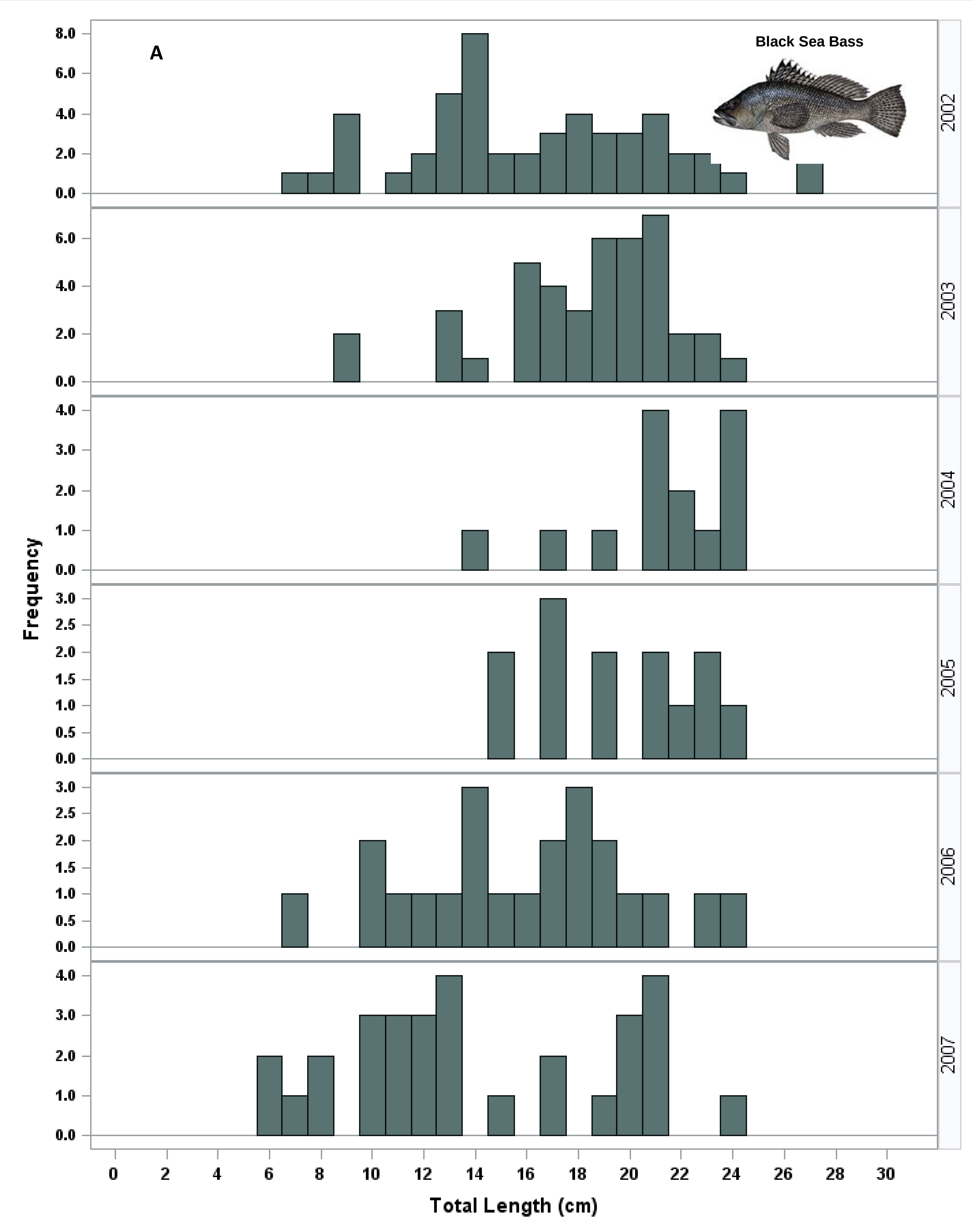


Figure 12. cont.

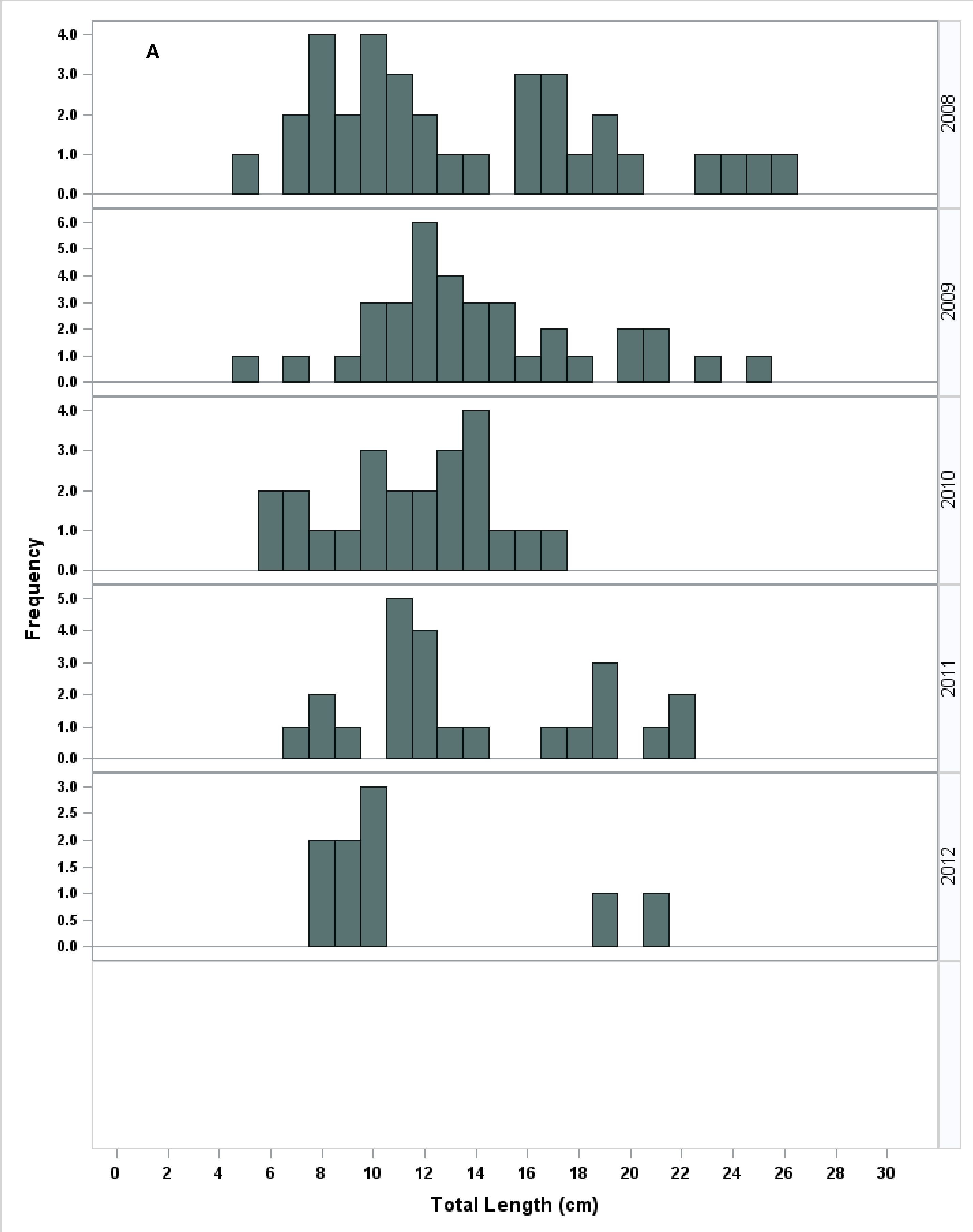


Figure 12. cont.

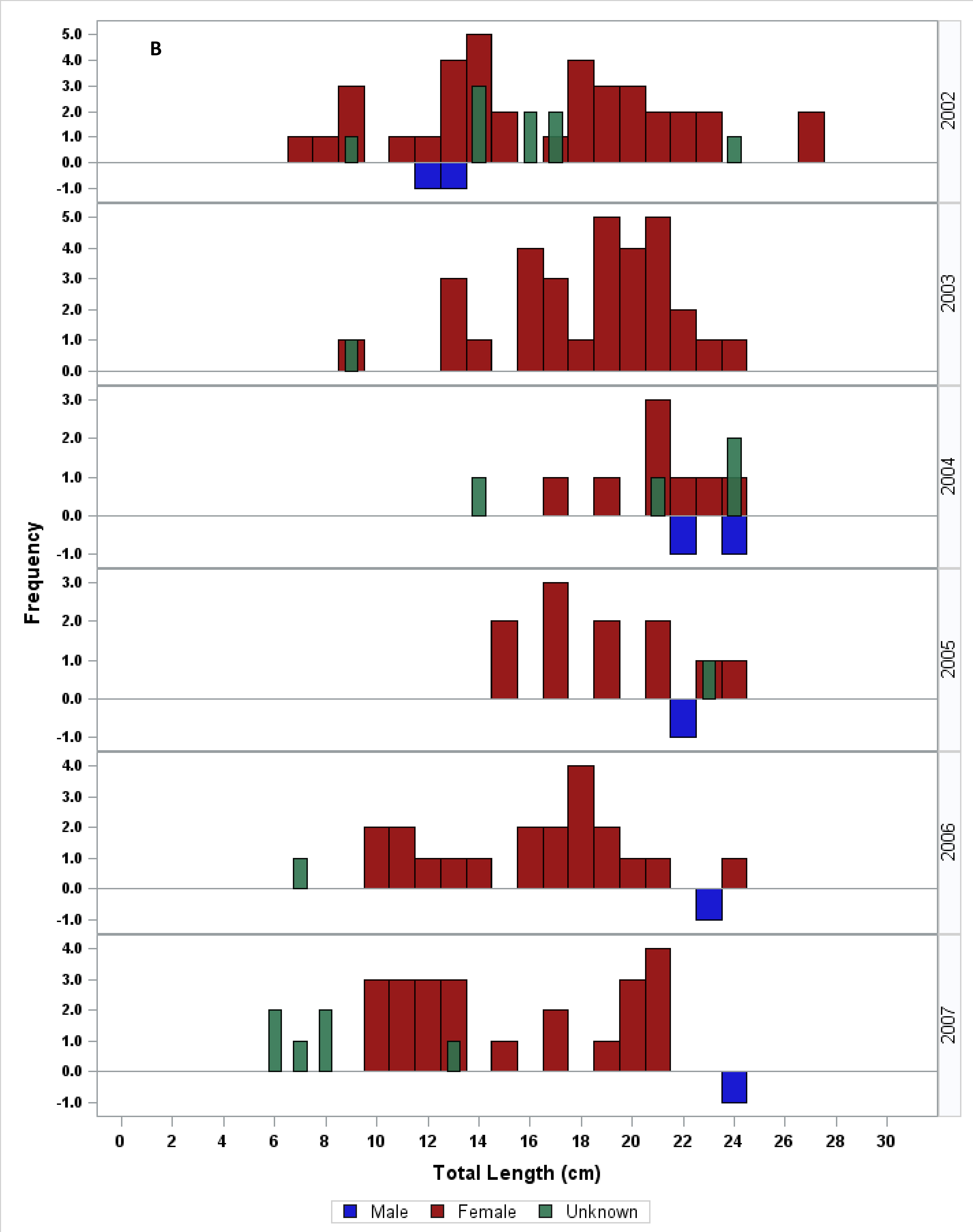


Figure 12. cont.

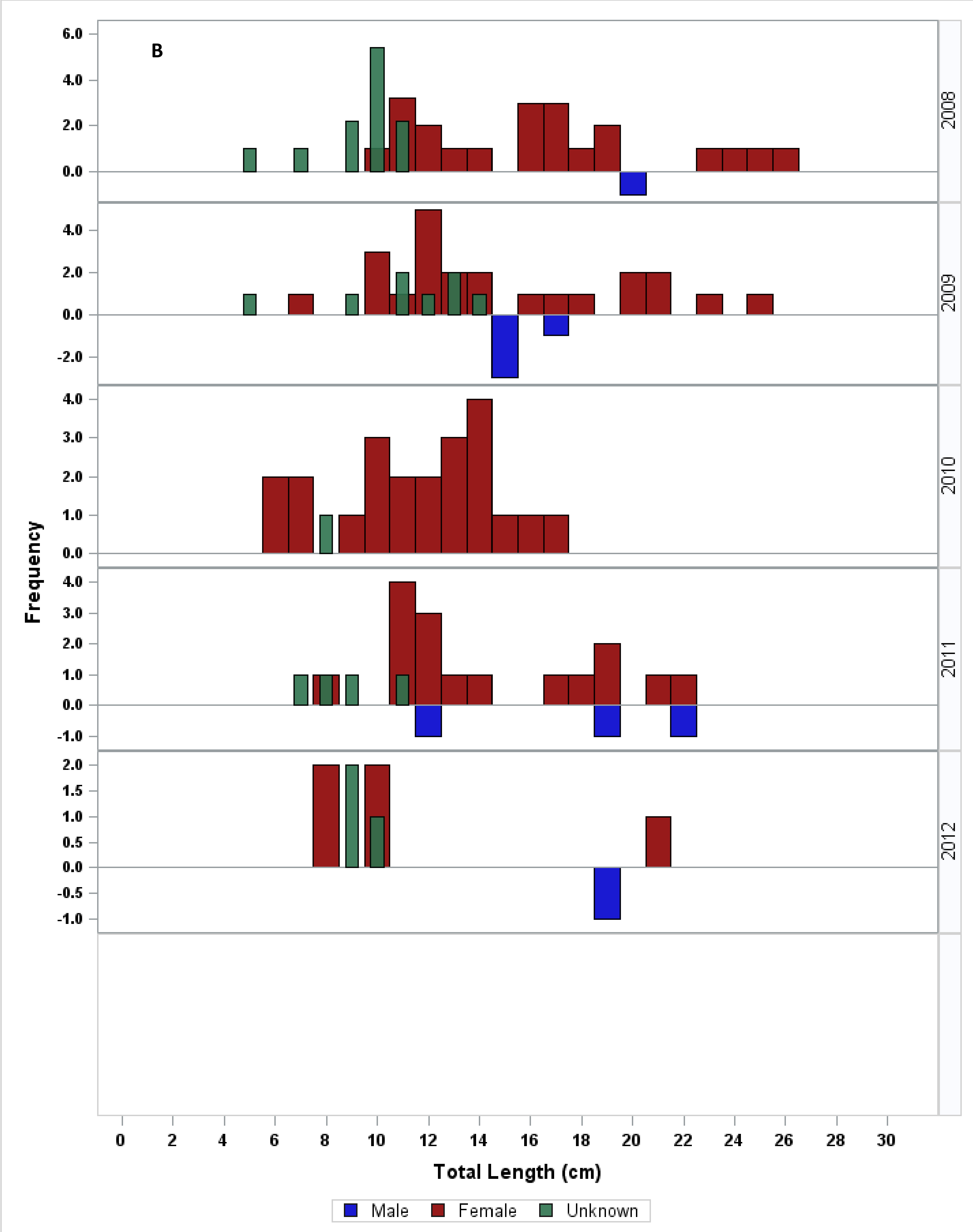


Figure 13. Black sea bass age-frequency by year, 2002-2011.

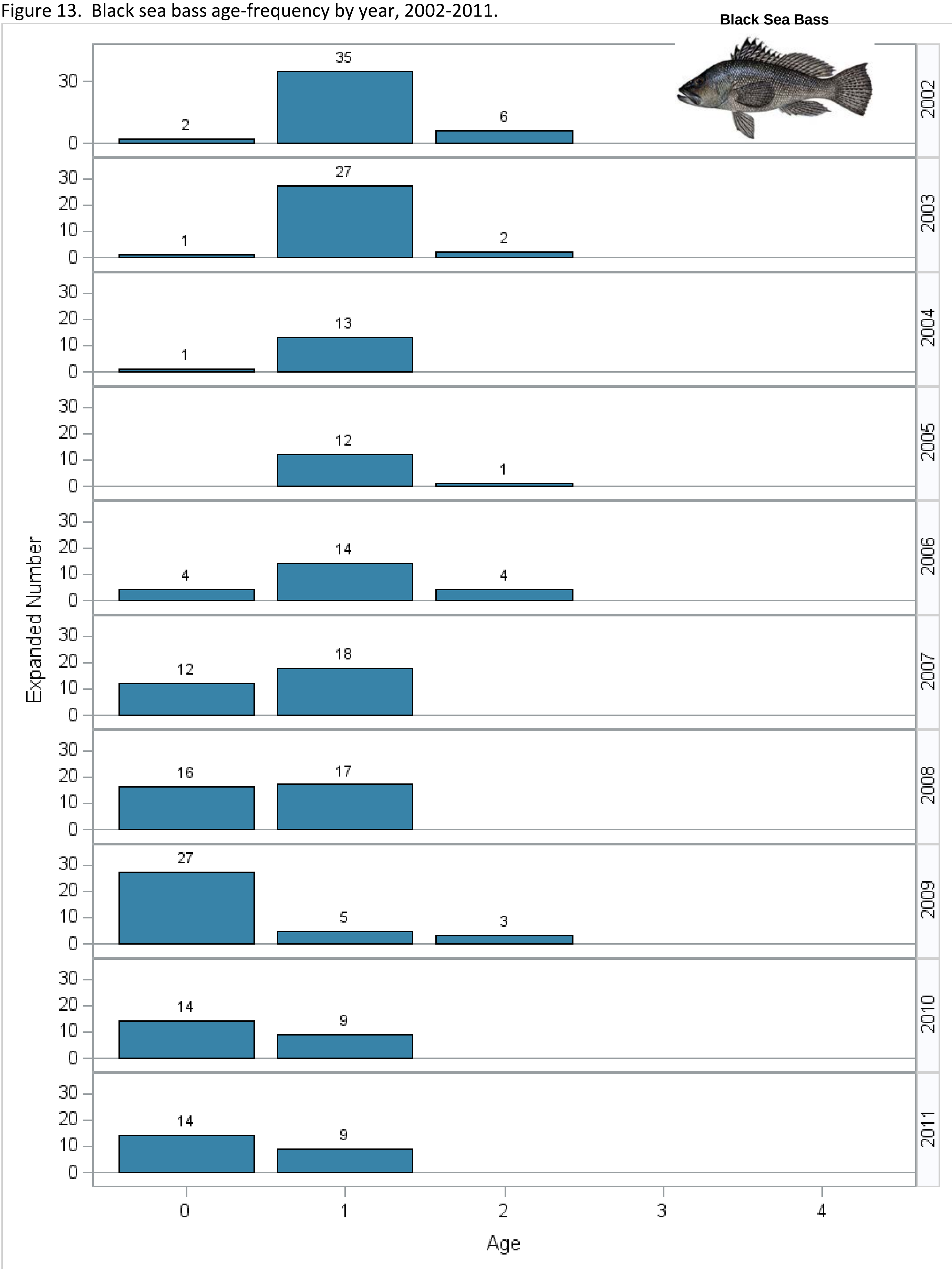


Figure 14. Black sea bass age-frequency by year, 2002-2011 standardized to 8,000 annual trawl minutes.

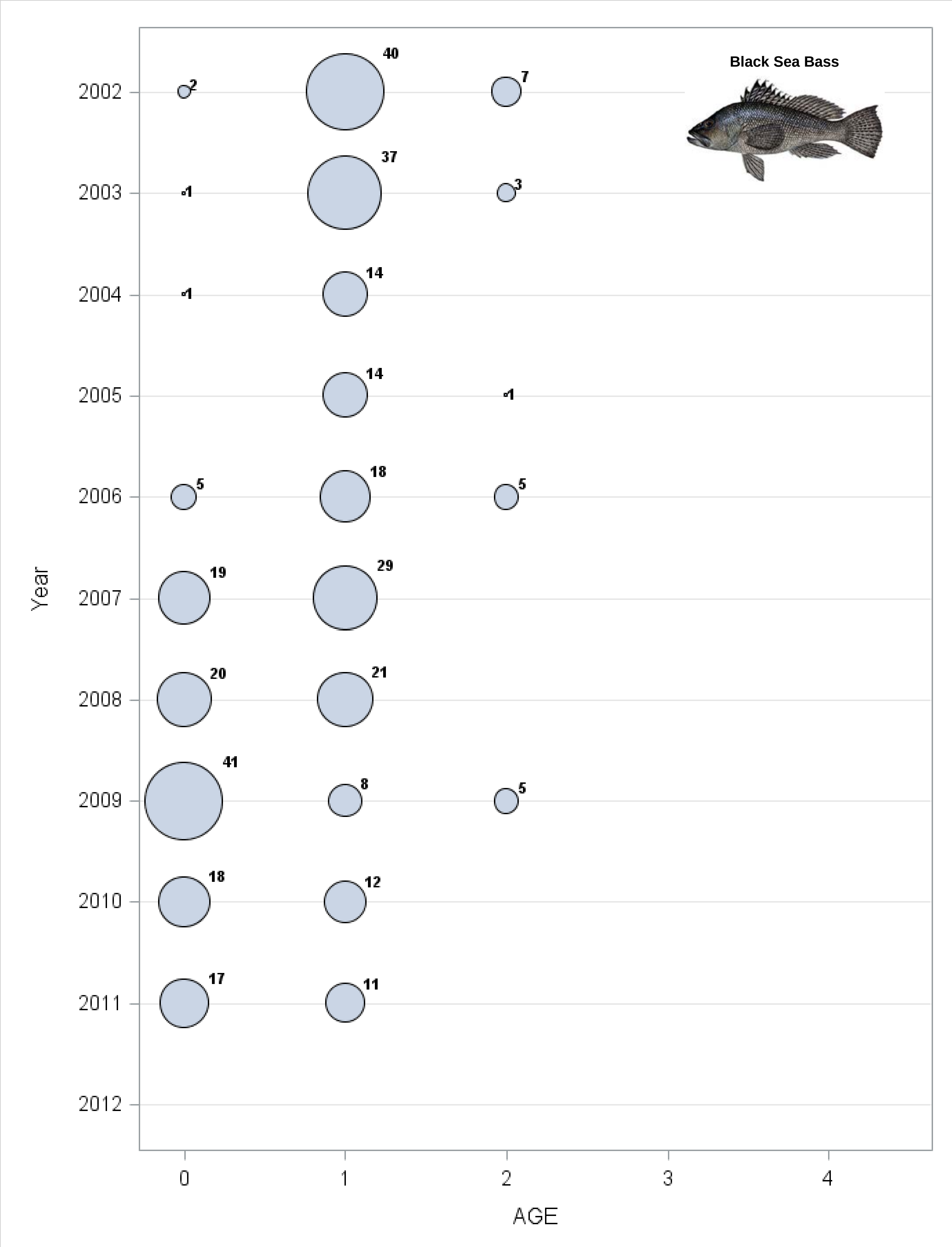


Figure 15. Black sea bass age-frequency by cruise month, 2002-2011 combined, actual (A) and standardized to 8,000 total annual trawl minutes (B).

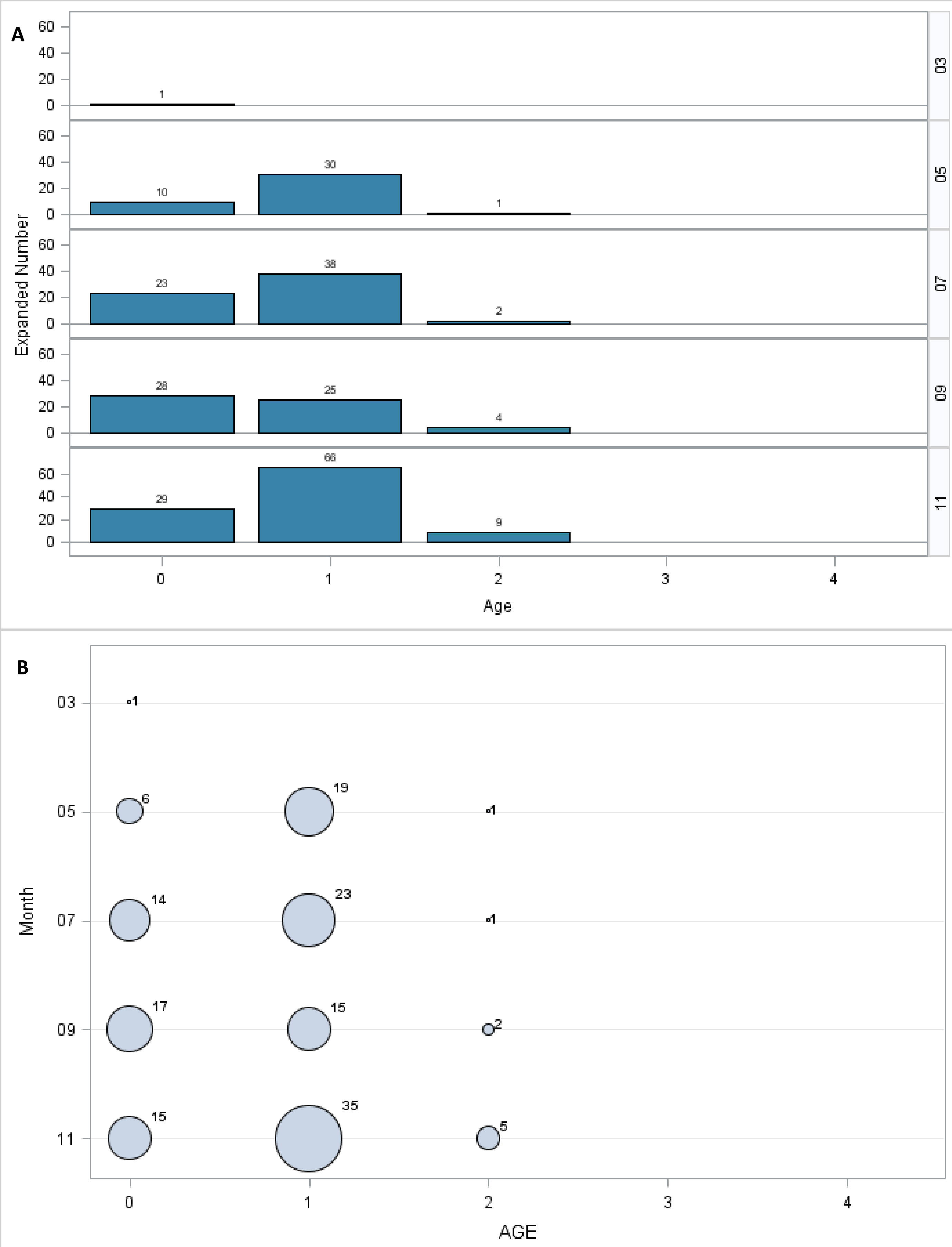


Figure 16. Diet composition, expressed as percent by weight (A) and percent by number (B) of black seabass collected during ChesMMAP cruises in 2002-2011 combined.

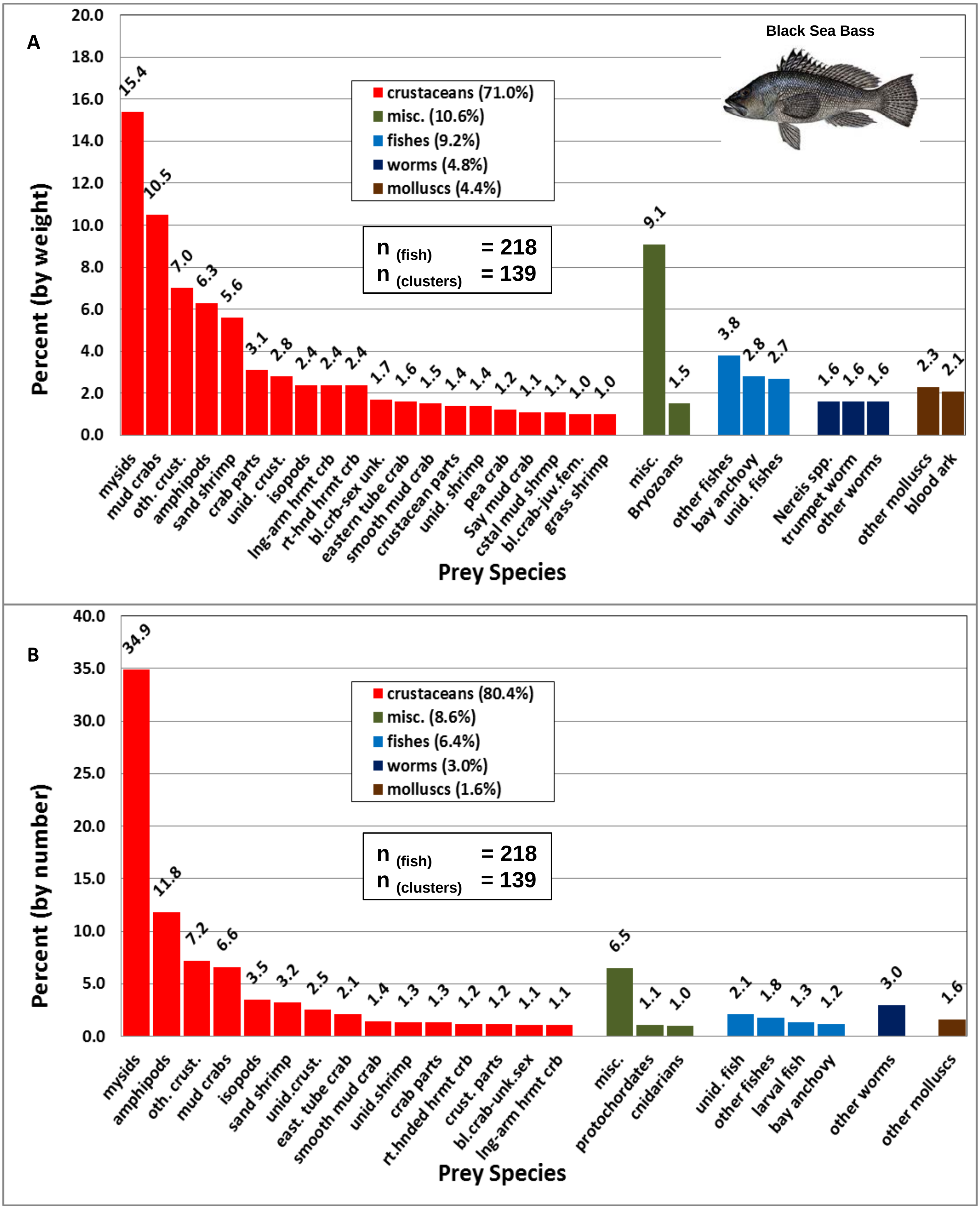


Figure 17. Abundance (kg per hectare swept) of bluefish in Chesapeake Bay, 2012.

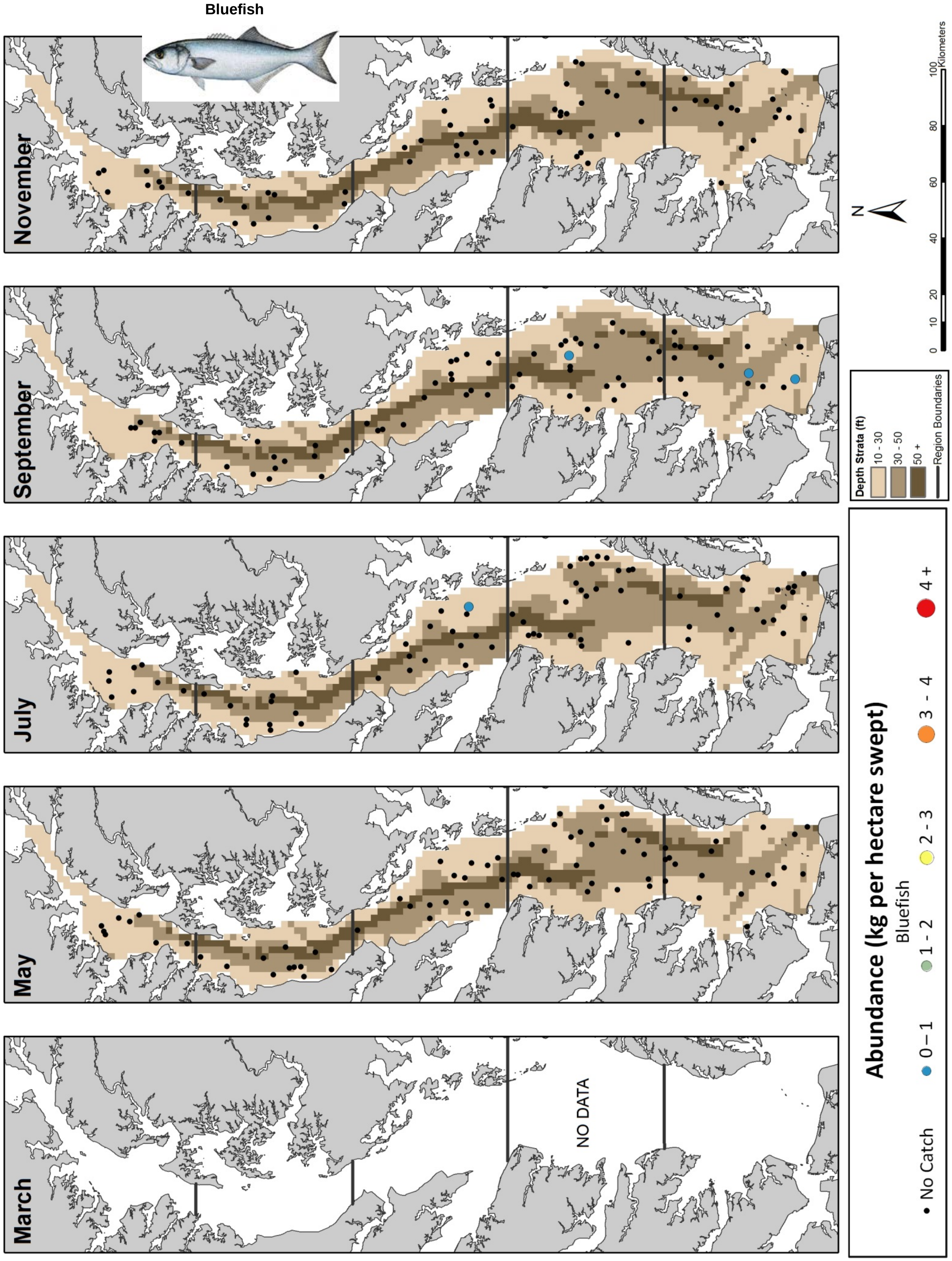


Table 7. Bluefish geometric mean indices of abundance, by number and biomass, overall and age-0.

Year	Age	n	Numerical Index LCI	Numerical Index Index	Numerical Index UCI	Biomass Index LCI	Biomass Index Index	Biomass Index UCI
2002	All	75	0.35	**1.00**	1.98	0.24	**0.68**	1.28
2003		101	1.59	**3.10**	5.49	0.67	**1.20**	1.91
2004		92	0.33	**0.84**	1.56	0.23	**0.58**	1.05
2005		86	1.19	**2.61**	4.94	0.67	**1.33**	2.27
2006		79	0.29	**0.87**	1.70	0.15	**0.49**	0.92
2007		44	1.28	**3.56**	8.11	0.77	**1.88**	3.71
2008		90	0.07	**0.39**	0.80	0.04	**0.23**	0.47
2009		90	0.07	**0.38**	0.80	0.04	**0.22**	0.44
2010		90	0.00	**0.31**	0.78	0.00	**0.19**	0.47
2011		89	0.03	**0.29**	0.61	0.02	**0.20**	0.42
2012		84	0.12	**0.51**	1.04	0.08	**0.33**	0.64
2013								
2014								
2015								
2016								

Year	Age	n	Numerical Index LCI	Numerical Index Index	Numerical Index UCI	Biomass Index LCI	Biomass Index Index	Biomass Index UCI
2002	0	75	0.24	**0.74**	1.44	0.16	**0.46**	0.84
2003		101	1.44	**2.79**	4.89	0.57	**1.01**	1.57
2004		92	0.20	**0.54**	0.98	0.12	**0.33**	0.58
2005		86	1.06	**2.32**	4.36	0.57	**1.14**	1.91
2006		79	0.25	**0.71**	1.35	0.13	**0.36**	0.65
2007		44	0.91	**2.61**	5.84	0.47	**1.16**	2.17
2008		90	0.07	**0.36**	0.74	0.04	**0.21**	0.40
2009		90	0.05	**0.32**	0.66	0.03	**0.17**	0.32
2010		90	0.00	**0.31**	0.77	0.00	**0.19**	0.47
2011		89	0.00	**0.20**	0.44	0.00	**0.13**	0.27
2012		84	0.09	**0.41**	0.82	0.05	**0.23**	0.43
2013								
2014								
2015								
2016								

Figure 18. Bluefish geometric mean indices of abundance, by number and biomass, for all ages combined and for age-0.

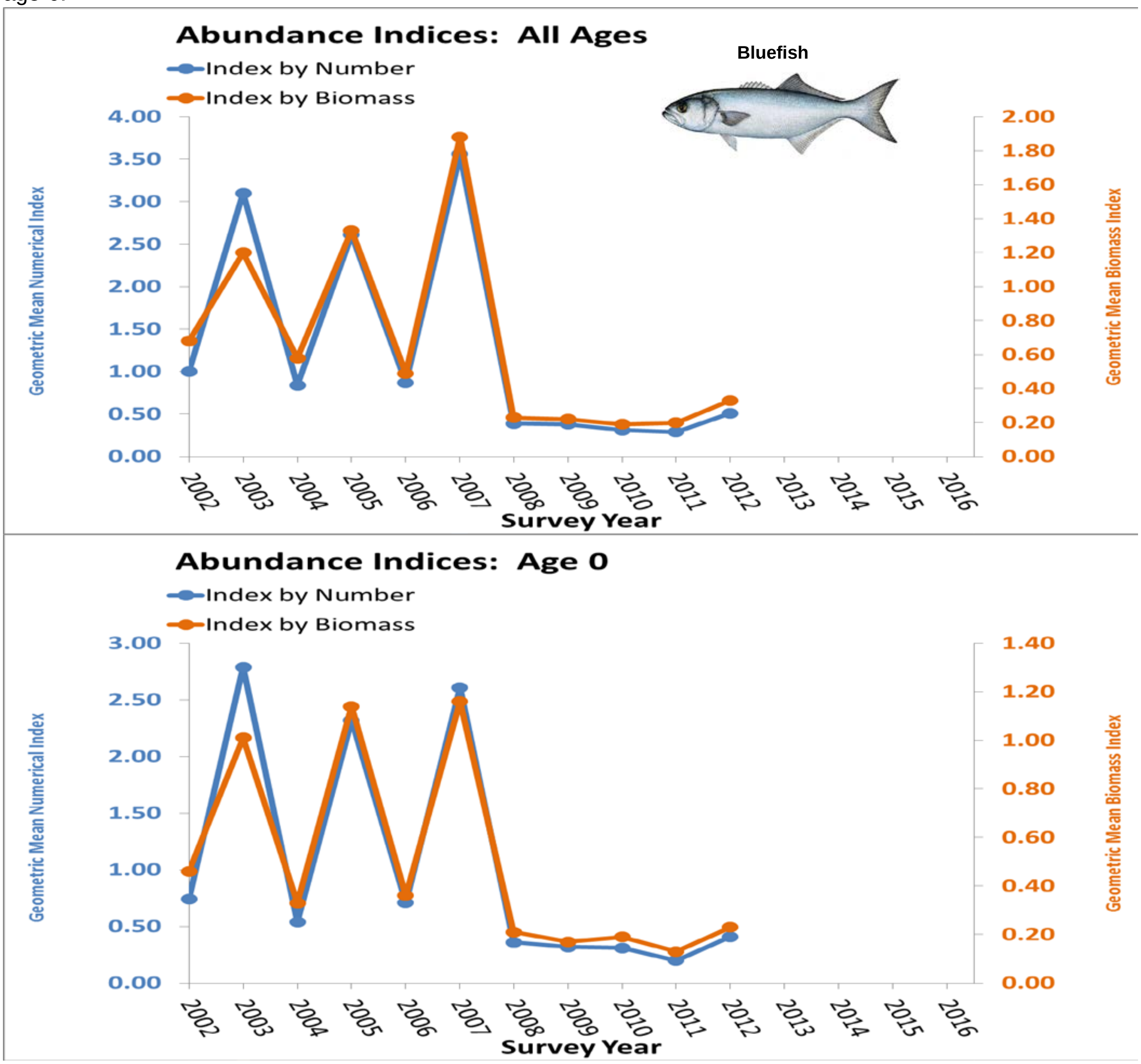
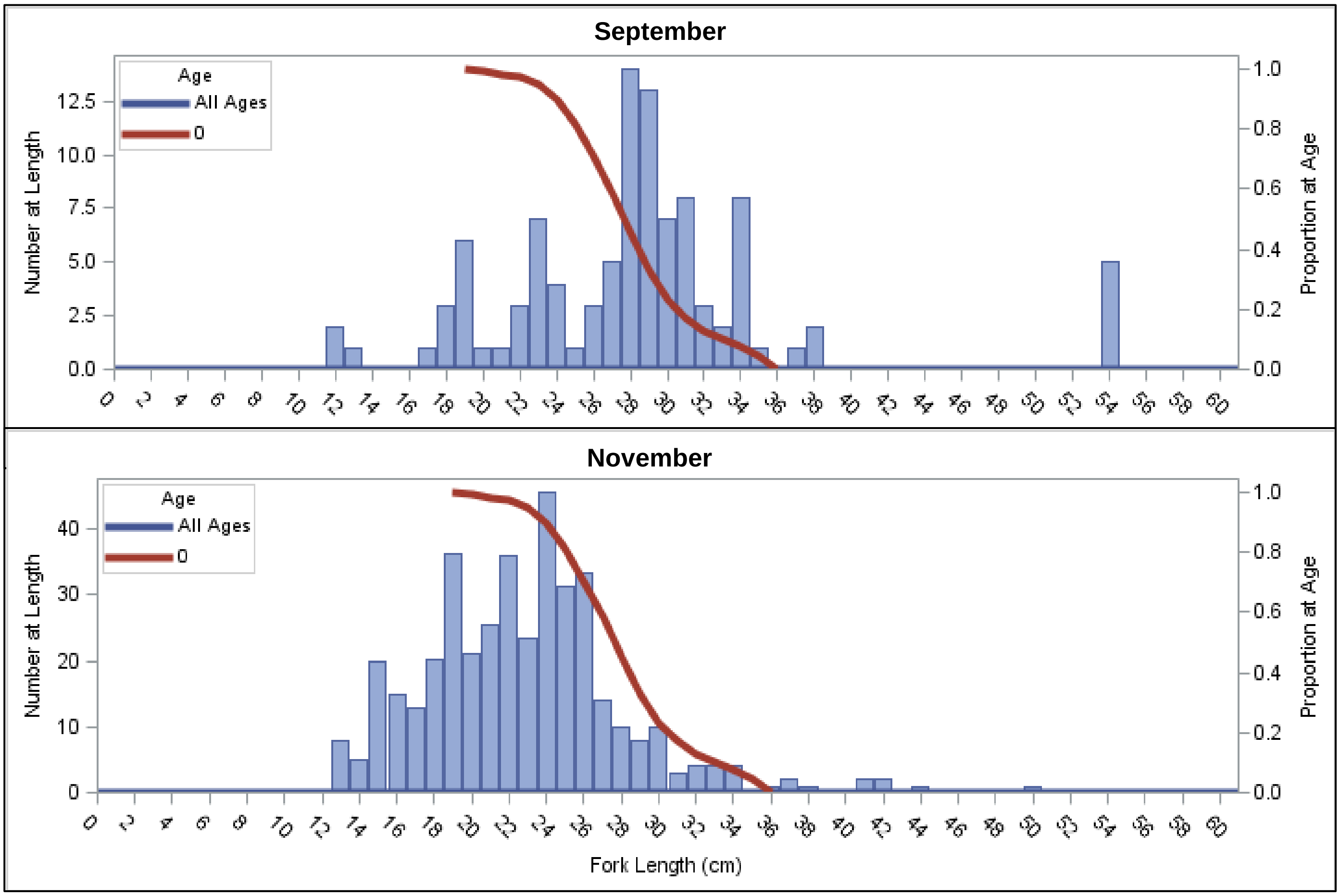


Figure 19. Bluefish ALK for all NEAMAP fall cruises, showing loess smoothed proportions at each 1cm length bin, overlaid on month-specific length frequencies pooled over all years. ALK proportions are adjusted such that the sums of values for each length bin within each month is forced to 1.0. Only used for age 0 for this report.



Fall				
Length (cm)	Age-0	Age-1	Age-2+	Sum
19	1.000	0.000		1.000
20	0.990	0.010		1.000
21	0.982	0.018		1.000
22	0.974	0.026	0.000	1.000
23	0.945	0.036	0.019	1.000
24	0.897	0.078	0.025	1.000
25	0.816	0.146	0.038	1.000
26	0.707	0.248	0.045	1.000
27	0.584	0.366	0.050	1.000
28	0.450	0.483	0.067	1.000
29	0.327	0.595	0.078	1.000
30	0.229	0.682	0.089	1.000
31	0.172	0.725	0.103	1.000
32	0.131	0.752	0.117	1.000
33	0.102	0.767	0.131	1.000
34	0.075	0.775	0.150	1.000
35	0.043	0.790	0.167	1.000
36	0.000	0.801	0.199	1.000
37		0.780	0.220	1.000
38		0.720	0.280	1.000
39		0.660	0.340	1.000
40		0.600	0.400	1.000
41		0.520	0.480	1.000
42		0.446	0.554	1.000
43		0.381	0.619	1.000
44		0.316	0.684	1.000
45		0.251	0.749	1.000
46		0.189	0.811	1.000
47		0.135	0.865	1.000
48		0.090	0.910	1.000
49		0.059	0.941	1.000
50		0.038	0.962	1.000
51		0.027	0.973	1.000
52		0.020	0.980	1.000
53		0.000	1.000	1.000

Figure 20. Bluefish length-frequency in Chesapeake Bay 2002-2012, overall (A) and by sex (B).

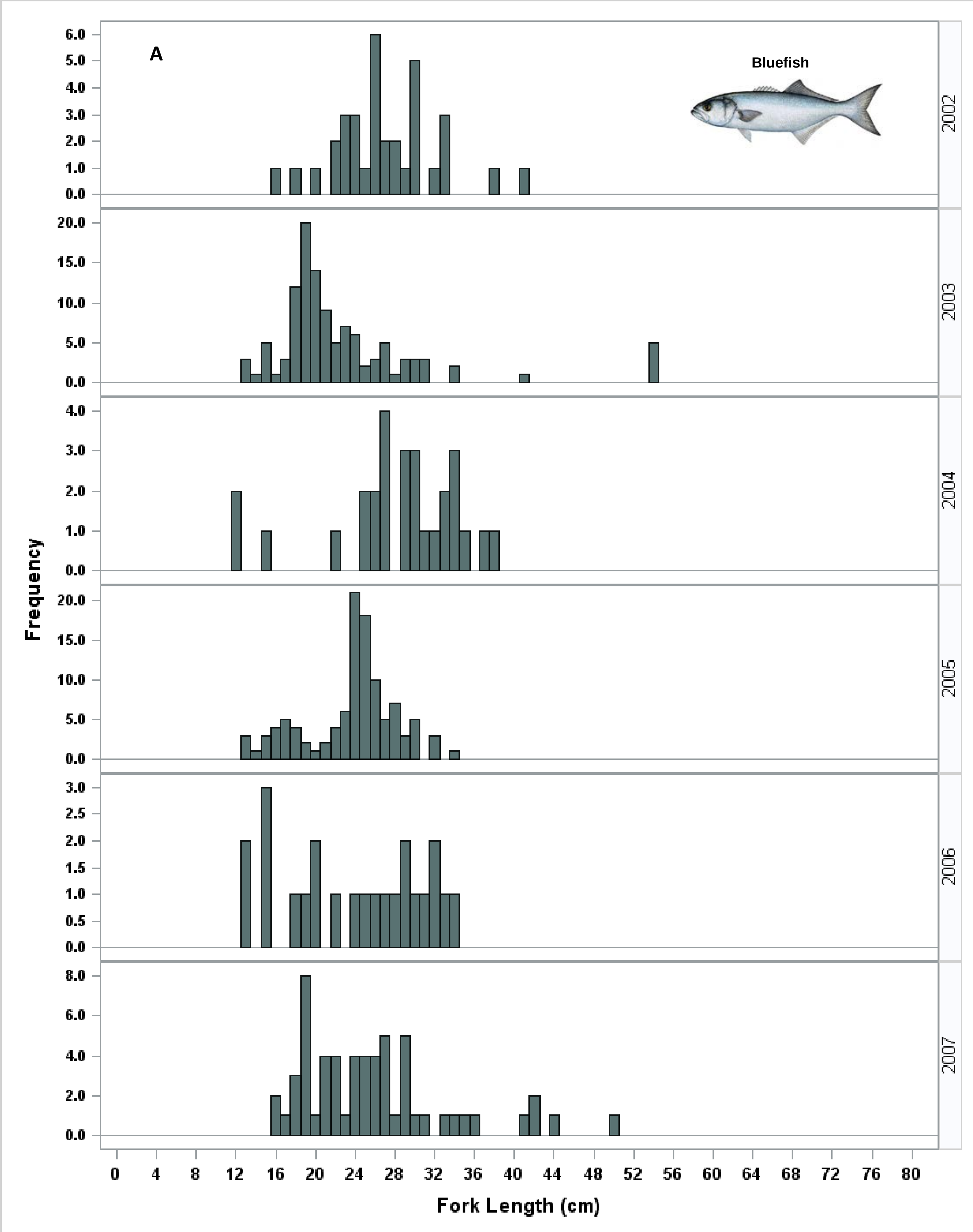


Figure 20. cont.

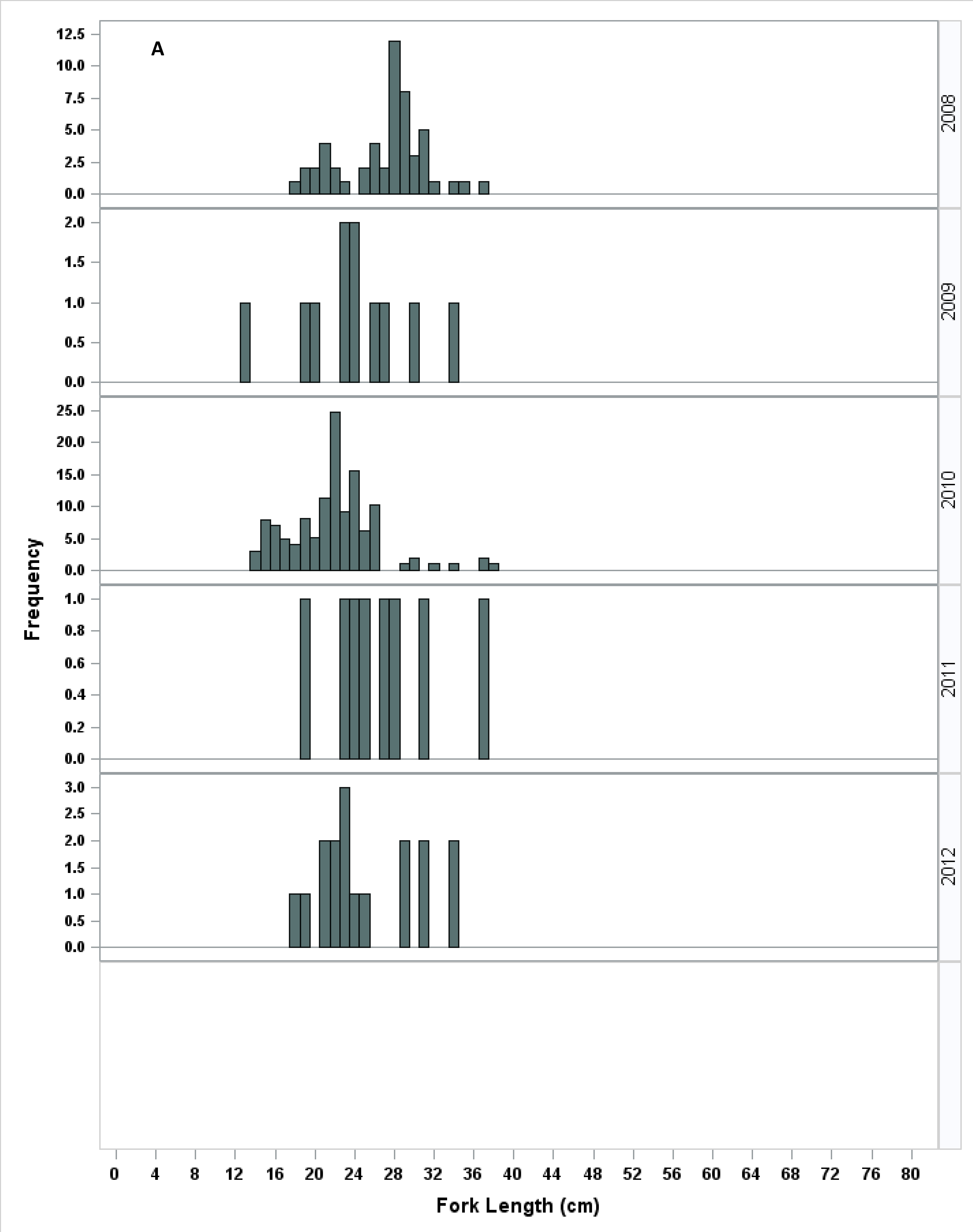


Figure 20. cont.

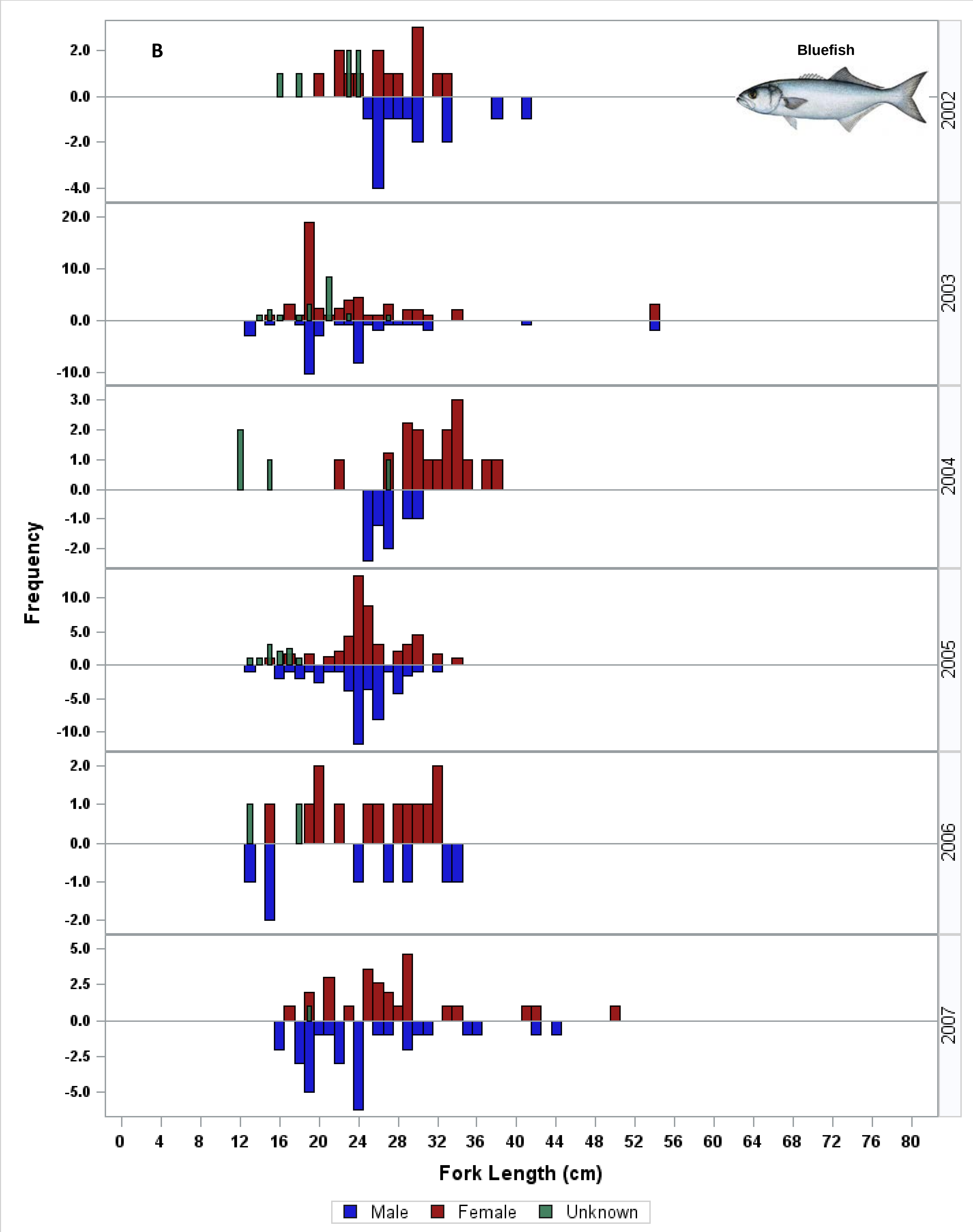


Figure 20. cont.

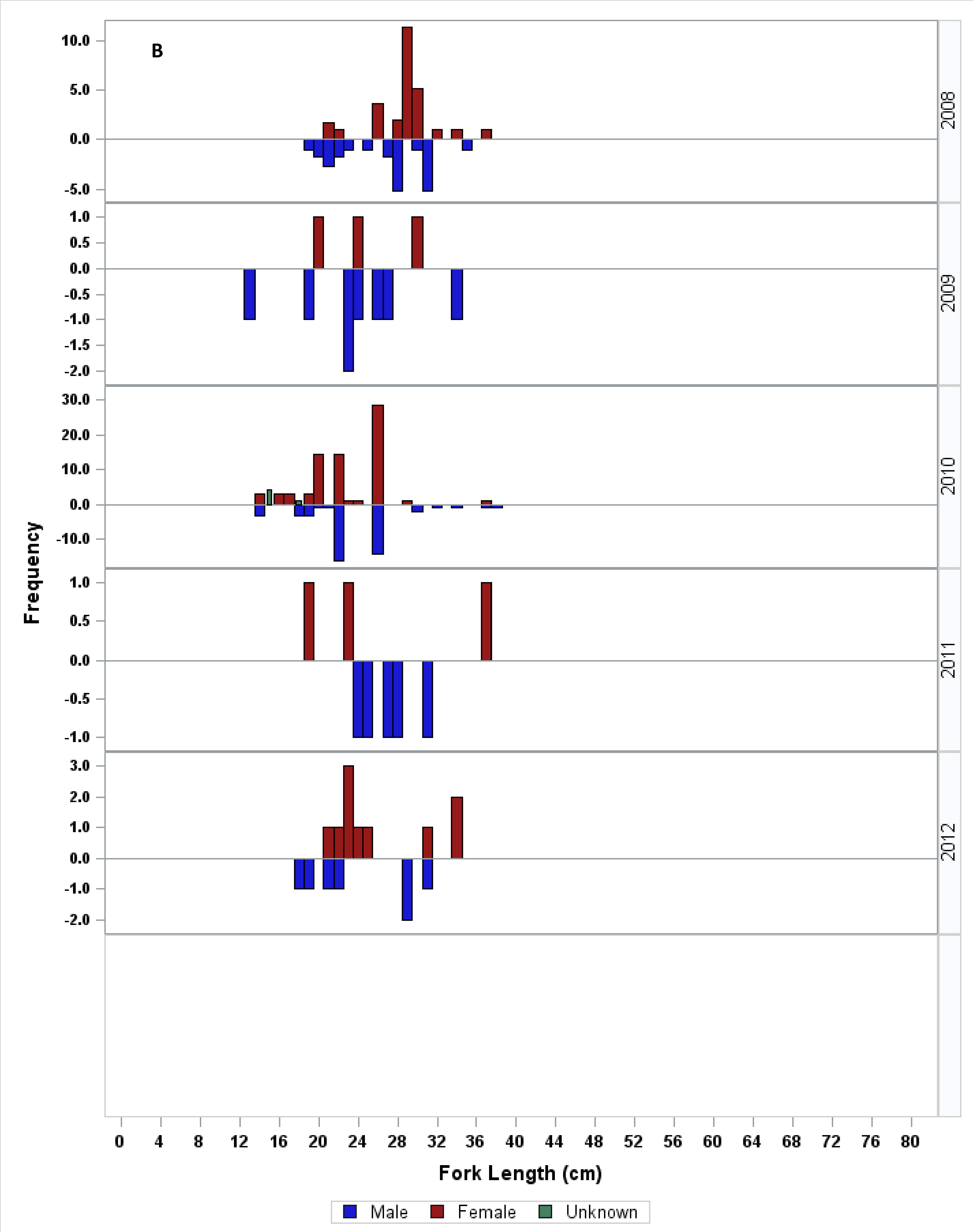


Figure 21. Bluefish age-frequency by year, 2002-2011.

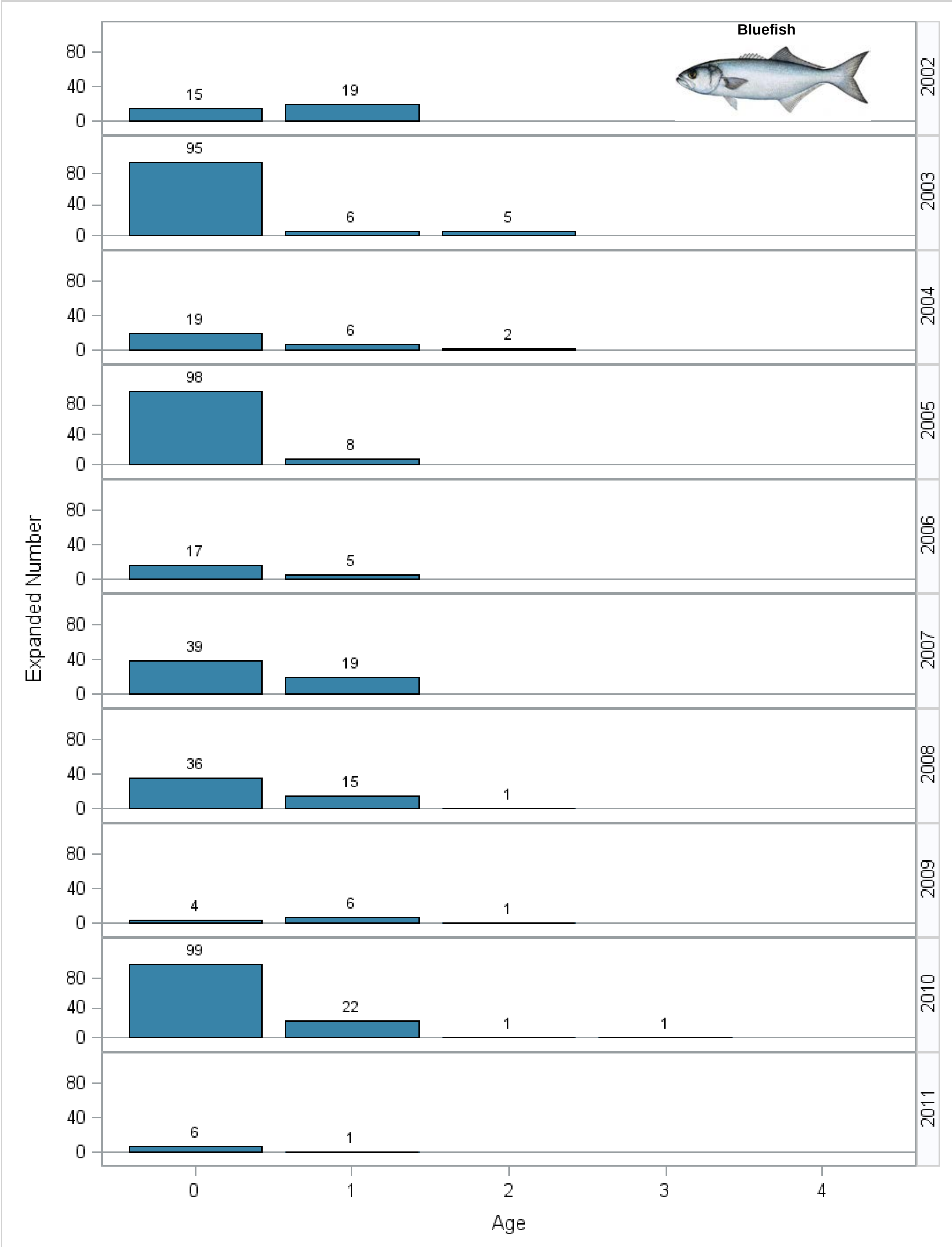


Figure 22. Bluefish age-frequency by year, 2002-2011 standardized to 8,000 annual trawl minutes.

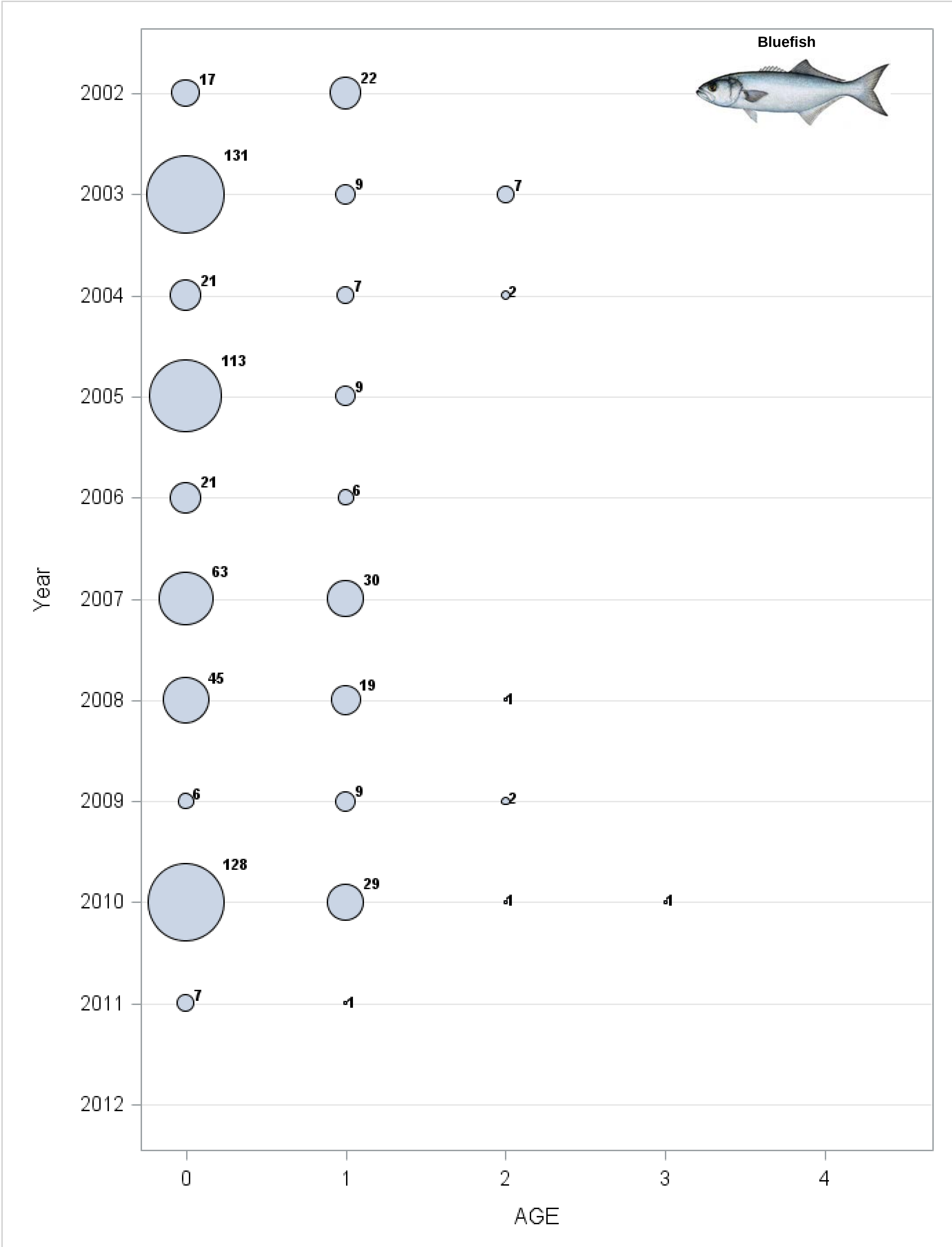


Figure 23. Bluefish age-frequency by cruise month, 2002-2011 combined, actual (A) and standardized to 8,000 total annual trawl minutes (B).

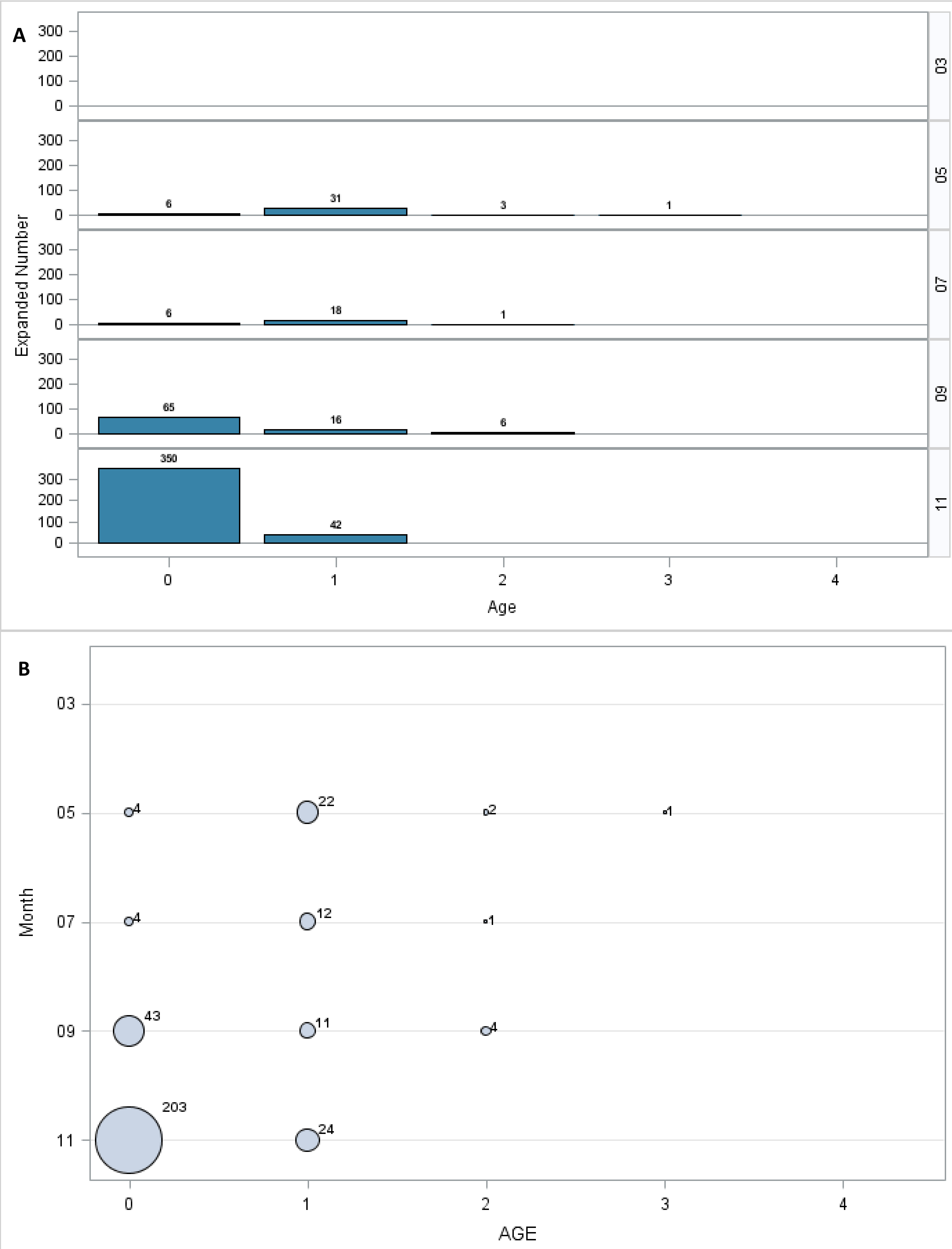


Figure 24. Diet composition, expressed as percent by weight (A) and percent by number (B) of bluefish collected during ChesMMAP cruises in 2002-2011 combined.

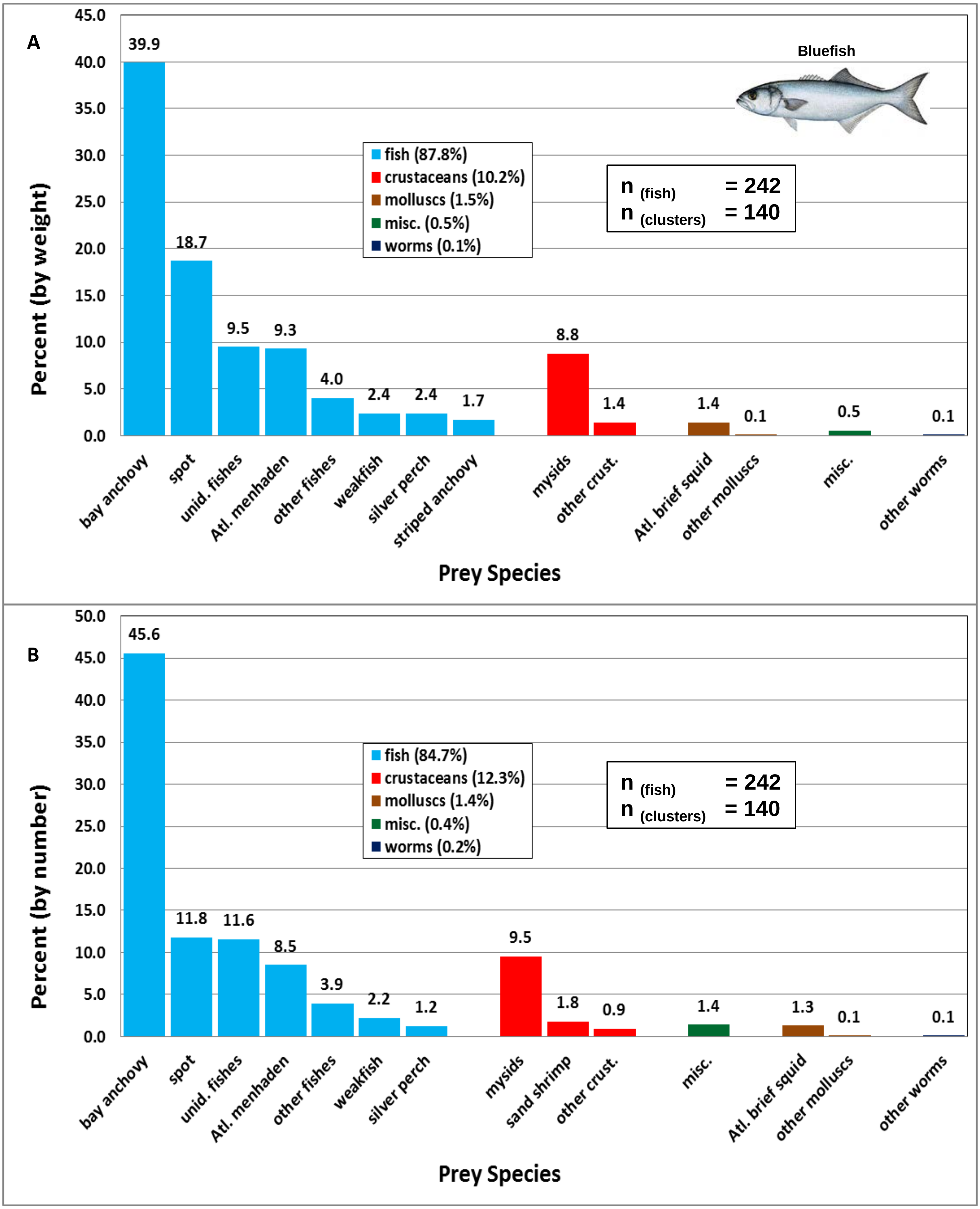


Figure 25. Abundance (kg per hectare swept) of butterfish in Chesapeake Bay, 2012.

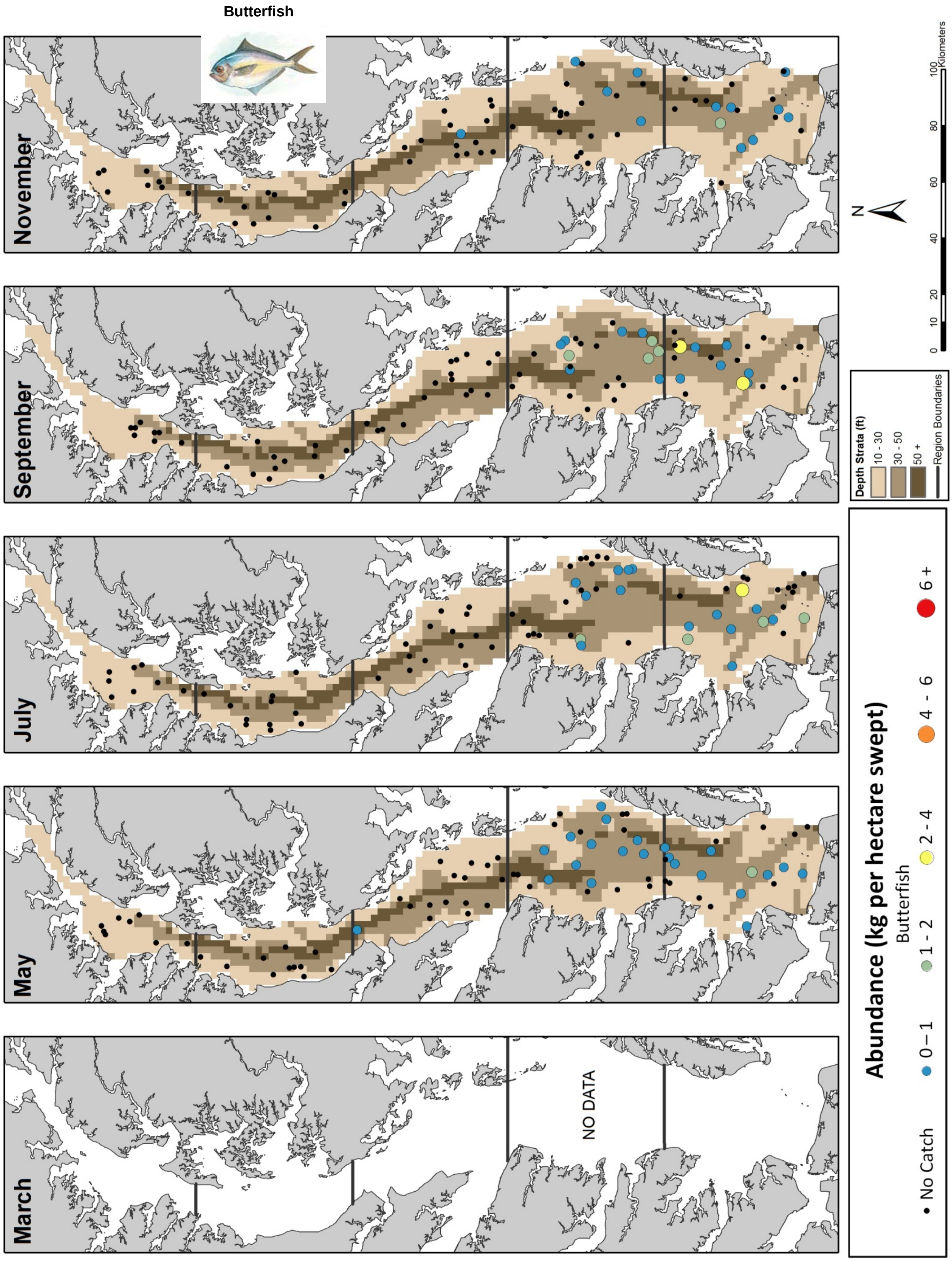


Table 8. Butterfish geometric mean indices of abundance, by number and biomass, overall and by age-class.

Year	Age	n	Numerical Index LCI	Numerical Index Index	Numerical Index UCI	Biomass Index LCI	Biomass Index Index	Biomass Index UCI
2002	All	31	10.01	31.16	92.97	1.87	3.90	7.37
2003		46	36.67	87.46	206.69	2.85	5.05	8.51
2004		42	22.19	59.34	156.01	3.40	6.53	11.87
2005		36	51.83	126.69	307.64	6.04	10.28	17.07
2006		39	32.71	81.79	202.38	4.01	7.91	14.84
2007		20	17.43	60.81	206.33	3.40	8.40	19.07
2008		39	28.64	73.82	187.87	5.10	9.89	18.45
2009		40	30.53	78.56	199.77	3.59	6.70	11.91
2010		40	5.01	13.62	34.57	1.21	2.57	4.76
2011		40	10.60	27.63	69.65	2.27	4.48	8.17
2012		37	4.87	15.12	43.31	1.77	4.24	8.88
2013								
2014								
2015								
2016								
2002	0	31	3.74	9.84	23.80	0.50	0.97	1.57
2003		46	10.58	23.30	49.97	0.67	1.09	1.61
2004		42	4.69	9.59	18.71	0.41	0.66	0.96
2005		36	10.20	23.13	50.98	0.90	1.41	2.06
2006		39	11.46	24.43	50.90	1.08	1.85	2.91
2007		20	3.20	9.03	22.96	0.49	1.19	2.23
2008		39	6.55	13.83	28.12	0.90	1.52	2.35
2009		40	14.51	32.68	72.13	1.35	2.29	3.63
2010		40	1.75	4.16	8.67	0.29	0.60	0.99
2011		40	4.17	9.45	20.13	0.70	1.37	2.31
2012		37	1.33	3.37	7.20	0.28	0.75	1.39
2013								
2014								
2015								
2016								

Year	Age	n	Numerical Index LCI	Numerical Index Index	Numerical Index UCI	Biomass Index LCI	Biomass Index Index	Biomass Index UCI
2002	1	31	6.97	19.84	53.50	1.16	2.27	3.96
2003		46	22.10	48.96	107.05	1.65	2.73	4.24
2004		42	11.40	26.09	58.20	1.53	2.59	4.11
2005		36	26.82	60.95	136.97	2.78	4.45	6.87
2006		39	19.15	43.45	97.06	2.23	4.11	7.09
2007		20	8.43	27.65	86.01	1.59	3.90	8.25
2008		39	16.09	37.16	84.20	2.66	4.77	8.10
2009		40	18.12	42.79	99.26	2.15	3.84	6.45
2010		40	3.42	8.39	18.92	0.74	1.50	2.59
2011		40	7.29	17.40	39.82	1.41	2.68	4.61
2012		37	3.41	9.57	24.32	1.11	2.49	4.78
2013								
2014								
2015								
2016								
2002	2+	31	4.96	12.94	31.59	0.82	1.75	3.17
2003		46	15.88	32.80	66.69	1.58	2.71	4.33
2004		42	14.44	36.60	90.58	2.51	4.74	8.39
2005		36	22.03	48.48	105.29	3.21	5.39	8.69
2006		39	10.58	24.36	54.53	1.72	3.59	6.74
2007		20	10.40	31.51	91.73	1.87	4.60	9.91
2008		39	13.58	32.28	74.98	2.71	5.26	9.55
2009		40	8.79	19.64	42.51	1.25	2.32	3.89
2010		40	2.64	6.58	14.76	0.63	1.41	2.55
2011		40	5.24	11.74	25.00	1.02	1.99	3.44
2012		37	3.75	10.66	27.62	1.29	2.93	5.74
2013								
2014								
2015								
2016								

Figure 26. Butterfish geometric mean indices of abundance, by number and biomass, for all ages combined and by age-class.

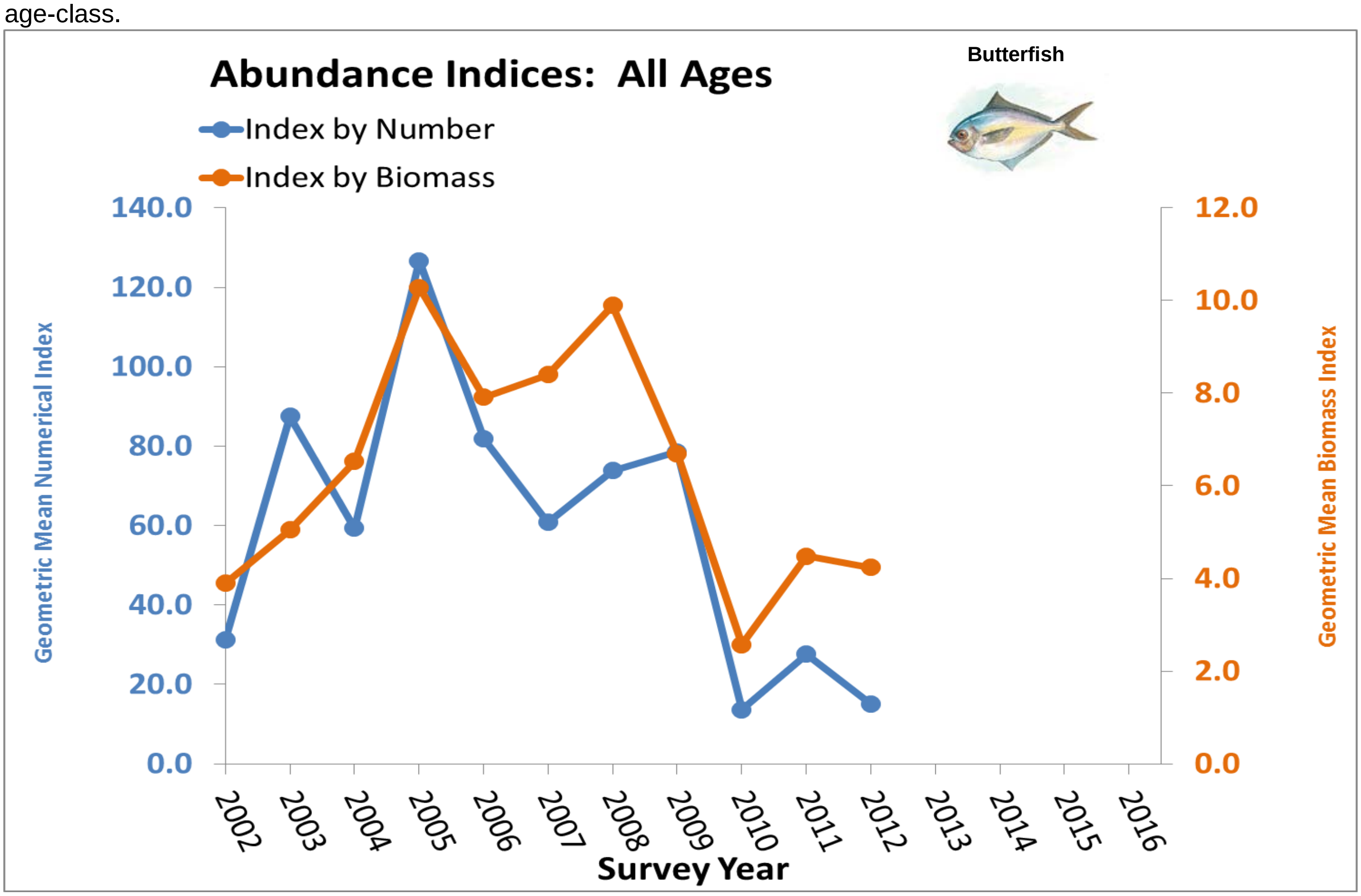


Figure 26. cont.

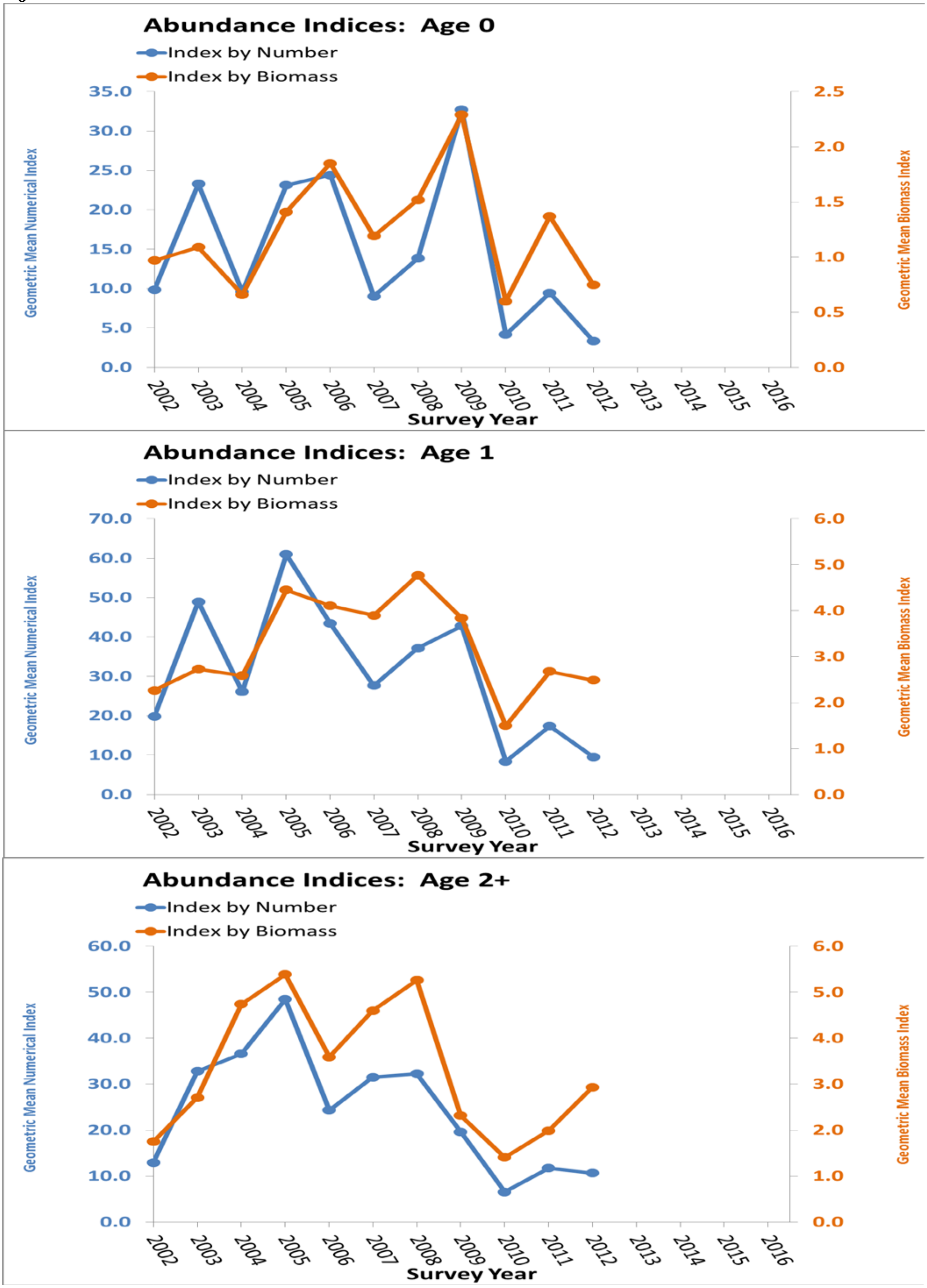
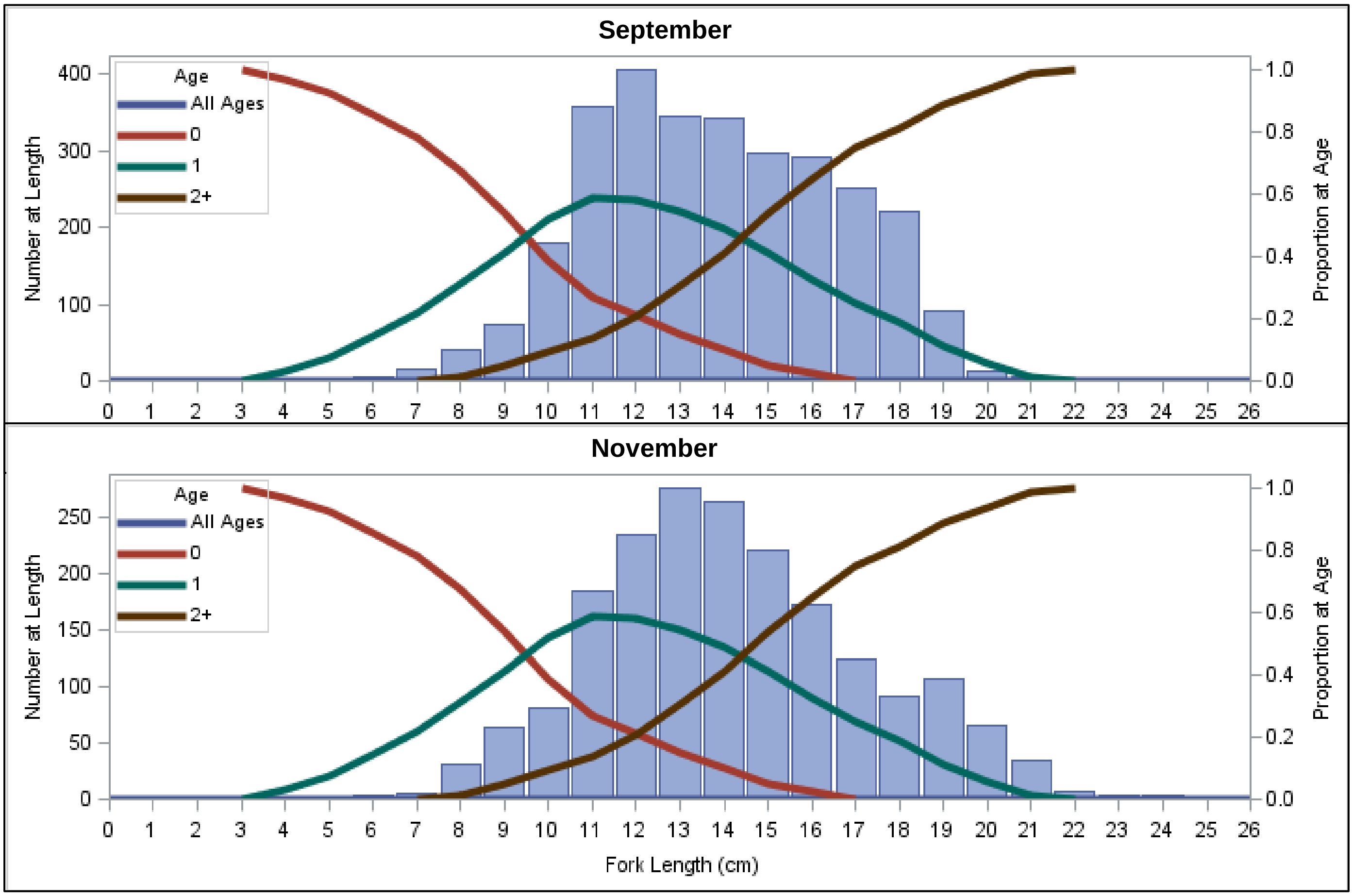


Figure 27. Butterfish ALK for all NEAMAP fall cruises, showing loess smoothed proportions at each 1cm length bin, overlaid on month-specific length frequencies pooled over all years. ALK proportions are adjusted such that the sums of values for each length bin within each month are forced to 1.0.



Fall				
Length (cm)	**Age-0**	**Age-1**	**Age-2+**	**Sum**
2				0.000
3	1.000	0.000		1.000
4	0.970	0.030		1.000
5	0.924	0.076		1.000
6	0.858	0.142		1.000
7	0.779	0.221	0.000	1.000
8	0.674	0.312	0.015	1.000
9	0.537	0.415	0.048	1.000
10	0.387	0.519	0.094	1.000
11	0.272	0.589	0.139	1.000
12	0.215	0.580	0.206	1.000
13	0.150	0.542	0.308	1.000
14	0.100	0.485	0.415	1.000
15	0.050	0.414	0.536	1.000
16	0.025	0.325	0.650	1.000
17	0.000	0.250	0.750	1.000
18		0.190	0.810	1.000
19		0.116	0.884	1.000
20		0.060	0.940	1.000
21		0.015	0.985	1.000
22		0.000	1.000	1.000

Figure 28. Butterfish length-frequency in Chesapeake Bay 2002-2012, overall.

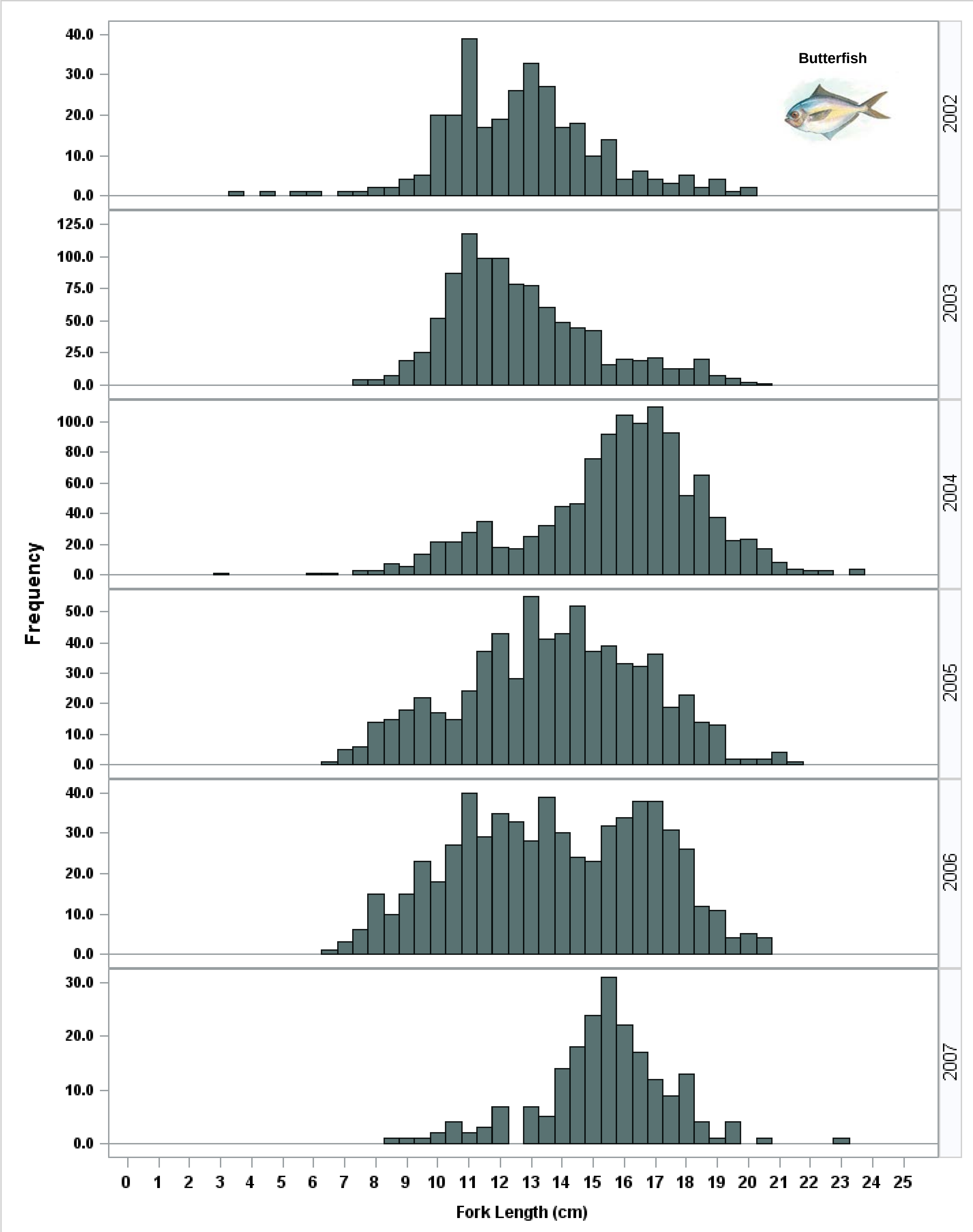


Figure 28. cont.

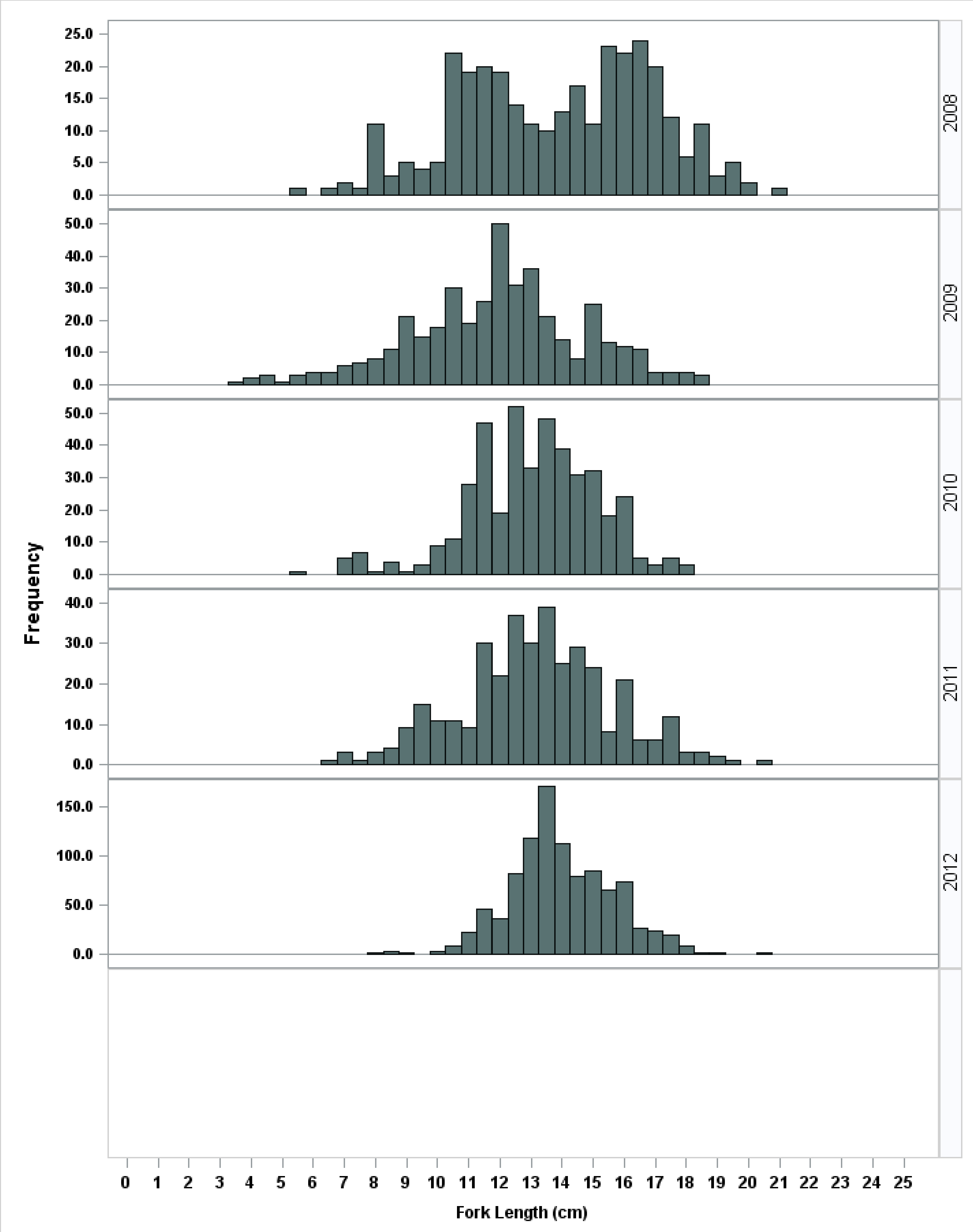


Figure 29. Abundance (kg per hectare swept) of kingfish in Chesapeake Bay, 2012.

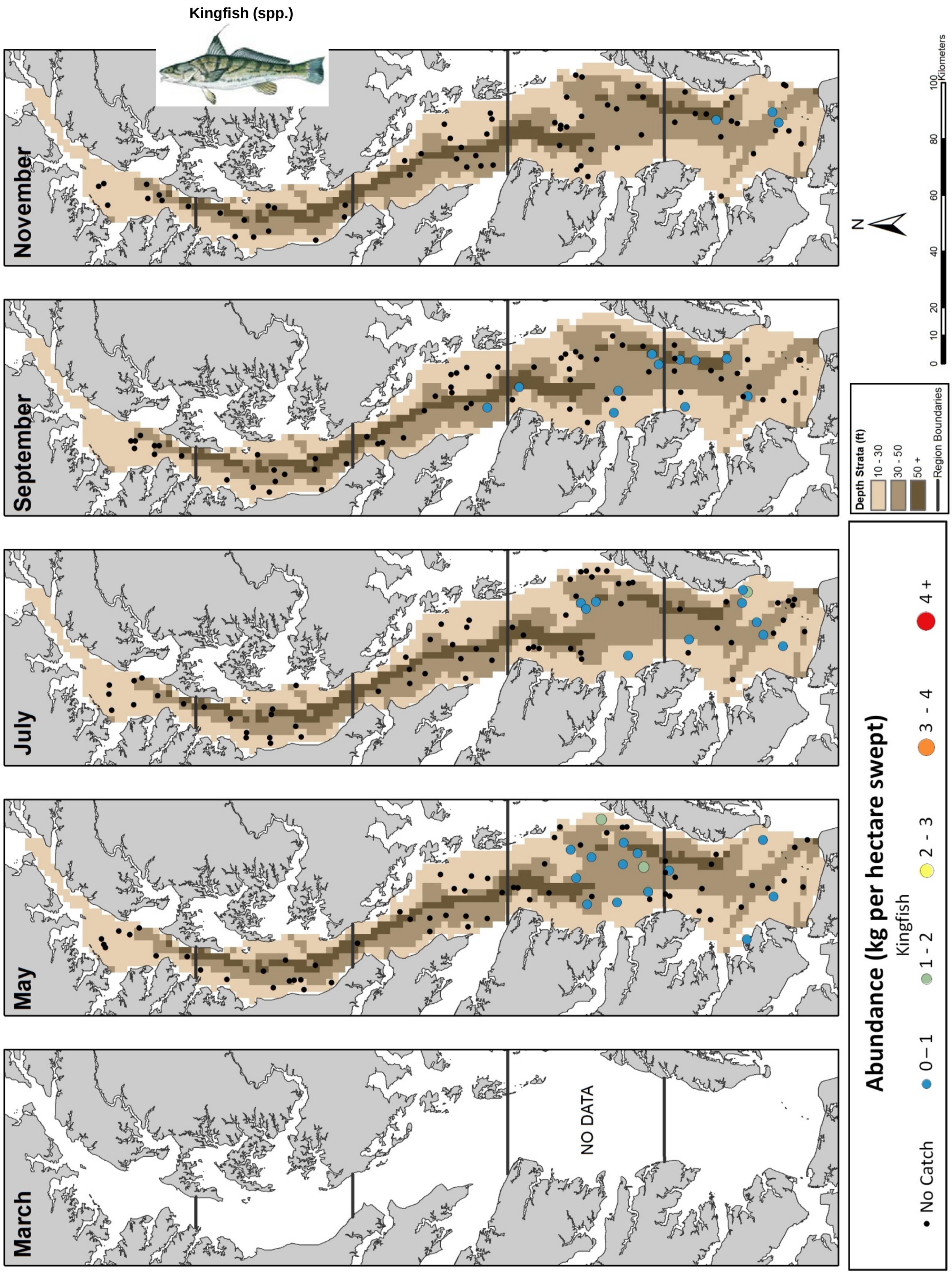


Table 9. Kingfish geometric mean indices of abundance, by number and biomass, overall and by age-class.

Year	Age	n	Numerical Index LCI	Numerical Index	Numerical Index UCI	Biomass Index LCI	Biomass Index	Biomass Index UCI
2002	All	79	0.8	1.8	3.4	0.5	1.0	1.7
2003		75	1.3	2.9	5.7	0.8	1.7	3.0
2004		94	0.8	1.7	3.1	0.4	0.9	1.6
2005		82	1.6	3.5	6.9	0.9	1.7	3.0
2006		75	4.2	8.7	17.4	2.0	3.8	6.5
2007		62	1.4	3.5	7.5	0.8	1.8	3.4
2008		84	4.7	10.0	20.2	2.1	4.1	7.2
2009		63	5.8	13.1	28.5	2.5	4.9	8.9
2010		84	5.7	12.3	25.4	2.8	5.3	9.6
2011		83	7.0	14.4	28.6	2.9	5.3	9.2
2012		82	1.3	3.0	5.7	0.7	1.4	2.5
2013								
2014								
2015								
2016								
2002	0	34	0.1	0.9	2.3	0.0	0.2	0.5
2003		51	0.1	0.6	1.3	0.1	0.2	0.4
2004		48	0.2	0.7	1.4	0.0	0.2	0.3
2005		40	1.0	3.0	7.2	0.3	0.7	1.4
2006		36	0.2	1.2	3.2	0.0	0.3	0.6
2007		21	0.0	0.9	2.9	0.0	0.3	0.8
2008		42	0.5	1.8	4.0	0.1	0.5	0.9
2009		42	0.4	1.5	3.6	0.1	0.5	1.0
2010		42	1.3	4.1	10.3	0.4	1.3	2.6
2011		41	1.2	3.1	6.7	0.4	0.8	1.4
2012		40	0.1	0.8	2.0	0.0	0.3	0.6
2013								
2014								
2015								
2016								
2002	1	79	0.2	0.6	1.1	0.1	0.3	0.5
2003		75	0.6	1.3	2.4	0.3	0.6	1.1
2004		94	0.2	0.6	1.0	0.1	0.3	0.5
2005		82	0.5	1.2	2.2	0.3	0.6	1.0
2006		75	1.0	2.1	3.8	0.5	0.9	1.4
2007		62	0.4	1.0	2.0	0.2	0.5	0.9
2008		84	1.4	2.9	5.4	0.7	1.4	2.3
2009		63	2.6	5.6	10.8	1.1	2.0	3.3
2010		84	2.5	5.2	9.8	1.2	2.2	3.8
2011		83	2.6	5.1	9.3	1.1	2.0	3.3
2012		82	0.5	1.2	2.2	0.2	0.6	0.9
2013								
2014								
2015								
2016								

Year	Age	n	Numerical Index LCI	Numerical Index	Numerical Index UCI	Biomass Index LCI	Biomass Index	Biomass Index UCI
2002	2	79	0.4	1.0	1.8	0.2	0.5	0.9
2003		75	0.7	1.6	2.9	0.4	0.9	1.5
2004		94	0.3	0.8	1.5	0.2	0.5	0.8
2005		82	0.8	1.6	2.9	0.4	0.9	1.4
2006		75	2.2	4.3	7.9	1.1	2.0	3.2
2007		62	0.8	1.9	3.8	0.5	1.0	1.8
2008		84	2.1	4.3	8.1	1.1	2.2	3.7
2009		63	2.8	5.9	11.6	1.3	2.4	4.1
2010		84	3.4	6.8	12.7	1.7	3.1	5.1
2011		83	3.5	6.6	12.0	1.6	2.8	4.6
2012		82	0.7	1.6	3.0	0.4	0.9	1.4
2013								
2014								
2015								
2016								
2002	3+	79	0.5	1.1	1.9	0.3	0.6	1.1
2003		75	0.8	1.8	3.3	0.5	1.1	1.8
2004		94	0.4	1.0	1.7	0.3	0.6	1.1
2005		82	0.8	1.7	3.1	0.5	1.0	1.6
2006		75	2.3	4.6	8.3	1.3	2.3	3.7
2007		62	0.8	2.0	4.0	0.5	1.1	2.1
2008		84	1.8	3.8	7.2	1.0	2.0	3.5
2009		63	2.0	4.2	7.9	1.0	1.9	3.2
2010		84	3.0	5.8	10.6	1.5	2.7	4.5
2011		83	2.8	5.4	9.6	1.4	2.5	4.0
2012		82	0.7	1.5	2.6	0.4	0.8	1.2
2013								
2014								
2015								
2016								

Figure 30. Kingfish geometric mean indices of abundance, by number and biomass, for all ages combined and by age-class.

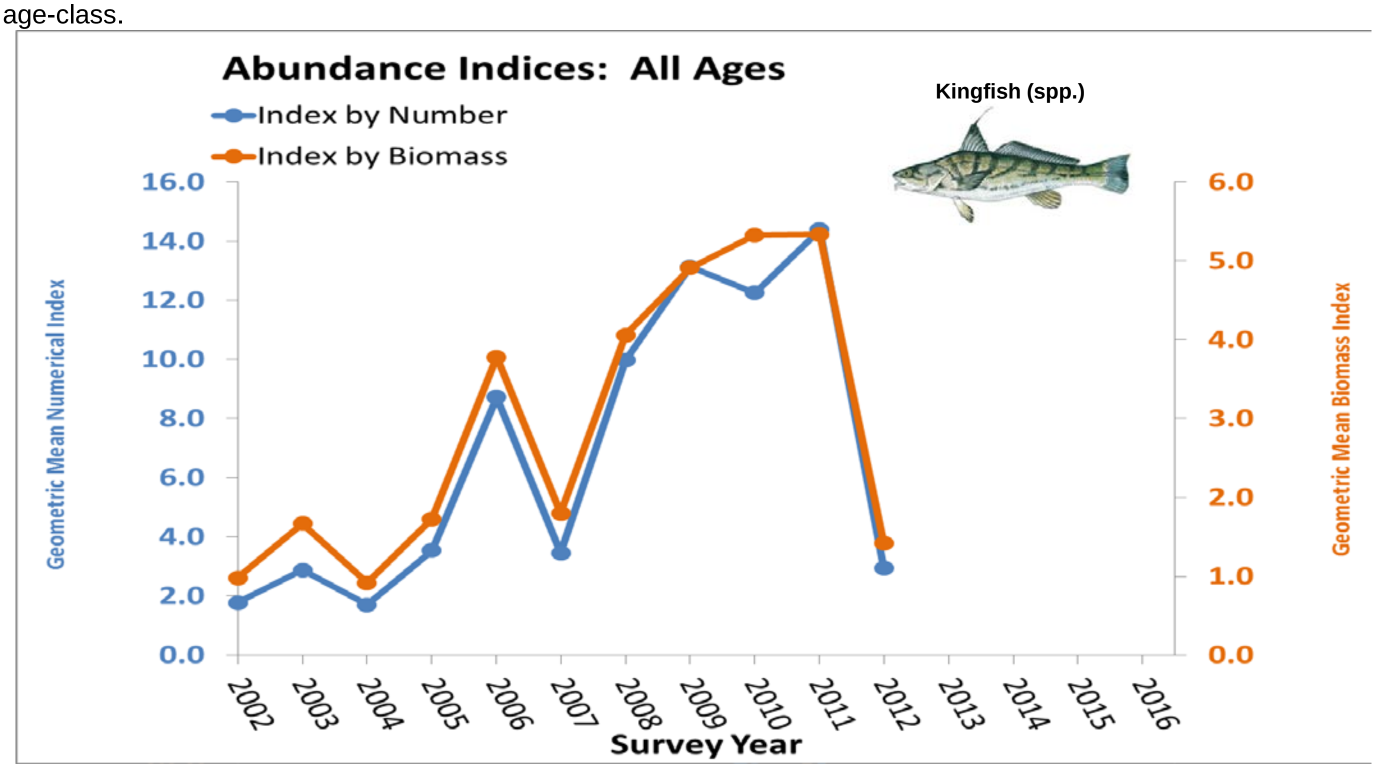
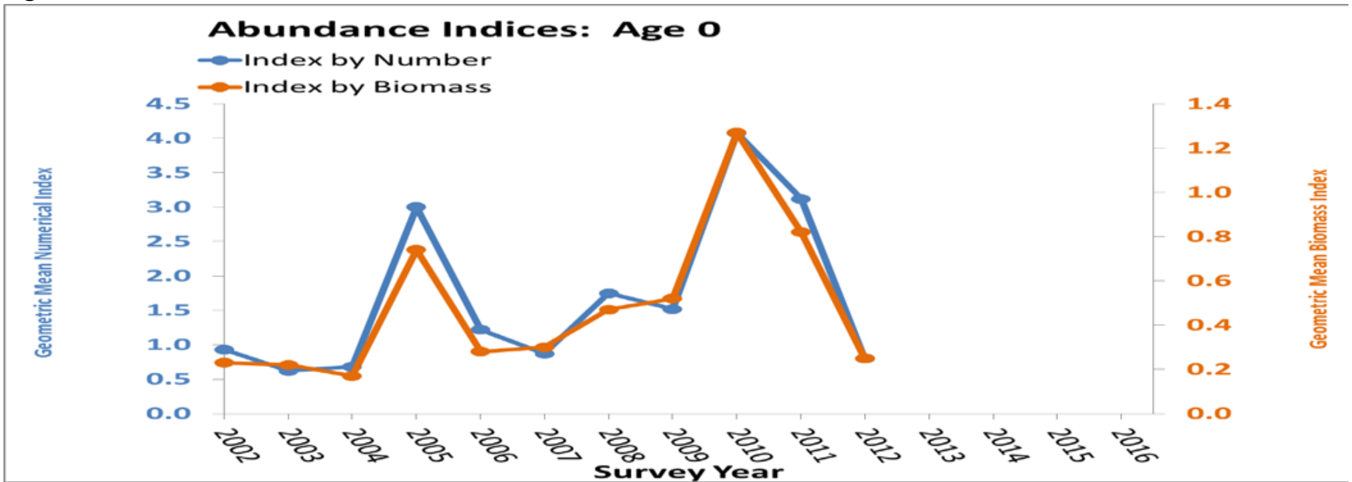
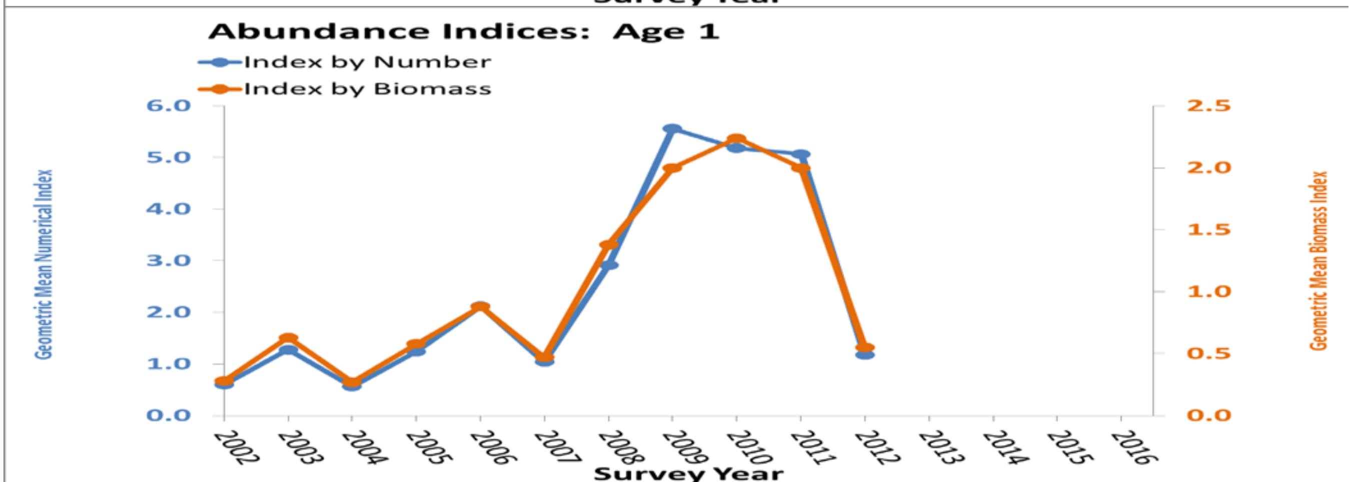
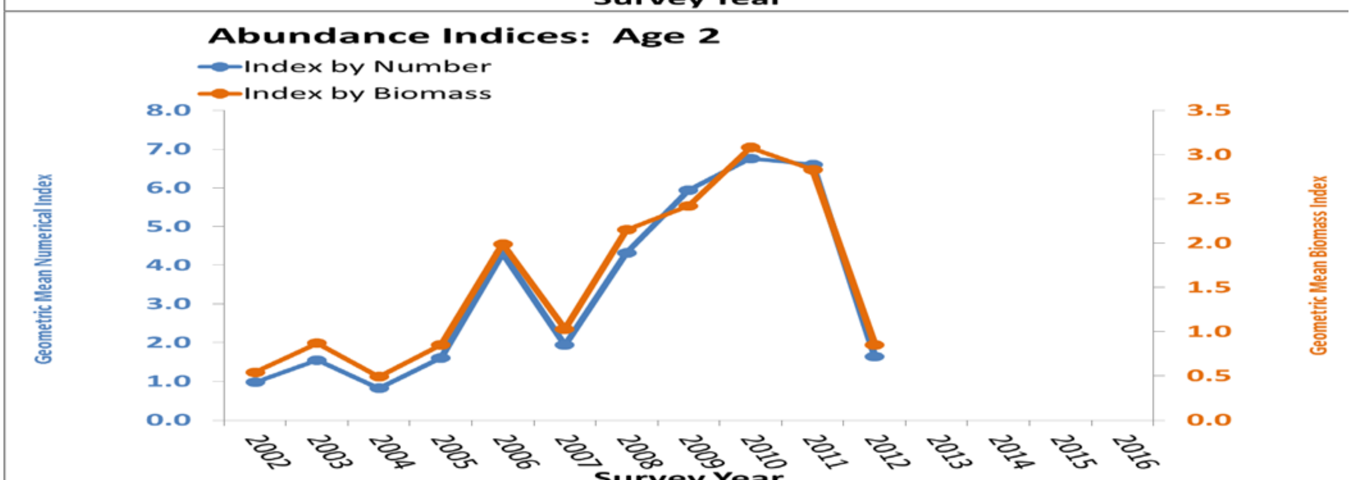


Figure 30. cont.







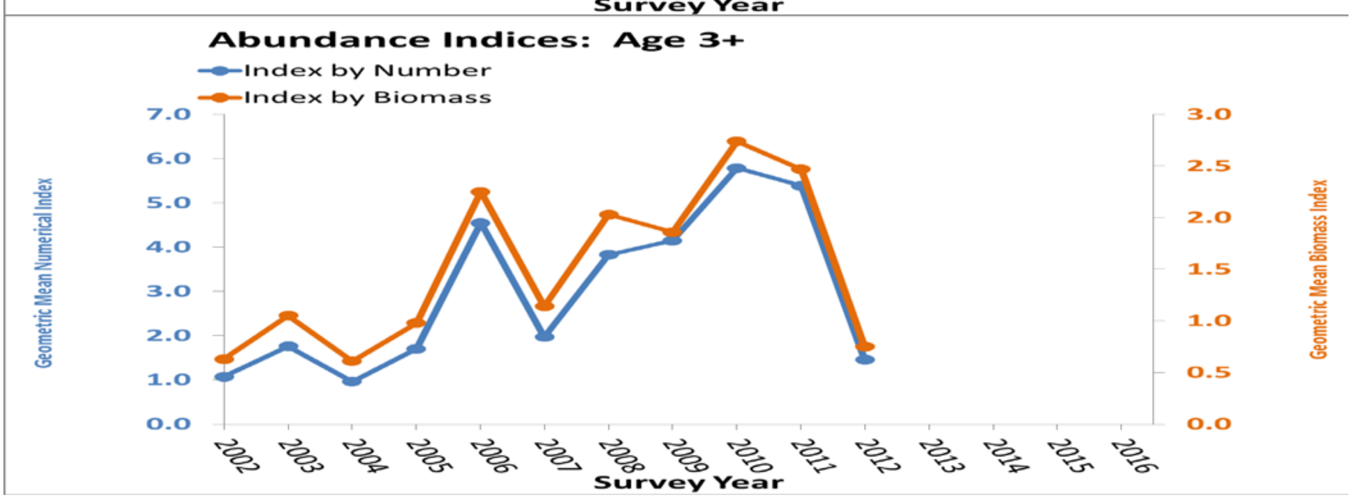


Figure 31. Kingfish ALK for all May/July, and September/Novembers cruises, showing loess smoothed proportions at each 1cm length bin, overlaid on month-specific length frequencies pooled over all years. ALK proportions are adjusted such that the sums of values for each length bin within each month are forced to 1.0

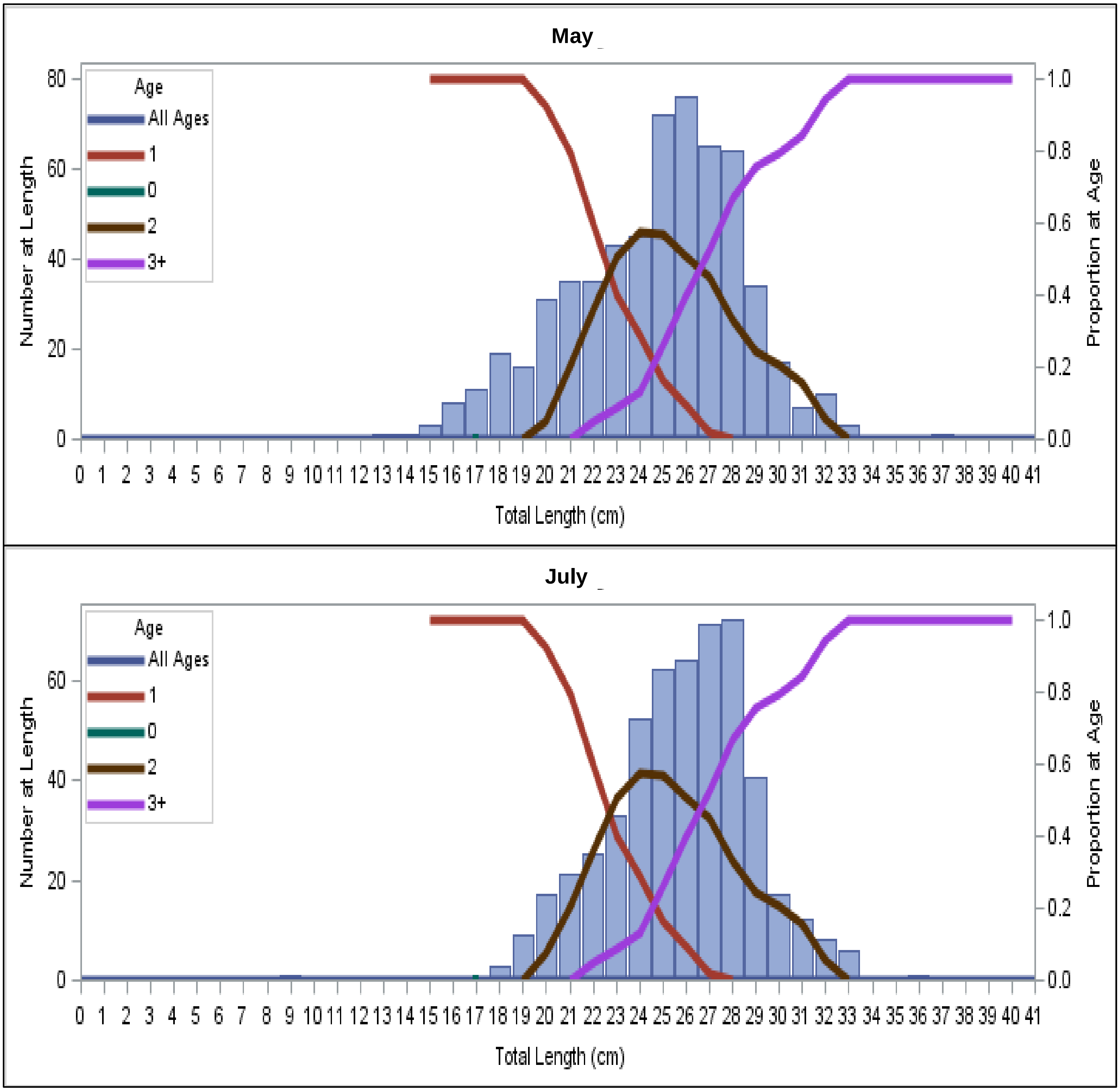
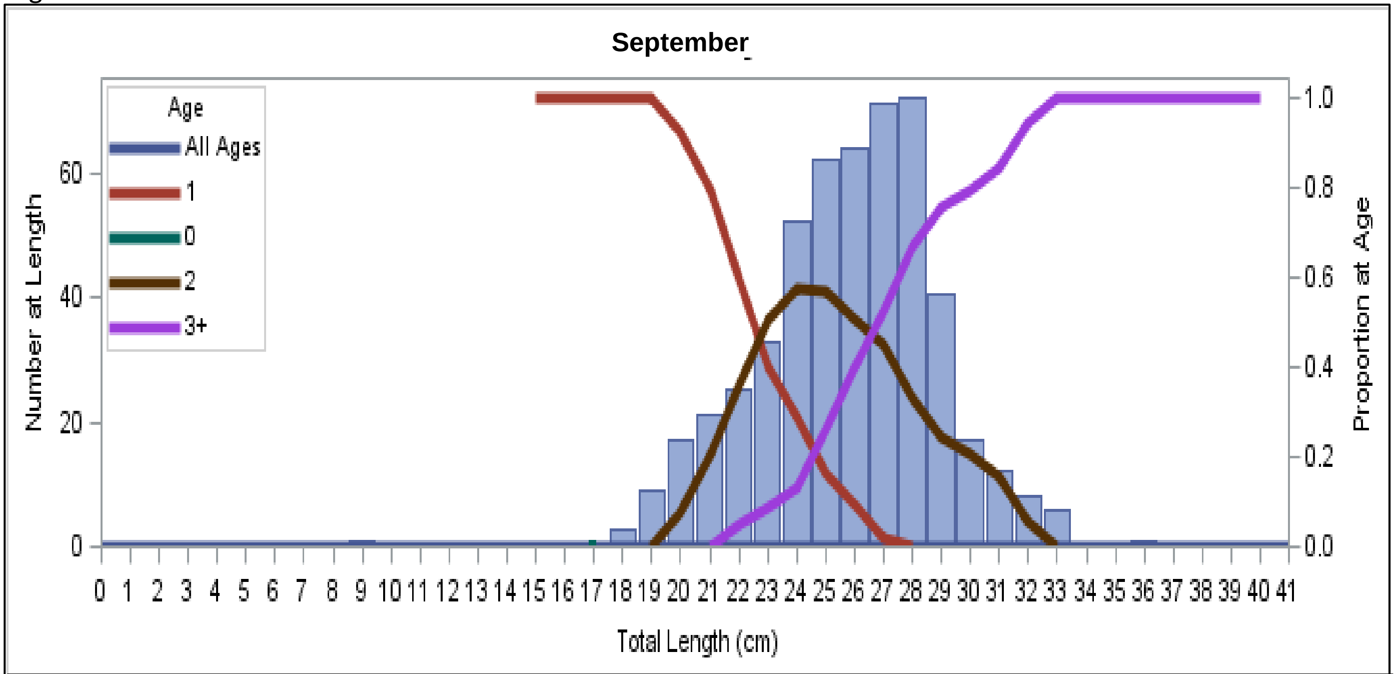
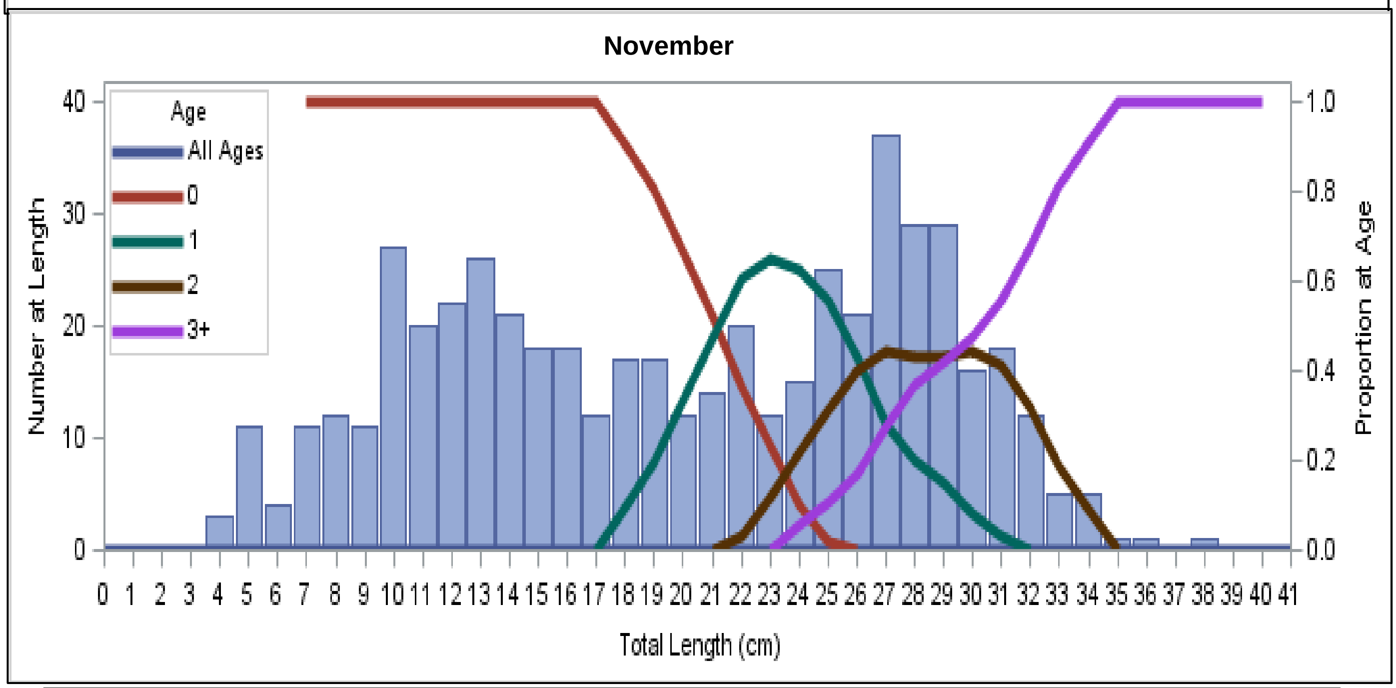


Figure 31. cont.





May - July						September - November					
Length (cm)	Age-0	Age-1	Age-2	Age-3+	Sum	Length (cm)	Age-0	Age-1	Age-2	Age-3+	Sum
15						15					
16						16					
17						17	1.000	0.000			1.000
18						18	0.908	0.092			1.000
19		1.000	0.000		1.000	19	0.808	0.192			1.000
20		0.926	0.074		1.000	20	0.668	0.332			1.000
21		0.795	0.205	0.000	1.000	21	0.516	0.484	0.000		1.000
22		0.591	0.361	0.048	1.000	22	0.361	0.605	0.034		1.000
23		0.403	0.509	0.089	1.000	23	0.234	0.648	0.118	0.000	1.000
24		0.288	0.577	0.135	1.000	24	0.100	0.623	0.219	0.059	1.000
25		0.163	0.571	0.266	1.000	25	0.018	0.556	0.316	0.110	1.000
26		0.094	0.504	0.402	1.000	26	0.000	0.430	0.398	0.172	1.000
27		0.020	0.452	0.528	1.000	27		0.282	0.444	0.275	1.000
28		0.000	0.334	0.666	1.000	28		0.203	0.430	0.367	1.000
29			0.244	0.756	1.000	29		0.150	0.430	0.420	1.000
30			0.205	0.795	1.000	30		0.081	0.444	0.475	1.000
31			0.155	0.845	1.000	31		0.032	0.414	0.554	1.000
32			0.059	0.941	1.000	32		0.000	0.322	0.678	1.000
33			0.000	1.000	1.000	33			0.190	0.810	1.000
34						34			0.089	0.911	1.000
35						35			0.000	1.000	1.000

Figure 32. Kingfish length-frequency in Chesapeake Bay 2002-2012, overall (A) and by sex (B).

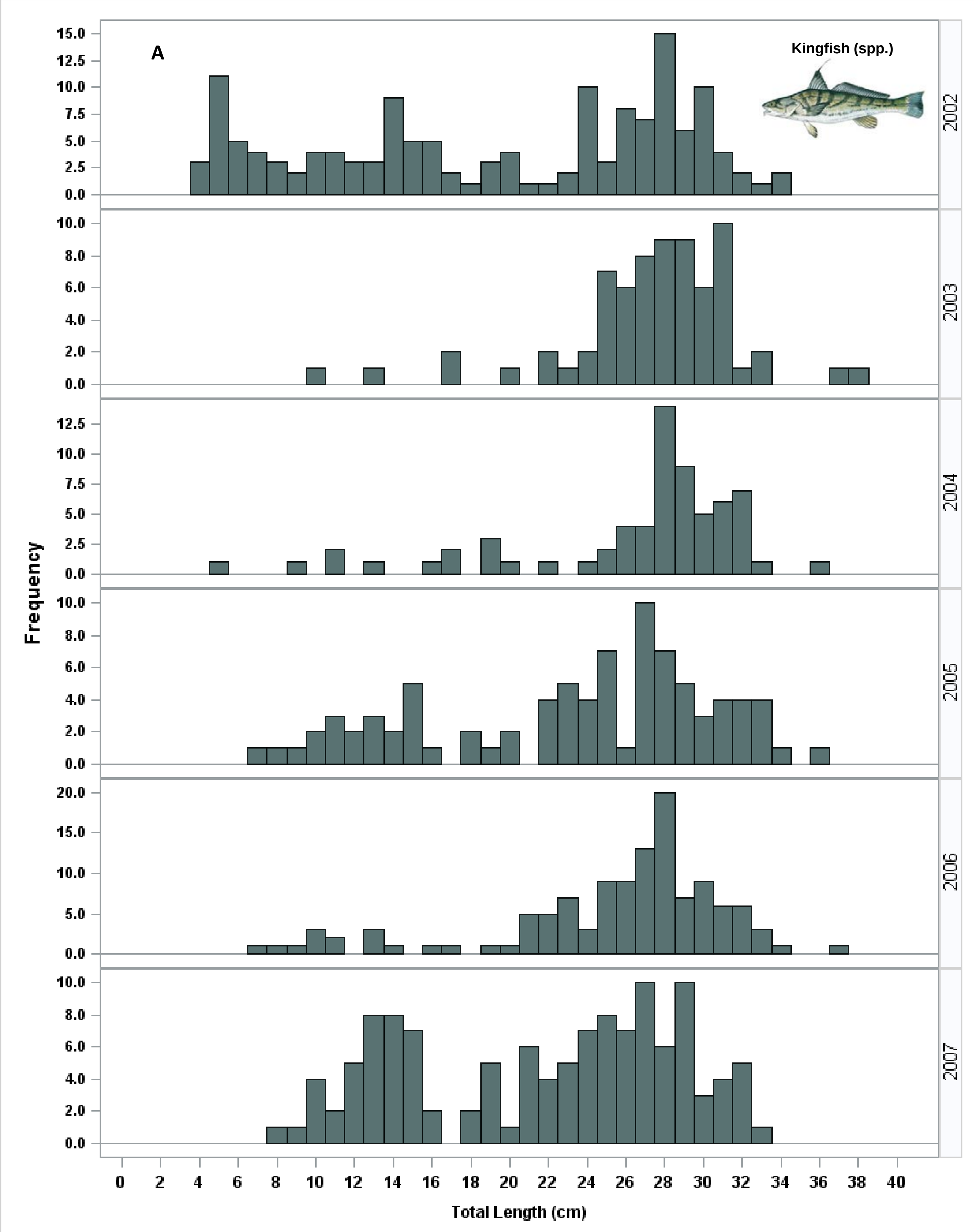


Figure 32. cont.

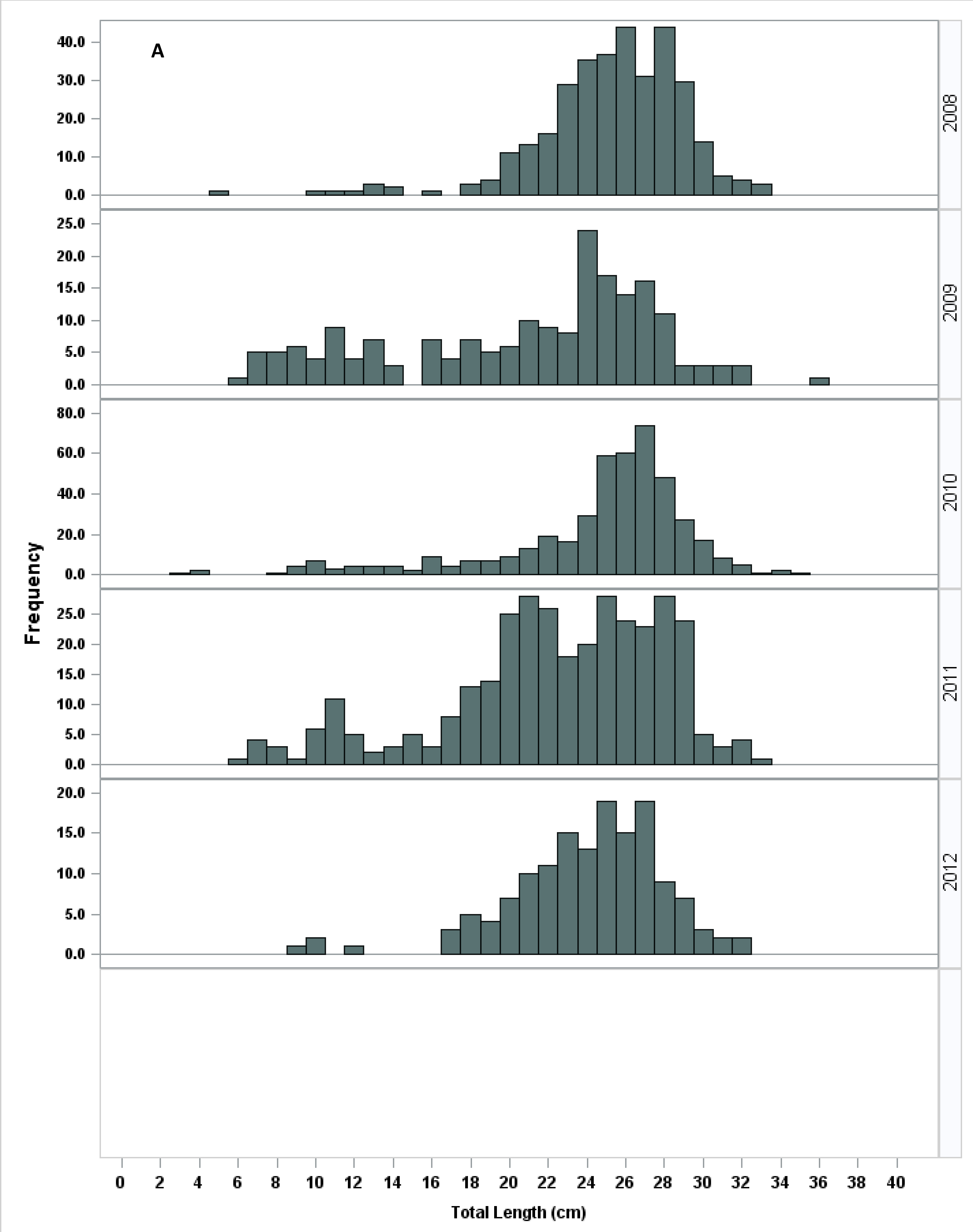


Figure 32. cont.

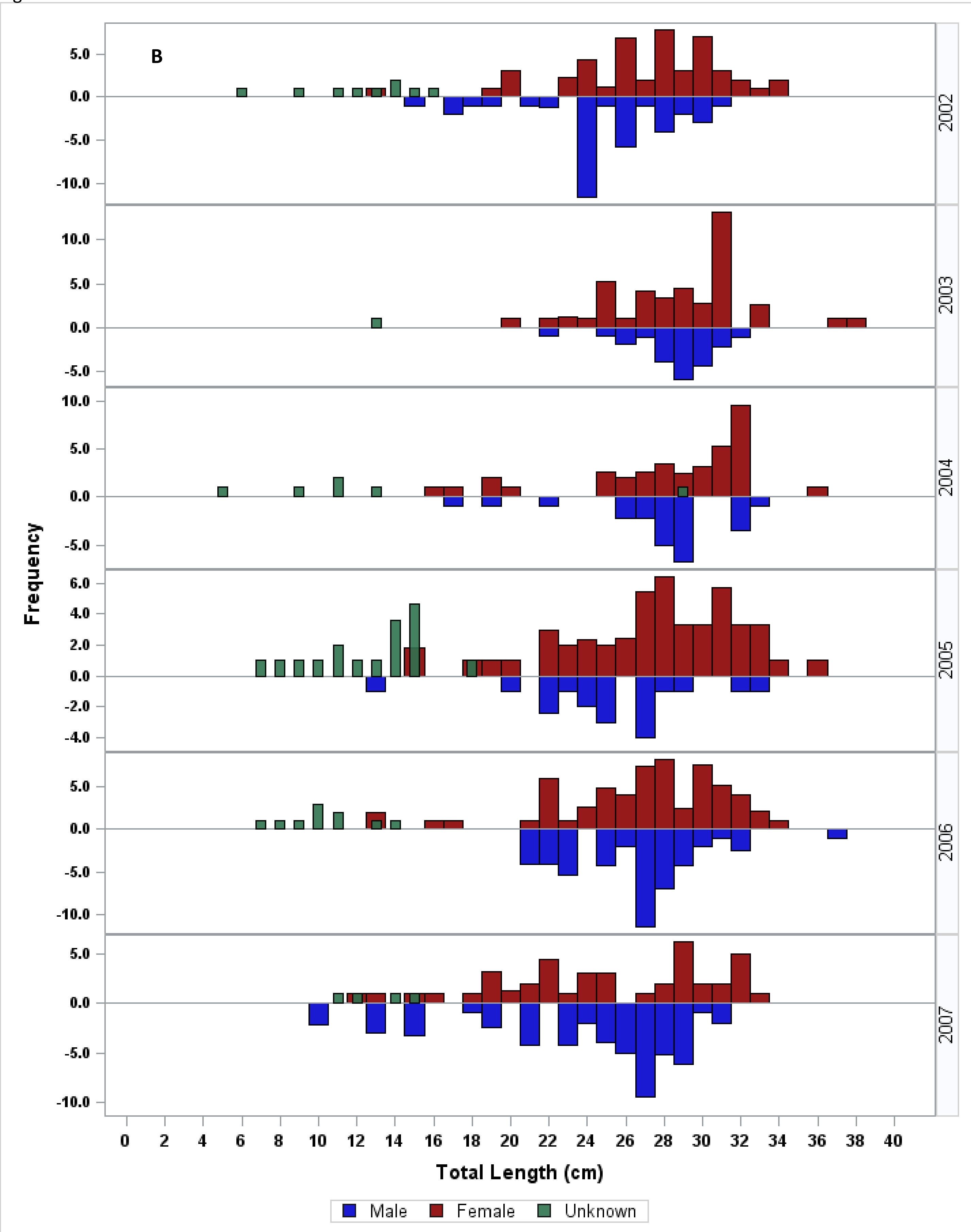


Figure 32. cont.

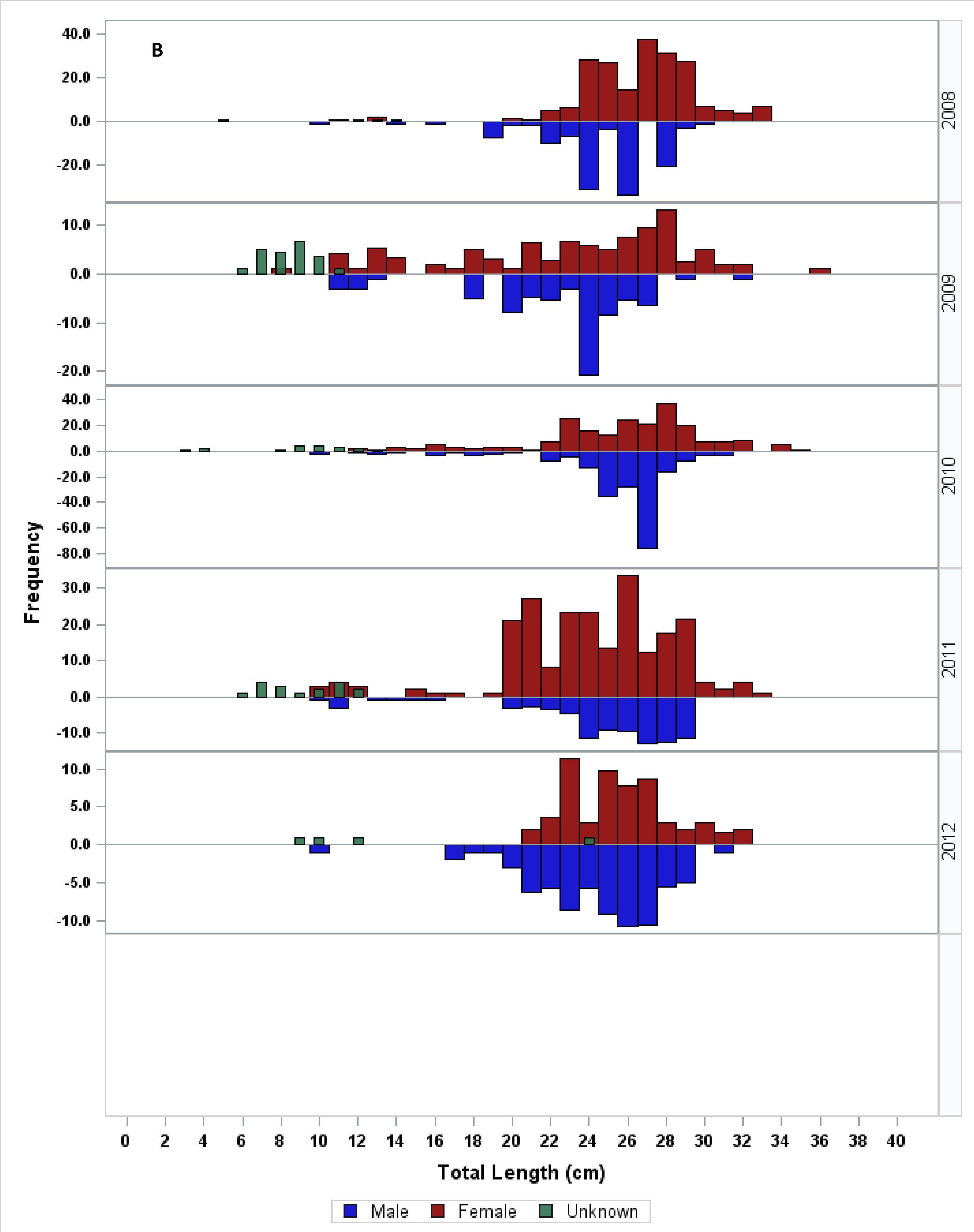


Figure 33. Kingfish age-frequency by year, 2002-2011.

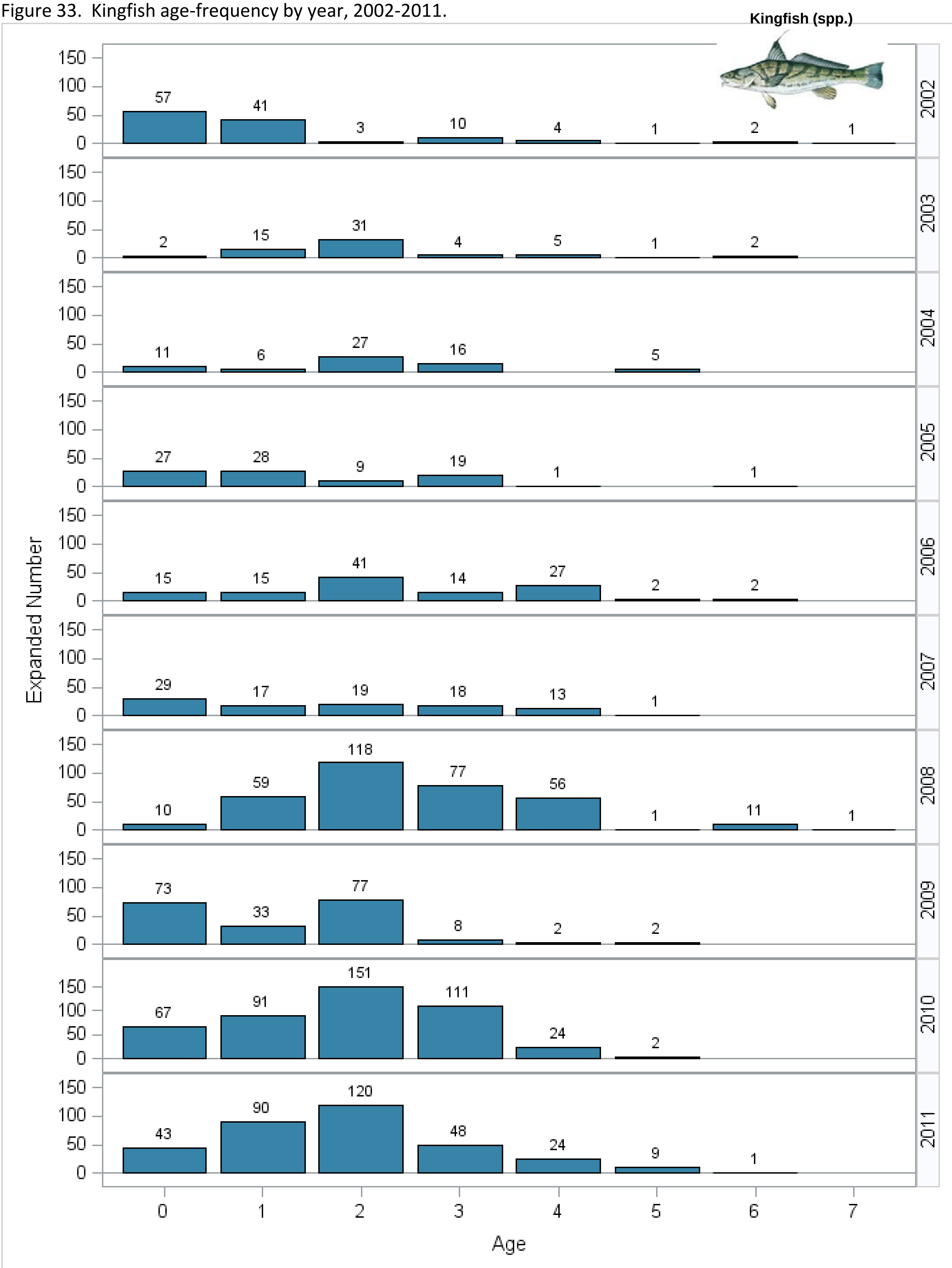


Figure 34. Kingfish age-frequency by year, 2002-2011 standardized to 8,000 annual trawl minutes.

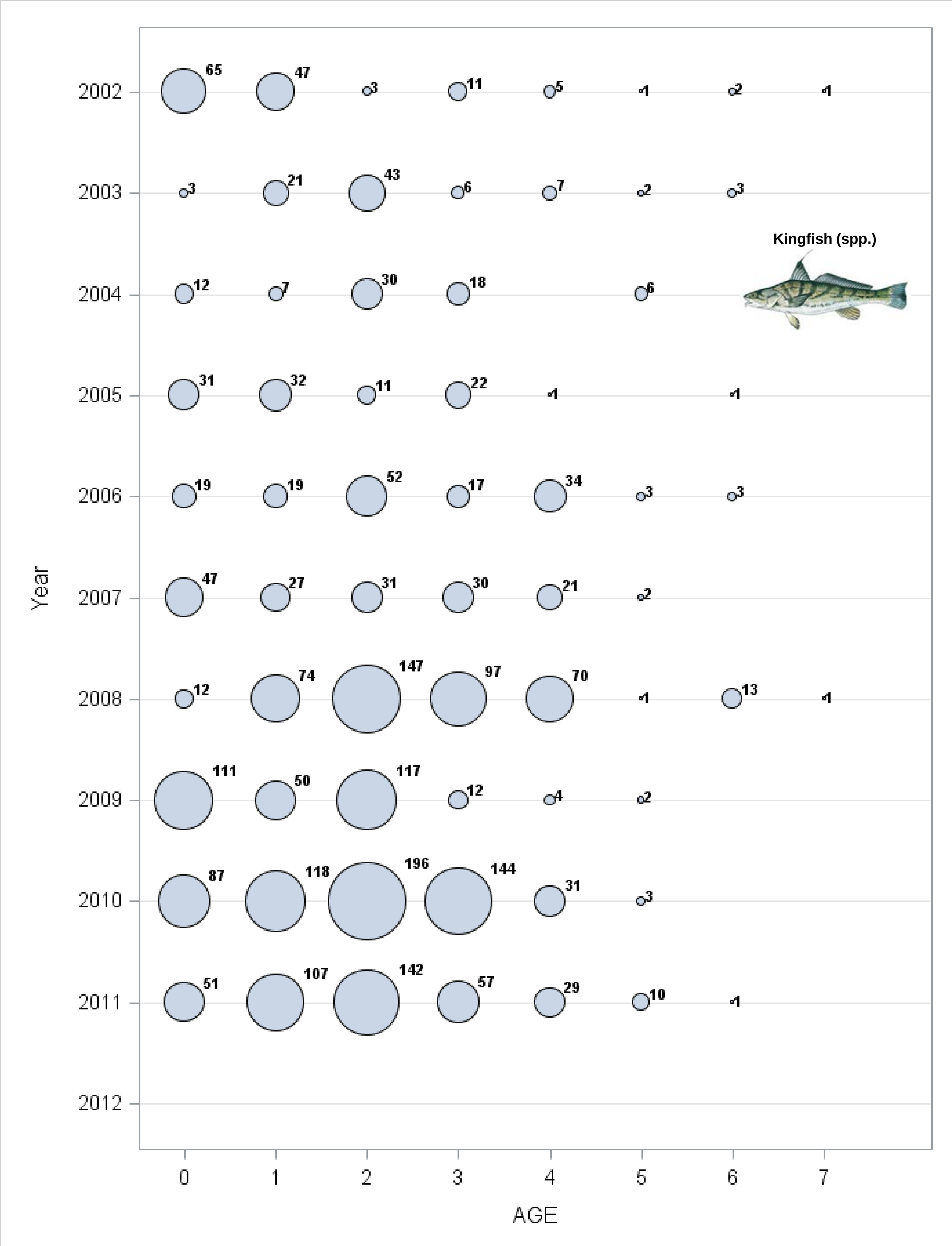


Figure 35. Kingfish age-frequency by cruise month, 2002-2011 combined, actual (A) and standardized to 8,000 total annual trawl minutes (B).

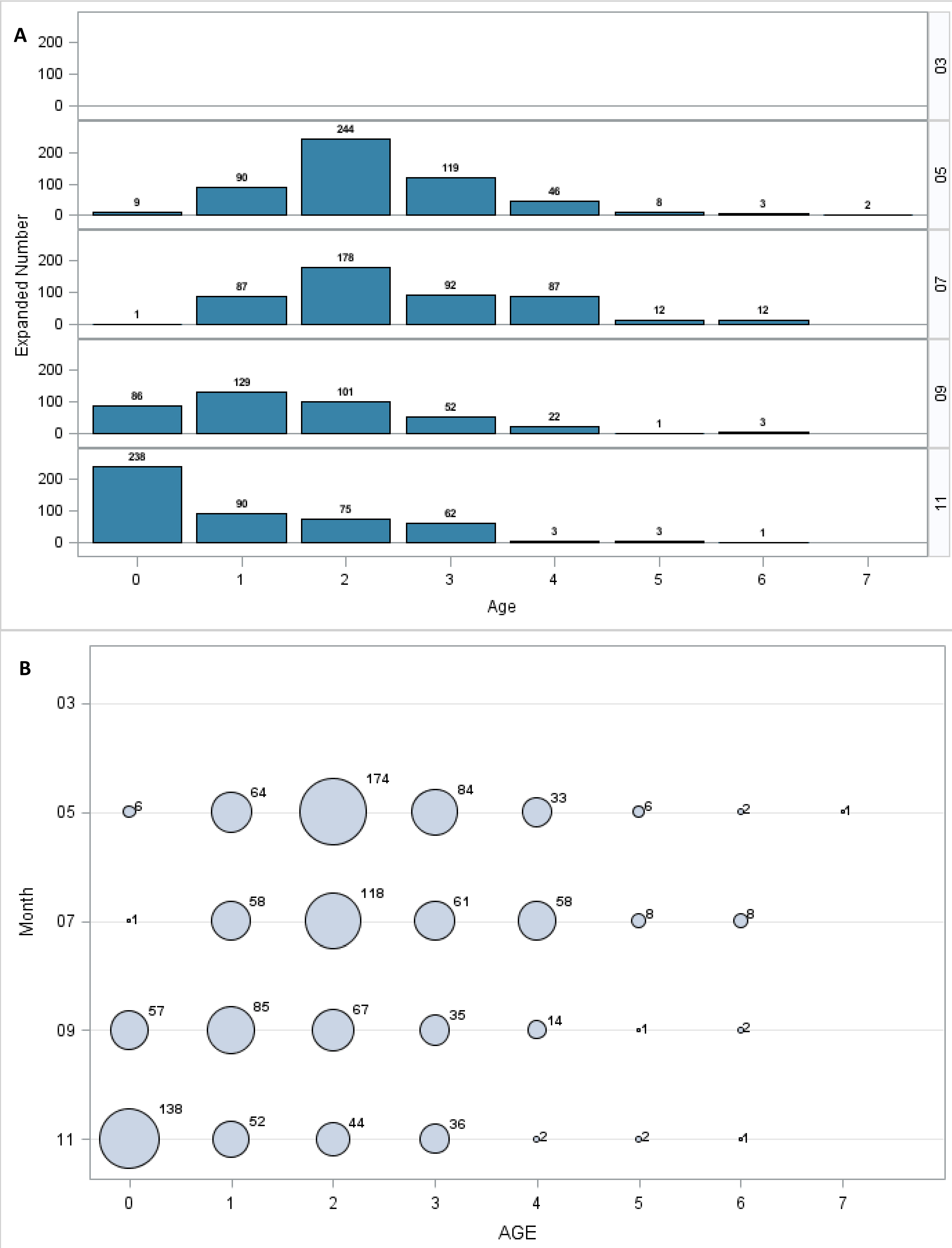


Figure 36. Diet composition, expressed as percent by weight (A) and percent by number (B) of kingfish collected during ChesMMAP cruises in 2002-2011 combined.

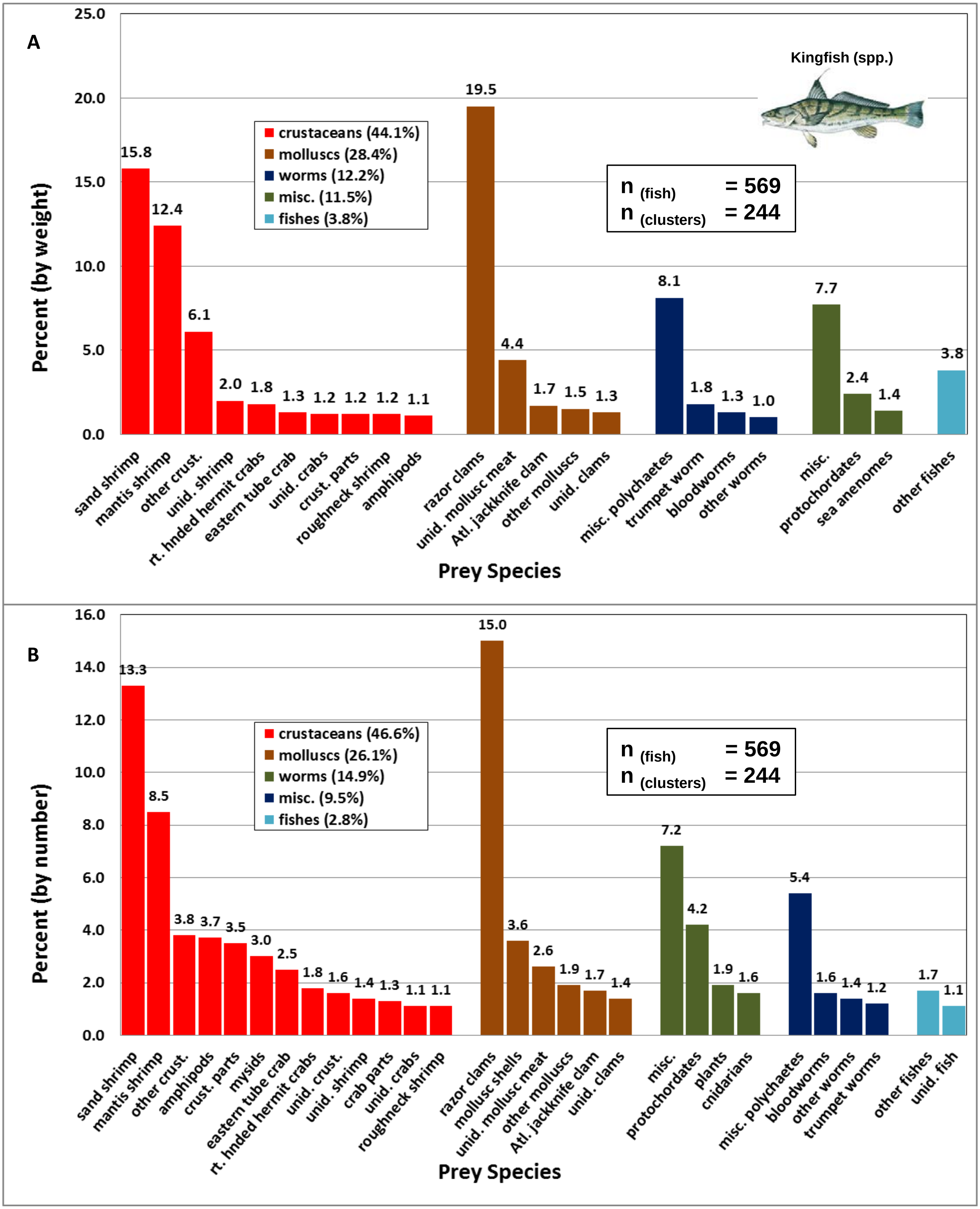


Figure 37. Abundance (kg per hectare swept) of northern puffer in Chesapeake Bay, 2012.

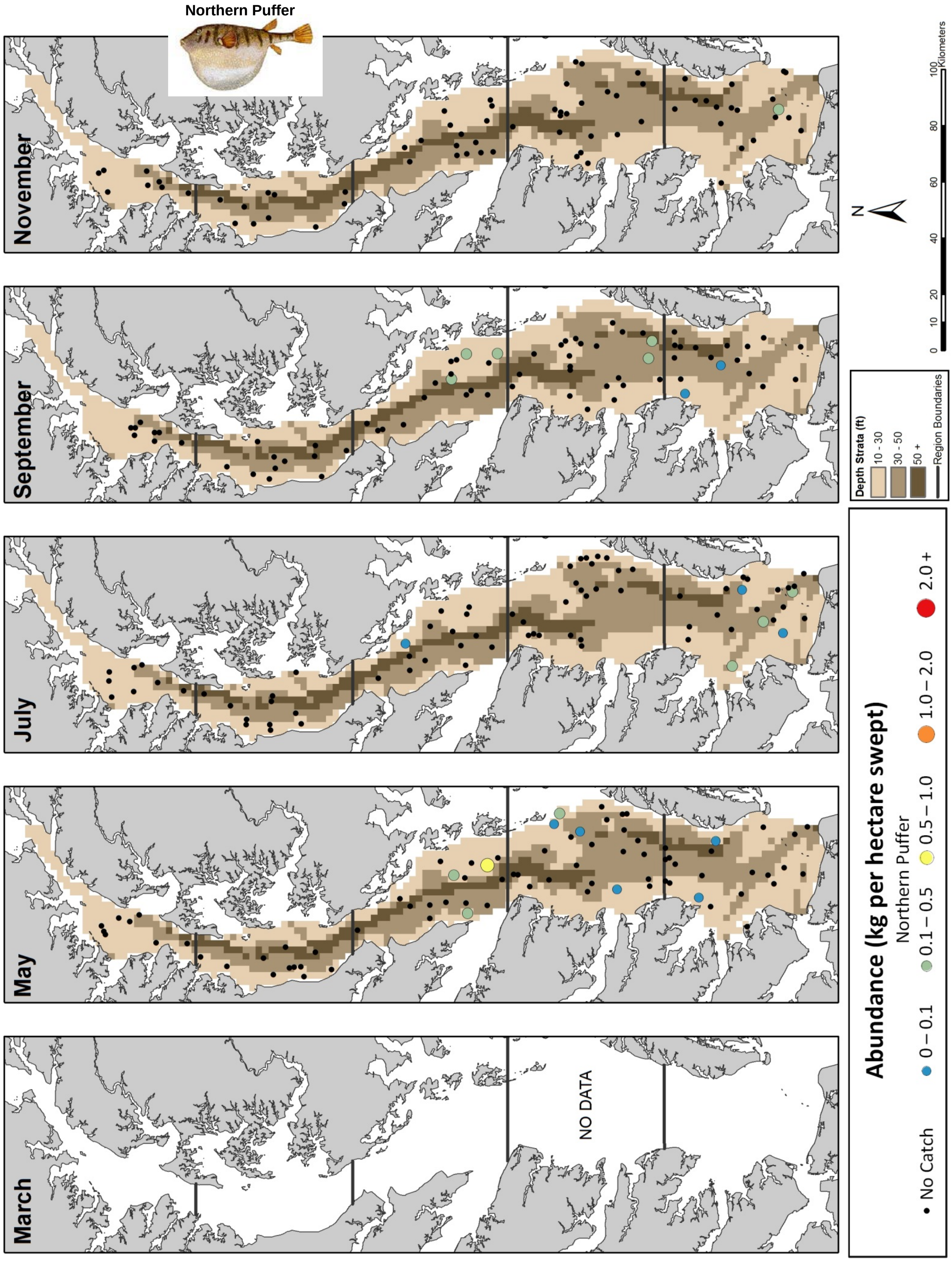


Table 10. Northern puffer geometric mean indices of abundance, by number and biomass, overall.

Year	Age	n	Numerical Index			Biomass Index		
			LCI	**Index**	UCI	LCI	**Index**	UCI
2002	All	30	14.88	**43.6**	124.24	3.76	**8.1**	16.38
2003		42	7.40	**19.1**	47.22	1.46	**3.3**	6.52
2004		42	0.28	**1.3**	3.23	0.13	**0.6**	1.38
2005		34	1.96	**6.1**	16.06	0.72	**1.9**	3.77
2006		31	1.14	**4.2**	11.42	0.52	**1.6**	3.43
2007		18	10.20	**28.1**	74.53	3.08	**6.7**	13.43
2008		36	0.95	**3.0**	7.11	0.37	**1.0**	1.99
2009		36	1.11	**3.8**	9.76	0.46	**1.3**	2.67
2010		36	5.49	**17.0**	48.60	1.48	**3.8**	8.39
2011		35	39.82	**95.4**	226.49	8.97	**17.2**	32.13
2012		34	0.31	**1.5**	3.65	0.07	**0.4**	0.72
2013								
2014								
2015								
2016								

Figure 38. Northern puffer geometric mean indices of abundance, by number and biomass, for all ages combined.

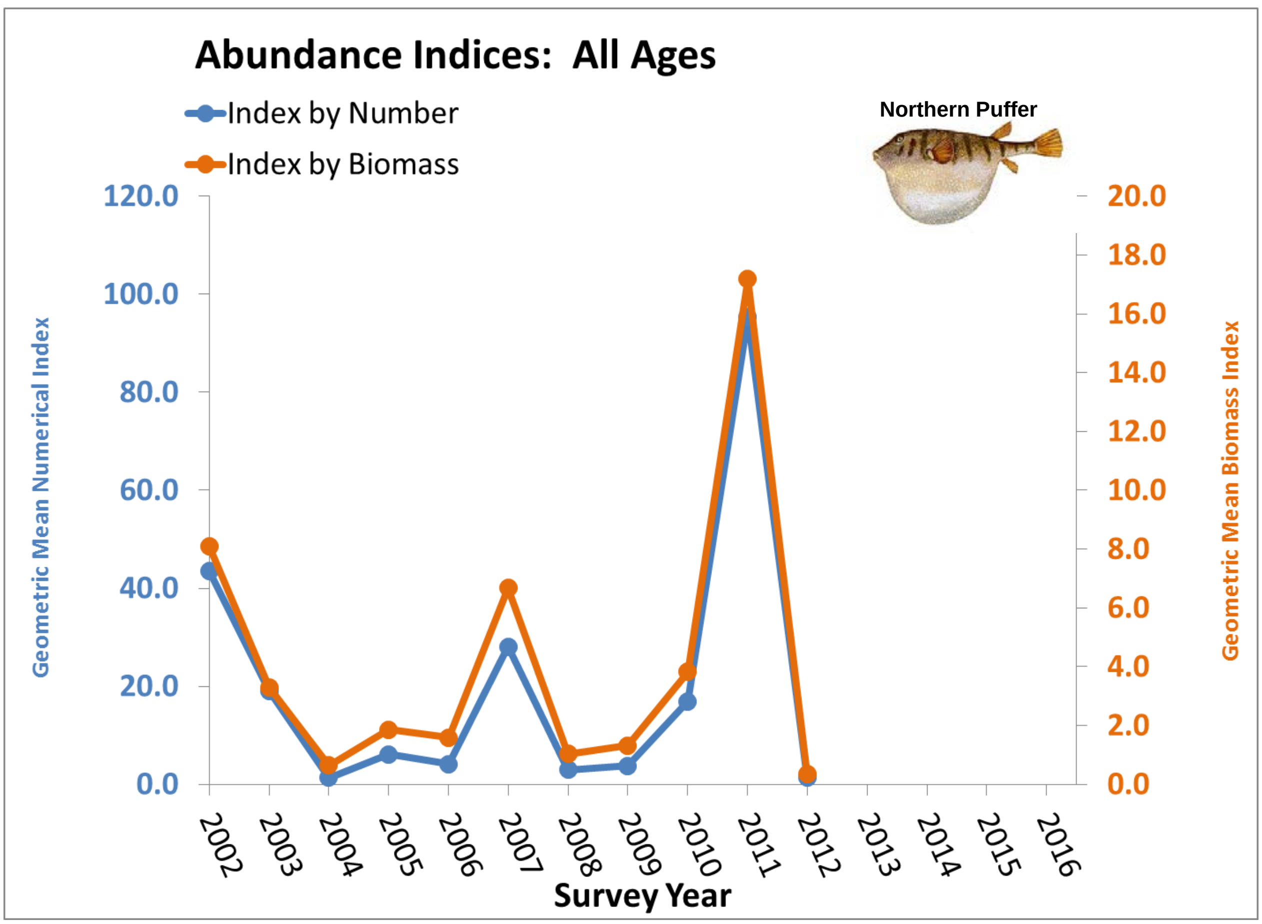


Figure 39. Northern puffer length-frequency in Chesapeake Bay 2002-2012, overall (A) and by sex (B).

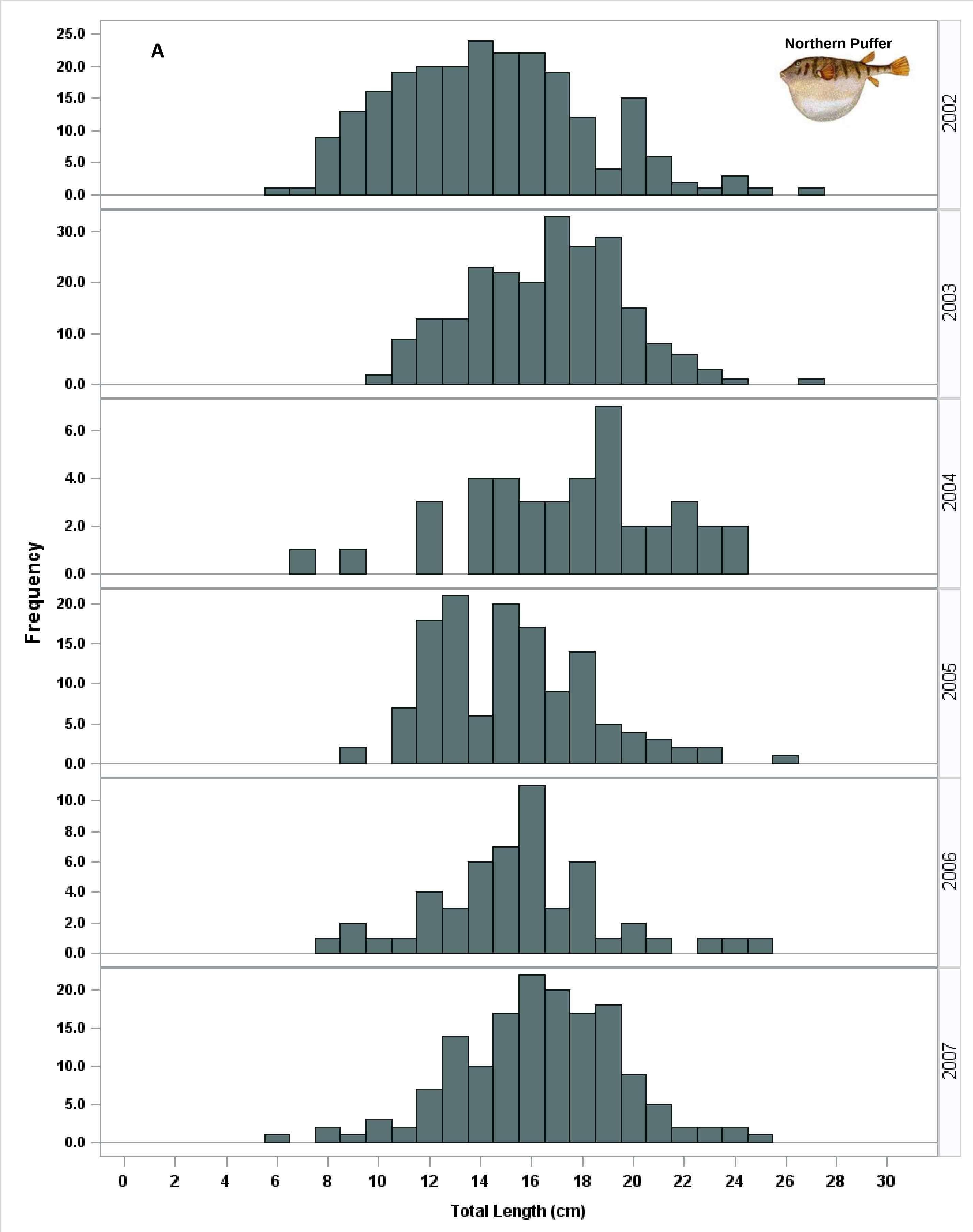


Figure 39. cont.

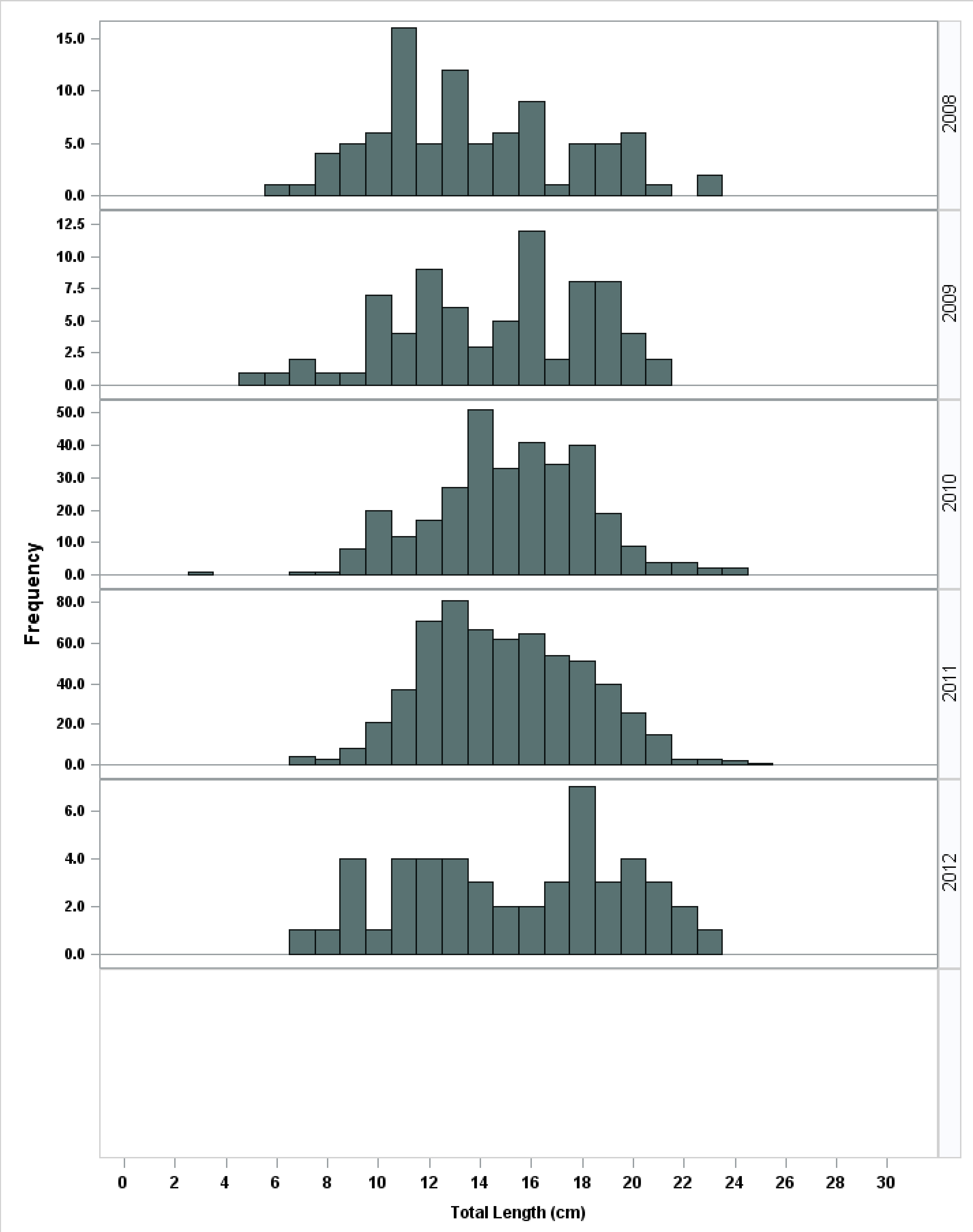


Figure 39. cont.

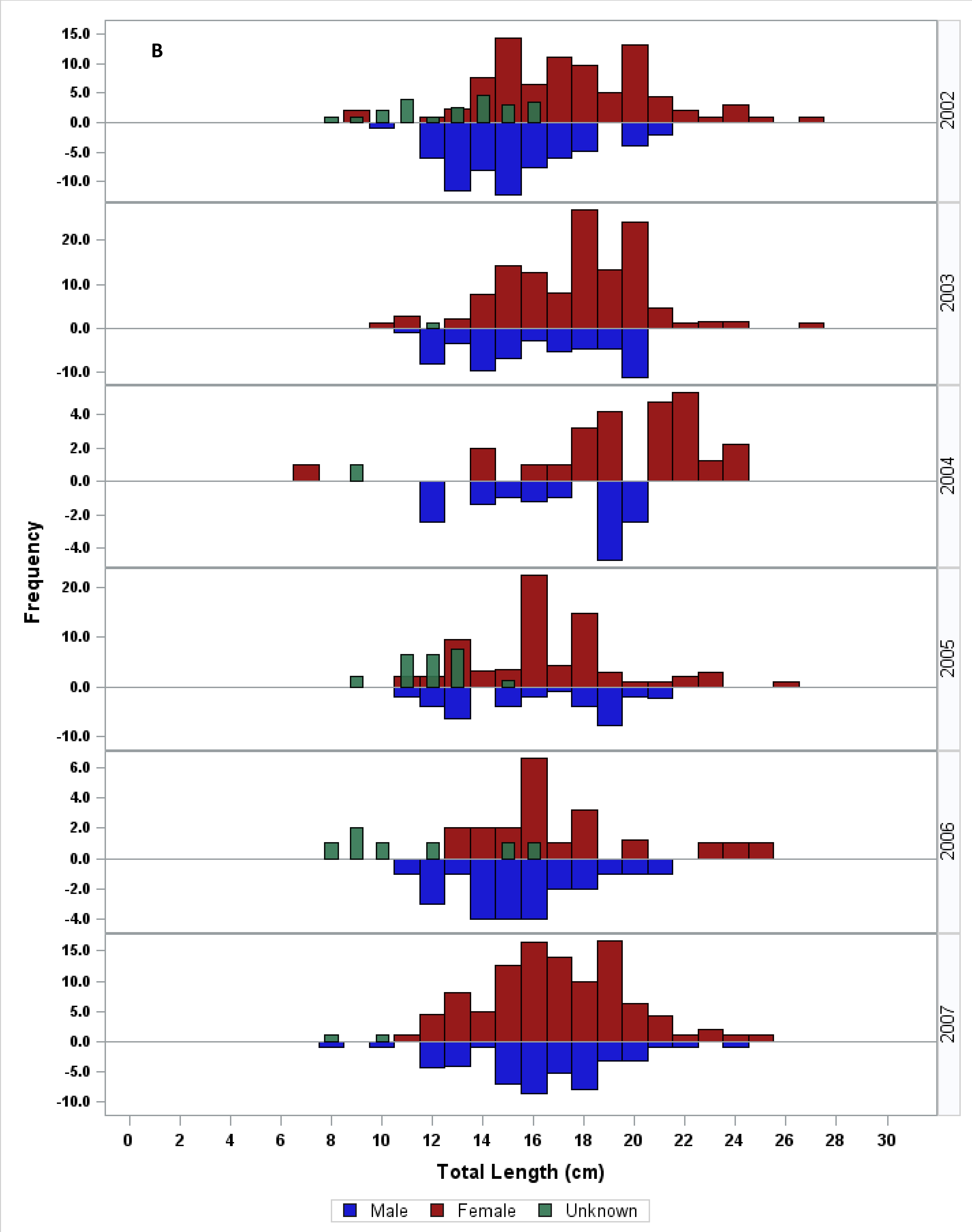


Figure 39. cont.

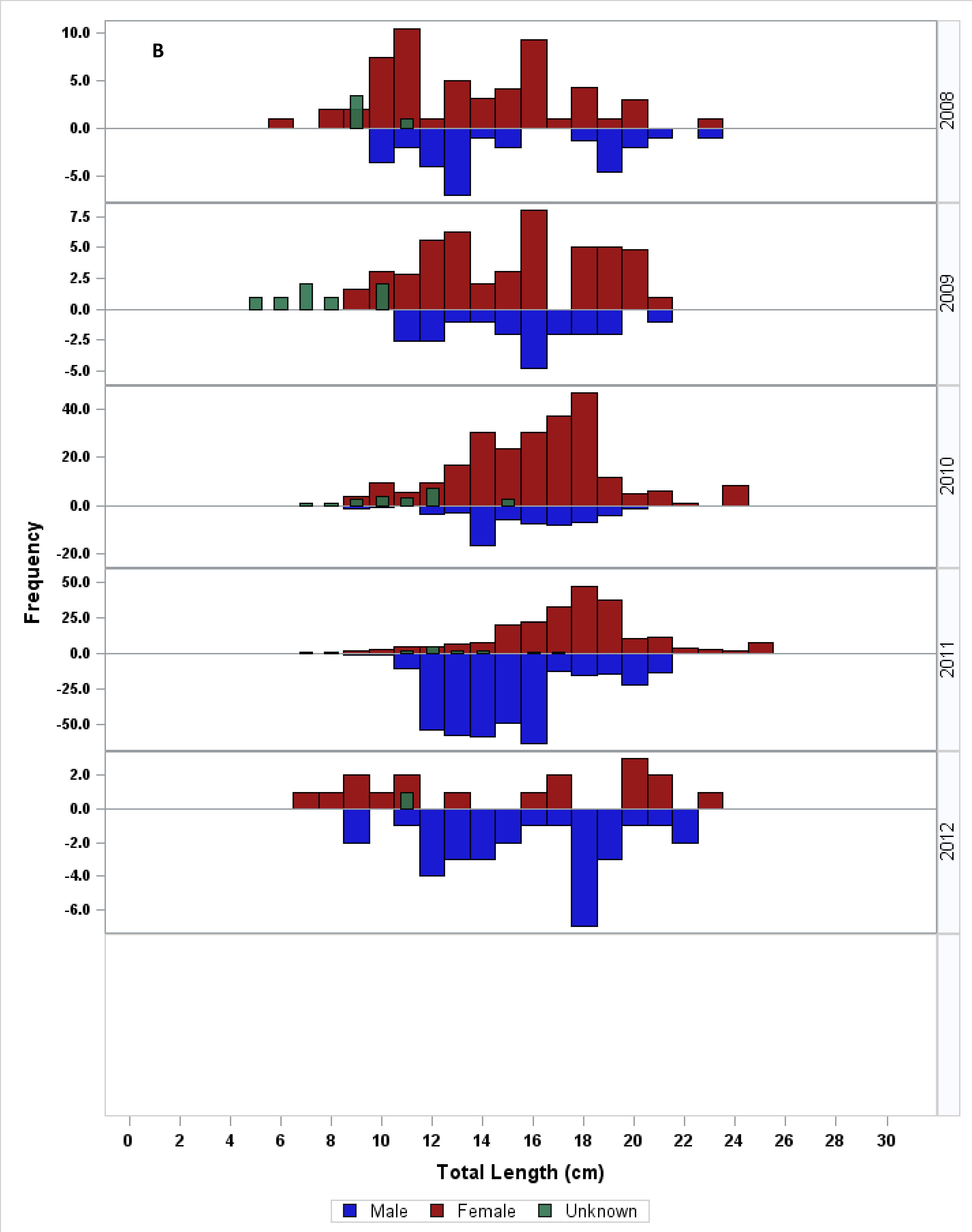


Figure 40. Diet composition, expressed as percent by weight (A) and percent by number (B) of northern puffer collected during ChesMMAP cruises in 2002-2011 combined.

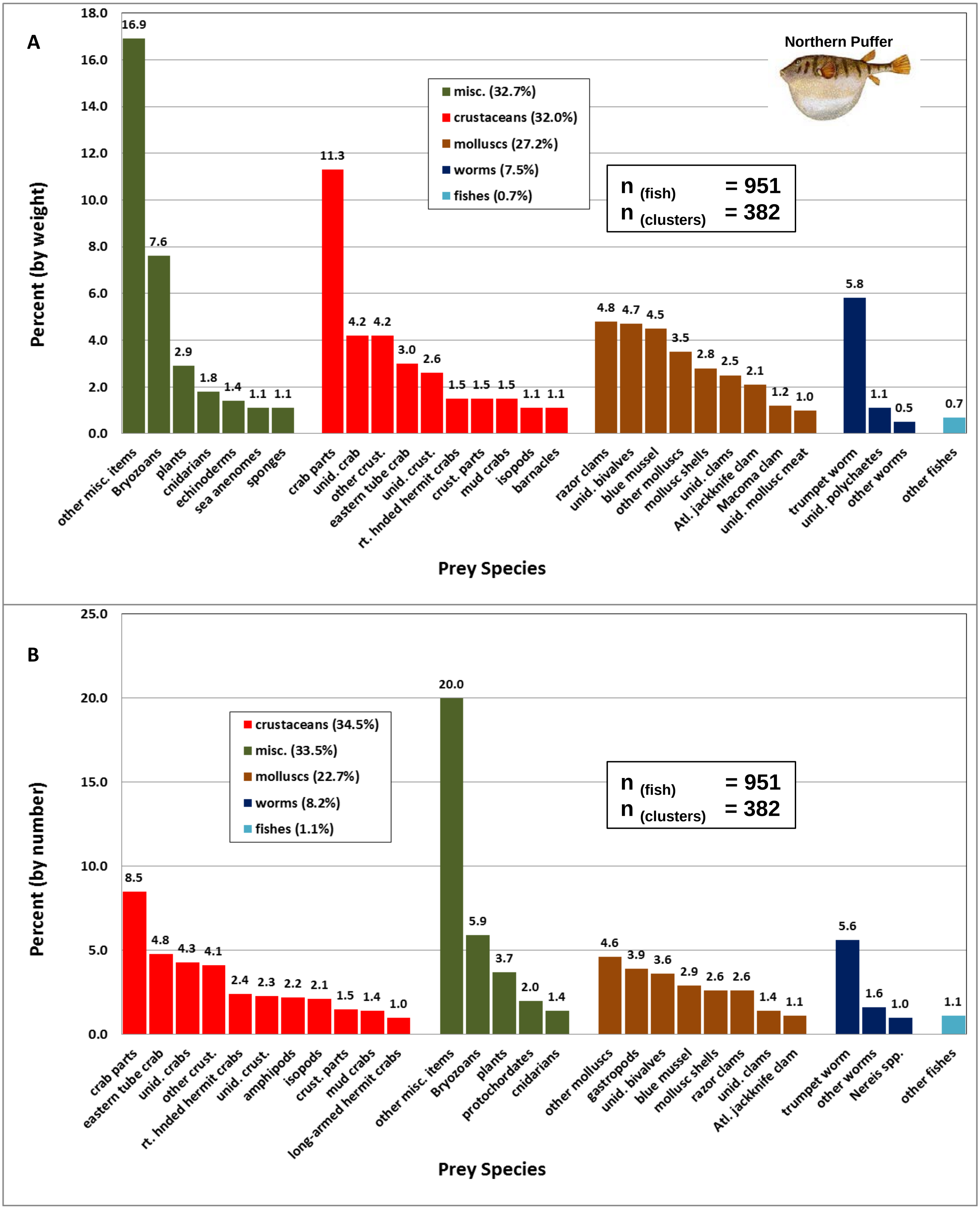


Figure 41. Abundance (kg per hectare swept) of scup in Chesapeake Bay, 2012.

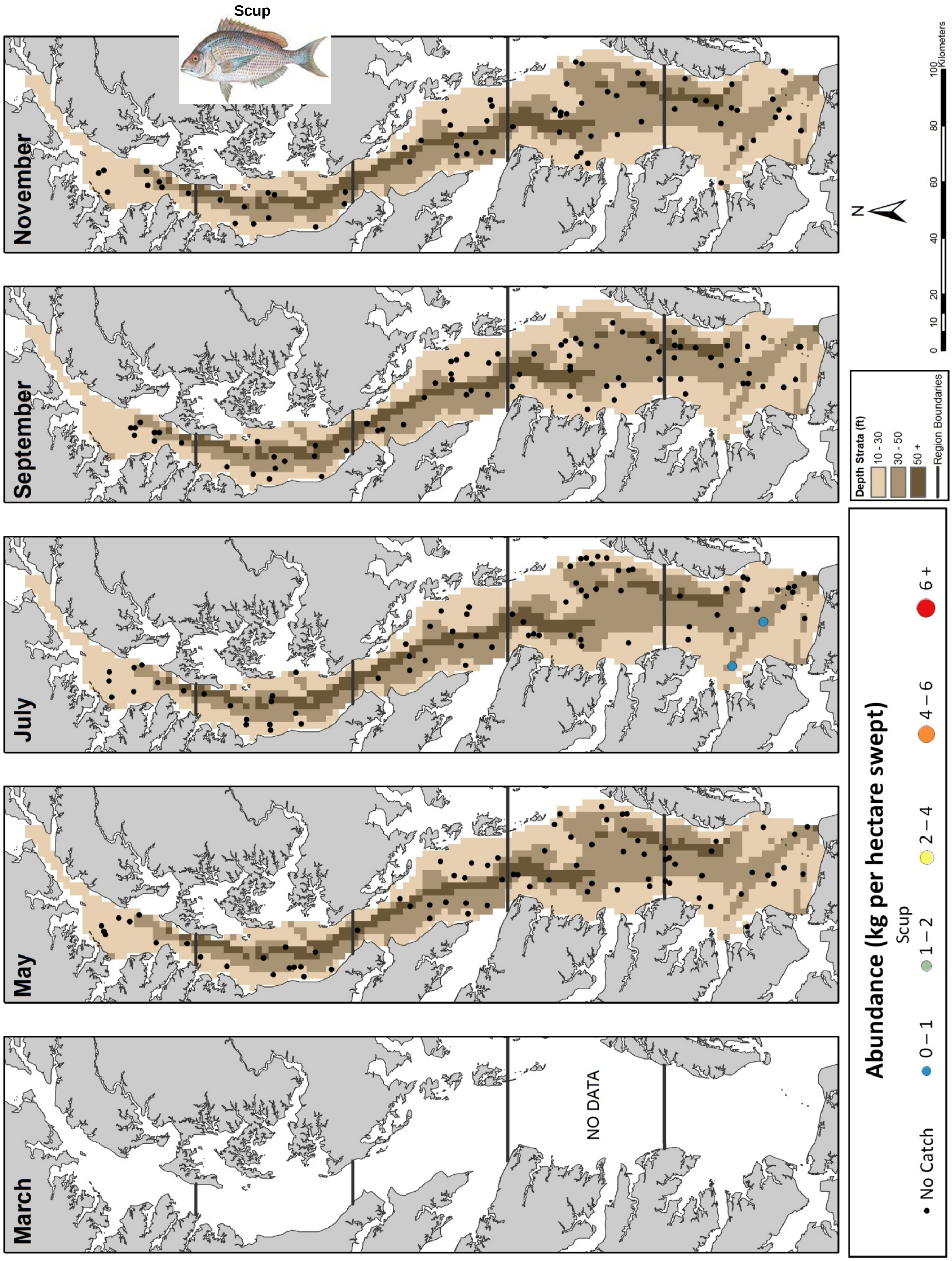


Table 11. Scup geometric mean indices of abundance, by number and biomass, overall and by age-class.

Year	Age	n	Numerical Index LCI	Numerical Index Index	Numerical Index UCI	Biomass Index LCI	Biomass Index Index	Biomass Index UCI
2002	All	50	1.3	**3.5**	7.8	0.4	**0.9**	1.6
2003		63	1.8	**4.6**	10.1	0.6	**1.2**	2.1
2004		60	5.7	**13.1**	28.8	1.3	**2.3**	3.8
2005		52	4.5	**13.0**	34.6	1.0	**1.9**	3.3
2006		46	3.9	**11.1**	28.9	1.0	**2.2**	4.0
2007		35	7.8	**23.0**	64.4	1.3	**2.7**	4.9
2008		54	0.4	**1.3**	2.8	0.1	**0.4**	0.8
2009		54	4.2	**11.0**	26.4	1.0	**1.9**	3.3
2010		54	10.3	**27.8**	72.8	2.0	**4.1**	7.6
2011		53	0.8	**2.3**	5.0	0.2	**0.6**	1.0
2012		52	0.0	**0.5**	1.2	0.0	**0.2**	0.3
2013								
2014								
2015								
2016								
2002	0	30	0.0	**0.7**	2.1	0.0	**0.2**	0.5
2003		42	2.6	**6.8**	15.9	0.5	**1.1**	1.8
2004		42	0.7	**1.8**	3.5	0.1	**0.4**	0.6
2005		34	5.5	**19.1**	61.3	0.8	**1.7**	3.1
2006		31	1.7	**6.3**	18.9	0.5	**1.5**	3.2
2007		18	0.4	**2.1**	5.7	0.1	**0.4**	0.9
2008		36	0.1	**0.6**	1.3	0.0	**0.2**	0.4
2009		36	0.8	**2.8**	7.0	0.2	**0.7**	1.4
2010		36	4.3	**15.4**	49.4	1.1	**3.0**	6.6
2011		35	0.2	**1.1**	2.9	0.0	**0.3**	0.7
2012		34	0.0	**0.0**	0.0	0.0	**0.0**	0.0
2013								
2014								
2015								
2016								

Year	Age	n	Numerical Index LCI	Numerical Index Index	Numerical Index UCI	Biomass Index LCI	Biomass Index Index	Biomass Index UCI
2002	1	50	0.1	**0.7**	1.6	0.0	**0.3**	0.6
2003		63	1.5	**3.7**	7.7	0.4	**0.9**	1.5
2004		60	1.3	**2.9**	5.6	0.5	**0.9**	1.5
2005		52	2.3	**6.8**	17.3	0.5	**1.1**	1.9
2006		46	0.9	**3.1**	7.6	0.3	**1.0**	1.9
2007		35	0.3	**1.4**	3.4	0.1	**0.5**	1.1
2008		54	0.1	**0.5**	1.3	0.0	**0.2**	0.5
2009		54	0.4	**1.5**	3.2	0.1	**0.5**	0.9
2010		54	2.0	**5.7**	13.9	0.7	**1.6**	3.0
2011		53	0.1	**0.7**	1.5	0.0	**0.2**	0.5
2012		52	0.0	**0.0**	0.0	0.0	**0.0**	0.0
2013								
2014								
2015								
2016								

Figure 42. Scup geometric mean indices of abundance, by number and biomass, for all ages combined and by age-class .

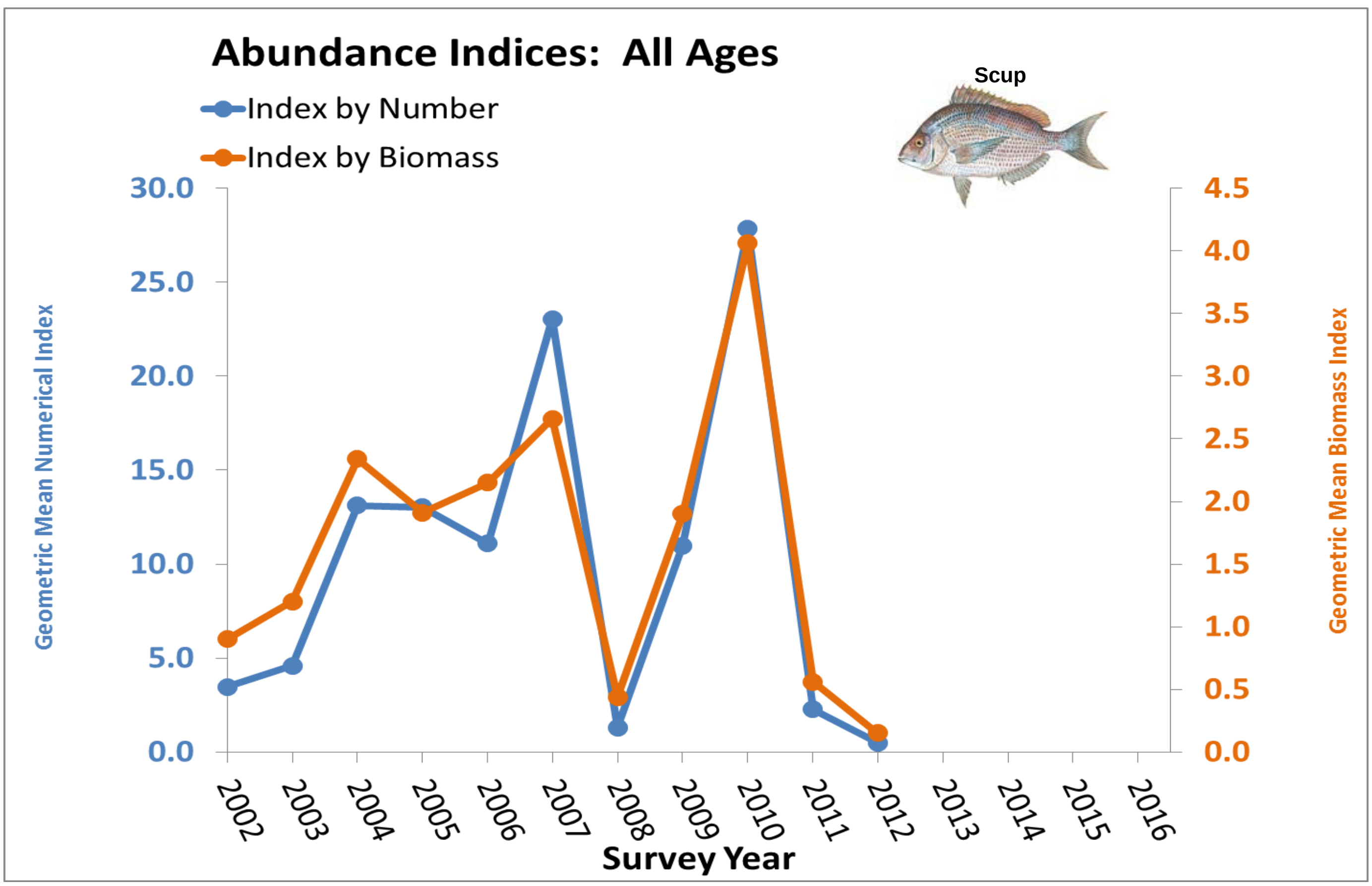
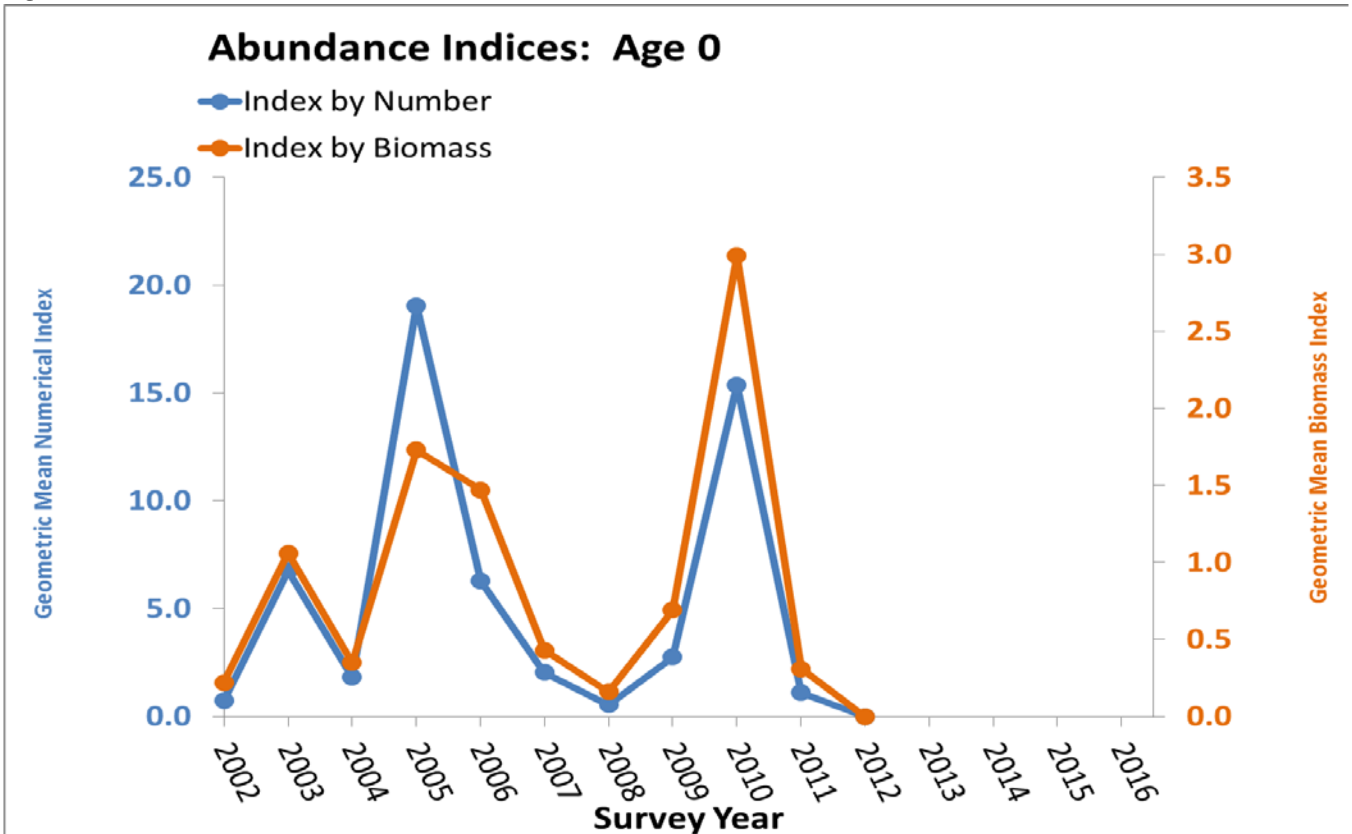


Figure 42. cont.



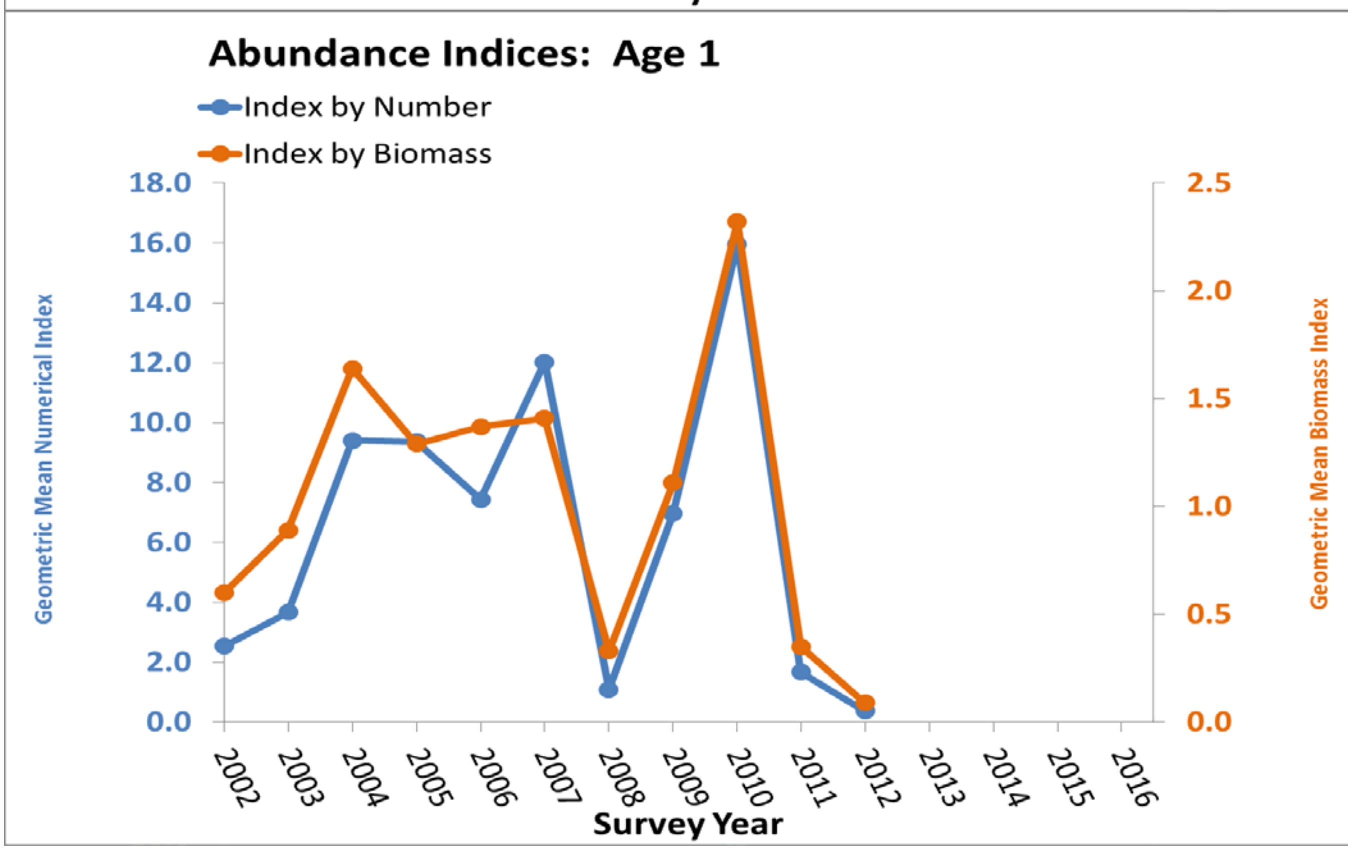
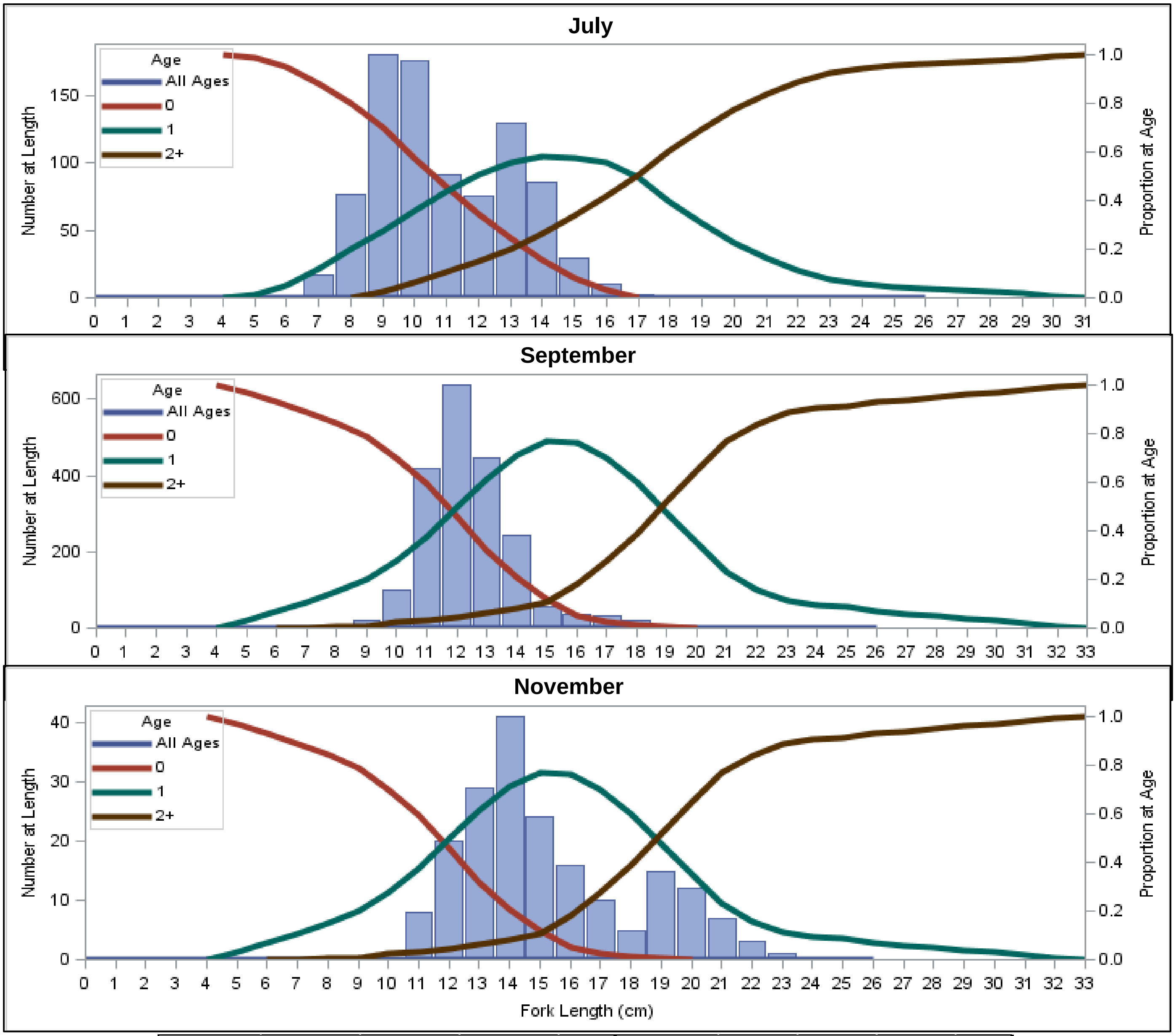


Figure 43. Scup ALK for all NEAMAP fall cruises, showing loess smoothed proportions at each 1cm length bin, overlaid on month-specific length frequencies pooled over all years. ALK proportions are adjusted such that the sums of values for each length bin within each month are forced to 1.0. Only used for ages 0 and 1 for this report.



	Spring					Fall			
Length (cm)	Age-0	Age-1	Age-2+	Sum	Length (cm)	Age-0	Age-1	Age-2+	Sum
4	1.000	0.000		1.000	4	1.000	0.000		1.000
5	0.989	0.011		1.000	5	0.970	0.030		1.000
6	0.950	0.050		1.000	6	0.933	0.067	0.000	1.000
7	0.881	0.119		1.000	7	0.889	0.107	0.004	1.000
8	0.802	0.198	0.000	1.000	8	0.843	0.149	0.008	1.000
9	0.698	0.278	0.025	1.000	9	0.789	0.201	0.010	1.000
10	0.577	0.358	0.065	1.000	10	0.701	0.273	0.026	1.000
11	0.457	0.436	0.108	1.000	11	0.593	0.374	0.033	1.000
12	0.342	0.505	0.152	1.000	12	0.457	0.501	0.043	1.000
13	0.243	0.558	0.199	1.000	13	0.322	0.613	0.065	1.000
14	0.156	0.580	0.265	1.000	14	0.209	0.711	0.080	1.000
15	0.085	0.578	0.336	1.000	15	0.119	0.771	0.110	1.000
16	0.030	0.554	0.416	1.000	16	0.051	0.765	0.184	1.000
17	0.000	0.493	0.507	1.000	17	0.026	0.699	0.275	1.000
18		0.396	0.604	1.000	18	0.015	0.600	0.385	1.000
19		0.304	0.696	1.000	19	0.010	0.474	0.516	1.000
20		0.227	0.773	1.000	20	0.000	0.350	0.650	1.000
21		0.165	0.835	1.000	21		0.233	0.767	1.000
22		0.115	0.885	1.000	22		0.160	0.840	1.000
23		0.078	0.922	1.000	23		0.115	0.885	1.000
24		0.056	0.944	1.000	24		0.096	0.904	1.000
25		0.045	0.955	1.000	25		0.087	0.913	1.000
26		0.039	0.961	1.000	26		0.070	0.930	1.000
27		0.035	0.965	1.000	27		0.060	0.940	1.000
28		0.025	0.975	1.000	28		0.050	0.950	1.000
29		0.020	0.980	1.000	29		0.040	0.960	1.000
30		0.010	0.990	1.000	30		0.030	0.970	1.000
31		0.000	1.000	1.000	31		0.020	0.980	1.000
32					32		0.010	0.990	1.000
33					33		0.000	1.000	1.000

Figure 44. Scup length-frequency in Chesapeake Bay 2002-2012, overall (A) and by sex (B).

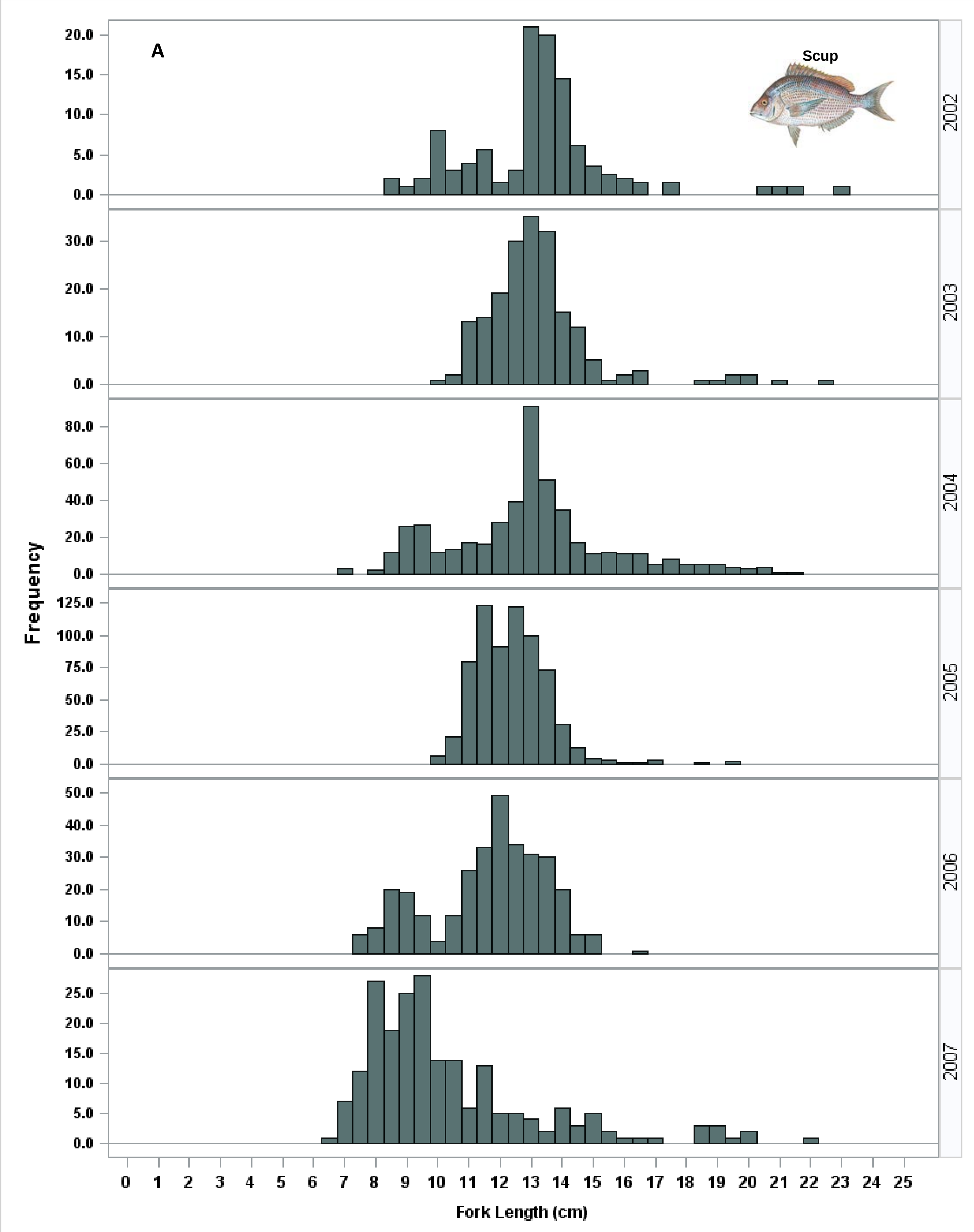


Figure 44. cont.

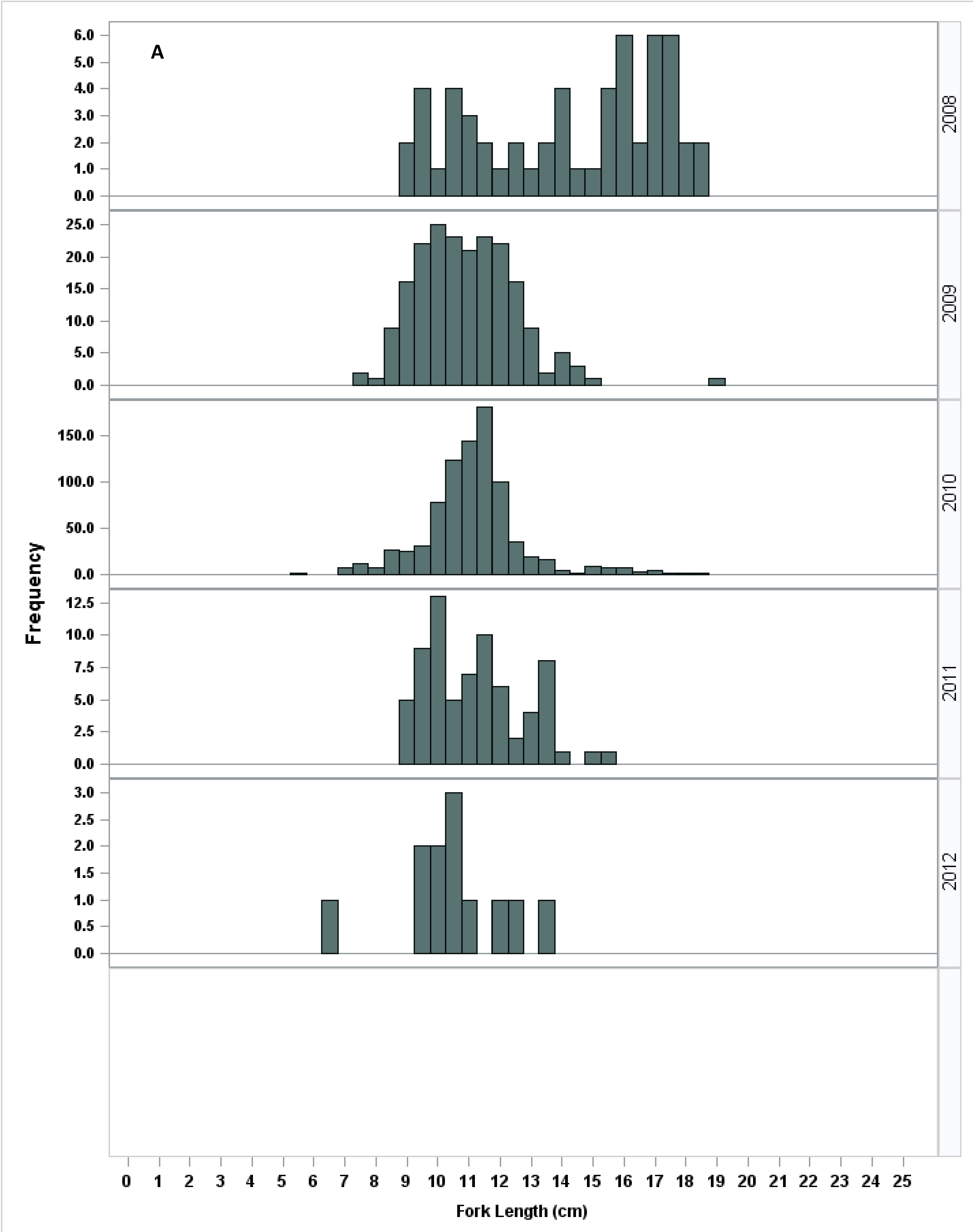


Figure 44. cont.

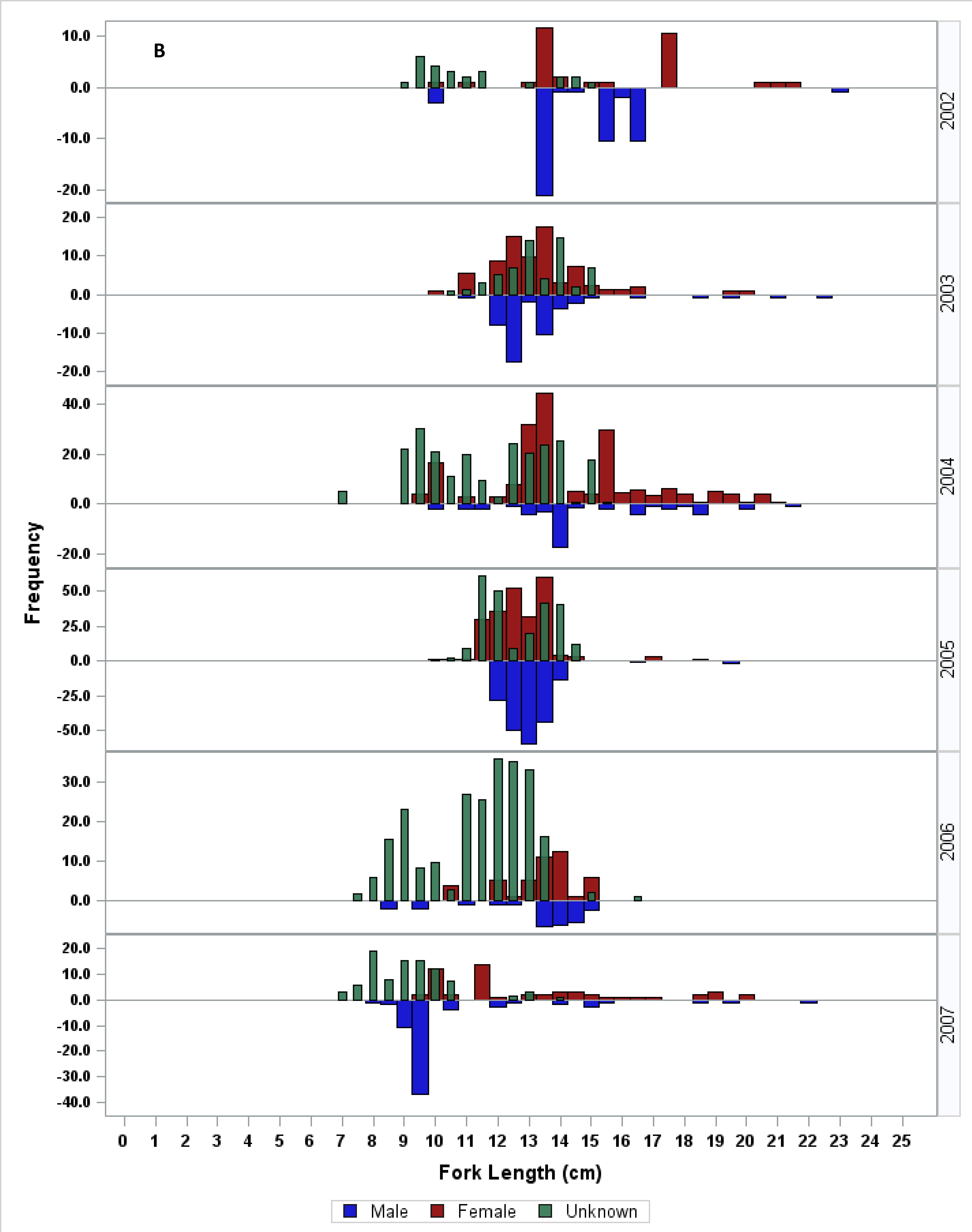


Figure 44. cont.

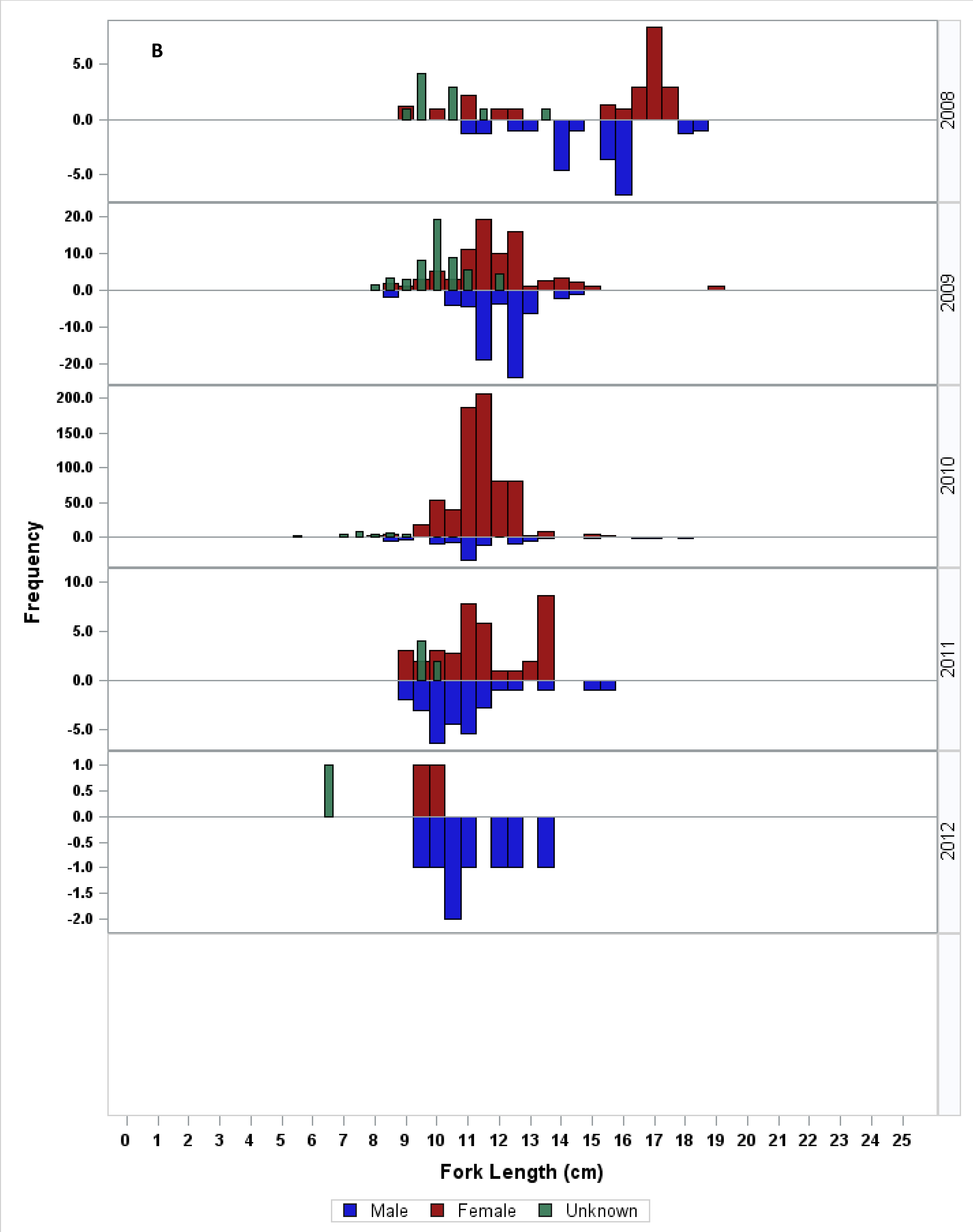


Figure 45. Scup age-frequency by year, 2002-2007.

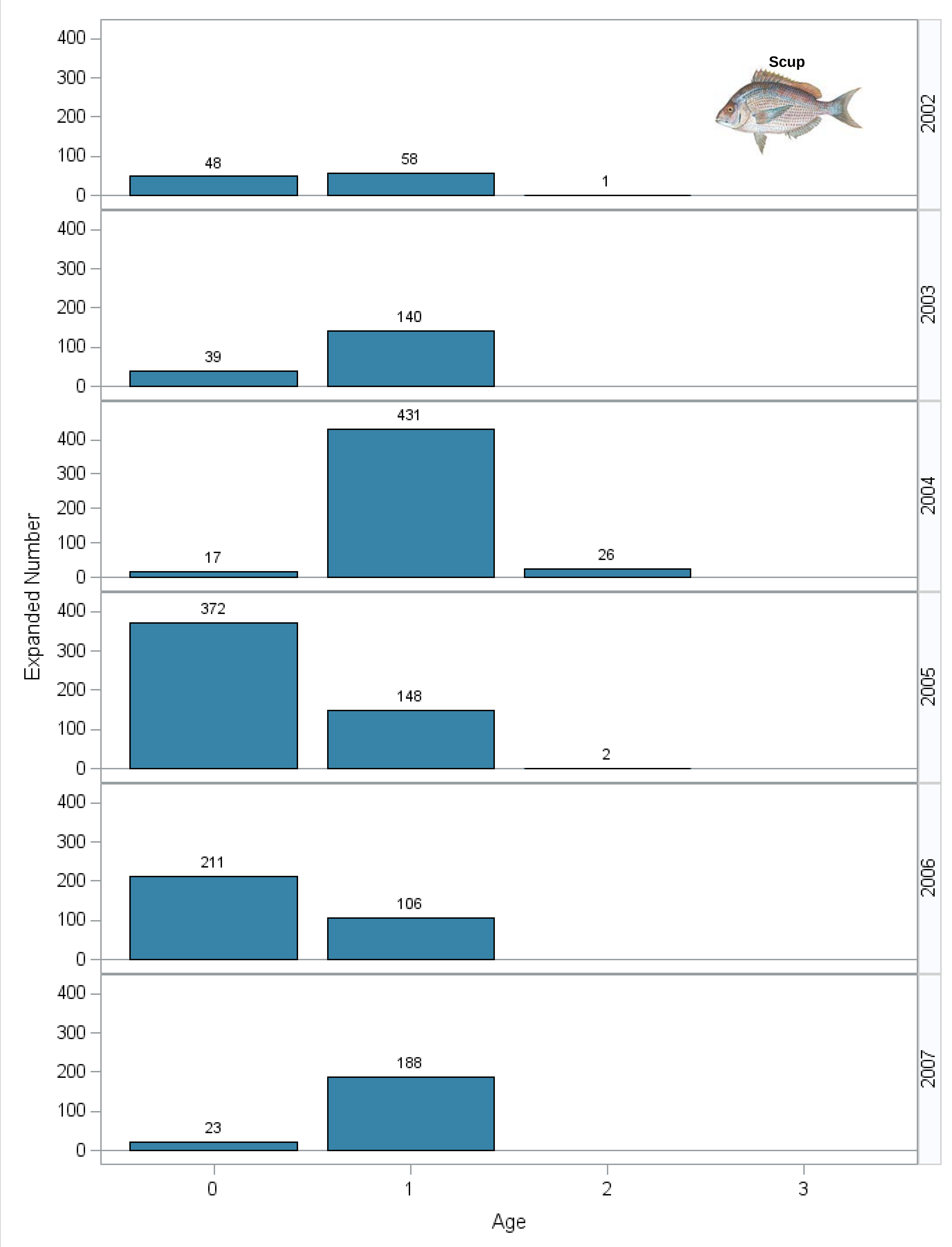


Figure 46. Scup age-frequency by year, 2002-2007 standardized to 8,000 annual trawl minutes.

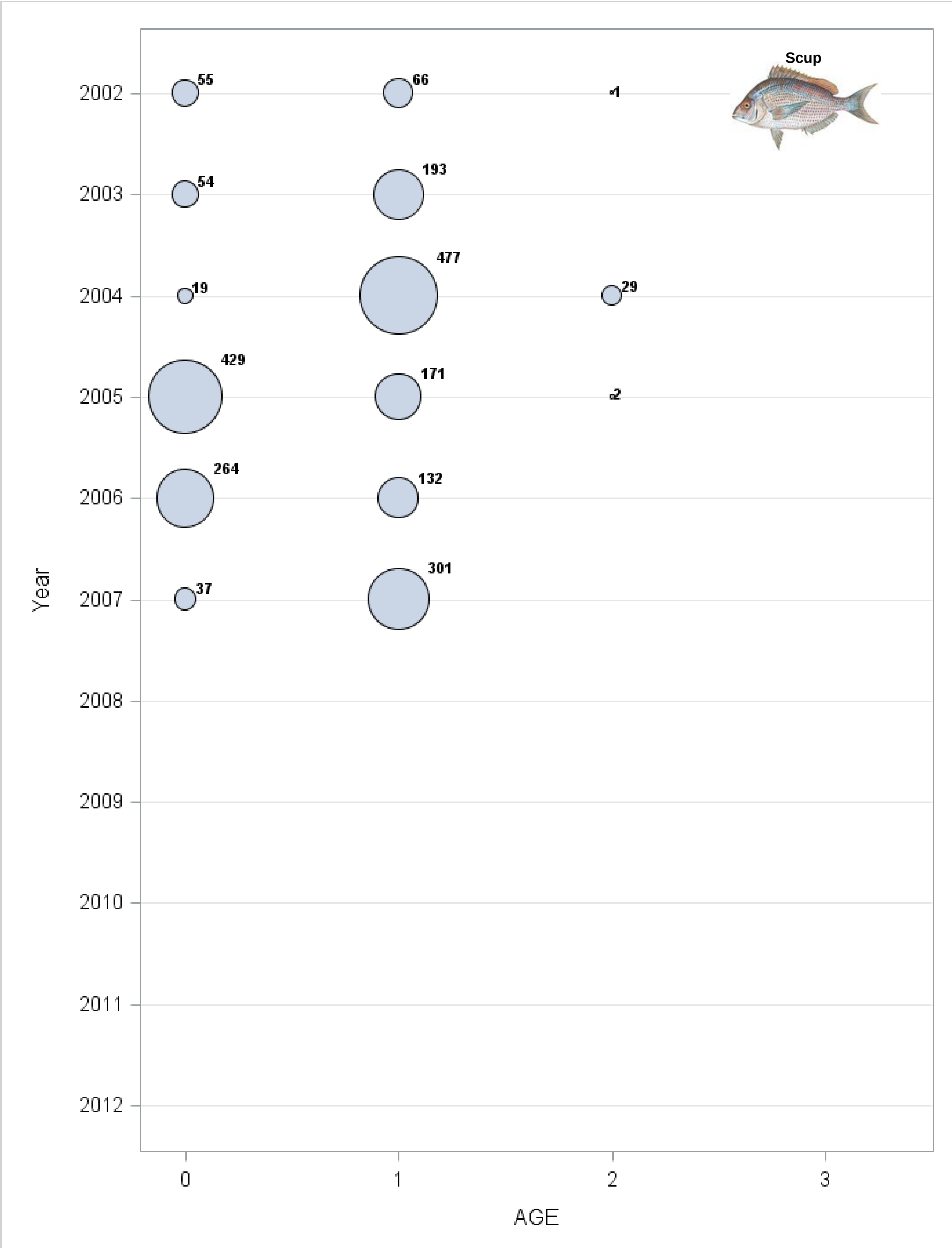


Figure 47. Scup age-frequency by cruise month, 2002-2007 combined, actual (A) and standardized to 8,000 total annual trawl minutes (B).

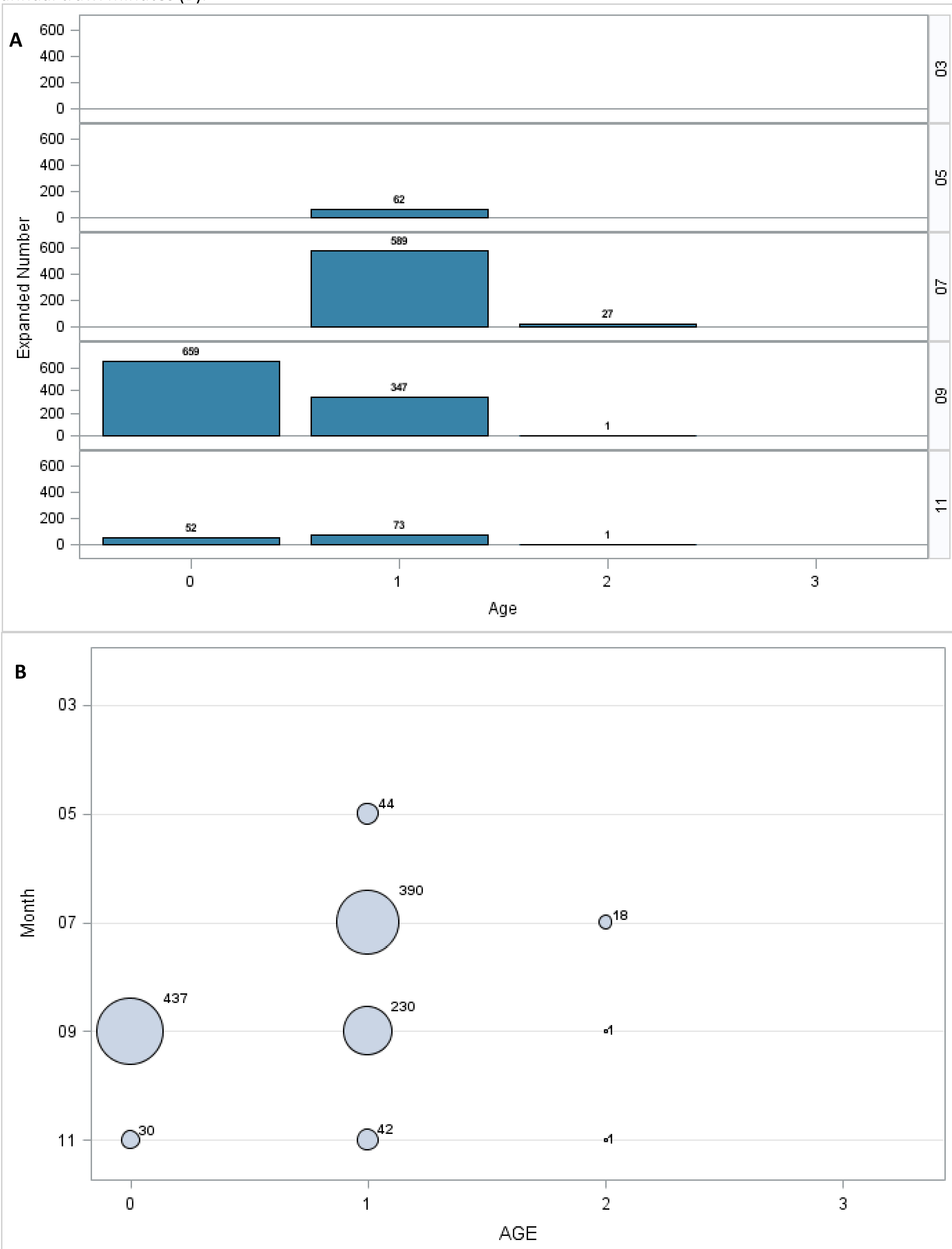


Figure 48. Diet composition, expressed as percent by weight (A) and percent by number (B) of scup collected during ChesMMAP cruises in 2002-2011 combined.

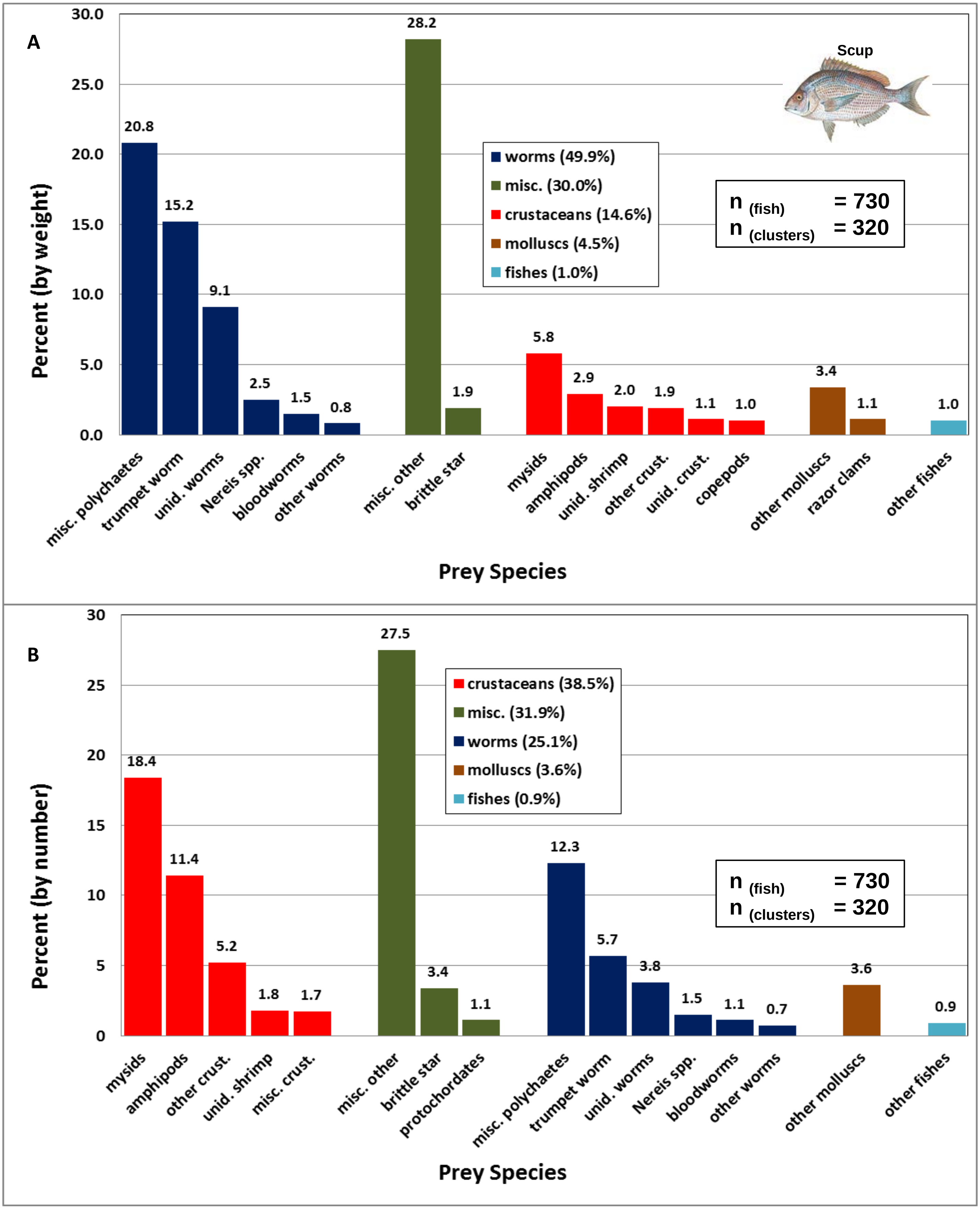


Figure 49. Abundance (kg per hectare swept) of spot in Chesapeake Bay, 2012.

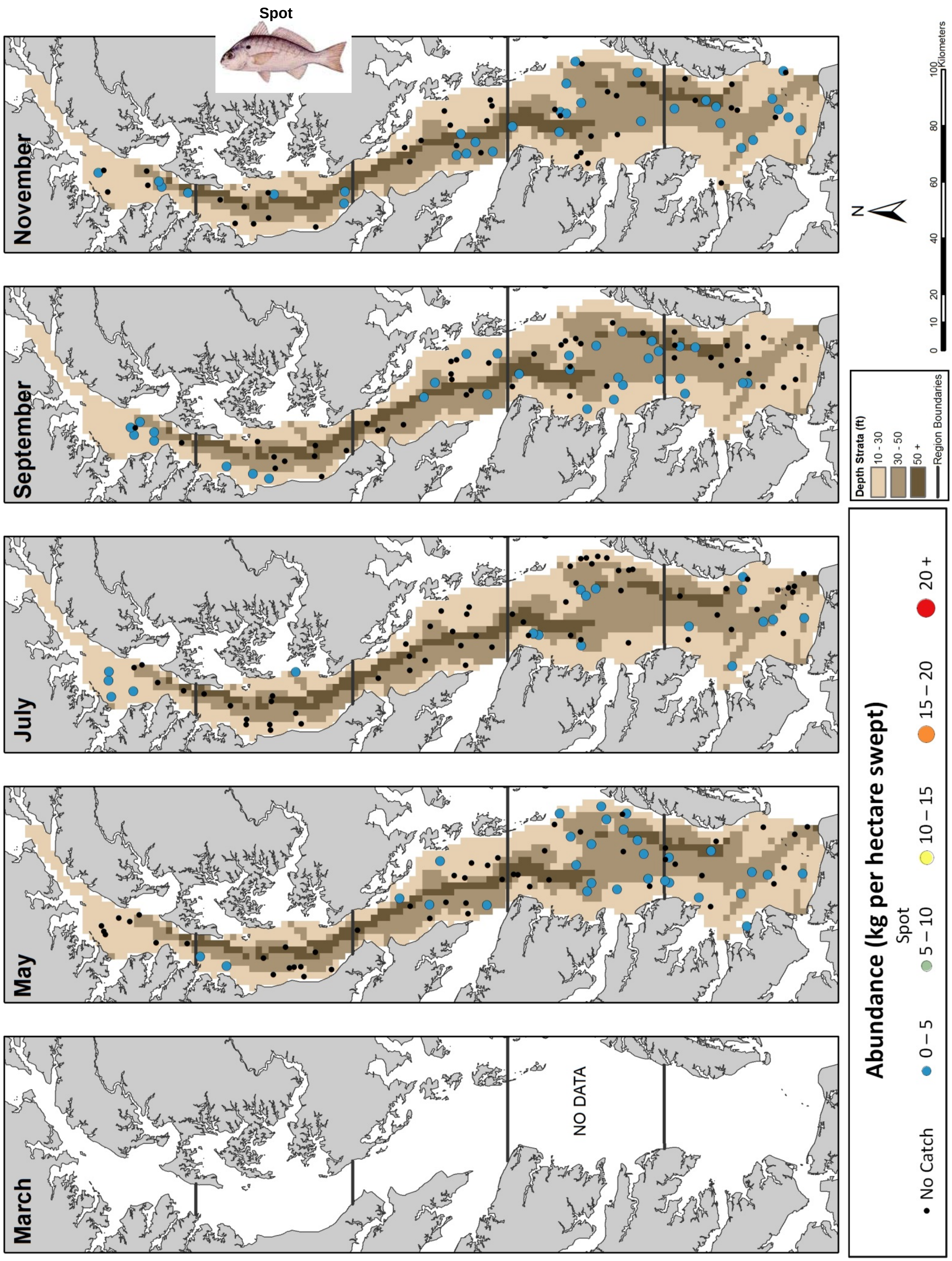


Table 12. Spot geometric mean indices of abundance, by number and biomass, overall and by age-class.

Year	Age	n	Numerical Index LCI	Numerical Index Index	Numerical Index UCI	Biomass Index LCI	Biomass Index Index	Biomass Index UCI
2002	All	153	21.6	37.2	63.5	4.7	6.9	9.9
2003		150	21.5	37.8	65.9	4.4	6.4	9.0
2004		139	36.9	66.7	119.9	5.9	8.6	12.3
2005		156	112.2	182.3	295.8	9.5	12.6	16.7
2006		143	191.3	303.6	481.4	30.9	44.5	63.8
2007		78	100.2	196.1	382.8	22.1	36.3	59.4
2008		160	31.3	55.6	98.1	7.8	11.9	17.9
2009		160	49.8	80.6	129.9	13.8	20.2	29.4
2010		125	17.5	35.4	70.4	3.3	5.3	8.1
2011		158	28.5	45.1	71.0	8.8	12.6	17.8
2012		159	4.4	7.7	13.0	1.5	2.3	3.3
2013								
2014								
2015								
2016								
2002	0	227	10.7	16.3	24.6	2.2	3.0	3.9
2003		240	9.4	14.0	20.6	1.6	2.1	2.6
2004		224	30.0	45.6	69.0	3.6	4.5	5.7
2005		235	123.6	184.0	273.8	6.1	7.5	9.2
2006		217	64.7	101.1	157.5	11.6	16.0	21.9
2007		155	58.0	94.7	154.1	9.2	13.0	18.3
2008		240	41.9	64.5	99.1	7.1	9.5	12.7
2009		238	14.8	22.3	33.2	4.3	5.9	8.0
2010		204	56.1	93.6	155.9	6.6	9.2	12.6
2011		236	6.0	8.8	12.7	2.2	3.0	4.1
2012		231	5.3	8.4	13.2	1.5	2.2	3.1
2013								
2014								
2015								
2016								

Year	Age	n	Numerical Index LCI	Numerical Index Index	Numerical Index UCI	Biomass Index LCI	Biomass Index Index	Biomass Index UCI
2002	1	153	14.9	24.8	40.9	3.4	4.9	6.8
2003		150	14.4	24.4	41.0	3.2	4.5	6.2
2004		139	20.7	35.2	59.4	3.5	5.1	7.2
2005		156	45.6	72.8	115.9	5.5	7.5	9.9
2006		143	89.0	136.2	208.2	15.8	22.4	31.6
2007		78	78.9	151.4	289.8	19.0	31.0	50.2
2008		160	14.1	23.5	38.8	3.9	6.0	8.9
2009		160	32.5	51.5	81.0	9.6	13.9	20.0
2010		125	4.4	7.4	11.9	1.1	1.7	2.4
2011		158	21.2	32.6	49.8	6.5	9.1	12.6
2012		159	2.0	3.2	5.0	0.5	0.9	1.3
2013								
2014								
2015								
2016								
2002	2+	153	2.1	3.0	4.3	0.4	0.7	0.9
2003		150	2.1	3.2	4.7	0.5	0.7	1.0
2004		139	2.3	3.4	4.9	0.5	0.7	1.0
2005		156	4.4	6.4	9.2	0.6	0.8	1.1
2006		143	3.8	5.4	7.5	1.0	1.4	1.9
2007		78	8.1	12.2	18.1	1.9	2.6	3.6
2008		160	1.4	2.2	3.2	0.5	0.7	1.0
2009		160	3.7	5.2	7.3	1.1	1.6	2.1
2010		125	0.4	0.6	0.9	0.1	0.2	0.3
2011		158	2.3	3.1	4.0	0.6	0.8	1.0
2012		159	0.1	0.2	0.4	0.0	0.1	0.1
2013								
2014								
2015								
2016								

Figure 50. Spot geometric mean indices of abundance, by number and biomass, for all ages combined and by age-class.

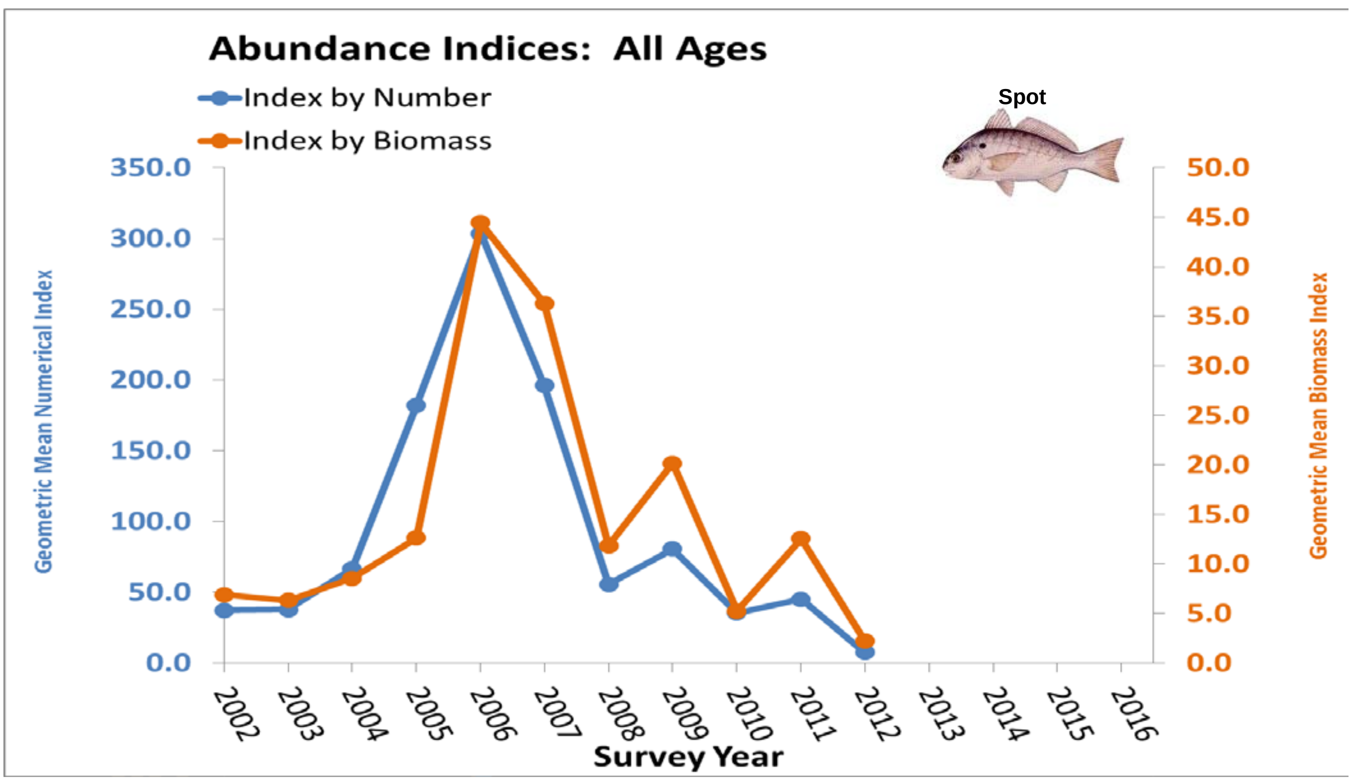
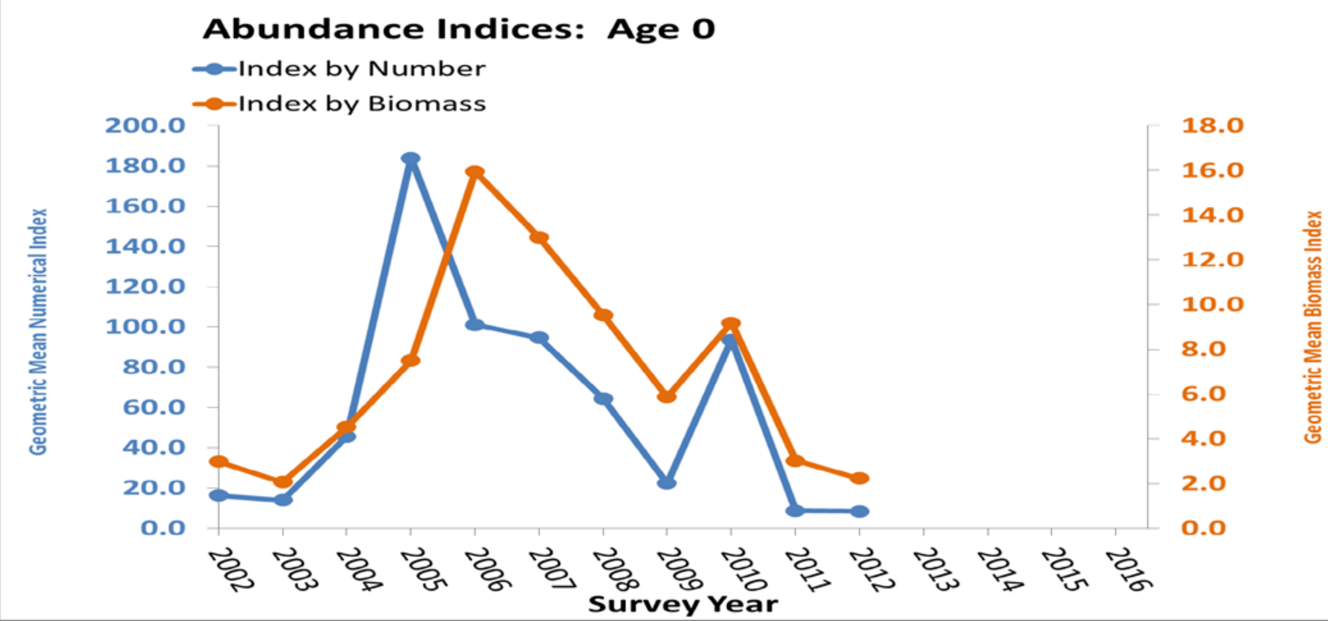
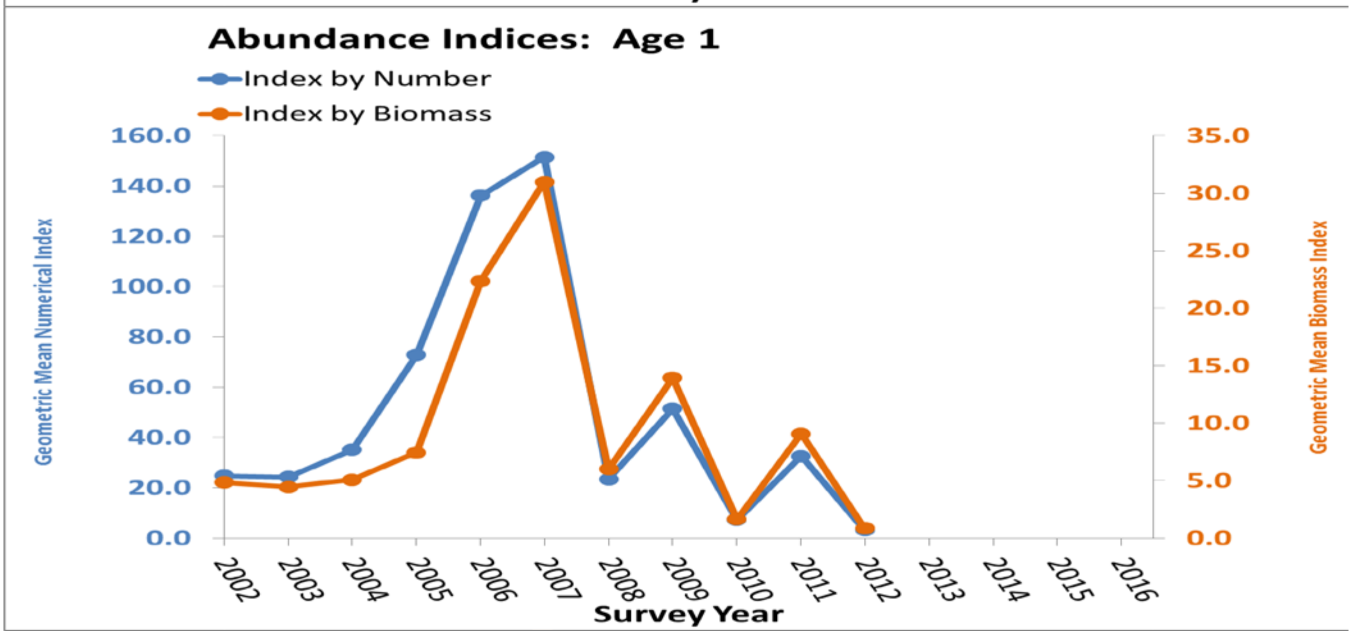


Figure 50. cont.





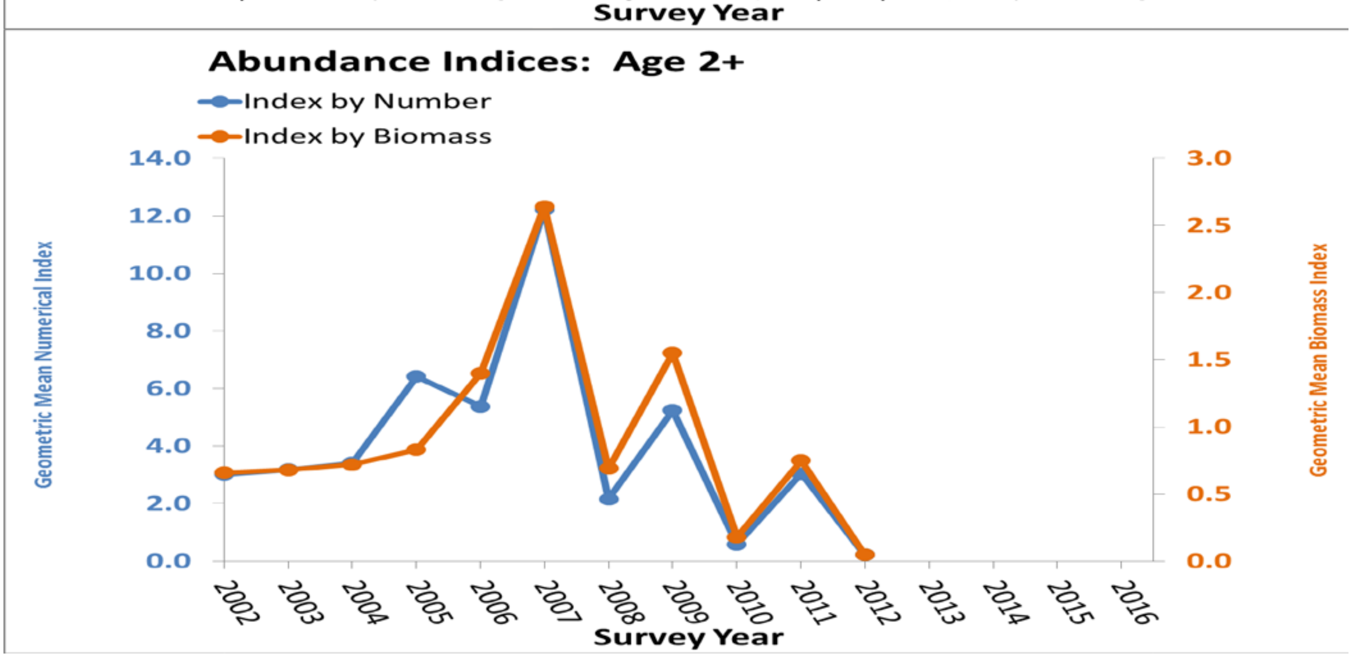
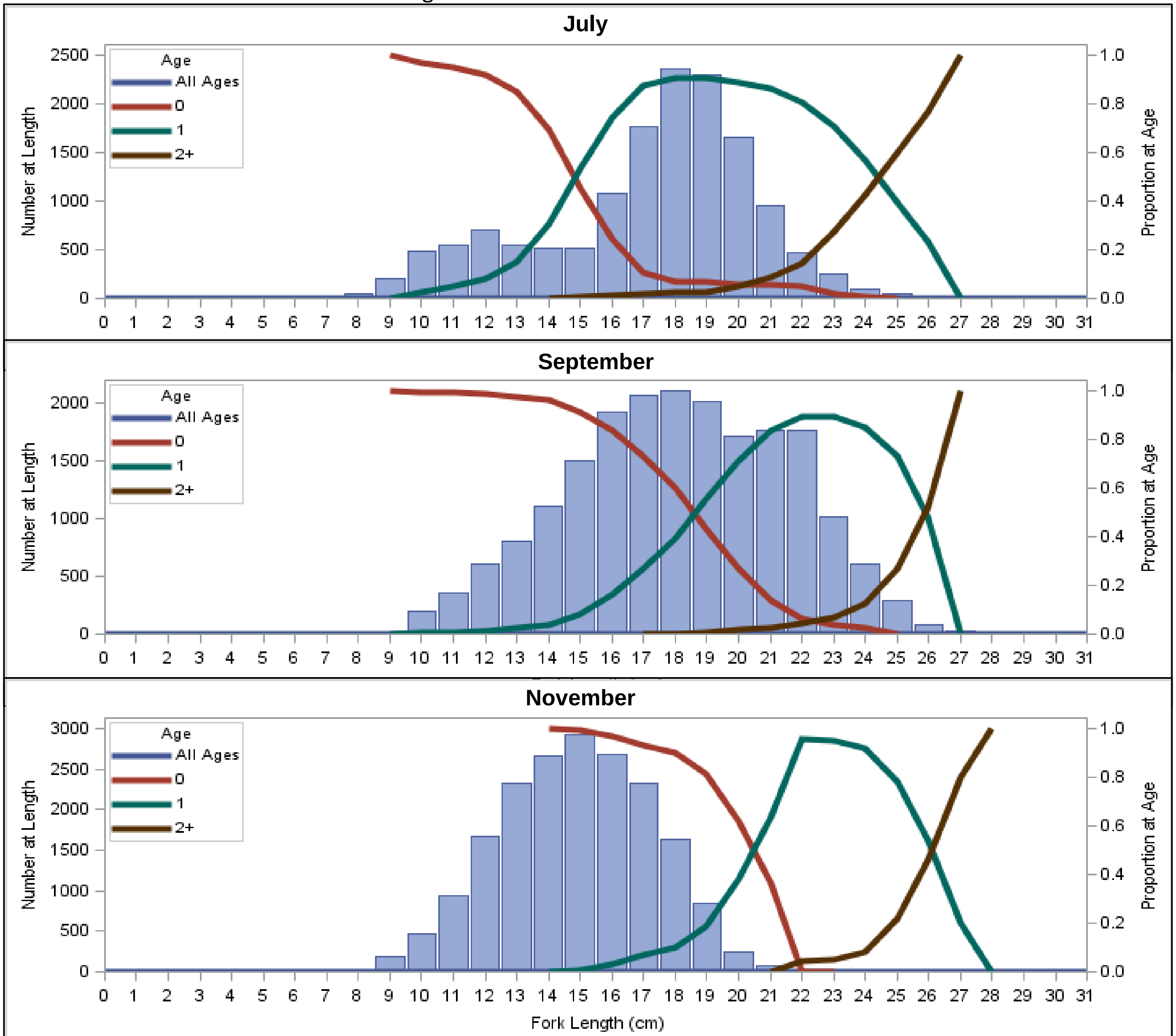


Figure 51. Spot ALK for all July, September and Novembers cruises, showing loess smoothed proportions at each 1cm length bin, overlaid on month-specific length frequencies pooled over all years. ALK proportions are adjusted such that the sums of values for each length bin within each month are forced to 1.0



July					September					November				
Length (cm)	Age-0	Age-1	Age-2	Sum	Length (cm)	Age-0	Age-1	Age-2	Sum	Length (cm)	Age-0	Age-1	Age-2	Sum
7					7					7				
8					8					8				
9	1.000	0.000		1.000	9					9				
10	0.978	0.021		1.000	10					10				
11	0.950	0.050		1.000	11					11				
12	0.920	0.080		1.000	12	1.000	0.000		1.000	12				
13	0.848	0.152		1.000	13	0.988	0.012		1.000	13				
14	0.691	0.309	0.000	1.000	14	0.964	0.036		1.000	14	1.000	0.000		1.000
15	0.446	0.536	0.019	1.000	15	0.931	0.069		1.000	15	0.995	0.005		1.000
16	0.201	0.774	0.025	1.000	16	0.848	0.152		1.000	16	0.970	0.030		1.000
17	0.060	0.915	0.025	1.000	17	0.734	0.266	0.000	1.000	17	0.930	0.070		1.000
18	0.040	0.935	0.025	1.000	18	0.617	0.379	0.004	1.000	18	0.897	0.103		1.000
19	0.021	0.953	0.027	1.000	19	0.445	0.546	0.009	1.000	19	0.814	0.186		1.000
20	0.000	0.959	0.041	1.000	20	0.252	0.733	0.015	1.000	20	0.617	0.383		1.000
21		0.950	0.050	1.000	21	0.100	0.874	0.026	1.000	21	0.365	0.635	0.000	1.000
22		0.929	0.071	1.000	22	0.001	0.955	0.044	1.000	22	0.001	0.955	0.044	1.000
23		0.838	0.162	1.000	23	0.000	0.950	0.050	1.000	23	0.000	0.950	0.050	1.000
24		0.694	0.306	1.000	24		0.916	0.084	1.000	24		0.916	0.084	1.000
25		0.462	0.538	1.000	25		0.780	0.220	1.000	25		0.780	0.220	1.000
26		0.229	0.771	1.000	26		0.540	0.460	1.000	26		0.540	0.460	1.000
27		0.050	0.950	1.000	27		0.200	0.800	1.000	27		0.200	0.800	1.000
28		0.000	1.000	1.000	28		0.000	1.000	1.000	28		0.000	1.000	1.000
29					29					29				
30					30									

November data same as September for lengths >= 22

Figure 52. Spot length-frequency in Chesapeake Bay 2002-2012, overall (A) and by sex (B).

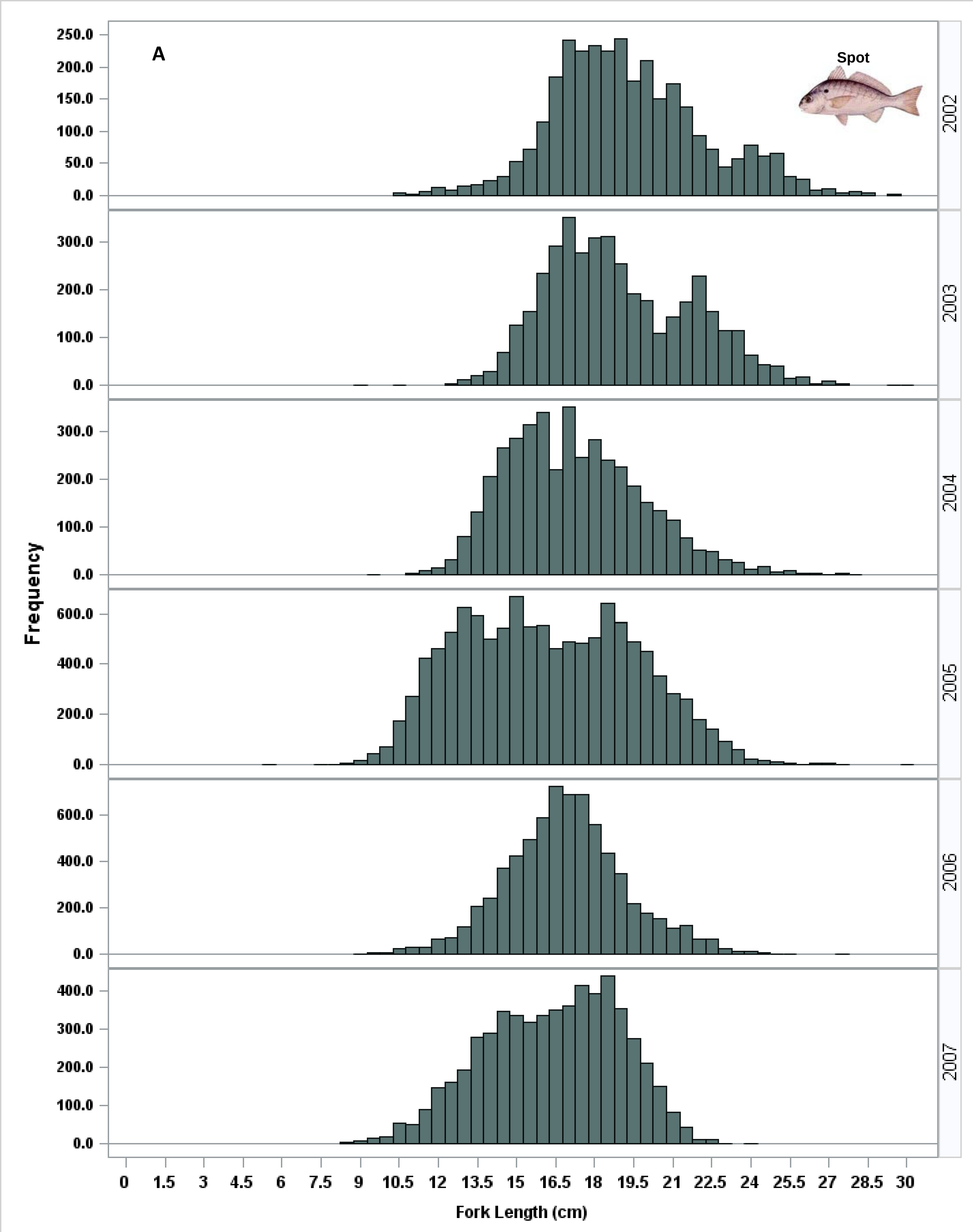


Figure 52. cont.

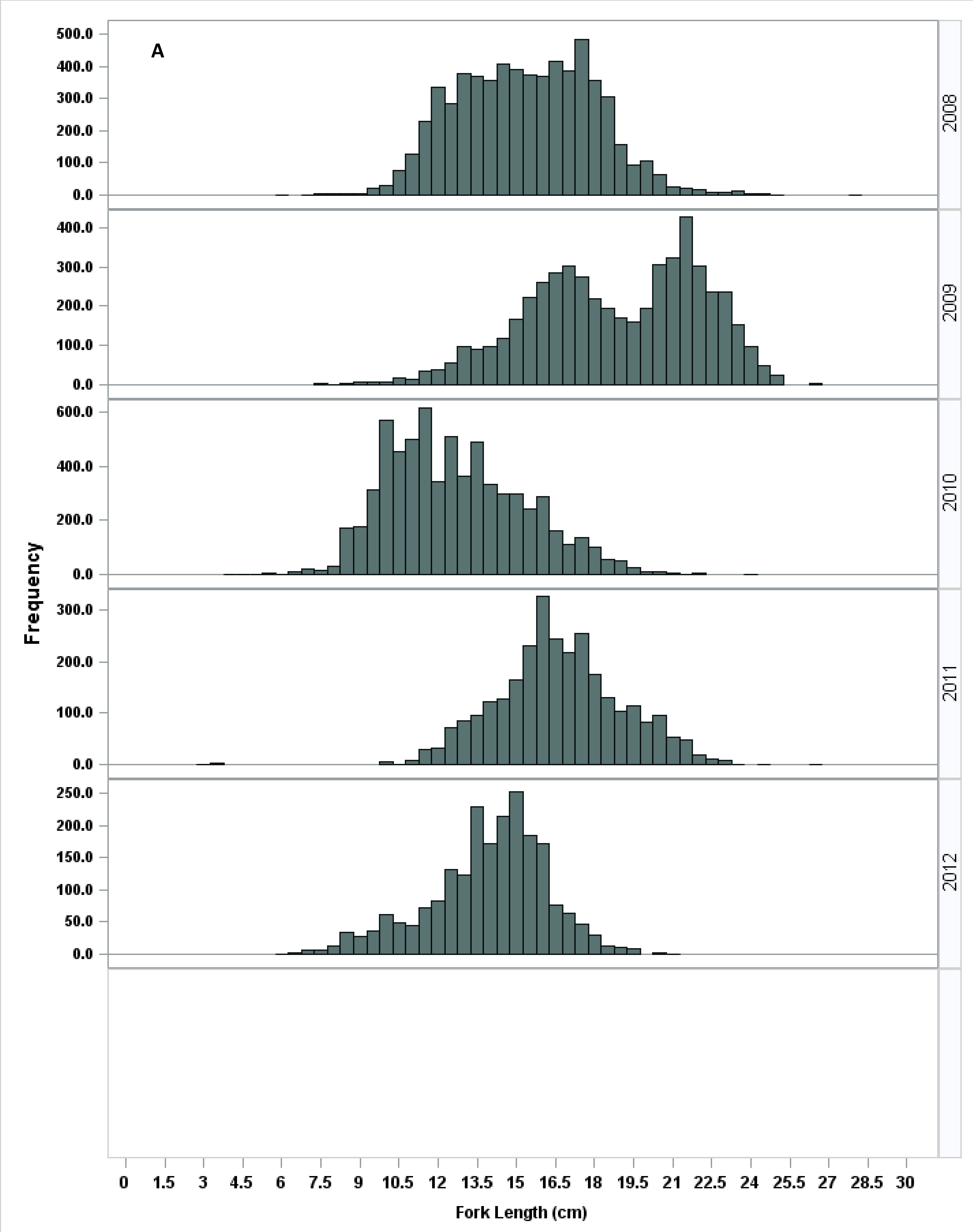


Figure 52. cont.

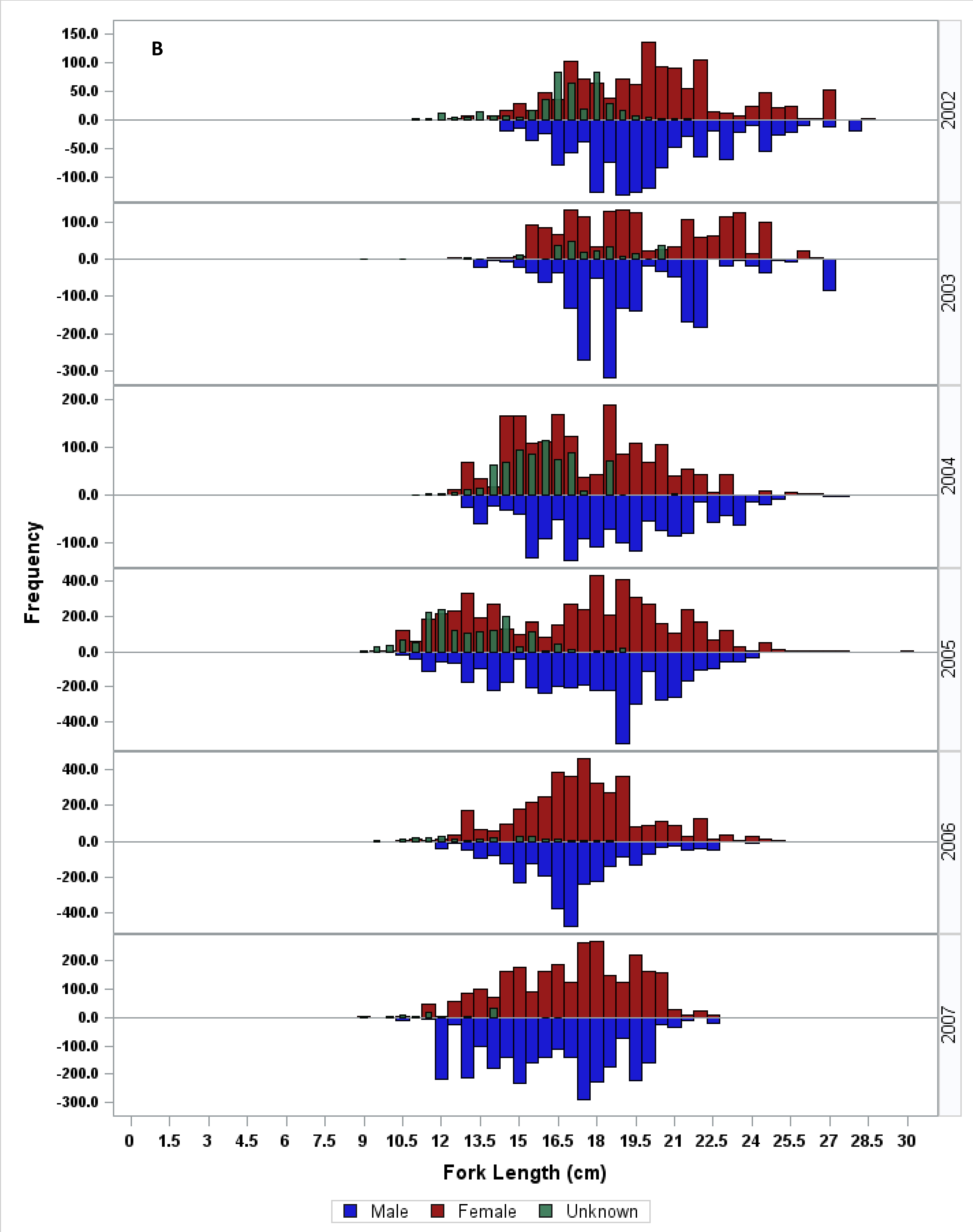


Figure 52. cont.

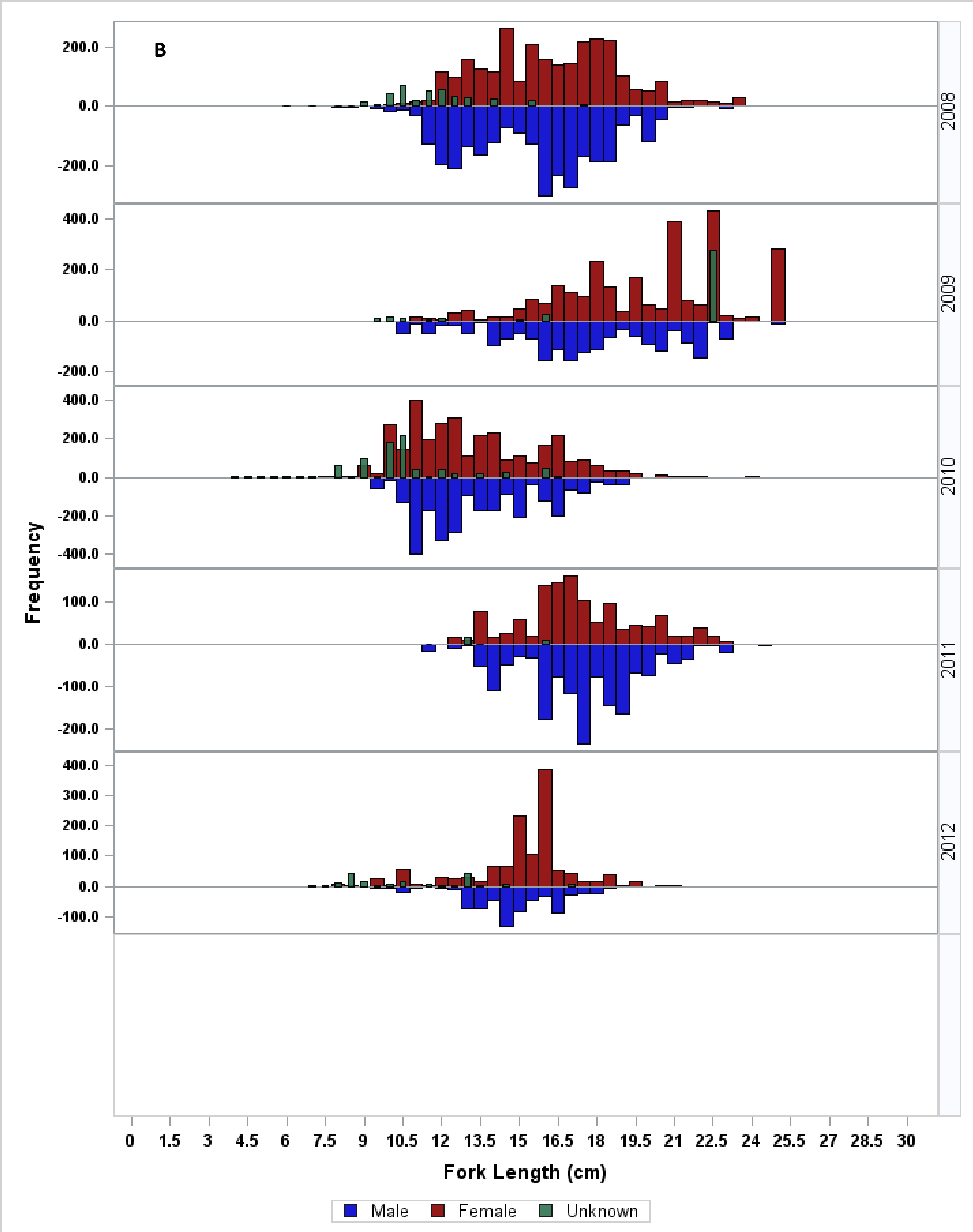


Figure 53. Spot age-frequency by year, 2002-2011.

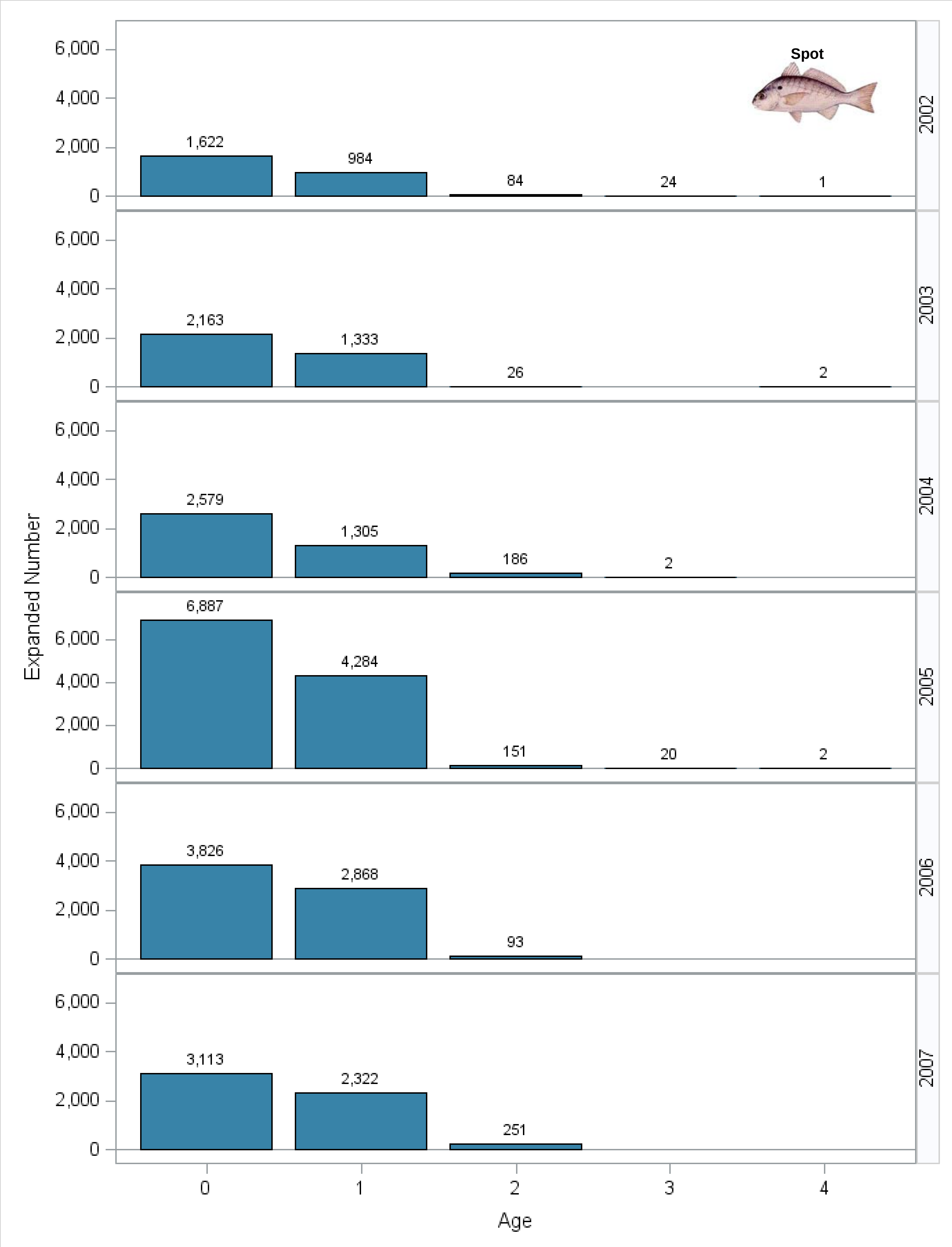


Figure 53. cont.

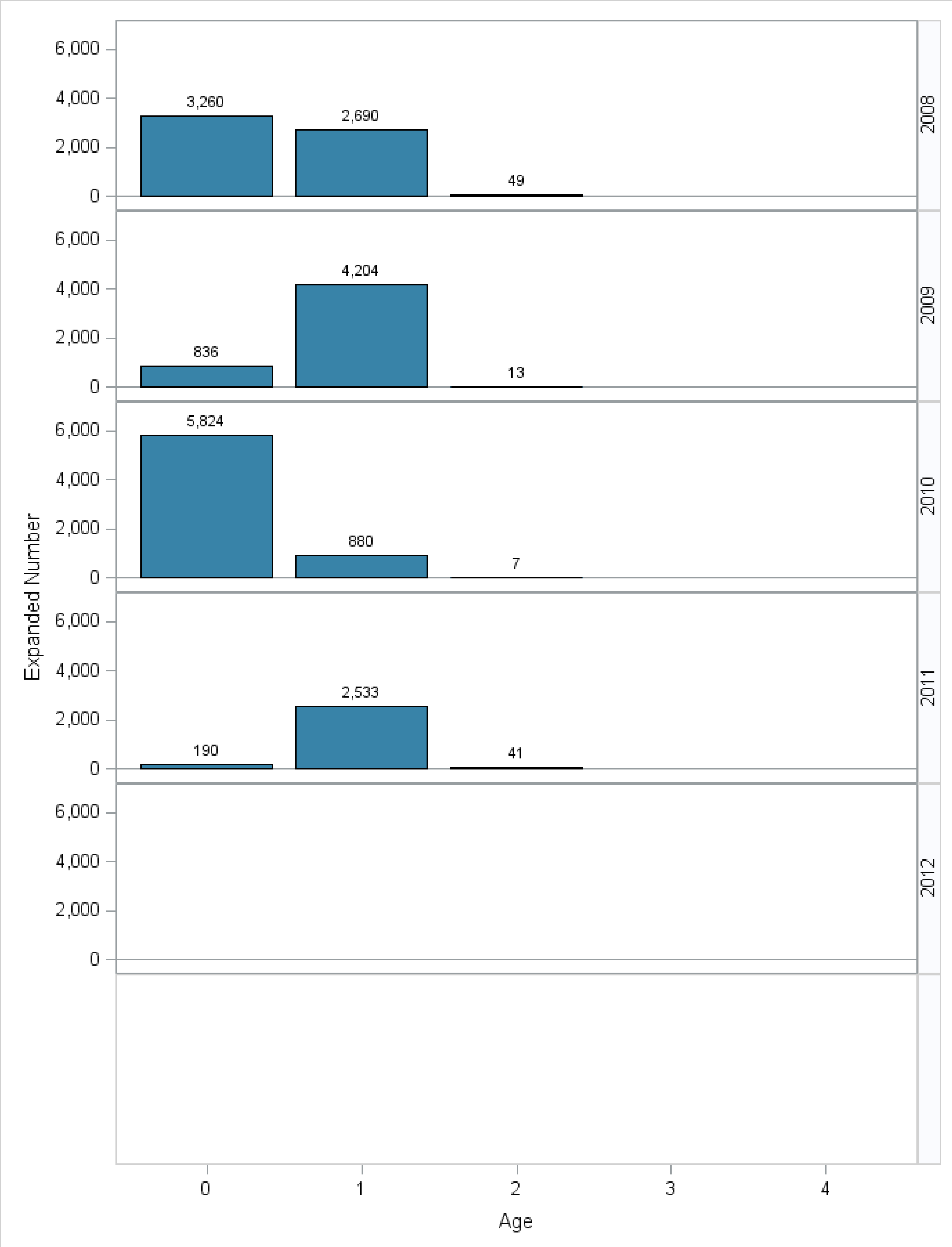


Figure 54. Spot age-frequency by year, 2002-2011 standardized to 8,000 annual trawl minutes.

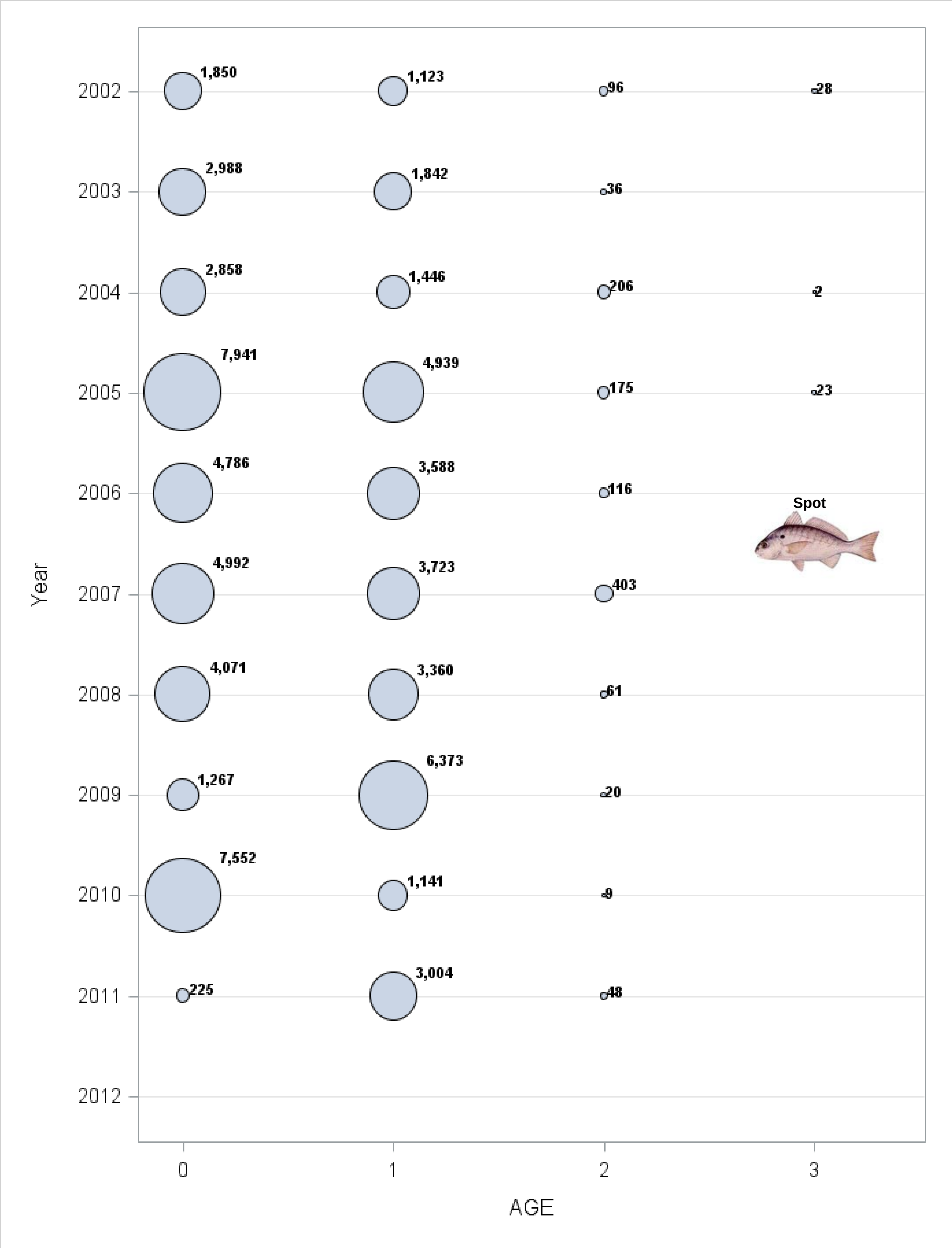


Figure 55. Spot age-frequency by cruise month, 2002-2011 combined, actual (A) and standardized to 8,000 total annual trawl minutes (B).

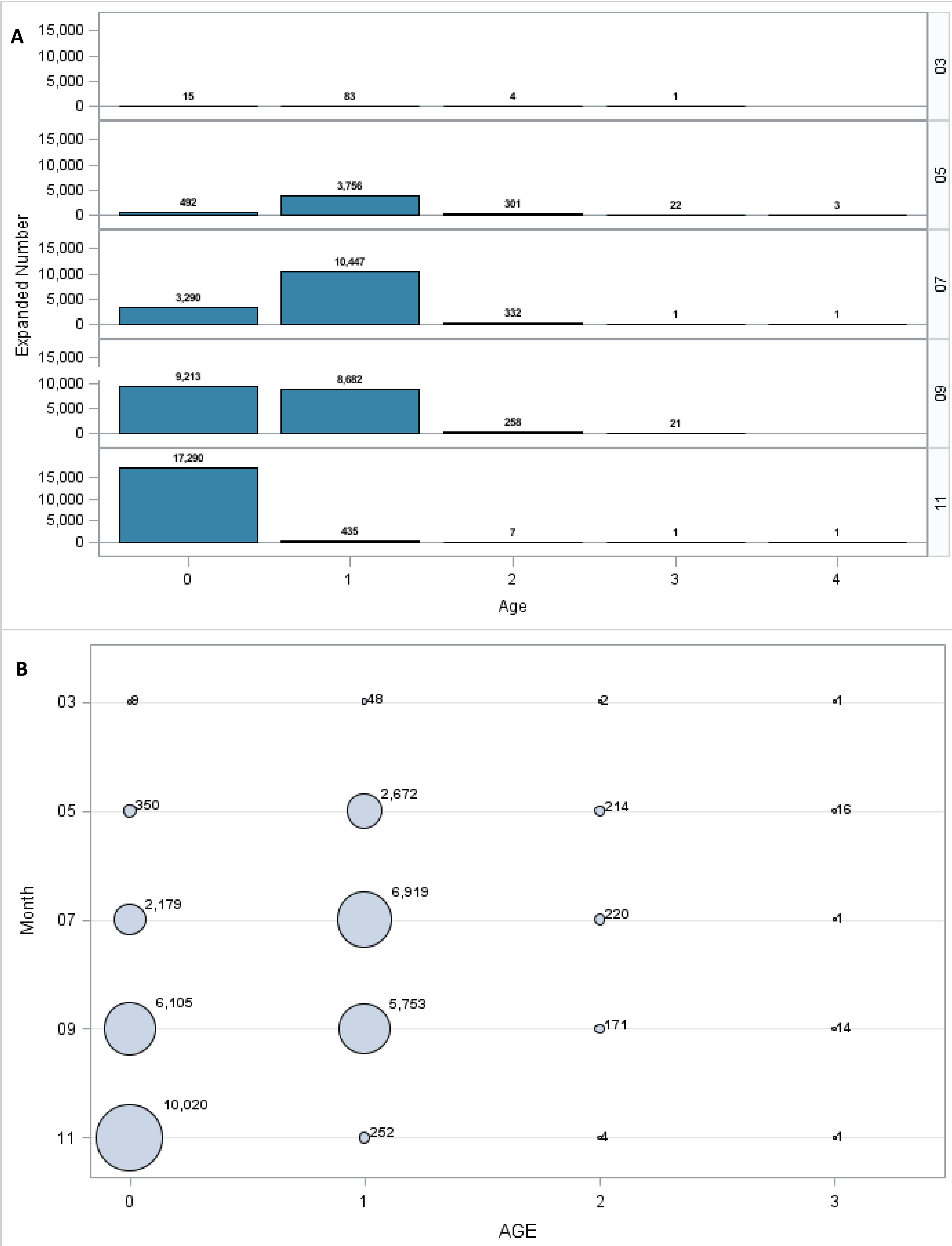


Figure 56. Diet composition, expressed as percent by weight (A) and percent by number (B) of spot collected during ChesMMAP cruises in 2002-2011 combined.

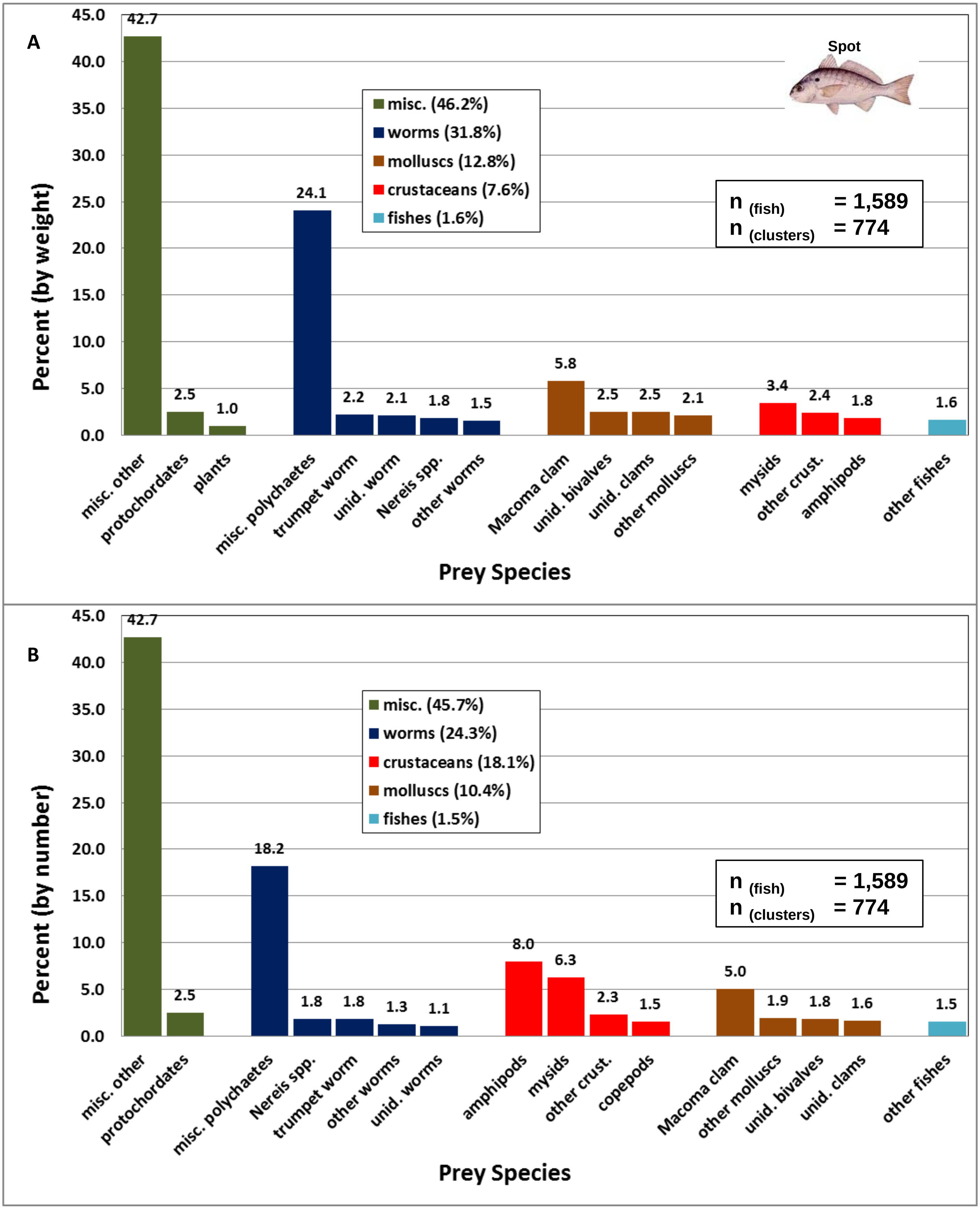


Figure 57. Abundance (kg per hectare swept) of striped bass in Chesapeake Bay, 2012.

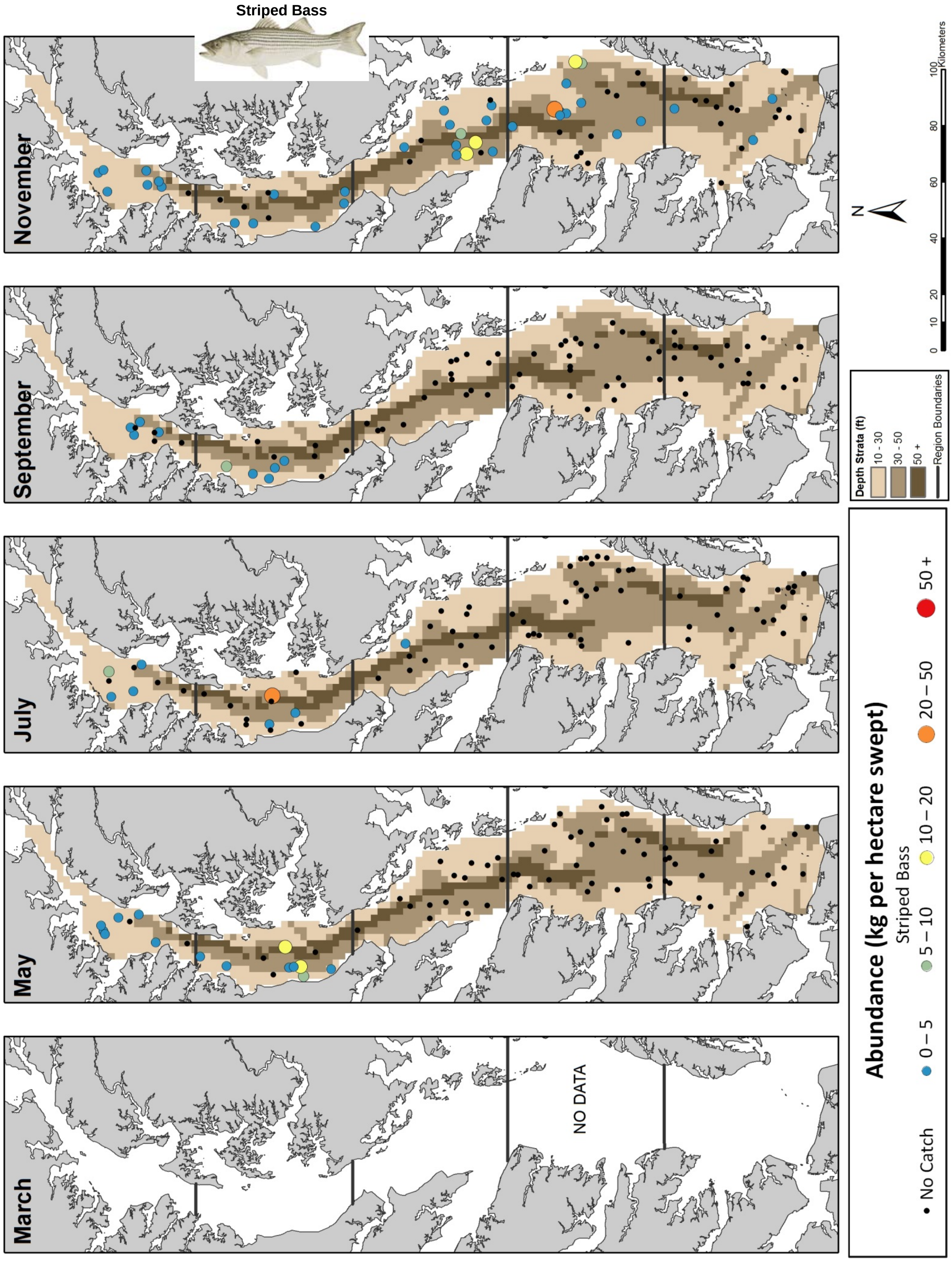
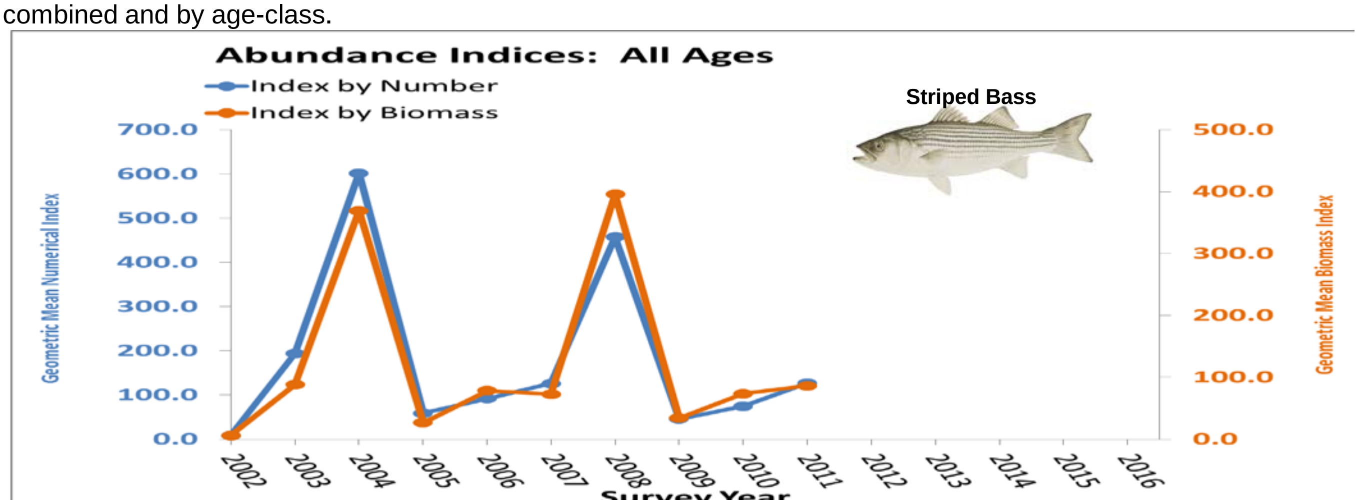


Table 13. Striped bass (March) geometric mean indices of abundance, by number and biomass, overall and by age-class.

Year	Age	n	Numerical Index LCI	Numerical Index Index	Numerical Index UCI	Biomass Index LCI	Biomass Index Index	Biomass Index UCI
2002	All	15	1.1	8.6	43.6	0.8	6.0	25.7
2003		17	73.2	193.8	510.5	27.6	88.2	276.7
2004		19	450.5	602.0	804.5	228.8	369.1	595.0
2005		15	13.9	58.6	237.0	8.5	26.4	78.4
2006		15	20.7	92.0	397.2	19.0	78.4	313.5
2007		17	26.5	126.0	586.7	17.2	72.6	296.6
2008		16	193.2	457.2	1,079.8	126.0	395.6	1,237.5
2009		16	9.2	45.7	212.5	6.9	33.9	152.8
2010		16	18.2	74.7	298.3	14.9	73.3	347.0
2011		16	42.9	127.2	373.4	28.3	86.3	258.9
2012		0						
2013								
2014								
2015								
2016								
2002	1	15	0.0	0.3	1.0	0.0	0.1	0.2
2003		17	0.9	4.4	14.1	0.2	0.7	1.4
2004		19	0.3	1.3	3.2	0.1	0.4	0.8
2005		15	0.3	2.0	5.9	0.1	0.5	1.1
2006		15	0.0	0.6	2.3	0.0	0.2	0.6
2007		17	0.1	1.0	2.6	0.0	0.3	0.6
2008		16	0.0	0.6	2.0	0.0	0.2	0.4
2009		16	0.3	0.5	0.6	0.2	0.2	0.3
2010		16	0.0	0.1	0.3	0.0	0.0	0.1
2011		16	0.0	0.3	0.8	0.0	0.1	0.3
2012		0				0.0		
2013								
2014								
2015								
2016								
2002	2	15	0.3	4.1	20.0	0.2	1.7	5.4
2003		17	36.6	86.4	202.1	10.8	22.0	43.6
2004		19	41.7	93.2	206.9	13.2	25.9	50.0
2005		15	4.5	22.1	96.5	2.2	8.1	24.4
2006		15	4.9	23.2	98.9	3.1	10.6	31.7
2007		17	5.2	22.5	88.7	2.7	9.0	26.1
2008		16	21.5	53.7	131.9	10.0	21.4	44.7
2009		16	3.1	11.3	36.1	2.0	6.2	16.6
2010		16	2.9	7.1	15.9	1.9	4.3	8.6
2011		16	3.9	16.7	62.3	2.3	7.3	20.4
2012		0						
2013								
2014								
2015								
2016								

Year	Age	n	Numerical Index LCI	Numerical Index Index	Numerical Index UCI	Biomass Index LCI	Biomass Index Index	Biomass Index UCI
2002	3	15	0.0	1.6	5.6	0.0	0.8	2.4
2003		17	18.7	50.9	135.9	7.0	19.1	49.3
2004		19	78.2	150.2	287.6	43.6	73.7	123.8
2005		15	7.8	27.4	91.2	4.8	13.6	35.7
2006		15	7.0	31.8	134.0	5.2	20.7	75.1
2007		17	12.2	46.6	170.5	8.6	30.0	99.5
2008		16	49.1	128.8	334.9	33.4	80.3	191.5
2009		16	5.9	25.5	100.4	4.3	16.1	54.2
2010		16	5.5	17.8	53.7	4.0	12.8	36.7
2011		16	9.8	32.3	102.1	6.6	18.6	49.4
2012		0						
2013								
2014								
2015								
2016								
2002	4+	15	0.0	1.5	5.4	0.0	2.2	10.2
2003		17	1.9	9.8	38.8	2.1	15.2	84.6
2004		19	69.4	128.9	239.0	81.0	174.5	374.9
2005		15	3.9	7.9	15.2	3.1	5.4	9.2
2006		15	8.0	27.8	91.2	7.7	33.5	135.9
2007		17	9.0	34.5	124.3	8.5	31.3	109.1
2008		16	40.3	133.3	435.8	51.0	204.4	811.2
2009		16	1.9	9.2	35.2	1.6	9.2	38.5
2010		16	7.9	33.2	130.7	7.4	40.2	200.0
2011		16	6.2	25.5	96.4	5.5	26.0	110.6
2012		0						
2013								
2014								
2015								
2016								

Figure 58. Striped bass (March) geometric mean indices of abundance, by number and biomass, for all ages combined and by age-class.



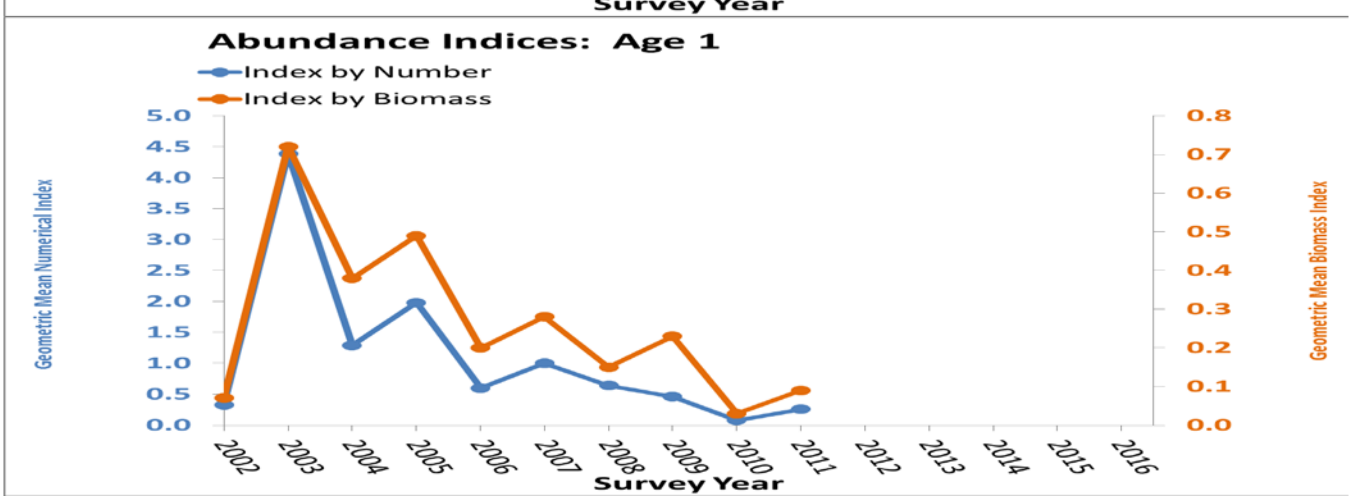
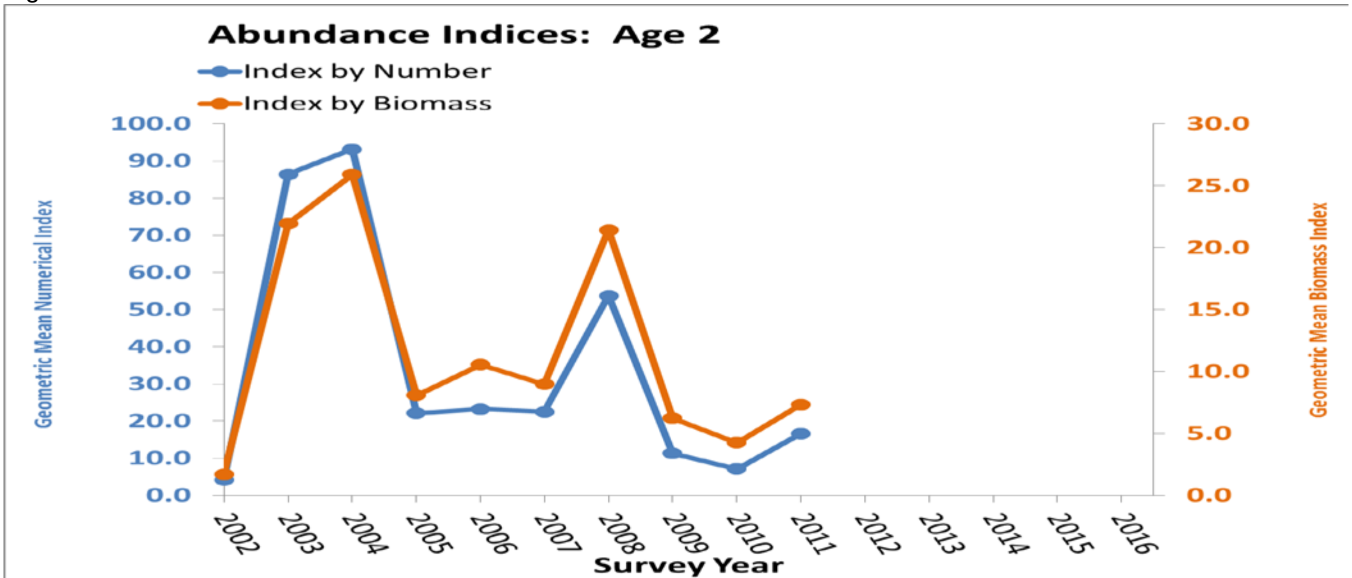
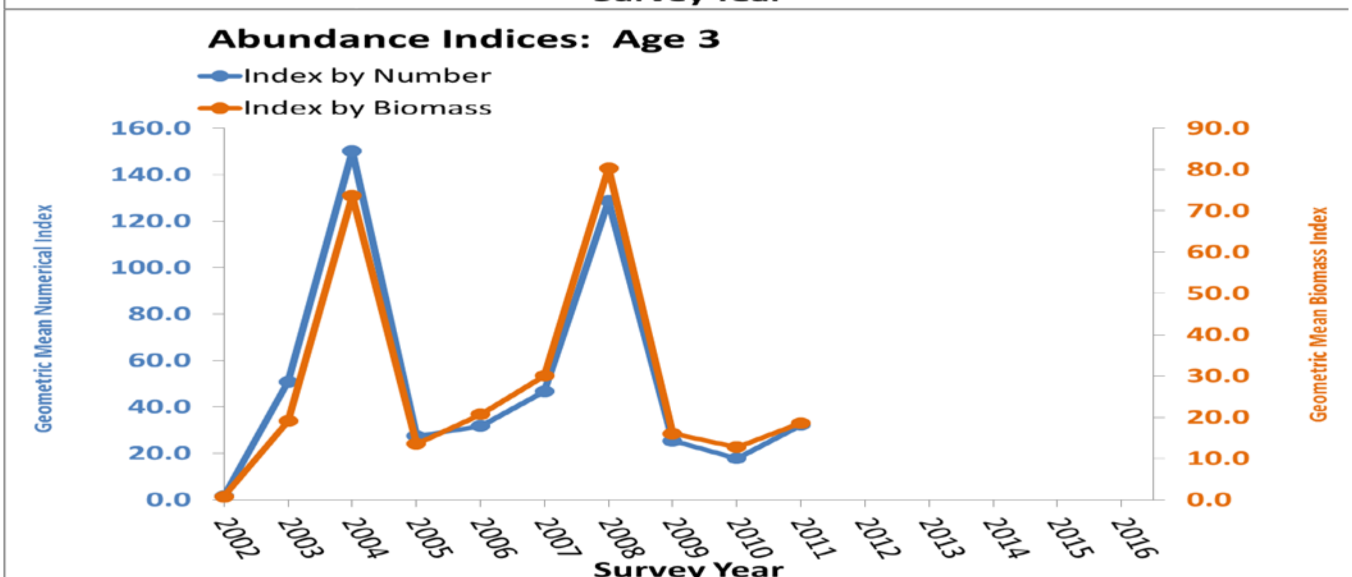


Figure 58. cont.





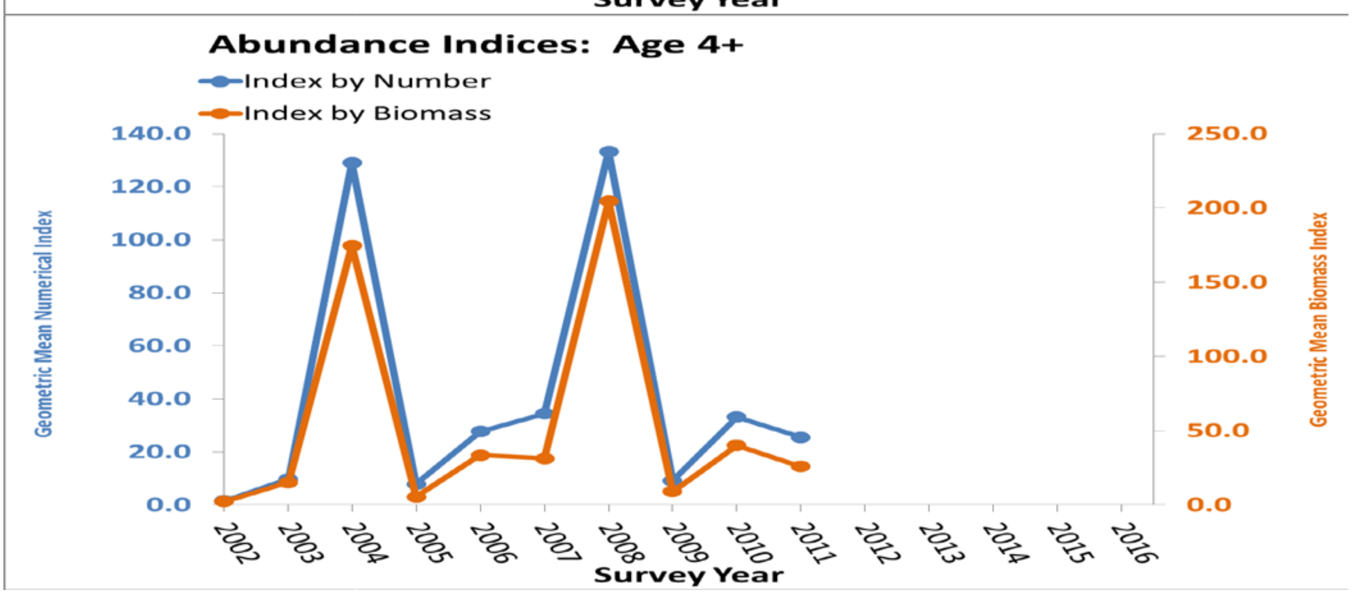
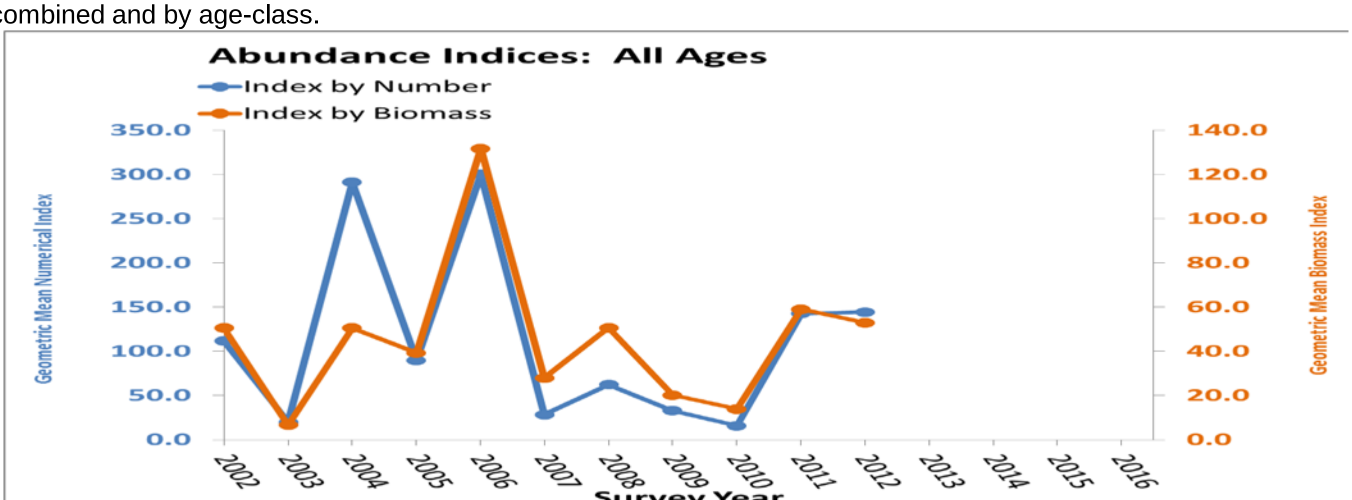


Table 14. Striped bass (November) geometric mean indices of abundance, by number and biomass, overall and by age-class.

Year	Age	n	Numerical Index LCI	Numerical Index Index	Numerical Index UCI	Biomass Index LCI	Biomass Index Index	Biomass Index UCI
2002	All	20	41.1	111.6	300.1	22.9	50.6	110.4
2003		11	2.5	19.8	124.7	2.5	6.6	15.3
2004		18	96.4	291.1	875.4	20.5	50.6	123.0
2005		15	14.1	89.8	546.3	8.5	39.2	168.8
2006		14	156.6	300.2	574.9	54.8	131.7	314.5
2007		15	3.0	28.3	213.8	3.3	27.9	196.0
2008		16	11.4	62.3	323.4	9.3	50.7	257.2
2009		16	3.6	32.9	246.5	2.5	20.1	126.9
2010		15	2.2	15.8	87.8	1.2	13.9	101.2
2011		15	28.5	142.7	698.3	13.6	59.0	245.1
2012		15	42.2	144.3	487.2	14.3	52.9	188.6
2013								
2014								
2015								
2016								
2002	1	20	16.3	42.6	109.0	6.1	12.1	23.1
2003		11	0.3	6.9	47.3	0.4	1.7	4.3
2004		18	75.9	220.9	639.9	13.4	27.7	56.2
2005		15	7.7	44.8	239.5	3.4	12.6	40.8
2006		14	30.7	79.3	202.6	7.1	14.4	28.3
2007		15	0.2	4.3	22.5	0.1	2.6	10.3
2008		16	2.5	12.9	54.0	1.7	6.7	21.1
2009		16	1.2	10.8	62.6	0.7	4.2	14.9
2010		15	1.8	4.6	9.9	1.1	2.5	4.9
2011		15	18.8	76.5	303.1	7.0	20.0	54.4
2012		15	11.5	43.3	156.1	3.2	10.1	28.0
2013								
2014								
2015								
2016								
2002	2	20	14.8	33.5	74.2	8.2	15.6	28.9
2003		11	2.2	5.3	11.5	1.5	3.4	6.7
2004		18	8.7	30.5	101.6	3.7	10.5	27.3
2005		15	5.4	28.9	138.6	3.6	13.2	43.6
2006		14	28.5	50.7	89.5	9.4	19.9	41.1
2007		15	0.7	7.7	44.2	0.6	5.5	25.7
2008		16	5.5	24.1	95.4	4.0	14.7	48.7
2009		16	1.7	12.5	67.3	1.0	7.4	35.1
2010		15	1.8	5.0	11.9	1.2	3.4	8.2
2011		15	7.7	33.1	133.1	2.9	12.3	44.0
2012		15	4.0	19.8	86.5	2.2	9.1	30.6
2013								
2014								
2015								
2016								

Year	Age	n	Numerical Index LCI	Numerical Index Index	Numerical Index UCI	Biomass Index LCI	Biomass Index Index	Biomass Index UCI
2002	3	20	8.2	15.9	30.2	6.1	12.0	22.6
2003		11	1.3	3.6	7.9	0.9	2.6	6.1
2004		18	1.5	5.5	15.6	1.0	3.5	9.1
2005		15	2.9	12.7	47.4	2.4	8.9	27.8
2006		14	7.1	29.9	117.2	6.3	25.1	92.8
2007		15	1.1	8.2	39.0	1.0	6.8	29.4
2008		16	4.2	15.3	50.0	3.5	13.5	45.4
2009		16	0.1	5.4	37.1	0.0	4.3	28.8
2010		15	0.6	2.8	8.1	0.3	2.2	6.6
2011		15	1.6	7.7	27.8	1.2	5.5	18.3
2012		15	1.4	7.6	30.2	1.1	6.3	24.2
2013								
2014								
2015								
2016								
2002	4+	20	1.9	5.9	15.2	1.8	6.3	17.8
2003		11	0.3	1.5	3.9	0.2	1.2	3.1
2004		18	0.0	1.2	3.5	0.0	1.2	3.7
2005		15	1.2	7.1	28.1	1.3	7.8	32.1
2006		14	5.0	22.7	92.4	4.7	23.8	107.1
2007		15	1.3	8.9	42.4	1.2	11.1	65.7
2008		16	1.8	8.9	34.8	2.0	11.4	51.0
2009		16	0.0	3.1	20.5	0.0	3.4	24.2
2010		15	0.0	3.6	25.9	0.0	4.8	44.5
2011		15	0.6	5.1	22.9	0.6	6.1	30.1
2012		15	1.0	7.4	34.9	1.0	8.4	44.2
2013								
2014								
2015								
2016								

Figure 59. Striped bass (November) geometric mean indices of abundance, by number and biomass, for all ages combined and by age-class.



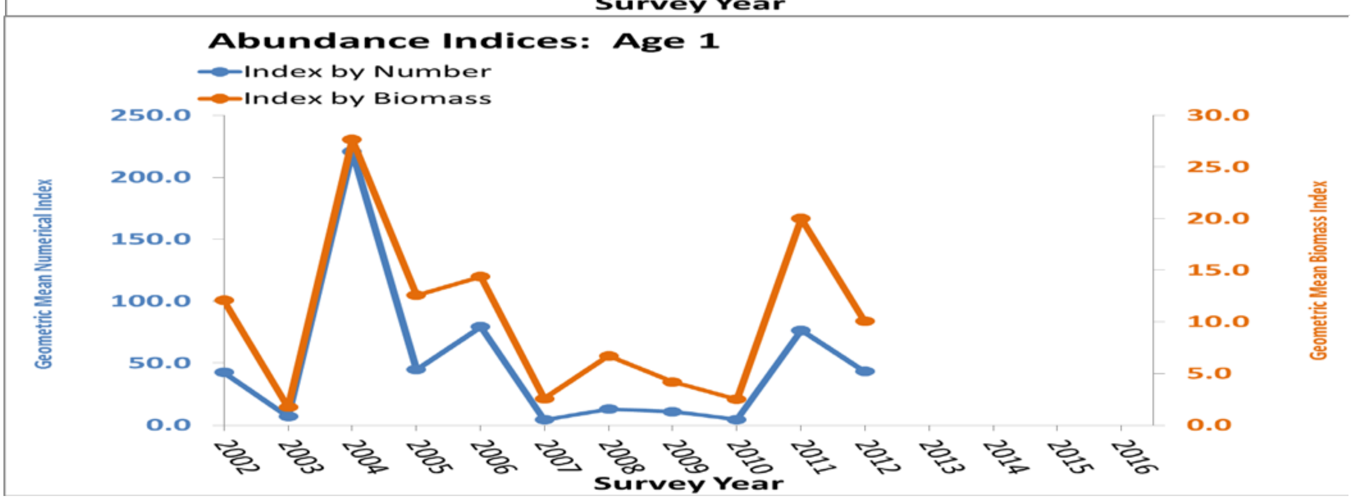
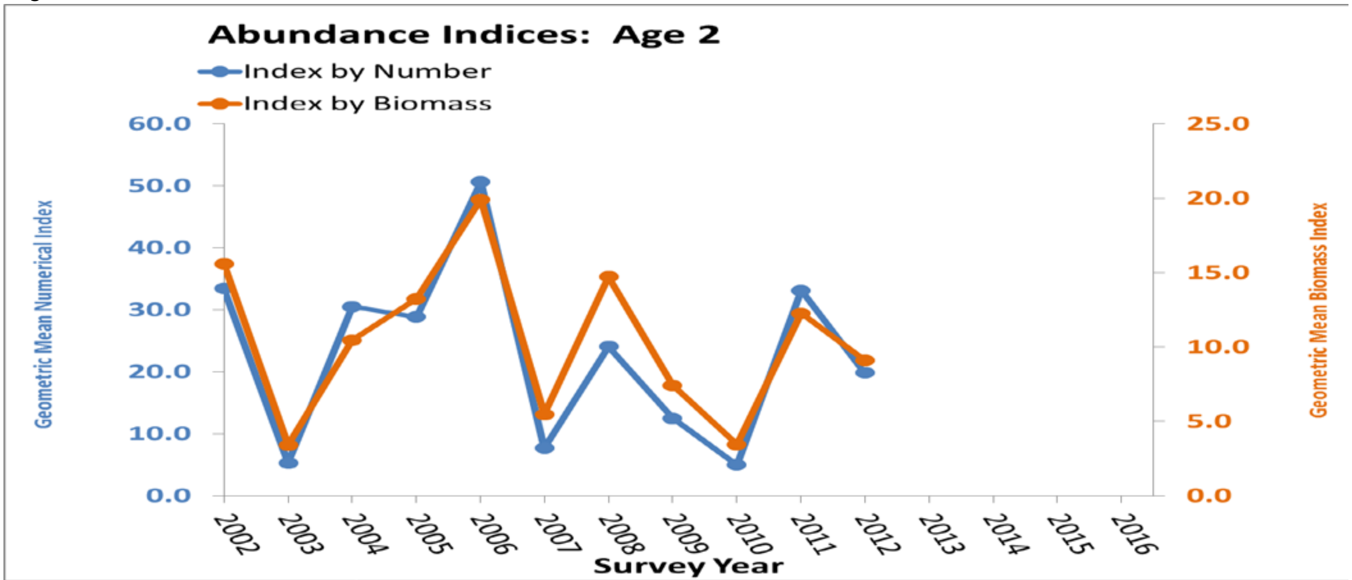
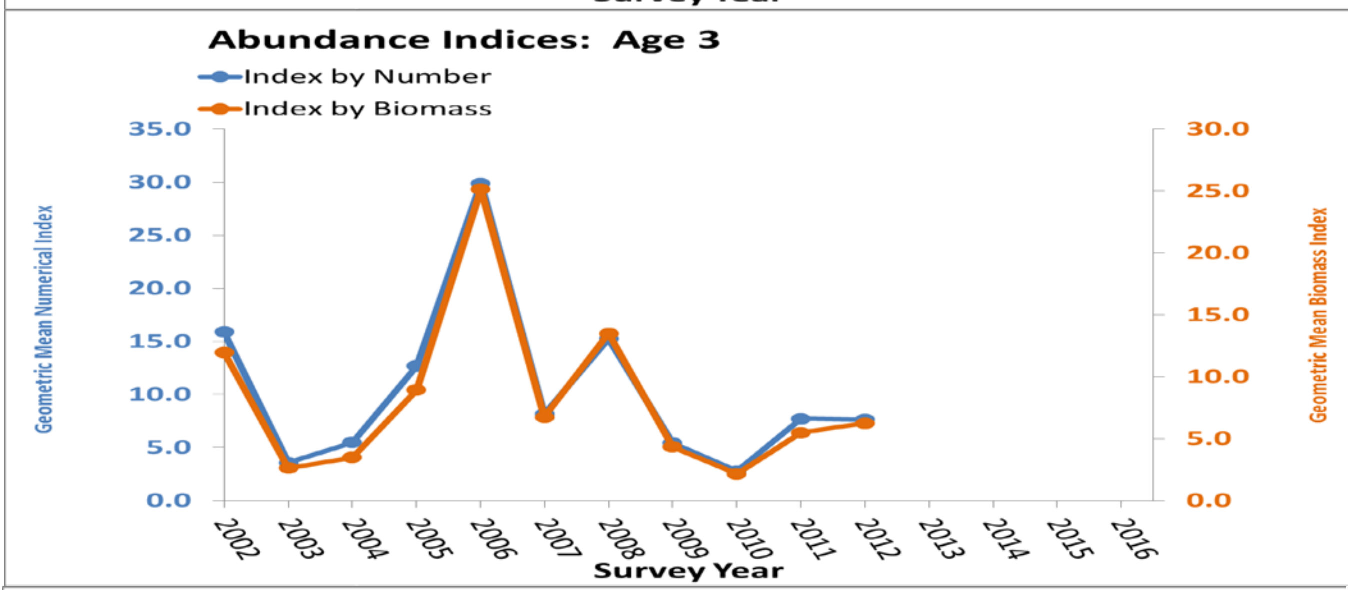


Figure 59. cont.





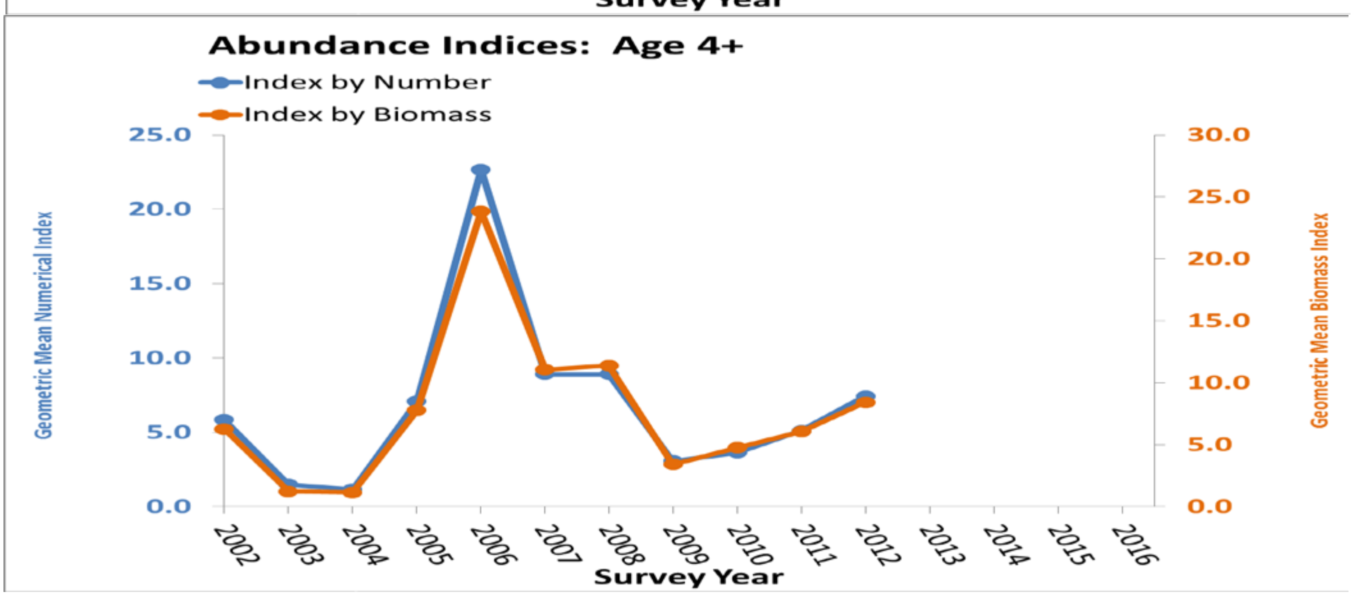
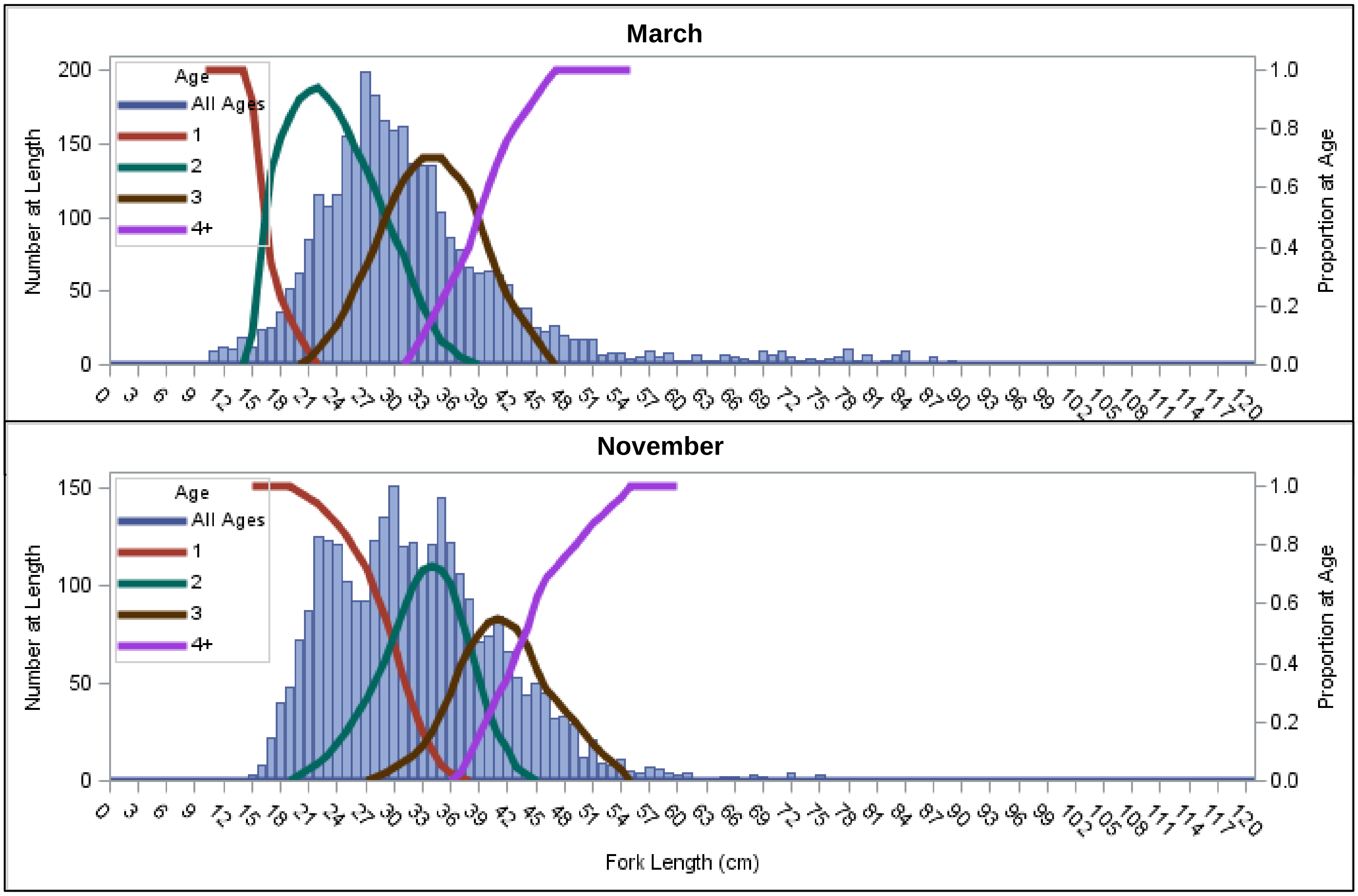


Figure 60. Striped bass ALK for all March and Novembers cruises, showing loess smoothed proportions at each 1cm length bin, overlaid on month-specific length frequencies pooled over all years. ALK proportions are adjusted such that the sums of values for each length bin within each month are forced to 1.0



March						November					
Length (cm)	Age-1	Age-2	Age-3	Age-4+	Sum	Length (cm)	Age-1	Age-2	Age-3	Age-4	Sum
12						12					
13						13					
14	1.000	0.000			1.000	14					
15	0.893	0.107			1.000	15					
16	0.600	0.400			1.000	16					
17	0.342	0.658			1.000	17					
18	0.230	0.770			1.000	18					
19	0.162	0.838			1.000	19	1.000	0.000			1.000
20	0.102	0.898	0.000		1.000	20	0.979	0.021			1.000
21	0.050	0.928	0.022		1.000	21	0.957	0.043			1.000
22	0.000	0.943	0.057		1.000	22	0.937	0.063			1.000
23		0.907	0.093		1.000	23	0.910	0.090			1.000
24		0.868	0.132		1.000	24	0.873	0.127			1.000
25		0.807	0.193		1.000	25	0.833	0.167			1.000
26		0.736	0.264		1.000	26	0.783	0.217			1.000
27		0.662	0.338		1.000	27	0.720	0.280	0.000		1.000
28		0.588	0.412		1.000	28	0.639	0.345	0.016		1.000
29		0.504	0.496		1.000	29	0.556	0.414	0.030		1.000
30		0.430	0.570		1.000	30	0.460	0.495	0.045		1.000
31		0.370	0.630	0.000	1.000	31	0.347	0.585	0.068		1.000
32		0.280	0.670	0.050	1.000	32	0.250	0.665	0.085		1.000
33		0.200	0.700	0.100	1.000	33	0.166	0.713	0.121		1.000
34		0.140	0.700	0.160	1.000	34	0.107	0.727	0.166		1.000
35		0.080	0.700	0.220	1.000	35	0.052	0.716	0.232		1.000
36		0.060	0.660	0.280	1.000	36	0.030	0.668	0.302	0.000	1.000
37		0.030	0.630	0.340	1.000	37	0.015	0.565	0.391	0.029	1.000
38		0.015	0.583	0.402	1.000	38	0.000	0.464	0.450	0.086	1.000
39		0.000	0.491	0.509	1.000	39		0.349	0.498	0.154	1.000
40			0.397	0.603	1.000	40		0.240	0.538	0.222	1.000
41			0.310	0.690	1.000	41		0.159	0.550	0.291	1.000
42			0.238	0.762	1.000	42		0.117	0.540	0.343	1.000
43			0.186	0.814	1.000	43		0.050	0.520	0.430	1.000
44			0.136	0.864	1.000	44		0.020	0.460	0.520	1.000
45			0.088	0.912	1.000	45		0.000	0.378	0.622	1.000
46			0.041	0.959	1.000	46			0.312	0.688	1.000
47			0.000	1.000	1.000	47			0.280	0.720	1.000
48						48			0.240	0.760	1.000
49						49			0.205	0.795	1.000
50						50			0.164	0.836	1.000
51						51			0.128	0.872	1.000
52						52			0.097	0.903	1.000
53						53			0.070	0.930	1.000
54						54			0.040	0.960	1.000
55						55			0.000	1.000	1.000

Figure 61. Striped bass length-frequency in Chesapeake Bay 2002-2012, overall (A) and by sex (B).

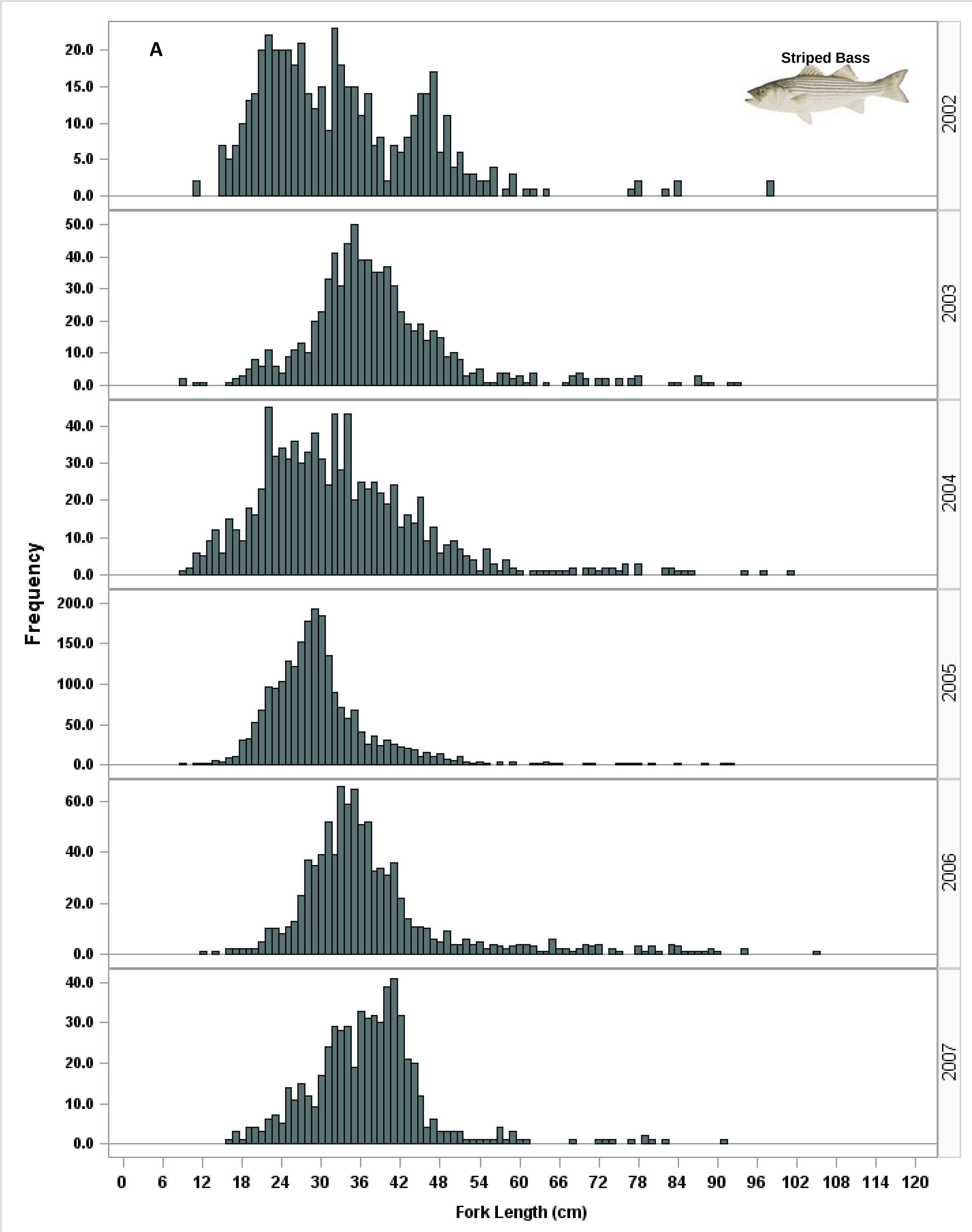


Figure 61. cont.

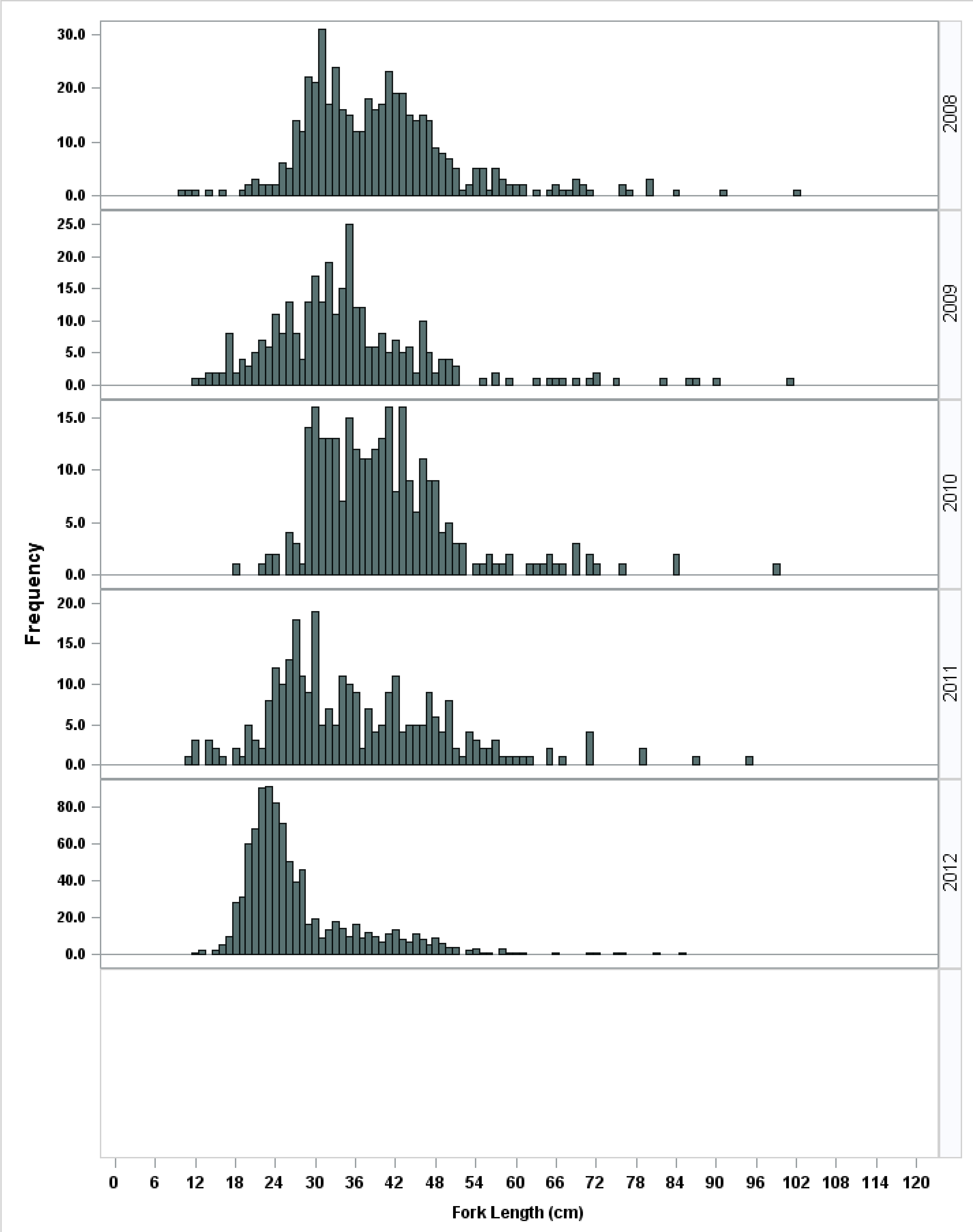


Figure 61. cont.

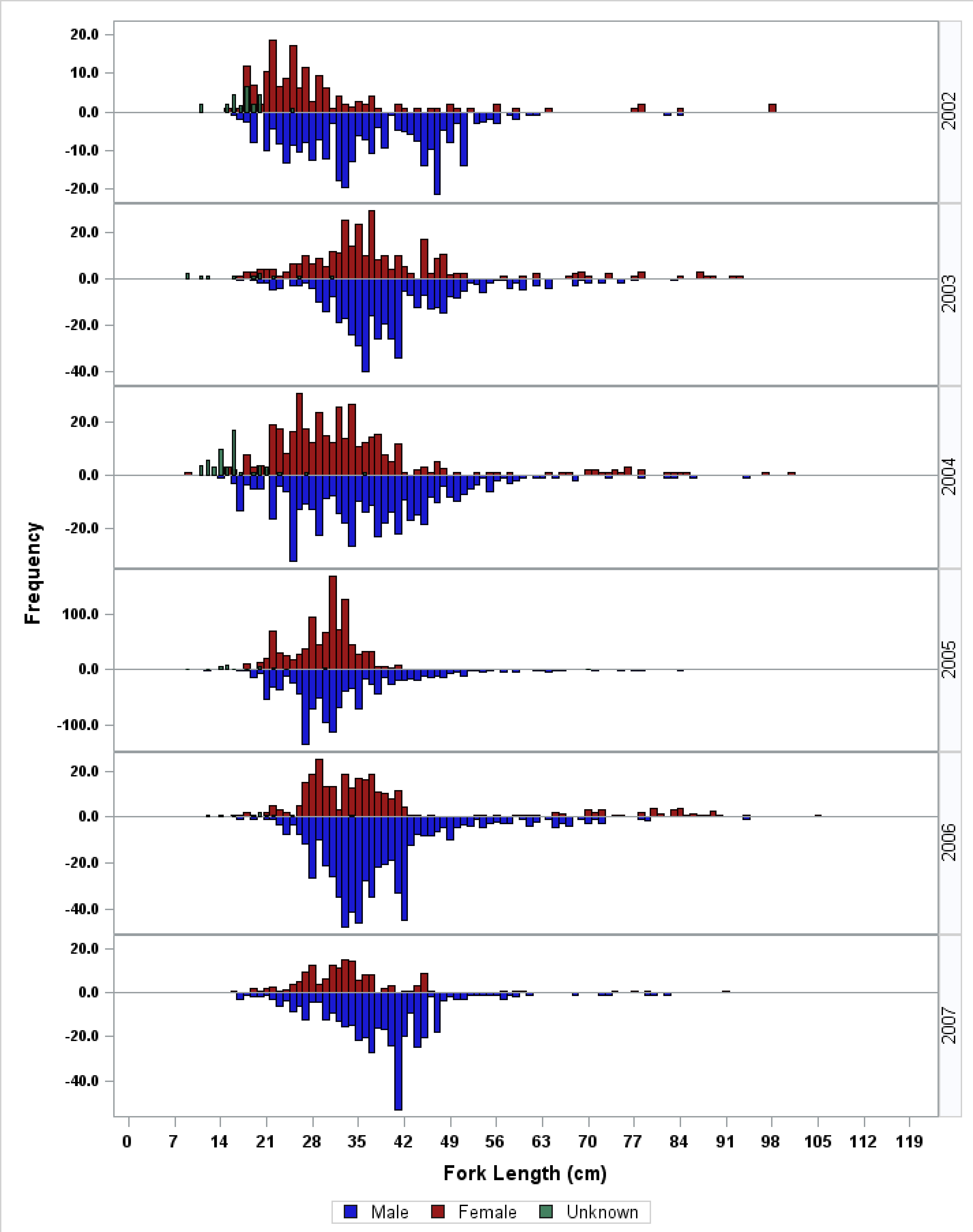


Figure 61. cont.

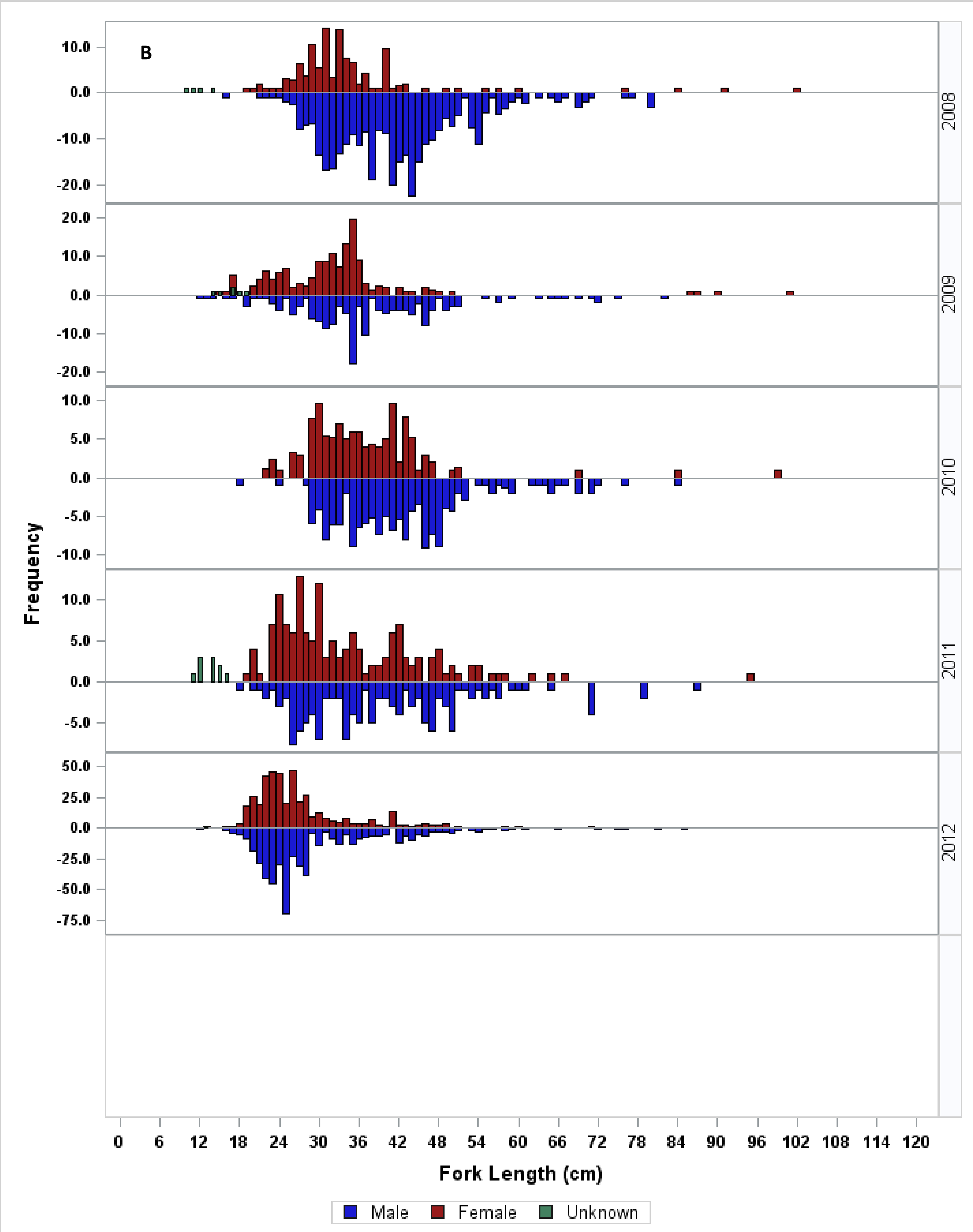


Figure 62. Striped bass total age-frequency, 2002-2012.

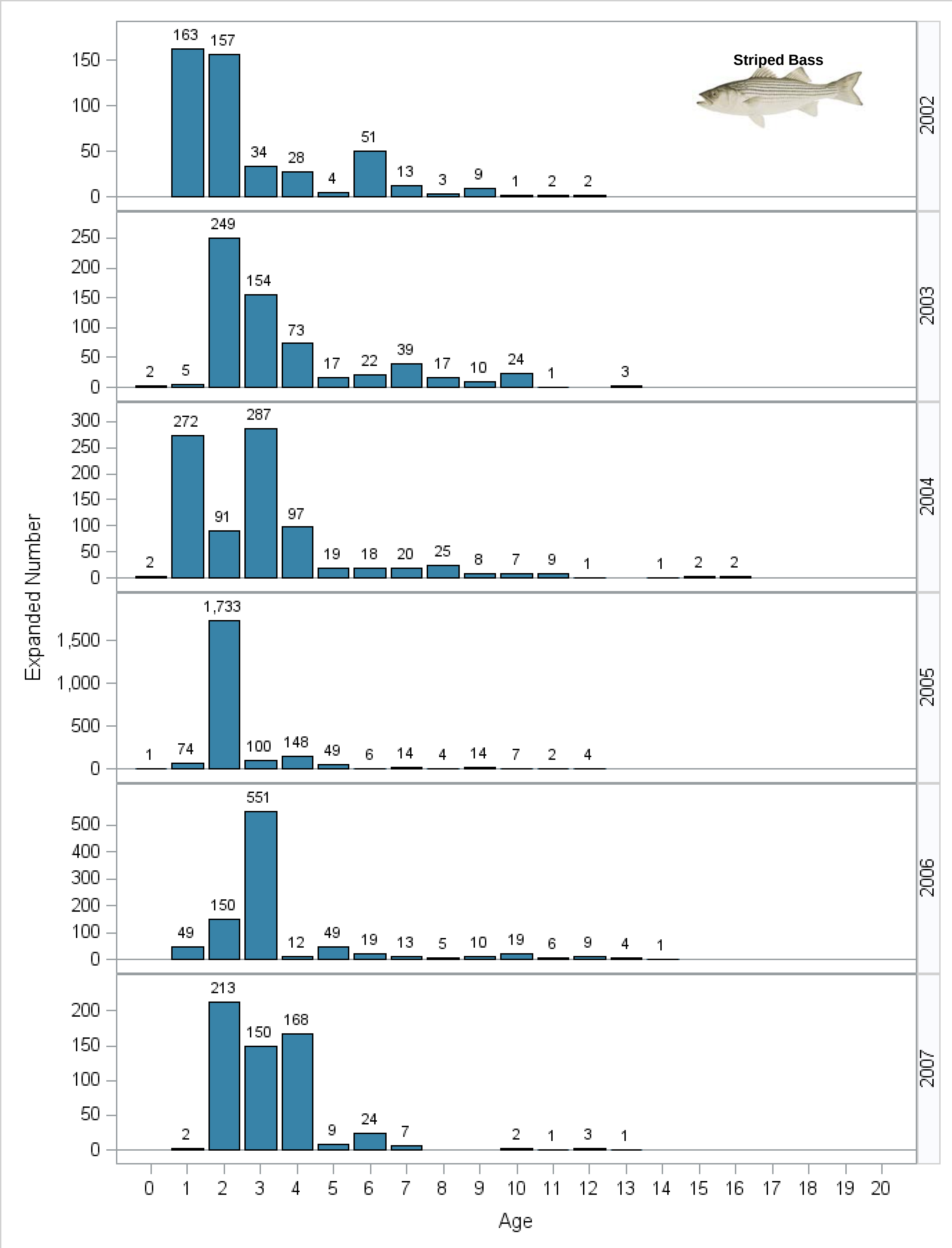


Figure 62. cont.

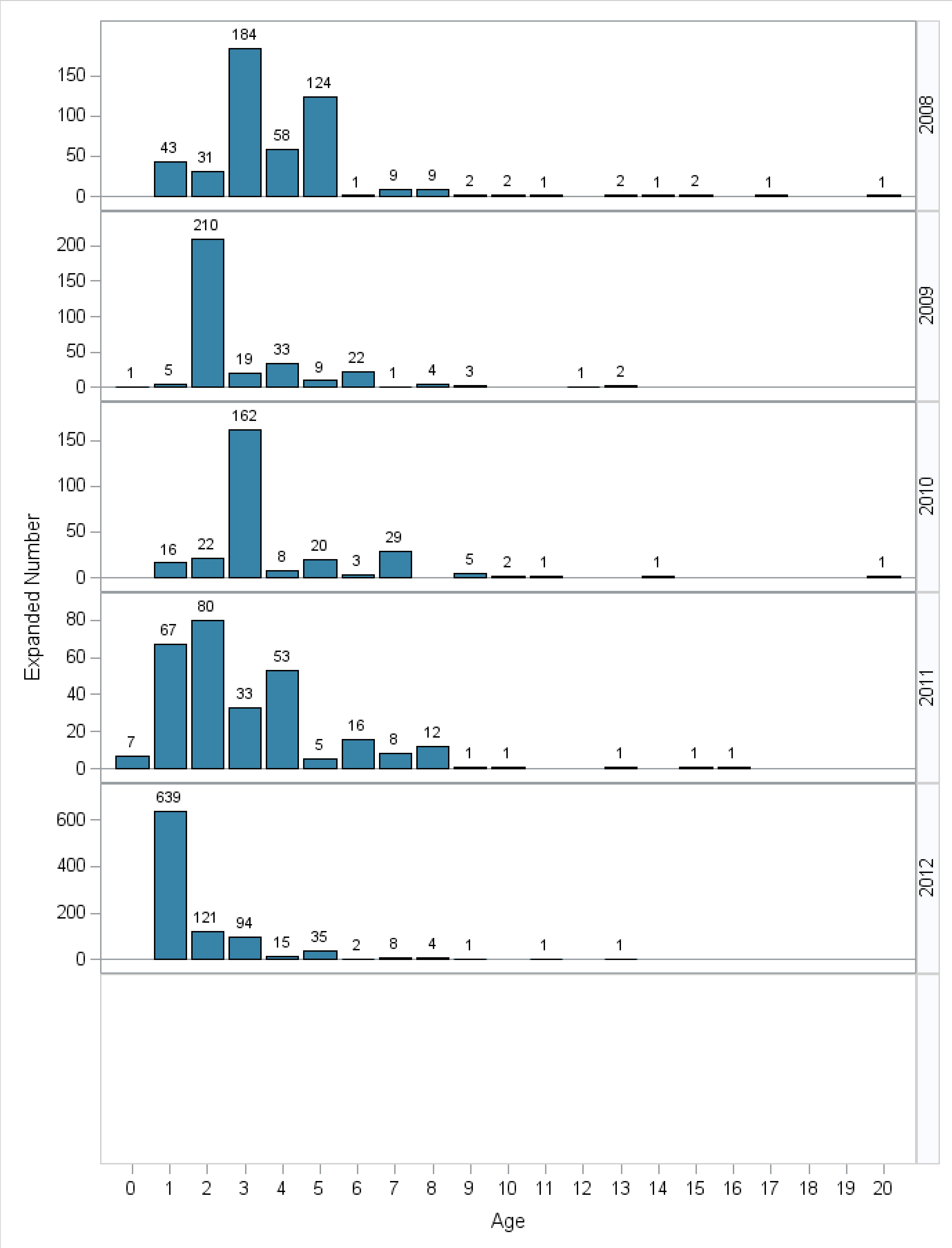


Figure 63. Striped bass age-frequency by year, 2002-2012 standardized to 8,000 annual trawl minutes.

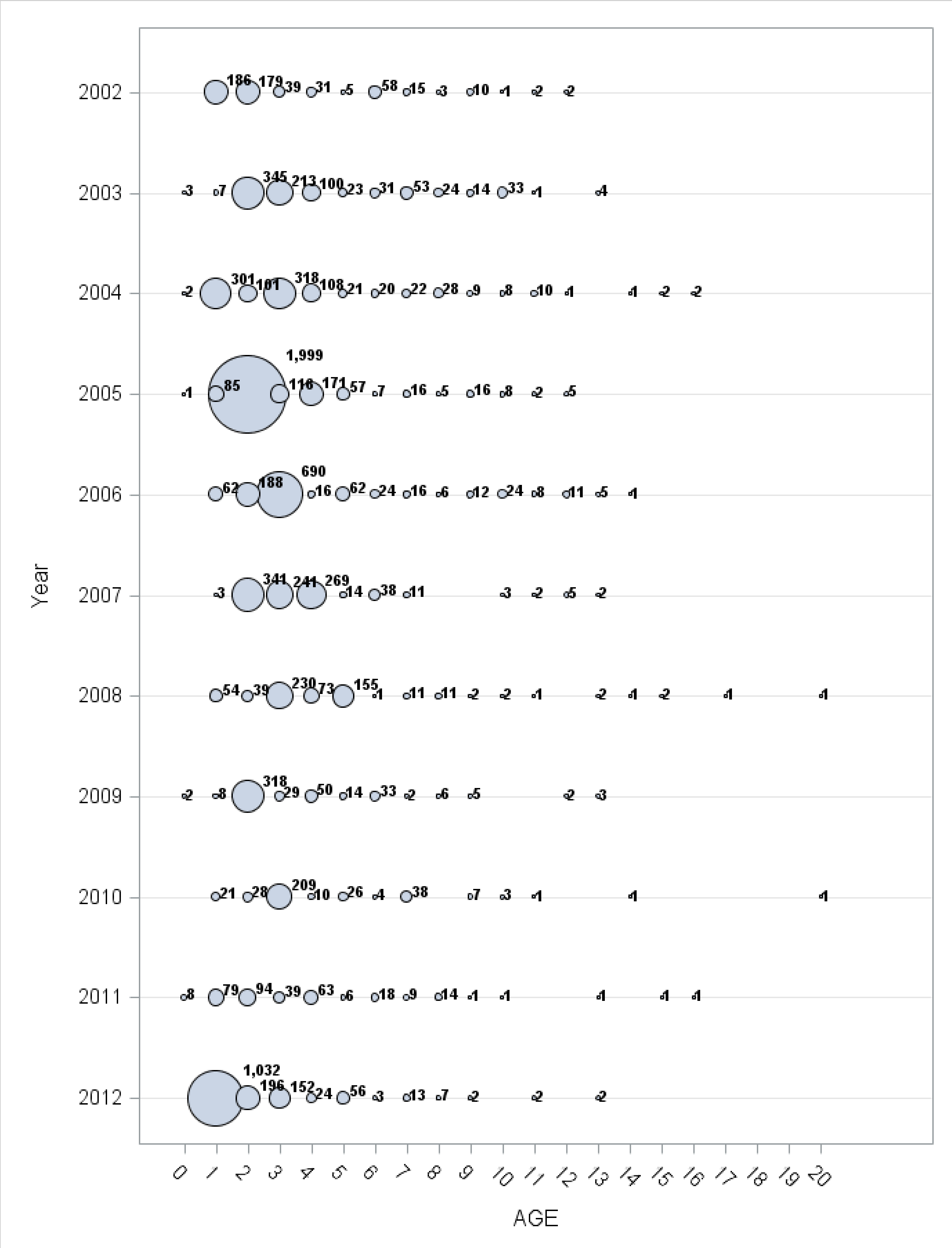


Figure 64. Striped bass age-frequency by cruise month, 2002-2012 combined, actual (A) and standardized to 8,000 total annual trawl minutes (B).

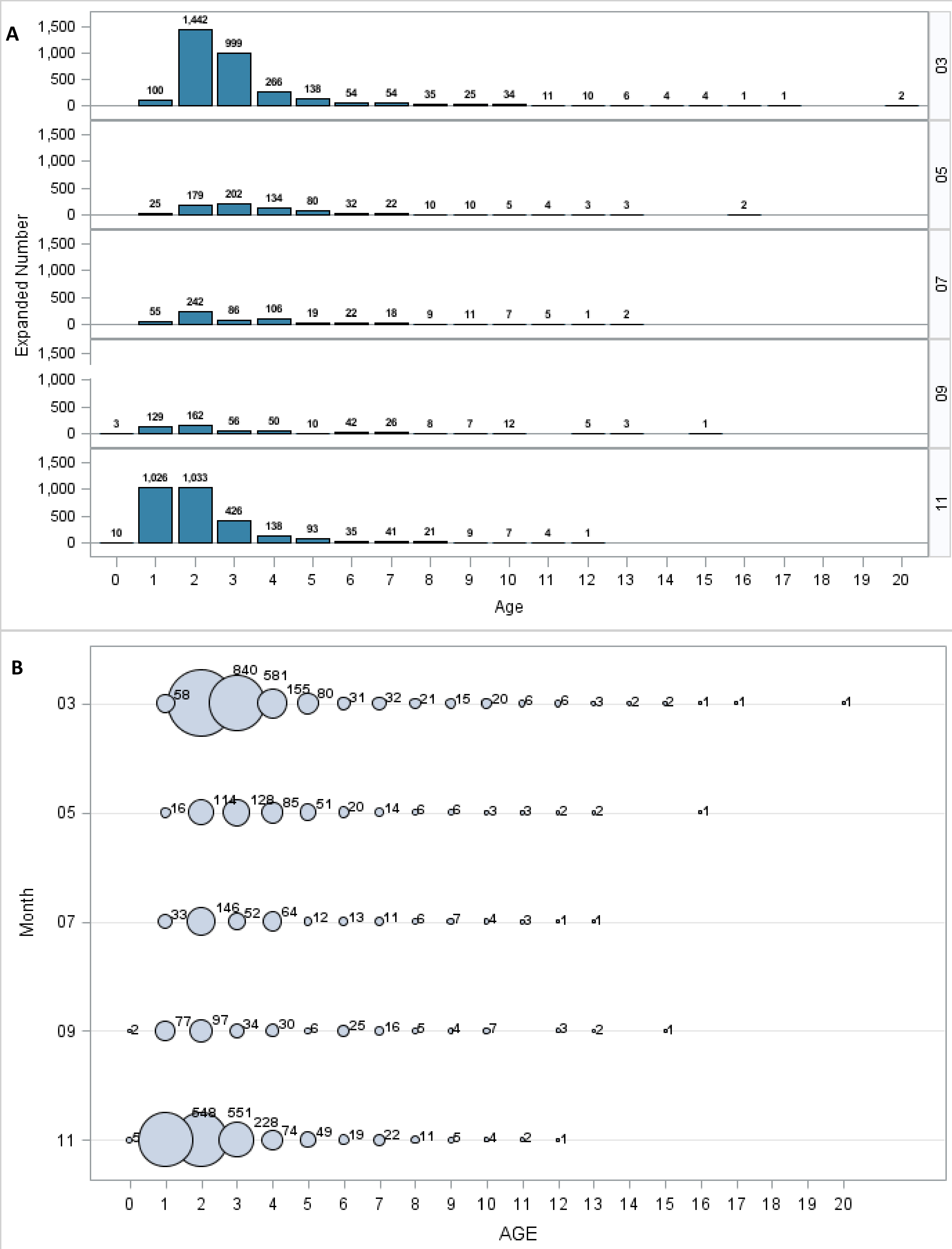


Figure 65. Diet composition, expressed as percent by weight (A) and percent by number (B) of striped bass collected during ChesMMAP cruises in 2002-2011 combined.

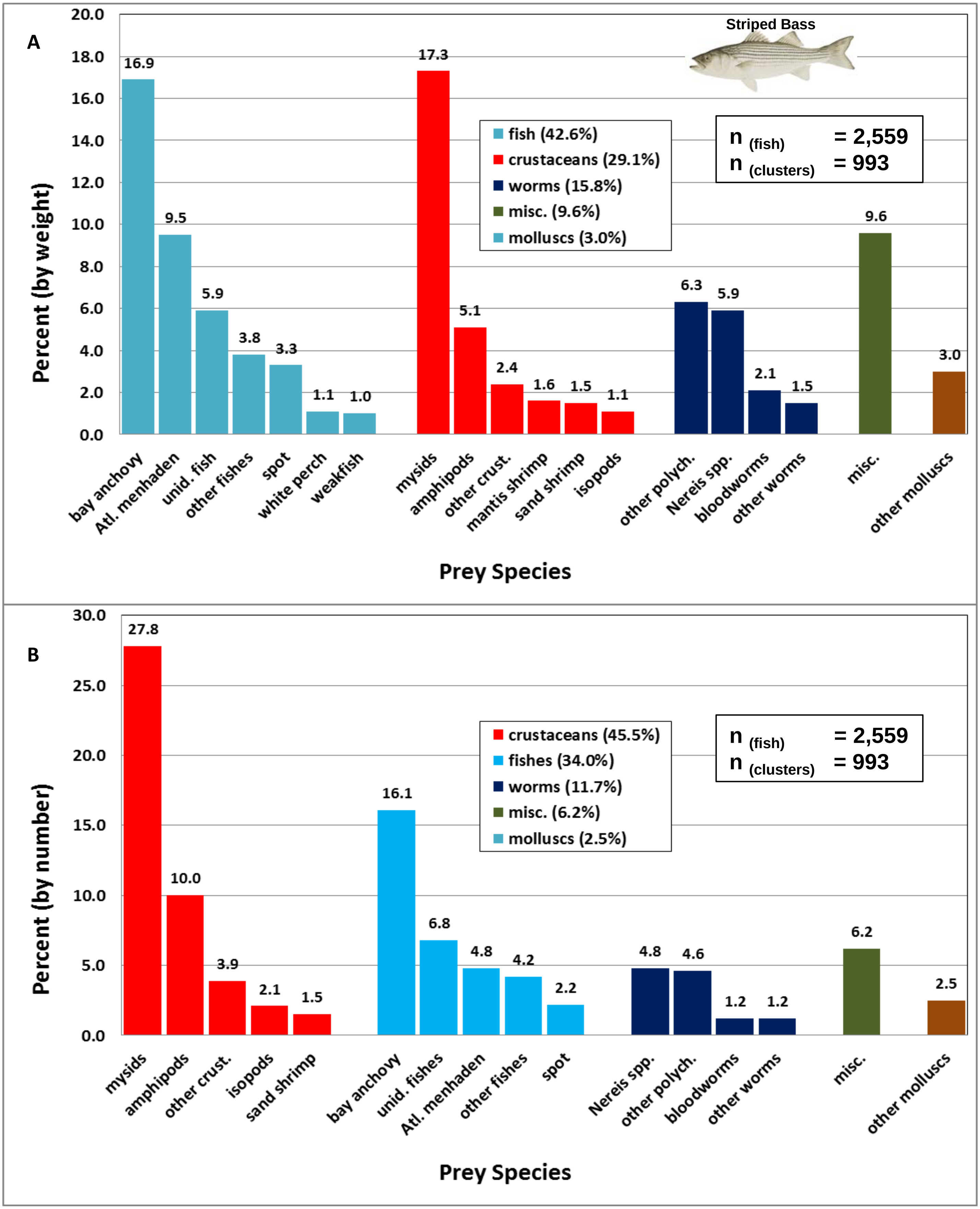


Figure 66. Abundance (kg per hectare swept) of striped bass in Chesapeake Bay, 2012.

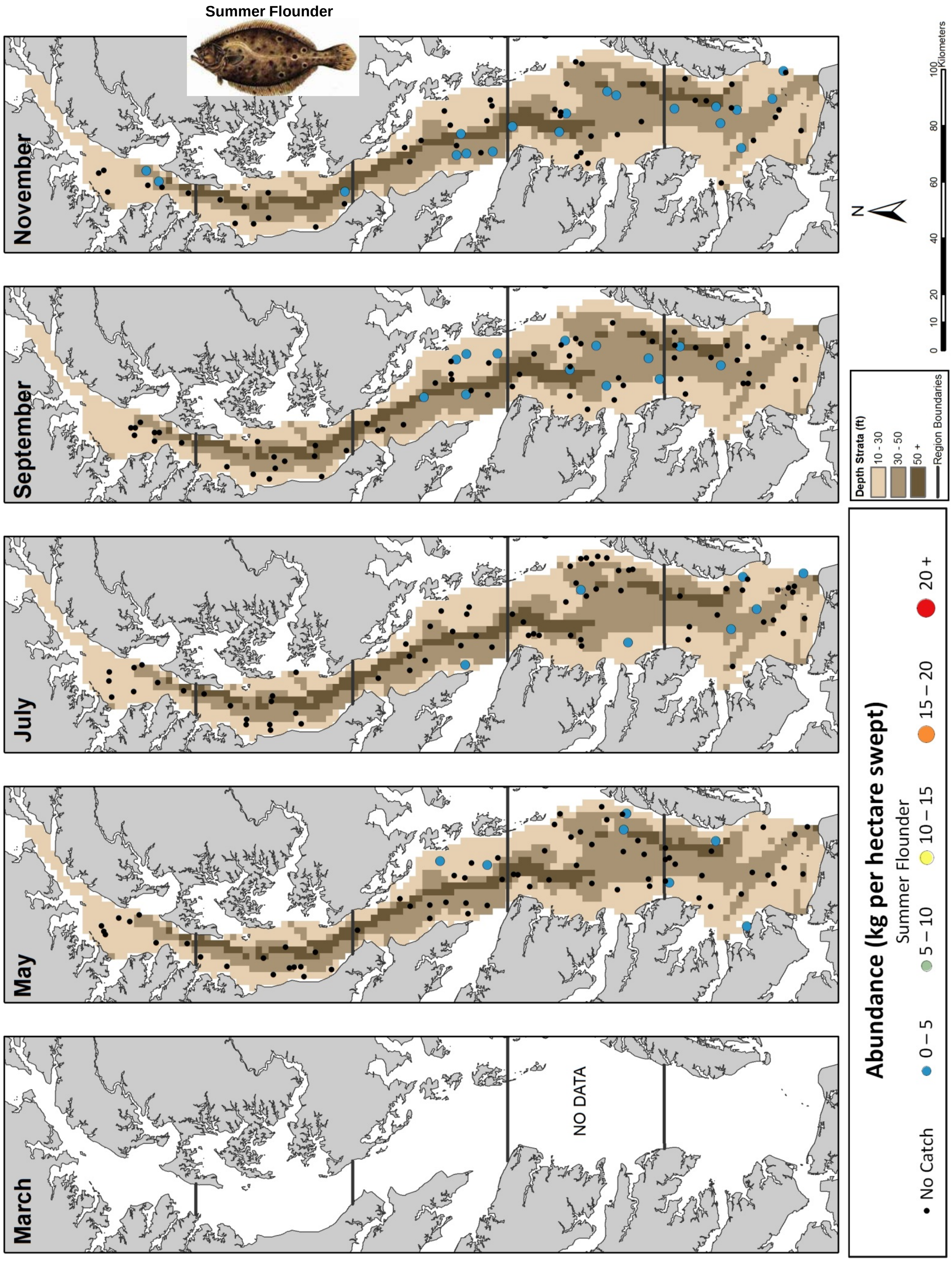
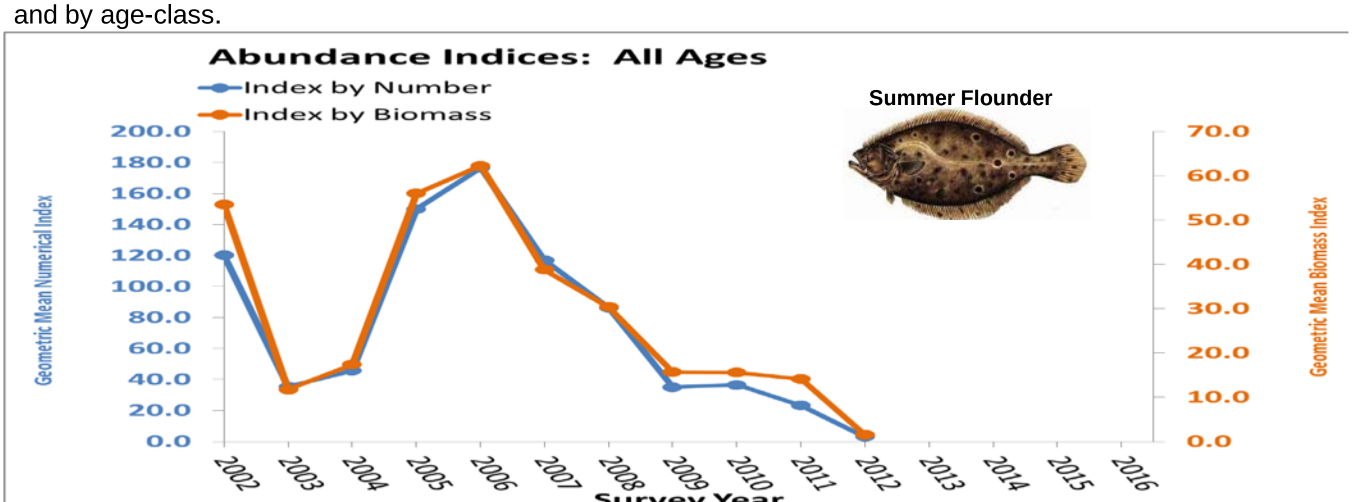


Table 15. Summer flounder geometric mean indices of abundance, by number and biomass, overall and by age-class.

Year	Age	n	Numerical Index LCI	Numerical Index Index	Numerical Index UCI	Biomass Index LCI	Biomass Index Index	Biomass Index UCI
2002	All	75	71.6	120.3	201.6	33.6	53.6	85.1
2003		101	19.9	35.4	62.2	6.7	11.8	20.2
2004		92	28.0	45.8	74.4	11.6	17.4	25.7
2005		86	100.0	150.1	225.0	38.8	56.1	80.8
2006		79	107.1	176.6	290.8	40.2	62.3	96.1
2007		44	61.7	117.0	221.1	22.2	38.8	67.3
2008		90	50.0	86.4	148.9	18.6	30.4	49.3
2009		90	19.9	35.1	61.4	9.6	15.7	25.5
2010		90	21.0	36.6	63.3	9.8	15.6	24.4
2011		89	13.4	23.2	39.8	8.5	14.1	23.0
2012		84	1.6	3.1	5.6	0.8	1.6	2.6
2013								
2014								
2015								
2016								
2002	0	75	34.4	59.0	100.8	9.5	14.3	21.2
2003		101	10.4	18.1	30.9	2.8	4.6	7.2
2004		92	13.9	23.8	40.1	4.1	6.0	8.7
2005		86	33.9	54.2	86.6	8.9	12.6	17.5
2006		79	52.4	90.2	154.5	12.5	18.6	27.3
2007		44	49.4	92.4	172.2	12.2	19.8	31.8
2008		90	28.2	49.0	84.7	6.5	9.9	14.7
2009		90	9.5	16.7	28.8	3.4	5.3	8.0
2010		90	10.1	17.7	30.6	3.6	5.4	8.0
2011		89	2.9	5.1	8.5	1.5	2.4	3.7
2012		84	0.9	1.9	3.4	0.3	0.7	1.1
2013								
2014								
2015								
2016								
2002	1	75	12.2	19.3	30.4	5.2	8.1	12.2
2003		101	7.5	12.3	19.8	2.6	4.3	6.7
2004		92	4.3	6.6	9.9	2.2	3.3	4.9
2005		86	18.8	28.5	42.9	9.1	13.4	19.4
2006		79	14.4	22.1	33.5	6.0	9.2	13.9
2007		44	7.1	12.7	22.1	3.4	6.1	10.4
2008		90	4.8	8.1	13.1	3.0	4.9	7.7
2009		90	3.8	6.5	10.7	2.1	3.5	5.4
2010		90	4.7	7.7	12.2	2.4	3.9	5.9
2011		89	4.4	7.3	11.8	2.8	4.4	6.7
2012		84	0.2	0.5	0.9	0.2	0.4	0.7
2013								
2014								
2015								
2016								

Year	Age	n	Numerical Index LCI	Numerical Index Index	Numerical Index UCI	Biomass Index LCI	Biomass Index Index	Biomass Index UCI
2002	2	75	3.2	5.6	9.3	2.8	4.9	8.0
2003		101	1.6	2.6	4.0	1.0	1.7	2.7
2004		92	1.6	2.6	4.0	1.3	2.1	3.2
2005		86	5.3	8.3	12.8	4.5	7.1	10.8
2006		79	4.1	6.8	11.2	3.4	5.6	9.0
2007		44	1.0	2.2	4.1	0.9	2.0	3.7
2008		90	2.4	4.2	7.0	2.2	3.8	6.2
2009		90	1.0	1.9	3.1	1.0	1.8	2.9
2010		90	1.0	1.8	3.0	0.8	1.5	2.4
2011		89	1.7	2.9	4.6	1.4	2.4	3.7
2012		84	0.2	0.5	0.9	0.2	0.5	0.9
2013								
2014								
2015								
2016								
2002	3	75	2.1	3.7	6.1	2.0	3.6	5.9
2003		101	0.7	1.2	2.0	0.6	1.2	2.0
2004		92	0.9	1.5	2.3	0.8	1.4	2.2
2005		86	1.9	3.3	5.2	1.9	3.2	5.0
2006		79	1.9	3.4	5.6	1.9	3.3	5.4
2007		44	0.2	0.8	1.7	0.3	0.9	1.9
2008		90	1.4	2.5	4.0	1.4	2.5	4.0
2009		90	0.9	1.6	2.6	0.9	1.7	2.7
2010		90	0.4	0.9	1.5	0.4	0.9	1.4
2011		89	0.9	1.6	2.6	0.8	1.5	2.4
2012		84	0.1	0.3	0.6	0.1	0.3	0.6
2013								
2014								
2015								
2016								
2002	4+	75	2.6	4.6	7.7	2.9	5.4	9.6
2003		101	0.7	1.3	2.2	0.7	1.5	2.5
2004		92	0.9	1.5	2.5	0.9	1.6	2.7
2005		86	1.7	2.9	4.6	1.7	3.0	4.9
2006		79	1.8	3.3	5.7	1.9	3.6	6.5
2007		44	0.5	1.3	2.7	0.5	1.6	3.4
2008		90	1.3	2.4	4.0	1.4	2.7	4.6
2009		90	0.8	1.4	2.3	0.8	1.5	2.6
2010		90	0.5	1.0	1.7	0.5	1.1	1.8
2011		89	0.8	1.4	2.4	0.7	1.5	2.5
2012		84	0.1	0.2	0.4	0.1	0.2	0.4
2013								
2014								
2015								
2016								

Figure 67. Summer flounder geometric mean indices of abundance, by number and biomass, for all ages combined and by age-class.



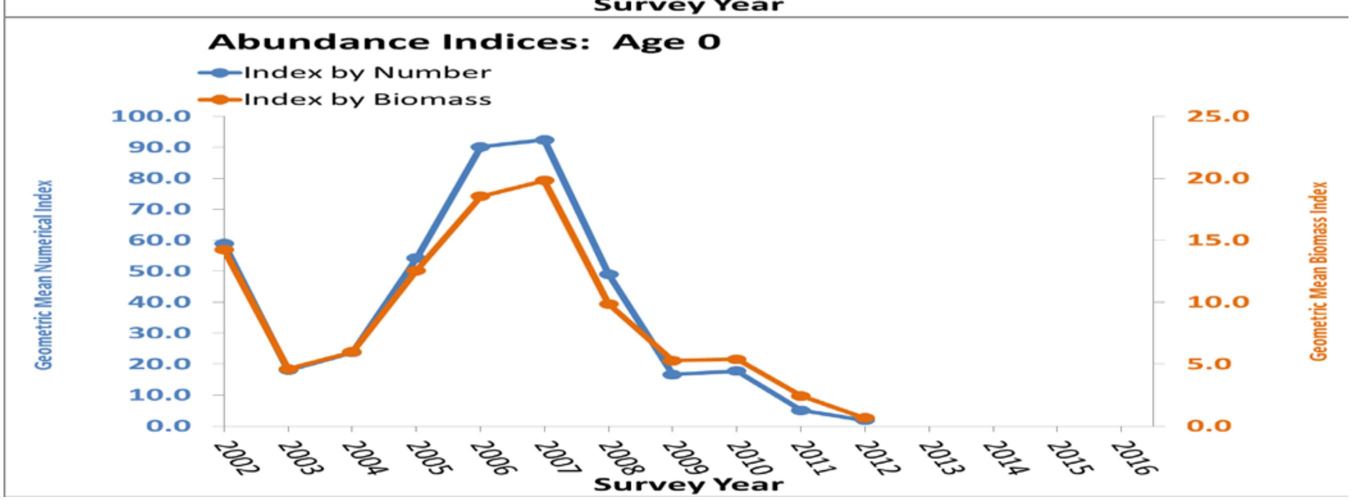
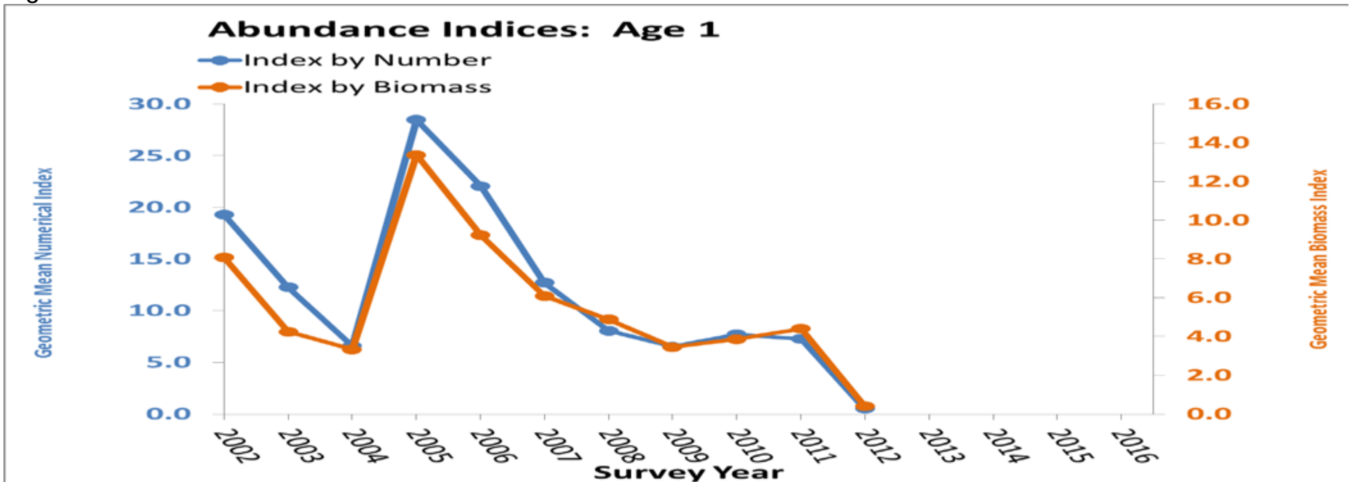
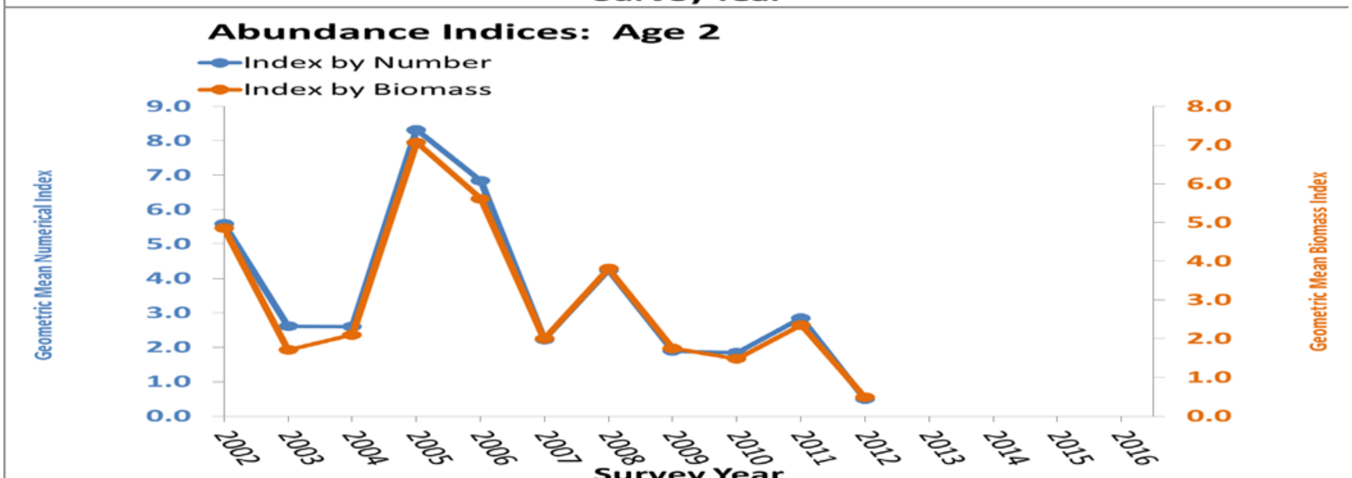
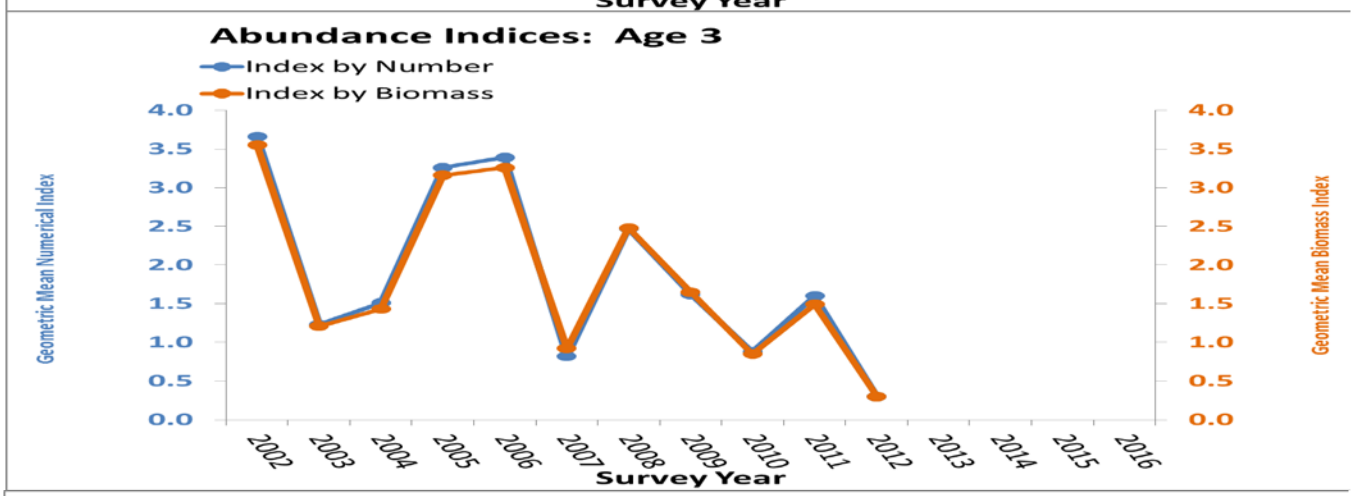


Figure 67. cont.







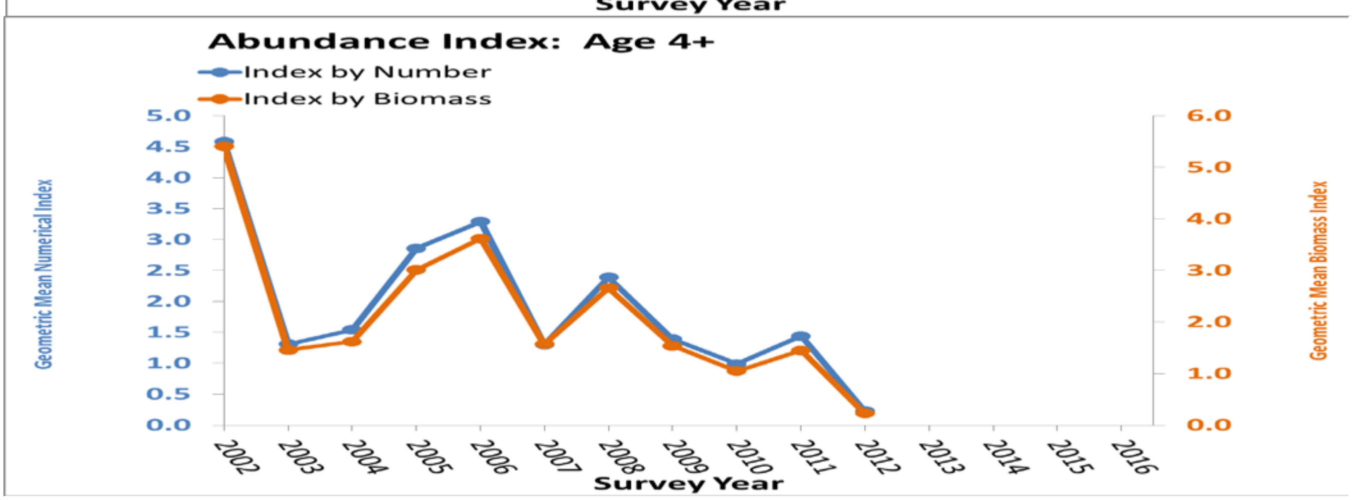
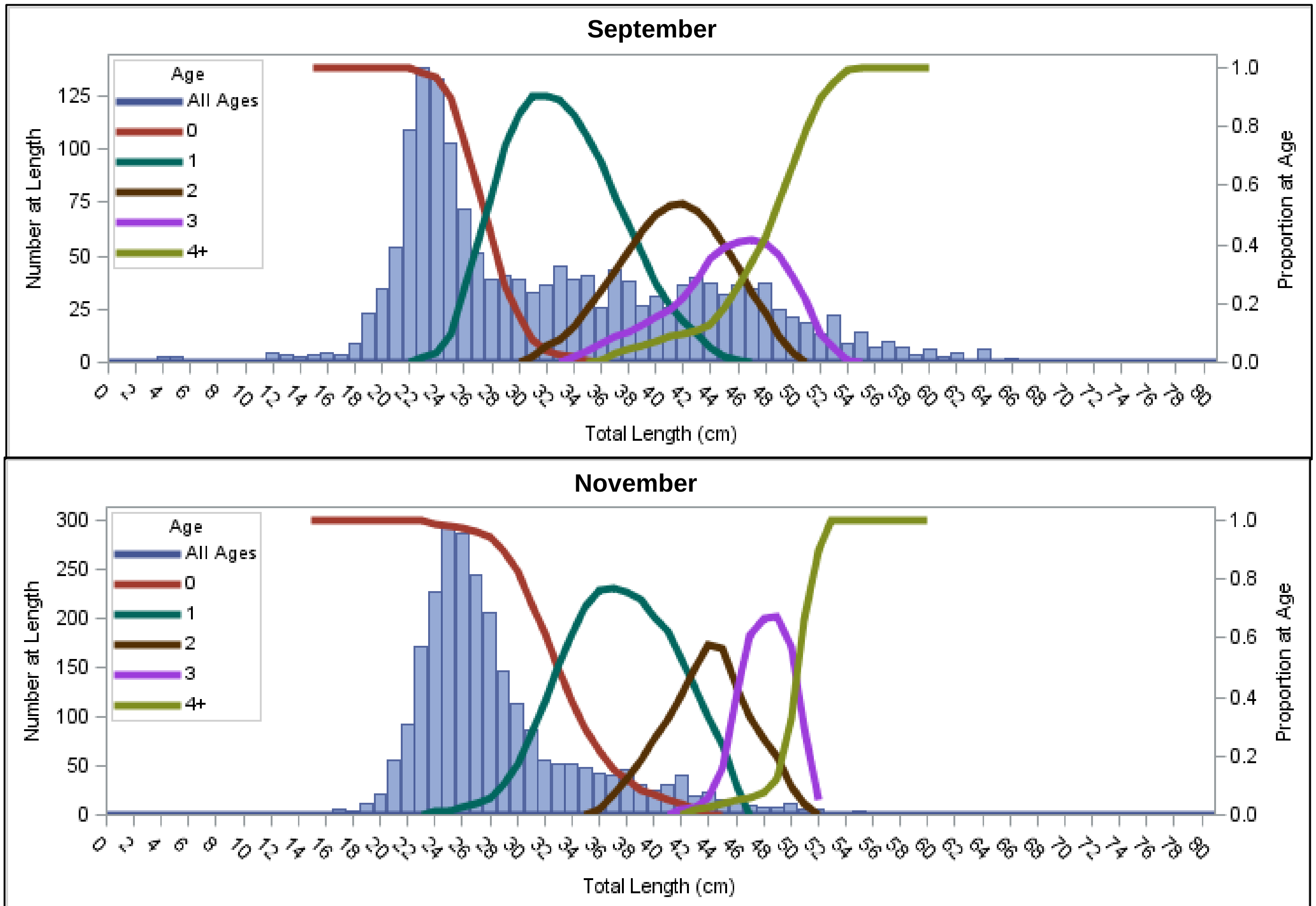


Figure 68. Summer flounder ALK for all September and Novembers cruises, showing loess smoothed proportions at each 1cm length bin, overlaid on month-specific length frequencies pooled over all years. ALK proportions are adjusted such that the sums of values for each length bin within each month are forced to 1.0



September							November						
Length (cm)	Age-0	Age-1	Age-2	Age-3	Age-4+	Sum	Length (cm)	Age-0	Age-1	Age-2	Age-3	Age-4+	Sum
22	1.000	0.000				1.000	22						
23	0.980	0.020				1.000	23	1.000	0.000				1.000
24	0.969	0.031				1.000	24	0.984	0.016				1.000
25	0.900	0.100				1.000	25	0.983	0.017				1.000
26	0.758	0.242				1.000	26	0.976	0.024				1.000
27	0.590	0.410				1.000	27	0.963	0.037				1.000
28	0.420	0.580				1.000	28	0.939	0.061				1.000
29	0.260	0.740				1.000	29	0.894	0.106				1.000
30	0.152	0.848	0.000			1.000	30	0.824	0.176				1.000
31	0.079	0.901	0.020			1.000	31	0.727	0.273				1.000
32	0.040	0.904	0.056			1.000	32	0.615	0.385				1.000
33	0.030	0.891	0.079	0.000		1.000	33	0.500	0.500				1.000
34	0.020	0.840	0.120	0.020		1.000	34	0.385	0.615				1.000
35	0.010	0.770	0.180	0.040	0.000	1.000	35	0.298	0.702	0.000			1.000
36	0.000	0.680	0.245	0.065	0.010	1.000	36	0.218	0.764	0.018			1.000
37		0.560	0.317	0.089	0.034	1.000	37	0.155	0.772	0.073			1.000
38		0.470	0.380	0.103	0.047	1.000	38	0.120	0.757	0.123			1.000
39		0.365	0.450	0.127	0.058	1.000	39	0.086	0.730	0.184			1.000
40		0.270	0.503	0.157	0.070	1.000	40	0.070	0.673	0.257			1.000
41		0.194	0.535	0.181	0.090	1.000	41	0.050	0.623	0.326	0.000		1.000
42		0.140	0.540	0.220	0.100	1.000	42	0.040	0.535	0.405	0.020	0.000	1.000
43		0.100	0.510	0.280	0.110	1.000	43	0.020	0.433	0.498	0.030	0.020	1.000
44		0.050	0.470	0.350	0.130	1.000	44	0.000	0.335	0.576	0.059	0.030	1.000
45		0.020	0.400	0.390	0.190	1.000	45		0.236	0.564	0.160	0.040	1.000
46		0.005	0.320	0.411	0.264	1.000	46		0.100	0.430	0.420	0.050	1.000
47		0.000	0.240	0.420	0.340	1.000	47		0.000	0.333	0.607	0.060	1.000
48			0.165	0.403	0.432	1.000	48			0.260	0.665	0.075	1.000
49			0.090	0.363	0.547	1.000	49			0.200	0.676	0.124	1.000
50			0.035	0.291	0.674	1.000	50			0.100	0.570	0.330	1.000
51			0.000	0.210	0.790	1.000	51			0.040	0.300	0.660	1.000
52				0.100	0.900	1.000	52			0.000	0.100	0.900	1.000
53				0.050	0.950	1.000	53				0.000	1.000	1.000
54				0.010	0.990	1.000	54						
55				0.000	1.000	1.000	55						

Figure 69. Summer flounder length-frequency in Chesapeake Bay 2002-2012, overall (A) and by sex (B).

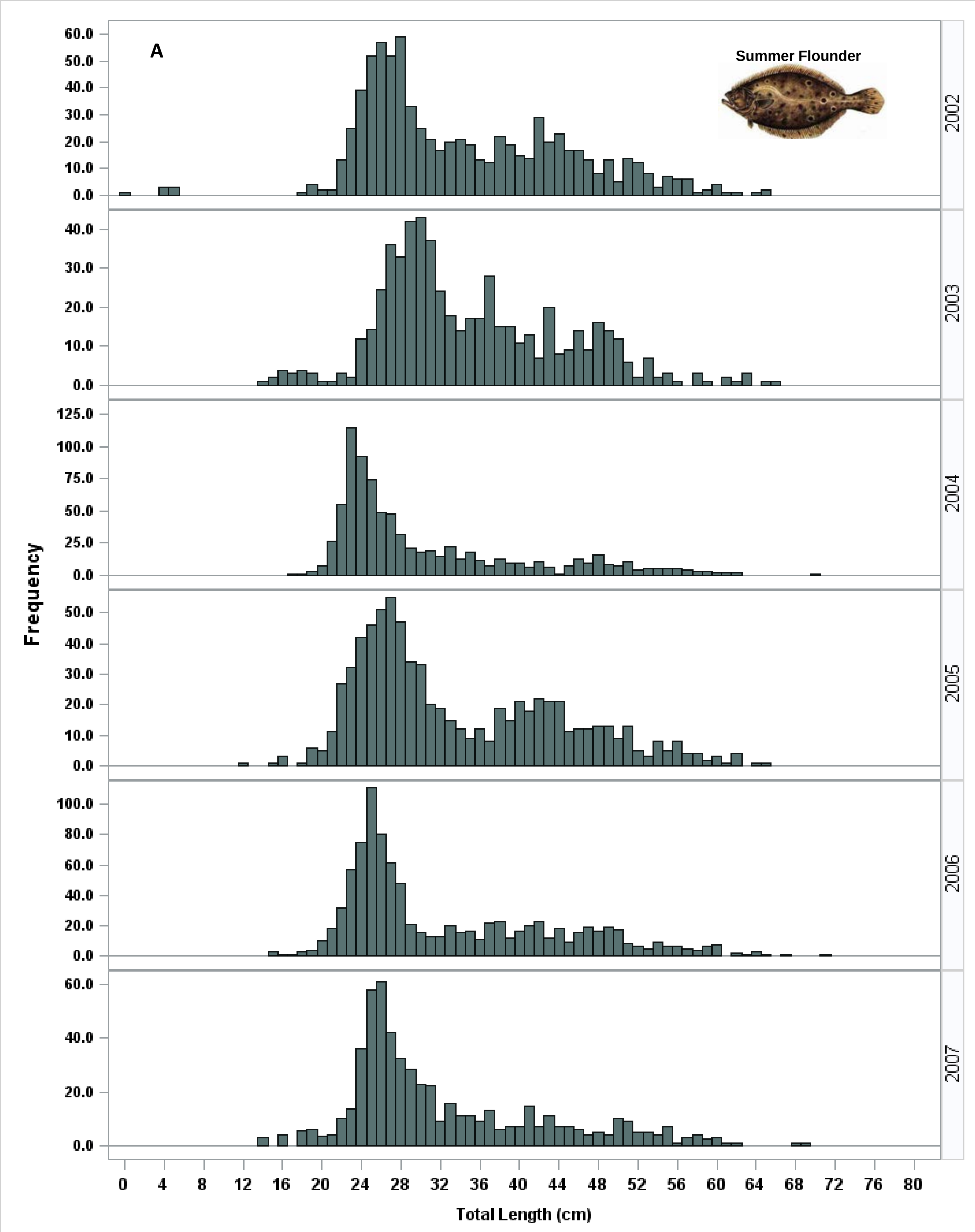


Figure 69. cont.

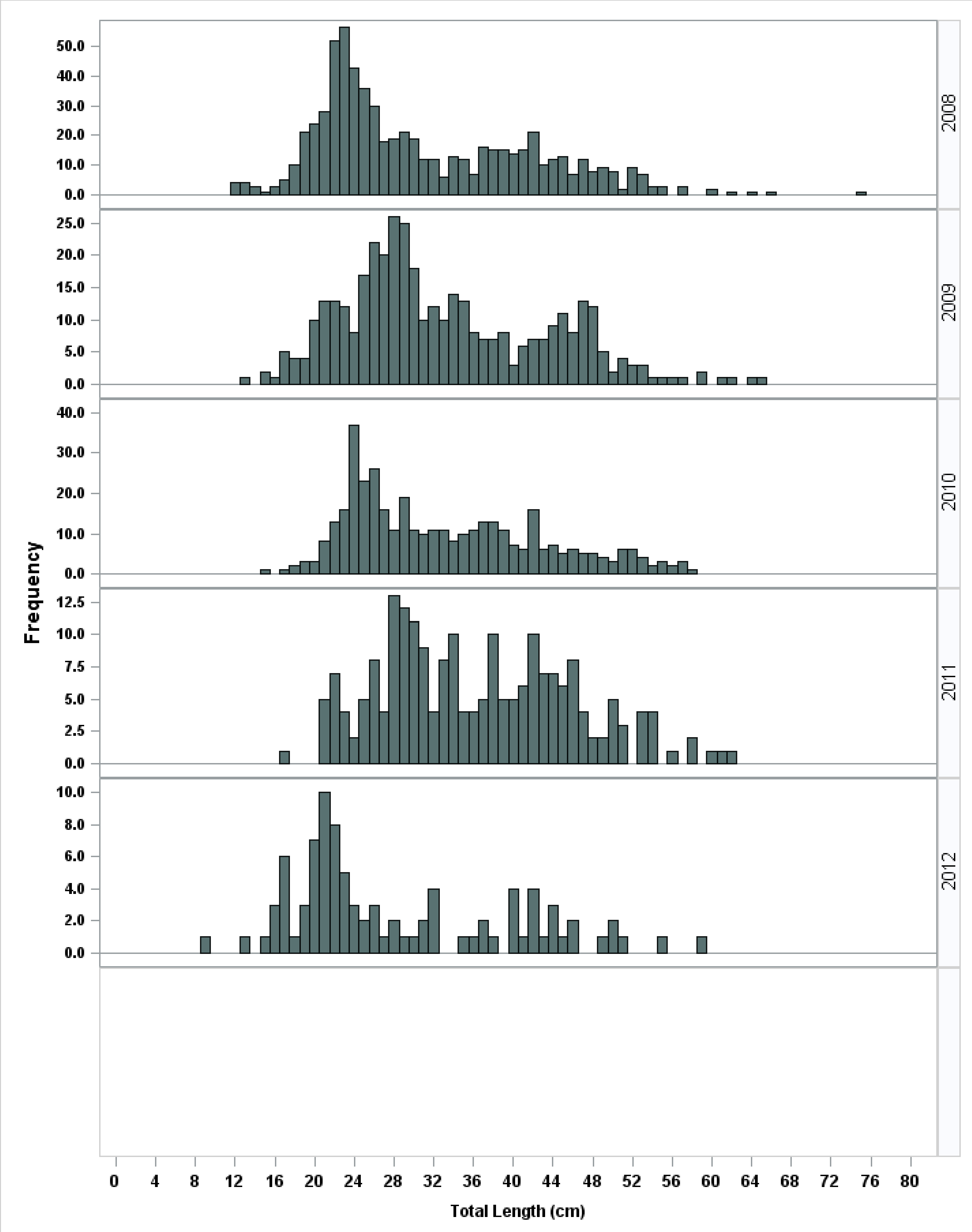


Figure 69. cont.

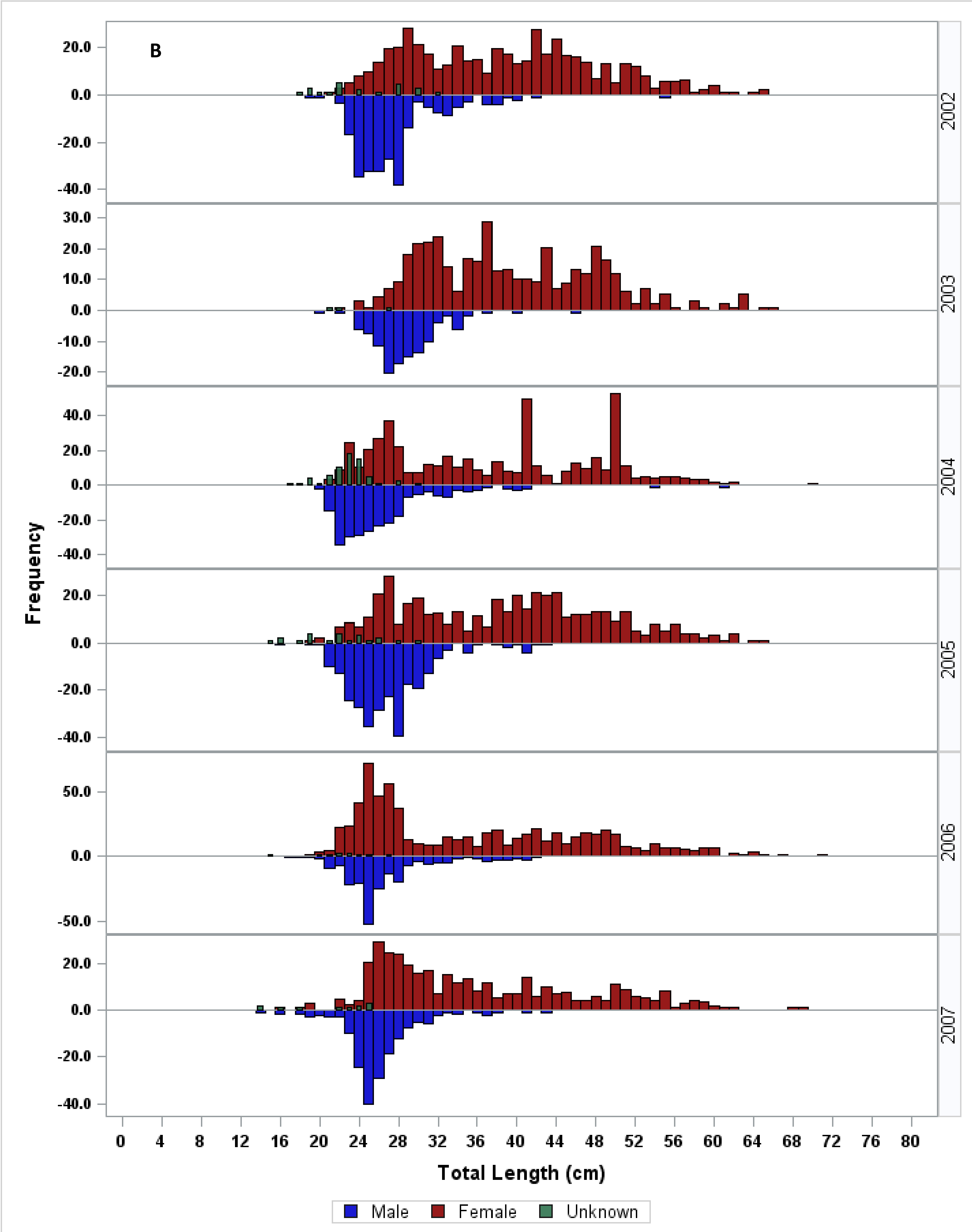


Figure 69. cont.

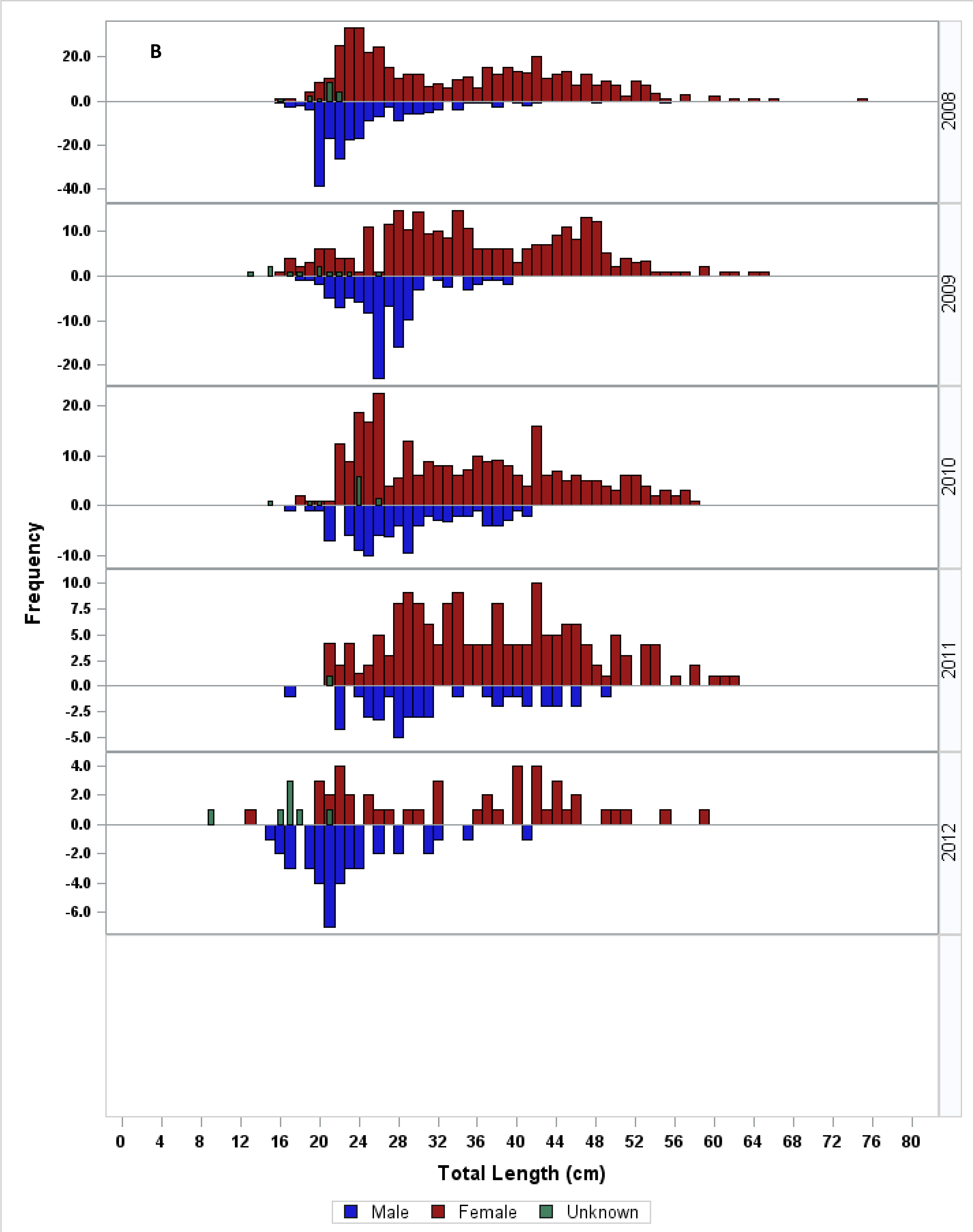


Figure 70. Summer flounder total age-frequency, 2002-2012.

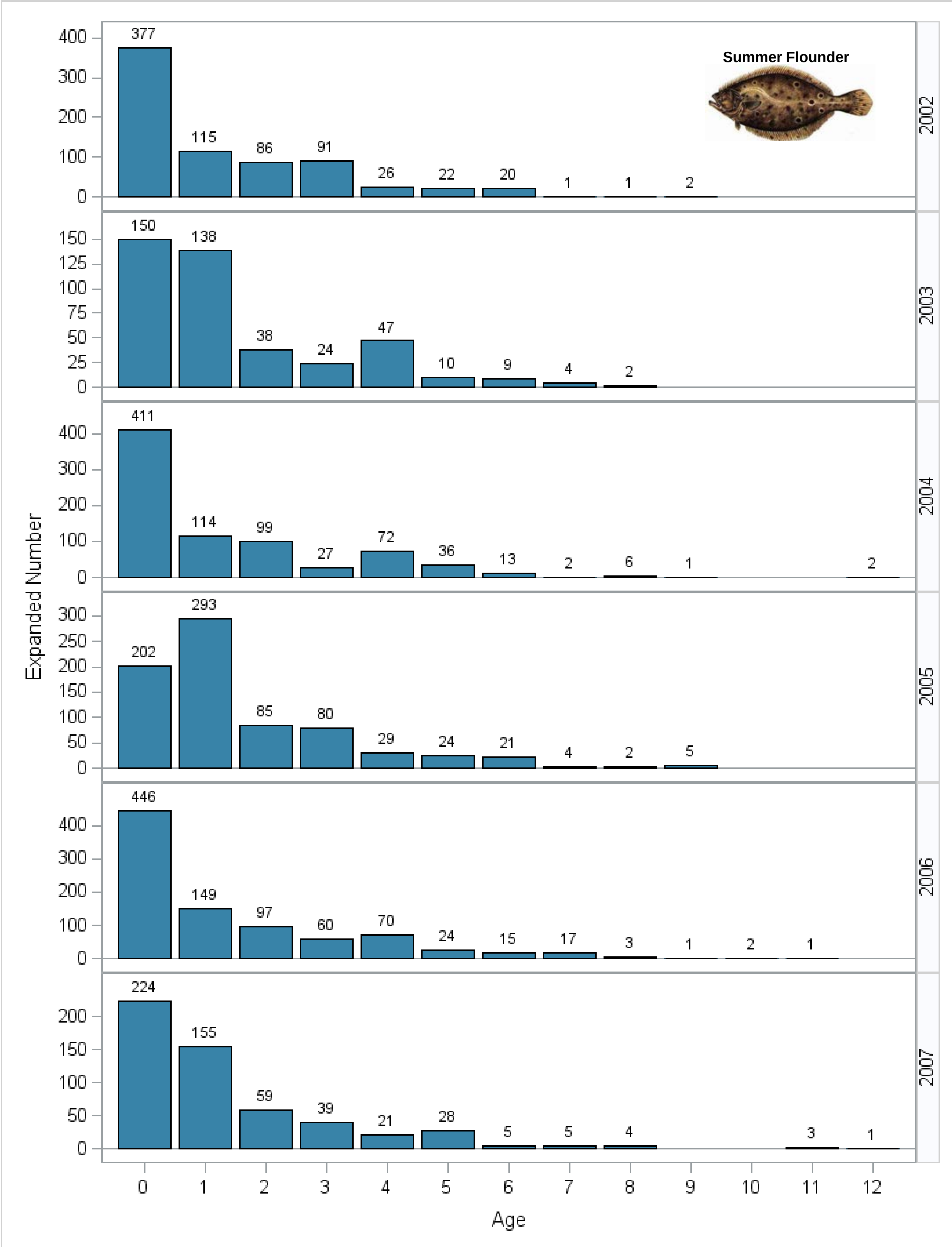


Figure 70. cont.

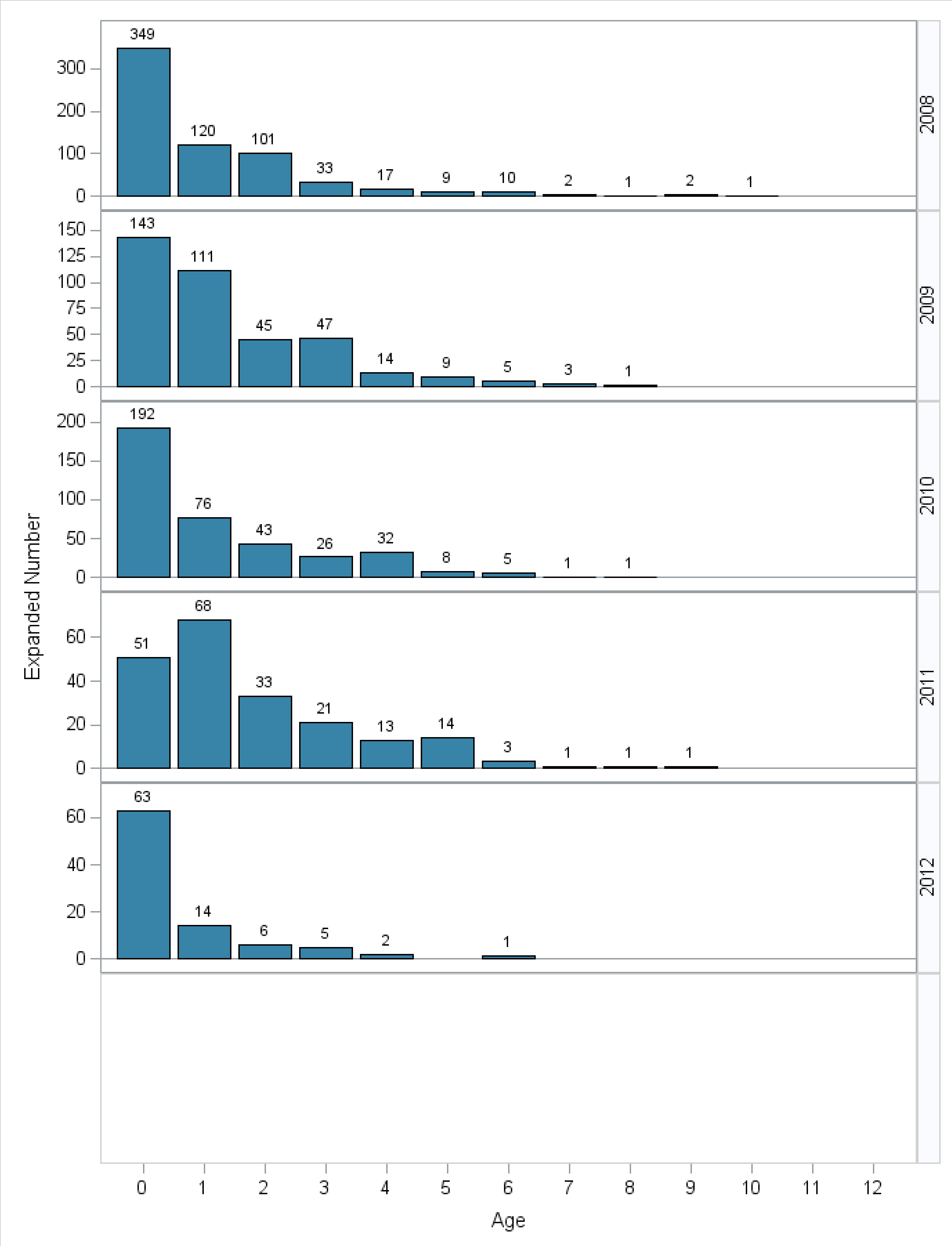


Figure 71. Summer flounder age-frequency by year, 2002-2012 standardized to 8,000 annual trawl minutes.

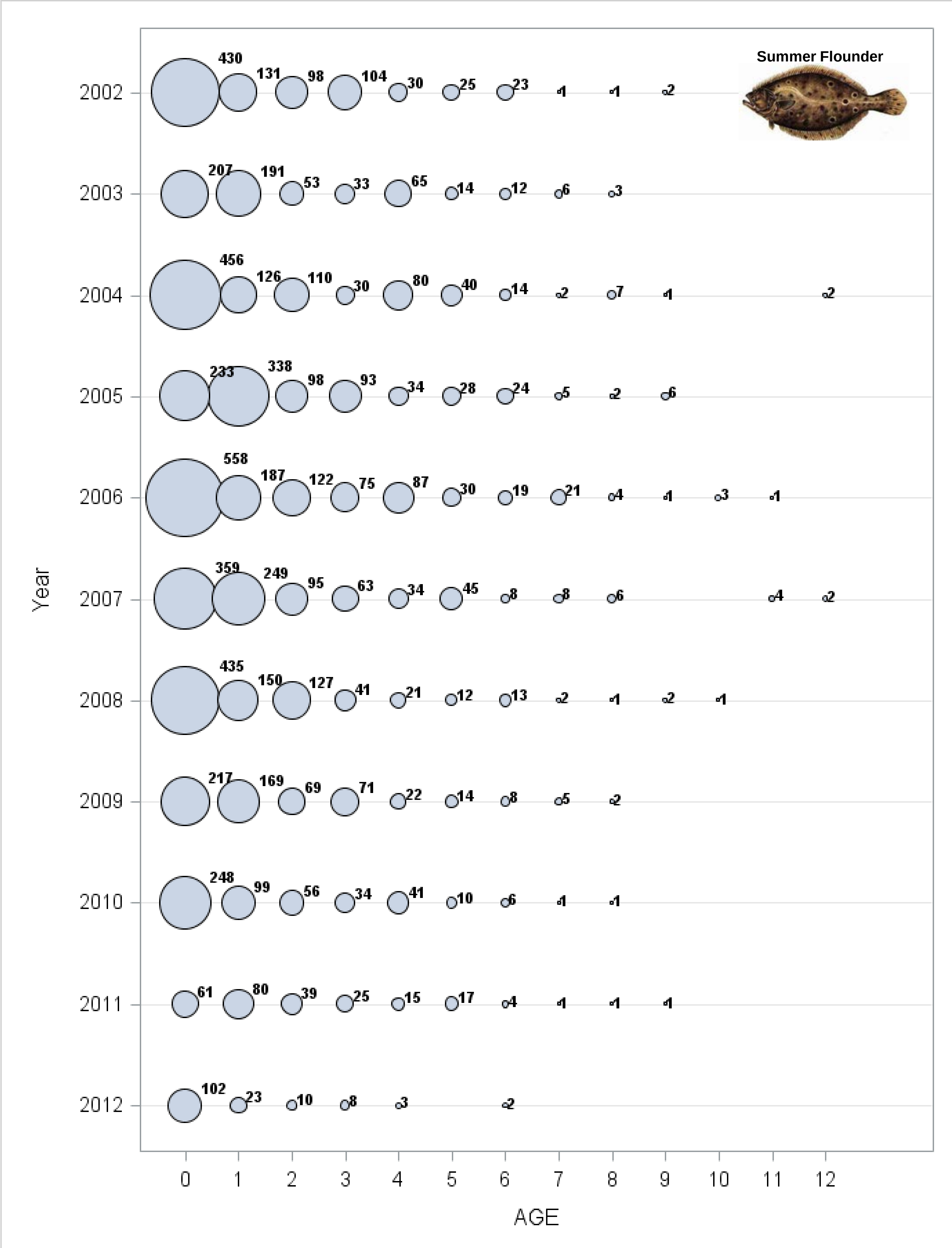


Figure 72. Summer flounder age-frequency by cruise month, 2002-2012 combined, actual (A) and standardized to 8,000 total annual trawl minutes (B).

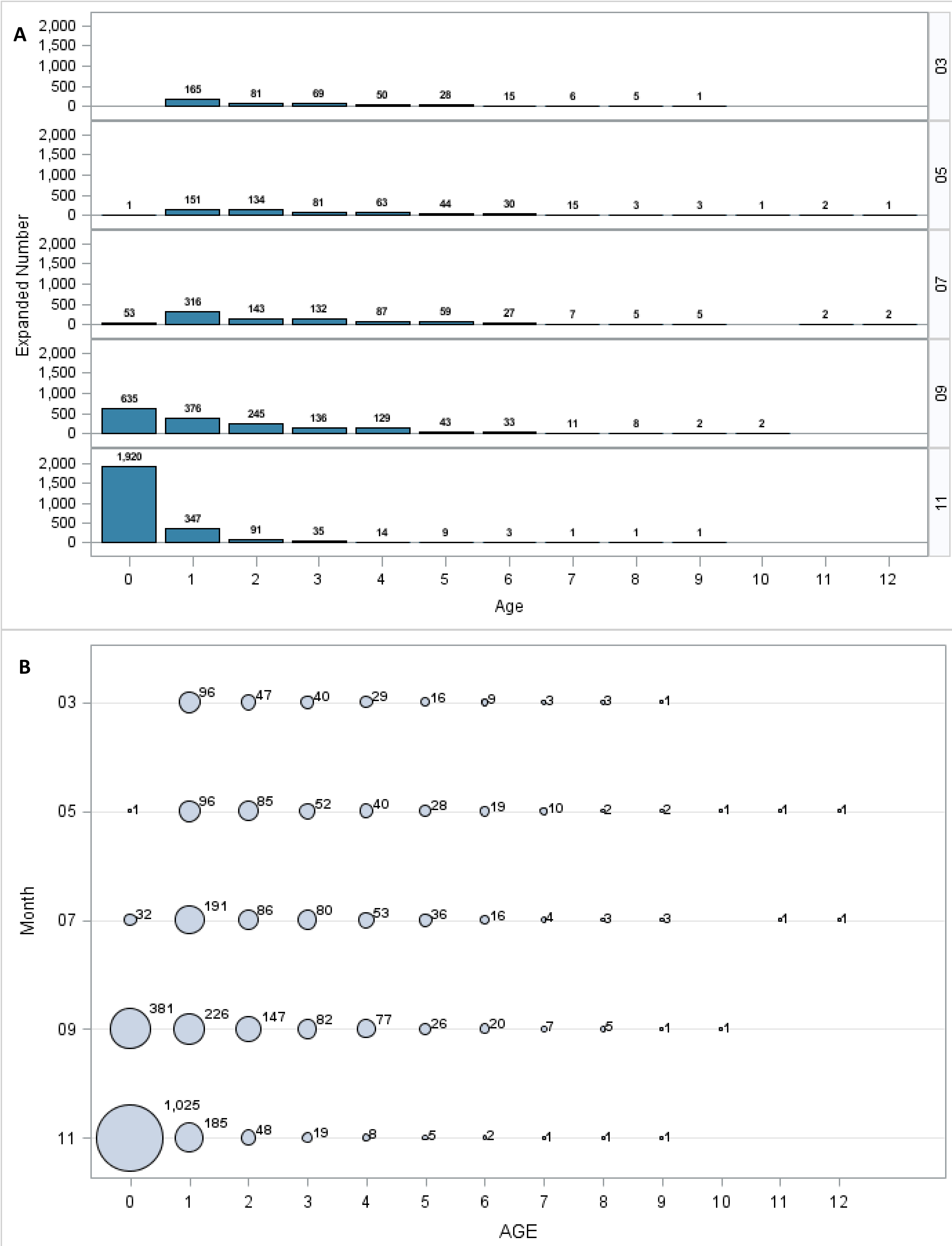


Figure 73. Diet composition, expressed as percent by weight (A) and percent by number (B) of striped bass collected during ChesMMAP cruises in 2002-2011 combined.

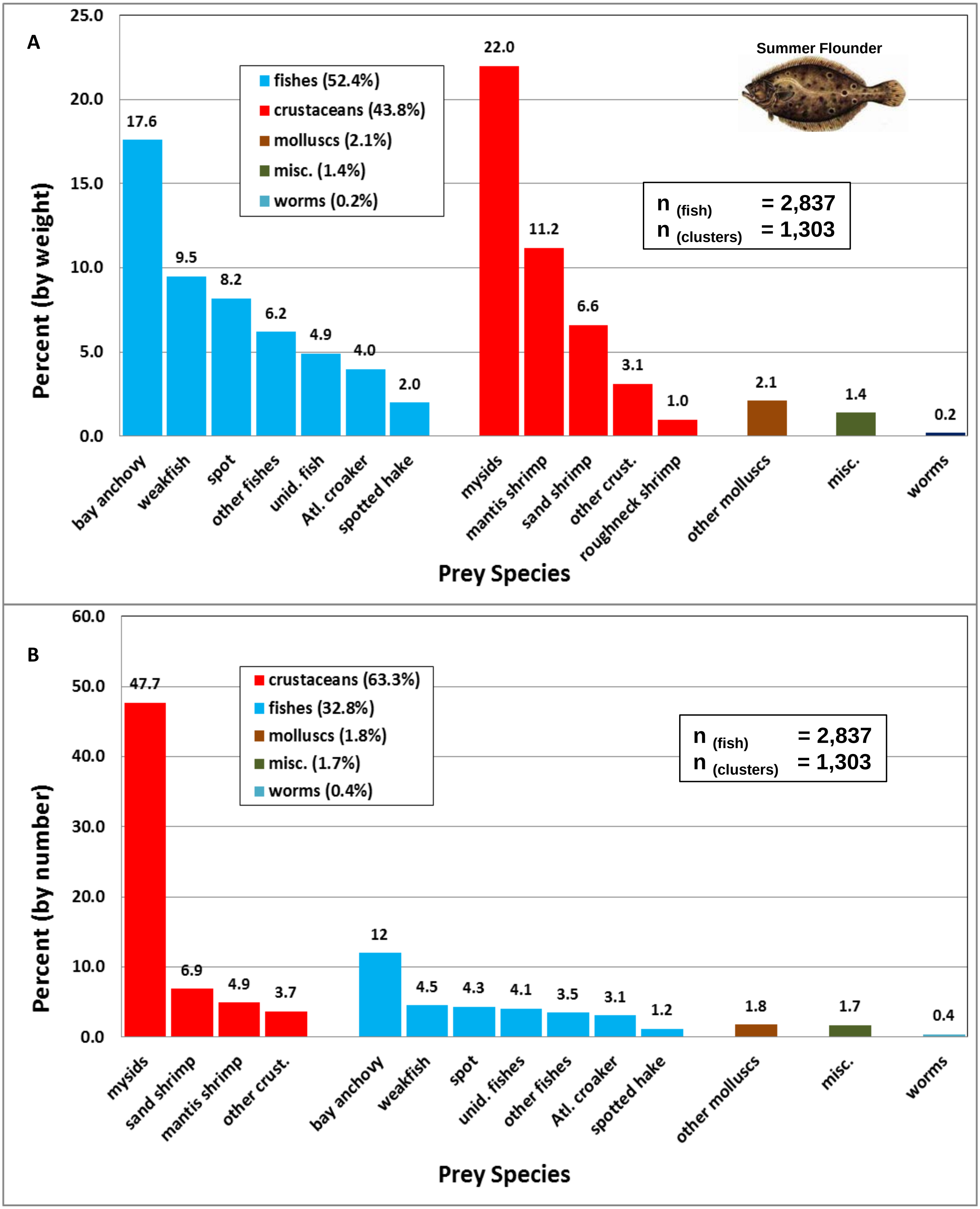


Figure 74. Abundance (kg per hectare swept) of weakfish in Chesapeake Bay, 2012.

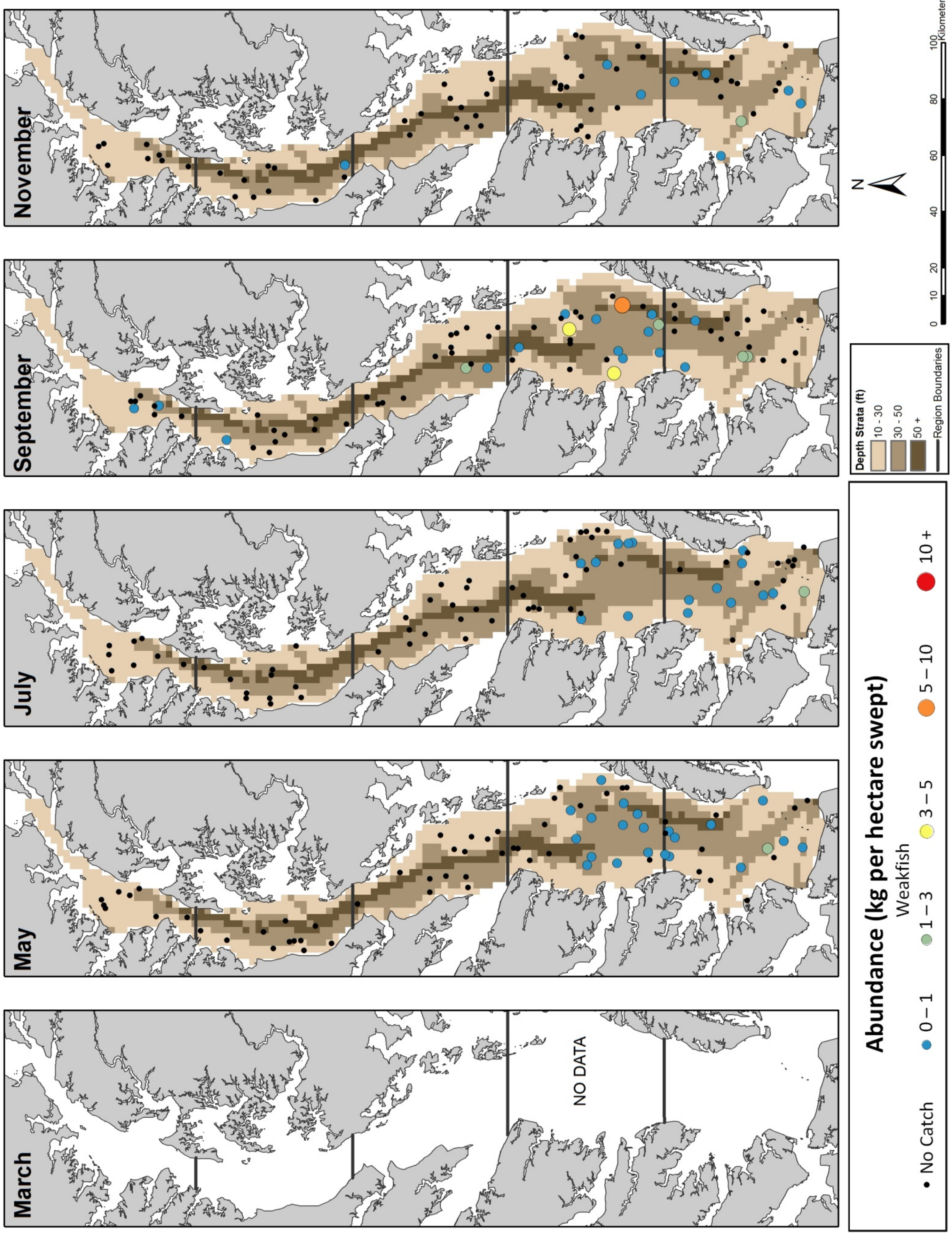


Table 16. Weakfish geometric mean indices of abundance, by number and biomass, overall and by age-class.

Year	Age	n	Numerical Index			Biomass Index		
			LCI	Index	UCI	LCI	Index	UCI
2002	All	41	14.8	42.7	120.0	4.1	9.3	19.8
2003		62	135.4	290.2	621.0	9.7	18.3	33.7
2004		54	139.1	302.6	656.9	18.4	31.2	52.4
2005		49	184.7	446.3	1,076.4	23.9	46.6	90.0
2006		50	64.4	156.3	377.8	11.8	23.3	45.0
2007		26	18.4	70.5	262.6	3.9	11.5	30.7
2008		51	15.9	39.2	94.3	3.9	7.7	14.5
2009		52	40.8	97.4	230.4	4.6	8.4	14.9
2010		52	148.7	290.0	564.7	13.2	21.5	34.8
2011		52	30.2	75.3	185.4	4.6	8.7	15.8
2012		49	3.1	9.5	25.9	1.2	3.2	6.7
2013								
2014								
2015								
2016								
2002	0	41	7.0	18.0	43.8	1.4	2.8	5.0
2003		62	62.4	124.2	246.5	3.3	5.3	8.2
2004		54	42.3	85.3	171.0	3.7	5.6	8.3
2005		49	91.7	198.1	426.8	6.0	9.6	14.9
2006		50	33.4	76.1	171.5	4.1	7.0	11.7
2007		26	15.5	55.8	193.8	2.3	5.9	13.4
2008		51	7.8	18.4	41.7	1.2	2.4	4.0
2009		52	30.9	73.8	174.5	2.9	5.3	8.9
2010		52	94.5	188.1	373.3	6.5	10.0	15.1
2011		52	23.8	57.3	135.9	3.0	5.3	9.1
2012		49	2.0	5.9	14.9	0.6	1.7	3.3
2013								
2014								
2015								
2016								

Year	Age	n	Numerical Index			Biomass Index		
			LCI	Index	UCI	LCI	Index	UCI
2002	1	41	6.1	16.9	44.0	2.2	4.8	9.5
2003		62	36.1	77.9	166.9	4.8	8.4	14.5
2004		54	49.2	108.4	237.4	8.7	14.4	23.4
2005		49	56.4	136.2	327.1	12.1	22.0	39.5
2006		50	21.3	49.2	111.8	6.0	11.5	21.5
2007		26	3.2	11.8	37.9	1.6	4.7	11.3
2008		51	4.8	11.2	24.7	2.0	3.9	6.9
2009		52	3.5	8.1	17.4	1.1	2.3	4.0
2010		52	15.2	32.1	66.6	3.7	6.7	11.5
2011		52	5.3	13.1	30.6	1.8	3.6	6.6
2012		49	1.7	5.0	12.5	0.8	2.0	4.1
2013								
2014								
2015								
2016								
2002	2+	41	4.9	13.8	36.0	2.1	4.8	9.8
2003		62	22.5	48.6	103.6	4.3	7.9	14.2
2004		54	30.0	63.5	133.6	6.6	11.3	18.9
2005		49	43.3	98.2	221.2	12.1	22.2	40.4
2006		50	11.9	26.4	57.0	4.1	7.8	14.0
2007		26	2.9	10.0	30.4	1.6	4.7	11.3
2008		51	3.3	6.9	13.5	1.4	2.7	4.6
2009		52	1.2	2.8	5.6	0.5	1.0	1.7
2010		52	5.9	12.0	23.3	2.0	3.6	5.9
2011		52	1.6	3.4	6.5	0.6	1.1	1.7
2012		49	0.9	2.4	5.0	0.4	1.0	1.8
2013								
2014								
2015								
2016								

Figure 75. Weakfish geometric mean indices of abundance, by number and biomass, for all ages combined and by age-class.

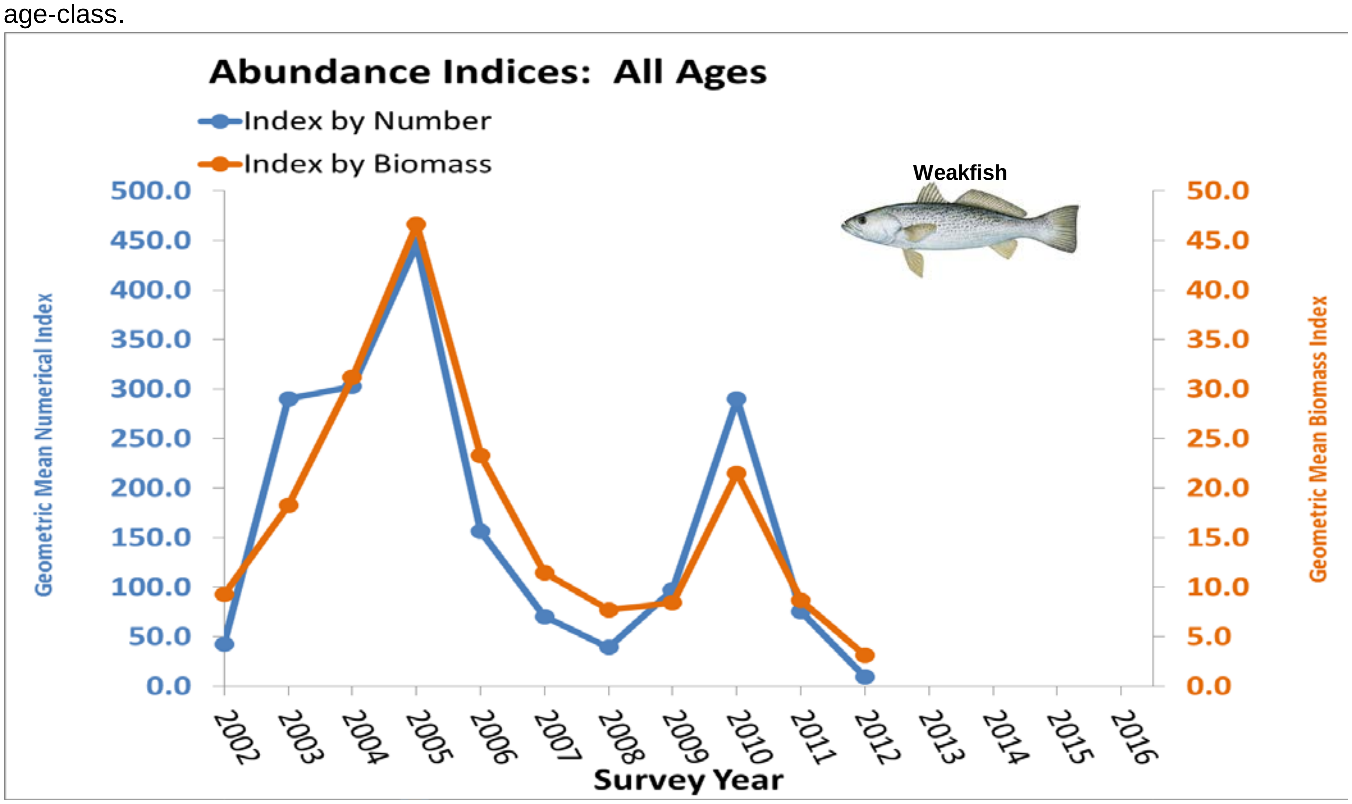


Figure 75. cont.

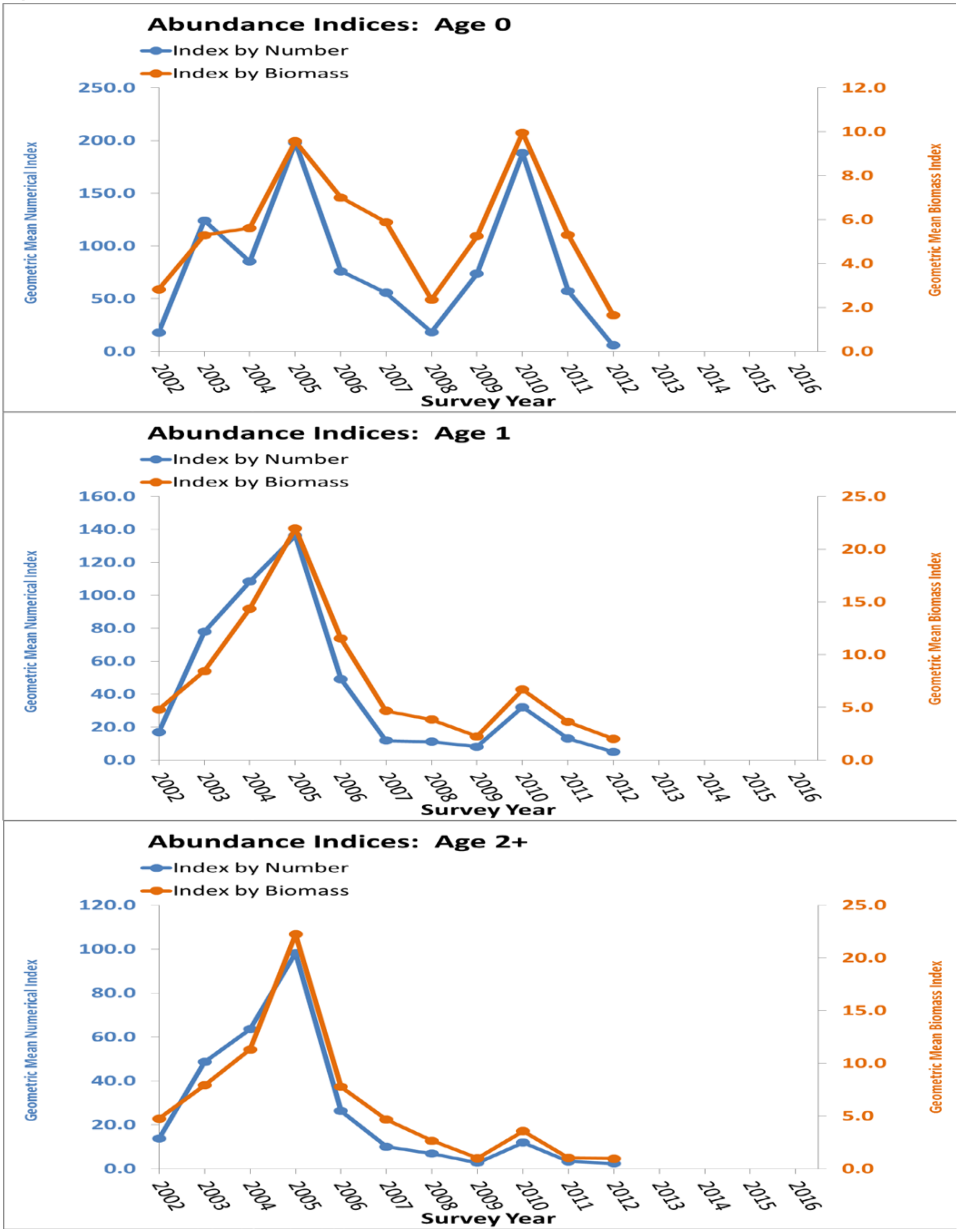
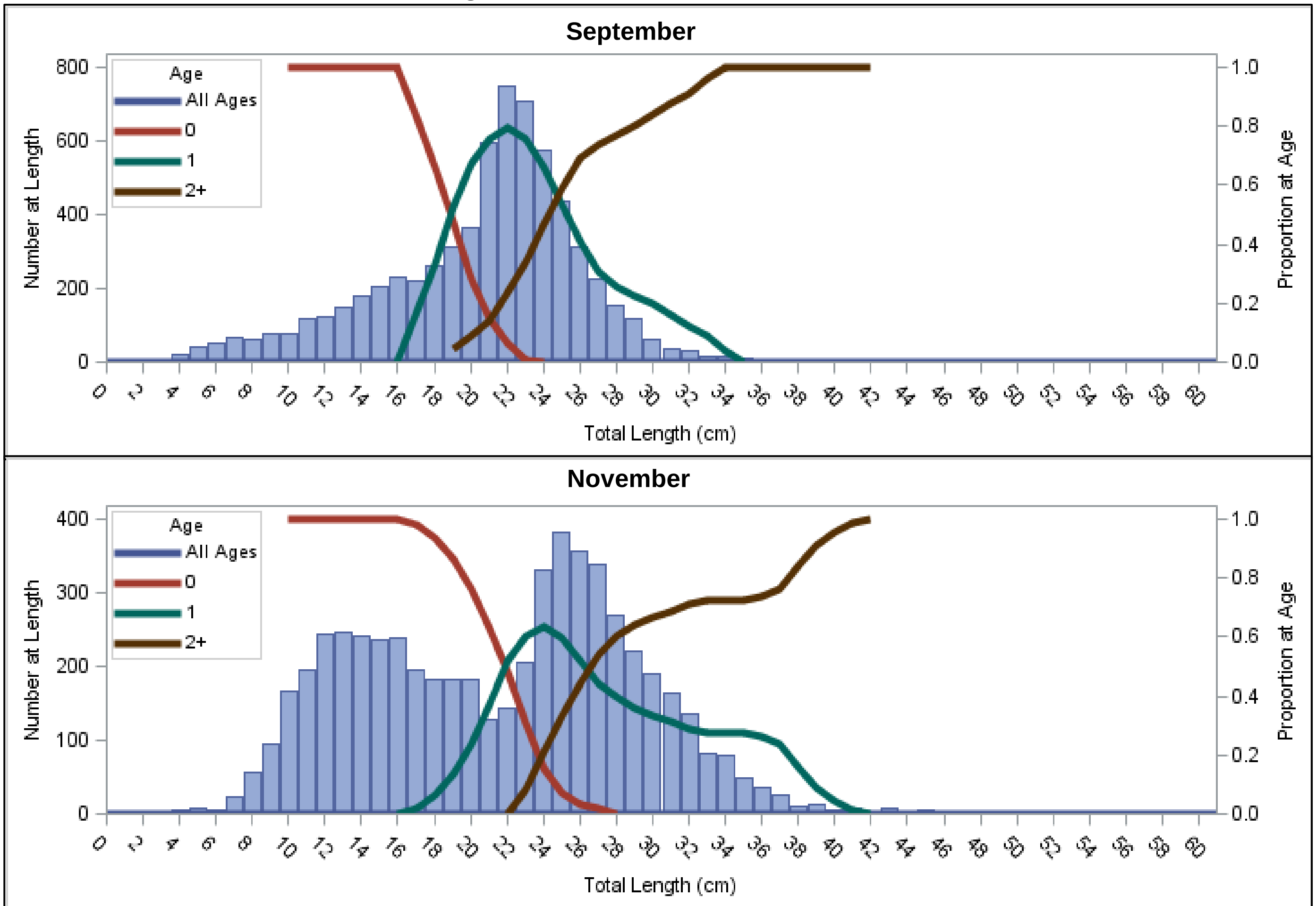


Figure 76. Weakfish ALK for all September and Novembers cruises, showing loess smoothed proportions at each 1cm length bin, overlaid on month-specific length frequencies pooled over all years. ALK proportions are adjusted such that the sums of values for each length bin within each month are forced to 1.0



September					November				
Length (cm)	Age-0	Age-1	Age-2+	Sum	Length (cm)	Age-0	Age-1	Age-2+	Sum
16	1.000	0.000		1.000	16	1.000	0.000		
17	0.829	0.171		1.000	17	0.980	0.020		
18	0.663	0.337		1.000	18	0.935	0.065		1.000
19	0.474	0.526	0.000	1.000	19	0.864	0.136		1.000
20	0.280	0.675	0.045	1.000	20	0.765	0.235		1.000
21	0.150	0.757	0.093	1.000	21	0.628	0.372		1.000
22	0.063	0.792	0.145	1.000	22	0.483	0.517	0.000	1.000
23	0.005	0.759	0.236	1.000	23	0.308	0.604	0.087	1.000
24	0.000	0.658	0.342	1.000	24	0.155	0.633	0.212	1.000
25		0.530	0.470	1.000	25	0.070	0.597	0.333	1.000
26		0.410	0.590	1.000	26	0.034	0.522	0.444	1.000
27		0.310	0.690	1.000	27	0.019	0.443	0.538	1.000
28		0.260	0.740	1.000	28	0.000	0.395	0.605	1.000
29		0.228	0.772	1.000	29		0.359	0.641	1.000
30		0.198	0.802	1.000	30		0.332	0.668	1.000
31		0.159	0.841	1.000	31		0.313	0.687	1.000
32		0.124	0.876	1.000	32		0.289	0.711	1.000
33		0.088	0.912	1.000	33		0.274	0.726	1.000
34		0.040	0.960	1.000	34		0.276	0.724	1.000
35		0.000	1.000	1.000	35		0.278	0.722	1.000
36					36		0.262	0.738	1.000
37					37		0.240	0.760	1.000
38					38		0.161	0.839	1.000
39					39		0.090	0.910	1.000
40					40		0.046	0.954	1.000
41					41		0.013	0.987	1.000
42					42		0.000	1.000	1.000

Figure 77. Weakfish length-frequency in Chesapeake Bay 2002-2012, overall (A) and by sex (B).

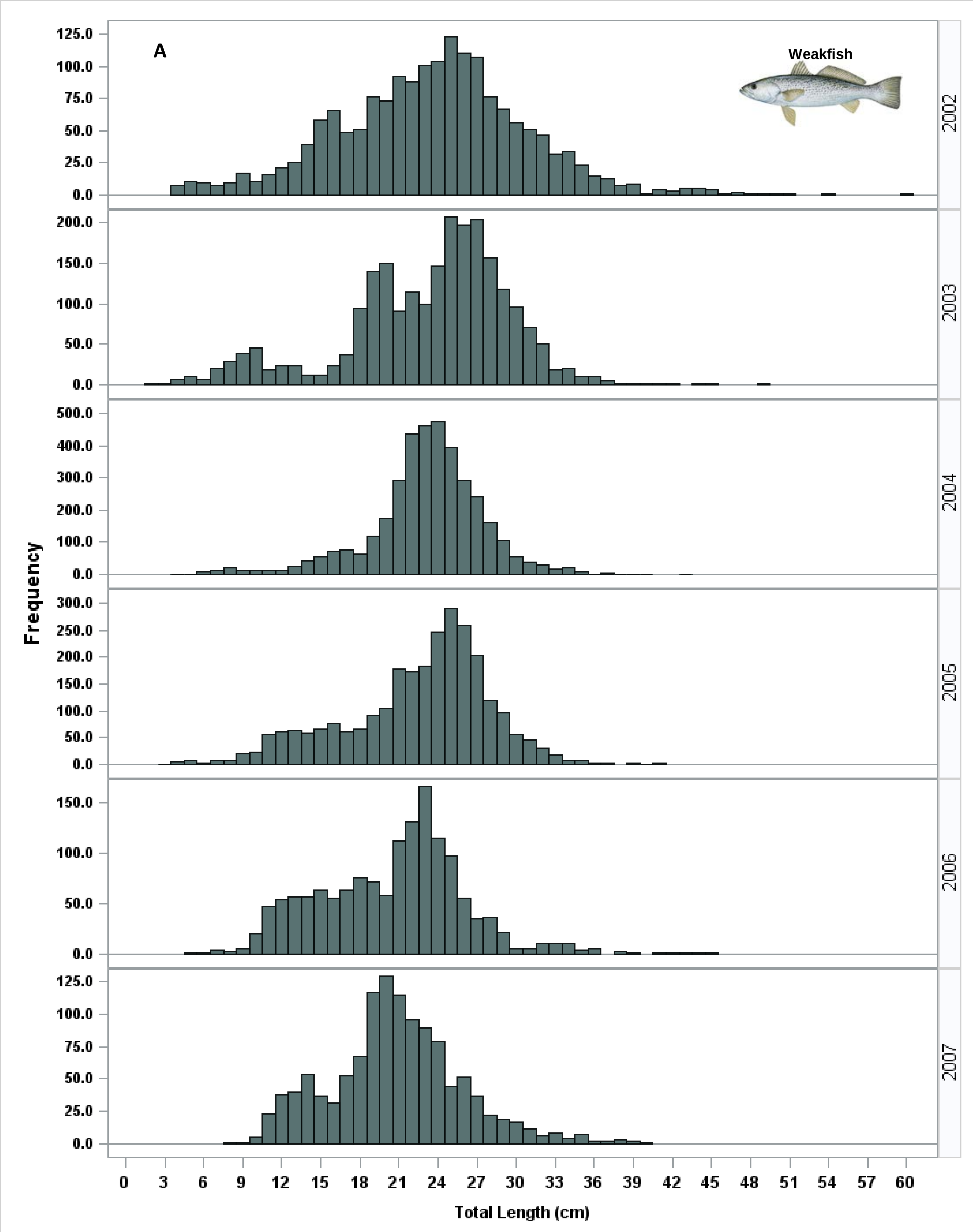


Figure 77. cont.

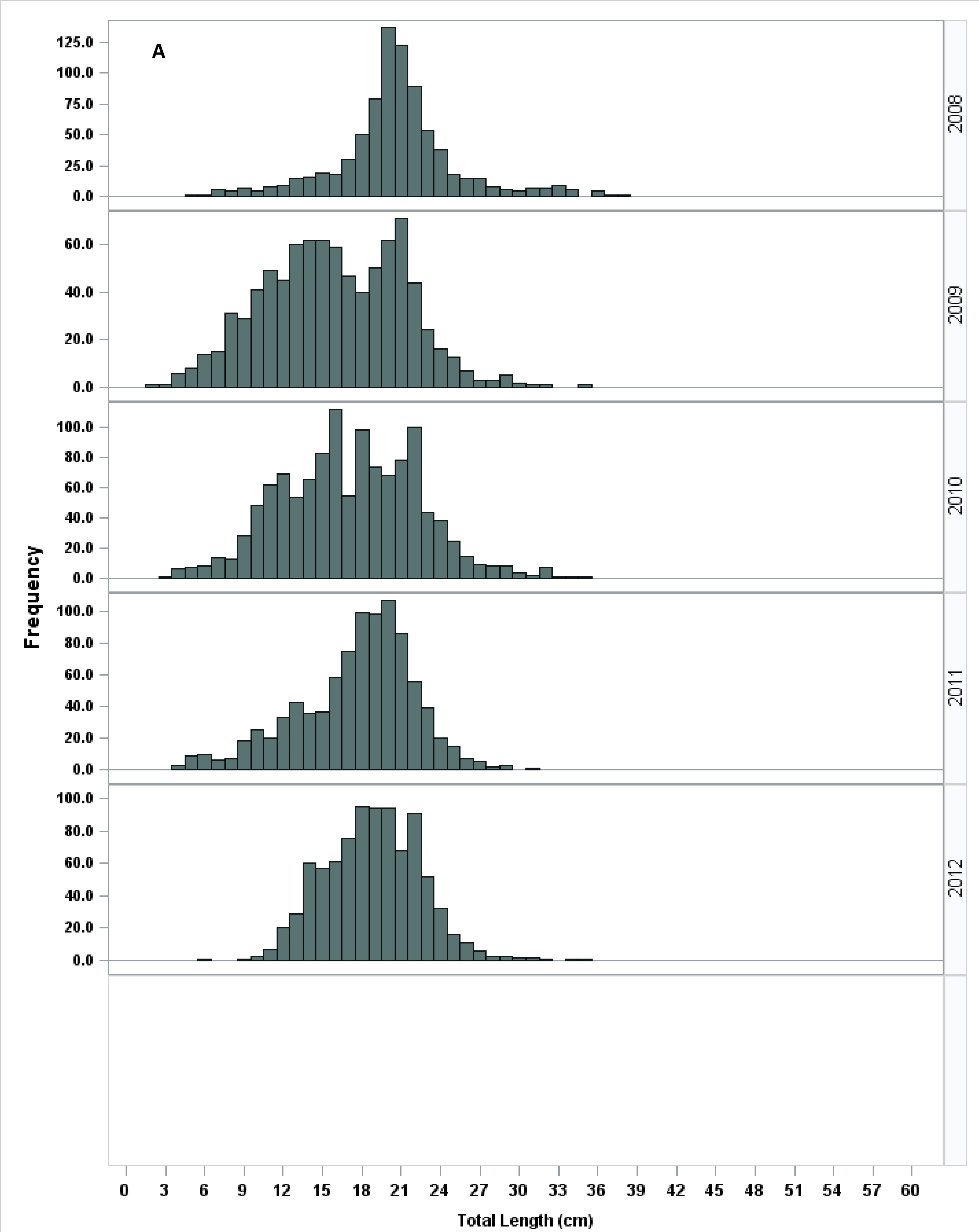


Figure 77. cont.

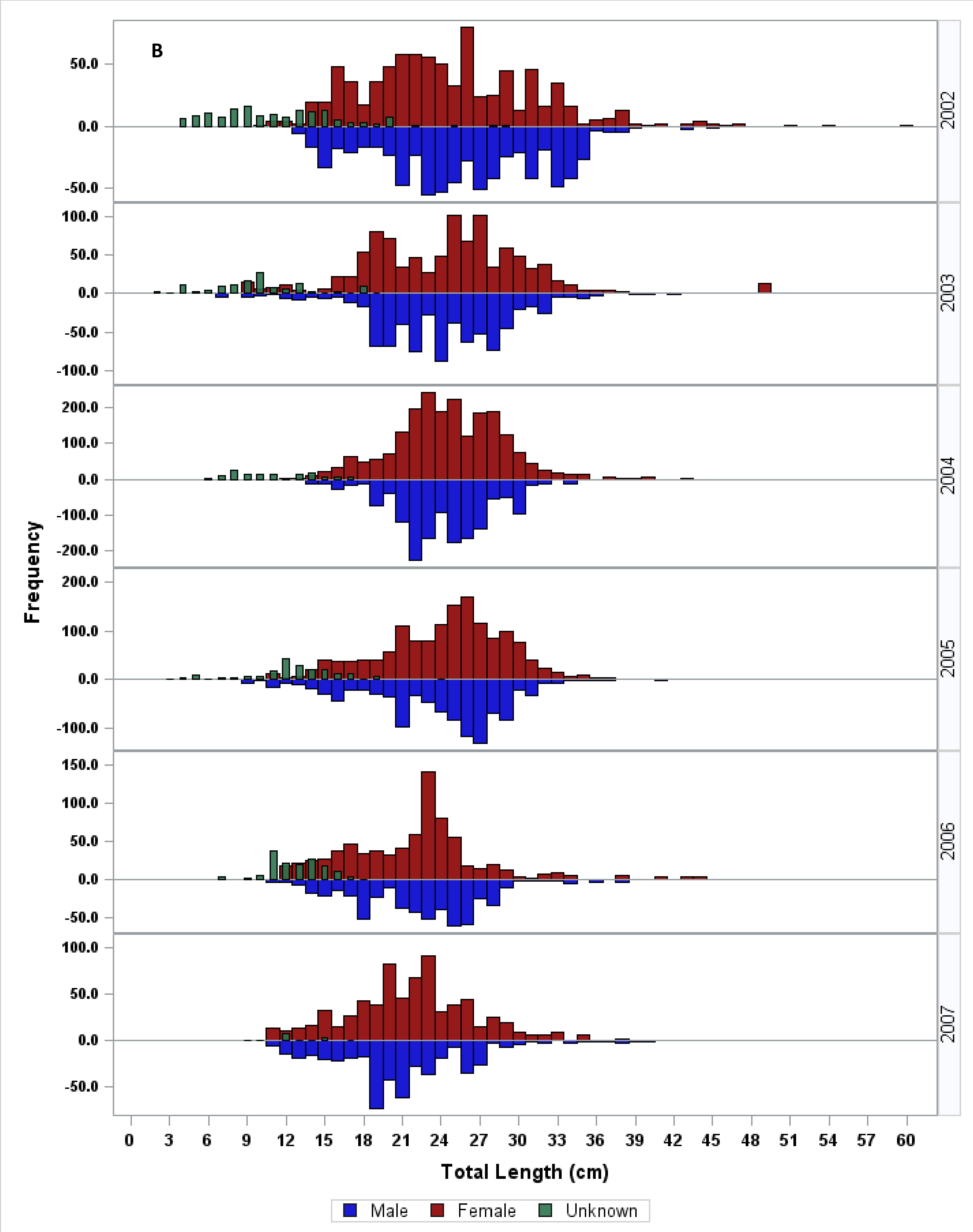


Figure 77. cont.

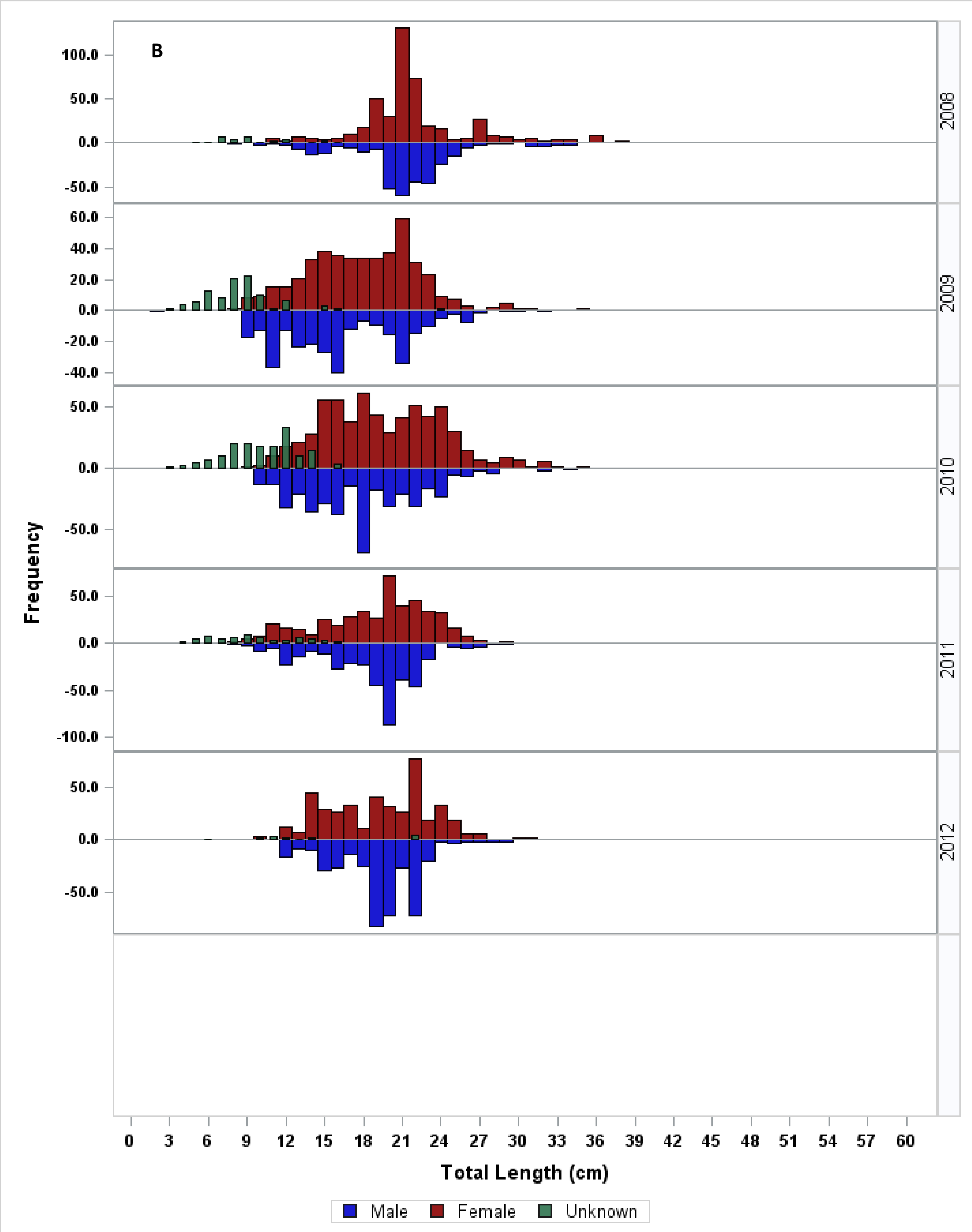


Figure 78. Weakfish total age-frequency, 2002-2012.

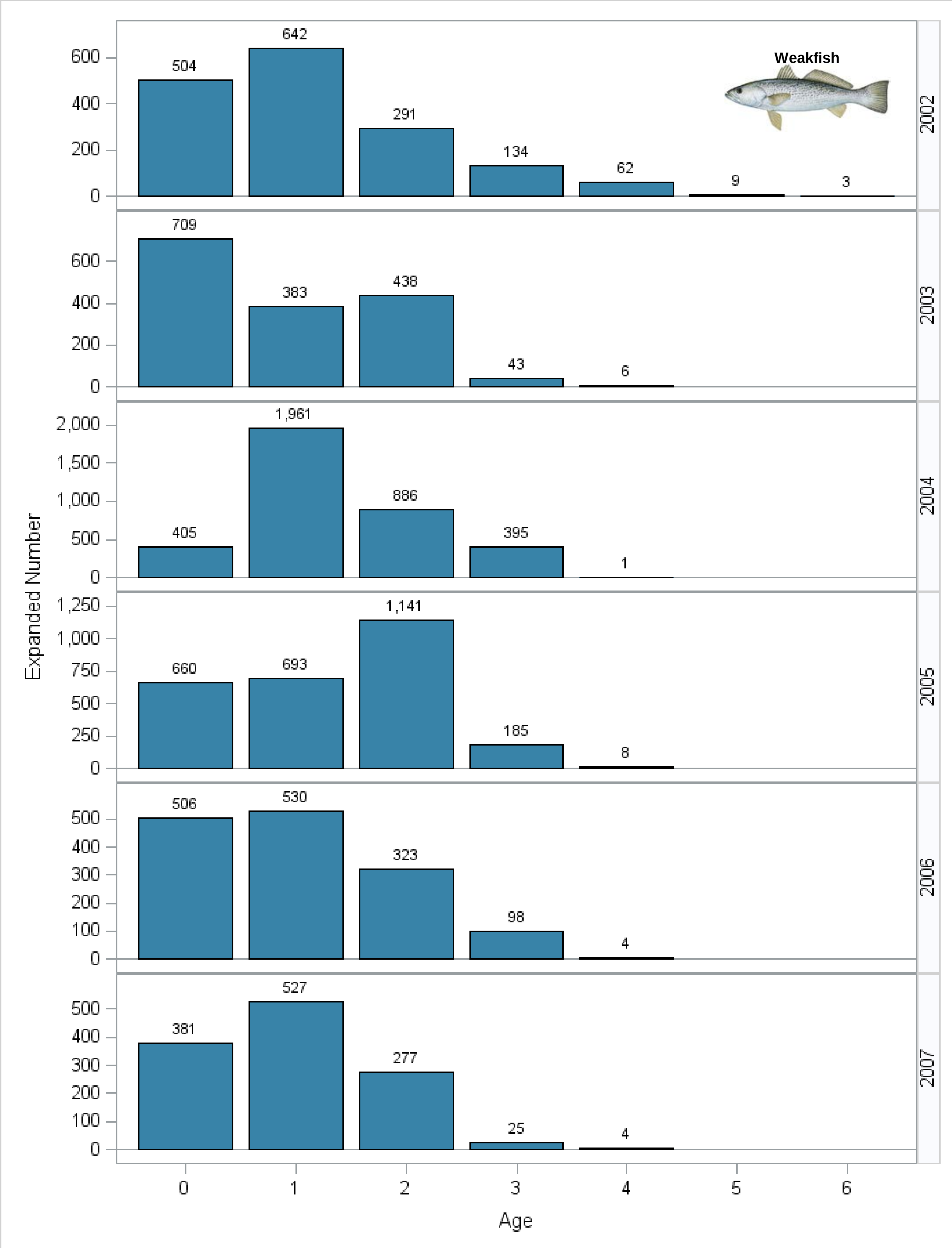


Figure 78. cont.

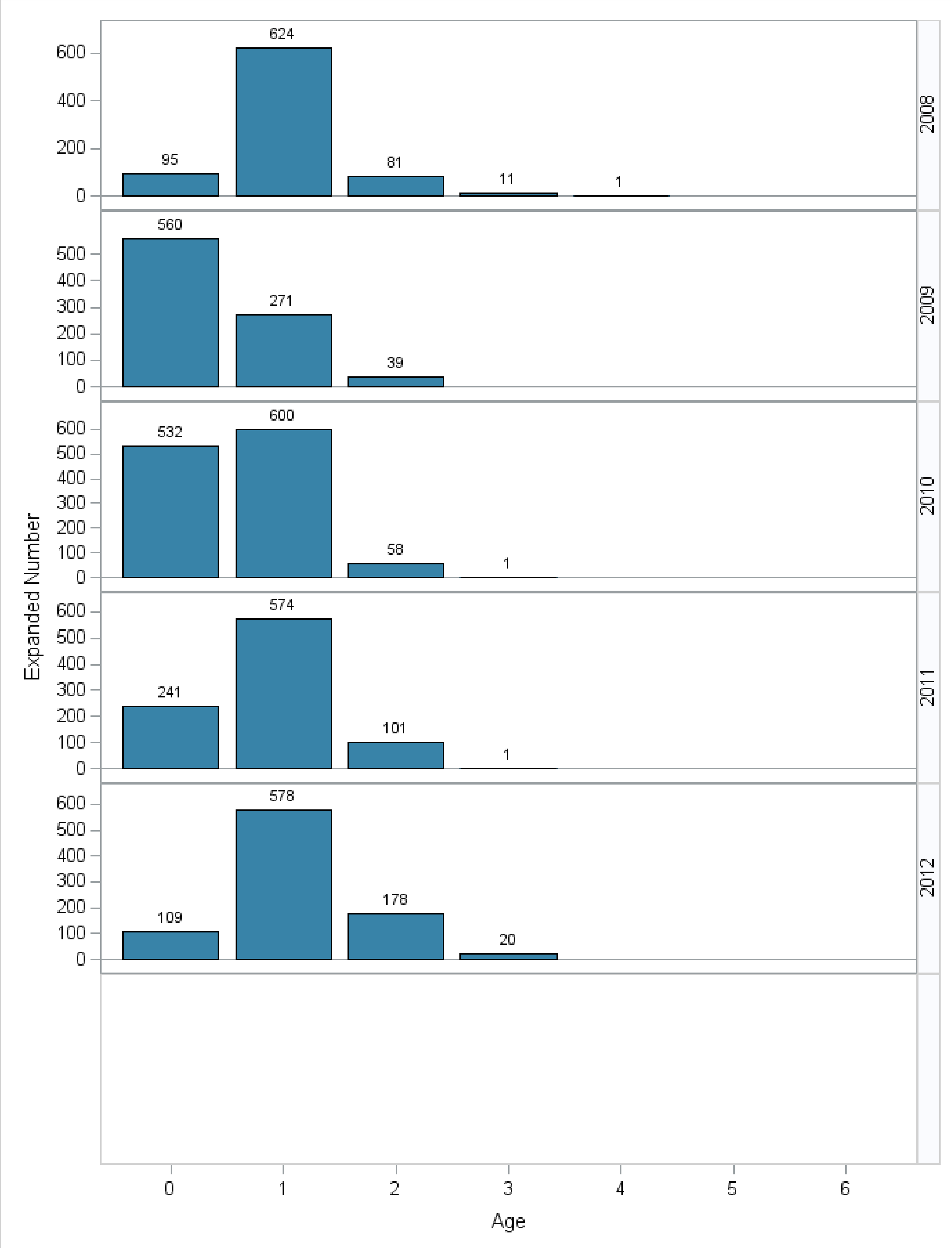


Figure 79. Weakfish age-frequency by year, 2002-2012 standardized to 8,000 annual trawl minutes.

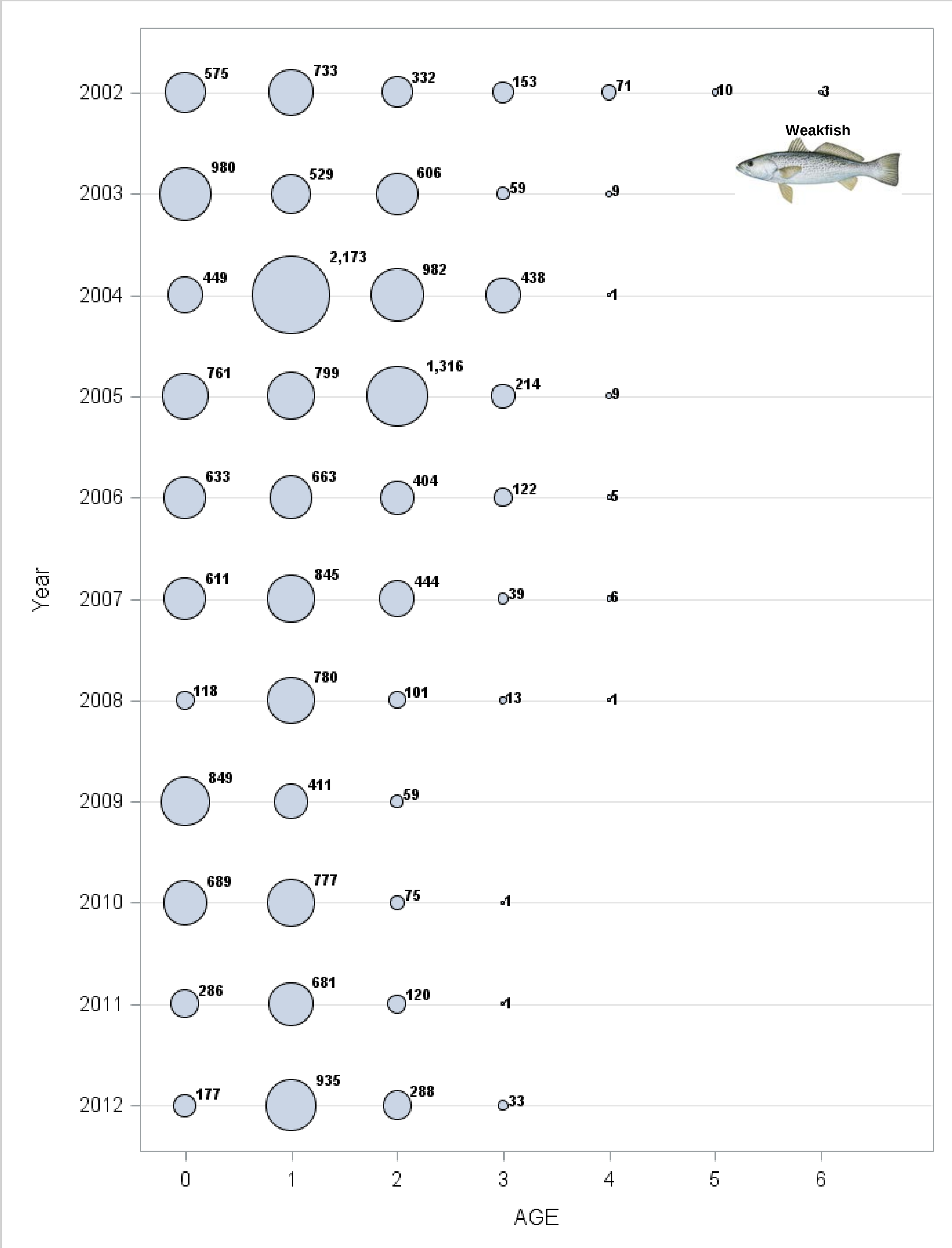


Figure 80. Weakfish age-frequency by cruise month, 2002-2012 combined, actual (A) and standardized to 8,000 total annual trawl minutes (B).

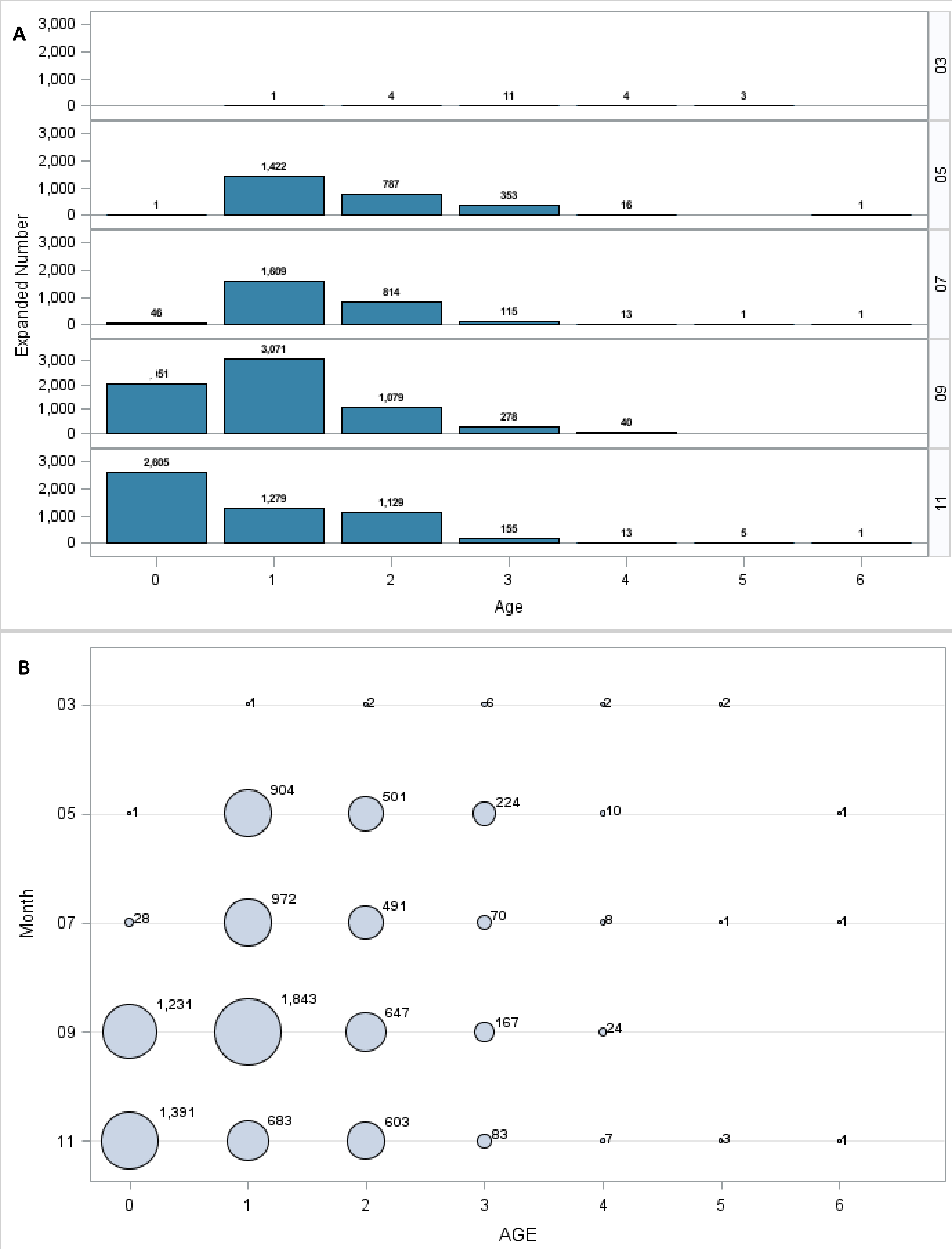


Figure 81. Diet composition, expressed as percent by weight (A) and percent by number (B) of weakfish collected during ChesMMAP cruises in 2002-2011 combined.

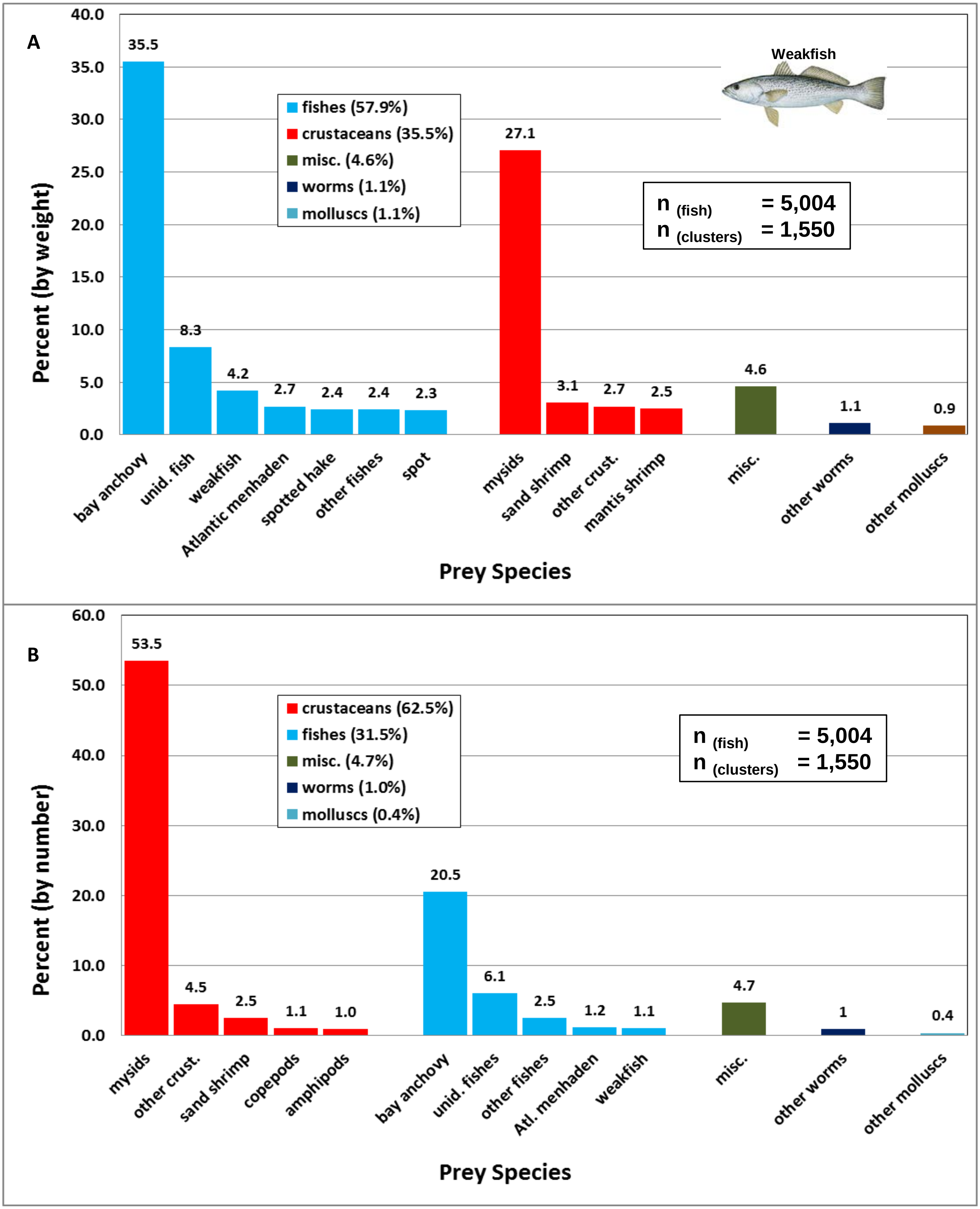


Figure 82. Abundance (kg per hectare swept) of white perch in Chesapeake Bay, 2012.

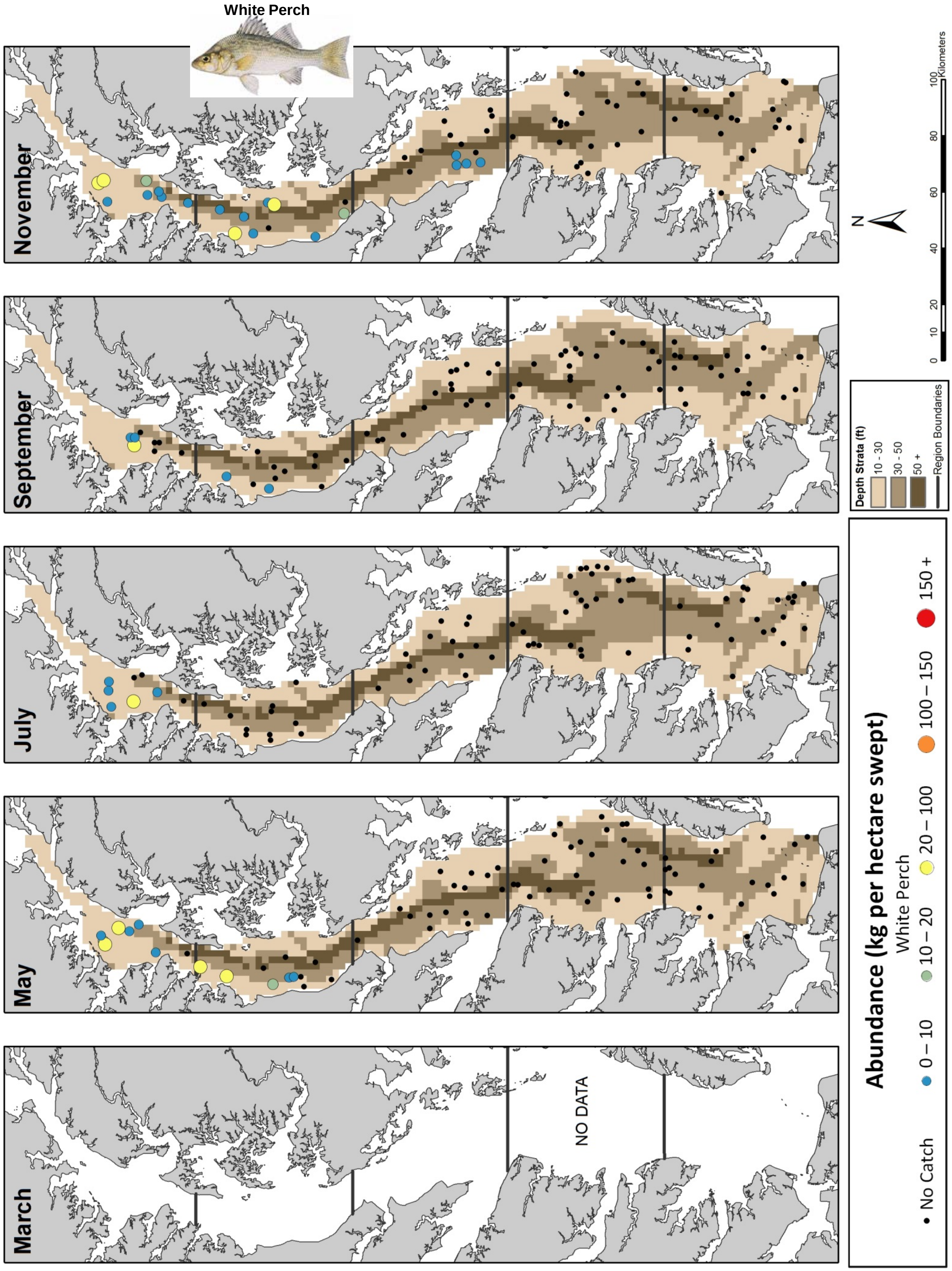


Table 17. White perch (March) geometric mean indices of abundance, by number and biomass, overall.

Year	Age	n	Numerical Index			Biomass Index		
			LCI	**Index**	UCI	LCI	**Index**	UCI
2002	All	15	19.00	37.7	73.92	8.07	12.9	20.34
2003		17	25.78	152.7	880.57	6.72	23.7	77.96
2004		19	292.33	721.2	1,777.12	35.47	64.3	116.08
2005		15	62.08	356.4	2,024.53	10.76	29.1	75.89
2006		15	91.42	475.2	2,453.05	24.83	104.7	431.70
2007		17	527.27	2,240.5	9,509.99	96.50	322.5	1,072.09
2008		16	796.67	2,351.1	6,934.70	129.64	314.8	762.58
2009		16	90.87	141.8	220.79	20.44	32.8	52.12
2010		16	64.18	215.8	720.28	21.44	60.8	169.02
2011		16	33.47	130.5	500.34	12.84	38.0	109.01
2012			0.00			0.00		
2013								
2014								
2015								
2016								

Figure 83. White perch (March) geometric mean indices of abundance, by number and biomass, for all ages combined and by age-class.

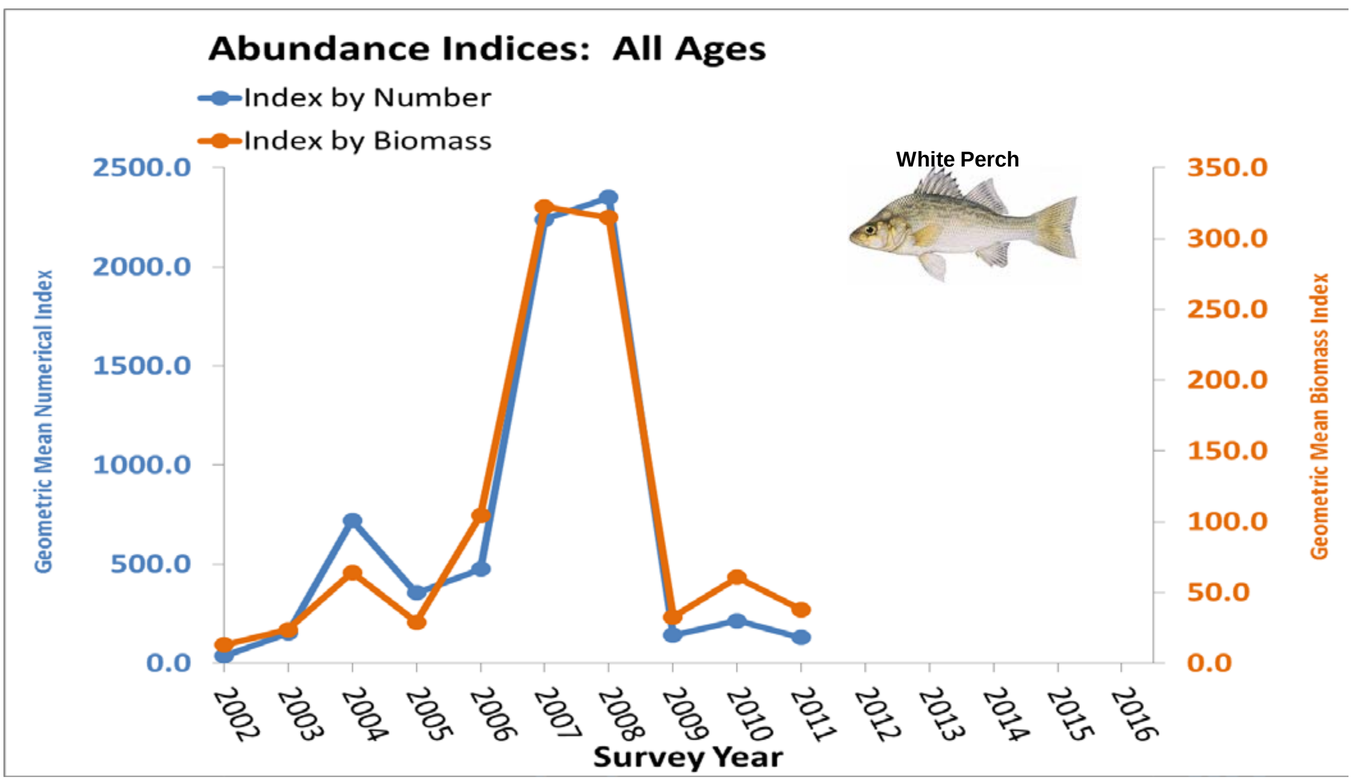


Table 18. White perch (November) geometric mean indices of abundance, by number and biomass, overall.

Year	Age	n	Numerical Index			Biomass Index		
			LCI	**Index**	UCI	LCI	**Index**	UCI
2002	All	20	218.35	**728.2**	2,423.07	23.70	**51.6**	111.05
2003		11	162.94	**376.8**	869.45	19.67	**27.3**	37.84
2004		18	2,060.72	**7,463.7**	27,025.62	65.83	**126.9**	243.68
2005		15	649.12	**2,405.1**	8,903.93	41.36	**84.0**	169.66
2006		14	4,088.78	**9,464.3**	21,905.47	460.76	**986.5**	2,110.97
2007		15	28.60	**86.6**	258.17	9.72	**24.3**	58.49
2008		16	68.81	**185.4**	496.85	15.12	**34.9**	79.10
2009		16	185.10	**1,069.3**	6,154.27	41.97	**197.8**	918.78
2010		15	1,246.00	**4,207.5**	14,201.98	217.96	**578.2**	1,530.95
2011		15	2,796.68	**6,235.5**	13,901.20	398.93	**878.6**	1,933.52
2012		15	507.66	**1,974.6**	7,672.46	101.75	**315.7**	975.10
2013								
2014								
2015								
2016								

Figure 84. White perch (November) geometric mean indices of abundance, by number and biomass, for all ages combined and by age-class.

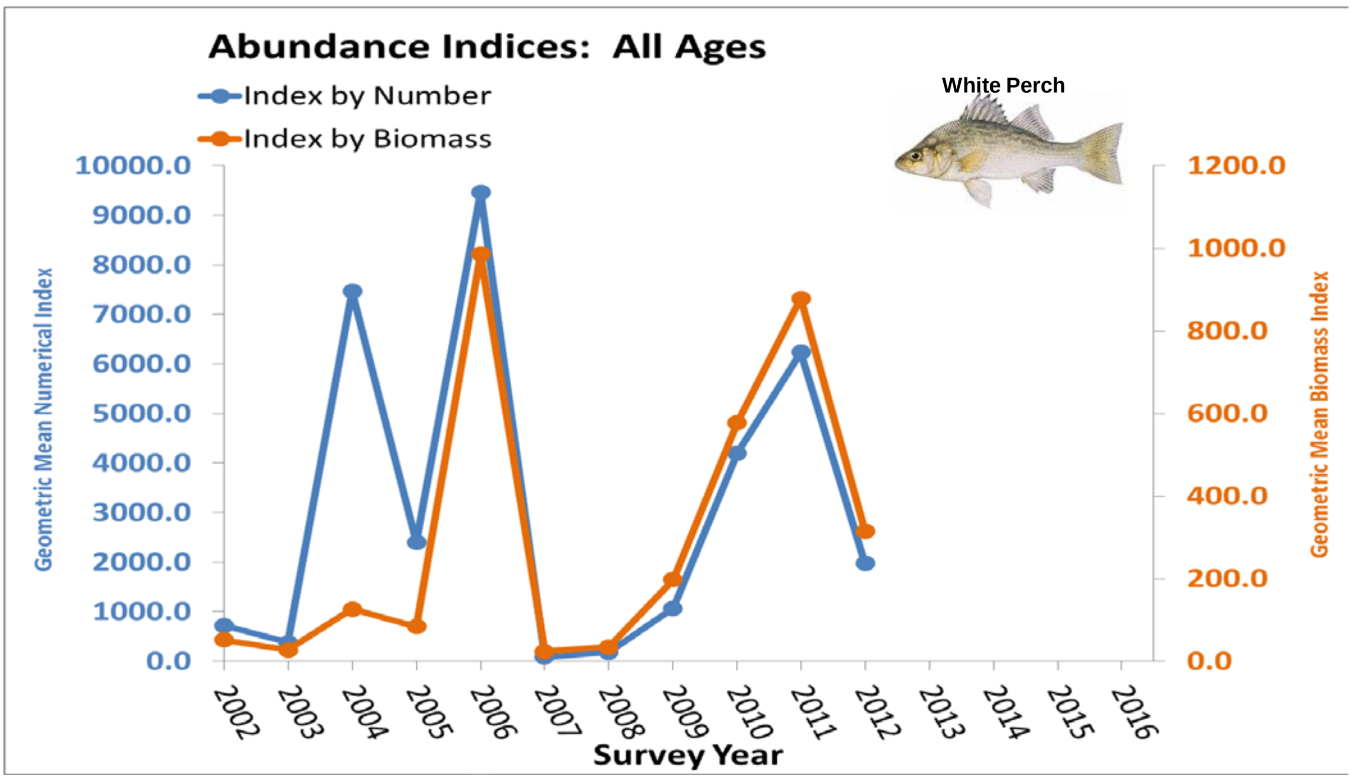


Figure 85. White perch length-frequency in Chesapeake Bay 2002-2012, overall (A) and by sex (B).

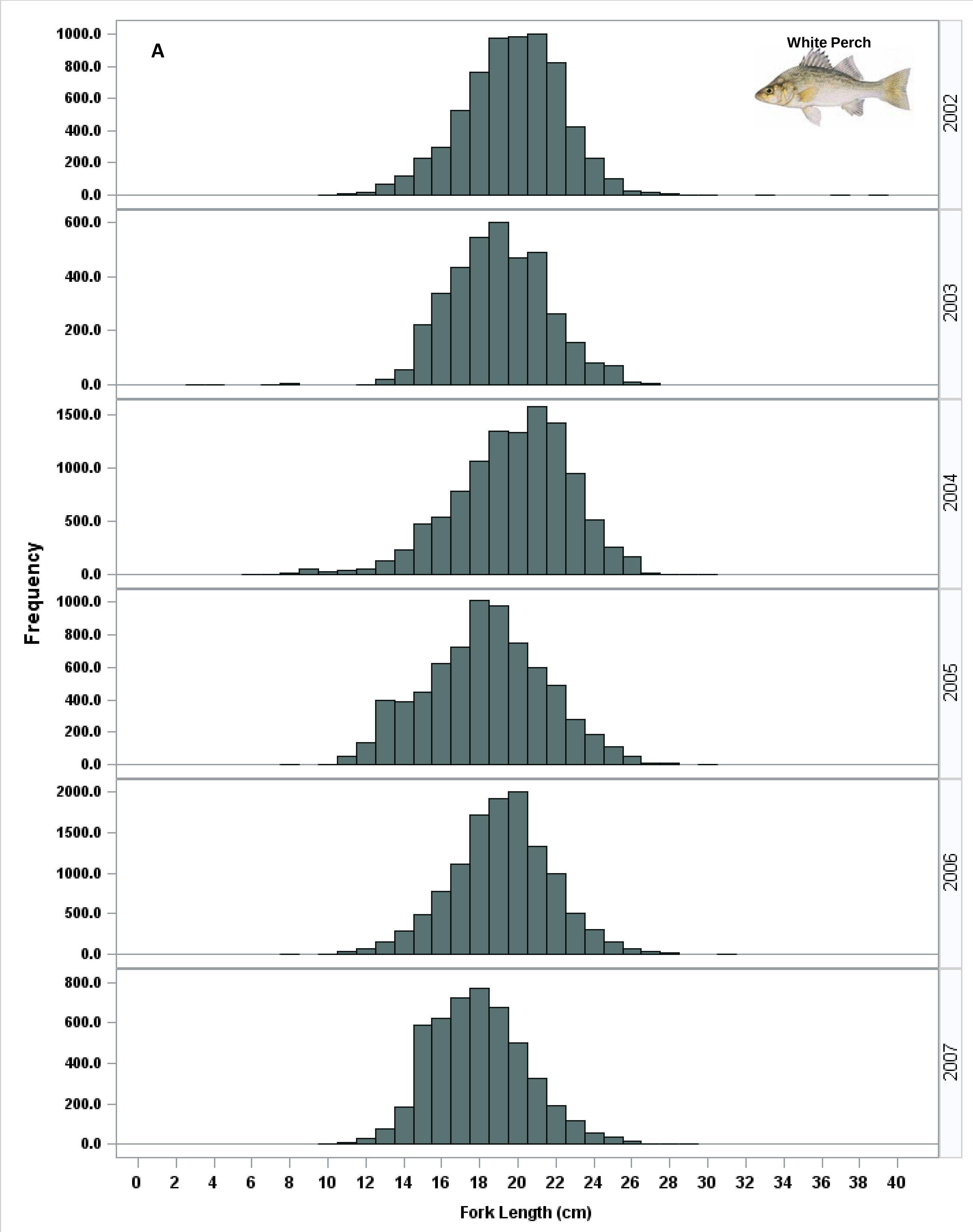


Figure 85. cont.

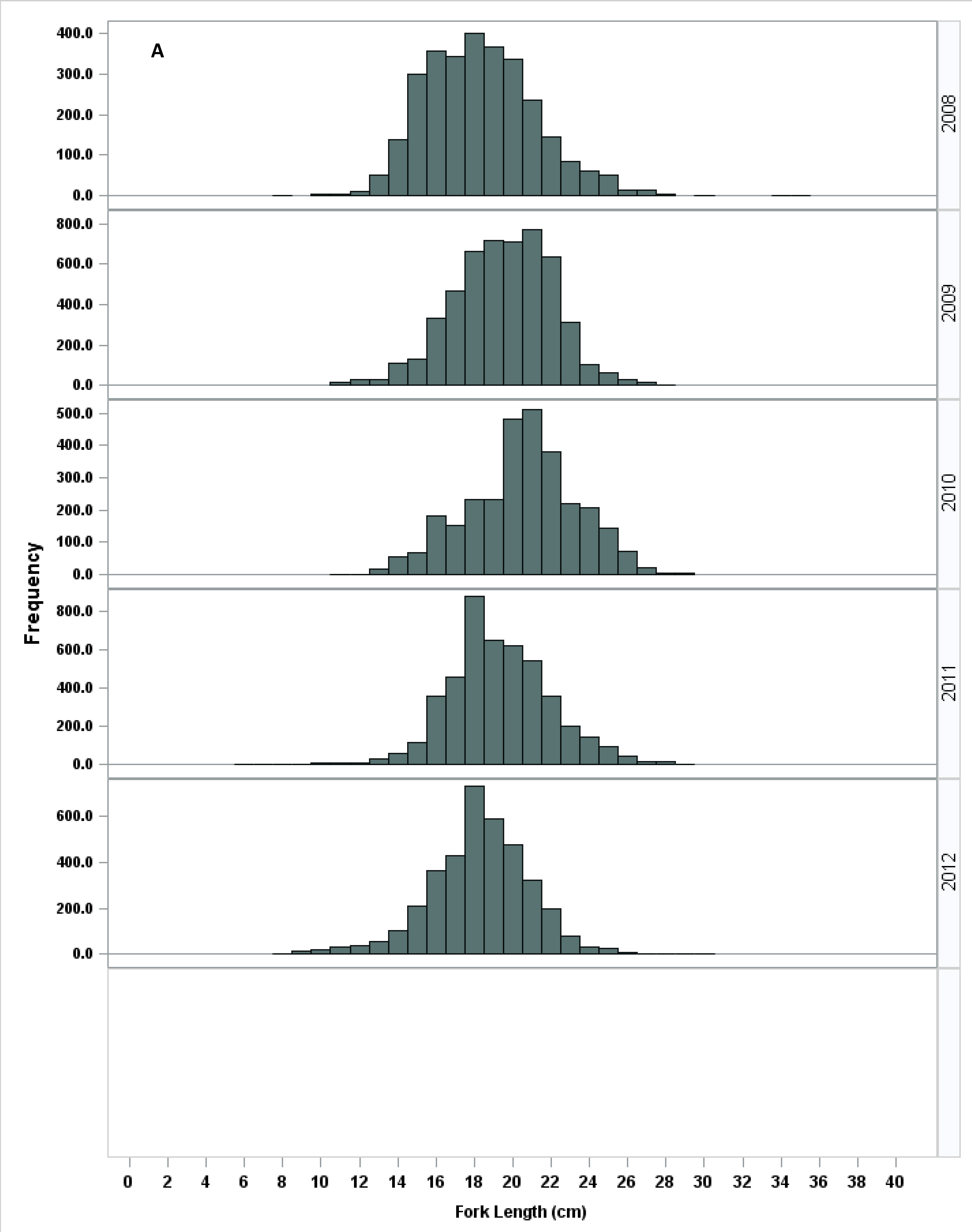


Figure 85. cont.

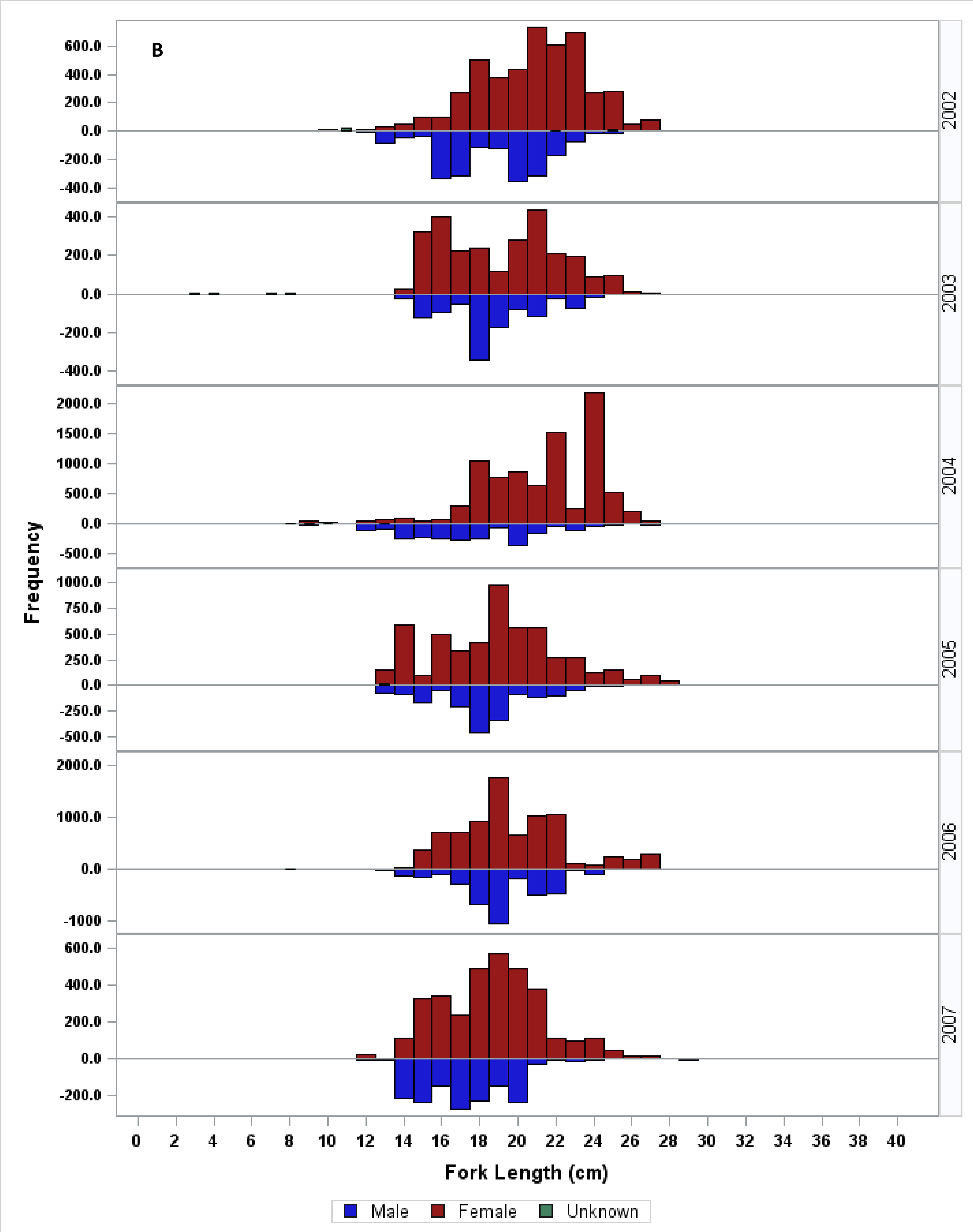


Figure 85. cont.

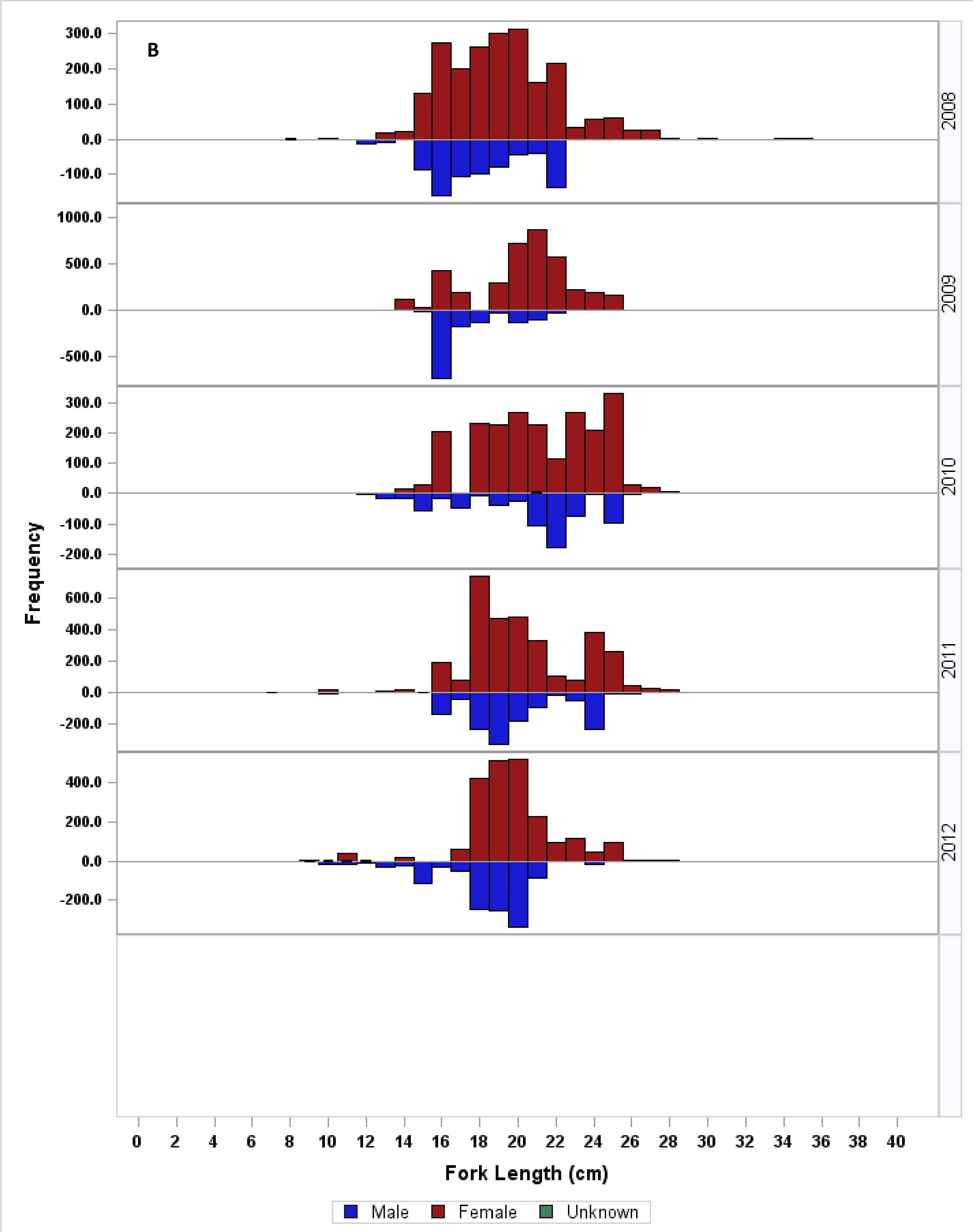


Figure 86. White perch total age-frequency, 2002-2011.

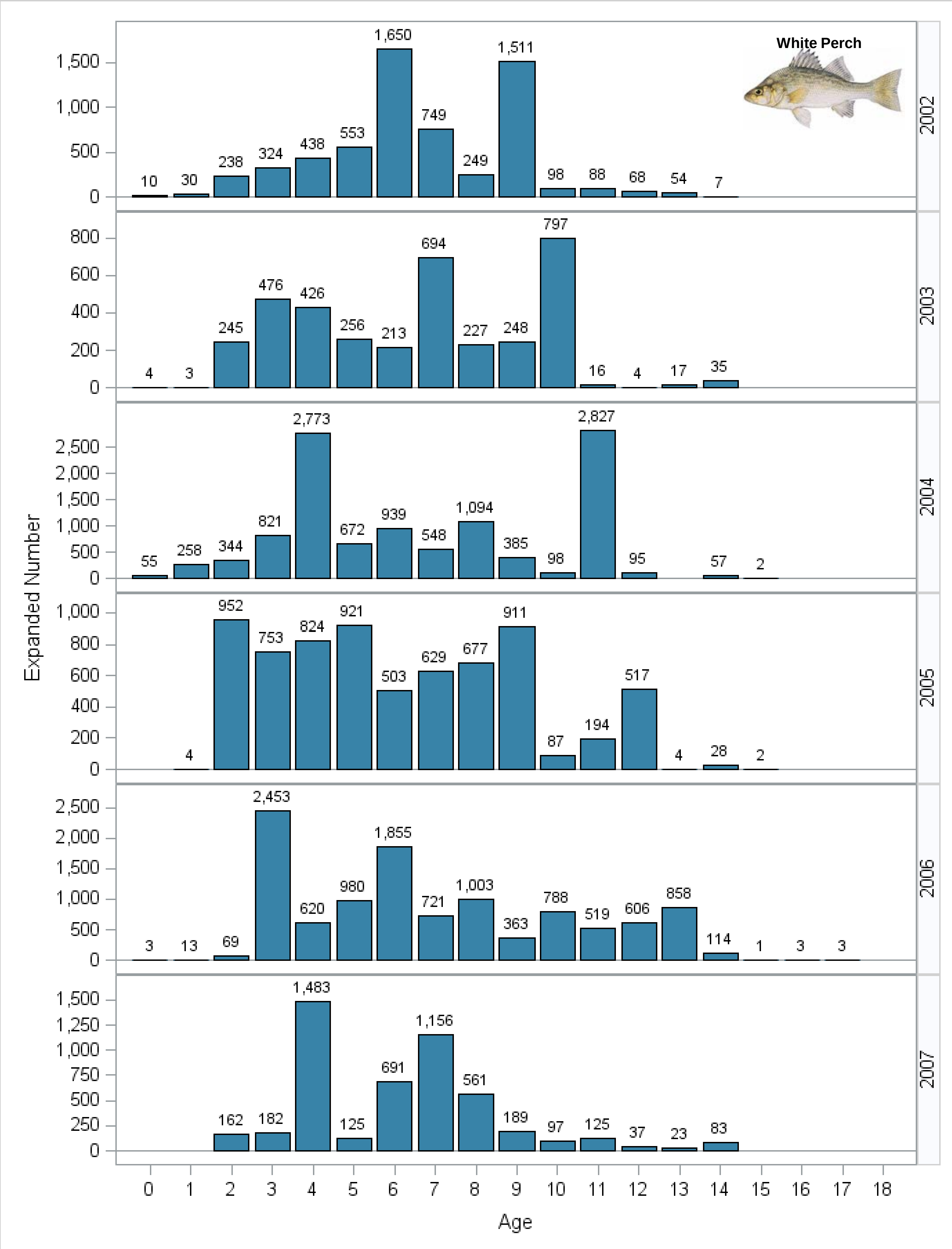


Figure 86. cont.

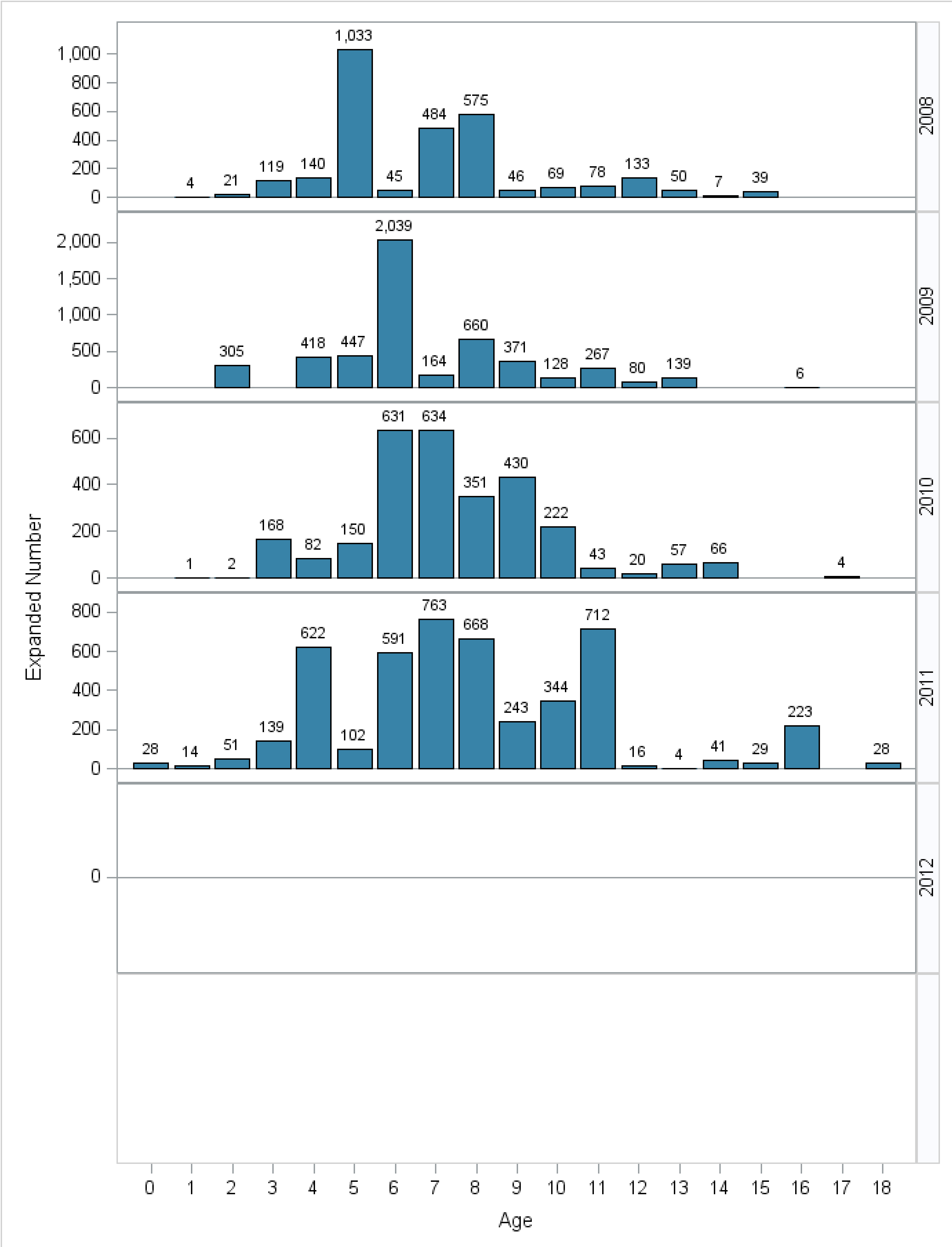


Figure 87. White perch age-frequency by year, 2002-2011 standardized to 8,000 annual trawl minutes.

Figure 88. White perch age-frequency by cruise month, 2002-2011 combined, actual (A) and standardized to 8,000 total annual trawl minutes (B).

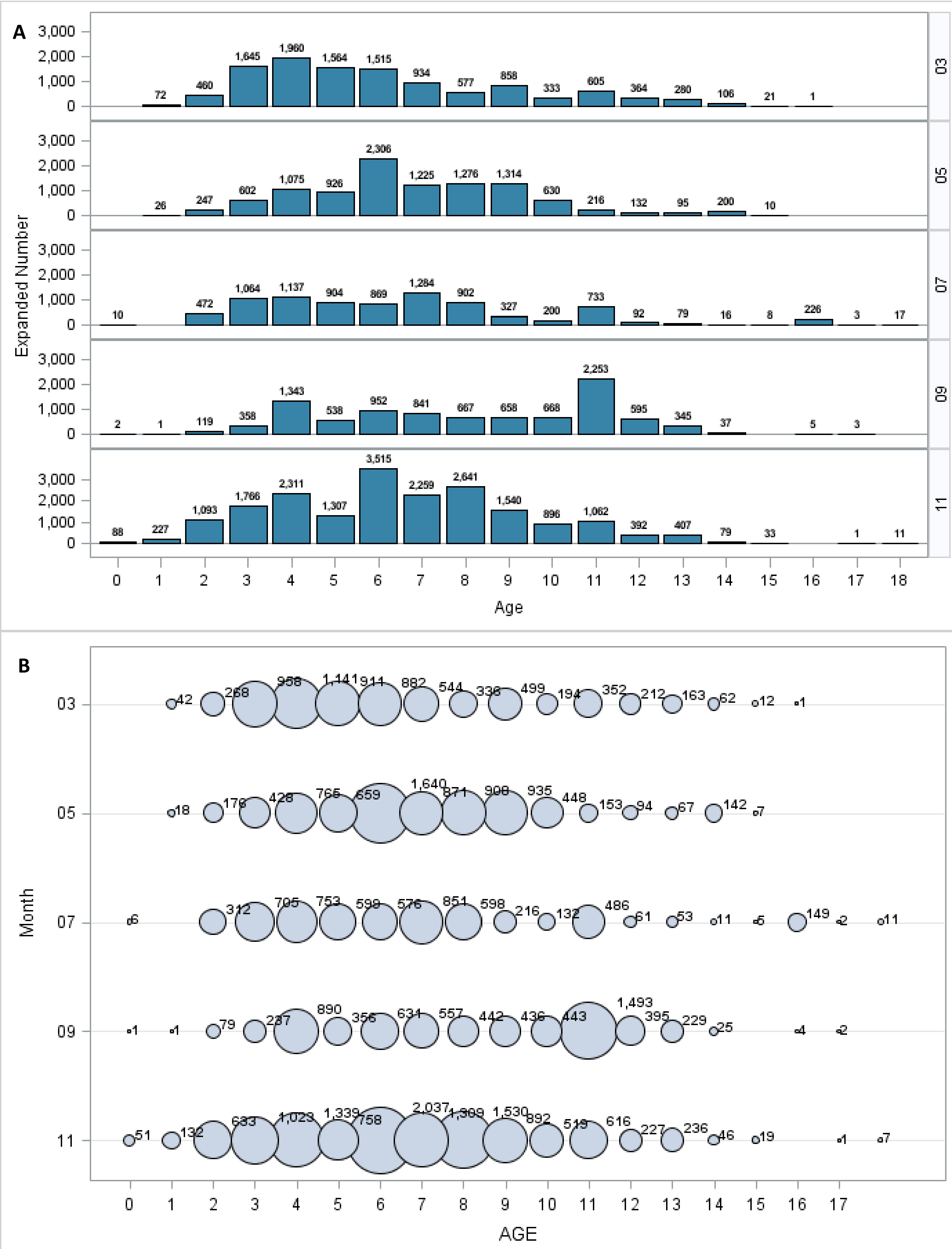


Figure 89. Diet composition, expressed as percent by weight (A) and percent by number (B) of white perch collected during ChesMMAP cruises in 2002-2011 combined.

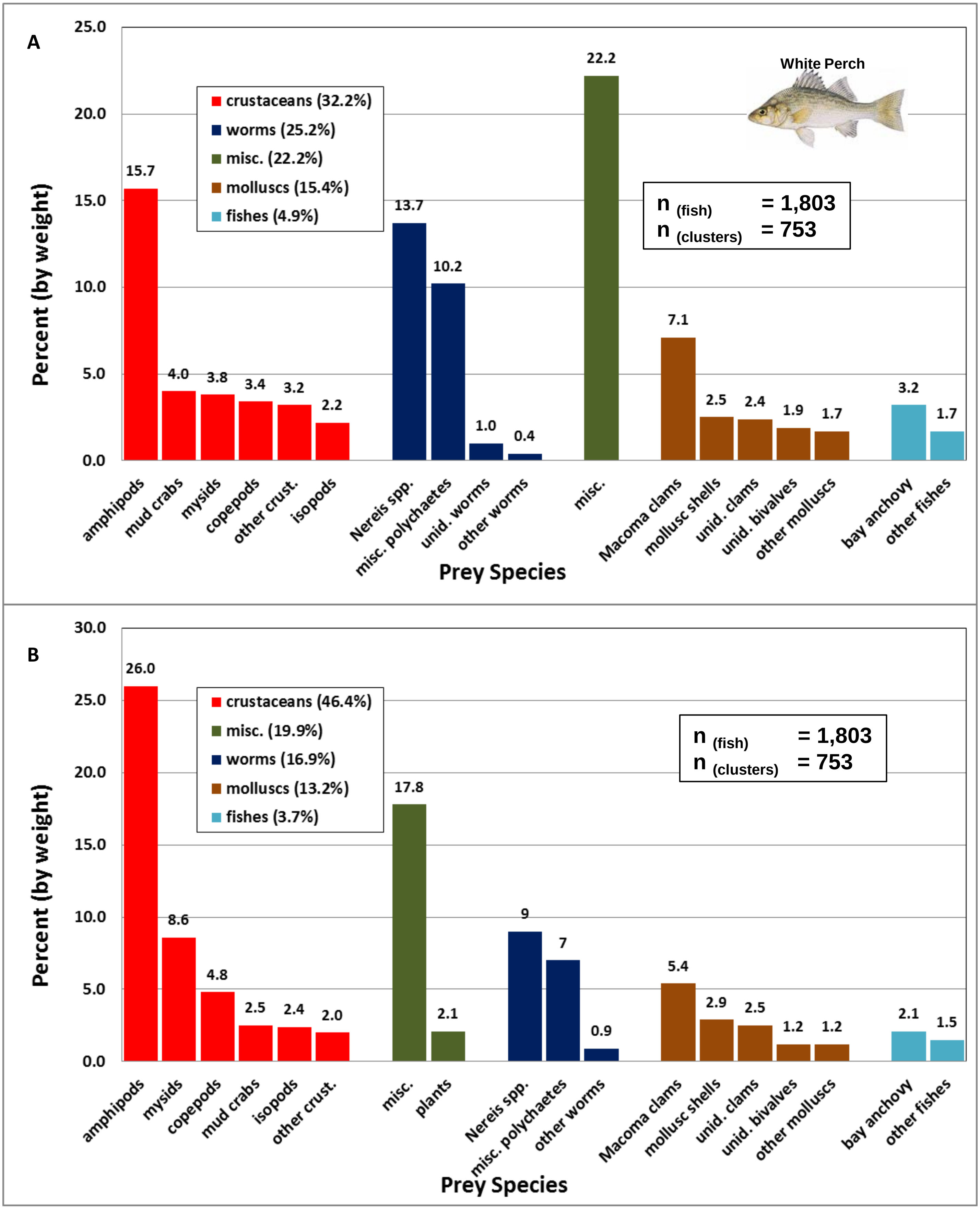
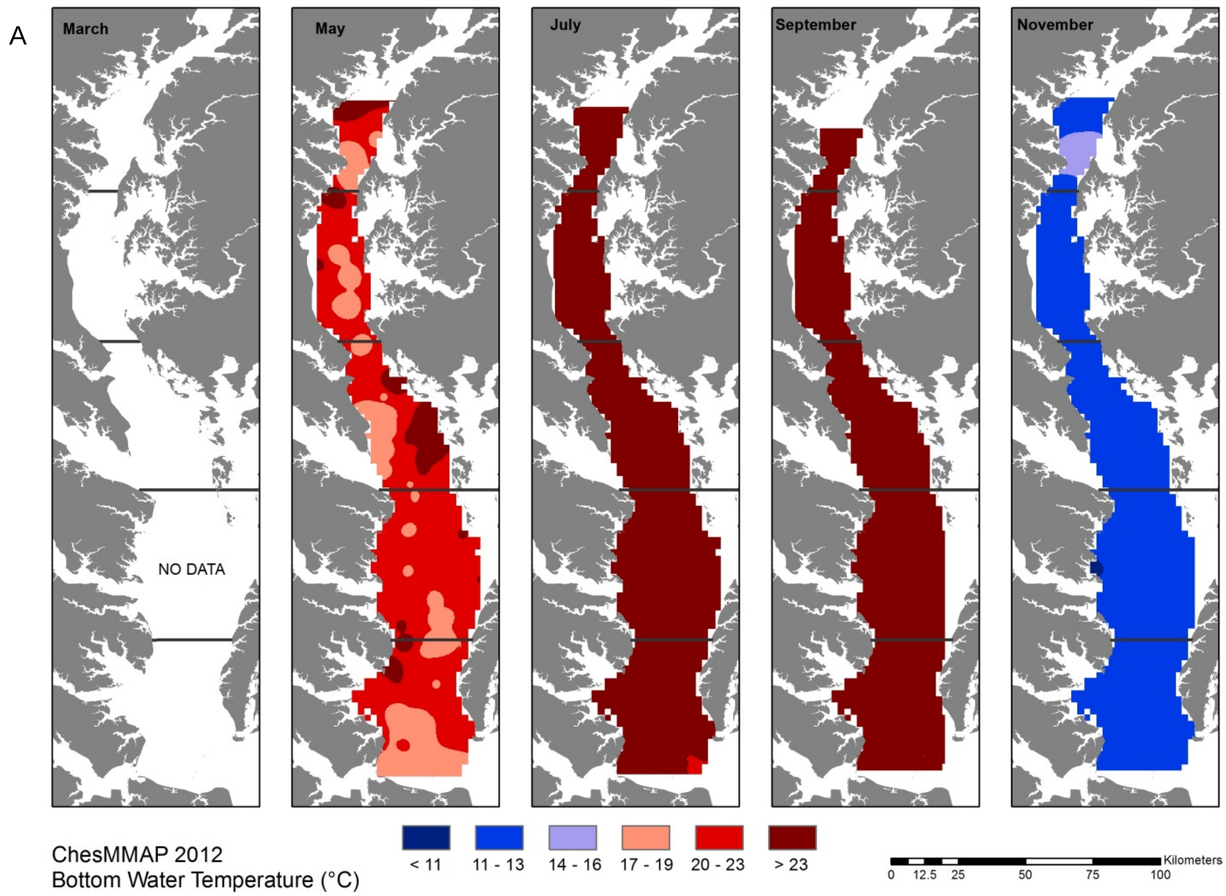


Figure 90. Interpolated bottom water temperatures in Chesapeake Bay, by cruise, for 2012 (A), and deviations from averages for all previous monthly cruises (B).



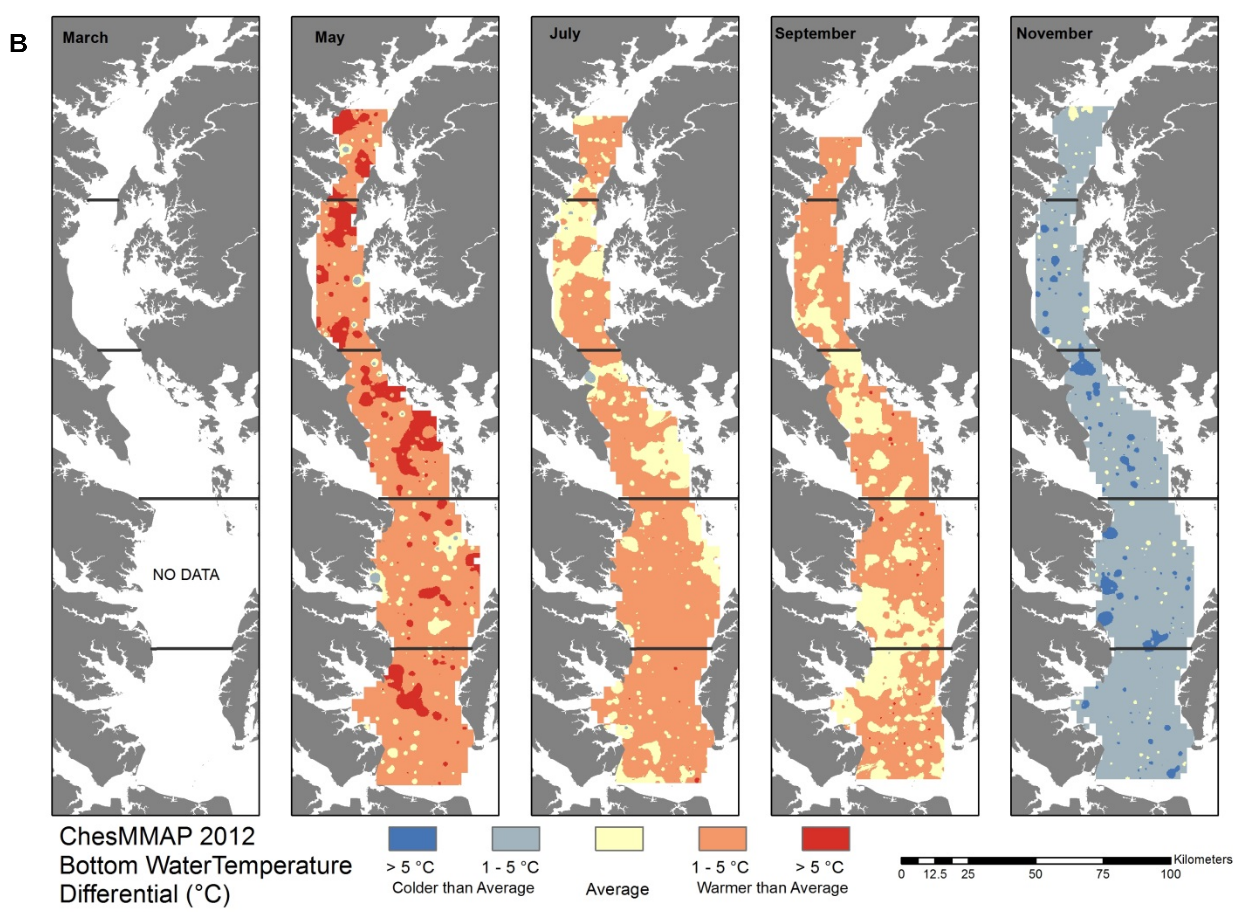


Figure 91. Interpolated bottom salinities in Chesapeake Bay, by cruise, for 2012 (A), and deviations from averages for all previous monthly cruises (B).

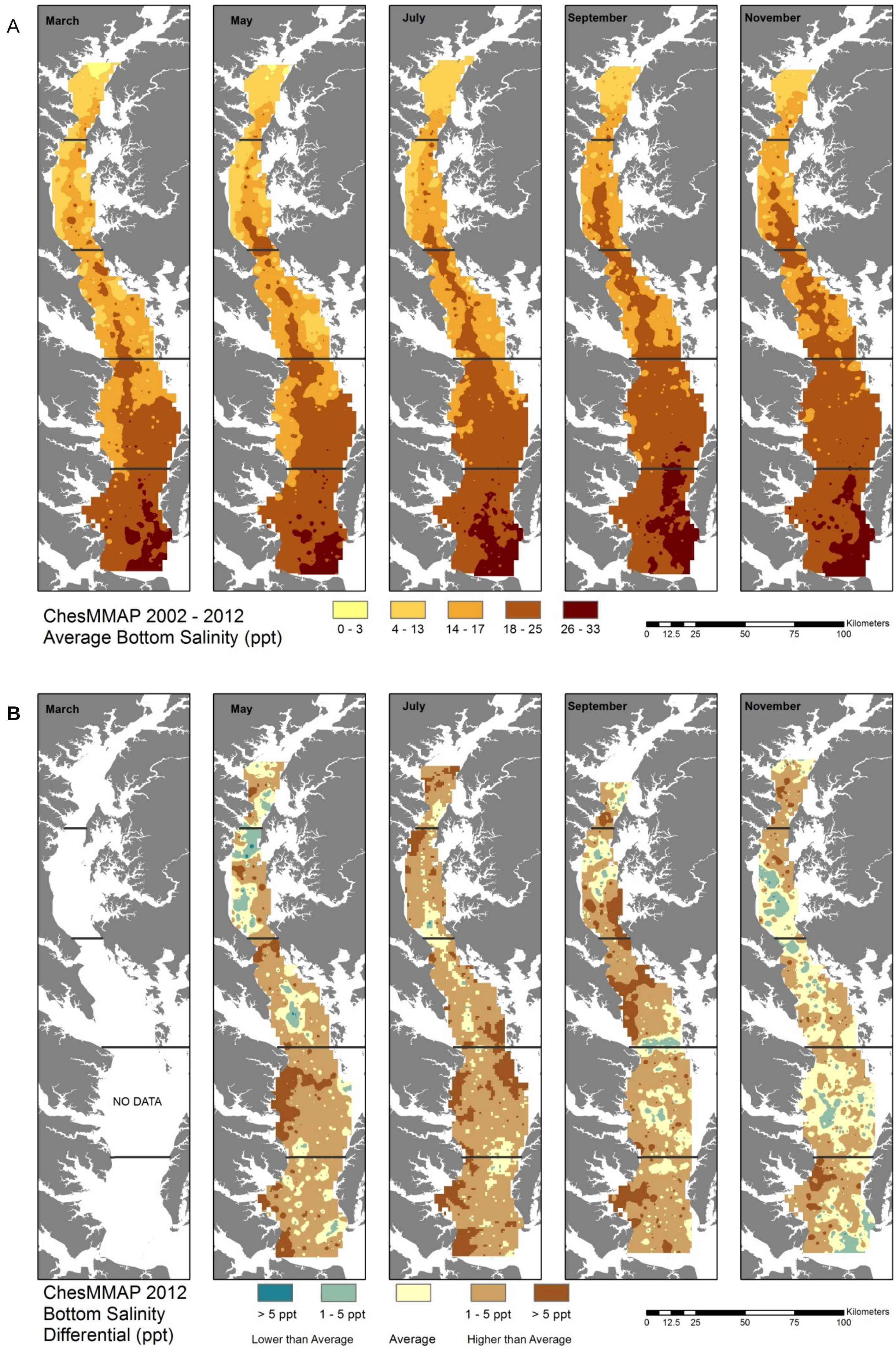


Figure 92. Interpolated bottom dissolved oxygen in Chesapeake Bay, by cruise, for 2012 (A), and deviations from averages for all previous monthly cruises (B).

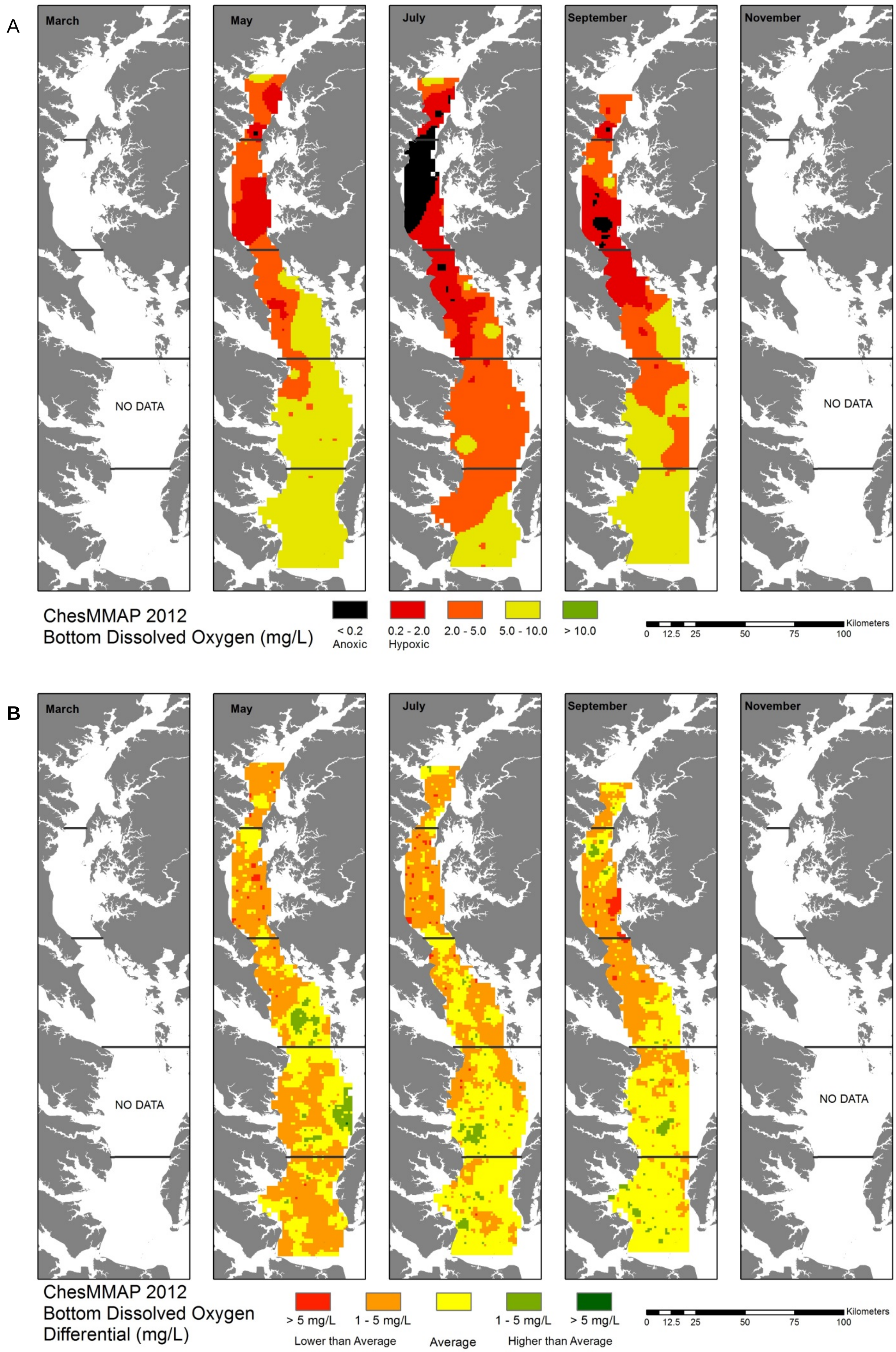


Figure 93. Interpolated bi-monthly water temperature profiles in Chesapeake Bay, 2012 (no March cruise).

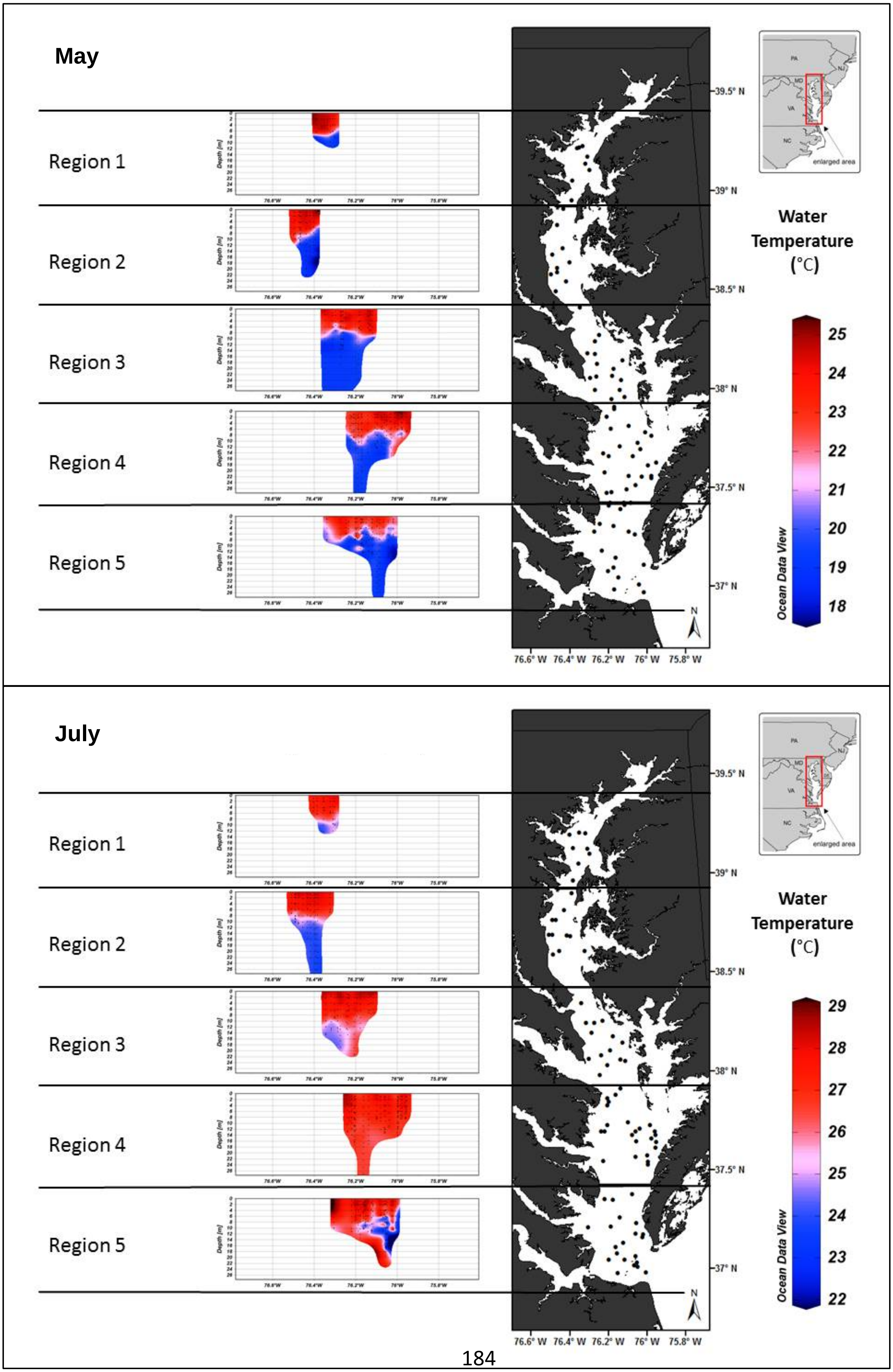


Figure 93. cont.

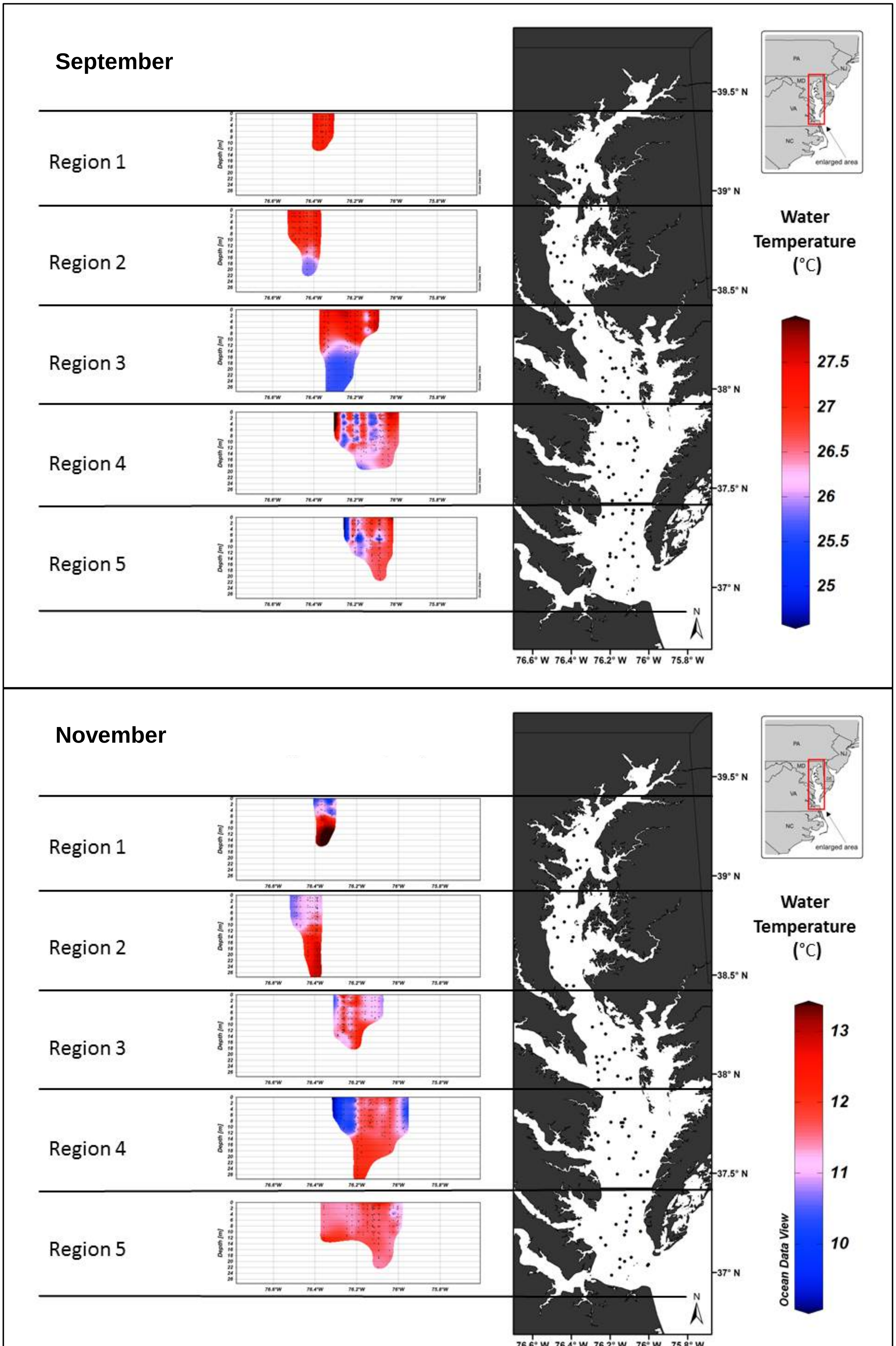


Figure 94. Interpolated bi-monthly salinity profiles in Chesapeake Bay, 2012 (no March cruise).

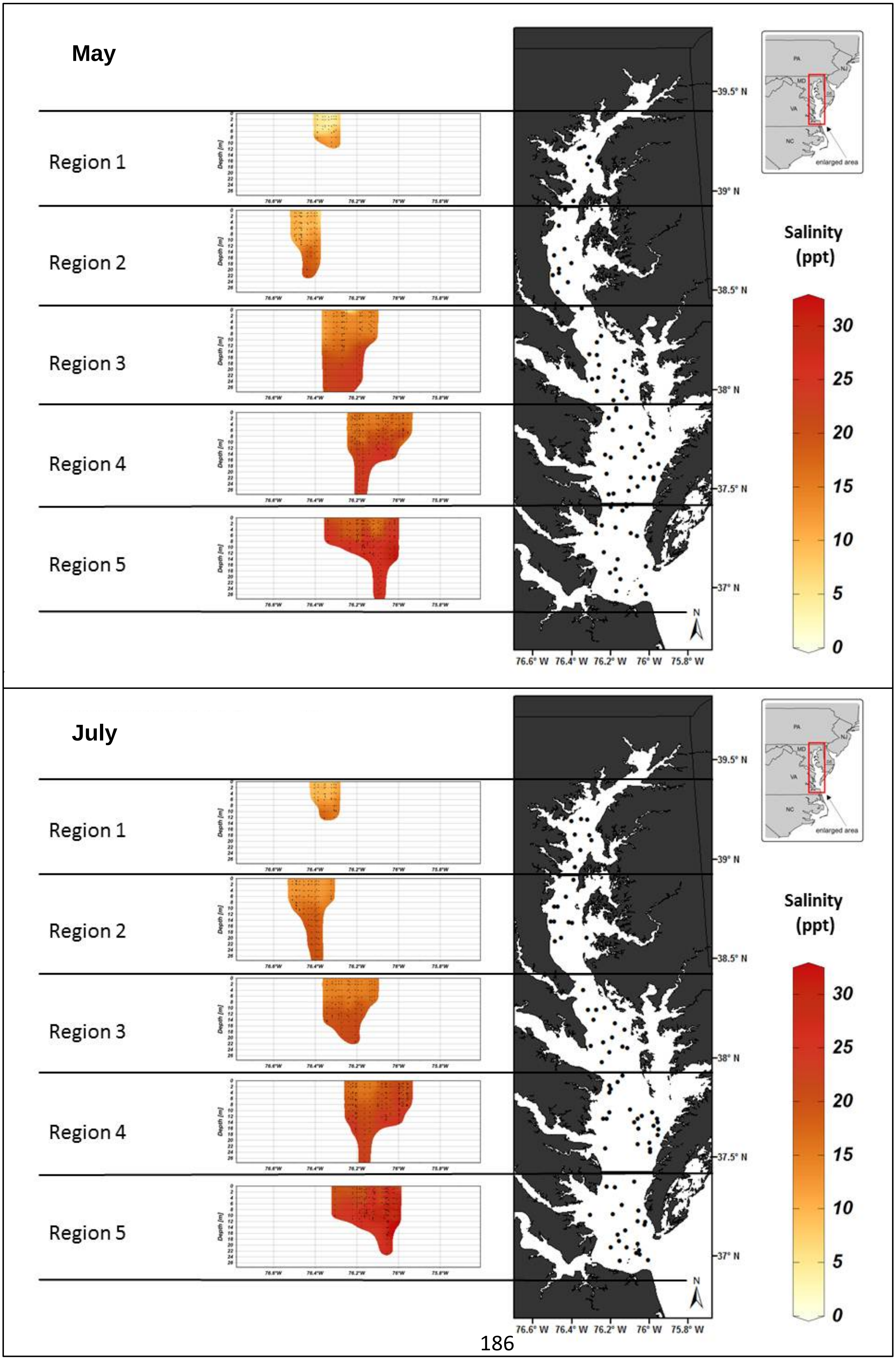


Figure 94. cont.

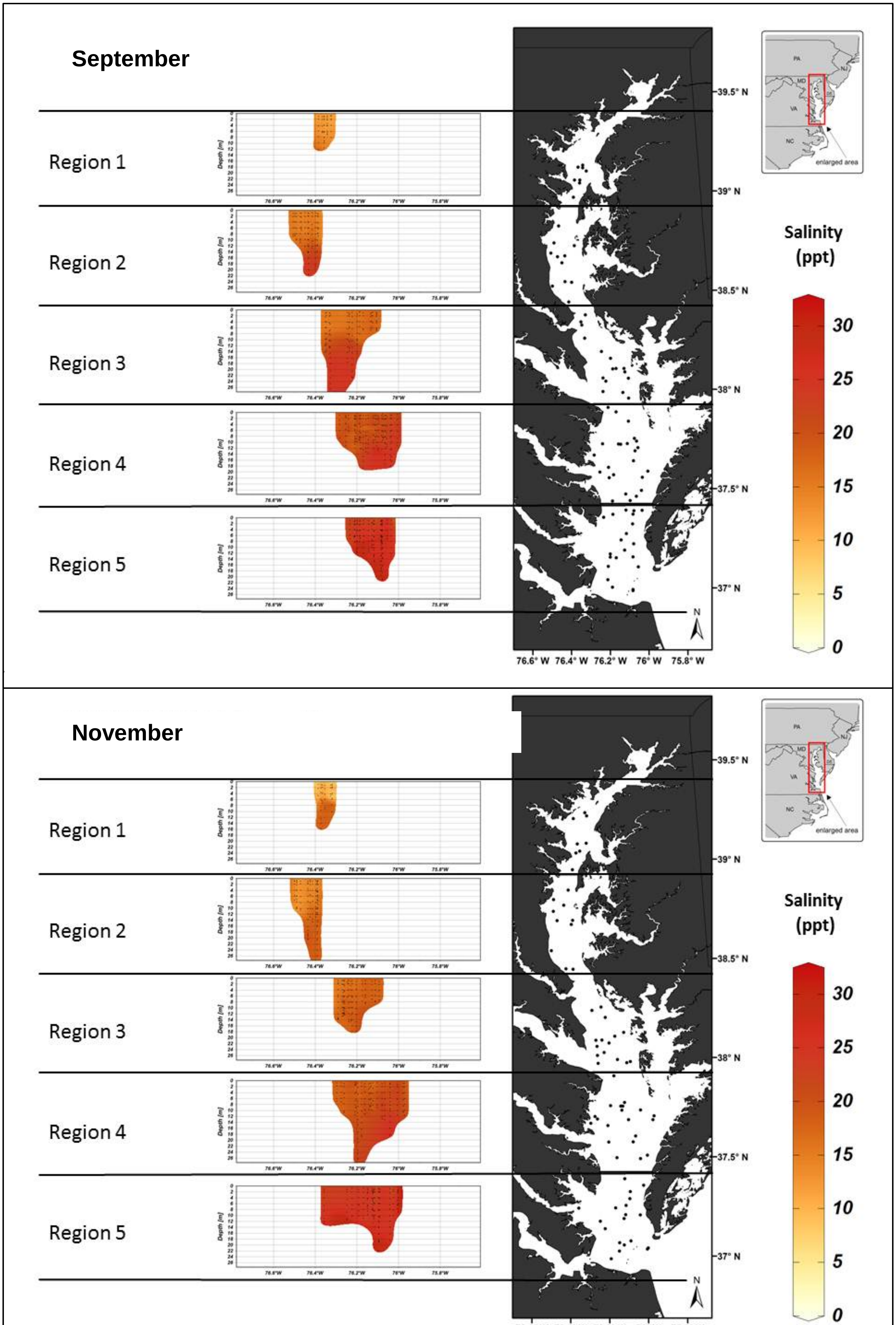


Figure 95. Interpolated bi-monthly dissolved oxygen profiles in Chesapeake Bay, 2012 (no March cruise, no November data due to equipment malfunction).

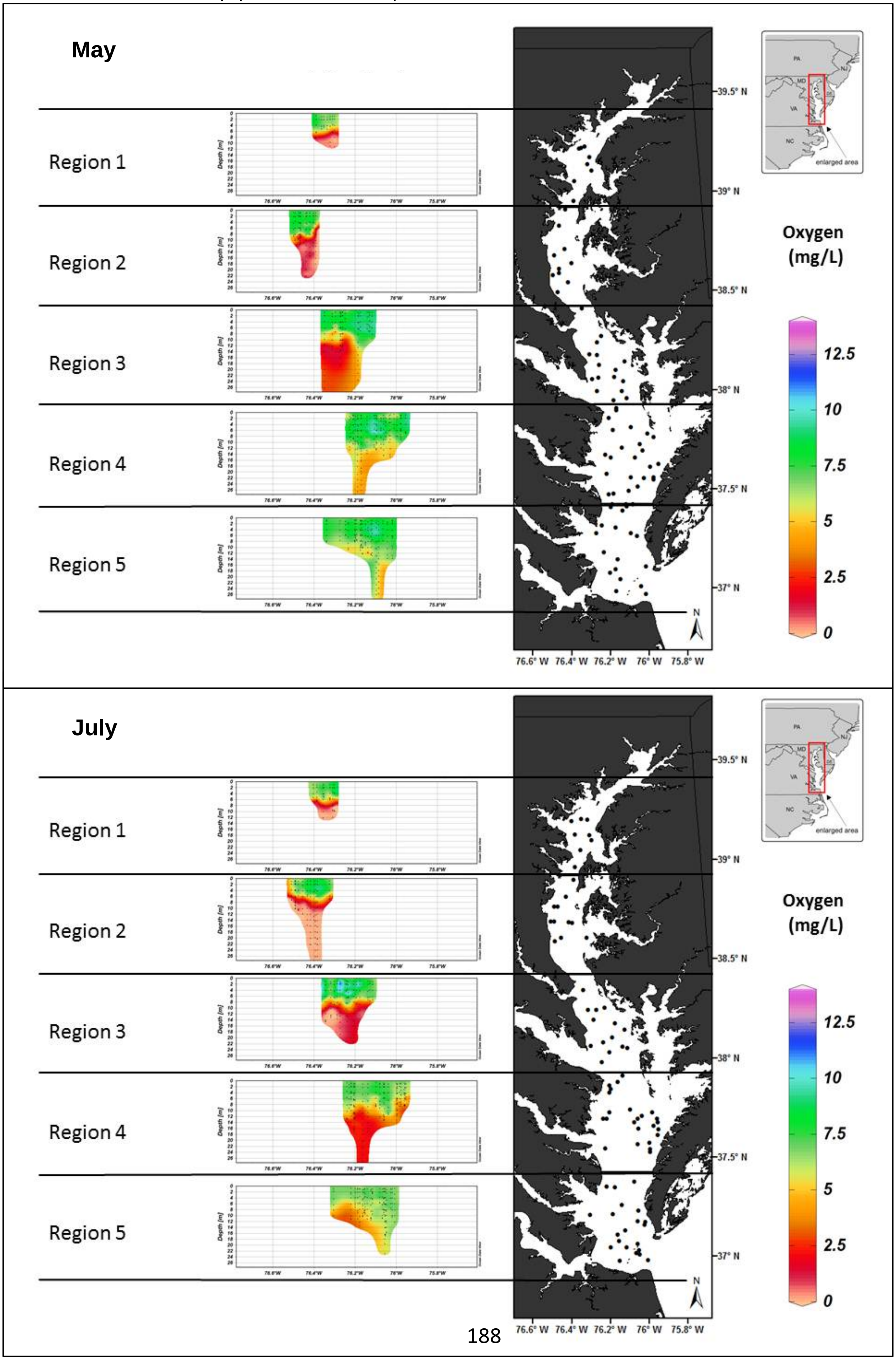
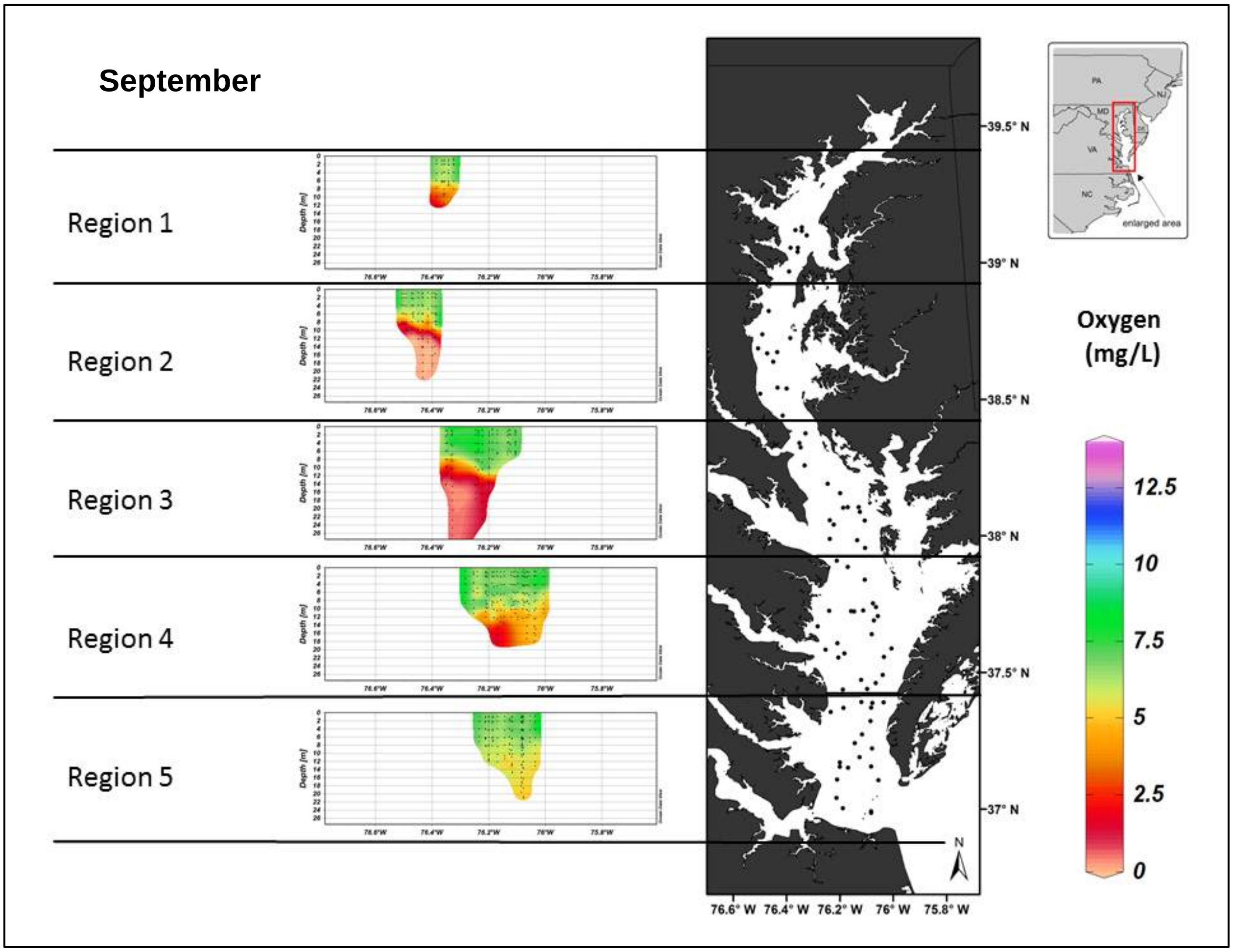


Figure 95. cont.



Appendix

Blue Crab and Clearnose Skate Abundance

Table A1. Male blue crab geometric mean indices of abundance, by number and biomass, overall .

Year	Age	n	Numerical Index			Biomass Index		
			LCI	**Index**	UCI	LCI	**Index**	UCI
2002	All	49	26.09	**59.5**	133.93	8.19	**15.3**	27.82
2003		31	10.61	**31.1**	87.50	4.00	**9.2**	19.73
2004		44	4.00	**11.2**	28.80	1.53	**3.6**	7.35
2005		37	17.22	**50.3**	143.22	5.63	**13.6**	31.30
2006		36	80.16	**164.6**	336.76	16.13	**29.8**	54.51
2007		18	2.47	**15.8**	80.67	1.27	**6.4**	22.81
2008		38	20.06	**45.4**	101.23	5.59	**11.6**	23.12
2009		38	10.10	**29.3**	81.44	4.44	**10.4**	22.78
2010		37	88.72	**200.0**	449.24	23.07	**42.7**	78.45
2011		36	35.60	**108.3**	325.57	10.16	**23.8**	54.19
2012		37	5.41	**17.1**	50.07	2.31	**5.8**	12.94
2013								
2014								
2015								
2016								

Figure A1. Male blue crab geometric mean indices of abundance, by number and biomass, for all ages combined and by age-class.

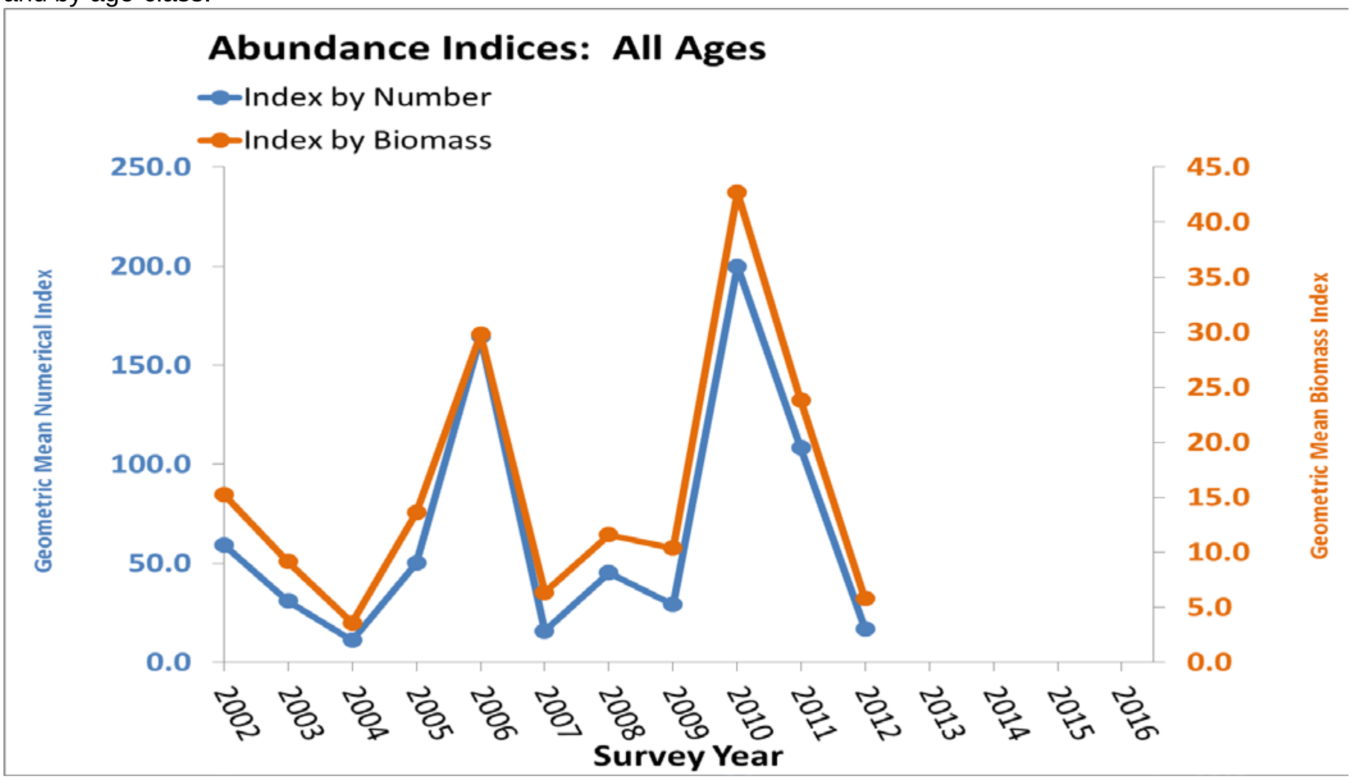


Figure A2. Abundance (kg per hectare swept) of male blue crabs in Chesapeake Bay, 2012.

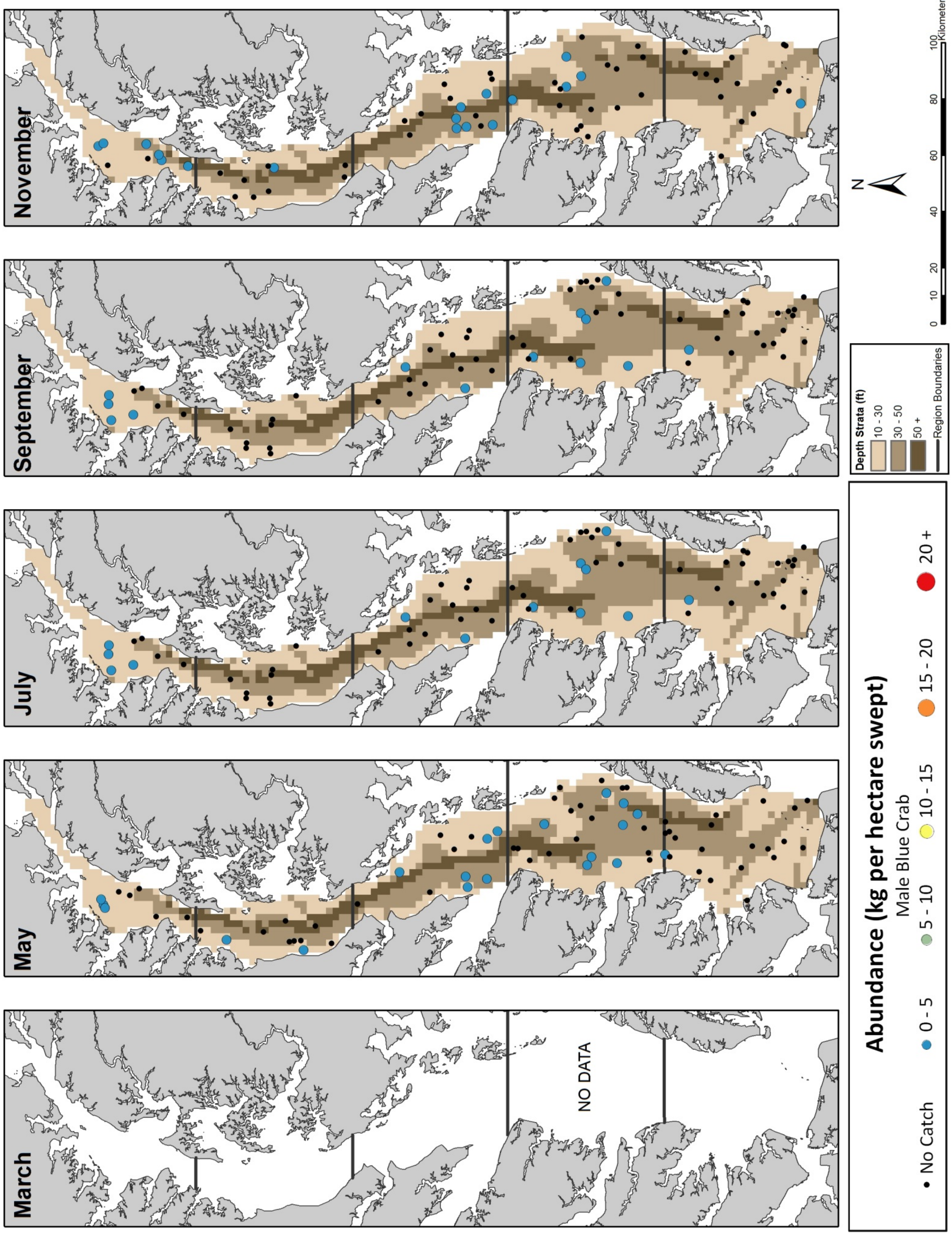


Table A2. Mature female blue crab geometric mean indices of abundance, by number and biomass, overall .

Year	Age	n	Numerical Index			Biomass Index		
			LCI	**Index**	UCI	LCI	**Index**	UCI
2002	All	20	51.56	161.3	499.96	13.27	33.5	82.42
2003		40	174.20	318.1	580.26	6.28	14.1	30.08
2004		28	69.11	161.3	374.71	14.26	25.7	45.76
2005		26	382.19	741.9	1,439.08	43.61	70.6	114.00
2006		26	353.51	522.2	771.01	45.42	68.0	101.64
2007		26	8.65	31.7	109.81	3.49	9.7	24.35
2008		26	741.85	1,216.9	1,995.79	101.09	170.7	287.65
2009		26	97.96	274.4	765.16	22.88	49.8	107.24
2010		26	335.62	770.9	1,769.18	56.10	115.8	237.80
2011		26	23.99	77.3	244.43	7.72	18.6	43.23
2012		23	24.22	94.6	361.62	6.86	20.1	55.62
2013								
2014								
2015								
2016								

Figure A3. Male blue crab geometric mean indices of abundance, by number and biomass, for all ages combined and by age-class.

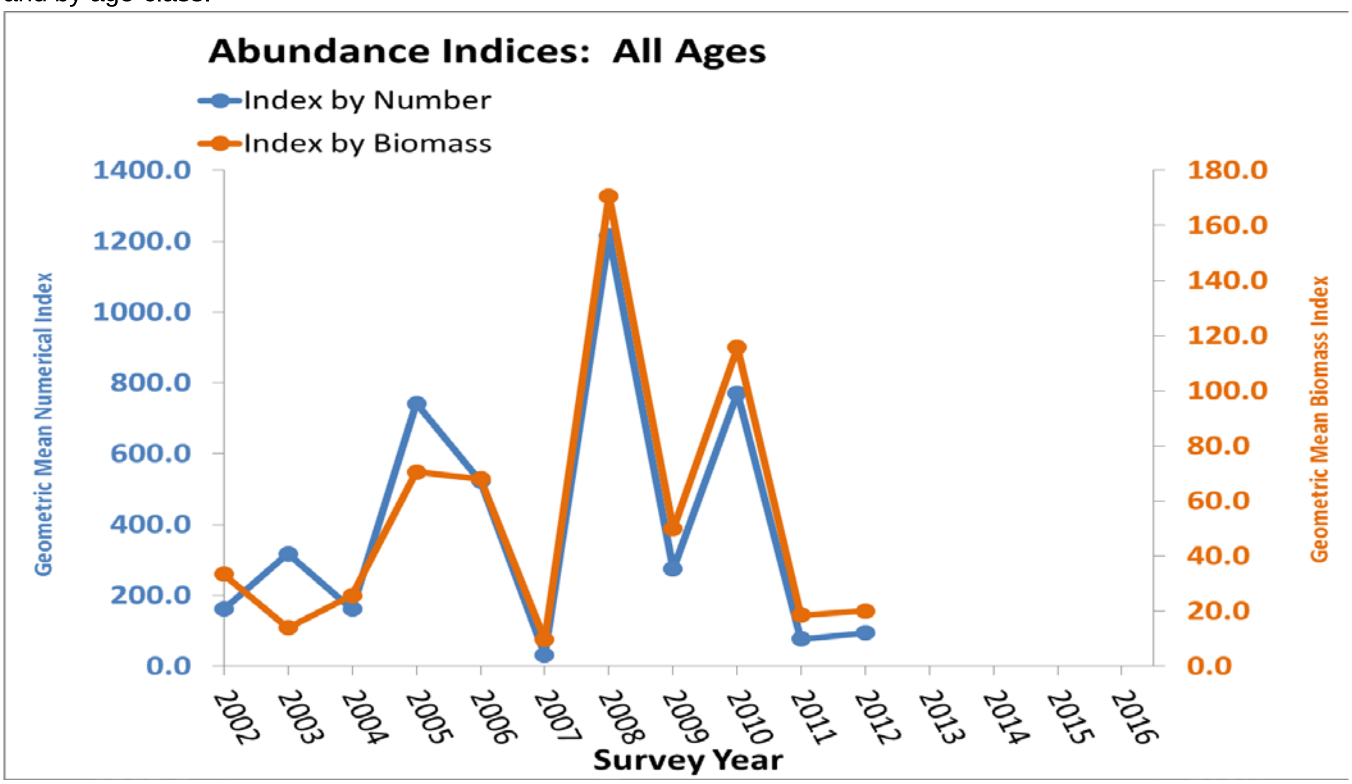


Figure A4. Abundance (kg per hectare swept) of adult female blue crabs in Chesapeake Bay, 2012.

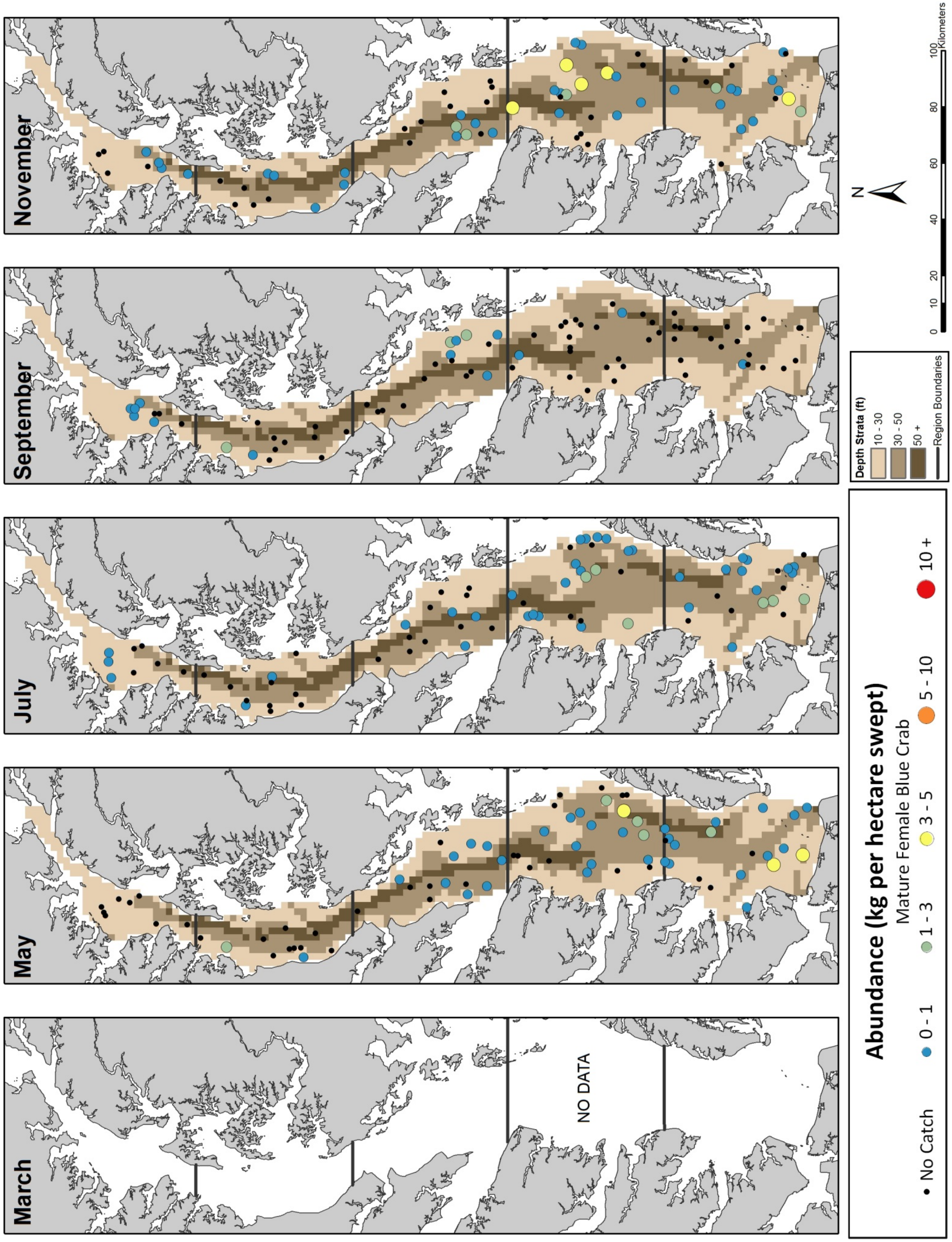


Table A3. Clearnose skate geometric mean indices of abundance, by number and biomass, overall .

Year	Age	n	Numerical Index			Biomass Index		
			LCI	**Index**	UCI	LCI	**Index**	UCI
2002	All	79	2.35	4.8	9.12	2.67	5.7	11.22
2003		75	2.37	4.6	8.14	2.43	4.9	9.08
2004		94	0.60	1.4	2.60	0.64	1.5	2.77
2005		82	1.83	3.9	7.31	1.97	4.3	8.31
2006		75	8.98	18.1	35.47	10.81	22.5	45.73
2007		62	4.18	10.2	23.16	4.96	12.5	29.70
2008		84	3.25	6.7	12.92	3.87	8.3	16.71
2009		63	4.45	10.3	22.51	5.49	13.4	31.02
2010		84	5.40	11.0	21.55	6.50	13.8	28.24
2011		83	6.70	13.6	26.62	8.24	17.4	35.66
2012		82	1.42	3.2	6.33	1.63	3.8	7.79
2013								
2014								
2015								
2016								

Figure A5. Clearnose skate geometric mean indices of abundance, by number and biomass, for all ages combined and by age-class.

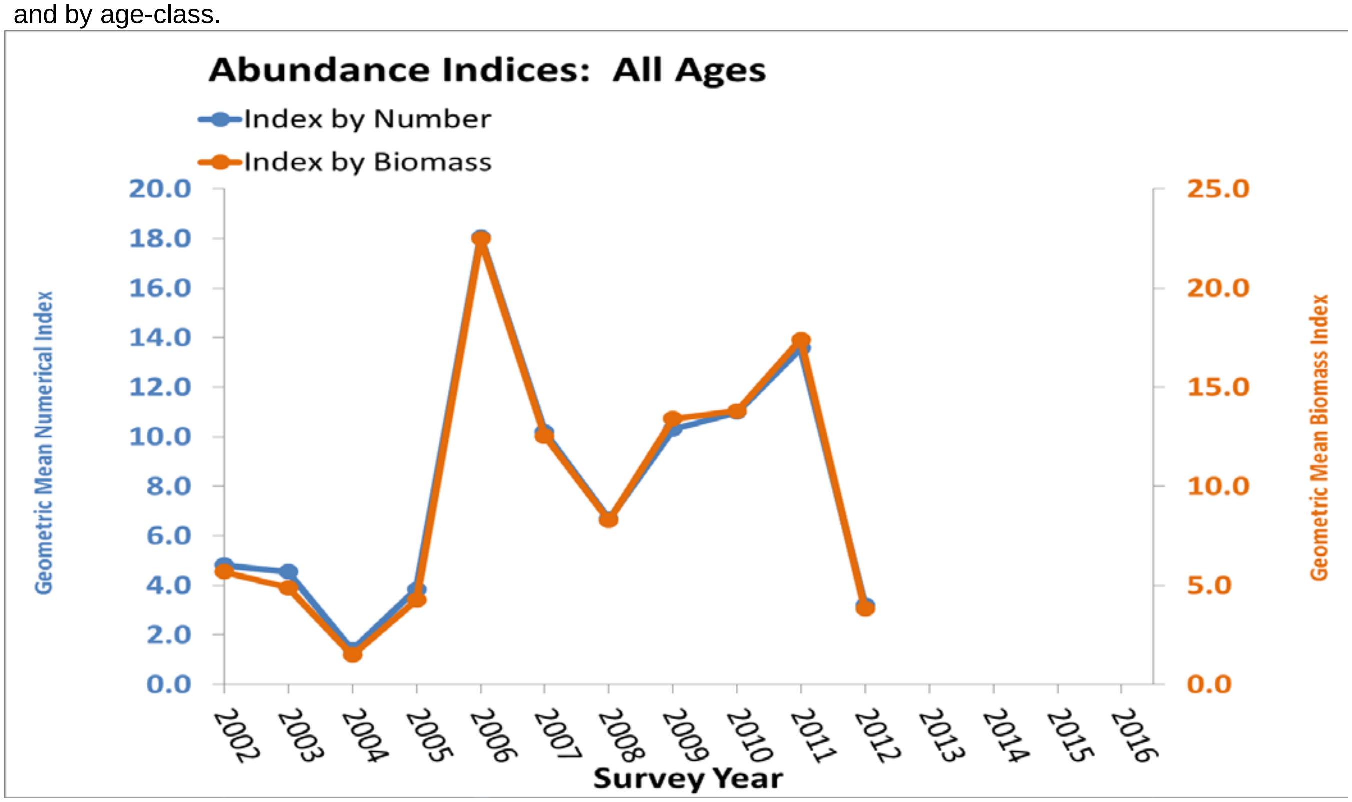


Figure A6. Abundance (kg per hectare swept) of clearnose skate in Chesapeake Bay, 2012.