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Annual Report - 2019 Data collection and analysis in support of single and multispecies stock assessments in Chesapeake Bay: The Chesapeake Bay Multispecies Monitoring and Assessment Program

Christopher F. Bonzek
Virginia Institute of Marine Science

James Gartland
Virginia Institute of Marine Science

Debra J. Gauthier
Virginia Institute of Marine Science

Robert J. Latour
Virginia Institute of Marine Science

ANNUAL REPORT

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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Prepared by:

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

School of Marine Science
College of William and Mary
Virginia Institute of Marine Science
Gloucester Point, VA 23062

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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.

In recent years, 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, Collie et al. 2014, Heymans et al. 2016). 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) development of planning processes for implementing ecosystem planning (C.B. Fisheries Ecosystem Advisory Panel, 2006) and most recently a Scientific and Technical Advisory Committee sponsored workshop title "Assessment the Chesapeake Bay Forage Base" at which ChesMMAP data were the principal source of data for numerous species (Ihde et al., 2015).

If either single-species or ecosystem-based management plans are to be developed and maintained, they must be based on sound stock assessments. In the Chesapeake Bay region, however, the data needed to perform single and multispecies assessments are typically 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. 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 2016 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). In late 2018 VIMS took delivery of the *Bay Eagle* replacement vessel, the *R/V Virginia* and beginning in June 2019 the new fishing system was implemented for ChesMMAP surveys.

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 in recent years:

- Introduction – Text, photos and drill-down links regarding the ChesMMAP program at https://www.vims.edu/research/departments/fisheries/programs/mrg_draft/chesmmap/index.php.
- Abundance Indices – All measures of relative abundance and most other analyses 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.
- An interactive Infogram report located at: https://infogram.com/2019-chesmmap-1h7j4dpzw13d4nr

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. Prior to 2019 the ChesMMAP sampling protocol was to conduct five 80-station surveys per year, one each in March, May, July, September and November, though this protocol was occasionally interrupted by funding shortfalls and/or logistical hurdles (e.g. vessel breakdowns). This sampling schedule changed in 2019 due to a combination of increased costs associated with the *R/V Virginia* and a decreasing budget. The result was that the equivalent of only 3 sampling cruises could be conducted. However, in considering the annual pattern of fish abundances and in examining the subsets of the data used for the various species' abundance indices, an alternative approach was implemented. In the early season (March) cruise none of the data from sampling in Virginia are used for any abundance indices. Likewise, in late season sampling (November), data for only one species in Maryland strata are used. Rather than settling for 3 full cruises we now sample in March, June, September and November, with the March and November trips sampling only in the upper (Maryland) and lower (Virginia) regions respectively. While not ideal, we can still sample during the entire spring/summer/fall annual cycle. In calendar year 2019, four (~80 station) research cruises were conducted. Initially the March 2019 cruise was not going to be run due to a funding shortfall during the previous project segment but funds made available for the April 2019 to March 2020 cycle allowed us to conduct an equivalent cruise in April 2019 on the *Bay Eagle*.

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 all cruises between March 2002 and April 2019. 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 cod-end 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.

Beginning with the June 2019 trip, sampling was and will be conducted onboard VIMS' new *R/V Virginia*, a 28.3m steel hull vessel with twin diesels tied to a single controllable-pitch propeller and a separate bow thruster for station-holding. The biota is sampled using a 200 x 12cm 3-bridle 4-seam trawl using Thyboron Type IV 44" steel doors attached to a double-warp system controlled by Rapp-Hydema's Pentagon© winch control software. The gear is a half-scale duplicate of the trawling system used both by the NEAMAP Mid-Atlantic survey and the North East Fisheries Science Center.

Between March 2002 and April 2019, the goal was to sample 80 sites throughout the mainstem of Chesapeake Bay during each cruise. 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 (note that due to the irregular state boundary it is possible that stations in the very southernmost portion of Region 3 may actually be in Virginia and likewise stations in the northernmost reaches of Region 4 may be north of the state border). 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.

Knowing that significant changes would be coming to the survey with the change in research vessel and sampling gear, we took the opportunity to also consider changes in the survey stratification. Analyses revealed that the prior design was over-stratified, with small numbers of samples coming from small strata but being over-represented in the design due to the criterion of sampling at least three stations from every stratum. Both the number of Regions and the number of depth strata were reduced. The prior three Regions corresponding to the Maryland portion of the bay were condensed to two and similarly the number of depth strata in each Region was reduced from three (described in the preceding paragraph) to two (<=12.2m, >12.2m). Thus the total number of strata sampled during any cruise was reduced from 14 (there was no deep stratum in Region 1) to 8. Regions are now described as Regions A (upper Maryland), B (lower Maryland, C (upper Virginia) and D (lower Virginia) and depth strata are similarly named A (shallow) and B (deep). While it may be somewhat confusing to use a similar labeling system for both the Region and the depths these conventions provide a clear distinction from the previous classifications.

For sampling aboard the *Bay Eagle,* 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 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. These same general parameters are held true for sampling on the *Virginia*.

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 modal length 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 1m intervals until the instrument reaches the bottom.

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 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.

<u>Task 4 – Estimate abundance</u>

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 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.

The methodology employed to develop the ALKs was modified during the current segment and new ALKs were used for the indices presented in this report. Previously ChesMMAP, ALK's represented data pooled over several years and were developed for each survey month (March, May, July, Sept., Nov.) using those pooled data. While providing a larger sample size this method resulted in a decreased ability to resolve year-to-year variability in age structure. The updated ALKs used for this report use year-specific data but in-year cruise data are pooled over two seasons labeled Spring and Summer. For most species March and May/June trips are pooled as the Spring season and those between July through November as Summer. For a few species data indicated that the July trip should be included with the Spring season. A further refinement was elimination of the loess smoothing in developing the updated ALKs. This step likely also contributed to a loss of resolution and the ability to detect year-to-year variation.

Once the ALKs were established for each season, all non-aged measured specimens were assigned to length bins, the total number of specimens captured within each length bin at each station was summed (full-workup specimens which had been aged remained in the assigned age class) and the season-specific age-at-length proportions applied to those sums. From this, the total number of age-specific fish captured at each station was determined. 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 within 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, model-based indices, and other methods of calculating relative abundance are being explored and will likely replace the geometric mean indices in future reports, on a species-by-species basis.

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 a previous segment report and were somewhat modified again in 2019 as a result of the restratification of the survey sampling frame.

2. 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 – 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 has 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 October 2018, after approximately six-years of development and construction, VIMS took delivery of the *R/V Virginia* as a replacement for the aging *R/V Bay Eagle.* Most survey groups faced with a change in sampling platform, perform extensive calibration studies prior to fully implementing the new gear. In contrast, MRG chose to immediately switch to the new vessel/gear while concurrently performing the calibrations. This will result in a short period (~2 years) in which the data from the two stanzas cannot be compared but we were confident that the new survey gear is so superior to the original one that such a delay is worth the cost. The *Virignia* was not yet Coast Guard certified in time for the April 2019 cruise but was put into service for full time ChesMMAP sampling beginning with the June 2019 trip.

Again, in contrast with many survey groups, MRG chose not to conduct calibration tows during regular survey operations. This choice was made to assure that no side-by-side vessel effects would bias the survey data.

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). For 2019 the decrease from five 80-station trips to two full trips (June and September) plus two half trips (April and November) decreased the total number of work days from approximately 40 to 28, which closely matched the budgeted request. It should be noted however that due to the slower cruising speed of the *Virginia* (~8kt) compared to the *Bay Eagle* (11-12kt) and to the much higher catch rates and therefore station processing times with the '200' net, the average number of stations completed per day decreased from 9-10 to 7-8.

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. Catch rates increased somewhat in 2013 but declined to a previously unseen low value in 2014 of only 11,000 fish.

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 abundant species, (e.g. Spot, Weakfish, Summer Flounder) 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. As anticipated, catch rates for most species increased substantially coinciding with use of the '200' net. For some species much of the increase is due to catching a broader size range, especially on the smaller end, but the increase is very large for almost every species. For those species in which either the average yearly catch between 2014 and 2018 or the 2019 total catch was greater than 100 specimens (31 species) the 2019 total catch was lower for four species and the average catch was approximately 26% lower. For the remaining 27 species the increase in total catch ranged between 4% and 24,000%. Of the species for which abundance indices are included in this report the difference in total catch ranged between -21% and 24,000% (Table 3). It should be noted that the April cruise was conducted using the *Bay Eagle* sampling system so these value likely represent an underestimate of the difference in catch rates.

The vast majority of ageing structures (i.e. otoliths, opercles, etc.) and stomach samples preserved have been analyzed (Table 4). Currently, most of the otolith and stomach samples which 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).

Table 2. Cruise dates and number of stations completed during ChesMMAP cruises 2002-2019.

Year	Cruise	Begin Date	End Date	Stations Completed	Calendar Days	Work Days	Year	Cruise	Begin Date	End Date	Stations Completed	Calendar Days	Work Days
2002	March	3/29/2002	4/16/2002	50	19	8	2011	March	3/22/2011	3/30/2011	80	9	7
	May	5/20/2002	5/28/2002	80	9	8		May	5/26/2011	6/1/2011	79	7	7
	July	7/8/2002	7/16/2002	77	9	8		July	7/7/2011	7/13/2011	79	7	7
	September	9/13/2002	9/22/2002	76	10	10		September	9/1/2011	9/8/2011	79	8	8
	November	10/28/2002	11/10/2002	74	14	9		November	11/2/2011	11/10/2011	78	9	8
2003	March	3/24/2003	4/4/2003	69	12	8	2012	March	No cruise due to vessel repowering.				
	May	5/20/2003	5/23/2003	29	4	4		May	5/26/2012	6/2/2012	80	8	8
	July	6/30/2003	7/10/2003	87	11	8		July	7/9/2012	7/16/2012	79	8	8
	September	9/30/2003	10/8/2003	73	9	8		September	9/3/2012	9/11/2012	80	9	8
	November	10/28/2003	11/5/2003	76	9	9		November	11/9/2012	11/17/2012	72	9	8
2004	March	3/20/2004	3/31/2004	90	12	8	2013	March	3/20/2013	3/28/2013	80	9	7
	May	5/17/2004	5/26/2004	90	10	10		May	6/4/2013	6/11/2013	80	8	7
	July	7/1/2004	7/10/2004	59	10	7		July	7/8/2013	7/15/2013	80	8	8
	September	9/2/2004	9/15/2004	80	14	8		September	9/3/2013	9/9/2013	80	7	7
	November	10/28/2004	11/10/2004	86	14	10		November	11/14/2013	11/22/2013	79	9	9
2005	March	3/16/2005	3/25/2005	80	10	8	2014	March	3/20/2014	3/27/2014	79	8	7
	May	5/2/2005	5/10/2005	80	9	8		May	5/29/2014	6/4/2014	80	7	7
	July	7/1/2005	7/12/2005	80	12	8		July	7/16/2014	7/25/2014	80	10	10
	September	9/8/2005	9/18/2005	76	11	8		September	9/3/2014	9/11/2014	80	9	8
	November	10/31/2005	11/9/2005	80	10	9		November	11/8/2014	11/16/2014	80	9	9
2006	March	3/23/2006	3/31/2006	80	9	8	2015	March	3/19/2015	3/30/2015	80	12	10
	May	5/15/2006	5/25/2006	80	11	8		May	5/28/2015	6/5/2015	80	9	8
	July	6/28/2006	7/13/2006	73	16	7		July	7/7/2015	7/12/2015	80	6	6
	September	8/30/2006	9/13/2006	70	15	8		September	8/29/2015	9/4/2015	80	7	7
	November	10/30/2006	11/7/2006	74	9	8		November	11/11/2015	11/18/2015	80	8	8
2007	March	3/13/2007	3/23/2007	77	11	8	2016	March	3/14/2016	3/20/2016	80	7	7
	May	5/9/2007	5/23/2007	77	15	9		May	5/25/2016	5/31/2016	80	7	7
	July	7/2/2007	7/10/2007	78	9	9		July	7/6/2016	7/11/2016	80	6	6
	September							September	8/29/2016	9/8/2016	80	11	7
	November	10/30/2007	11/12/2007	77	14	8		November	11/9/2016	11/19/2016	80	11	9
2008	March	3/17/2008	3/26/2008	80	10	8	2017	March	3/20/2017	3/28/2017	79	9	8
	May	5/20/2008	5/27/2008	78	8	8		May	5/15/2017	5/24/2017	80	10	8
	July	6/28/2008	7/7/2008	80	10	7		July	7/6/2017	7/12/2017	79	7	7
	September	9/2/2008	9/11/2008	80	10	7		September	9/6/2017	9/15/2017	80	10	8
	November	10/30/2008	11/11/2008	80	13	8		November	11/12/2017	11/29/2017	80	18	9
2009	March	3/16/2009	3/26/2009	80	11	7	2018	March					
	May			0	0	0		May	5/22/2018	5/28/2018	80	7	7
	July	7/14/2009	7/20/2009	80	7	7		July	7/2/2018	7/8/2018	80	7	7
	September	9/2/2009	9/12/2009	80	11	8		September	9/4/2018	9/10/2018	57	7	5
	November	11/3/2009	11/10/2009	78	8	7		November	11/7/2018	11/17/2018	80	11	7
2010	March	3/22/2010	3/31/2010	79	10	7	2019	April	4/2/2019	4/5/2019	35	4	4
	May	5/22/2010	5/28/2010	79	7	7		June	5/31/2019	6/8/2019	80	9	9
	July	7/6/2010	7/9/2010	45	4	4		September	9/3/2019	9/14/2019	79	12	10
	September	8/31/2010	9/11/2010	80	12	8		November	11/19/2019	11/23/2019	45	5	5
	November	11/2/2010	11/15/2010	79	14	8							

Table 3. Average yearly catch for 2014 through 2018 compared to total catch in 2019 for which either value exceeded 100 specimens. Species for which abundance indices are reported are highlighted.

Species	Average 2014 - 2018	Total 2019	Percent Difference
Atlantic Brief Squid	27.8	815	2,831.7
Atlantic Croaker	1,314.6	11,685	788.9
Atlantic Cutlassfish	10.8	2,634	24,288.9
Atlantic Menhaden	769.2	1,182	53.7
Atlantic Moonfish	84.8	510	501.4
Atlantic Spadefish	80.2	111	38.4
Atlantic Thread Herring	24.6	4,204	16,989.4
Bay Anchovy	752.6	57,661	7,561.6
Black Seabass	21.4	445	1,979.4
Blue Crab - ad. fem.	1,826.0	1,444	(20.9)
Blue Crab - juv. fem.	104.6	392	274.8
Blue Crab - male	303.0	322	6.3
Butterfish	328.6	828	152.0
Clearnose Skate	127.2	92	(27.7)
Harvestfish	784.4	1,865	137.8
Hogchoker	26.8	544	1,929.9
Inshore Lizardfish	5.6	391	6,882.1
Kingfish Sp.	289.0	3,871	1,239.4
Longfin Squid	4.2	183	4,257.1
Mantis Shrimp	192.2	263	36.8
Northern Puffer	267.0	143	(46.4)
Northern Searobin	692.8	724	4.5
Scup	305.4	1,126	268.7
Silver Perch	100.6	2,352	2,238.0
Spot	1,124.0	67,938	5,944.3
Spotted Hake	51.4	284	452.5
Striped Anchovy	32.2	2,870	8,813.0
Striped Bass	868.2	2,559	194.7
Striped Burrfish	108.4	99	(8.7)
Summer Flounder	101.8	623	512.0
Weakfish	907.8	18,987	1,991.5
White Perch	8,011.2	9,870	23.2
White Shrimp	19.8	2,489	12,470.7
Total	19,668.2	199,506	914.4

Table 4. Number of specimens collected, measured and processed for age determination and diet composition information from ChesMMAP, 2002 – 2019.

Year	Fish Collected	Fish Measured	Otoliths Collected	Otoliths Processed	Stomachs Collected	Stomachs Processed
2002	32,014	23,602	5,657	4,495	4,875	3,041
2003	30,914	20,819	4,246	3,058	3,767	2,423
2004	47,618	31,241	5,482	4,290	4,721	3,325
2005	45,201	36,906	6,358	5,006	5,359	3,429
2006	43,957	31,247	5,416	4,230	4,403	3,503
2007	30,893	22,127	4,282	3,276	3,671	2,868
2008	26,299	19,598	4,209	3,048	3,678	3,432
2009	22,050	15,697	3,227	2,263	2,729	2,643
2010	26,336	20,565	4,003	2,677	3,424	3,237
2011	21,185	16,397	3,429	2,017	2,742	2,525
2012	17,329	14,955	2,497	1,519	2,015	1,732
2013	21,369	14,623	2,739	1,646	1,939	1,375
2014	11,316	7,807	1,740	988	893	837
2015	22,981	13,011	2,502	1,439	1,137	1,126
2016	28,165	18,042	3,341	1,517	1,606	1,587
2017	21,246	16,516	3,169	1,625	1,887	1,863
2018	18,806	13,150	2,343	1,093	1,273	1,264
2019	200,637	78,995	5,094	3,078	2,738	2,709
Total	668,316	415,298	69,734	47,265	52,857	42,919

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. 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 5). Those limiting parameters have been updated for some species based on subsequent analyses conducted during 2010 and 2012 (but not presented here). For species for which age-specific indices can be calculated, those indices are shown in both graphical and tabular formats.

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 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.

Table 5. Selected months, regions, and depth strata data used for abundance indices for each species (modified in comparison to previous segment reports).

Atlantic Croaker

2002 - 2018

	March			May			July			Sept.			November		
Region	Shlw	Mid	Deep	Shlw	Mid	Deep	Shlw	Mid	Deep	Shlw	Mid	Deep	Shlw	Mid	Deep
MD-North															
MD-Mid															
MD-South															
VA-North															
VA-South															

2019 and forward

	March		June		Sept.		Nov.	
Region	Shlw	Deep	Shlw	Deep	Shlw	Deep	Shlw	Deep
MD-North								
MD-South								
VA-North								
VA-South								

Black Sea Bass

2002 - 2018

	March			May			July			Sept.			November		
Region	Shlw	Mid	Deep	Shlw	Mid	Deep	Shlw	Mid	Deep	Shlw	Mid	Deep	Shlw	Mid	Deep
MD-North															
MD-Mid															
MD-South															
VA-North															
VA-South															

2019 and forward

	March		June		Sept.		Nov.	
Region	Shlw	Deep	Shlw	Deep	Shlw	Deep	Shlw	Deep
MD-North								
MD-South								
VA-North								
VA-South								

Bluefish

2002 - 2018

	March			May			July			Sept.			November		
Region	Shlw	Mid	Deep	Shlw	Mid	Deep	Shlw	Mid	Deep	Shlw	Mid	Deep	Shlw	Mid	Deep
MD-North															
MD-Mid															
MD-South															
VA-North															
VA-South															

2019 and forward

	March		June		Sept.		Nov.	
Region	Shlw	Deep	Shlw	Deep	Shlw	Deep	Shlw	Deep
MD-North								
MD-South								
VA-North								
VA-South								

Butterfish

2002 - 2018

	March			May			July			Sept.			November		
Region	Shlw	Mid	Deep	Shlw	Mid	Deep	Shlw	Mid	Deep	Shlw	Mid	Deep	Shlw	Mid	Deep
MD-North															
MD-Mid															
MD-South															
VA-North															
VA-South															

2019 and forward

	March		June		Sept.		Nov.	
Region	Shlw	Deep	Shlw	Deep	Shlw	Deep	Shlw	Deep
MD-North								
MD-South								
VA-North								
VA-South								

Kingfish

2002 - 2018

	March			May			July			Sept.			November		
Region	Shlw	Mid	Deep	Shlw	Mid	Deep	Shlw	Mid	Deep	Shlw	Mid	Deep	Shlw	Mid	Deep
MD-North															
MD-Mid															
MD-South															
VA-North															
VA-South															

2019 and forward

	March		June		Sept.		Nov.	
Region	Shlw	Deep	Shlw	Deep	Shlw	Deep	Shlw	Deep
MD-North								
MD-South								
VA-North								
VA-South								

Northern Puffer

2002 - 2018

	March			May			July			Sept.			November		
Region	Shlw	Mid	Deep	Shlw	Mid	Deep	Shlw	Mid	Deep	Shlw	Mid	Deep	Shlw	Mid	Deep
MD-North															
MD-Mid															
MD-South															
VA-North															
VA-South															

2019 and forward

	March		June		Sept.		Nov.	
Region	Shlw	Deep	Shlw	Deep	Shlw	Deep	Shlw	Deep
MD-North								
MD-South								
VA-North								
VA-South								

Scup

2002 - 2018

	March			May			July			Sept.			November		
Region	Shlw	Mid	Deep	Shlw	Mid	Deep	Shlw	Mid	Deep	Shlw	Mid	Deep	Shlw	Mid	Deep
MD-North															
MD-Mid															
MD-South															
VA-North															
VA-South															

2019 and forward

	March		June		Sept.		Nov.	
Region	Shlw	Deep	Shlw	Deep	Shlw	Deep	Shlw	Deep
MD-North								
MD-South								
VA-North								
VA-South								

Table 5. cont.

Spot

2002 - 2018

	March			May			July			Sept.			November		
Region	Shlw	Mid	Deep	Shlw	Mid	Deep	Shlw	Mid	Deep	Shlw	Mid	Deep	Shlw	Mid	Deep
MD-North															
MD-Mid															
MD-South															
VA-North															
VA-South															

2019 and forward

	March		June		Sept.		Nov.	
Region	Shlw	Deep	Shlw	Deep	Shlw	Deep	Shlw	Deep
MD-North								
MD-South								
VA-North								
VA-South								

Striped Bass - March

2002 - 2018 — March Indices

	March			May			July			Sept.			November		
Region	Shlw	Mid	Deep	Shlw	Mid	Deep	Shlw	Mid	Deep	Shlw	Mid	Deep	Shlw	Mid	Deep
MD-North															
MD-Mid															
MD-South															
VA-North															
VA-South															

2019 and forward

	March		June		Sept.		Nov.	
Region	Shlw	Deep	Shlw	Deep	Shlw	Deep	Shlw	Deep
MD-North								
MD-South								
VA-North								
VA-South								

Striped Bass - November

2002 - 2018 — November Indices

	March			May			July			Sept.			November		
Region	Shlw	Mid	Deep	Shlw	Mid	Deep	Shlw	Mid	Deep	Shlw	Mid	Deep	Shlw	Mid	Deep
MD-North															
MD-Mid															
MD-South															
VA-North															
VA-South															

2019 and forward

	March		June		Sept.		Nov.	
Region	Shlw	Deep	Shlw	Deep	Shlw	Deep	Shlw	Deep
MD-North								
MD-South								
VA-North								
VA-South								

Summer Flounder

2002 - 2018

	March			May			July			Sept.			November		
Region	Shlw	Mid	Deep	Shlw	Mid	Deep	Shlw	Mid	Deep	Shlw	Mid	Deep	Shlw	Mid	Deep
MD-North															
MD-Mid															
MD-South															
VA-North															
VA-South															

2019 and forward

	March		June		Sept.		Nov.	
Region	Shlw	Deep	Shlw	Deep	Shlw	Deep	Shlw	Deep
MD-North								
MD-South								
VA-North								
VA-South								

Weakfish

2002 - 2018

	March			May			July			Sept.			November		
Region	Shlw	Mid	Deep	Shlw	Mid	Deep	Shlw	Mid	Deep	Shlw	Mid	Deep	Shlw	Mid	Deep
MD-North															
MD-Mid															
MD-South															
VA-North															
VA-South															

2019 and forward

	March		June		Sept.		Nov.	
Region	Shlw	Deep	Shlw	Deep	Shlw	Deep	Shlw	Deep
MD-North								
MD-South								
VA-North								
VA-South								

White Perch - March

2002 - 2018 — March Indices

	March			May			July			Sept.			November		
Region	Shlw	Mid	Deep	Shlw	Mid	Deep	Shlw	Mid	Deep	Shlw	Mid	Deep	Shlw	Mid	Deep
MD-North															
MD-Mid															
MD-South															
VA-North															
VA-South															

2019 and forward

	March		June		Sept.		Nov.	
Region	Shlw	Deep	Shlw	Deep	Shlw	Deep	Shlw	Deep
MD-North								
MD-South								
VA-North								
VA-South								

White Perch -Fall

2002 - 2018 — Fall Indices

	March			May			July			Sept.			November		
Region	Shlw	Mid	Deep	Shlw	Mid	Deep	Shlw	Mid	Deep	Shlw	Mid	Deep	Shlw	Mid	Deep
MD-North															
MD-Mid															
MD-South															
VA-North															
VA-South															

2019 and forward

	March		June		Sept.		Nov.	
Region	Shlw	Deep	Shlw	Deep	Shlw	Deep	Shlw	Deep
MD-North								
MD-South								
VA-North								
VA-South								

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 table which summarizes the numbers and biomass captured and measured during each survey year as well as the numbers of ageing structure and stomach samples preserved and processed.
2) A series of GIS figures showing total abundance at each sampling site overlaid on the survey depth strata, for each cruise during the year.
3) Figures and tables presenting overall and age-specific (for appropriate species) area-swept-corrected abundance indices by number and biomass, calculated using geometric means.
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) in both histogram and bubble plot format, as described above.
6) Diet analyses by weight and number, using all data collected and analyzed 2002-2018. 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 ' x - other' (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.

Species Data Summaries

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

Abundance: Atlantic Croaker is typically among the most abundant species in ChesMMAP survey catches, especially during the mid-year. During the years 2002 through 2007 at least 12,000 specimens totaling 2,600kg or more were captured. Between 2008 and 2012 no more than half that number were ever captured. In 2013 the number rose to about 9,000 specimens but the years 2014 through 2018 were the five lowest catch years in the 17-year time series with no more than 1,723 specimens in any year. In 2019 with the new sampling gear the total number and biomass captured rose by a factor of 10 to 11,685 fish weighing 920kg (Table 6).

The majority of fish are captured in regions 4 and 5 (Virginia). In years of higher abundance specimens are regularly captured in all survey regions and in June and September of 2019 Atlantic Croaker were captured at the northernmost Maryland stations. Catches decline in November as this summer resident species leaves bay waters (Figure 1).

Through 2018 relative abundance indices were calculated using data collected during May, July and September, in Regions 4 and 5 from only the mid-depth and deep strata. With the 2019 restratification samples used were from Regions C and D in June and September, and both depth strata (Table 5). As reflected in the trends of total catch, indices 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 very low abundances from 2008 through 2018 (Table 7, Figure 2). Anecdotal information as well as trends in commercial and recreational landings suggests that this period of low abundance in ChesMMAP samples is representative of a coast wide phenomenon and may be related to cyclical abundances that have been observed in the past, though this continued period of very low abundance is concerning. Age-specific abundances are shown for ages 0 through 7+ and largely follow the same pattern as described above. Nearly all of the increase in abundance in 2019 was in Age-0 fish. How much of this increase represents a true rise and how much is attributable to the increased efficiency of the sampling gear will be revealed when the full calibration data are available. Abundances along the coast as measured by the near shore North East Area Monitoring and Abundance (NEAMAP) survey showed a steep rise in the fall of 2012 following into the spring of 2013 and those fish may be represented by the moderate rise in the Age-0 ChesMMAP index in 2013. 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.

Length and Age: Specimens between 14mm and 499mm in total length (Figure 3) and between age 0 and 17 (Figure 4, Figure5) appear in survey data. In recent years both the length frequency distribution and the age structure appear to have become increasingly truncated towards smaller and younger fish; most individuals range between 150mm and 350mm and ages 1-5. In most years, no particular pattern of differences in sex-specific length frequencies were observed though in 2018 the samples were heavily weighted towards females.

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 and which was present in ChesMMAP samples until 2013, as 7-year olds. 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. A moderately abundant 2012 year-class was still present in 2018 in very low numbers. Though the original ChesMMAP sampling gear was not efficient at capturing age-0 Croaker, when substantial numbers are present it can be an indicator to expect larger numbers the following year as age-1s. In 2018 the second largest number of age-0 Croaker in the ChesMMAP time series were observed.

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. This phenomenon can cause a bit of confusion in interpreting year-and-age-specific indices of abundance and we hope to influence a change in the age-assignment protocol in the future.

Compared to other survey years, a relatively large number of age-negative 1 fish were captured in the fall of 2011. These may be the same cohort that was so abundant in the NEAMAP survey in the fall of 2012 and the spring of 2013 and we could observe this moderately successful 2012 year-class still moving through the stock through 2016 though it is now nearly absent in 2017.

Diet: Various identifiable and non-identifiable polychaetes as well as other worm species (42.1% by weight (W) and 33.3% by number (N)) represent the largest single prey type in the diet of Atlantic Croaker. Miscellaneous prey items (primarily unidentifiable material) are the second most important prey category both by weight and number (26.6%: 27.0% respectively). This unidentified material is likely made up largely of worms and soft-bodied molluscs. Several clam and mussel prey types contribute 15.0% and 12.1% of croaker diets by weight (third largest taxonomic category) and number (fourth highest category) respectively. Small bodied crustaceans (e.g. mysid shrimp) constitute the fourth major prey category by weight totaling 14.6% by weight and 26.5% by number (third highest). Fishes constitute very minor amounts (1.8% W, 1.1% N) of Croaker diets (Figure 7).

Atlantic Croaker Tables and Figures:

Table 6. Atlantic Croaker sampling rates and preserved specimen analysis status by year.

Figure 1. Station specific biomass of Atlantic Croaker in Chesapeake Bay, 2019.

Table 7. 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 length-frequency in Chesapeake Bay 2002-2019, overall (A) and by sex (B).

Figure 4. Atlantic Croaker age-frequency by year, 2002-2019.

Figure 5. Atlantic Croaker age-frequency by year, 2002-2019 standardized to 8,000 (4,800 for 2019) annual trawl minutes.

Figure 6. Diet composition, expressed as percent by weight (A) and percent by number (B) of Atlantic Croaker collected during ChesMMAP cruises in 2002-2018 combined.

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

Abundance: The ChesMMAP survey gear and sampling methodology are not considered particularly effective for a structure-oriented species such as Black Sea Bass. Indeed, 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.

Until 2019 the maximum number of specimens captured during a sample year was 50 in 2002 and the minimum of only two were seen between 2012 and 2015 when between 2 and 11 fish were sampled. The total number captured in 2016 was 42 which is tied with 2003 for the second most captures and 35 were captured in 2017 which is approximately the same number captured during the period 2007 -2009. In 2018 just 8 specimens were observed but with the new sampling gear deployed in 2019 total catch was roughly an order of magnitude greater than any other year at 445 (Table 8). Catches are typically highest during the summer and fall cruises and are concentrated in Regions 4 and 5 (C and D). It appears that the stations with the largest catches are concentrated along the edges of the various bay channels (Figure 7).

For purposes of calculating abundance indices, stations used include (Table 5):

- Through 2018: July, September, November - Regions 4 and 5 – All depth strata.
- 2019: June, September, November, Regions C and D – Both depth strata.
- Age-0 indices do not use data from the June/July cruises.

Overall relative abundance indices expressed either in numbers or biomass exhibit nearly identical inter-annual patterns, indicating that the sizes of captured specimens are 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. In 2013 only two Black Sea Bass were captured and the indices found new time-series lows for both number and biomass. Between 2013 there was a definite upward trend which greatly accelerated in 2016 with the numerical index reaching a time-series high value and the biomass index at the third highest value in the series. In 2017 the indices fell to approximately average values and in 2018 fell again to approximately the time series low. The extremely high values for 2019 are likely primarily due to the greater capture efficiency of the '200' net but this will have to be borne out during calibration studies (Table 9, Figure 8). 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.

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 9). 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 otoliths collected have been assigned ages. Age-frequencies reveal that in most years the survey catches are dominated by either age-0 or age-1 specimens (Figure 10, Figure 11).

Diet: Though the sample size is relatively small (299 specimens, 194 clusters) and the size range of samples is limited, the diet data is probably the most valuable ChesMMAP contribution for this species. Crustaceans (70.9% W, 77.8% N), dominated by mud crabs (16.5% W, 9.8% N), mysids (11.8% W, 27.4% N), and amphipods (7.7% W, 17.7% N) contribute the highest portions of the diet, among identifiable prey. Fishes constitute 8.9% of the diet by weight and 5.6% by number with Bay Anchovy (2.9% W) the largest component among identifiable species. A variety of worms (6.0% W, 4.4% N) molluscs (3.4% W, 1.5% N) and other less prominent or unidentifiable taxa comprise the remainder of the diet (Figure 12).

Black Sea Bass Tables and Figures:

Table 8. Black Sea Bass sampling rates and preserved specimen analysis status by year.

Figure 7. Station specific biomass Black Sea Bass in Chesapeake Bay, 2019

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

Figure 8. Black Sea Bass geometric mean indices of abundance, by number and biomass, for all ages combined and by age-class.

Figure 9. Black Sea Bass length-frequency in Chesapeake Bay 2002-2019, overall (A) and by sex (B).

Figure 10. Black Sea Bass age-frequency by year, 2002-2019.

Figure 11. Black Sea Bass age-frequency by year, 2002-2019 standardized to 8,000 (4,800 for 2019) annual trawl minutes.

Figure 12. Diet composition, expressed as percent by weight (A) and percent by number (B) of black seabass collected during ChesMMAP cruises in 2002-2018 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. No more than 126 (in 2010) and 125 (in 2015) Bluefish have so far been captured during a ChesMMAP sampling year. The maximum biomass captured was about 32kg in 2003 due to a few large specimens which were captured that year. In 2016 through 2018 moderate numbers of specimens (36, 40, 85 respectively) were sampled. In contrast to several other species, catch rates using the new trawl gear in 2019 were not any greater than in previous years. Except for a very small number of mishandled or mislabeled specimens all preserved stomachs and otoliths have been fully processed (Table 10).

When captured, typically between just one and four specimens occur in a tow (Figure 13) 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 (C and D) 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 are calculated using data from (Table 5):

- Through 2018: September and November cruises – Regions 3 and 4 (this is an update from previous reports) – all Depth strata.
- 2019: September and November cruises – Regions C and D – Depths A and B.

Abundance indices for all ages of Bluefish combined alternated between low and high values from 2002 to 2007, were consistently at time series lows between 2008 and 2011, exhibited a moderately rising pattern between 2012 and 2015, fell again in 2016 and rose slightly in both 2017 and 2018 and fell in 2019 though the 2019 data are not yet calibrated with previous years (Table 11, Figure 14). 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.

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 15). 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 16, Figure 17).

Diet: Diet data presented here are consistent with previous studies in showing that Bluefish are highly piscivorous (Figure 18). For the 382 specimens examined, which represent 227 clusters, Bay Anchovy constitute 52.2% of the diet by weight and 50.5% by number, while Spot (11.7% W, 7.4% N) are the other major identifiable fish prey. All fish species together represent 89.6% by weight and 82.3% by number. Crustaceans, mainly mysid shrimp at 5.5% W and 5.9% N, and sand shrimp (2.3% W, 7.5% N) represent most of the remainder.

Bluefish Tables and Figures:

Table 10. Bluefish sampling rates and preserved specimen analysis status by year.

Figure 13. Station specific biomass of Bluefish in Chesapeake Bay, 2019.

Table 13. Bluefish geometric mean indices of abundance, by number and biomass, overall and age-0.

Figure 14. Bluefish geometric mean indices of abundance, by number and biomass, for all ages combined and for ages 0 and 1.

Figure 15. Bluefish length-frequency in Chesapeake Bay 2002-2019, overall (A) and by sex (B).

Figure 16. Bluefish age-frequency by year, 2002-2019.

Figure 17. Bluefish age-frequency by year, 2002-2019 standardized to 8,000 (4,800 for 2019) annual trawl minutes.

Figure 18. Diet composition, expressed as percent by weight (A) and percent by number (B) of Bluefish collected during ChesMMAP cruises in 2002-2018 combined.

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

Abundance: Butterfish are moderately abundant in ChesMMAP survey tows with several hundred to over 1,000 specimens typically captured during any survey year (Table 12). Numerically, 2019 saw the fourth highest catch rate of the time series but sampling with the new trawl gear yielded roughly the same total numbers as in prior years. Butterfish abundance follows a generally predictable annual pattern, building from near-zero during March, increasing (albeit low) abundance through the spring and summer, and reaching a maximum generally during the September and November cruises (Figure 19).

Abundance indices are generated from survey tows during the peak months of September and November in Regions 4 and 5 (C and D). During 2017 the depth strata used to calculate abundance for this species were reexamined. Previously only the mid-depth strata were included but the reexamination indicated that all three depth strata should be used (Table 5). Abundance indices generally varied without trend between 2002 and 2009 then declined significantly in 2010 and have remained at lower levels in succeeding years, with modest upticks in 2016 and 2017 but reaching a time-series low value in 2018. At the request of assessment analysts at NEFSC indices for age-classes up to age-4+ (previously only up to age-2+) are now generated. Based on just a single year's data it appears that the new trawl gear may be more efficient at capturing age-0 specimens (Table 13, Figure 20).

Length and Age: Yearly length frequency diagrams (Figure 21) 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. This program (and others) has found Butterfish collected from estuarine areas extremely difficult to age. We are still investigating methods to obtain accurate age determinations from otolith samples. Pending the results of those efforts the otoliths collected during earlier survey years have not been processed (age-specific abundance indices were calculated using age-length keys derived from NEAMAP data).

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 were not an efficient use of resources and the decision was made to discontinue preservation and analysis of Butterfish stomachs.

Butterfish Tables and Figures:

Table 12. Butterfish sampling rates and preserved specimen analysis status by year.

Figure 19. Station specific biomass of Butterfish in Chesapeake Bay, 2019.

Table 13. Butterfish geometric mean indices of abundance, by number and biomass, overall and by age-class.

Figure 20. Butterfish geometric mean indices of abundance, by number and biomass, for all ages combined and by age-class.

Figure 21. Butterfish length-frequency in Chesapeake Bay 2002-2019, 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 (*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: Kingfish are moderately abundant in ChesMMAP tows with approximately 100-600 total specimens captured each year. In 2019, sampling with the '200' net total catch numbers increased approximately 10-fold to almost 3,900 specimens (Table 14). ChesMMAP catches for this species are almost exclusively in Regions 4 and 5 (C and D - lower bay), occur throughout the warm weather months and are often high into November (Figure 22).

Abundance indices are generated from these stations (Table 5):

- Through 2018: May, July, September, November - Regions 4 and 5 – All depth strata.
- 2019: June, September, November, Regions C and D – Both depth strata.
- Age-0 indices do not use data from the May/June/July cruises.

Until 2010 it appeared that Kingfish had been on a nearly consistent increasing abundance trend throughout the survey years. However, between 2011 and 2014 a nearly seven-fold decline was observed in the indices back to levels observed at the beginning of the time series. This was followed by a slight increase in 2015 and then a very large uptick again in 2016 to time series high values for both numbers and biomass. In 2017 overall abundance decreased significantly but was still among the five highest values in the time series and in 2018 there was a slight increase to the fourth highest value in the time series. The very large increase in total numbers captured in 2019 is reflected in the abundance indices though these data will be subjected to calibration factors when available. Age-specific ChesMMAP indices follow similar patterns with generally lower values through 2007, an increasing trend through 2010 or 2011, with a sharp decline in 2012, an uptick in 2013 and declines again 2014, with a significant rise in 2016 and nearly stable values in 2017. The increase in overall abundance in 2018 was due to a large increase in age-0 fish while abundance for other ages were on par with 2017 values. The pre-calibrated 2019 values were much higher for nearly all age-classes (Table 15, Figure 23).

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 24). 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 original ChesMMAP sampling gear until at least age-1 and perhaps even age-2 (Figure 25, Figure 26). As this species is not subjected to regular stock assessments the VIMS Multispecies Research Group assigns it to lower level of priority for specimen processing so there is currently a backlog of unprocessed otoliths dating to 2012. Once true ages have been assigned the patterns observed in age-specific abundance indices will change.

Diet: The largest taxa of prey items in Kingfish stomachs are crustaceans (40.8% W, 44.0% N), primarily small shrimps and crabs. Molluscs and worms constitute the next largest portions (25.9% W, 23.0%N and 15.5% W, 12.6 %N respectively) of the diet, with fishes and several other categories completing the diet (Figure 27).

Kingfish Tables and Figures:

Table 14. Kingfish sampling rates and preserved specimen analysis status by year.

Figure 22. Station specific biomass of Kingfish in Chesapeake Bay, 2019.

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

Figure 23. Kingfish geometric mean indices of abundance, by number and biomass, for all ages combined and by age-class.

Figure 24. Kingfish length-frequency in Chesapeake Bay 2002-2019, overall (A) and by sex (B).

Figure 25. Kingfish age-frequency by year, 2002-2019.

Figure 26. Kingfish age-frequency by year, 2002-2019 standardized to 8,000 (4,800 for 2019) annual trawl minutes

Figure 27. Diet composition, expressed as percent by weight (A) and percent by number (B) of Kingfish collected during ChesMMAP cruises in 2002-2018 combined.

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

Abundance: Abundance of Northern Puffer in ChesMMAP samples varies by an order of magnitude among years, with as many as 600 being captured in 2011 and as few as 41 in 2005 (Table 16). 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 (C and D), though the species is common into Region 3 (Figure 28). Catch rates with the new sampling gear in 2019 were comparable to those in previous years. As catches in the survey are patchy, estimates of abundance for this species are of unknown reliability.

Abundance indices are generated from these stations (Table 5):

- Through 2018: September, November - Regions 4 and 5 – All depth strata.
- 2019: September, November, Regions C and D – Both depth strata.

The peak year for the relative abundance indices from survey data have (both in numbers and biomass) was in 2007, though the total number of specimens captured that year was merely average. This lone high value likely was the result of restricted sampling that year which probably artificially inflated the index. Other years have varied without apparent trend though there was a modest increase in both 2015 and 2016, a decline in 2017 and a modest rise in 2018 (Table 17, Figure 29).

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. There may be evidence that the new trawl gear samples some number of smaller specimens than were previously observed (Figure 30). However, as this is not a high priority species and as standard ageing protocols have not been established, ageing of vertebrae has not been attempted. The largest individuals captured have generally been females but there appears to be no overall pattern of differential growth between sexes.

Diet: Molluscs (32.6% W, 27.2% N), miscellaneous taxa including unidentified material (32.0%W, 31.9%N) and crustaceans, primarily small crab species (27.8%W, 31.0%N) constitute approximately equal parts of the diets of Northern Puffer. Worms (7.2% W, 9.2% N) make up nearly all of the remainder with fish tissue contributing less than 1% by both weight and number (Figure 31).

Northern Puffer Tables and Figures:

Table 16. Northern Puffer sampling rates and preserved specimen analysis status by year.

Figure 28. Station specific biomass of Northern Puffer in Chesapeake Bay, 2019.

Table 17. Northern Puffer geometric mean indices of abundance, by number and biomass, overall.

Figure 29. Northern Puffer geometric mean indices of abundance, by number and biomass, for all ages combined.

Figure 30. Northern Puffer length-frequency in Chesapeake Bay 2002-2019, overall (A) and by sex (B).

Figure 31. Diet composition, expressed as percent by weight (A) and percent by number (B) of Northern Puffer collected during ChesMMAP cruises in 2002-2018 combined.

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

Abundance: Total yearly captures of Scup are highly variable, probably as a result both of actual coast wide abundance and availability to the survey gear (Table 18). For example, in 2015 a time series (pre-2019) peak of almost 1,000 scup were captured by ChesMMAP, due mainly to a small number of large catches during the September cruise but in 2016 the total number caught was only 65. In 2017 only 25 Scup were present, which was the second-lowest number in the time series but catches rebounded in 2018 with 386 total specimens captured, the fifth highest total number during the survey years. Use of the '200' net during 2019 yielded over 1,100 scup, the most of any survey year. 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 32). The species is most abundant in Regions 4 and 5 (C and D) 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').

For purposes of calculating abundance indices, stations used include (Table 5):

- Through 2018: July, September, November - Regions 4 and 5 – Shallow and mid-depth strata.
- 2019: June, September, November, Regions C and D – Both depth strata.

- Age-0 indices do not use data from the June/July cruises.

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. Following time-series low values between 2011 and 2014 there was a substantial increase in 2015 followed by another low value in 2016, a lower value still in 2017 but substantial increase in 2018. The apparent large increase in 2019 is likely to be largely due to the change in survey trawl gear but this analysis will have to wait for the completion of calibration studies (Table 19, Figure 33). As nearly all specimens captured by ChesMMAP are either age-0 or age-1, the age-2+ survey index should be interpreted with care.

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 34). 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 35, Figure 36). Both the length frequency and age distribution were similar in 2019 to those in previous years.

Diet: By weight, worm species constitute a majority (48.9%) of identifiable items in Scup stomachs but represent only 28.0% of prey by number (Figure 37). Unidentifiable prey (likely largely constituted of worms and other soft-bodied prey) also make up a large portion (17.1% W, 13.5% N). At 16.5% by weight, crustaceans (primarily mysids and amphipods) are also a major prey source, and at 35.1% represent the largest single taxon in Scup diets when measured by number.

Scup Tables and Figures:

Table 18. Scup sampling rates and preserved specimen analysis status by year.

Figure 32. Station specific biomass of Scup in Chesapeake Bay, 2019.

Table 19. Scup geometric mean indices of abundance, by number and biomass, overall and by age-class.

Figure 33. Scup geometric mean indices of abundance, by number and biomass, for all ages combined and by age-class.

Figure 34. Scup length-frequency in Chesapeake Bay 2002-2019, overall (A) and by sex (B).

Figure 35. Scup age-frequency by year, 2002-2019.

Figure 36. Scup age-frequency by year, 2002-2019 standardized to 8,000 (4,800 for 2019) annual trawl minutes.

Figure 37. Diet composition, expressed as percent by weight (A) and percent by number (B) of Scup collected during ChesMMAP cruises in 2002-2018 combined.

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

Abundance: Spot are typically among the most abundant species in the survey during all cruises except March. Prior to 2014 between 2,000 and 11,500 Spot (115kg-1000kg) were captured annually during the 12 survey years. However, in 2014 only 939 specimens were sampled and in 2015 this figure fell further to only 401 individuals. While the total number captured rose to over 1,000 in 2016 this was still the third lowest total during the time series, with moderate increases to 1,586 fish in 2017 and 1,635 in 2018. Deployment of the new sampling gear in 2019 resulted in at least a 10 fold increase in numbers sampled (Table 20). This species is well distributed throughout the bay, though concentrations are highest in regions 4 and 5 (Figure 38).

Overall abundances for the time series were on a generally rising trend between 2002 and 2006 and have followed a downward trajectory since. Indices have been very low in each year since 2011 (Table 28, Figure 39). This pattern does not follow the trend in coastal and regional landings (both commercial and recreational) which have been erratic but generally flat during the overlapping time series and this phenomenon deserves further attention. 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.

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 40). 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 41, Figure 42). 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. Much of the very large increase in catch of this species with the new trawling system appears to come in smaller, Age-0, specimens.

Diet: Not surprisingly, given the bottom-feeding habit of this species, the largest single prey type is ‘unidentified material’ (31.6% W, 26.4% N). In total ‘miscellaneous’ items (those which do not fit into one of the other major taxa) constitute 46.1% by weight and 45.6% by number of Spot diets. This is followed by worms (32.8% W, 25.7% N) which for the most part were not identifiable to specific taxa. Molluscs (primarily clams) at 11.8% by weight and 9.7% by number, and crustaceans (8.0% W, 17.7% N), principally mysids and amphipods, were also major portions of the diet for Spot (Figure 43).

Spot Tables and Figures:

Table 20. Spot sampling rates and preserved specimen analysis status by year.

Figure 38. Station specific biomass of Spot in Chesapeake Bay, 2019.

Table 21. Spot geometric mean indices of abundance, by number and biomass, overall and by age-class.

Figure 39. Spot geometric mean indices of abundance, by number and biomass, for all ages combined and by age-class.

Figure 40. Spot length-frequency in Chesapeake Bay 2002-2019, overall (A) and by sex (B).

Figure 41. Spot age-frequency by year, 2002-2019.

Figure 42. Spot age-frequency by year, 2002-2019 standardized to 8,000 (4,800 for 2019) annual trawl minutes.

Figure 43. Diet composition, expressed as percent by weight (A) and percent by number (B) of Spot collected during ChesMMAP cruises in 2002-2018 combined.

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

Abundance: Striped Bass are typically captured in relatively high numbers each survey year with as many as 2,200 (weighing almost 1,000kg) sampled in 2005 and 2,259 captured in 2019 with the new trawl gear (Table 22). 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 (A and B - 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 44).

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. Slightly different station sets are used for these two indices: in March all stations in Regions 1-3 (A and B) are included while in November all available stations (pre-2019: Regions 1 – 5 2019: Regions C and D) contribute to the index calculations (Table 5).

March abundance for all ages combined, as measured both by number and biomass, was highest in 2004, 2008, 2013 and 2016, otherwise varying within a fairly narrow range in most years. After three low index values in 2009-2011 (no March cruise was conducted in 2012 due to vessel unavailability) a significant rise was seen in 2013 due mainly to high values for age-3 and age-4 fish. 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 follows that in years of high overall abundance that all age classes would be present (Table 23, Figure 45). In 2018 no March cruise was conducted due to a funding shortfall. Note that the March/April 2019 cruise was conducted using the original sampling gear and the *R/V Bay Eagle*.

November abundance indices (summer residents) show high values in 2004 (more so in numbers than in biomass), 2006, 2014 and 2016. In 2011 through 2013 abundance turned upwards to mid-level values after a brief decline over the preceding two years then rose substantially in 2014, fell again in 2015 and rose again in 2016 and declined in both 2017 and 2018. Again, the same general pattern is seen in age-specific indices though variations do exist. The uptick in 2011-2014 appears to be due mainly to a larger number of age-2, age-3, and age-4+ specimens captured. The increases in 2016 indices appear to be

mainly due to larger numbers of smaller/younger specimens (Table 24, Figure 46). Going forward, the November Striped Bass will be affected by the change in the annual sampling schedule, as no samples will be collected in the Regions A and B (Maryland) in November. This species and White Perch are the only species for which such an effect will occur.
New abundance indices which include data from all months and all regions, using a newly developed methodology, have been submitted to the ASMFC Striped Bass Technical Committee and ChesMMAP indices were indeed included in the 2018 Benchmark Assessment.

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 47). However, age distribution figures (Figure 48, Figure 49) readily reveal year-class strength (high peaks during one year tend to follow into succeeding years, as do low abundances) which generally correspond to strong and weak year-classes as measured by the Maryland and Virginia young-of-year beach 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, age-20, were captured in 2008, 2010, and 2015 (1988, 1990 and 1995 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.

Diet: Results of diet analyses from this study differ appreciably from previous studies using specimens from Chesapeake Bay (Figure 50). Fish comprise the largest taxonomic group in the diet (54.9% W, 47.1% N), with crustaceans the next most abundant (20.8% W vs. 33.0% N) due to consumption of a large number of small bodied mysid shrimp and amphipods. Among fish species, this survey consistently finds that Bay Anchovy contributes the highest proportion by weight (26.3%) with Atlantic menhaden second (12.2%). Mysid shrimp (10.0% W, 16.7%N) and amphipods (4.7% W, 8.3% N) combined constitute large portions of the diet, a sharp contrast to previous studies; and worms make up the only other major prey type (14.5% W, 11.5% 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.

Striped Bass Tables and Figures:

Table 22. Striped Bass sampling rates and preserved specimen analysis status by year.

Figure 44. Station specific biomass of Striped Bass in Chesapeake Bay, 2019.

Table 30. Months, latitudinal regions, and depth strata used for Striped Bass index calculations.

Table 23. Striped Bass (March) geometric mean indices of abundance, by number and biomass, overall and by age-class.

Figure 45. Striped Bass (March) geometric mean indices of abundance, by number and biomass, for all ages combined and by age-class.

Table 24. Striped Bass (November) geometric mean indices of abundance, by number and biomass, overall and by age-class.

Figure 46. Striped Bass (November) geometric mean indices of abundance, by number and biomass, for all ages combined and by age-class.

Figure 47. Striped Bass length-frequency in Chesapeake Bay 2002-2018, overall (A) and by sex (B).

Figure 48. Striped Bass total age-frequency, 2002-2019.

Figure 49. Striped Bass age-frequency by year, 2002-2019 standardized to 8,000 (4,800 for 2019) annual trawl minutes.

Figure 50. Diet composition, expressed as percent by weight (A) and percent by number (B) of Striped Bass collected during ChesMMAP cruises in 2002-2018 combined.

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

<u>*Abundance:*</u> Though capture numbers (and biomass) have been lower in recent years, Summer Flounder are a primary target species for the survey with several hundred being sampled in most years (up to about 1,000 specimens weighing 450kg). While the number captured in 2019 using the updated sampling gear was significantly higher than it had been in recent years it was within the range captured in other survey years (Table 25). 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 51). Summer flounder are most abundant in Regions 4 and 5 (C and D) but are common in Regions 2 and 3 (~ Region B) 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 Virginia waters but this is not an absolute.

For purposes of calculating abundance indices, stations used include (Table 5):

- Through 2018: September, November - Regions 4 and 5 – All depth strata.
- 2019: September, November, Regions C and D – Both depth strata.

Abundance indices have varied considerably over the time but exhibit a consistent downward trend since 2006, reaching time series low values in 2012 through 2018 (Table 26, Figure 52). This is consistent with recent stock assessment updates. In 2019 the uncalibrated index rose substantially, though within the historical range.

Age-specific indices were calculated for ages 0 through 7+ (changed from 4+ previously in order to coincide with the current stock assessment strategy). 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.

Length and Age: Fish which measure between approximately 20cm and 50cm total length are most prevalent in survey samples though fish as large as 760mm have been captured (Figure 53). In several years a large number of fish under 30cm (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 54, Figure 55). This could be the result of differential migration patterns among different sized fish or of fishery preferences and/or regulations. As well as the declining abundance estimates described above, the Chesapeake portion of the Summer Flounder stock appear to have constricted somewhat in the age distribution in recent years. Since approximately 2007, as total captures have decreased the age composition of the Chesapeake Summer Flounder has also compressed.

Diet: As measured by percent weight, fish comprise a majority (53.8%) of summer flounder diets (Figure 56) in the survey, with the primary prey being Bay Anchovy (18.6%), Weakfish (9.0%), and Spot (7.8%) and with crustaceans (42.2%) only slightly lower; as measured by number, crustaceans constitute about four-fifths of the diet (60.6%) with the main prey types being mysid shrimp (45.0%), sand shrimp (6.7%), and mantis shrimp (4.8%). 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.

Summer Flounder Tables and Figures:

Figure 56. Diet composition, expressed as percent by weight (A) and percent by number (B) of Summer Flounder collected during ChesMMAP cruises in 2002-2018 combined.

Weakfish (Cynoscion regalis)

Abundance: Weakfish is among the most abundant species in survey samples and until 2010 most years resulted in 1,000 to 3,500 (75kg – 550kg) total captures. In recent years numbers have dropped and only 172 Weakfish were sampled in 2014 though this rose to 688 specimens in 2015 and again reached the 1,000 mark in 2016, declined to slightly less than 1,000 in 2017 and rose again to over 1,600 in 2018. In 2019 with the new sampling gear catches increased 5 to 10 times over previous levels to near 19,000 fish weighing over 1,300kg (Table 27). 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 57). Catches are typically higher in mid-depth (30' – 50') and deep (>50') stations than at shallow ones (10' – 30').

For purposes of calculating abundance indices, stations used include (Table 5):

- Through 2018: July, September, November - Regions 4 and 5 – All depth strata.
- 2019: June, September, November, Regions C and D – Both depth strata.

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 through 2015 with a slight-to-moderate uptick in 2016, another decrease in 2017 and nearly flat values in 2018. Indices for 2019 increased remarkably presumably due mainly to the change in trawl gear (Table 28, Figure 58). 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.

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. The length distribution in 2019 was similar to that in other survey years though at much higher numbers (Figure 59). 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 60, Figure 61). 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.

Diet: Fish (60.6%), primarily Bay Anchovy (38.0%), comprise a majority of prey types in the Weakfish diet as measured by biomass ingested (Figure 62). Notably, Weakfish account for 3.8% 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 (55.0%), dominated by mysid shrimp at 43.5%. Bay Anchovy are 25.0% of the diet by number. The relatively low percent of Atlantic menhaden seen in the survey stomach samples (2.1% W, <1.0% 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.

Weakfish Tables and Figures:

Table 27. Weakfish sampling rates and preserved specimen analysis status by year.

Figure 57. Station specific biomass of Weakfish in Chesapeake Bay, 2019.

Table 28. Weakfish geometric mean indices of abundance, by number and biomass, overall and by age-class.

Figure 58. Weakfish geometric mean indices of abundance, by number and biomass, for all ages combined and by age-class.

Figure 59. Weakfish length-frequency in Chesapeake Bay 2002-2019, overall (A) and by sex (B).

Figure 60. Weakfish total age-frequency, 2002-2019.

Figure 61. Weakfish age-frequency by year, 2002-2019 standardized to 8,000 (4,800 for 2019) annual trawl minutes.

Figure 62. Diet composition, expressed as percent by weight (A) and percent by number (B) of Weakfish collected during ChesMMAP cruises in 2002-2018 combined.

White Perch (Morone americana)

Abundance: White Perch are extremely abundant in survey samples throughout each year in Regions 1 and 2 (Region A and upper Region B) and are common into Region 3 (Region B and lower Region A - Table 29, Figure 63). 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. For both the March and November indices, data only from the shallow and mid-depth stations in Regions 1 and 2 are included. Interestingly, these two sets of indices show nearly opposing trends in abundance. The March indices (Table 30, Figure 64), 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, with a significant uptick in 2013 and downward points in 2014 and 2015 then up to record high values in 2016. Meanwhile, the November indices (Table 31, Figure 65) 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 and 2013 then upticks in 2014 and 2015 with slight declines in 2016. 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. Due to the planned cessation of November sampling in new Regions A and B the November White Perch indices will terminated or perhaps replaced in future reports.

Length and Age: All White Perch of sizes greater than approximately 150mm fork length are well sampled in the survey (Figure 66). 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-4 (Figure 67, Figure 68); however past that age the survey appears to adequately represent all age classes. Specimens as old as 19 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, 2011 year-classes).

Diet: Amphipods represents the largest single prey category by both weight and number (17.5% W, 26.9% N) in White Perch stomachs among identifiable prey, and crustaceans (31.2% W, 44.3% N) constitute the largest identifiable taxon, followed by a number of other small crustacean prey. Worms (26.3% W, 19.8% N), primarily *Nereis* clam worms (11.4% W, 8.3% N) and other polychaetes (13.0% W, 9.7% N), are the second most abundant prey, followed by a variety of mollusc species, (15.8% W, 13.6% N). Notably, a small number of Bay Anchovy (3.0% W, 2.2% N) are present in White Perch stomachs (Figure 69).

White Perch Tables and Figures:

Table 29. White Perch sampling rates and preserved specimen analysis status by year.

Figure 63. Station specific biomass of White Perch in Chesapeake Bay, 2019.

Table 30. White Perch geometric mean indices of abundance for March by number and biomass, overall and by age class.

Figure 64. White Perch geometric mean indices of abundance, by number and biomass, for all ages combined and by age-class for March.

Table 31. White Perch geometric mean indices of abundance for November by number and biomass, overall and by age class.

Figure 65. White Perch geometric mean indices of abundance, by number and biomass, for all ages combined and by age-class for November.

Figure 66. White Perch length-frequency in Chesapeake Bay 2002-2017, overall (A) and by sex (B).

Figure 67. White Perch total age-frequency, 2002-2019.

Figure 68. White Perch age-frequency by year, 2002-2019 standardized to 8,000 (4,800 for 2019) annual trawl minutes.

Figure 69. Diet composition, expressed as percent by weight (A) and percent by number (B) of White Perch collected during ChesMMAP cruises in 2002-2016 combined.

<u>Task 5 – Evaluation of alternative sampling gear</u>
As noted in several previous proposals and annual reports, ChesMMAP intends to implement a change to its sampling gear to a bottom trawl that is the same design and half of the size of that used by NEAMAP. This net is often called the '200' net which refers to the number of 12cm meshes around the mouth (200 x 12cm). This style of net achieves a greater headline height, more consistent geometry, and better bottom contact relative to typical survey trawls. The current ChesMMAP net typically fishes at about 8m of wingspread and 1m of headrope height. In flume tank tests and in field trials the '200' net has a similar wingspread but more than double the headrope height. In short, it is expected to provide a much better sample of the demersal and semi-pelagic biota.

After a six-year design and construction process, VIMS took delivery of its new research vessel (*R/V Virginia)* in October 2018. This vessel is specifically outfitted to deploy, fish and retrieve the '200' net and to allow efficient processing of the catch. The *R/V Bay Eagle* will remain in the VIMS fleet until at least 2021 which should allow adequate time for calibrations. Following delivery, MRG made several important decisions regarding sampling aboard the new vessel:

New Sampling

- The *R/V Virginia* is considerably larger than the *R/V Bay Eagle* (93'LOA v. 65'LOA) and more expensive to operate and it will require both a larger vessel crew and scientific crew, both of which increase daily costs. Further, we have been notified by VMRC that in coming years we should expect fewer available Wallop-Breaux funds. In combination, these two facts necessitate a decrease in the number of days-at-sea available for ChesMMAP. Initially MRG planned to decrease the number of annual trips from five bimonthly cruises (March, May, July, September, November) to three seasonal ones (Spring, Summer, Fall). However, further thought and analysis resulted in a choice to conduct two full bay-wide cruises (June and September) and two 'half-cruises' in March and November. While this strategy departs somewhat from our goal of synoptic sampling across the ecosystem, prior ChesMMAP data reveal that few fish stocks of interest are utilizing the lower (Virginia) bay in March or the upper (Maryland) bay in November. Just two sets of abundance indices (November Striped Bass and White Perch) will be impacted by this choice.
- Full trips will continue sampling at up to 80 sites per trip. The goal of the March and November trips will be 35 and 45 stations respectively.
- Rather than wait approximately 2 years to complete calibration studies and then commence official sampling with the new vessel/gear combination we chose to implement the new sampling platform as soon as it was fully available (June 2019). We are convinced that the new system is far superior to the previous one in many respects and it is worth a temporary break in availability of calibrated survey data to begin collecting better data immediately.
- We made a choice to *not* conduct side-by-side calibration tows during regular survey operations with the new vessel. Rather calibration tows will be conducted in between survey dates. This assures that survey data are not affected by the presence of another fishing vessel in the immediate vicinity.
- Once calibrations are complete, we will calibrate the older data series to the newer, rather than the converse.
- In the future we plan to implement, at a random subset of sites, to collect an increased amount of synoptic data. Along with the newer bottom trawling gear we will also deploy a mid-water trawl to sample pelagic species which are currently under-represented in our data. As a part of a graduate student/proof of concept project three years ago we established that fishing such a

net from the older vessel was possible and we gathered considerable data on how to properly design and fish such a trawl.

- At this same subset of stations, we plan to take bottom 'grabs' to sample the benthos as well as a plankton net with which we especially hope to sample mysid shrimp, which previous ChesMMAP food habits data have shown to be very important, but unmonitored, prey items for many other economically and ecologically valuable fish species. Over time, this synoptic data collection system will provide for development of much improved multi-species and ecosystem models of Chesapeake Bay. Both of these last two increases in sampling will be dependent on additional funding, either from VMRC or other sources.

Calibration:

While vessel availability due to scheduling or breakdowns of either the *Virginia* or the *Bay Eagle* and/or availability of MRG personnel due to other commitments somewhat constrained the availability of sampling days, four calibration trips were made in June, July, and December 2019 and March 2020. A total of 61 paired tows were completed. The first three of these trips were conducted in Virginia waters and the March 2020 trip was in Maryland. These trips were made soon after regularly scheduled ChesMMAP cruises were completed and concentrated effort in in 'index' strata for target (i.e. managed) species, in locations where high concentrations of these fishes had been found during survey operations.

Side-by-side tows were completed as simultaneously as possible with the two vessels within approximately one quarter mile of one another (Figure 70). All deployment, retrieval and catch processing procedures were identical to those employed during regular surveys except that all specimens were processed using the 'deck' protocol wherein each species/modal size group sample was weighed in whole and then individual fish were measured. No 'full workup' biological sampling occurred though in the December trip when large numbers of Striped Bass were encountered a small number of them were tagged as part of the Interstate Tagging Program.

A complete description of the calibration methodology will be reported upon completion of the calibration studies.

Preliminary Results:

For descriptive purposes only, a set of preliminary results are presented. For any given species the number of tows in which both vessels encountered that species is limited. Further, the analysis methodology shown here is for a 'first look' only and does not represent the methods which will be used to develop final calibration coefficients. So even though simple regression parameters are included these results they must not be used to adjust any data presented elsewhere in this report.

For each species two types of figures are shown:

- A linear regression of tow-specific *Virginia* catch on *Bay Eagle* catch, in numbers. When final calibration coefficients are calculated we intend for *Bay Eagle* data to be adjusted to *Virginia* data but for these preliminary analyses the *Virginia* data are shown as the independent variable. Raw catch numbers for each vessel are adjusted to a 'standard' area swept value for that vessel. For species for which visual examination of the data revealed obvious modal size cohorts, analyses were performed separately for each cohort.

Each plot contains several elements:

- Black dots represent tows in which both vessels encountered the species.
- Blue dots signify tows in which the *Virginia* captured the species but the *Bay Eagle* did not.
- Red dots are tows in which the species was seen in the *Bay Eagle* catch but not in the *Virginia* catch.
- The black line is the one-to-one line where points would appear if catch rates were equal.
- The green 'Non-Zero Reg' line is the linear regression including only those tows in the species was seen by both vessels. The regression parameters are shown in the inset box.
- Some figures include points which are circled in yellow. These points represent tows in which one vessel or the other encountered an extreme number of fish and these points may skew the regression line. In these cases, a second yellow regression line ('Edited Reg') and related parameters are shown.

- An overlaid comparison of length frequencies for each species, for all tows combined, with no editing or restricting of data points. Consistent with the color coding above, *Virginia* data are in blue and *Bay Eagle* data are in reddish hues.

As expected, for most species catches on the *R/V Virginia* using the new '200' net are substantially larger and the length frequencies are much broader than those using the original sampling system. Many of the additional fish are on the smaller end of the length scale.

Calibration Figures:

Figure 70. The *R/V Bay Eagle* and the *R/V Virginia* preparing to conduct a calibration tow (A) and the *R/V Virginia* travelling towards the next site upon completion of a tow (B).

Figure 71. Preliminary comparison of catch rates during calibration tows for Atlantic Croaker, 0 – 125mm.

Figure 72. Preliminary comparison of catch rates during calibration tows for Atlantic Croaker, 126 – 180mm.

Figure 73. Preliminary comparison of catch rates during calibration tows for Atlantic Croaker, 181+mm.

Figure 74. Comparison of length frequency distributions during calibration tows for Atlantic Croaker.

Figure 75. Preliminary comparison of catch rates during calibration tows for Black Sea Bass, all sizes.

Figure 76. Comparison of length frequency distributions during calibration tows for Black Sea Bass.

Figure 77. Preliminary comparison of catch rates during calibration tows for Butterfish, 0 – 95mm.

Figure 78. Preliminary comparison of catch rates during calibration tows for Butterfish, 96+mm.

Figure 79. Comparison of length frequency distributions during calibration tows for Butterfish.

Figure 80. Preliminary comparison of catch rates during calibration tows for Kingfish, 0 – 200mm.

Figure 81. Preliminary comparison of catch rates during calibration tows for Kingfish, 201+mm.

Figure 82. Comparison of length frequency distributions during calibration tows for Kingfish.

Figure 83. Preliminary comparison of catch rates during calibration tows for Scup, all sizes.

Figure 84. Comparison of length frequency distributions during calibration tows for Scup.

Figure 85. Preliminary comparison of catch rates during calibration tows for Spot, 0 – 140mm.

Figure 86. Preliminary comparison of catch rates during calibration tows for Spot, 141+mm.

Figure 87. Comparison of length frequency distributions during calibration tows for Spot.

Figure 88. Preliminary comparison of catch rates during calibration tows for Striped Bass, 0- 200mm.

Figure 89. Preliminary comparison of catch rates during calibration tows for Striped Bass, 201- 300mm.

Figure 90. Preliminary comparison of catch rates during calibration tows for Striped Bass, 301+mm.

Figure 91. Comparison of length frequency distributions during calibration tows for Scup.

Figure 92. Preliminary comparison of catch rates during calibration tows for Summer Flounder, all sizes.

Figure 93. Comparison of length frequency distributions during calibration tows for Summer Flounder.

Figure 94. Preliminary comparison of catch rates during calibration tows for Weakfish, all sizes.

Figure 95. Comparison of length frequency distributions during calibration tows for Weakfish.

Figure 96. Preliminary comparison of catch rates during calibration tows for White Perch, 0 – 190mm.

Figure 97. Preliminary comparison of catch rates during calibration tows for White Perch, 0 – 190mm.

Figure 98. Comparison of length frequency distributions during calibration tows for White Perch.

Water Quality

Bottom temperature (Figure 99), salinity (Figure 100), dissolved oxygen (Figure 101) readings, interpolated among sample locations for each trip, reveal varying physical conditions both within and among years. For each parameter three figures are presented; A) two-dimensional interpolation of 2019 readings, B) similar interpolation including data from all sample years, and C) the difference between the two. In April 2019 the upper portion of the bay was somewhat warmer, saltier and with slightly higher oxygen readings than in previous years. In June, bottom temperatures were still generally higher than average, salinities were generally near average, as was dissolved oxygen except in larger portions of Maryland waters where summer hypoxic readings were beginning to show. Similar conditions held in September except that the hypoxic zones were much smaller. Virginia recordings in November were close to average with no exceptional readings.

Using readings of the water profiles at each sampling station, three dimensional interpolations of the same parameters for each Region were also calculated (Figure 102, Figure 103, Figure 104). While these summarizations collapse three-dimensional data from fairly large portions of the bay into simpler two-dimensional figures, they do provide a measure of understanding of the complex and varying seasonal and geographical conditions in Chesapeake Bay.

Figure 99. Interpolated Chesapeake Bay bottom water temperature by cruise for 2019 (A), averaged over 2002 through 2019 (B), and 2019 deviation from average (C).

Figure 100. Interpolated Chesapeake Bay bottom salinity by cruise for 2019 (A), averaged over 2002 through 2019 (B), and 2019 deviation from average (C).

Figure 101. Interpolated Chesapeake Bay bottom dissolved oxygen by cruise for 2019 (A), averaged over 2002 through 2019 (B), and 2019 deviation from average (C).

Figure 102. Interpolated bi-monthly water temperature profiles in Chesapeake Bay, 2019.

Figure 103. Interpolated bi-monthly salinity profiles in Chesapeake Bay, 2019.

Figure 104. Interpolated bi-monthly dissolved oxygen profiles in Chesapeake Bay, 2019.

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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Table 6. Atlantic Croaker sampling rates and preserved specimen analysis status by year.

Year	Number Caught	Biomass Caught (kg)	Presence at Index Stations (%)	Number Measured	Age Specimens	Ages Read	Stomach Specimens	Stomachs Analyzed
2002	12,689	2,835.8	57.6	7,082	1,126	1,126	1,104	93
2003	12,217	2,850.9	68.2	5,721	548	548	542	62
2004	20,394	5,330.5	74.8	8,850	717	717	702	254
2005	13,281	3,184.8	74.8	7,757	716	716	704	261
2006	14,878	3,486.6	79.0	8,904	854	854	834	750
2007	12,678	1,963.6	68.5	5,974	526	526	523	506
2008	6,260	1,031.3	53.3	3,070	480	480	460	454
2009	3,797	523.0	72.2	3,250	369	369	361	358
2010	3,243	454.3	55.2	2,355	322	322	317	310
2011	5,187	605.5	57.8	2,776	322	322	291	287
2012	2,448	152.9	42.2	1,998	312	312	280	269
2013	8,971	655.1	45.9	3,684	282	282	237	231
2014	1,449	143.3	24.4	620	111	111	73	71
2015	1,723	167.4	36.3	1,402	160	160	110	107
2016	919	90.6	27.4	551	113	113	69	69
2017	1,318	92.9	31.1	1,037	247	247	190	188
2018	1,164	51.6	20.7	455	88	88	56	56
2019	11,685	919.7	84.4	5,792	354	354	233	230

Figure 1. Station specific biomass of Atlantic Croaker in Chesapeake Bay, 2019.

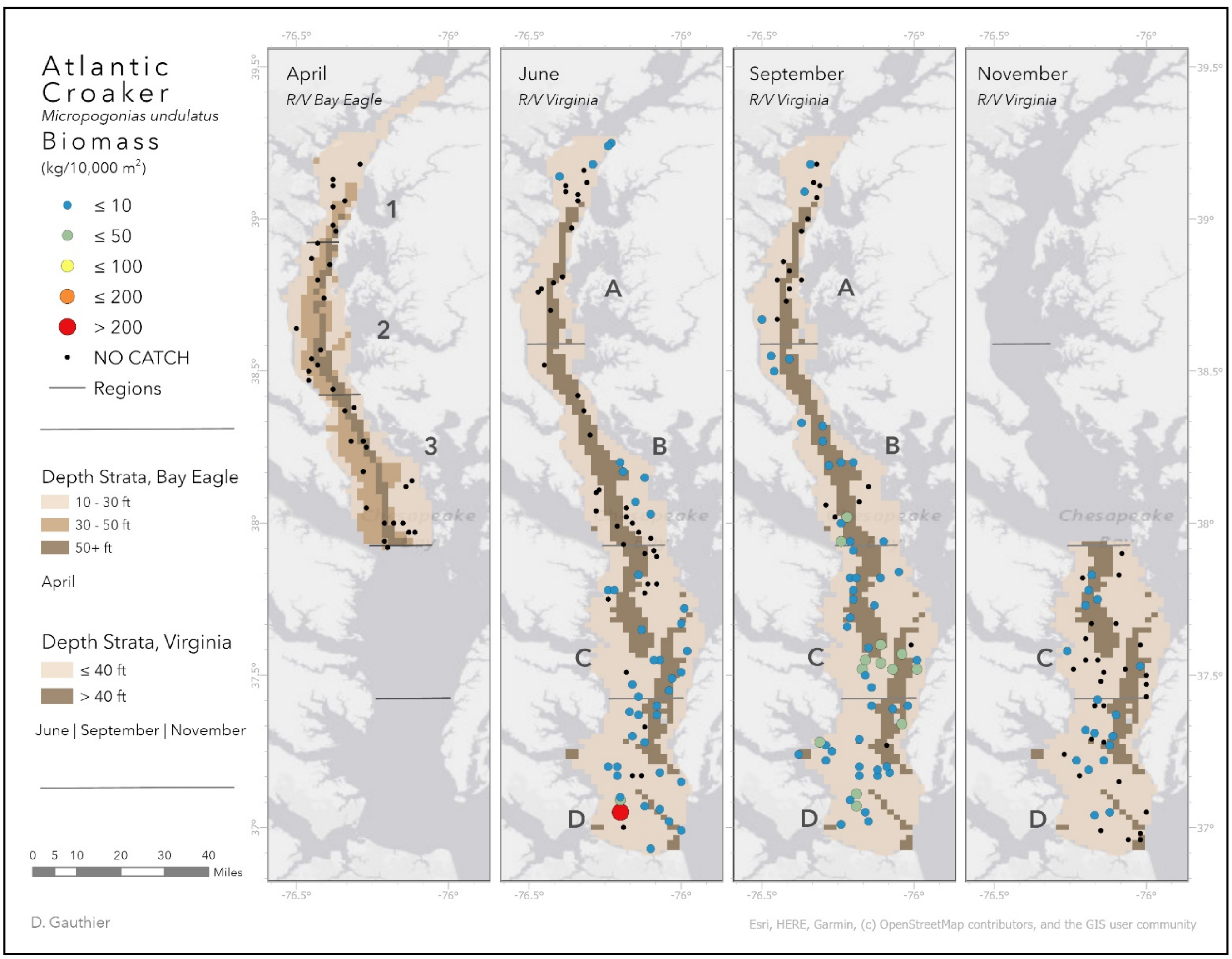


Table 7. Atlantic Croaker geometric mean indices of abundance, by number and biomass, overall and by age-class.

Year	Age	n	Numerical Index			Biomass Index		
			LCI	Index	UCI	LCI	Index	UCI
2002	All	70	7.9	14.3	25.1	2.8	4.7	7.4
2003		48	7.5	15.3	30.3	2.5	4.7	8.5
2004		77	33.8	53.9	85.7	10.3	15.9	24.1
2005		77	22.6	35.9	56.6	6.8	10.2	15.2
2006		74	20.5	33.0	52.8	5.8	8.8	13.2
2007		52	26.5	53.1	105.3	7.1	12.6	21.7
2008		76	3.9	6.6	10.8	0.9	1.5	2.2
2009		52	9.6	16.6	28.2	1.7	2.7	4.2
2010		78	3.3	5.4	8.5	0.7	1.1	1.7
2011		78	3.8	6.4	10.4	0.9	1.4	2.1
2012		78	1.9	3.4	5.7	0.3	0.6	0.9
2013		78	3.6	6.8	12.3	0.9	1.5	2.3
2014		78	0.6	1.3	2.2	0.1	0.4	0.6
2015		78	0.9	1.7	2.9	0.2	0.5	0.8
2016		78	0.6	1.2	2.1	0.1	0.3	0.5
2017		78	0.8	1.5	2.5	0.1	0.3	0.6
2018		78	0.3	0.5	0.8	0.0	0.1	0.2
2019		90	8.4	13.3	21.0	1.3	1.9	2.8
2020								
2002	0	70	1.5	2.8	4.9	0.4	0.8	1.3
2003		48	1.3	2.8	5.1	0.4	0.8	1.4
2004		77	1.4	2.4	3.8	0.4	0.7	1.1
2005		77	1.8	3.0	4.7	0.5	0.7	1.0
2006		74	1.6	2.7	4.3	0.4	0.7	1.0
2007		52	1.3	2.8	5.2	0.5	0.9	1.4
2008		76	1.6	2.7	4.4	0.3	0.5	0.7
2009		52	2.7	4.3	6.7	0.4	0.6	0.8
2010		78	0.6	1.0	1.5	0.1	0.2	0.3
2011		78	0.8	1.5	2.3	0.2	0.3	0.5
2012		78	1.3	2.4	4.0	0.2	0.4	0.6
2013		78	0.8	1.5	2.3	0.1	0.3	0.4
2014		78	0.1	0.3	0.5	0.0	0.1	0.1
2015		78	0.0	0.2	0.4	0.0	0.1	0.1
2016		78	0.4	0.9	1.6	0.1	0.2	0.4
2017		78	0.6	1.2	1.9	0.1	0.2	0.4
2018		78	0.1	0.3	0.5	0.0	0.1	0.1
2019		90	6.9	11.3	18.3	1.1	1.8	2.7
2020								
2002	1	70	1.5	2.4	3.6	0.5	0.7	1.0
2003		48	5.2	10.3	19.7	1.7	3.1	5.4
2004		77	2.2	3.6	5.6	0.7	1.2	1.8
2005		77	5.3	8.6	13.8	1.5	2.3	3.3
2006		74	4.8	7.4	11.1	1.2	1.7	2.3
2007		52	12.7	25.4	50.0	3.3	5.7	9.5
2008		76	1.2	2.0	3.1	0.3	0.5	0.7
2009		52	4.5	8.2	14.3	1.0	1.6	2.5
2010		78	1.6	2.7	4.2	0.3	0.5	0.8
2011		78	2.5	4.1	6.4	0.5	0.9	1.3
2012		78	0.5	1.0	1.6	0.1	0.2	0.3
2013		78	3.2	6.0	10.6	0.8	1.3	2.1
2014		78	0.4	0.8	1.3	0.1	0.2	0.4
2015		78	0.5	1.0	1.8	0.1	0.3	0.5
2016		78	0.2	0.5	1.0	0.0	0.1	0.3
2017		78	0.2	0.6	1.0	0.0	0.1	0.3
2018		78	0.2	0.4	0.6	0.0	0.1	0.1
2019		90	0.1	0.2	0.3	0.0	0.0	0.1
2020								
2002	2	70	1.2	2.0	3.1	0.5	0.8	1.2
2003		48	1.3	2.3	3.8	0.4	0.8	1.3
2004		77	11.8	20.2	34.3	4.3	6.9	10.8
2005		77	3.7	5.4	7.9	1.2	1.8	2.4
2006		74	5.5	8.7	13.5	1.7	2.6	3.7
2007		52	7.3	13.6	24.5	2.1	3.4	5.3
2008		76	0.9	1.6	2.6	0.3	0.6	0.9
2009		52	0.9	1.6	2.6	0.2	0.4	0.6
2010		78	1.2	2.0	3.2	0.3	0.6	0.8
2011		78	0.8	1.3	2.1	0.2	0.4	0.6
2012		78	0.3	0.6	1.0	0.1	0.2	0.3
2013		78	0.3	0.6	0.9	0.1	0.1	0.2
2014		78	0.4	0.9	1.4	0.1	0.2	0.4
2015		78	0.4	0.8	1.4	0.1	0.2	0.4
2016		78	0.2	0.6	1.0	0.0	0.2	0.3
2017		78	0.1	0.3	0.5	0.0	0.1	0.1
2018		78	0.2	0.3	0.5	0.0	0.1	0.1
2019		90	0.2	0.4	0.6	0.0	0.1	0.1
2020								
2002	3	70	2.0	3.4	5.7	0.9	1.5	2.3
2003		48	0.2	0.6	1.0	0.1	0.3	0.6
2004		77	2.3	3.6	5.5	1.0	1.5	2.1
2005		77	5.9	9.4	14.6	2.5	3.9	5.7
2006		74	2.4	3.7	5.6	0.9	1.4	1.9
2007		52	5.6	10.1	17.5	2.0	3.2	4.8
2008		76	0.4	0.8	1.4	0.1	0.3	0.5
2009		52	0.6	1.1	1.9	0.2	0.4	0.6
2010		78	0.5	0.8	1.3	0.1	0.2	0.3
2011		78	0.5	0.9	1.5	0.1	0.3	0.5
2012		78	0.1	0.3	0.4	0.0	0.1	0.1
2013		78	0.3	0.6	1.0	0.1	0.1	0.2
2014		78	0.1	0.2	0.3	0.0	0.0	0.1
2015		78	0.3	0.7	1.3	0.1	0.2	0.4
2016		78	0.1	0.5	0.8	0.0	0.1	0.3
2017		78	0.1	0.3	0.5	0.0	0.1	0.1
2018		78	0.1	0.3	0.4	0.0	0.0	0.1
2019		90	0.1	0.2	0.3	0.0	0.0	0.1
2020								

Year	Age	n	Numerical Index			Biomass Index		
			LCI	Index	UCI	LCI	Index	UCI
2002	4	70	2.0	3.5	5.8	0.9	1.5	2.4
2003		48	0.5	1.2	2.2	0.3	0.7	1.2
2004		77	1.7	2.6	3.8	0.8	1.2	1.7
2005		77	1.6	2.4	3.5	0.7	1.1	1.5
2006		74	2.4	4.0	6.3	1.2	2.0	2.9
2007		52	2.0	3.2	4.9	0.8	1.2	1.7
2008		76	0.3	0.5	0.8	0.1	0.2	0.3
2009		52	0.3	0.7	1.1	0.1	0.2	0.4
2010		78	0.2	0.3	0.5	0.0	0.1	0.2
2011		78	0.3	0.5	0.8	0.1	0.1	0.2
2012		78	0.1	0.2	0.4	0.0	0.1	0.1
2013		78	0.1	0.2	0.3	0.0	0.0	0.1
2014		78	0.0	0.1	0.2	0.0	0.0	0.1
2015		78	0.0	0.2	0.4	0.0	0.1	0.1
2016		78	0.1	0.4	0.7	0.0	0.1	0.3
2017		78	0.1	0.2	0.4	0.0	0.0	0.1
2018		78	0.1	0.3	0.4	0.0	0.0	0.1
2019		90	0.0	0.1	0.2	0.0	0.0	0.0
2020								
2002	5	70	1.0	1.7	2.8	0.5	0.8	1.2
2003		48	0.5	1.2	2.2	0.3	0.7	1.3
2004		77	3.5	5.4	8.1	1.6	2.5	3.6
2005		77	0.5	0.8	1.2	0.3	0.4	0.6
2006		74	0.7	1.2	1.8	0.4	0.6	0.9
2007		52	1.2	2.0	3.1	0.5	0.9	1.4
2008		76	0.1	0.3	0.6	0.0	0.1	0.2
2009		52	0.1	0.2	0.4	0.0	0.1	0.1
2010		78	0.1	0.2	0.3	0.0	0.0	0.1
2011		78	0.0	0.1	0.3	0.0	0.0	0.1
2012		78	0.0	0.1	0.3	0.0	0.0	0.1
2013		78	0.0	0.1	0.2	0.0	0.0	0.1
2014		78	0.1	0.2	0.3	0.0	0.0	0.1
2015		78	0.0	0.2	0.4	0.0	0.1	0.1
2016		78	0.1	0.3	0.7	0.0	0.1	0.2
2017		78	0.1	0.2	0.4	0.0	0.0	0.1
2018		78	0.1	0.3	0.5	0.0	0.1	0.1
2019		90	0.0	0.1	0.2	0.0	0.0	0.0
2020								
2002	6	70	0.3	0.5	0.8	0.1	0.2	0.3
2003		48	0.3	0.6	1.2	0.2	0.4	0.7
2004		77	2.8	4.4	6.6	1.4	2.2	3.2
2005		77	1.5	2.3	3.2	0.7	1.1	1.6
2006		74	0.5	0.8	1.2	0.3	0.4	0.7
2007		52	0.4	0.7	1.1	0.2	0.3	0.5
2008		76	0.1	0.3	0.4	0.0	0.1	0.2
2009		52	0.1	0.2	0.3	0.0	0.1	0.1
2010		78	0.0	0.1	0.2	0.0	0.0	0.0
2011		78	0.0	0.1	0.3	0.0	0.1	0.1
2012		78	0.0	0.1	0.3	0.0	0.0	0.1
2013		78	0.0	0.1	0.2	0.0	0.0	0.0
2014		78	0.1	0.2	0.3	0.0	0.0	0.1
2015		78	0.0	0.2	0.4	0.0	0.1	0.1
2016		78	0.1	0.3	0.7	0.0	0.1	0.2
2017		78	0.1	0.2	0.4	0.0	0.0	0.1
2018		78	0.1	0.3	0.4	0.0	0.0	0.1
2019		90	0.0	0.1	0.2	0.0	0.0	0.0
2020								
2002	7+	70	0.3	0.5	0.8	0.1	0.3	0.4
2003		48	0.2	0.4	0.7	0.1	0.3	0.5
2004		77	1.5	2.5	3.7	0.9	1.4	2.1
2005		77	2.3	3.5	5.1	1.1	1.6	2.3
2006		74	1.3	2.2	3.5	0.7	1.2	1.9
2007		52	0.6	1.1	1.7	0.3	0.5	0.8
2008		76	0.1	0.2	0.4	0.0	0.1	0.2
2009		52	0.0	0.0	0.1	0.0	0.0	0.0
2010		78	0.0	0.1	0.1	0.0	0.0	0.0
2011		78	0.0	0.1	0.2	0.0	0.0	0.1
2012		78	0.0	0.1	0.3	0.0	0.0	0.1
2013		78	0.0	0.1	0.2	0.0	0.0	0.0
2014		78	0.0	0.1	0.2	0.0	0.0	0.1
2015		78	0.0	0.2	0.4	0.0	0.1	0.1
2016		78	0.1	0.3	0.7	0.0	0.1	0.2
2017		78	0.1	0.2	0.4	0.0	0.0	0.1
2018		78	0.1	0.3	0.4	0.0	0.0	0.1
2019		90	0.0	0.1	0.2	0.0	0.0	0.0
2020								

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

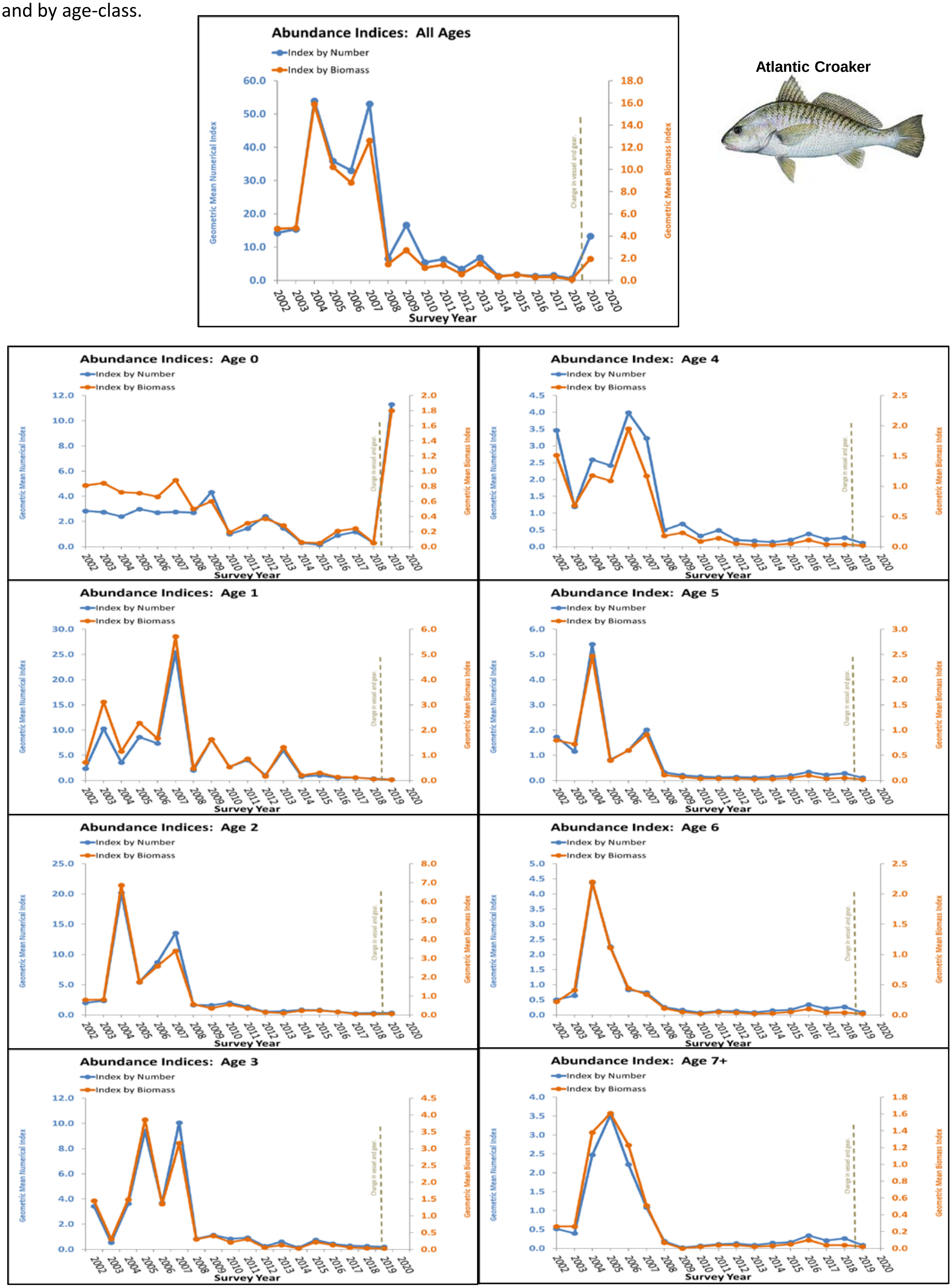


Figure 3. Atlantic Croaker length-frequency in Chesapeake Bay 2002-2019, overall (A) and by sex (B).

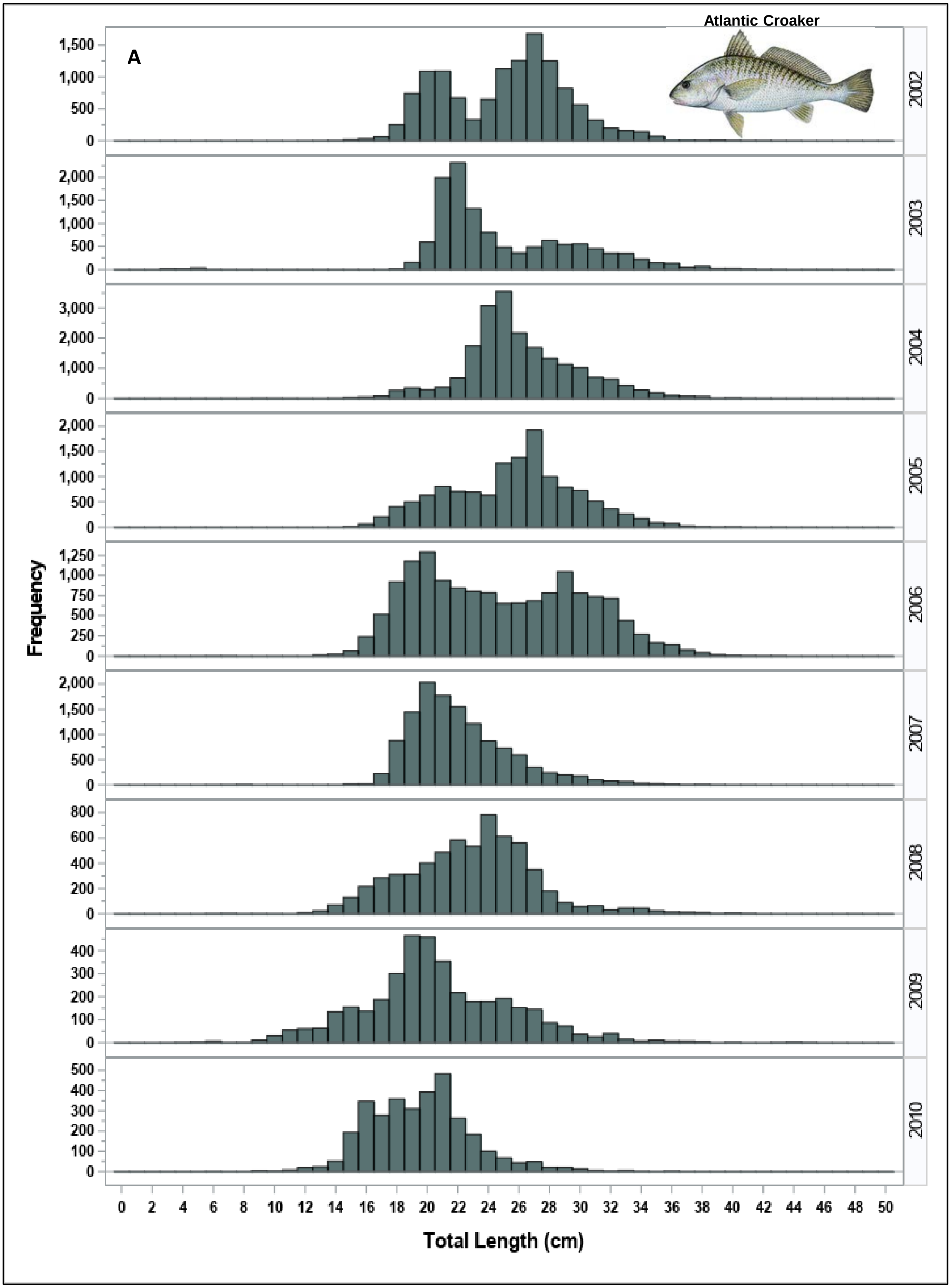


Figure 3. continued.

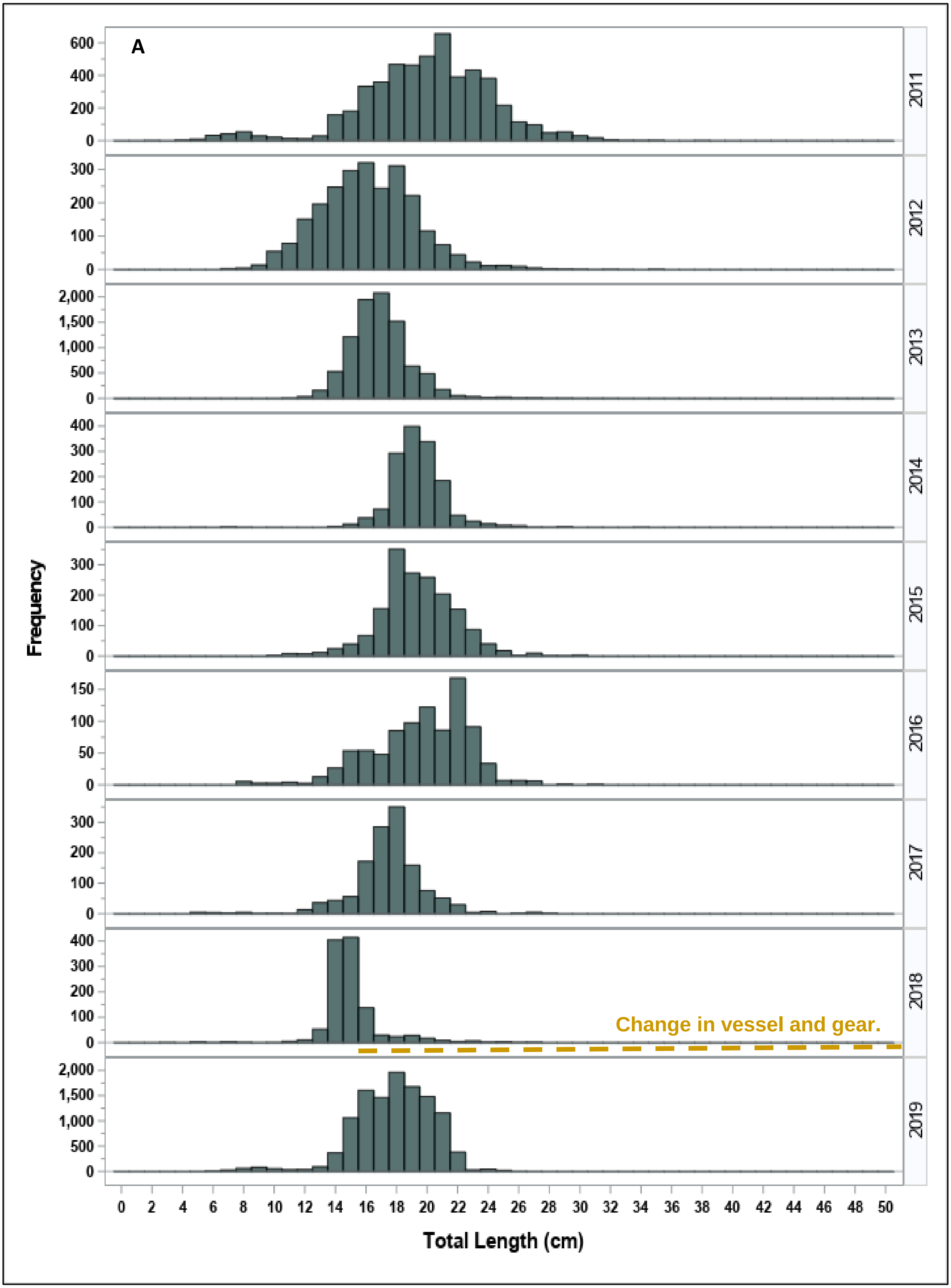


Figure 3. continued.

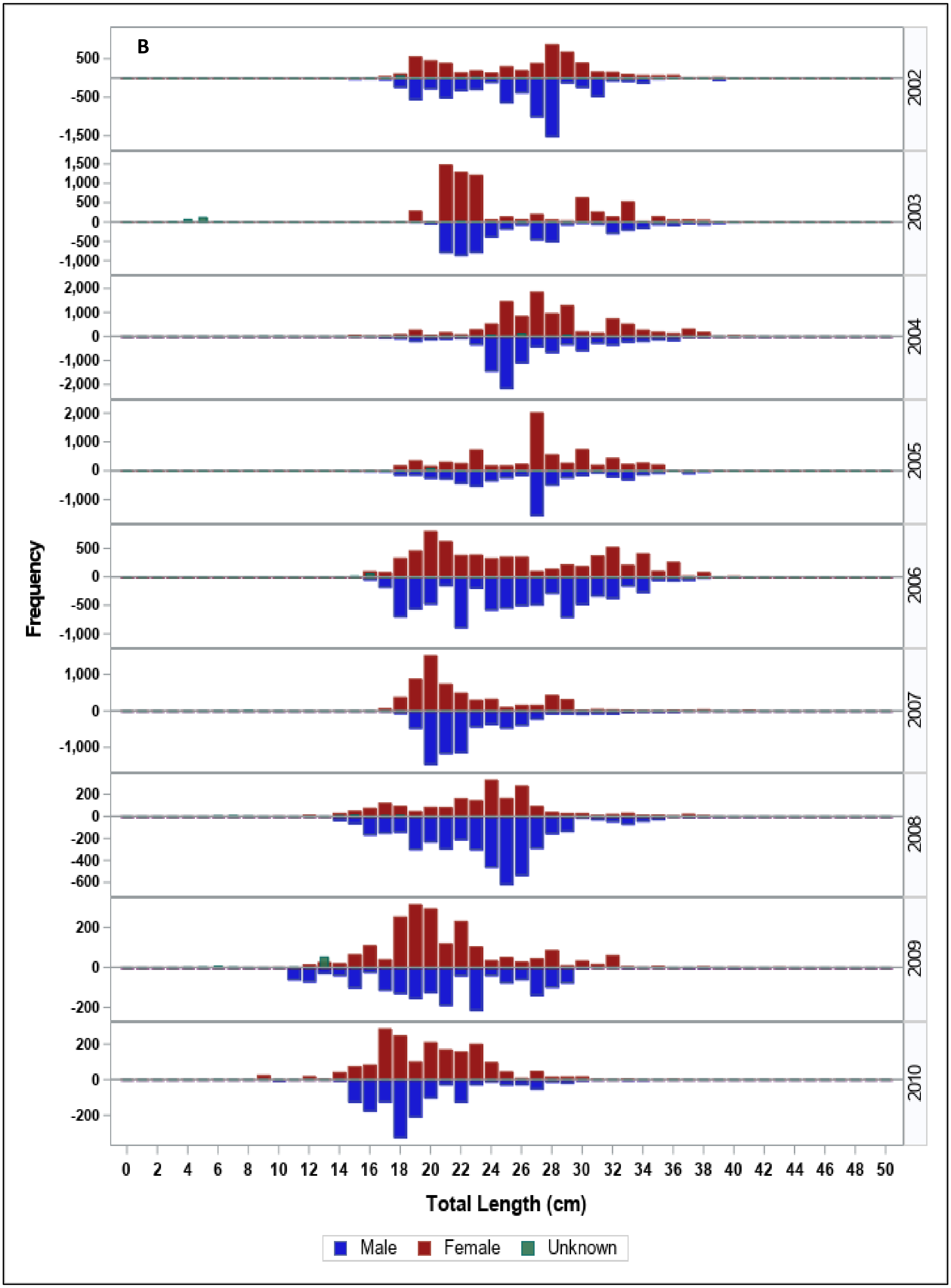


Figure 3. continued.

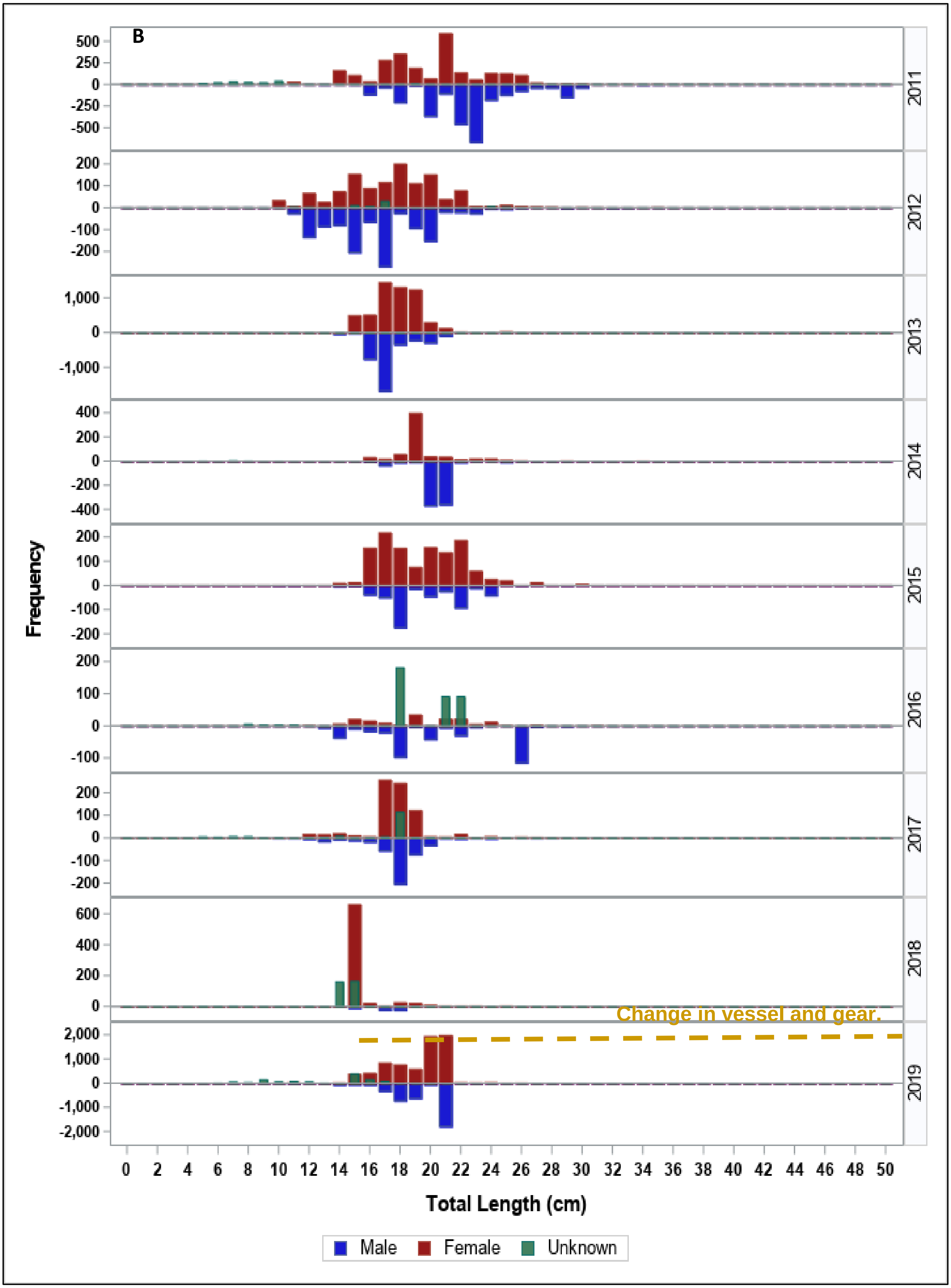


Figure 4. Atlantic Croaker age-frequency by year, 2002-2019.

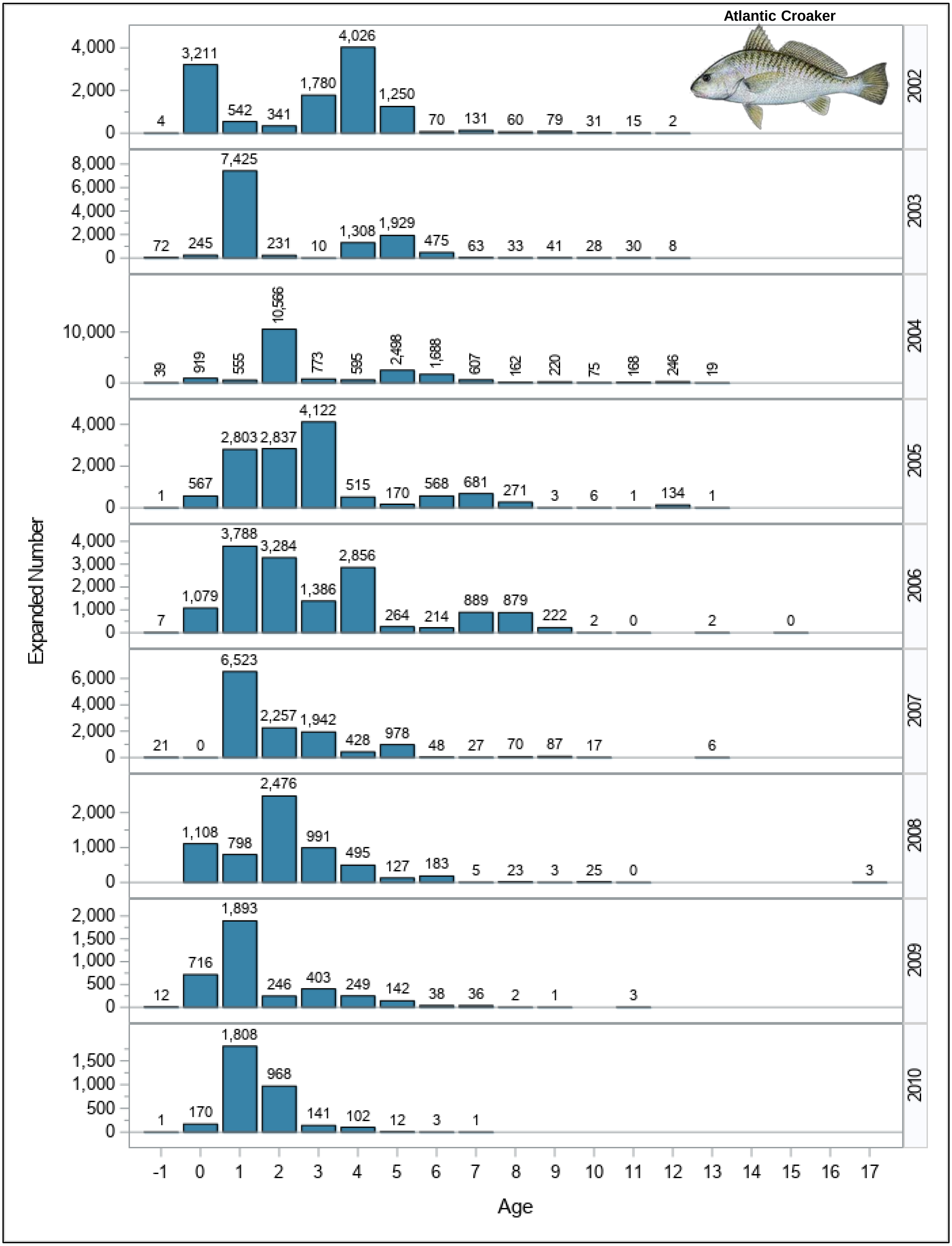


Figure 4. cont.

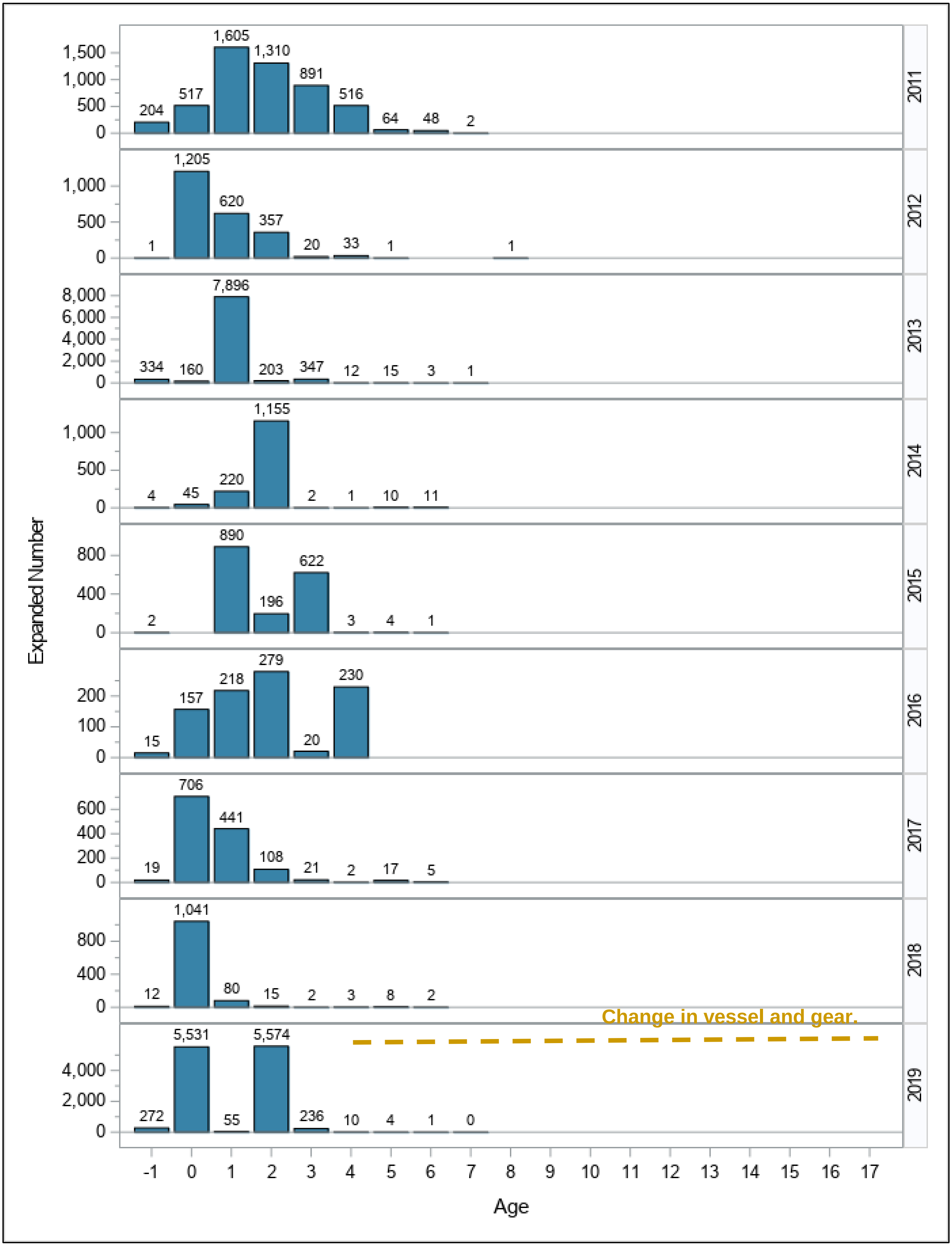


Figure 5. Atlantic Croaker age-frequency by year, 2002-2019 standardized to 8,000 (4,800 for 2019) annual trawl minutes.

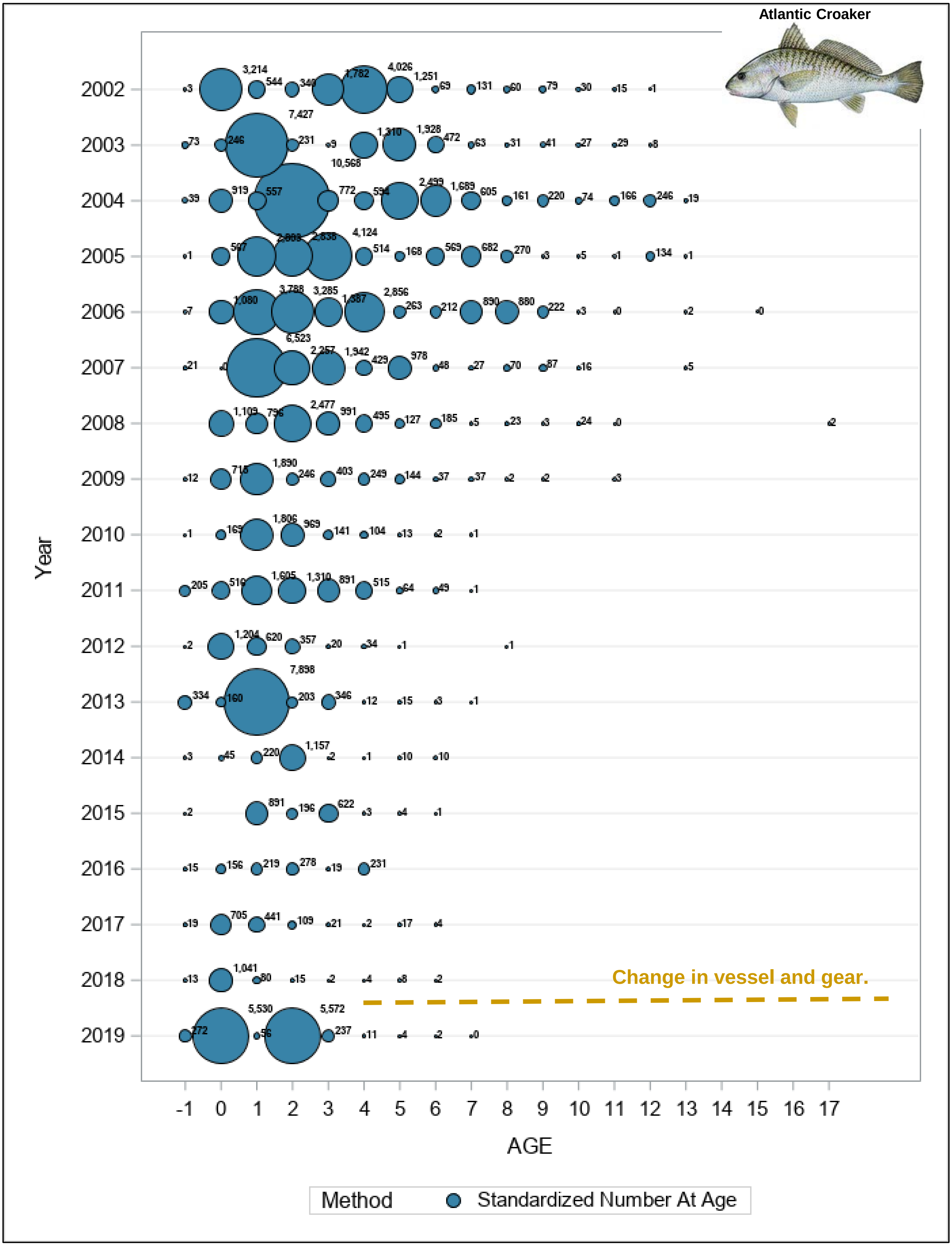


Figure 6. Diet composition, expressed as percent by weight (A) and percent by number (B) of Atlantic Croaker collected during ChesMMAP cruises in 2002-2018 combined.

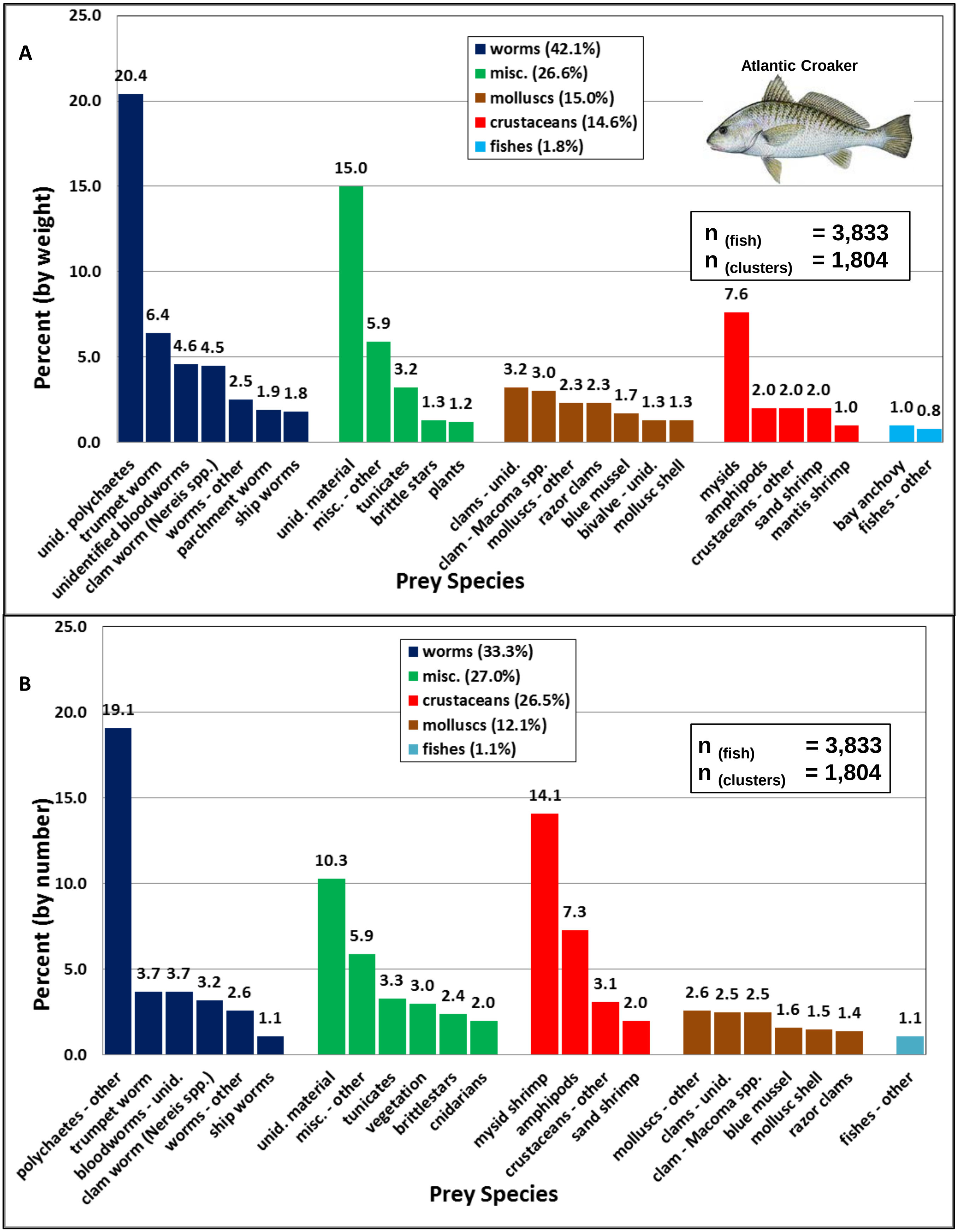


Table 8. Black Sea Bass sampling rates and preserved specimen analysis status by year.

Year	Number Caught	Biomass Caught (kg)	Presence at Index Stations (%)	Number Measured	Age Specimens	Ages Read	Stomach Specimens	Stomachs Analyzed
2002	50	4.4	14.8	50	48	48	46	46
2003	42	5.0	15.3	42	32	32	31	31
2004	14	2.2	7.8	14	14	14	14	14
2005	13	1.7	5.3	13	13	13	13	12
2006	22	1.7	6.7	22	17	17	16	16
2007	30	1.8	13.6	30	30	30	29	28
2008	34	2.2	5.9	34	28	28	26	25
2009	35	2.0	14.1	35	35	35	35	34
2010	23	0.6	8.9	23	23	23	22	22
2011	23	1.4	9.7	23	23	23	21	21
2012	9	0.4	2.3	9	9	9	8	7
2013	2	0.1	1.5	2	2	2	1	1
2014	11	0.6	3.7	11	11	11	8	8
2015	11	0.5	5.9	11	11	11	9	9
2016	42	2.0	16.3	42	42	42	30	30
2017	35	1.3	7.4	35	34	34	22	22
2018	8	0.4	1.5	8	8	8	4	4
2019	445	11.1	51.1	445	209	209	148	147

Figure 7. Station specific biomass Black Sea Bass in Chesapeake Bay, 2019.

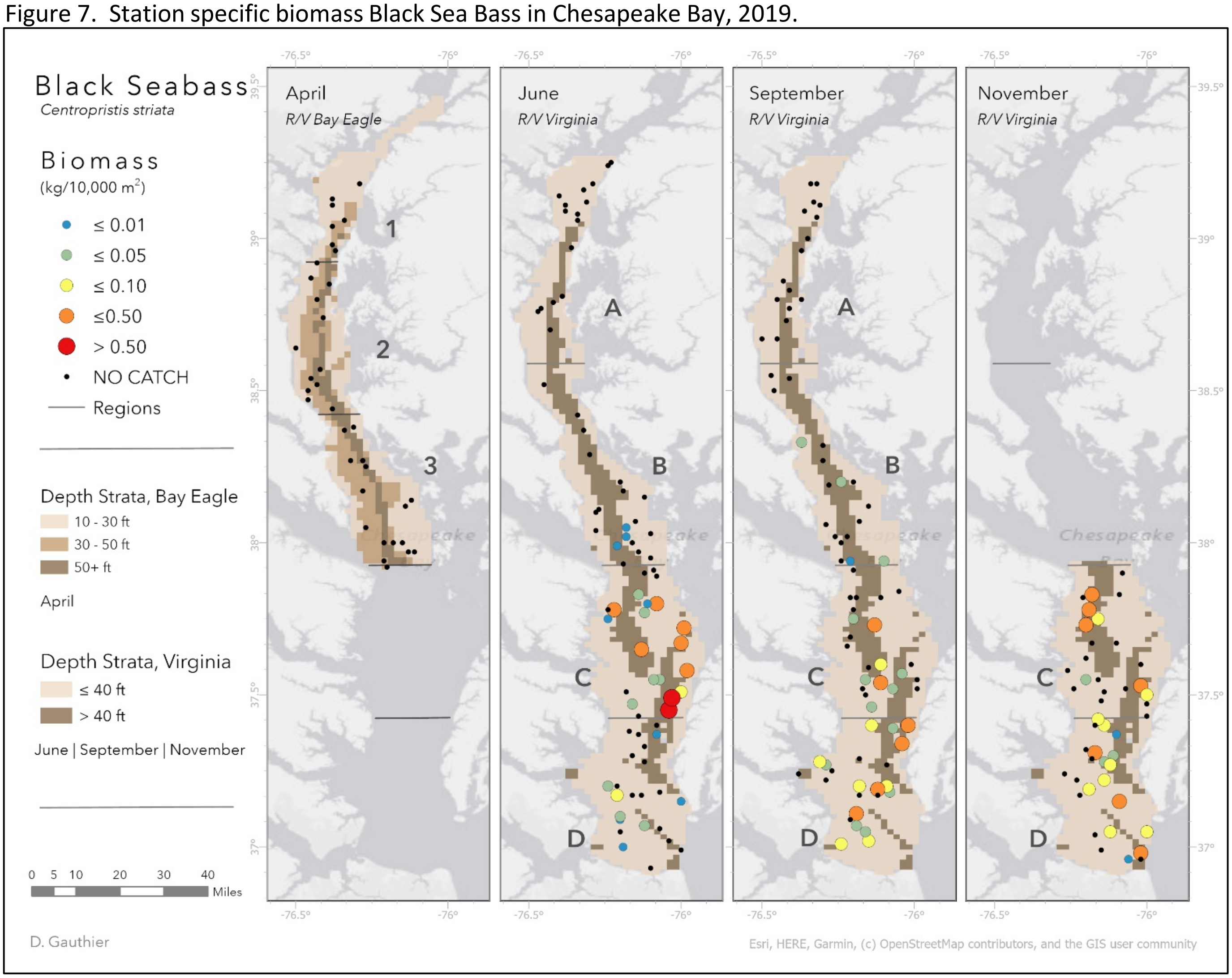


Table 9. Black Sea Bass geometric mean indices of abundance, by number and biomass, overall and by age-class.

Year	Age	n	Numerical Index			Biomass Index		
			LCI	**Index**	UCI	LCI	**Index**	UCI
2002	All	122	0.08	**0.16**	0.23	0.01	**0.02**	0.03
2003		149	0.07	**0.14**	0.21	0.01	**0.02**	0.04
2004		127	0.03	**0.07**	0.12	0.00	**0.02**	0.03
2005		131	0.01	**0.06**	0.10	0.00	**0.01**	0.02
2006		120	0.01	**0.07**	0.14	0.00	**0.01**	0.02
2007		88	0.07	**0.17**	0.27	0.01	**0.02**	0.03
2008		135	0.01	**0.05**	0.10	0.00	**0.01**	0.02
2009		135	0.08	**0.16**	0.24	0.01	**0.02**	0.03
2010		135	0.03	**0.09**	0.14	0.00	**0.01**	0.01
2011		134	0.04	**0.09**	0.15	0.00	**0.01**	0.02
2012		129	0.00	**0.02**	0.05	0.00	**0.00**	0.00
2013		134	0.00	**0.01**	0.03	0.00	**0.00**	0.00
2014		135	0.00	**0.03**	0.06	0.00	**0.00**	0.00
2015		135	0.02	**0.05**	0.09	0.00	**0.00**	0.01
2016		135	0.09	**0.16**	0.24	0.01	**0.01**	0.02
2017		135	0.02	**0.08**	0.14	0.00	**0.00**	0.01
2018		135	0.00	**0.01**	0.02	0.00	**0.00**	0.00
2019		135	0.85	**1.18**	1.56	0.05	**0.07**	0.10
2020								
2002	0	75	0.01	**0.05**	0.09	0.00	**0.01**	0.02
2003		101	0.01	**0.05**	0.09	0.00	**0.01**	0.02
2004		92	0.02	**0.06**	0.11	0.00	**0.01**	0.03
2005		86	0.00	**0.05**	0.11	0.00	**0.01**	0.02
2006		79	0.00	**0.05**	0.13	0.00	**0.01**	0.02
2007		44	0.03	**0.16**	0.30	0.01	**0.03**	0.05
2008		90	0.01	**0.07**	0.14	0.00	**0.01**	0.03
2009		90	0.05	**0.14**	0.23	0.00	**0.02**	0.03
2010		90	0.00	**0.02**	0.04	0.00	**0.00**	0.00
2011		89	0.02	**0.08**	0.13	0.00	**0.01**	0.02
2012		84	0.00	**0.02**	0.04	0.00	**0.00**	0.01
2013		89	0.00	**0.01**	0.03	0.00	**0.00**	0.00
2014		90	0.00	**0.03**	0.07	0.00	**0.00**	0.00
2015		90	0.00	**0.02**	0.05	0.00	**0.00**	0.01
2016		90	0.00	**0.03**	0.06	0.00	**0.00**	0.01
2017		90	0.00	**0.01**	0.03	0.00	**0.00**	0.00
2018		90	0.00	**0.01**	0.02	0.00	**0.00**	0.00
2019		90	0.05	**0.12**	0.20	0.00	**0.01**	0.01
2020								

Year	Age	n	Numerical Index			Biomass Index		
			LCI	**Index**	UCI	LCI	**Index**	UCI
2002	1	122	0.08	**0.15**	0.22	0.01	**0.02**	0.03
2003		149	0.07	**0.13**	0.20	0.01	**0.02**	0.04
2004		127	0.02	**0.07**	0.11	0.00	**0.01**	0.03
2005		131	0.01	**0.06**	0.10	0.00	**0.01**	0.02
2006		120	0.01	**0.06**	0.12	0.00	**0.01**	0.02
2007		88	0.06	**0.16**	0.26	0.00	**0.02**	0.03
2008		135	0.01	**0.04**	0.08	0.00	**0.01**	0.01
2009		135	0.05	**0.10**	0.16	0.00	**0.01**	0.02
2010		135	0.03	**0.07**	0.12	0.00	**0.00**	0.01
2011		134	0.01	**0.06**	0.10	0.00	**0.01**	0.02
2012		129	0.00	**0.02**	0.05	0.00	**0.00**	0.00
2013		134	0.00	**0.01**	0.03	0.00	**0.00**	0.00
2014		135	0.00	**0.03**	0.06	0.00	**0.00**	0.00
2015		135	0.02	**0.05**	0.09	0.00	**0.00**	0.01
2016		135	0.09	**0.16**	0.24	0.01	**0.01**	0.02
2017		135	0.02	**0.08**	0.14	0.00	**0.00**	0.01
2018		135	0.00	**0.01**	0.02	0.00	**0.00**	0.00
2019		135	0.71	**0.96**	1.26	0.04	**0.06**	0.08
2020								

Figure 8. Black Sea Bass geometric mean indices of abundance, by number and biomass, for all ages combined and by age-class.

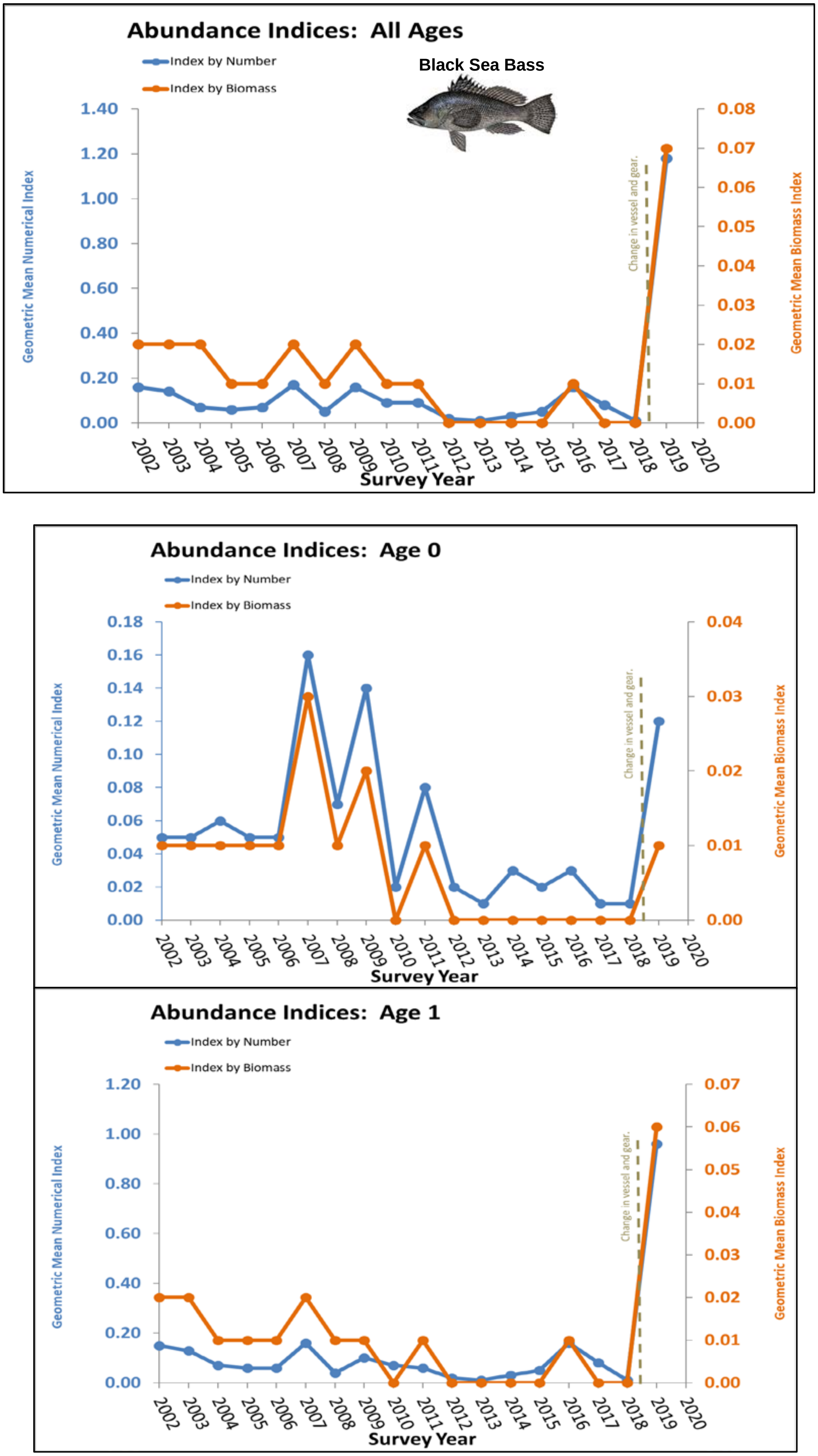


Figure 9. Black Sea Bass length-frequency in Chesapeake Bay 2002-2019, overall (A) and by sex (B).

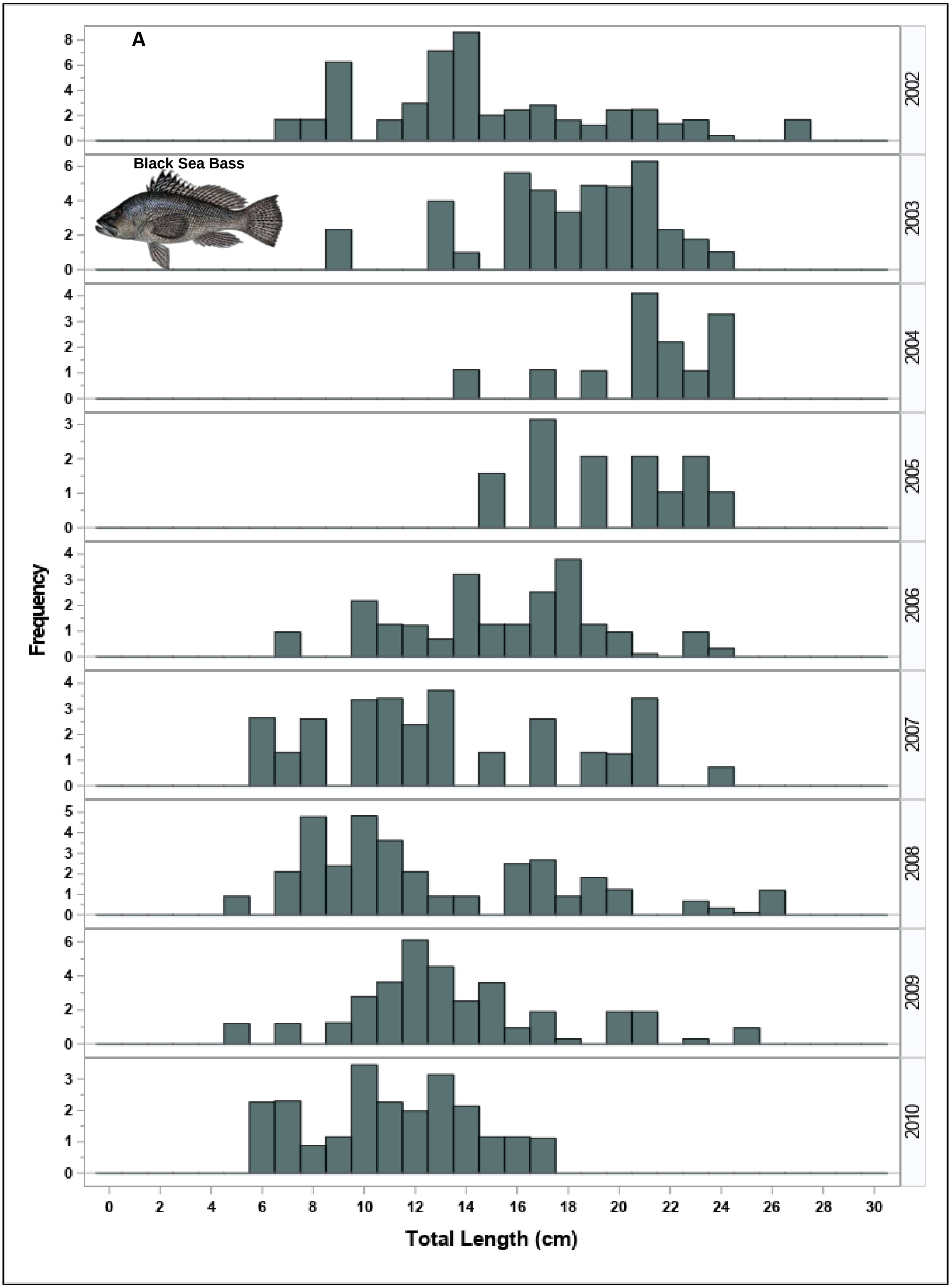


Figure 9. cont.

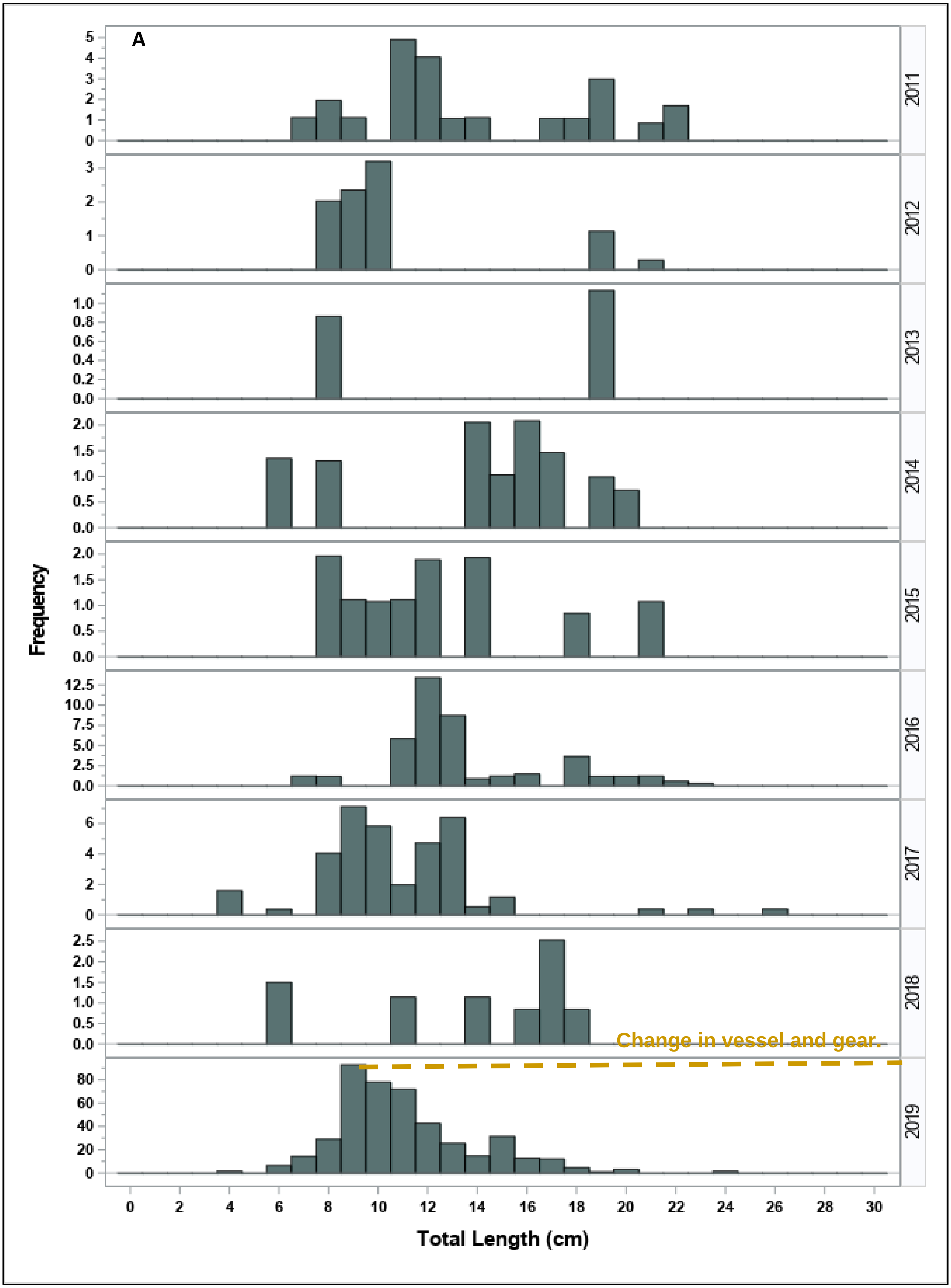


Figure 9. cont.

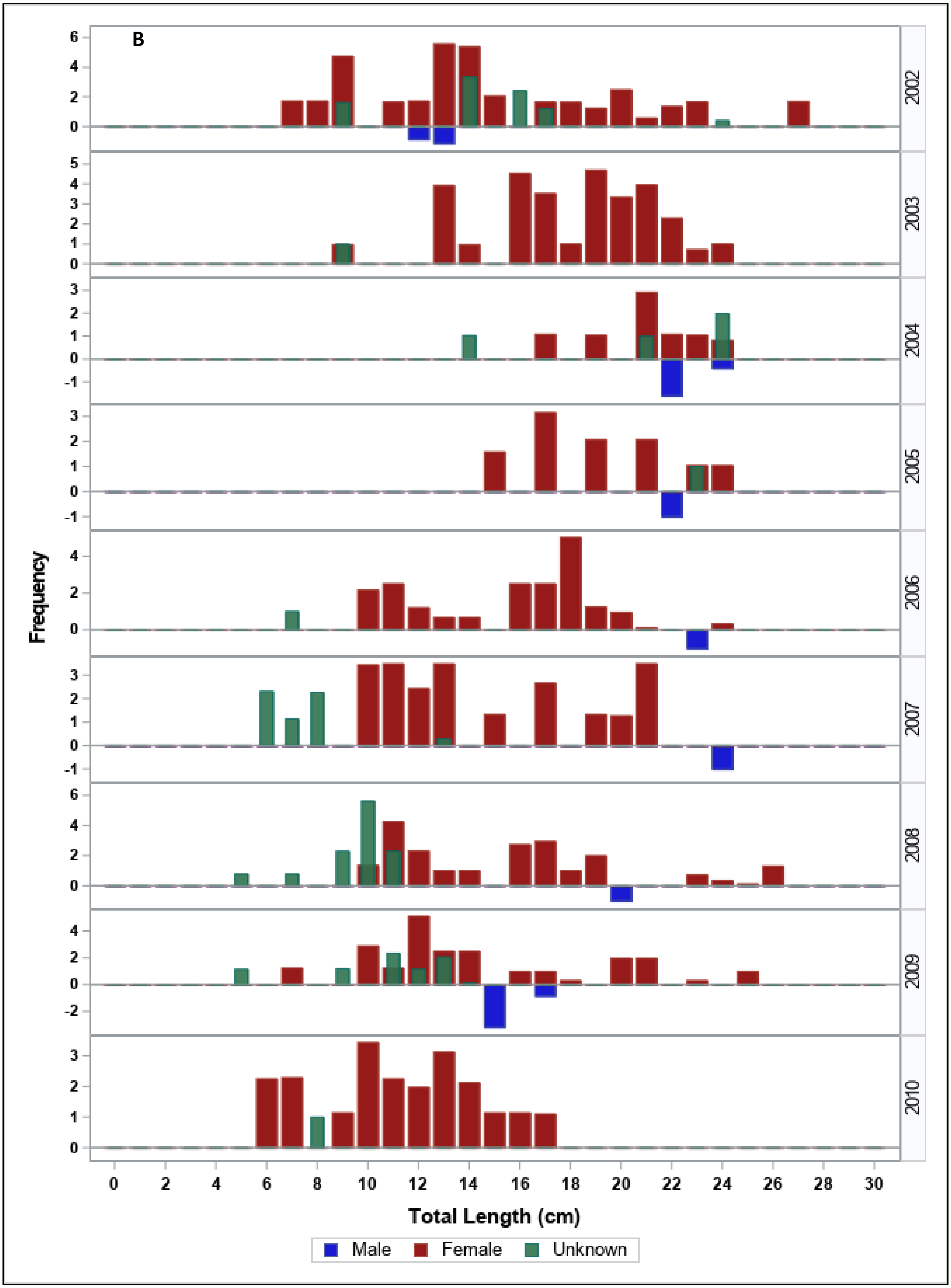


Figure 9. cont.

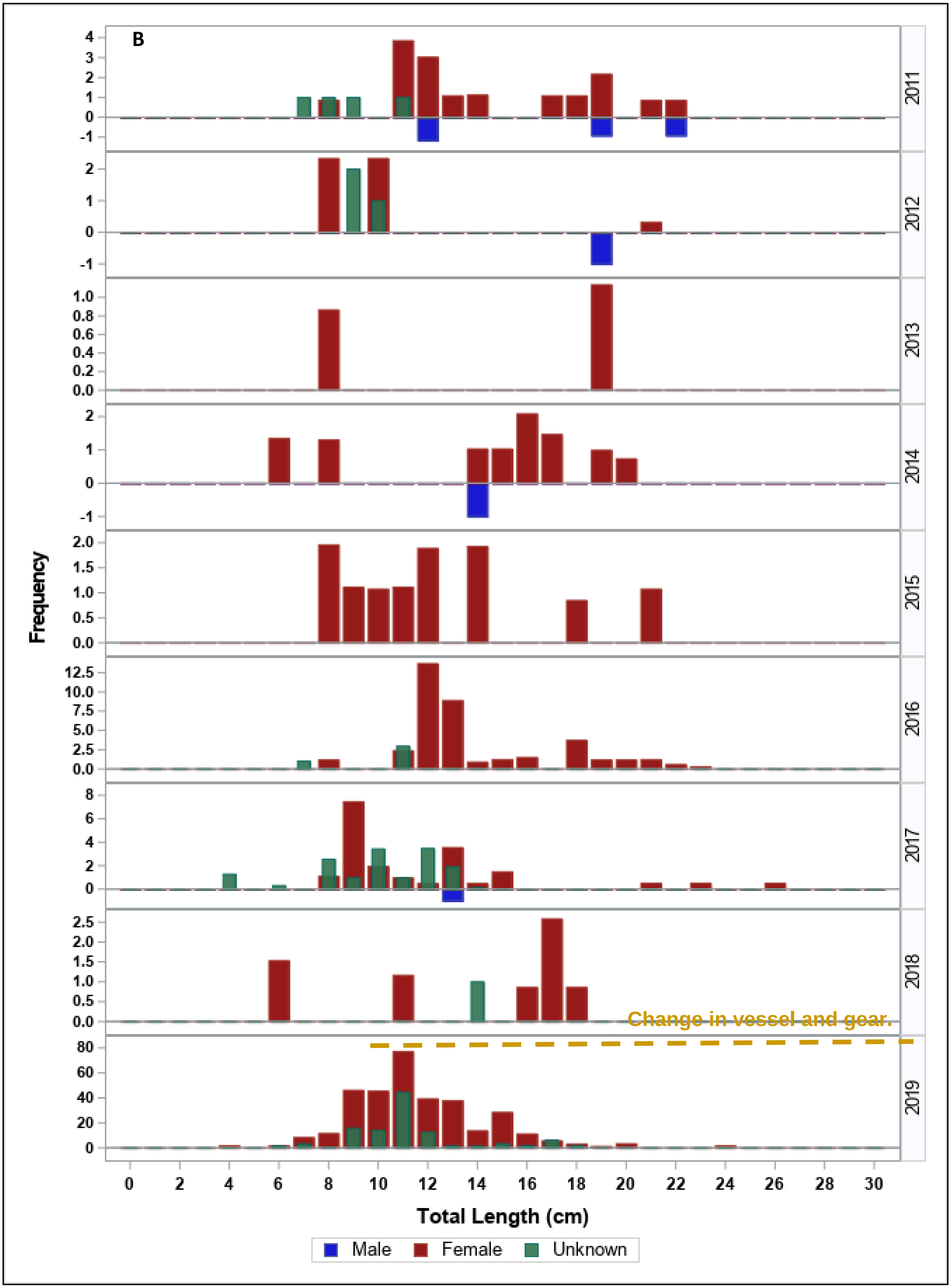


Figure 10. Black Sea Bass age-frequency by year, 2002-2019.

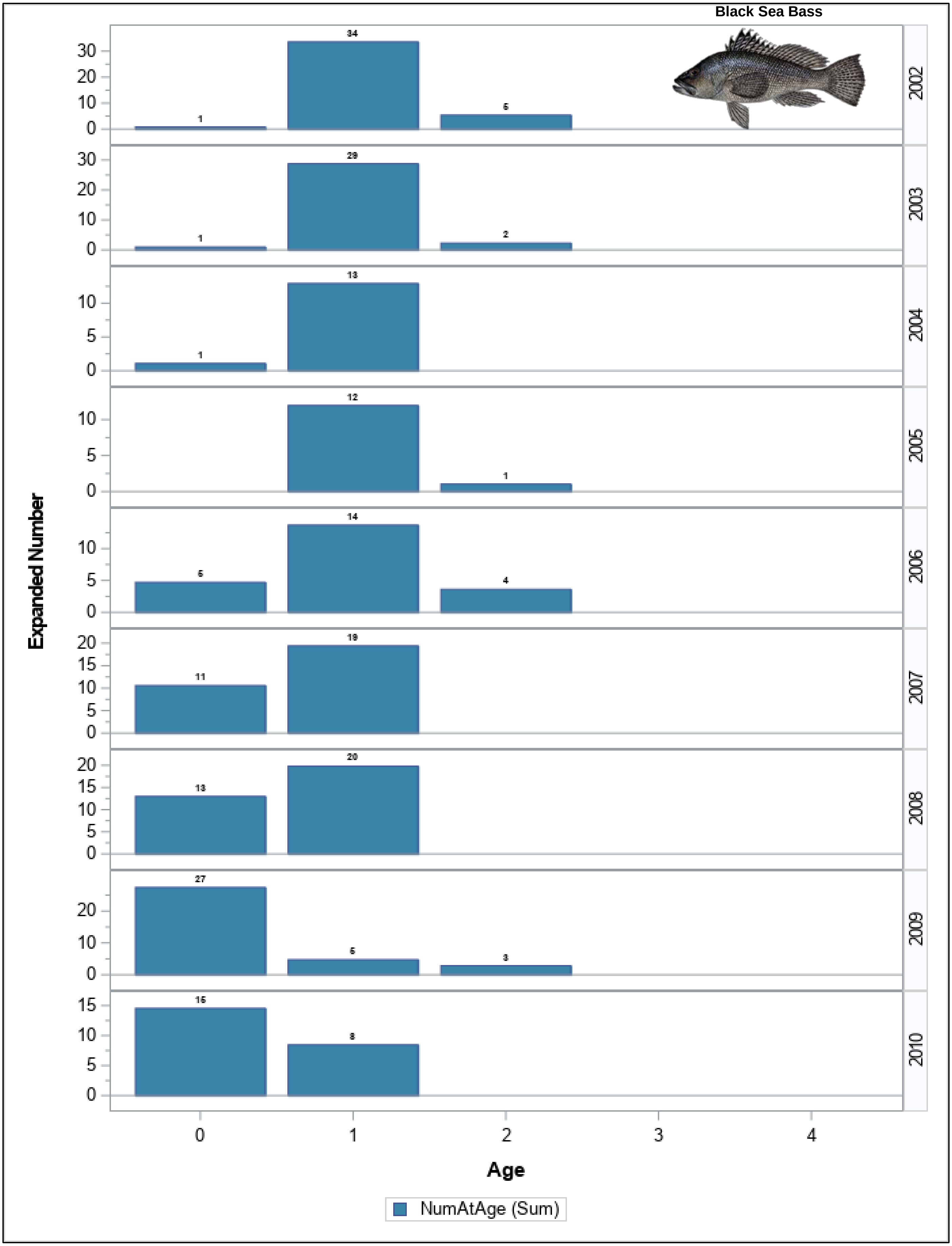


Figure 10. cont.

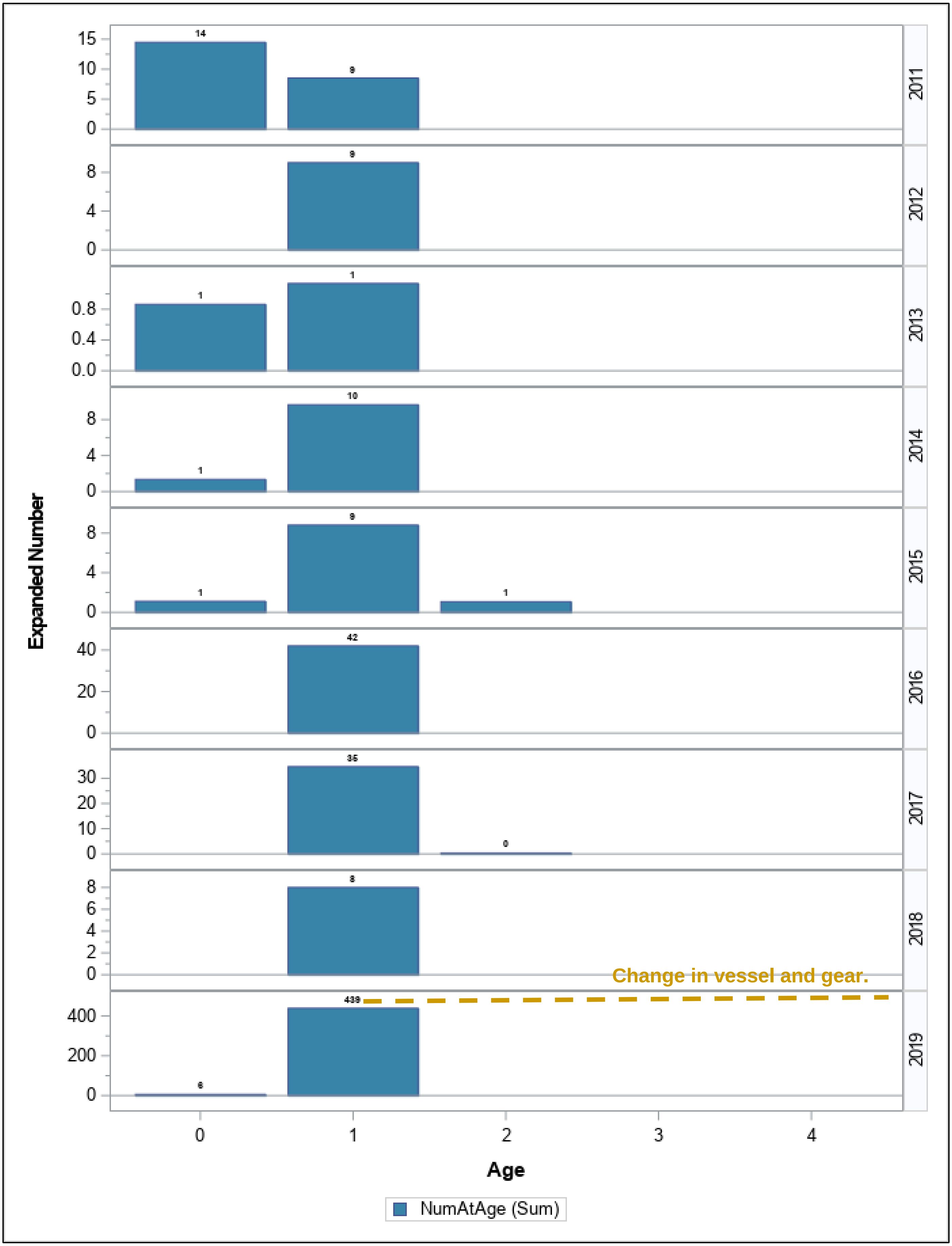


Figure 11. Black Sea Bass age-frequency by year, 2002-2019 standardized to 8,000 (4,800 for 2019) annual trawl minutes.

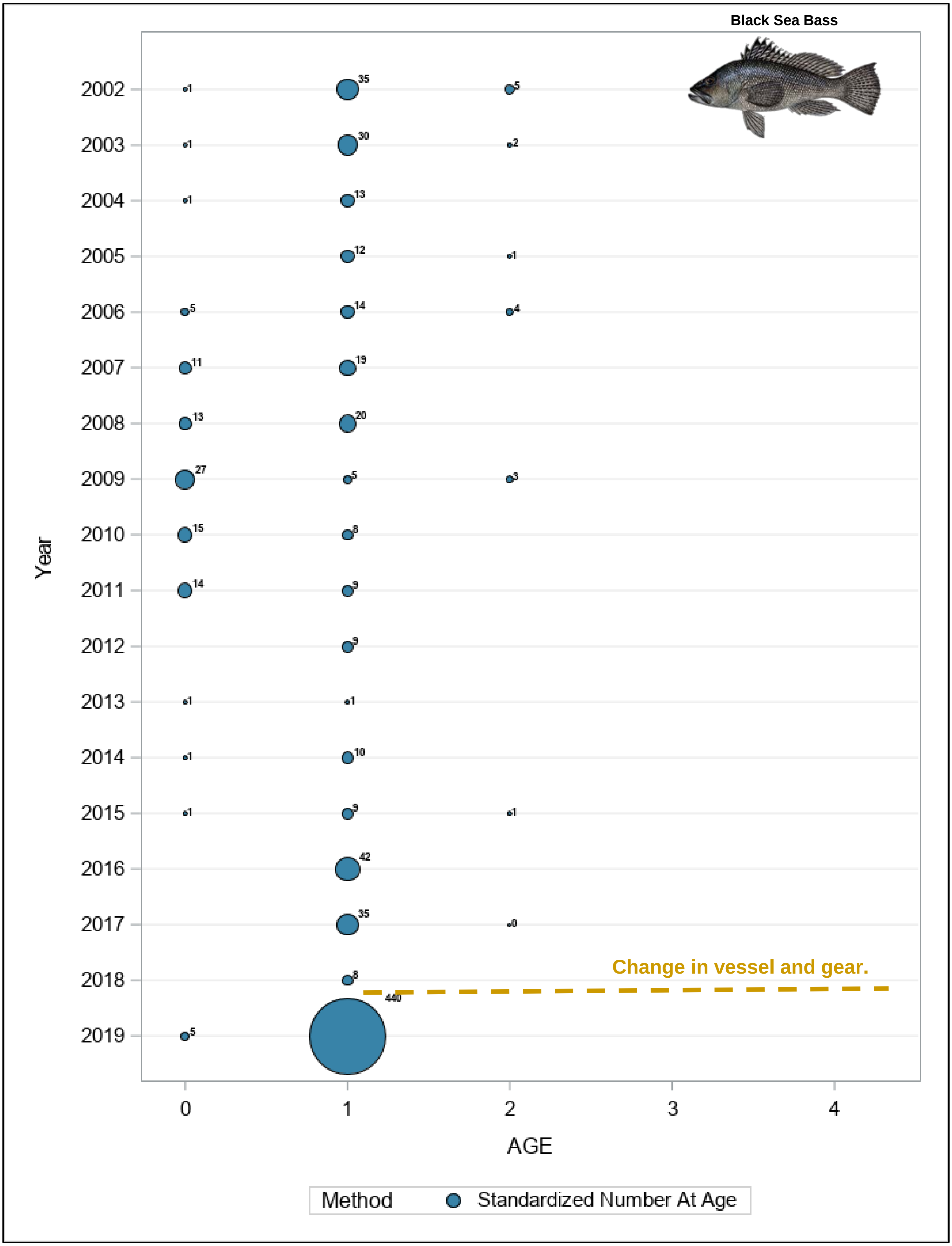


Figure 12. Diet composition, expressed as percent by weight (A) and percent by number (B) of black seabass collected during ChesMMAP cruises in 2002-2018 combined.

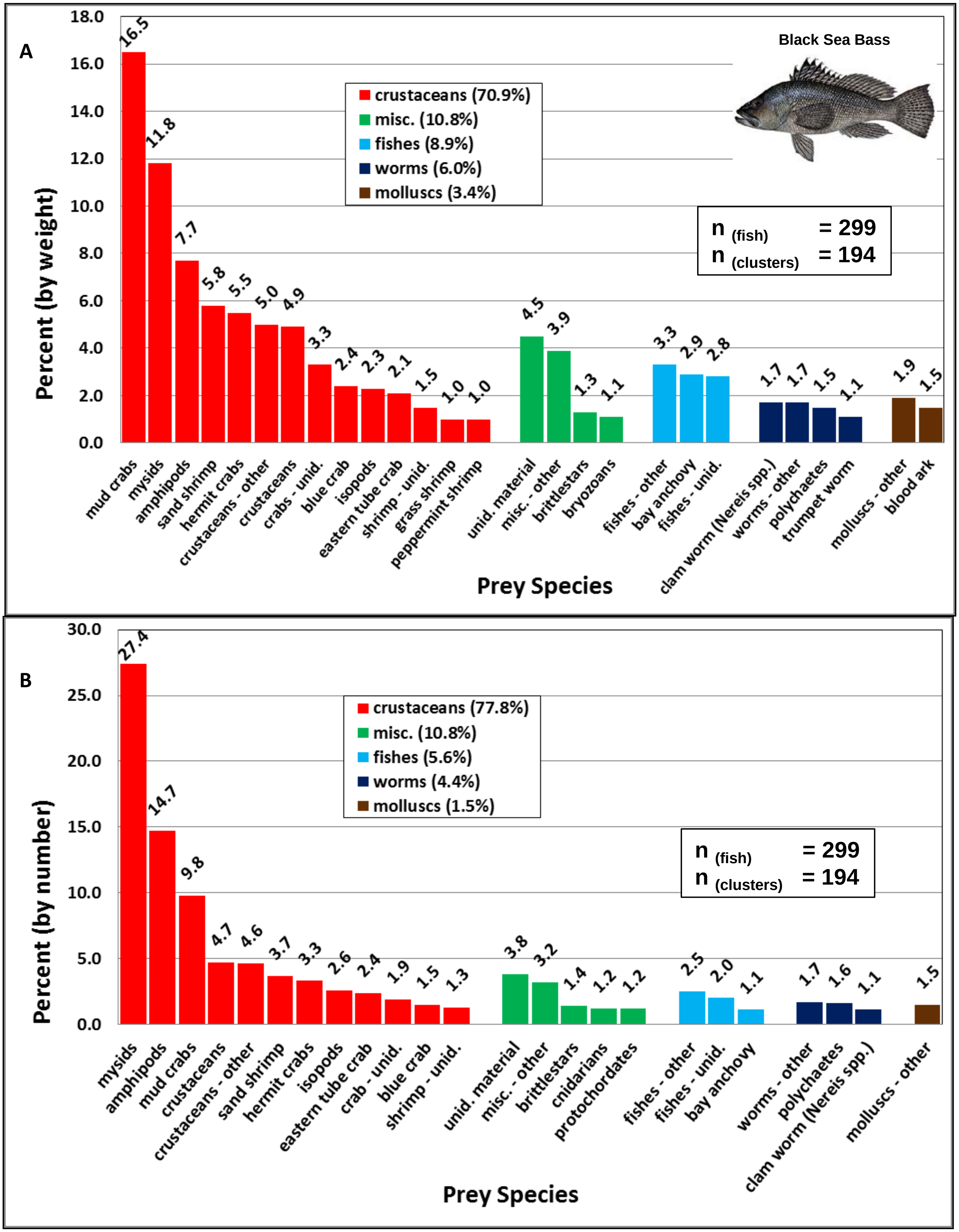


Table 10. Bluefish sampling rates and preserved specimen analysis status by year.

Year	Number Caught	Biomass Caught (kg)	Presence at Index Stations (%)	Number Measured	Age Specimens	Ages Read	Stomach Specimens	Stomachs Analyzed
2002	34	10.7	10.3	34	34	34	24	22
2003	114	31.7	24.8	114	74	74	63	62
2004	28	10.0	11.8	28	27	27	22	22
2005	108	22.2	16.1	108	71	71	60	60
2006	23	5.5	9.9	23	23	23	17	17
2007	58	18.2	31.8	58	50	50	44	44
2008	52	15.8	8.0	52	27	27	14	13
2009	11	2.3	4.8	11	11	11	9	9
2010	126	20.2	4.0	82	30	30	13	12
2011	8	2.3	4.9	8	8	8	7	6
2012	17	4.0	6.7	17	17	17	12	12
2013	32	5.4	7.3	32	32	32	26	26
2014	44	5.9	12.8	44	39	39	26	25
2015	125	18.5	12.8	125	49	49	28	28
2016	36	9.8	7.2	36	36	36	19	19
2017	40	6.6	7.2	40	31	31	20	20
2018	85	8.4	12.7	85	41	41	24	24
2019	35	6.4	10.5	35	33	33	14	14

Figure 13. Station specific biomass of Bluefish in Chesapeake Bay, 2019.

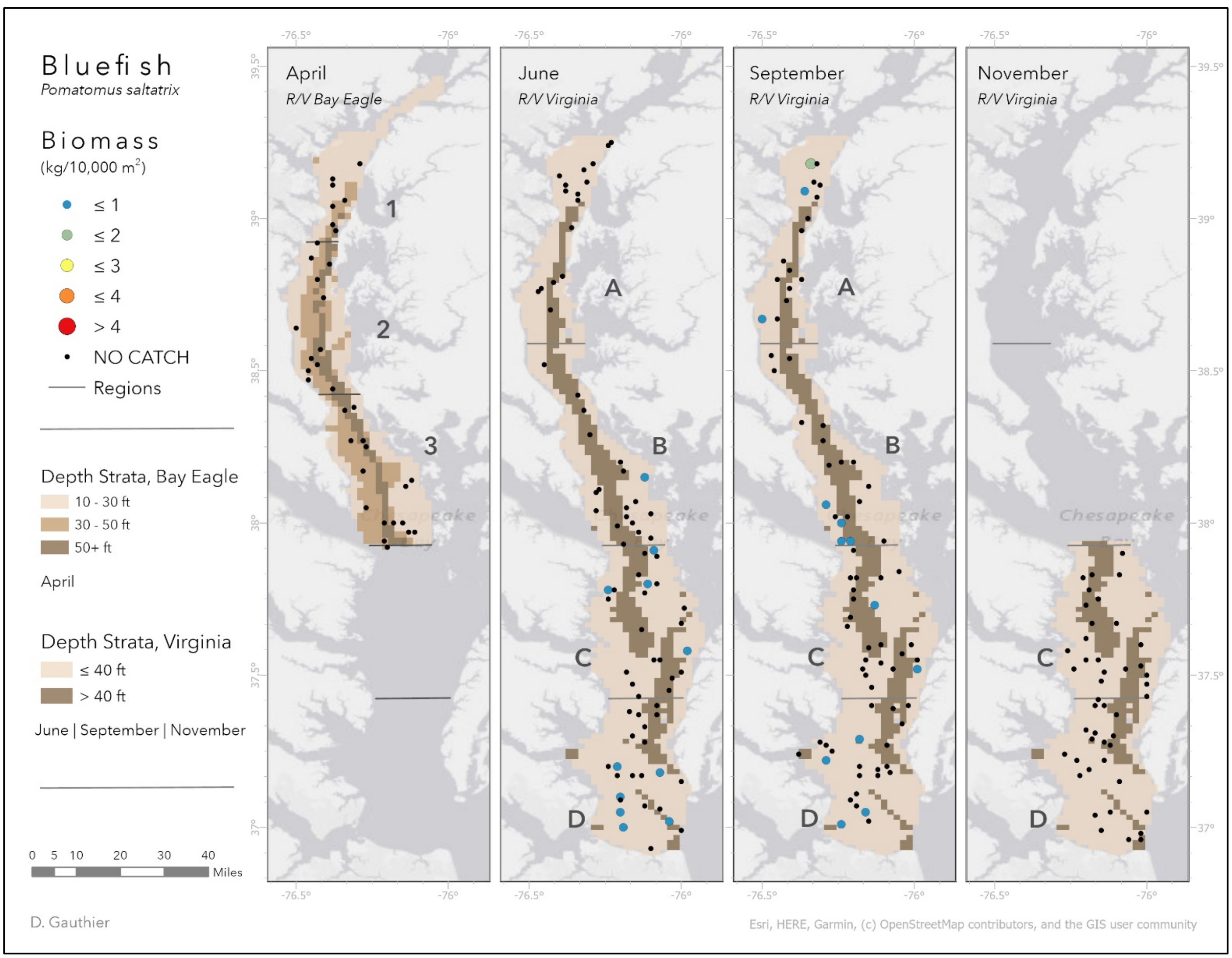


Table 11. Bluefish geometric mean indices of abundance, by number and biomass, overall and age-0.

Year	Age	n	Numerical Index LCI	Numerical Index Index	Numerical Index UCI	Biomass Index LCI	Biomass Index Index	Biomass Index UCI
2002	All	75	0.05	0.16	0.28	0.02	0.07	0.12
2003		101	0.20	0.36	0.55	0.04	0.09	0.15
2004		92	0.05	0.12	0.20	0.02	0.06	0.10
2005		86	0.22	0.42	0.66	0.06	0.15	0.24
2006		79	0.04	0.12	0.21	0.01	0.04	0.08
2007		44	0.17	0.38	0.62	0.05	0.13	0.22
2008		90	0.01	0.07	0.13	0.00	0.02	0.05
2009		90	0.01	0.06	0.12	0.00	0.02	0.03
2010		90	0.00	0.12	0.28	0.00	0.05	0.12
2011		89	0.00	0.04	0.09	0.00	0.02	0.04
2012		84	0.02	0.08	0.15	0.01	0.03	0.05
2013		89	0.02	0.09	0.16	0.01	0.03	0.06
2014		90	0.09	0.21	0.33	0.02	0.04	0.07
2015		90	0.10	0.20	0.31	0.01	0.03	0.05
2016		90	0.01	0.07	0.14	0.00	0.02	0.04
2017		90	0.02	0.09	0.16	0.00	0.02	0.05
2018		90	0.06	0.17	0.28	0.00	0.04	0.08
2019		135	0.05	0.10	0.15	0.01	0.03	0.04
2020								
2002	0	75	0.03	0.13	0.24	0.01	0.06	0.10
2003		101	0.19	0.35	0.53	0.04	0.09	0.15
2004		92	0.03	0.10	0.17	0.01	0.05	0.08
2005		86	0.21	0.42	0.66	0.06	0.14	0.23
2006		79	0.04	0.11	0.18	0.01	0.03	0.06
2007		44	0.16	0.37	0.61	0.05	0.13	0.21
2008		90	0.01	0.07	0.13	0.00	0.02	0.05
2009		90	0.01	0.06	0.12	0.00	0.02	0.03
2010		90	0.00	0.12	0.28	0.00	0.05	0.12
2011		89	0.00	0.04	0.09	0.00	0.02	0.04
2012		84	0.02	0.08	0.15	0.01	0.03	0.05
2013		89	0.01	0.07	0.14	0.00	0.02	0.05
2014		90	0.08	0.19	0.31	0.01	0.03	0.06
2015		90	0.09	0.18	0.29	0.01	0.03	0.04
2016		90	0.00	0.05	0.10	0.00	0.01	0.01
2017		90	0.02	0.09	0.16	0.00	0.02	0.05
2018		90	0.06	0.17	0.28	0.00	0.04	0.08
2019		135	0.05	0.09	0.14	0.01	0.03	0.04
2020								
2002	1	75	0.05	0.13	0.21	0.02	0.06	0.09
2003		101	0.05	0.12	0.20	0.01	0.03	0.04
2004		92	0.03	0.09	0.16	0.01	0.04	0.08
2005		86	0.06	0.14	0.23	0.01	0.04	0.07
2006		79	0.03	0.10	0.16	0.00	0.03	0.06
2007		44	0.03	0.13	0.25	0.01	0.07	0.13
2008		90	0.00	0.04	0.09	0.00	0.01	0.04
2009		90	0.01	0.05	0.10	0.00	0.02	0.03
2010		90	0.00	0.09	0.24	0.00	0.04	0.11
2011		89	0.00	0.04	0.07	0.00	0.02	0.03
2012		84	0.01	0.07	0.13	0.00	0.02	0.04
2013		89	0.02	0.07	0.12	0.00	0.02	0.04
2014		90	0.04	0.11	0.18	0.01	0.03	0.04
2015		90	0.03	0.10	0.17	0.00	0.02	0.04
2016		90	0.00	0.05	0.11	0.00	0.02	0.04
2017		90	0.00	0.03	0.06	0.00	0.01	0.02
2018		90	0.02	0.10	0.17	0.00	0.02	0.04
2019		135	0.03	0.06	0.10	0.01	0.02	0.04
2020								

Figure 14. Bluefish geometric mean indices of abundance, by number and biomass, for all ages combined and for ages 0 and 1.

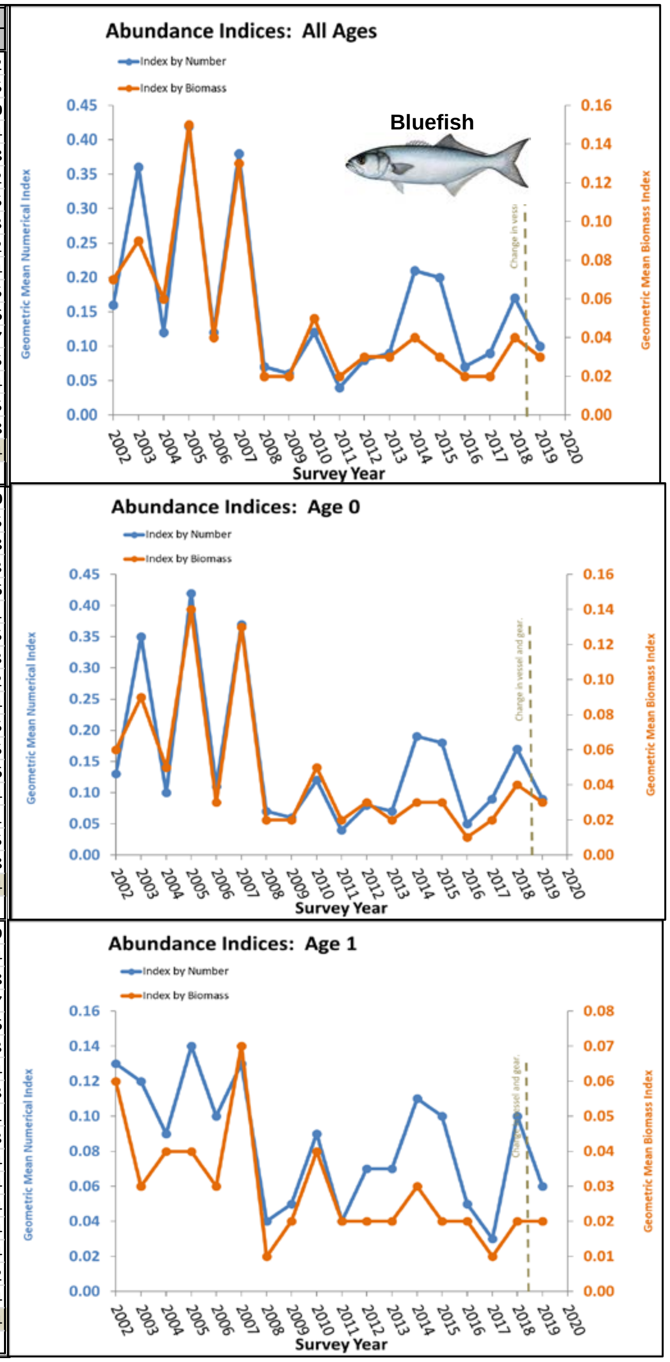


Figure 15. Bluefish length-frequency in Chesapeake Bay 2002-2019, overall (A) and by sex (B).

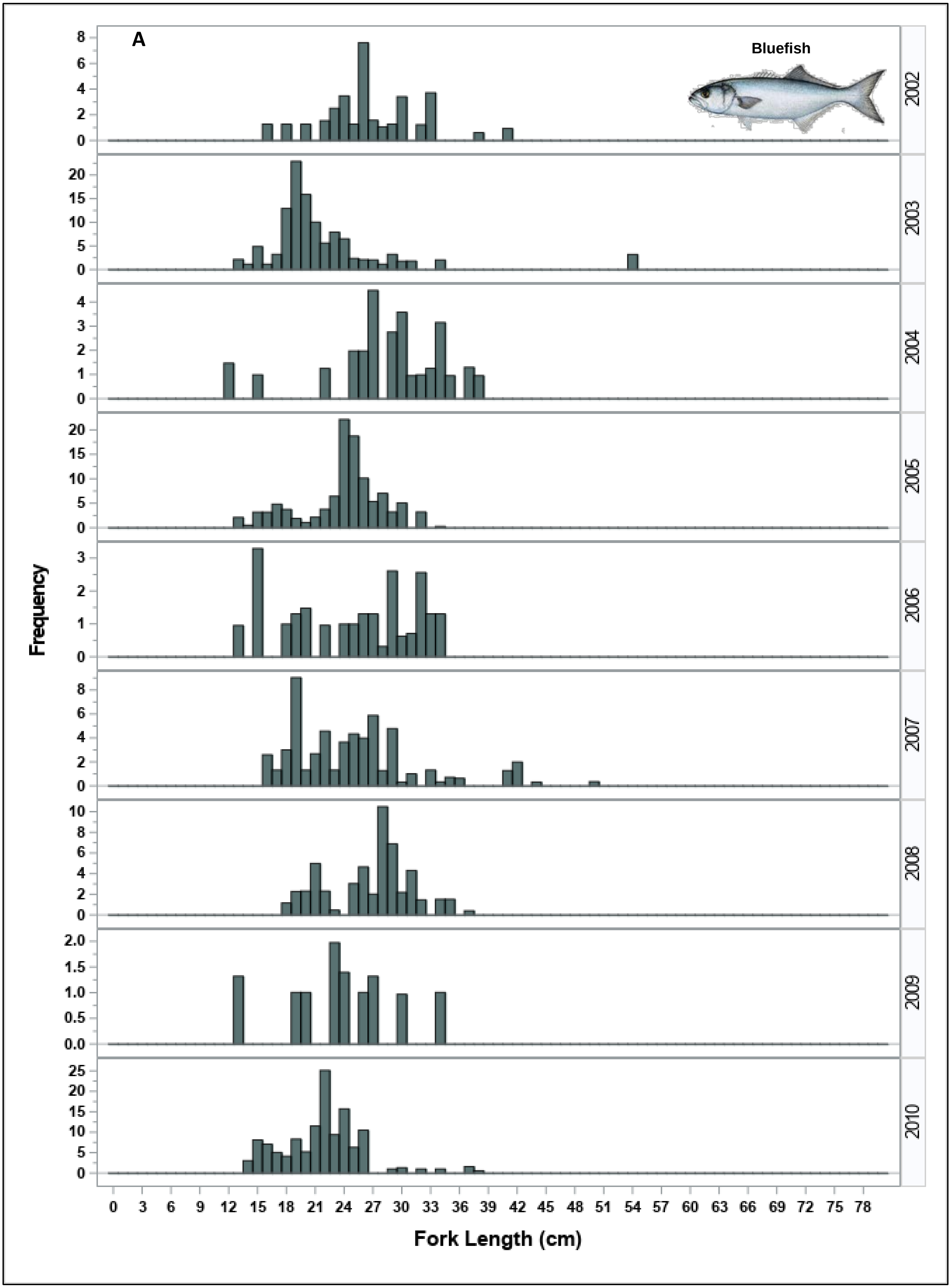


Figure 15. cont.

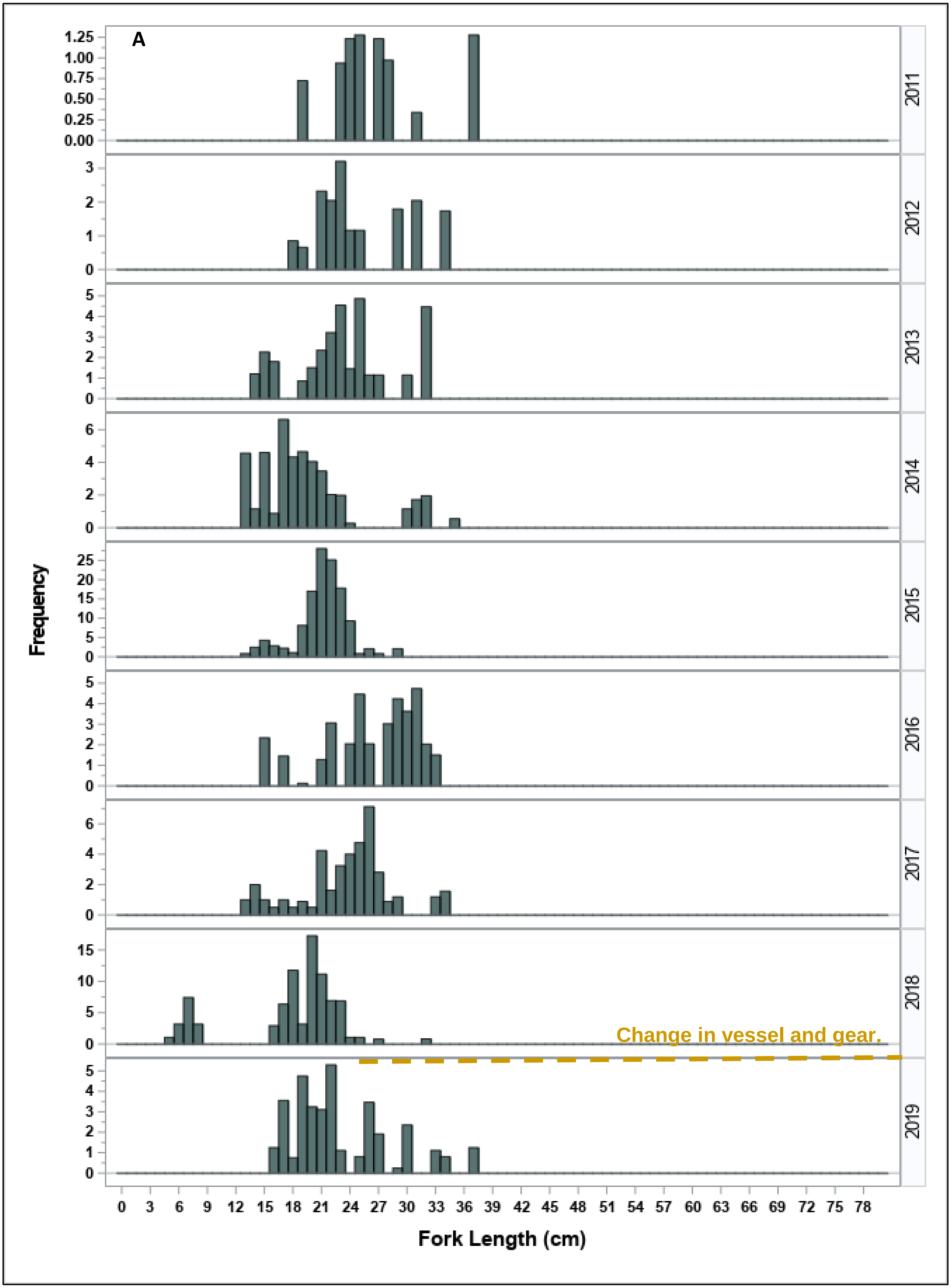


Figure 15. cont.

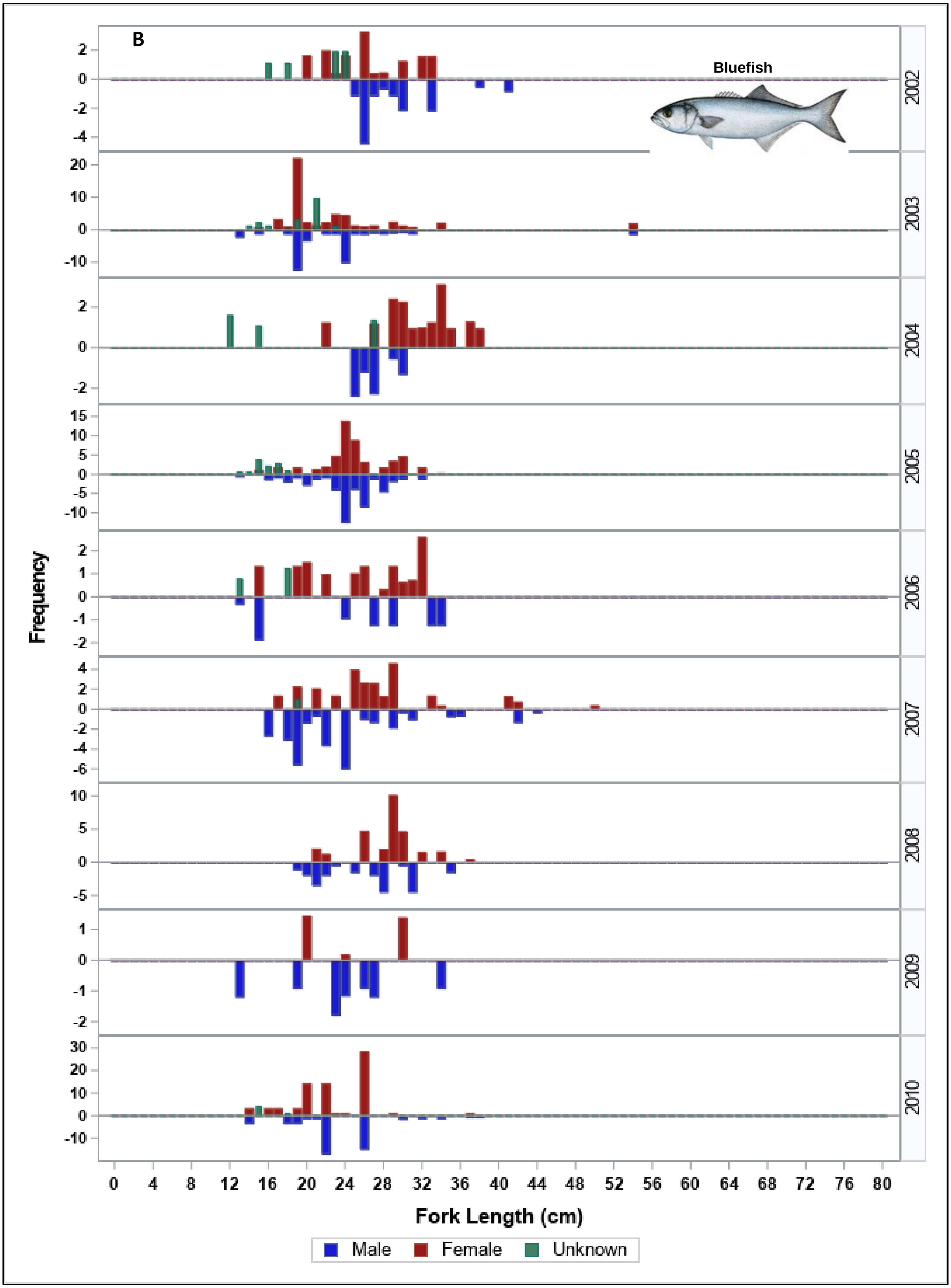


Figure 15. cont.

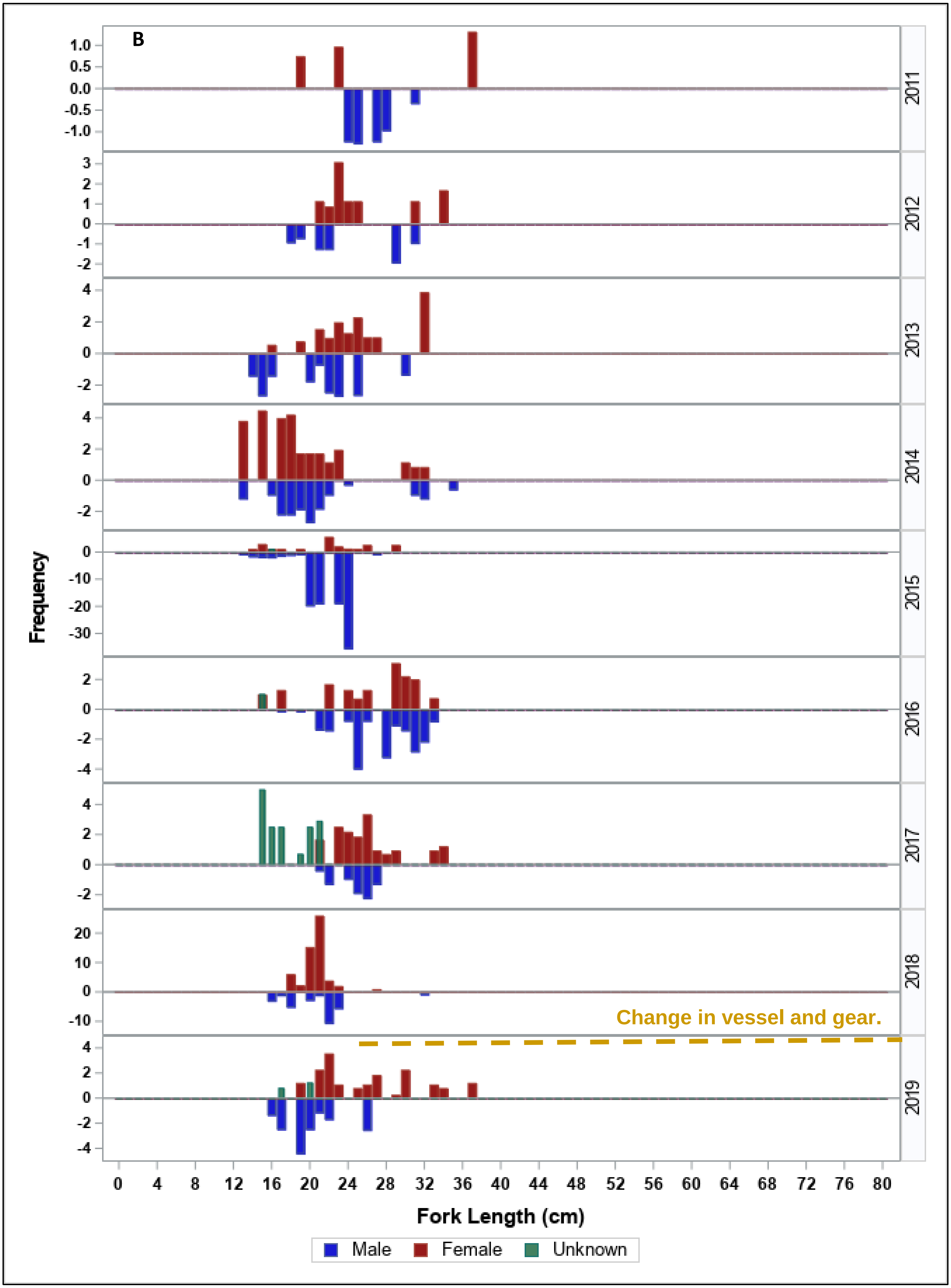


Figure 16. Bluefish age-frequency by year 2002-2019.

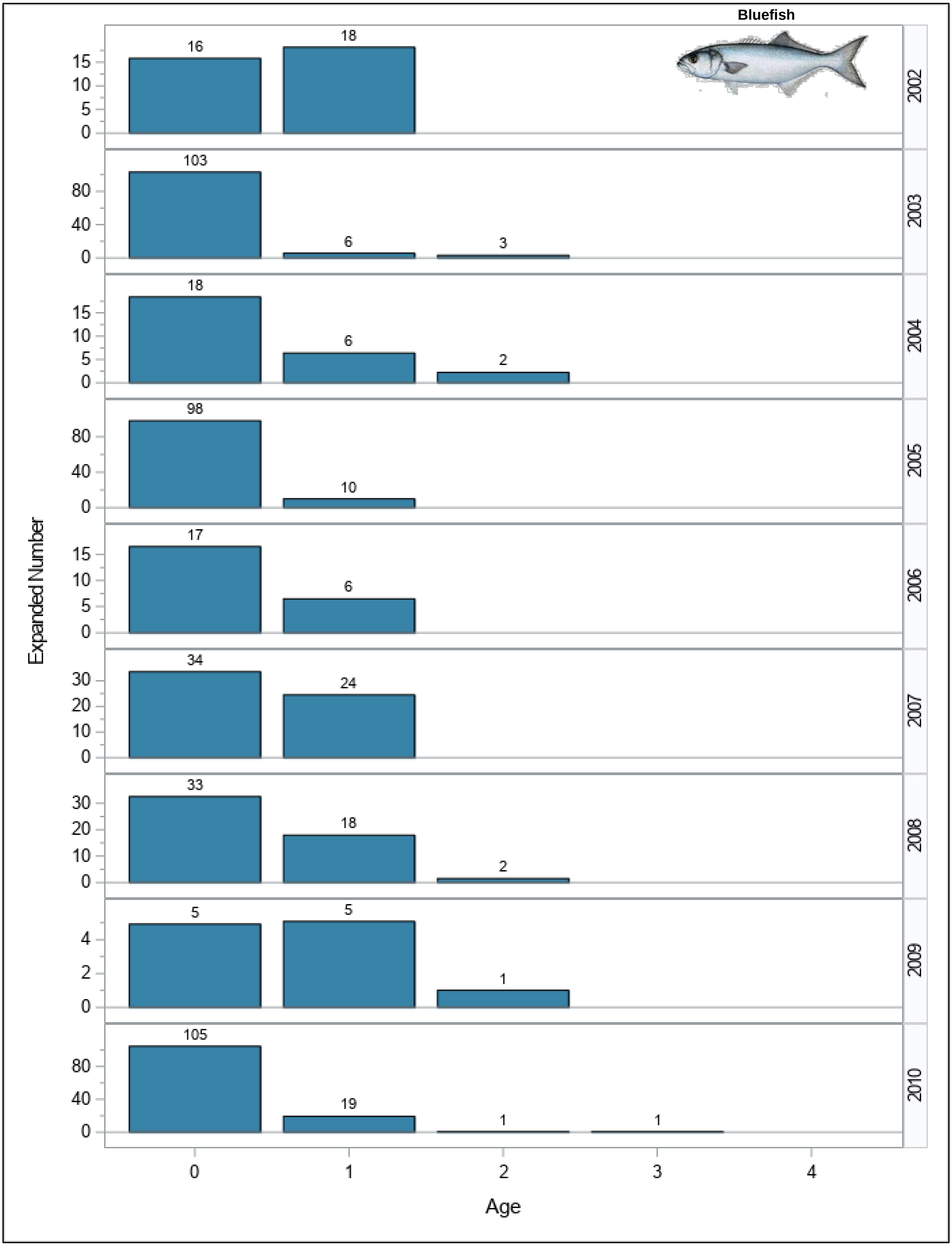


Figure 16. cont.

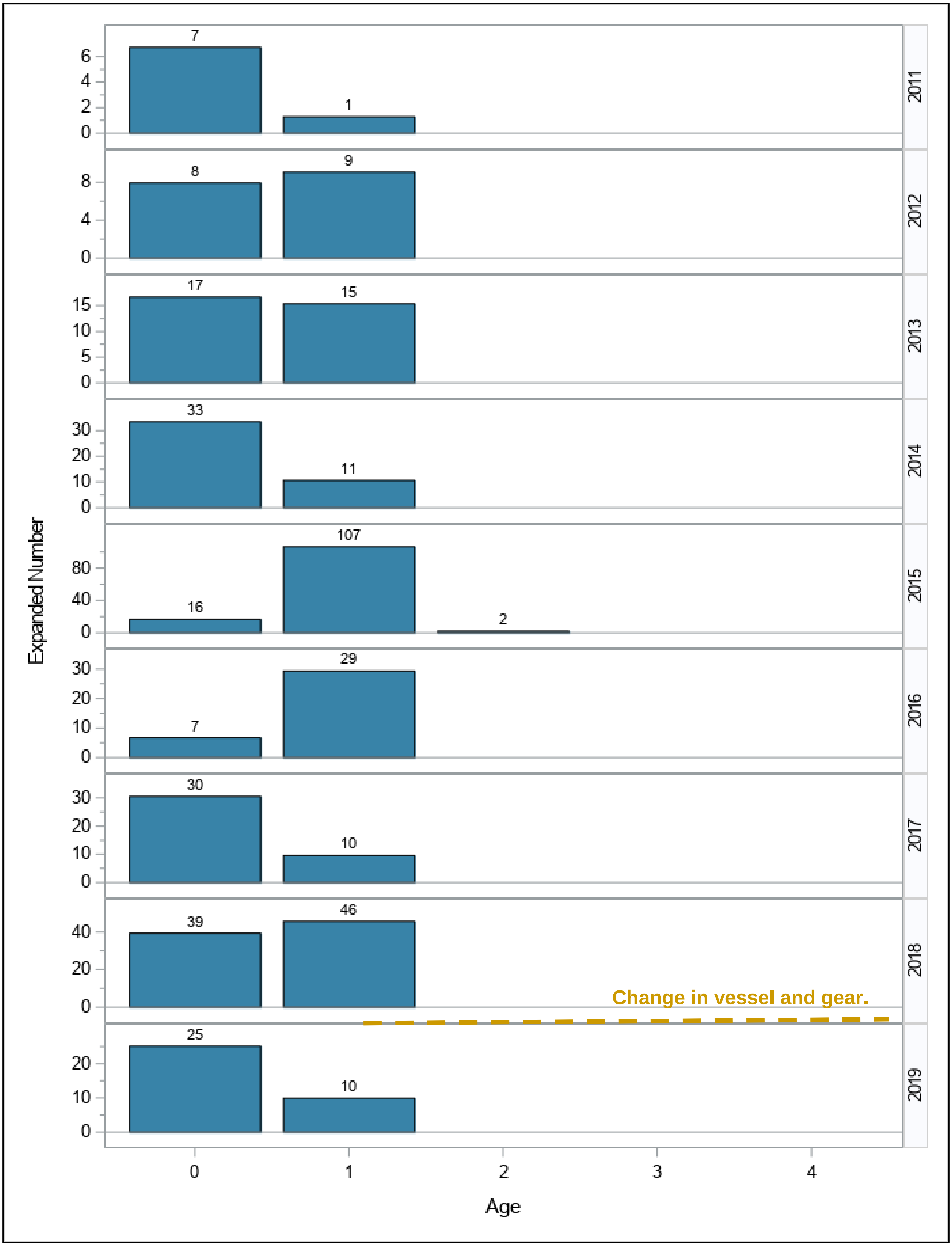


Figure 17. Bluefish age-frequency by year, 2002-2019 standardized to 8,000 (4,800 for 2019) annual trawl minutes.

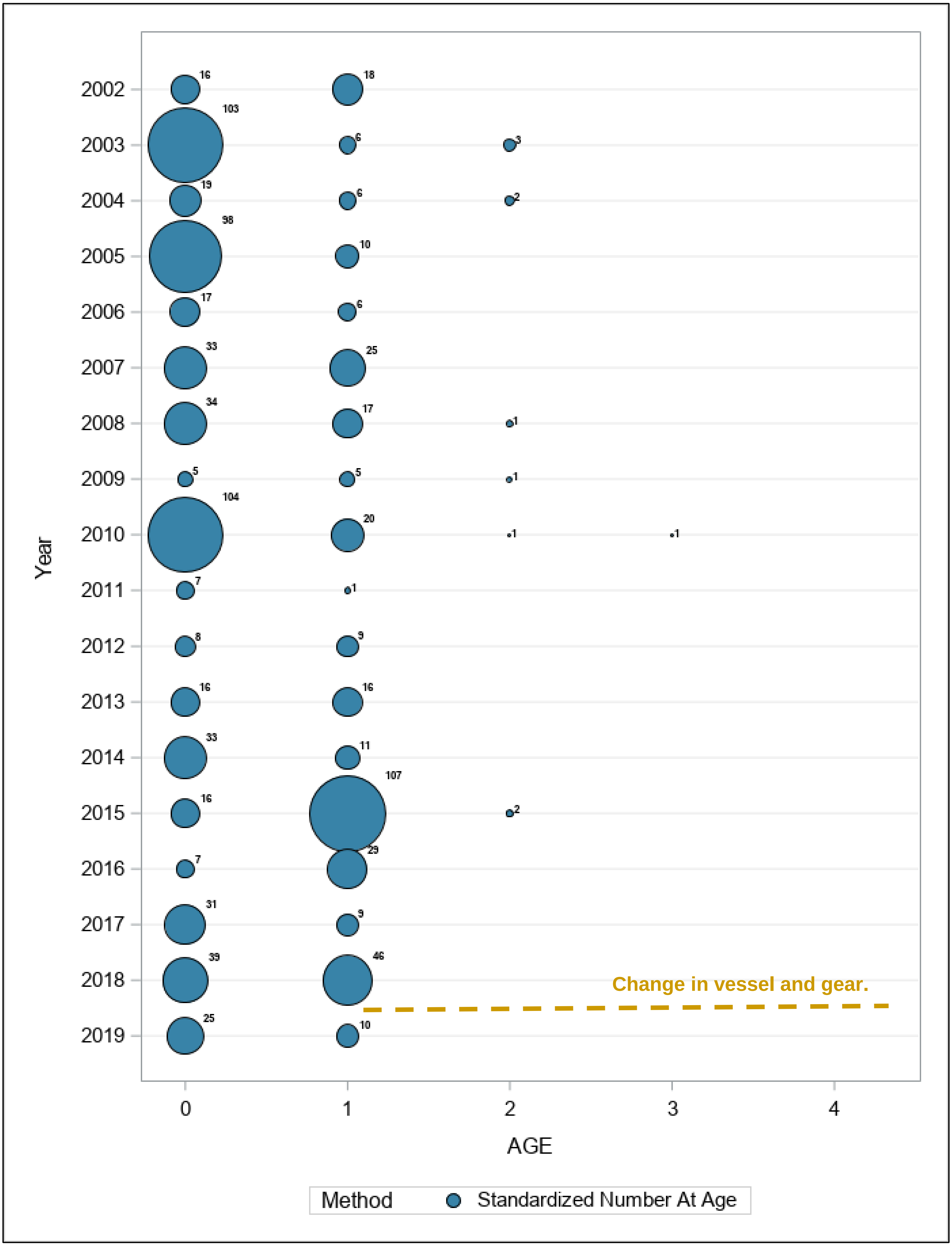


Figure 18. Diet composition, expressed as percent by weight (A) and percent by number (B) of Bluefish collected during ChesMMAP cruises in 2002-2018 combined.

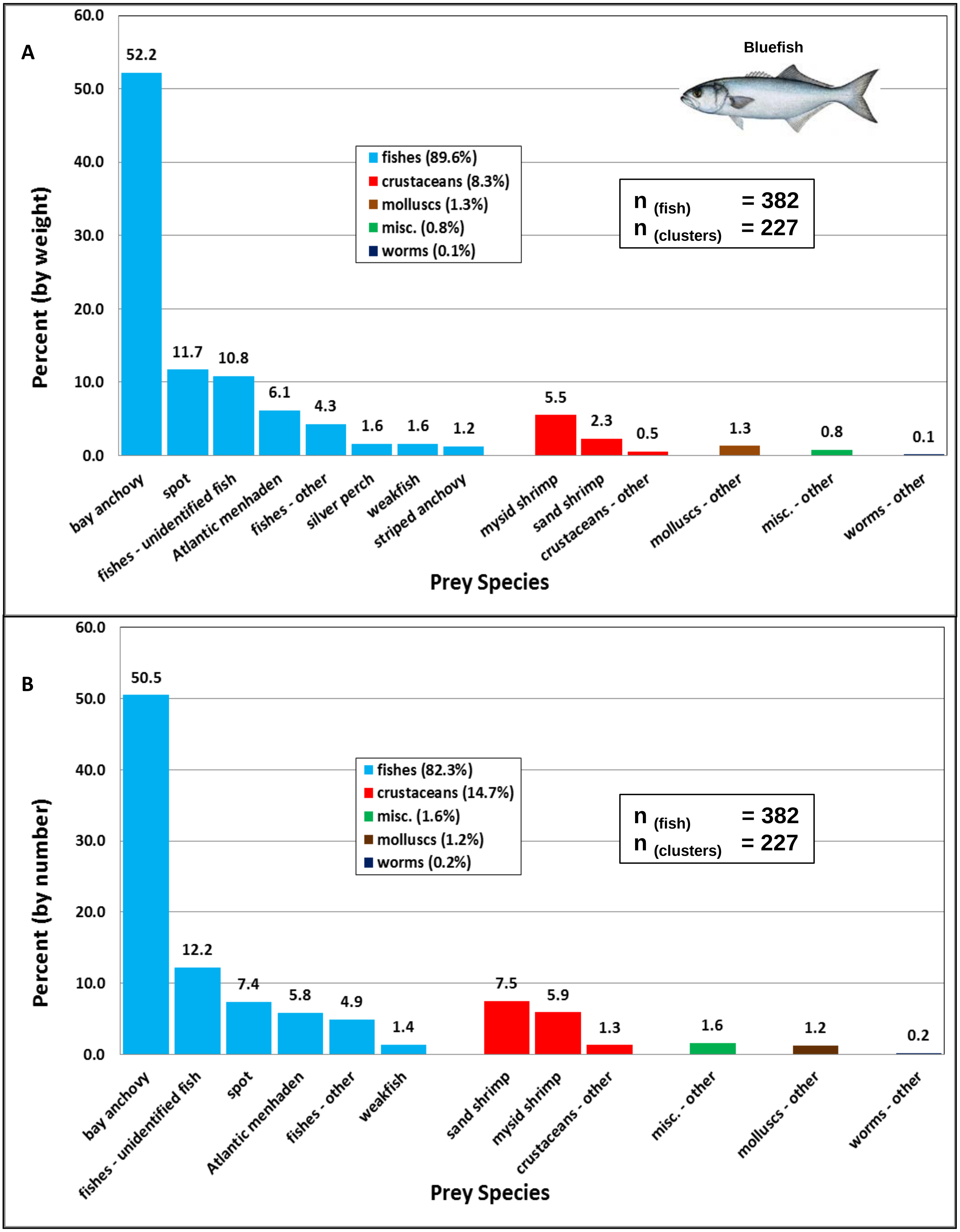


Table 12. Butterfish sampling rates and preserved specimen analysis status by year.

Year	Number Caught	Biomass Caught (kg)	Presence at Index Stations (%)	Number Measured	Age Specimens	Ages Read	Stomach Specimens	Stomachs Analyzed
2002	310	18.3	44.0	310	170	0	168	158
2003	1,000	57.4	62.7	1,000	334	0	334	17
2004	1,133	113.4	55.9	1,071	316	0	316	1
2005	693	48.0	57.0	693	294	0	293	0
2006	634	43.7	62.0	634	3	0	1	0
2007	204	18.8	47.7	204	0	0	0	0
2008	318	22.0	37.8	318	2	0	0	0
2009	415	18.7	55.6	415	0	0	0	0
2010	429	21.9	36.7	429	0	0	0	0
2011	366	22.5	44.9	366	0	0	0	0
2012	991	65.3	35.7	991	0	0	0	0
2013	220	9.6	29.2	220	1	0	0	0
2014	409	20.2	36.7	409	0	0	0	0
2015	402	25.6	21.1	402	0	0	0	0
2016	300	23.3	28.9	300	0	0	0	0
2017	408	21.8	36.7	408	0	0	0	0
2018	124	6.7	20.0	124	0	0	0	0
2019	828	39.9	35.6	828	0	0	0	0

Figure 19. Station specific biomass of Butterfish in Chesapeake Bay, 2019.

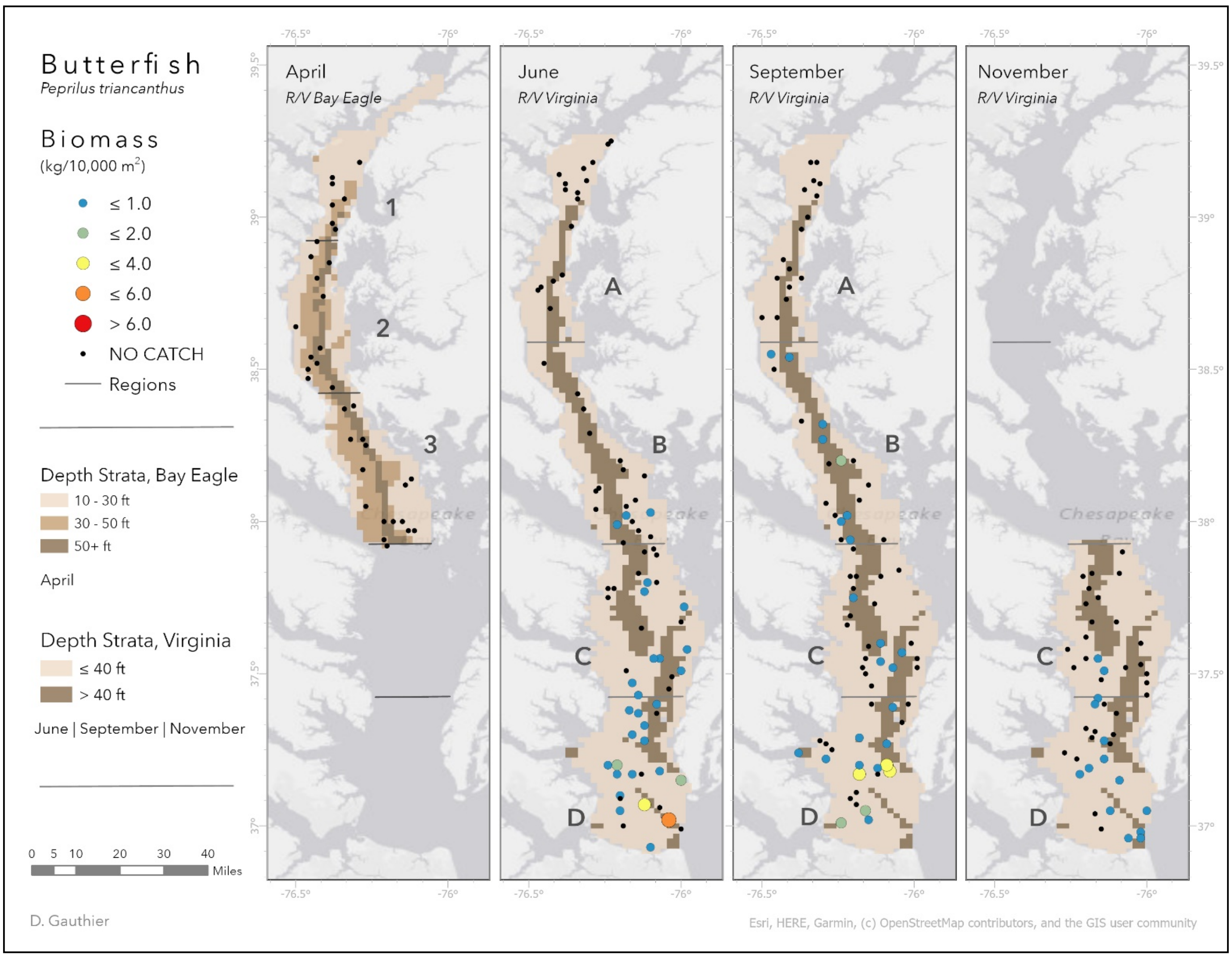


Table 13. Butterfish geometric mean indices of abundance, by number and biomass, overall and by age-class.

Year	Age	n	Numerical Index			Biomass Index		
			LCI	Index	UCI	LCI	Index	UCI
2002	All	75	0.71	1.19	1.80	0.08	0.15	0.23
2003		101	1.54	2.27	3.21	0.18	0.26	0.36
2004		92	1.52	2.25	3.18	0.29	0.43	0.58
2005		86	1.74	2.64	3.83	0.23	0.34	0.46
2006		79	1.44	2.29	3.44	0.16	0.30	0.45
2007		44	0.54	0.97	1.52	0.06	0.15	0.25
2008		90	0.77	1.15	1.60	0.10	0.17	0.24
2009		90	1.32	1.91	2.65	0.11	0.16	0.22
2010		90	0.65	1.11	1.69	0.09	0.17	0.26
2011		89	0.79	1.23	1.77	0.08	0.16	0.24
2012		84	0.49	0.86	1.32	0.09	0.18	0.28
2013		89	0.33	0.62	0.97	0.03	0.08	0.12
2014		90	0.55	0.89	1.30	0.05	0.11	0.17
2015		90	0.32	0.63	1.01	0.05	0.12	0.18
2016		90	0.43	0.72	1.08	0.07	0.14	0.21
2017		90	0.61	1.03	1.57	0.07	0.13	0.20
2018		90	0.13	0.28	0.45	0.00	0.04	0.07
2019		90	0.51	0.86	1.29	0.07	0.14	0.22
2020								
2002	0	75	0.31	0.55	0.83	0.02	0.05	0.08
2003		101	0.72	1.09	1.53	0.06	0.10	0.13
2004		92	0.32	0.48	0.66	0.02	0.04	0.05
2005		86	0.66	1.02	1.44	0.05	0.08	0.11
2006		79	0.66	1.03	1.48	0.05	0.08	0.11
2007		44	0.16	0.29	0.45	0.01	0.03	0.05
2008		90	0.08	0.17	0.27	0.00	0.01	0.01
2009		90	0.16	0.29	0.43	0.01	0.01	0.02
2010		90	0.10	0.22	0.34	0.01	0.02	0.03
2011		89	0.34	0.56	0.81	0.03	0.06	0.09
2012		84	0.06	0.17	0.29	0.00	0.03	0.05
2013		89	0.24	0.47	0.73	0.02	0.05	0.08
2014		90	0.35	0.60	0.91	0.02	0.06	0.11
2015		90	0.07	0.16	0.27	0.00	0.01	0.02
2016		90	0.05	0.14	0.24	0.00	0.02	0.03
2017		90	0.24	0.44	0.67	0.02	0.04	0.06
2018		90	0.09	0.20	0.31	0.00	0.02	0.03
2019		90	0.34	0.59	0.89	0.03	0.07	0.11
2020								
2002	1	75	0.46	0.77	1.14	0.04	0.09	0.14
2003		101	0.91	1.34	1.86	0.10	0.14	0.19
2004		92	0.90	1.32	1.83	0.15	0.23	0.31
2005		86	1.07	1.61	2.28	0.13	0.20	0.27
2006		79	0.86	1.39	2.05	0.09	0.18	0.28
2007		44	0.38	0.69	1.07	0.04	0.10	0.17
2008		90	0.34	0.54	0.76	0.03	0.05	0.07
2009		90	0.95	1.39	1.94	0.07	0.11	0.15
2010		90	0.32	0.58	0.89	0.03	0.08	0.12
2011		89	0.49	0.78	1.12	0.04	0.10	0.16
2012		84	0.40	0.71	1.08	0.07	0.14	0.21
2013		89	0.18	0.36	0.56	0.01	0.04	0.06
2014		90	0.26	0.45	0.66	0.03	0.06	0.09
2015		90	0.26	0.51	0.81	0.04	0.08	0.13
2016		90	0.40	0.68	1.02	0.07	0.13	0.19
2017		90	0.45	0.78	1.18	0.05	0.10	0.15
2018		90	0.03	0.15	0.28	0.00	0.03	0.06
2019		90	0.21	0.43	0.69	0.04	0.09	0.14
2020								

Year	Age	n	Numerical Index			Biomass Index		
			LCI	Index	UCI	LCI	Index	UCI
2002	2	75	0.15	0.27	0.41	0.01	0.03	0.05
2003		101	0.34	0.49	0.66	0.03	0.05	0.07
2004		92	0.58	0.86	1.19	0.11	0.17	0.23
2005		86	0.45	0.66	0.91	0.06	0.09	0.13
2006		79	0.32	0.58	0.90	0.03	0.09	0.16
2007		44	0.14	0.30	0.47	0.01	0.04	0.07
2008		90	0.35	0.55	0.77	0.04	0.08	0.12
2009		90	0.33	0.49	0.67	0.02	0.04	0.06
2010		90	0.38	0.66	1.00	0.04	0.09	0.14
2011		89	0.11	0.23	0.36	0.01	0.03	0.05
2012		84	0.17	0.33	0.51	0.02	0.05	0.08
2013		89	0.08	0.17	0.27	0.01	0.02	0.03
2014		90	0.05	0.12	0.19	0.00	0.01	0.01
2015		90	0.12	0.26	0.42	0.02	0.04	0.07
2016		90	0.00	0.04	0.09	0.00	0.01	0.01
2017		90	0.00	0.04	0.09	0.00	0.01	0.02
2018		90	0.00	0.02	0.06	0.00	0.00	0.00
2019		90	0.05	0.10	0.16	0.00	0.01	0.02
2020								
2002	3	75	0.04	0.10	0.15	0.00	0.01	0.02
2003		101	0.11	0.17	0.23	0.01	0.02	0.03
2004		92	0.29	0.44	0.61	0.05	0.08	0.12
2005		86	0.16	0.25	0.35	0.02	0.04	0.05
2006		79	0.12	0.27	0.45	0.01	0.04	0.08
2007		44	0.05	0.12	0.21	0.00	0.02	0.03
2008		90	0.18	0.31	0.46	0.03	0.05	0.08
2009		90	0.12	0.21	0.29	0.01	0.02	0.02
2010		90	0.16	0.29	0.43	0.01	0.03	0.05
2011		89	0.03	0.10	0.17	0.00	0.01	0.02
2012		84	0.01	0.05	0.08	0.00	0.01	0.01
2013		89	0.04	0.10	0.16	0.00	0.01	0.02
2014		90	0.00	0.05	0.11	0.00	0.00	0.01
2015		90	0.00	0.02	0.05	0.00	0.00	0.00
2016		90	0.00	0.03	0.08	0.00	0.00	0.01
2017		90	0.00	0.01	0.03	0.00	0.00	0.00
2018		90	0.00	0.02	0.06	0.00	0.00	0.00
2019		90	0.00	0.02	0.05	0.00	0.00	0.01
2020								
2002	4+	75	0.00	0.03	0.07	0.00	0.00	0.01
2003		101	0.01	0.04	0.07	0.00	0.00	0.01
2004		92	0.05	0.13	0.20	0.01	0.02	0.03
2005		86	0.02	0.06	0.10	0.00	0.01	0.02
2006		79	0.02	0.11	0.21	0.00	0.02	0.03
2007		44	0.00	0.04	0.09	0.00	0.01	0.02
2008		90	0.05	0.12	0.18	0.01	0.02	0.02
2009		90	0.03	0.08	0.13	0.00	0.01	0.01
2010		90	0.02	0.05	0.08	0.00	0.00	0.01
2011		89	0.00	0.04	0.09	0.00	0.01	0.02
2012		84	0.00	0.01	0.04	0.00	0.00	0.01
2013		89	0.03	0.08	0.14	0.00	0.01	0.02
2014		90	0.00	0.05	0.10	0.00	0.00	0.00
2015		90	0.00	0.02	0.05	0.00	0.00	0.00
2016		90	0.00	0.03	0.08	0.00	0.00	0.01
2017		90	0.00	0.01	0.03	0.00	0.00	0.00
2018		90	0.00	0.02	0.06	0.00	0.00	0.00
2019		90	0.00	0.02	0.05	0.00	0.00	0.01
2020								

Figure 20. Butterfish geometric mean indices of abundance, by number and biomass, for all ages combined and by age-class.

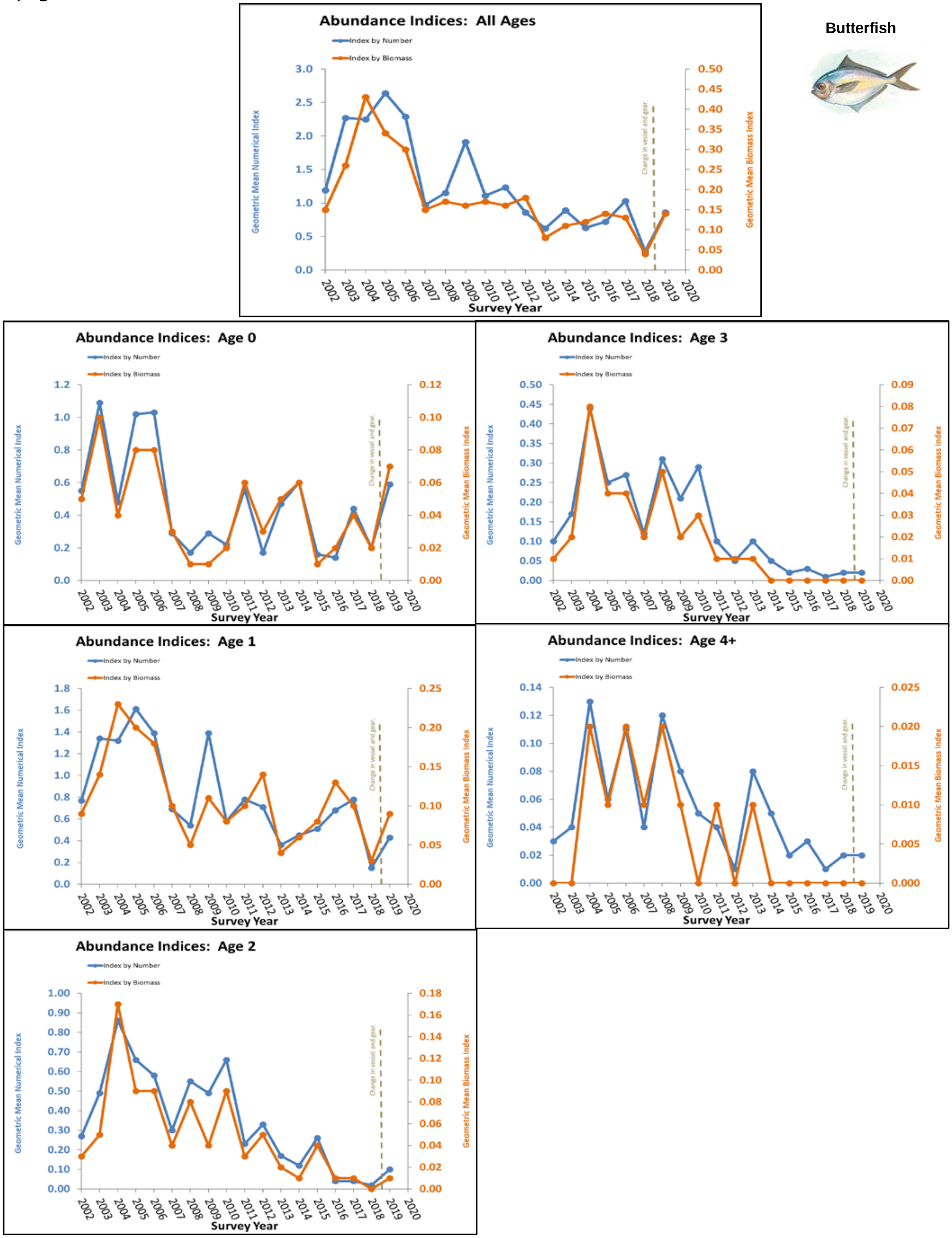


Figure 21. Butterfish length-frequency in Chesapeake Bay 2002-2019, overall.

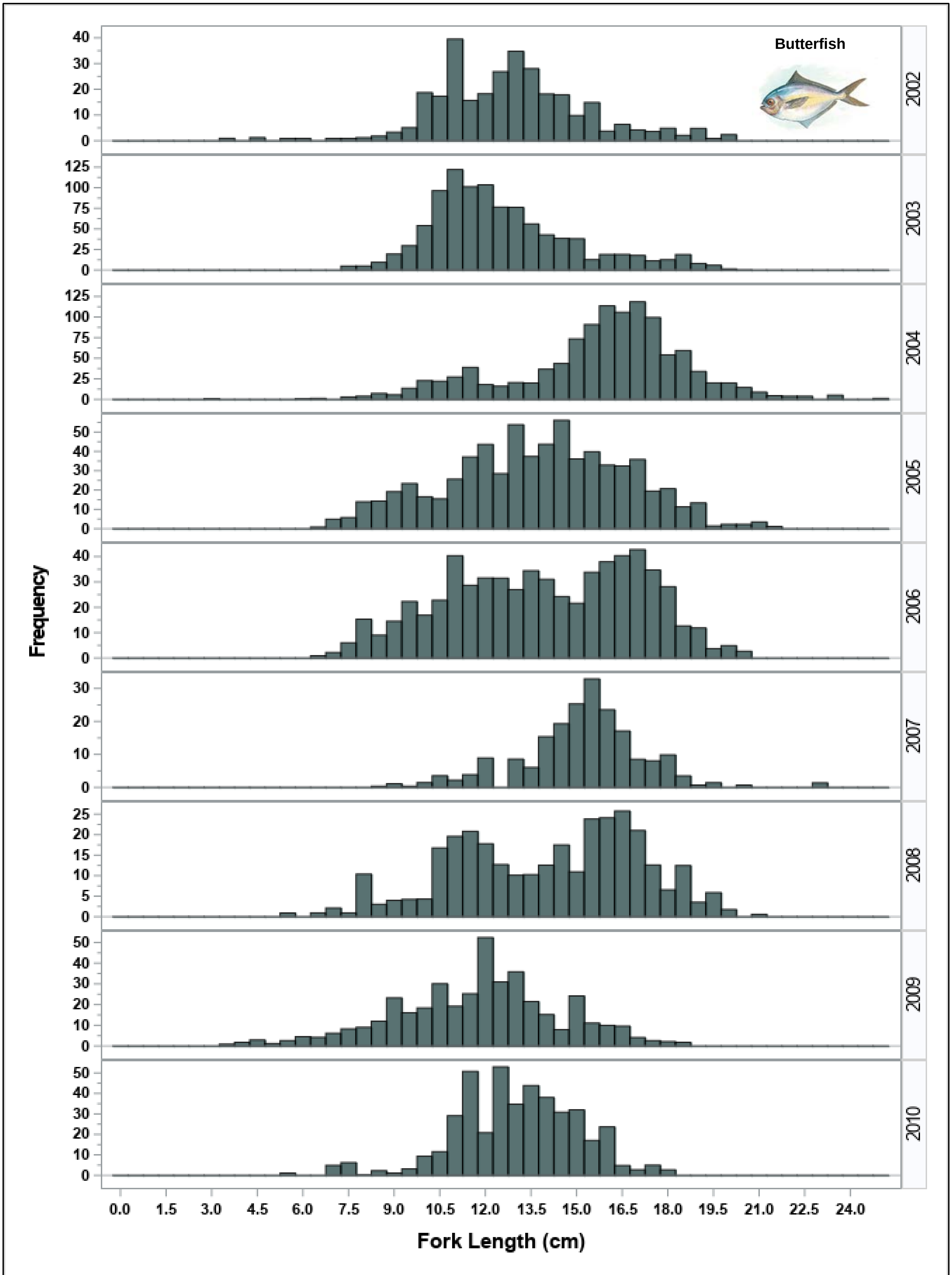


Figure 21. cont.

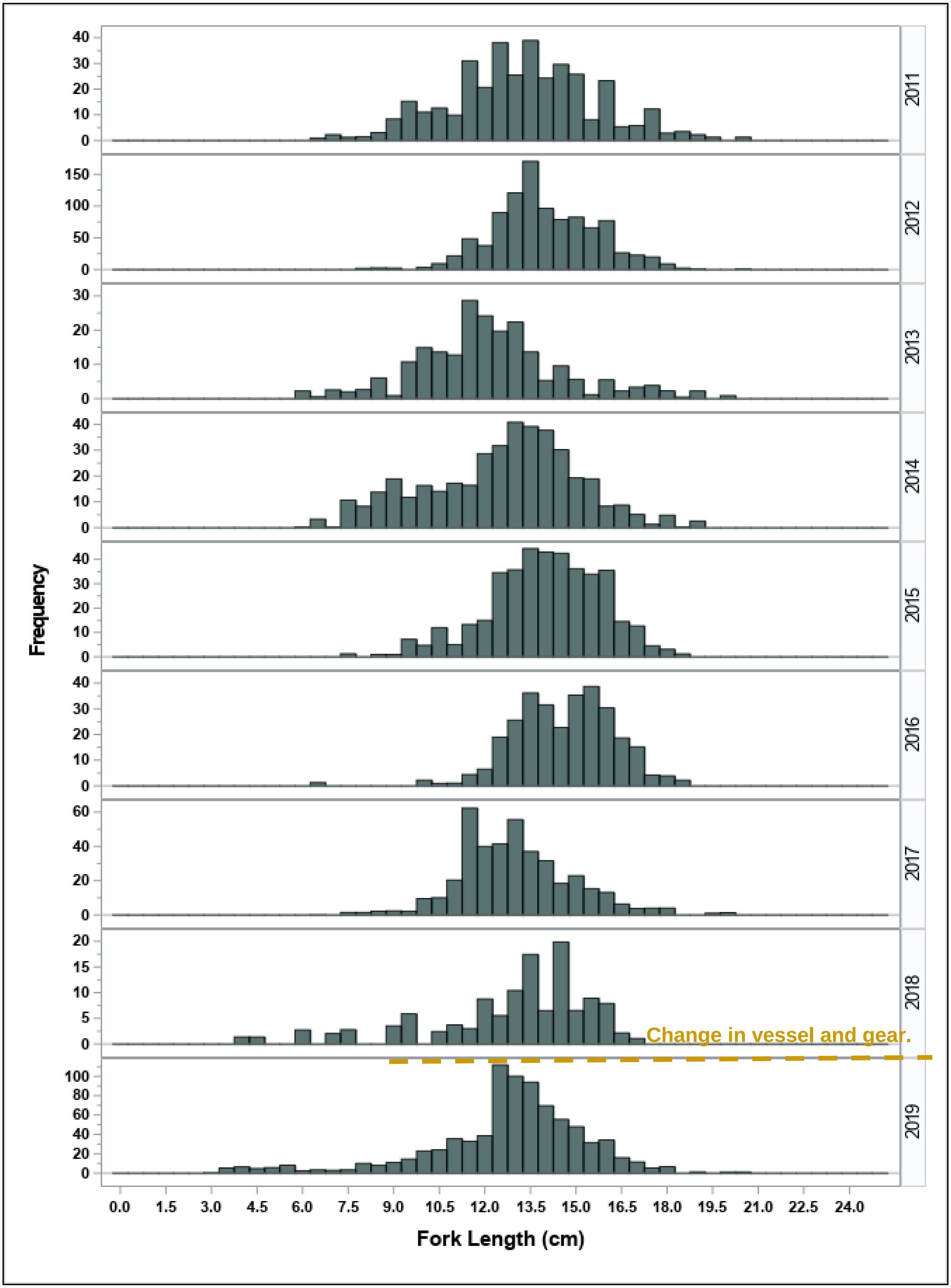


Table 14. Kingfish sampling rates and preserved specimen analysis status by year.

Year	Number Caught	Biomass Caught	PercentPresence	Number Measured	Age Specimens	Ages Read	Stomach Specimens	Stomachs Analyzed
2002	143	18.5	22.4	143	91	91	87	79
2003	68	19.2	12.9	68	55	55	55	50
2004	67	16.0	14.0	67	55	55	50	48
2005	86	15.3	19.3	86	72	72	69	68
2006	120	24.1	26.1	120	94	94	84	83
2007	122	17.7	25.6	122	88	88	78	76
2008	333	62.6	21.7	300	113	113	97	97
2009	195	24.8	36.3	195	152	152	135	134
2010	447	82.5	35.8	447	231	231	206	199
2011	336	55.7	32.4	336	176	175	155	155
2012	148	24.6	25.9	148	114	0	96	92
2013	165	32.1	24.0	165	106	0	77	77
2014	76	14.2	12.8	76	57	0	39	36
2015	156	24.1	19.4	156	112	0	61	60
2016	613	80.1	42.8	613	265	0	166	163
2017	361	55.2	30.6	361	198	0	138	137
2018	239	39.0	37.2	239	167	0	104	104
2019	3,871	435.9	71.9	2,904	331	0	217	213

Figure 22. Station specific biomass of Kingfish in Chesapeake Bay, 2019.

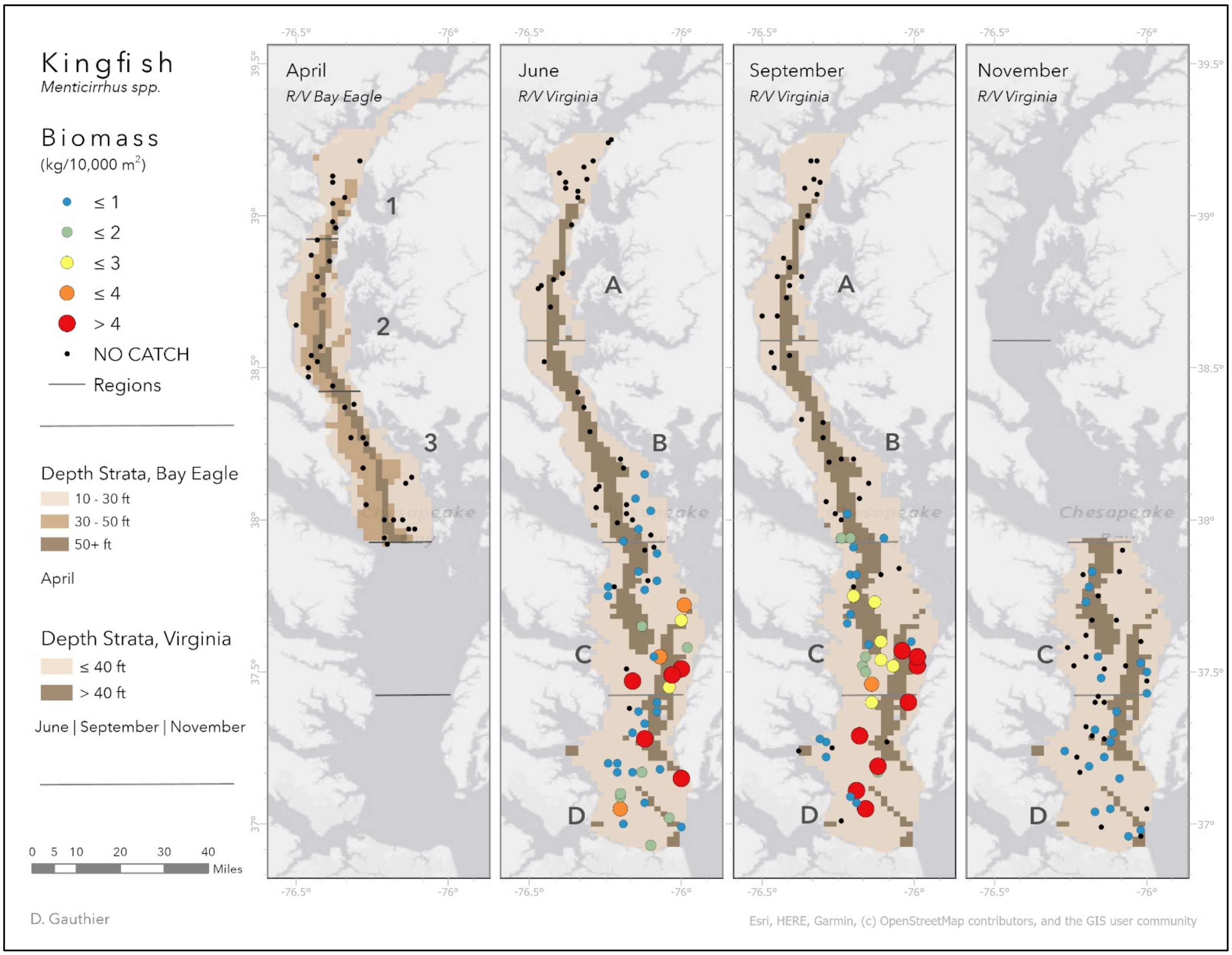


Table 15. Kingfish geometric mean indices of abundance, by number and biomass, overall and by age-class.

Year	Age	n	Numerical Index LCI	Numerical Index Index	Numerical Index UCI	Biomass Index LCI	Biomass Index Index	Biomass Index UCI
2002	All	165	0.16	0.25	0.35	0.03	0.06	0.09
2003		149	0.10	0.18	0.28	0.04	0.08	0.12
2004		177	0.07	0.13	0.20	0.02	0.05	0.08
2005		176	0.16	0.25	0.36	0.04	0.07	0.10
2006		165	0.25	0.38	0.53	0.08	0.12	0.17
2007		133	0.25	0.41	0.58	0.06	0.10	0.15
2008		180	0.29	0.46	0.66	0.09	0.17	0.26
2009		135	0.50	0.73	1.00	0.11	0.17	0.23
2010		179	0.60	0.86	1.16	0.18	0.28	0.38
2011		179	0.50	0.71	0.95	0.13	0.20	0.28
2012		174	0.26	0.39	0.54	0.07	0.11	0.15
2013		179	0.25	0.38	0.53	0.08	0.13	0.17
2014		180	0.10	0.19	0.28	0.03	0.06	0.09
2015		180	0.18	0.29	0.41	0.05	0.08	0.12
2016		180	0.75	1.04	1.37	0.20	0.28	0.37
2017		180	0.45	0.66	0.89	0.13	0.19	0.26
2018		180	0.45	0.62	0.81	0.11	0.16	0.21
2019		135	3.61	5.16	7.24	0.80	1.12	1.51
2020								
2002	0	75	0.18	0.32	0.48	0.02	0.05	0.08
2003		101	0.02	0.08	0.14	0.01	0.03	0.05
2004		92	0.05	0.10	0.15	0.01	0.02	0.03
2005		86	0.12	0.26	0.41	0.02	0.05	0.08
2006		79	0.03	0.13	0.24	0.00	0.02	0.05
2007		44	0.15	0.40	0.71	0.01	0.05	0.08
2008		90	0.01	0.07	0.15	0.00	0.00	0.00
2009		90	0.14	0.31	0.50	0.01	0.04	0.07
2010		90	0.27	0.47	0.71	0.03	0.07	0.11
2011		89	0.15	0.29	0.44	0.01	0.02	0.04
2012		84	0.02	0.08	0.14	0.00	0.01	0.02
2013		89	0.00	0.02	0.05	0.00	0.01	0.02
2014		90	0.00	0.05	0.10	0.00	0.01	0.02
2015		90	0.07	0.20	0.35	0.01	0.04	0.07
2016		90	0.22	0.41	0.62	0.04	0.08	0.13
2017		90	0.01	0.09	0.18	0.00	0.02	0.03
2018		90	0.12	0.23	0.36	0.00	0.02	0.04
2019		90	1.56	2.49	3.75	0.33	0.57	0.85
2020								
2002	1	165	0.09	0.16	0.24	0.02	0.05	0.07
2003		149	0.06	0.12	0.19	0.02	0.05	0.08
2004		177	0.03	0.08	0.13	0.01	0.03	0.05
2005		176	0.10	0.18	0.26	0.02	0.05	0.07
2006		165	0.09	0.18	0.27	0.02	0.05	0.08
2007		133	0.11	0.21	0.32	0.03	0.05	0.08
2008		180	0.16	0.28	0.41	0.04	0.09	0.15
2009		135	0.17	0.28	0.40	0.03	0.06	0.09
2010		179	0.31	0.45	0.60	0.09	0.13	0.18
2011		179	0.21	0.34	0.49	0.05	0.10	0.16
2012		174	0.13	0.22	0.31	0.03	0.05	0.08
2013		179	0.14	0.23	0.32	0.04	0.07	0.10
2014		180	0.07	0.13	0.20	0.02	0.04	0.06
2015		180	0.10	0.19	0.27	0.02	0.05	0.08
2016		180	0.43	0.60	0.80	0.11	0.16	0.21
2017		180	0.28	0.41	0.57	0.07	0.11	0.15
2018		180	0.23	0.33	0.44	0.05	0.07	0.10
2019		135	1.59	2.30	3.21	0.40	0.57	0.77
2020								
2002	2	165	0.06	0.11	0.18	0.01	0.03	0.05
2003		149	0.07	0.13	0.21	0.02	0.05	0.09
2004		177	0.05	0.11	0.17	0.01	0.04	0.07
2005		176	0.09	0.16	0.22	0.02	0.04	0.06
2006		165	0.14	0.25	0.36	0.04	0.08	0.11
2007		133	0.11	0.21	0.31	0.03	0.06	0.09
2008		180	0.16	0.29	0.43	0.05	0.11	0.17
2009		135	0.31	0.46	0.64	0.08	0.12	0.17
2010		179	0.32	0.46	0.62	0.09	0.14	0.19
2011		179	0.22	0.35	0.49	0.05	0.10	0.15
2012		174	0.15	0.24	0.32	0.04	0.06	0.08
2013		179	0.15	0.24	0.34	0.04	0.08	0.11
2014		180	0.08	0.15	0.22	0.02	0.04	0.07
2015		180	0.12	0.21	0.30	0.03	0.06	0.09
2016		180	0.33	0.46	0.60	0.08	0.11	0.15
2017		180	0.29	0.42	0.57	0.07	0.11	0.15
2018		180	0.26	0.36	0.47	0.06	0.08	0.11
2019		135	0.76	1.05	1.40	0.16	0.23	0.30
2020								

Year	Age	n	Numerical Index LCI	Numerical Index Index	Numerical Index UCI	Biomass Index LCI	Biomass Index Index	Biomass Index UCI
2002	3	165	0.07	0.13	0.19	0.02	0.03	0.05
2003		149	0.02	0.07	0.12	0.01	0.03	0.04
2004		177	0.03	0.08	0.13	0.01	0.03	0.05
2005		176	0.09	0.16	0.23	0.02	0.04	0.07
2006		165	0.11	0.19	0.28	0.03	0.06	0.09
2007		133	0.11	0.21	0.32	0.03	0.06	0.09
2008		180	0.15	0.26	0.39	0.04	0.09	0.15
2009		135	0.11	0.19	0.29	0.02	0.05	0.07
2010		179	0.30	0.43	0.58	0.08	0.13	0.18
2011		179	0.15	0.26	0.38	0.03	0.07	0.12
2012		174	0.10	0.16	0.23	0.02	0.04	0.06
2013		179	0.10	0.17	0.25	0.03	0.05	0.08
2014		180	0.06	0.12	0.18	0.01	0.03	0.05
2015		180	0.11	0.19	0.28	0.03	0.05	0.08
2016		180	0.21	0.29	0.38	0.05	0.07	0.09
2017		180	0.16	0.25	0.35	0.03	0.06	0.08
2018		180	0.19	0.26	0.34	0.04	0.05	0.07
2019		135	0.33	0.46	0.60	0.06	0.09	0.11
2020								
2002	4	165	0.06	0.12	0.18	0.01	0.03	0.04
2003		149	0.03	0.08	0.13	0.01	0.03	0.05
2004		177	0.03	0.07	0.12	0.00	0.03	0.05
2005		176	0.07	0.13	0.19	0.01	0.03	0.05
2006		165	0.12	0.21	0.31	0.04	0.07	0.10
2007		133	0.08	0.18	0.27	0.02	0.05	0.07
2008		180	0.11	0.21	0.31	0.03	0.07	0.12
2009		135	0.09	0.17	0.26	0.02	0.04	0.06
2010		179	0.15	0.22	0.30	0.03	0.05	0.07
2011		179	0.13	0.23	0.35	0.02	0.06	0.11
2012		174	0.07	0.12	0.18	0.01	0.03	0.05
2013		179	0.07	0.13	0.20	0.02	0.04	0.06
2014		180	0.05	0.11	0.17	0.01	0.03	0.05
2015		180	0.09	0.17	0.25	0.02	0.05	0.07
2016		180	0.13	0.21	0.28	0.03	0.05	0.07
2017		180	0.12	0.20	0.28	0.02	0.04	0.07
2018		180	0.14	0.20	0.27	0.02	0.04	0.06
2019		135	0.15	0.23	0.31	0.03	0.04	0.05
2020								
2002	5+	165	0.06	0.11	0.18	0.01	0.03	0.04
2003		149	0.02	0.07	0.12	0.01	0.03	0.05
2004		177	0.03	0.07	0.12	0.00	0.03	0.05
2005		176	0.07	0.13	0.19	0.01	0.03	0.05
2006		165	0.07	0.14	0.22	0.02	0.04	0.07
2007		133	0.07	0.15	0.24	0.02	0.04	0.06
2008		180	0.09	0.17	0.27	0.02	0.06	0.10
2009		135	0.09	0.16	0.24	0.01	0.03	0.06
2010		179	0.11	0.18	0.25	0.02	0.04	0.06
2011		179	0.08	0.17	0.27	0.01	0.05	0.09
2012		174	0.05	0.10	0.16	0.01	0.03	0.04
2013		179	0.06	0.12	0.18	0.02	0.04	0.06
2014		180	0.05	0.10	0.16	0.01	0.03	0.05
2015		180	0.08	0.16	0.24	0.02	0.04	0.07
2016		180	0.10	0.17	0.24	0.02	0.04	0.06
2017		180	0.10	0.17	0.25	0.02	0.04	0.06
2018		180	0.11	0.17	0.24	0.02	0.03	0.05
2019		135	0.10	0.16	0.23	0.02	0.03	0.04
2020								

Figure 23. Kingfish geometric mean indices of abundance, by number and biomass, for all ages combined and by age-class.

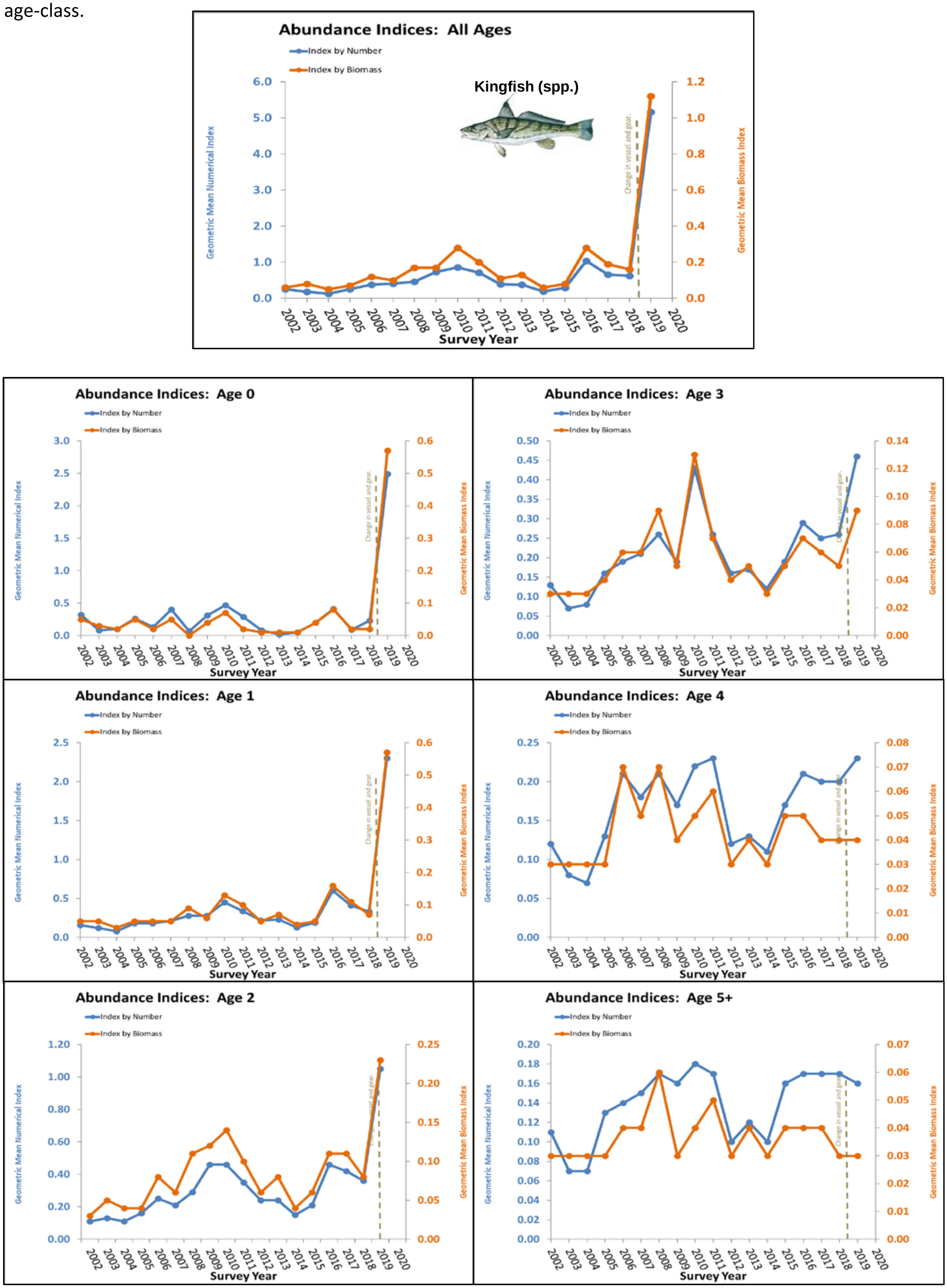


Figure 24. Kingfish length-frequency in Chesapeake Bay 2002-2019, overall (A) and by sex (B).

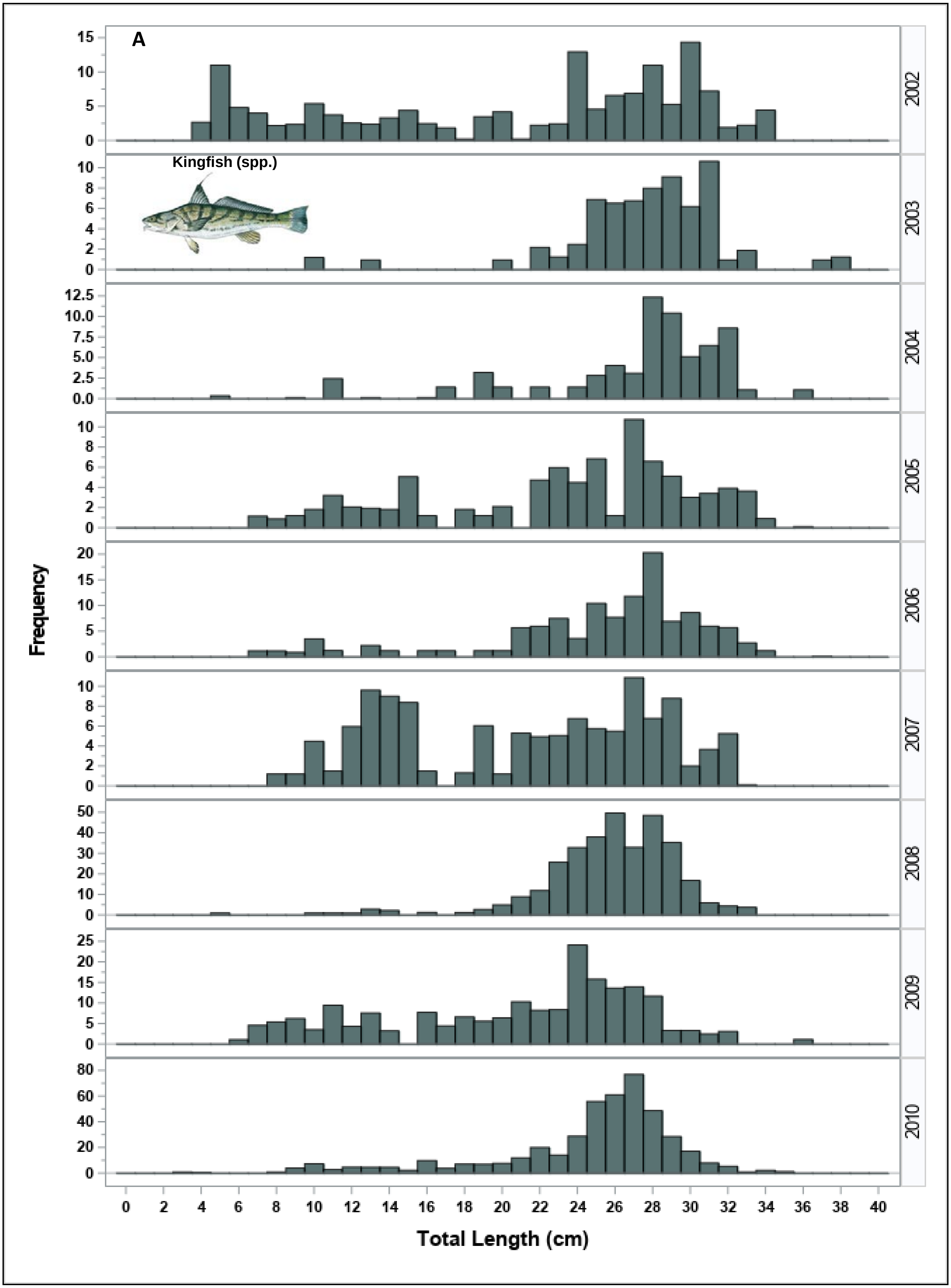


Figure 24. cont.

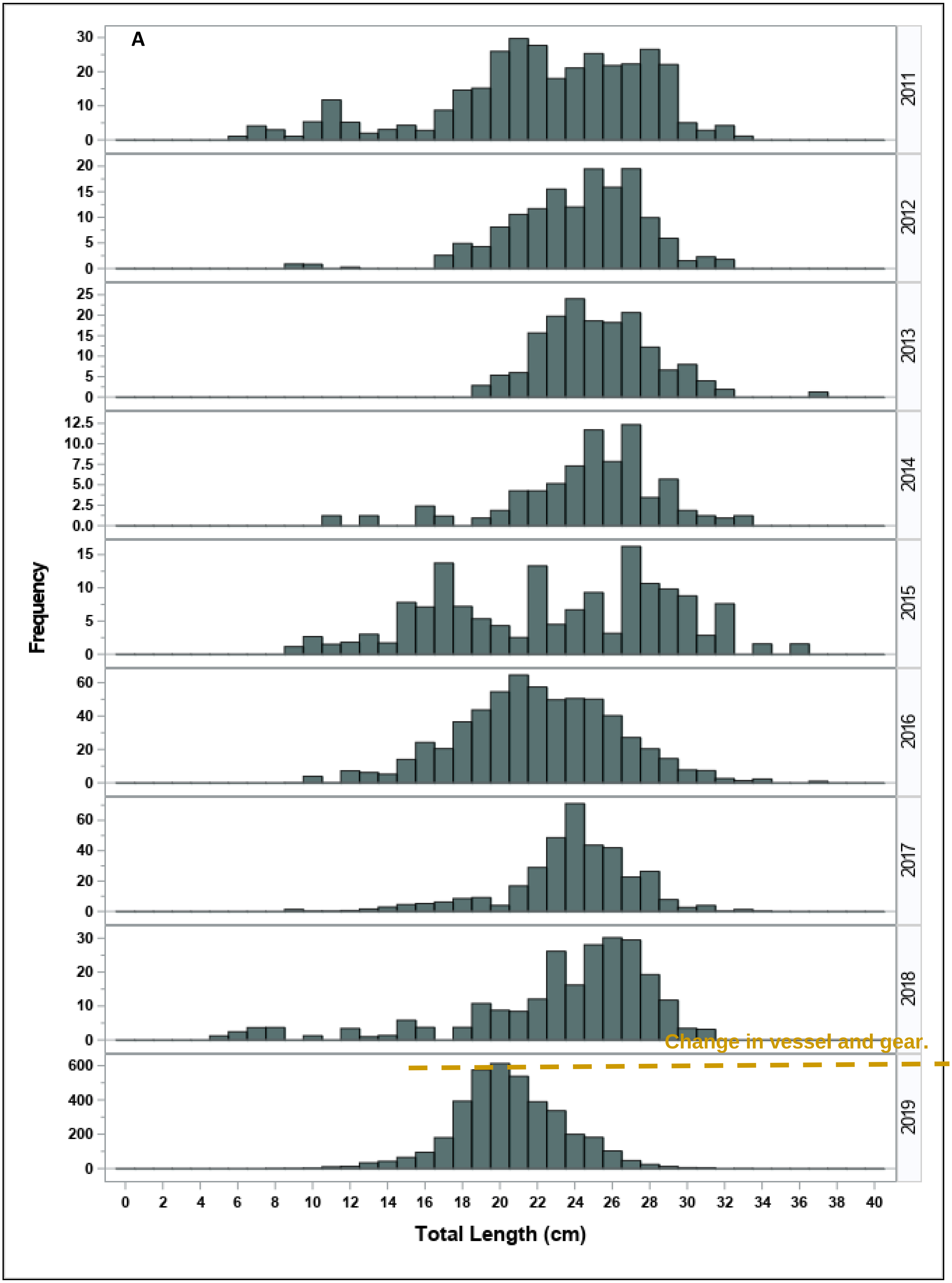


Figure4. cont.

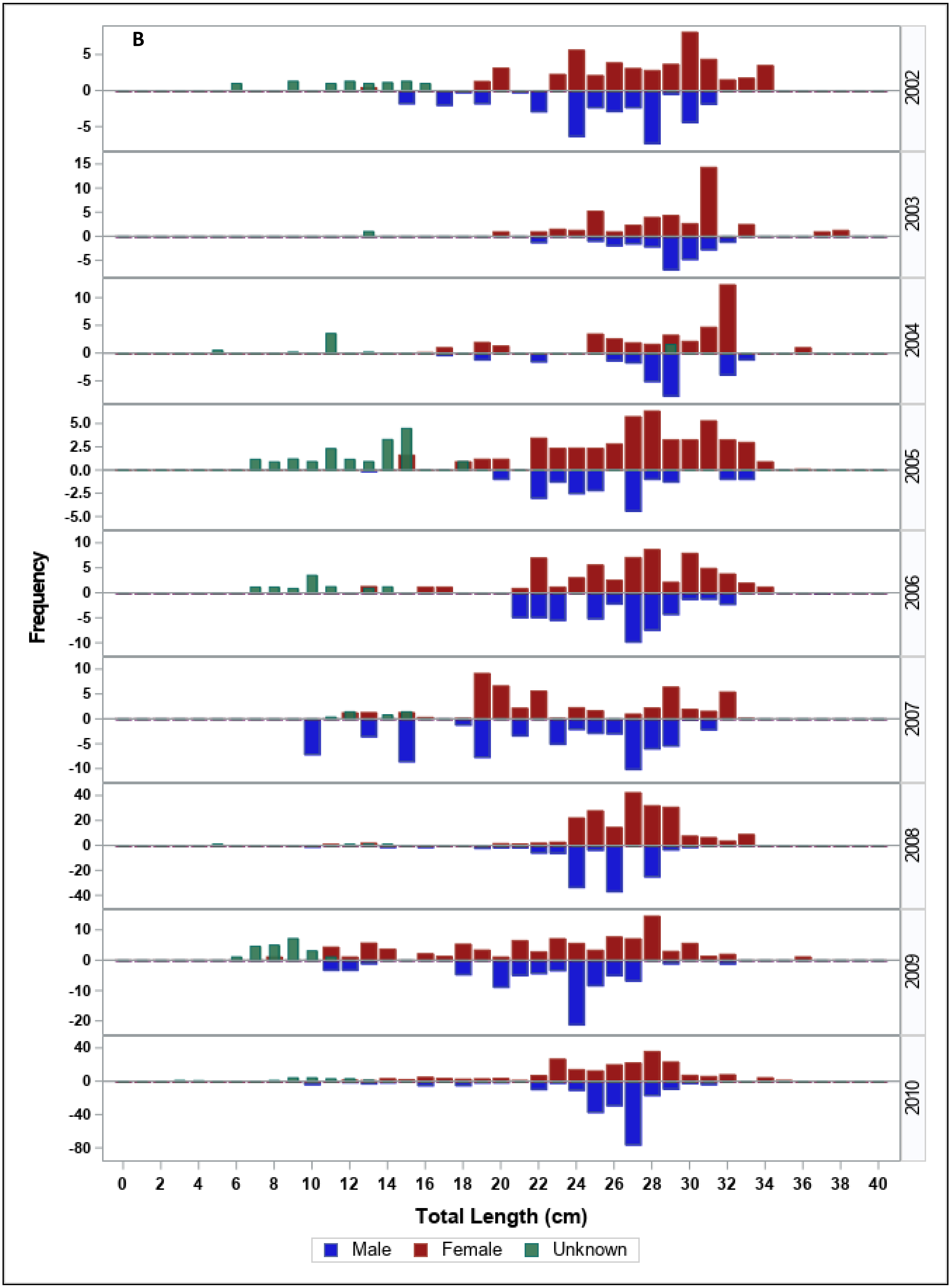


Figure 24. cont.

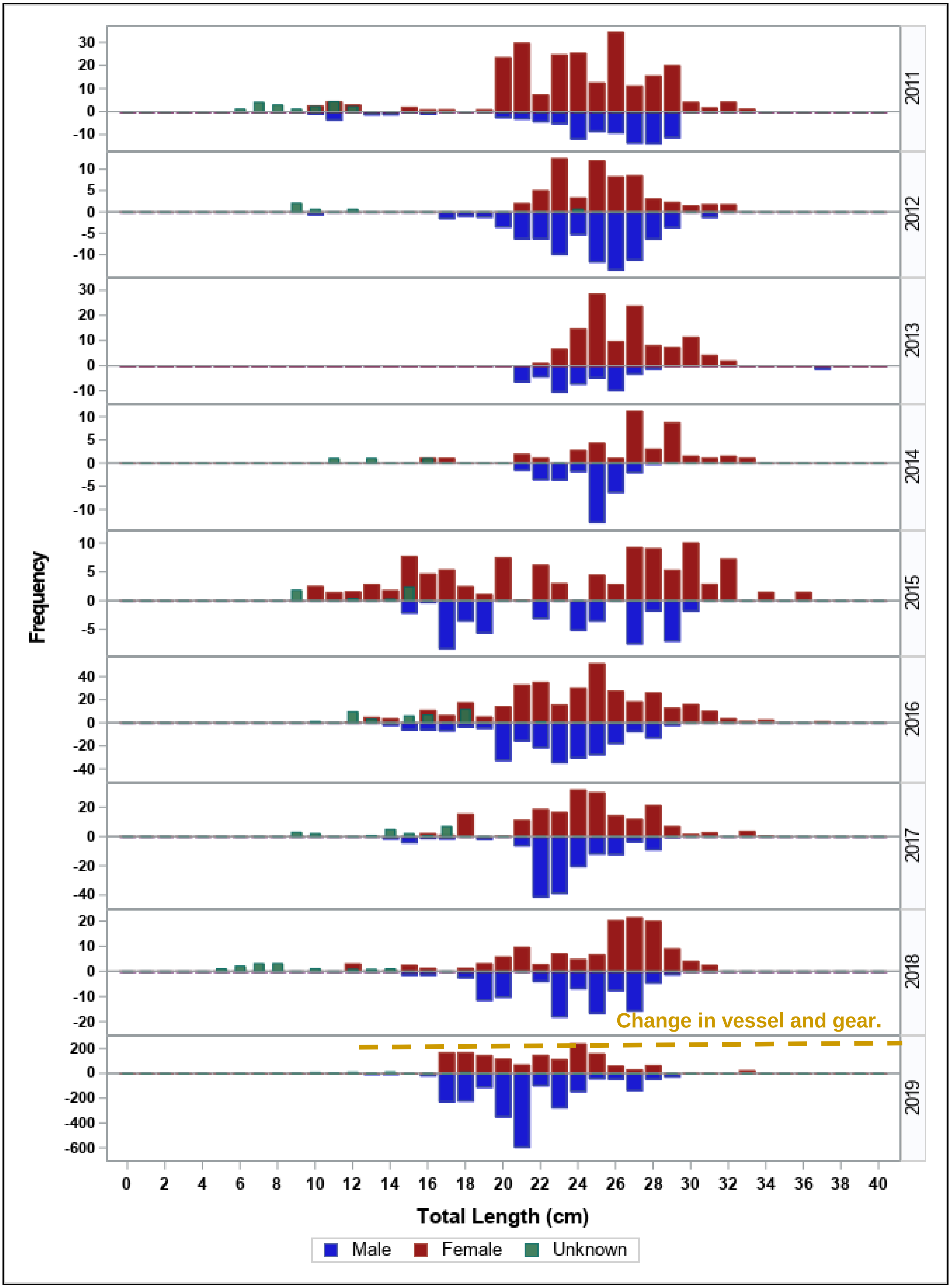


Figure 25. Kingfish age-frequency by year, 2002-2019.

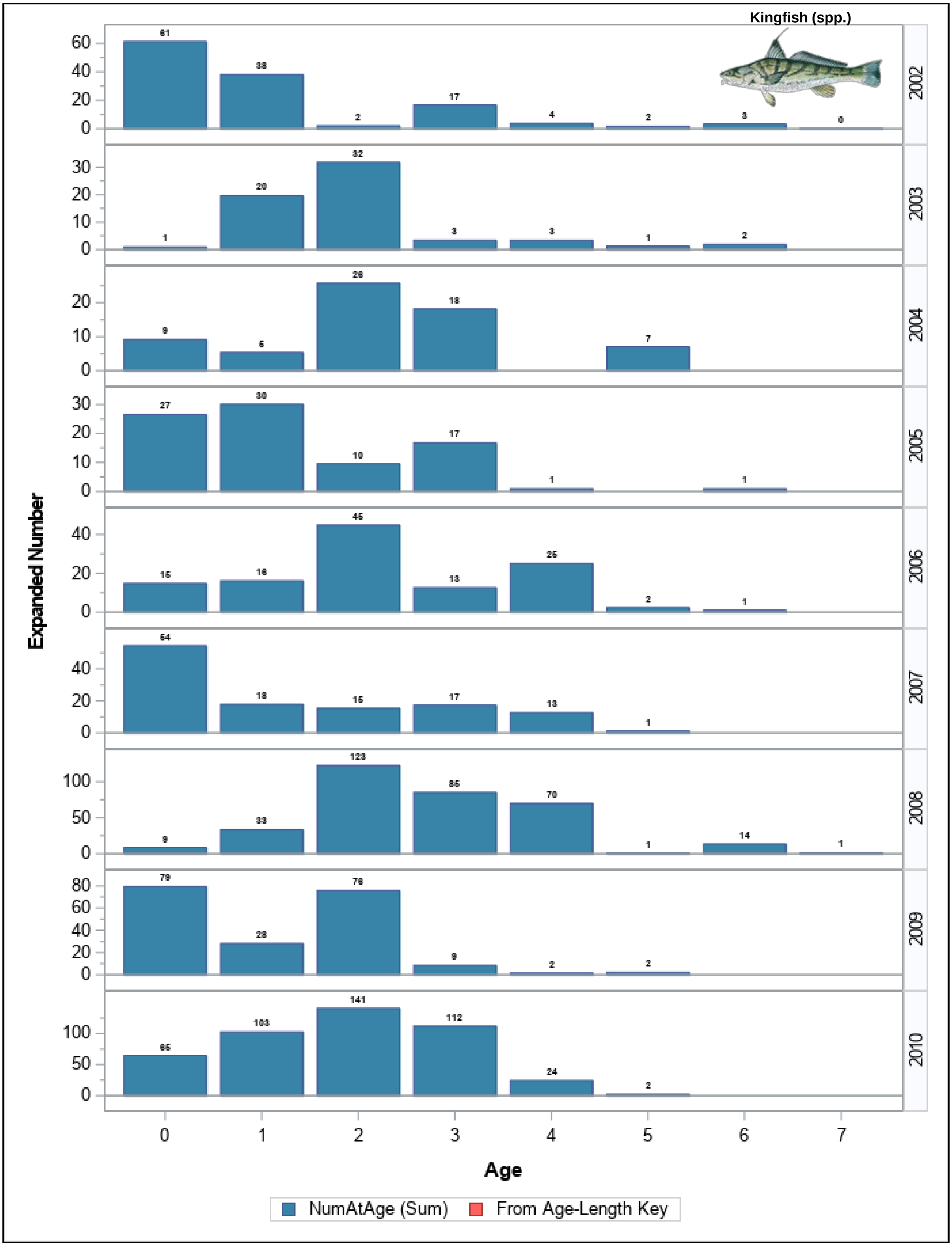


Figure 25. cont.

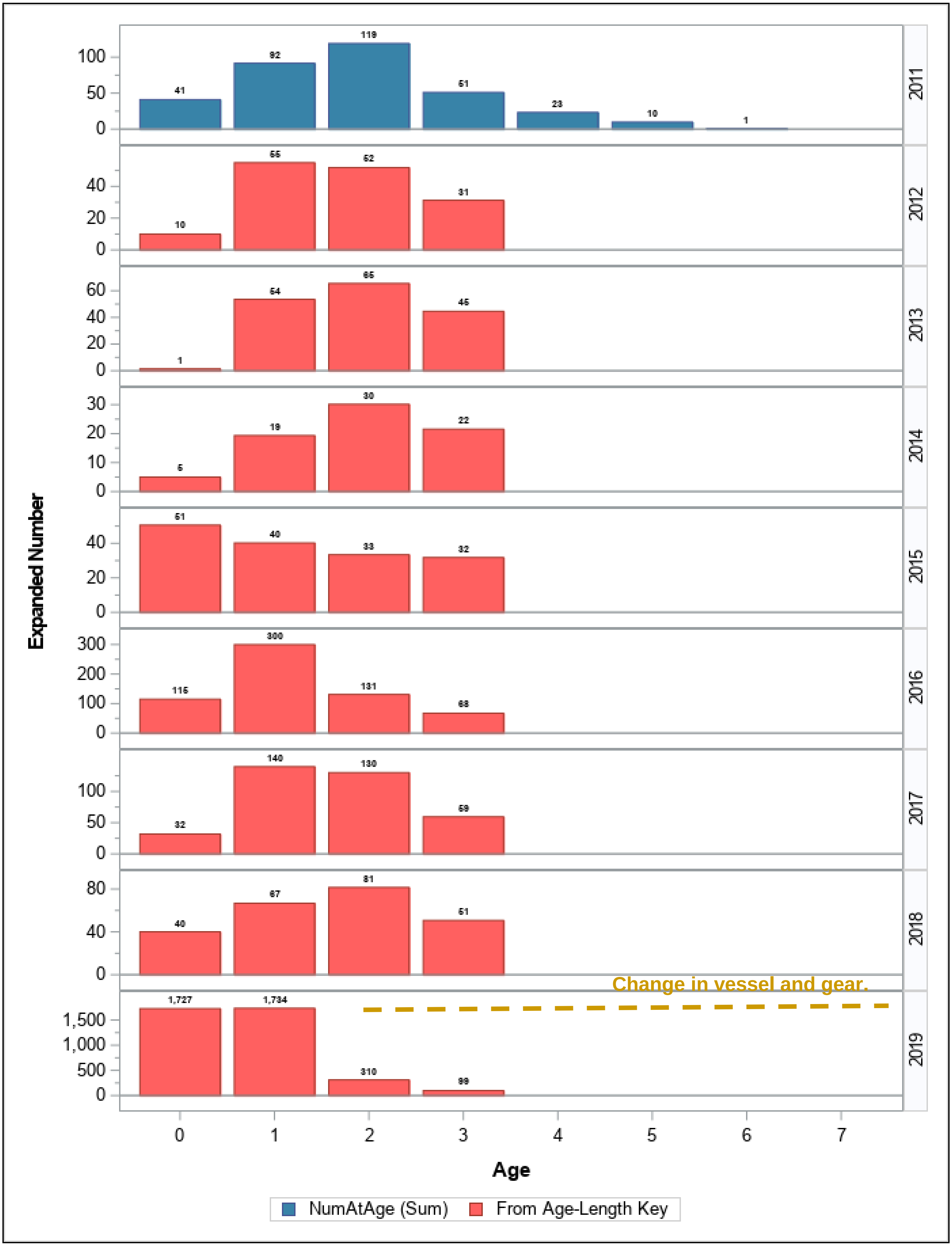


Figure 26. Kingfish age-frequency by year, 2002-2019 standardized to 8,000 (4,800 for 2019) annual trawl minutes.

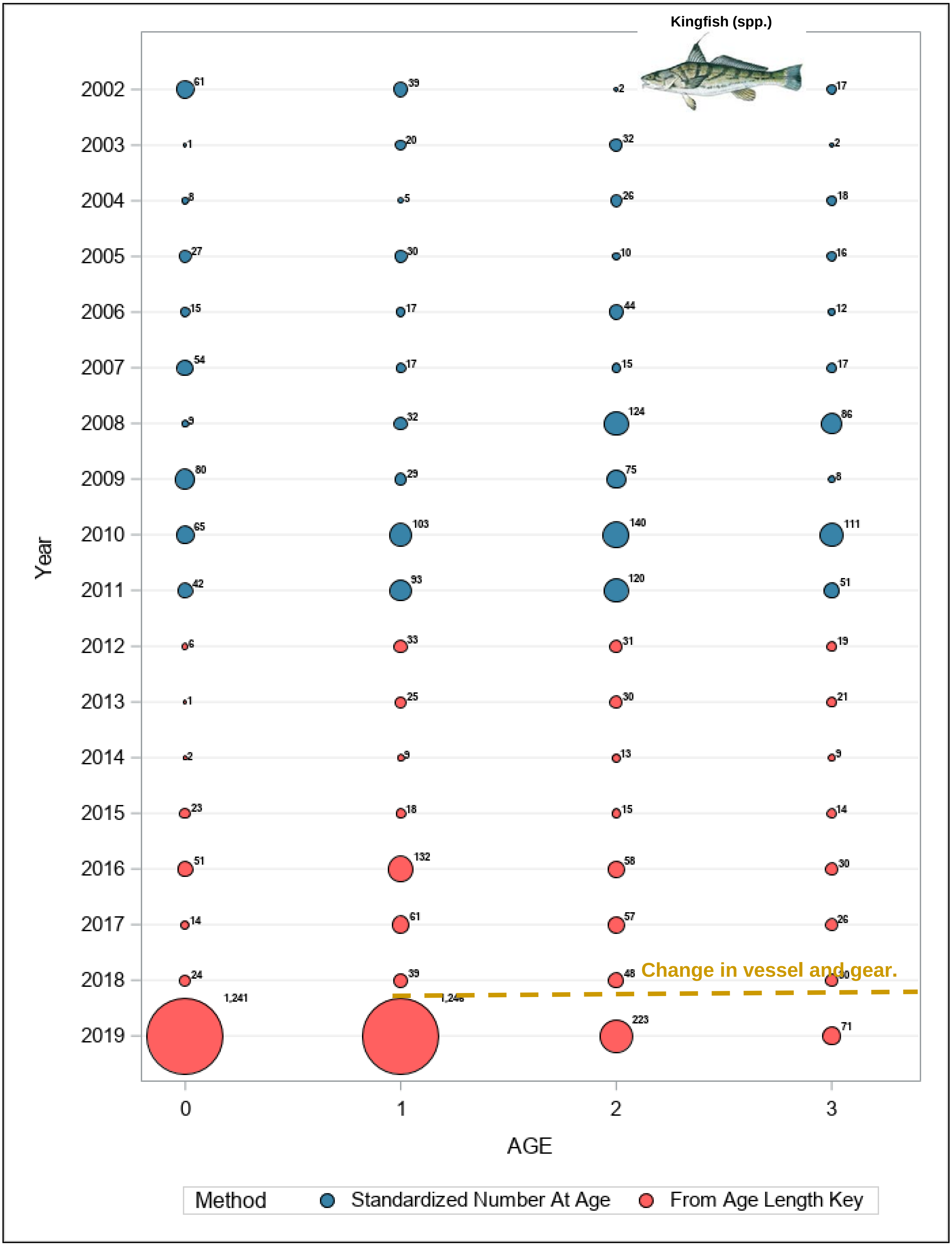


Figure 27. Diet composition, expressed as percent by weight (A) and percent by number (B) of Kingfish collected during ChesMMAP cruises in 2002-2018 combined.

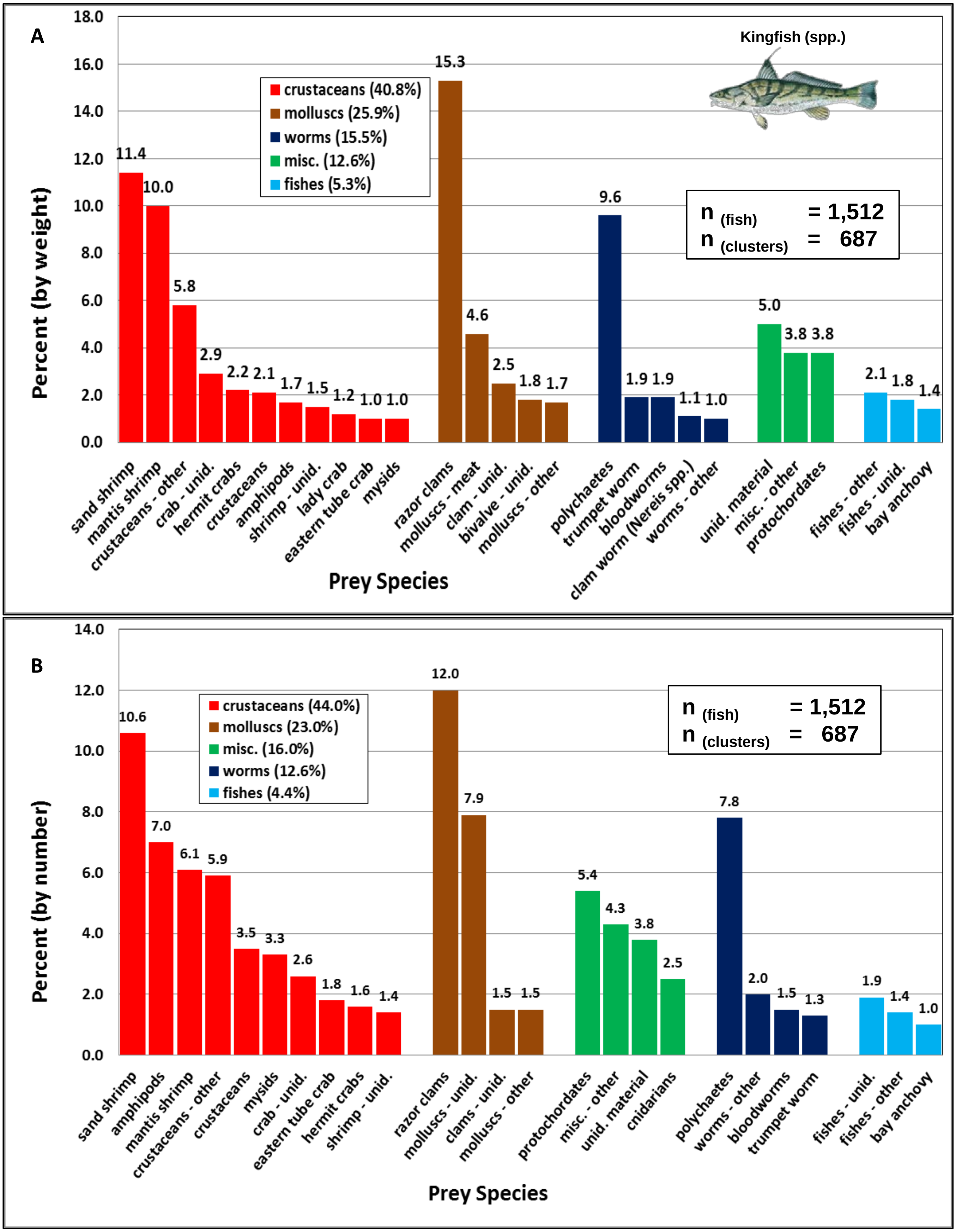


Table 16. Northern Puffer sampling rates and preserved specimen analysis status by year.

Year	Number Caught	Biomass Caught (kg)	Presence at Index Stations (%)	Number Measured	Age Specimens	Ages Read	Stomach Specimens	Stomachs Analyzed
2002	231	24.2	48.0	231	177	0	171	156
2003	225	33.1	36.3	225	100	0	92	91
2004	41	6.9	9.7	41	31	0	27	26
2005	131	13.7	25.6	131	84	0	84	83
2006	52	5.5	17.7	52	51	0	48	47
2007	155	19.8	75.0	155	127	0	124	124
2008	90	6.9	21.1	90	78	0	77	77
2009	76	7.2	24.4	76	69	0	68	67
2010	326	54.7	44.4	326	176	0	157	156
2011	614	55.0	50.6	614	247	0	238	236
2012	50	5.3	11.9	50	50	0	41	40
2013	63	4.2	15.7	63	61	0	55	52
2014	49	3.7	12.2	49	39	0	16	16
2015	290	44.1	36.7	290	157	0	54	54
2016	519	65.6	40.0	519	231	0	99	97
2017	231	22.4	25.6	231	148	0	116	116
2018	246	24.5	28.9	246	128	0	87	87
2019	143	13.6	22.2	143	99	0	77	75

Figure 28. Station specific biomass of Northern Puffer in Chesapeake Bay, 2019.

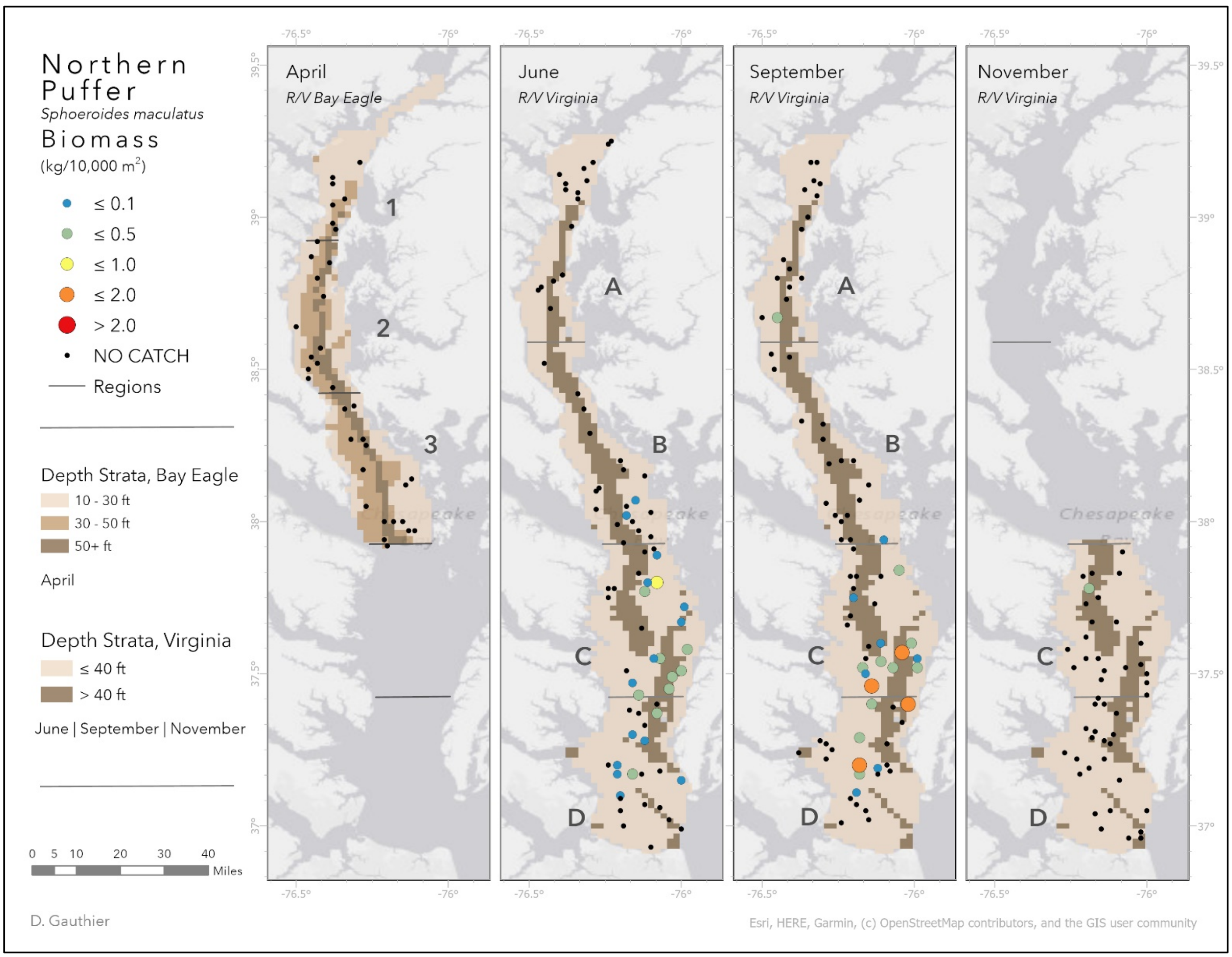


Table 17. Northern Puffer geometric mean indices of abundance, by number and biomass, overall.

Year	Age	n	Numerical Index			Biomass Index		
			LCI	Index	UCI	LCI	Index	UCI
2002	All	75	0.76	1.14	1.60	0.13	0.20	0.27
2003		101	0.45	0.69	0.97	0.10	0.17	0.25
2004		92	0.04	0.13	0.22	0.01	0.04	0.07
2005		86	0.22	0.42	0.66	0.04	0.09	0.15
2006		79	0.11	0.25	0.41	0.02	0.05	0.08
2007		44	1.54	2.23	3.11	0.26	0.39	0.52
2008		90	0.15	0.29	0.45	0.02	0.05	0.08
2009		90	0.22	0.40	0.61	0.04	0.07	0.11
2010		90	0.82	1.29	1.87	0.16	0.30	0.46
2011		89	1.17	1.69	2.33	0.20	0.34	0.48
2012		84	0.04	0.12	0.20	0.00	0.01	0.02
2013		89	0.08	0.18	0.30	0.00	0.01	0.02
2014		90	0.05	0.16	0.29	0.01	0.02	0.04
2015		90	0.49	0.82	1.22	0.12	0.24	0.37
2016		90	0.66	1.14	1.76	0.15	0.29	0.45
2017		90	0.21	0.37	0.57	0.03	0.06	0.10
2018		90	0.34	0.62	0.96	0.06	0.13	0.22
2019		90	0.20	0.38	0.60	0.03	0.08	0.13
2020								

Figure 29. Northern Puffer geometric mean indices of abundance, by number and biomass, for all ages combined.

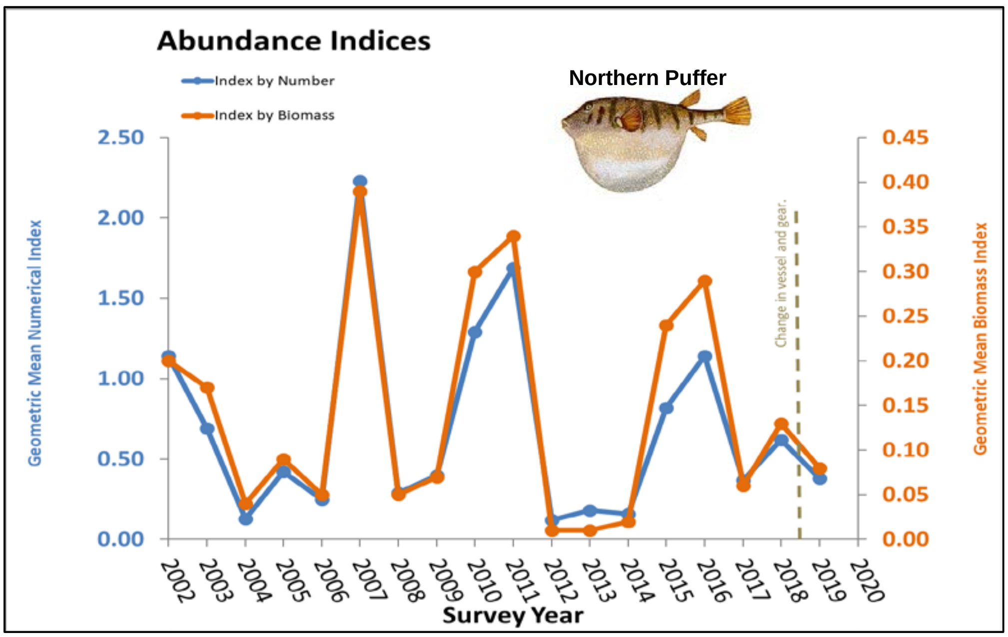


Figure 30. Northern Puffer length-frequency in Chesapeake Bay 2002-2019, overall (A) and by sex (B).

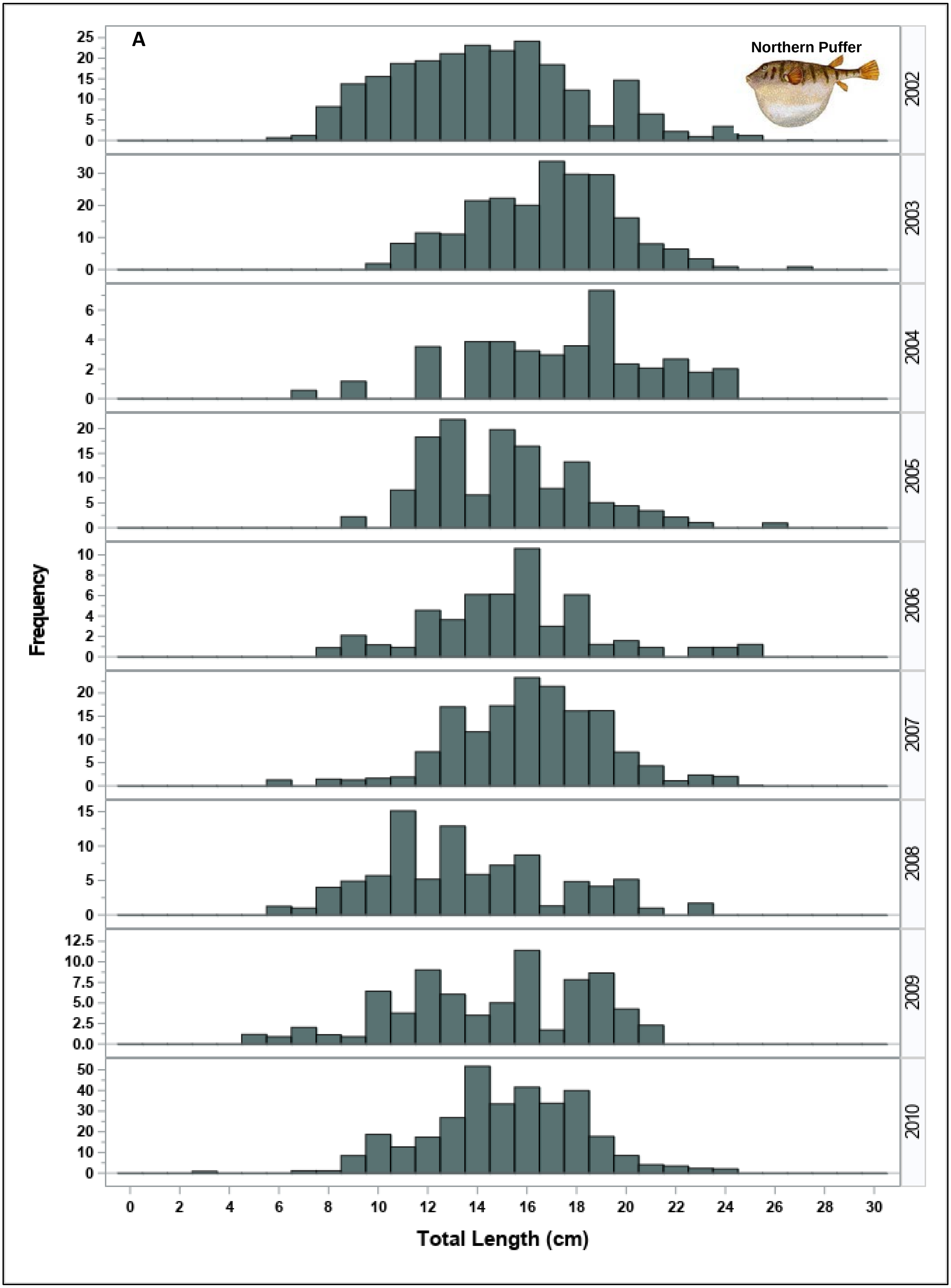


Figure 30. cont.

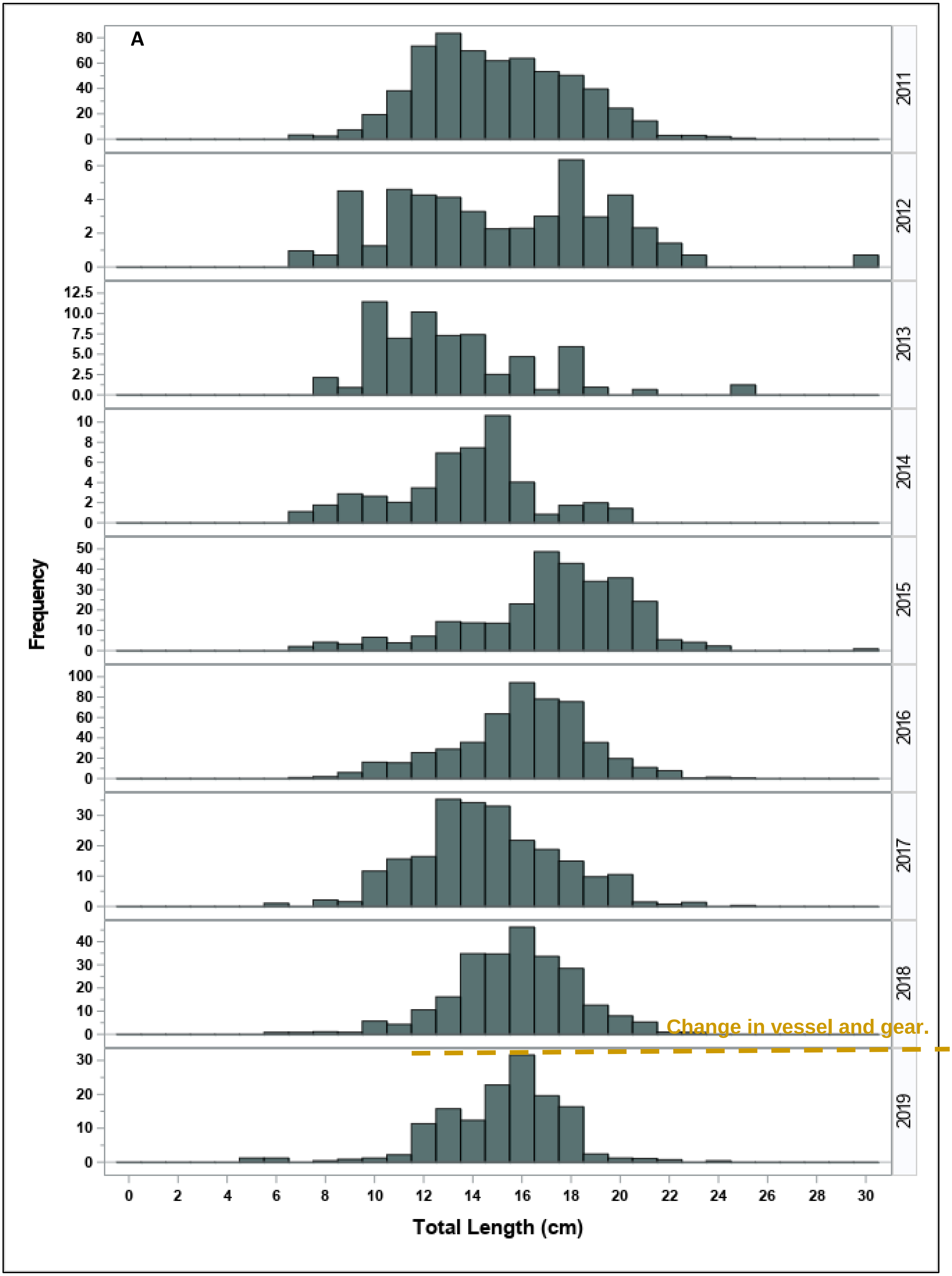


Figure 30. cont.

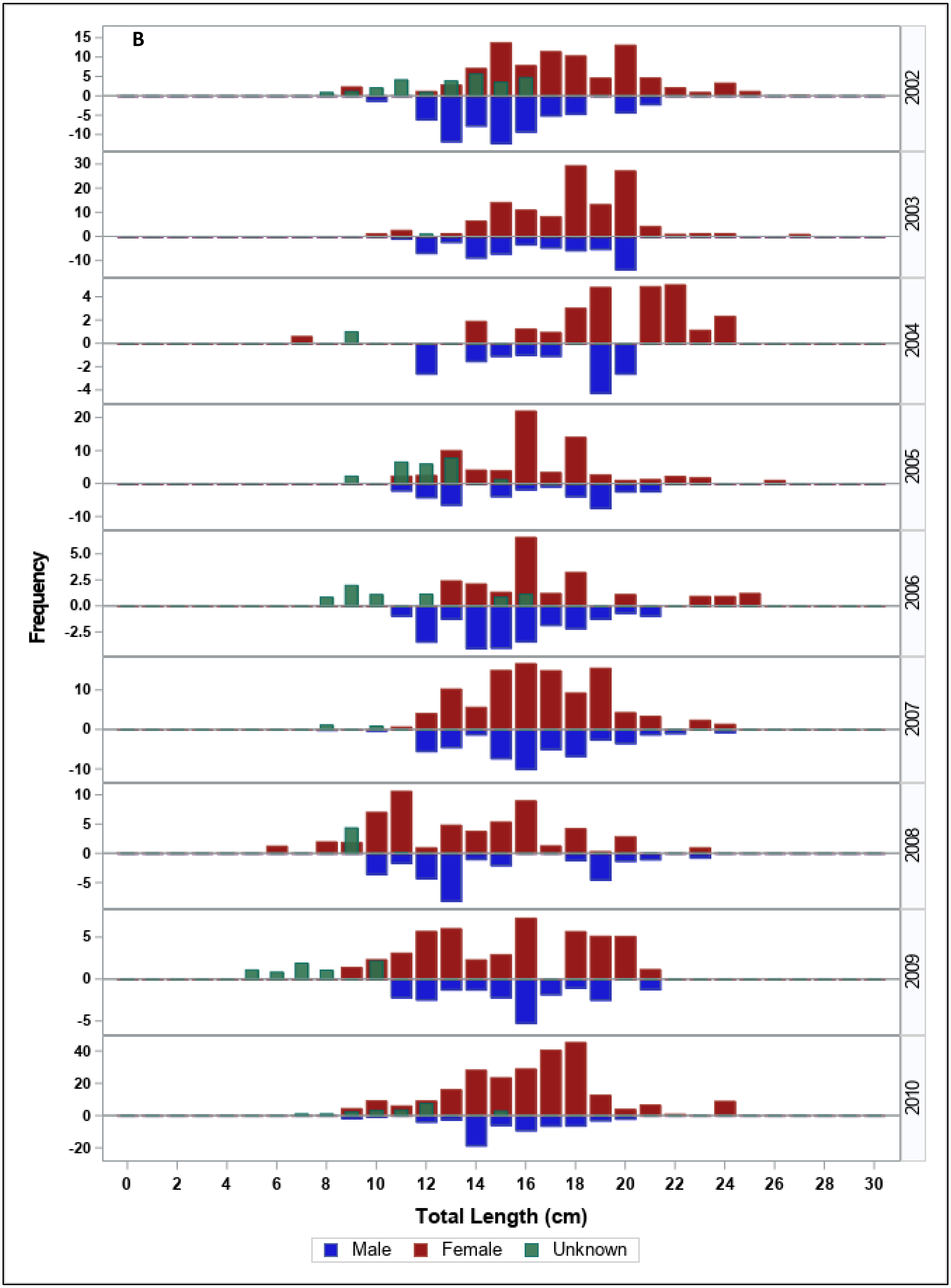


Figure 30. cont.

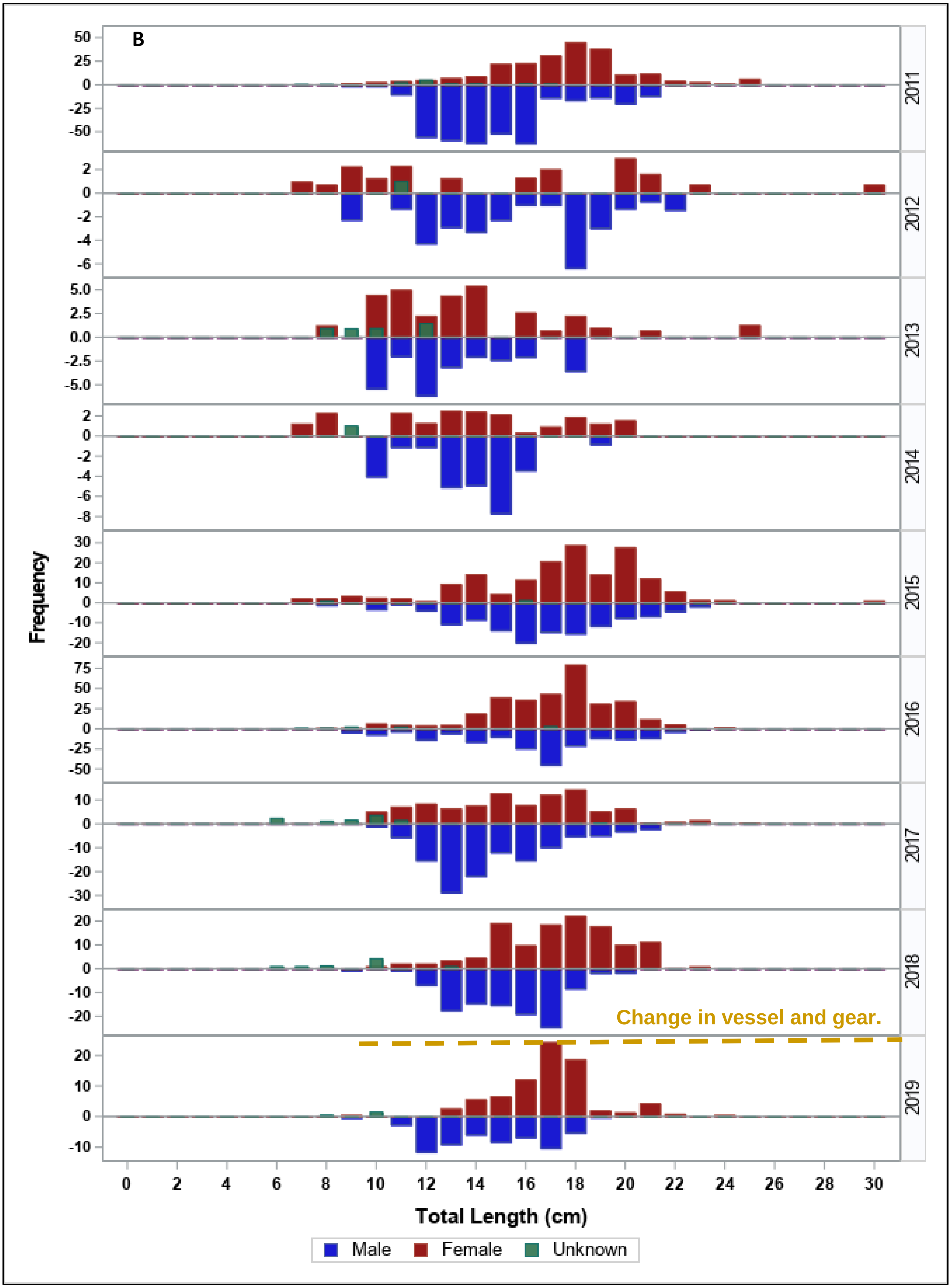


Figure 31. Diet composition, expressed as percent by weight (A) and percent by number (B) of Northern Puffer collected during ChesMMAP cruises in 2002-2018 combined.

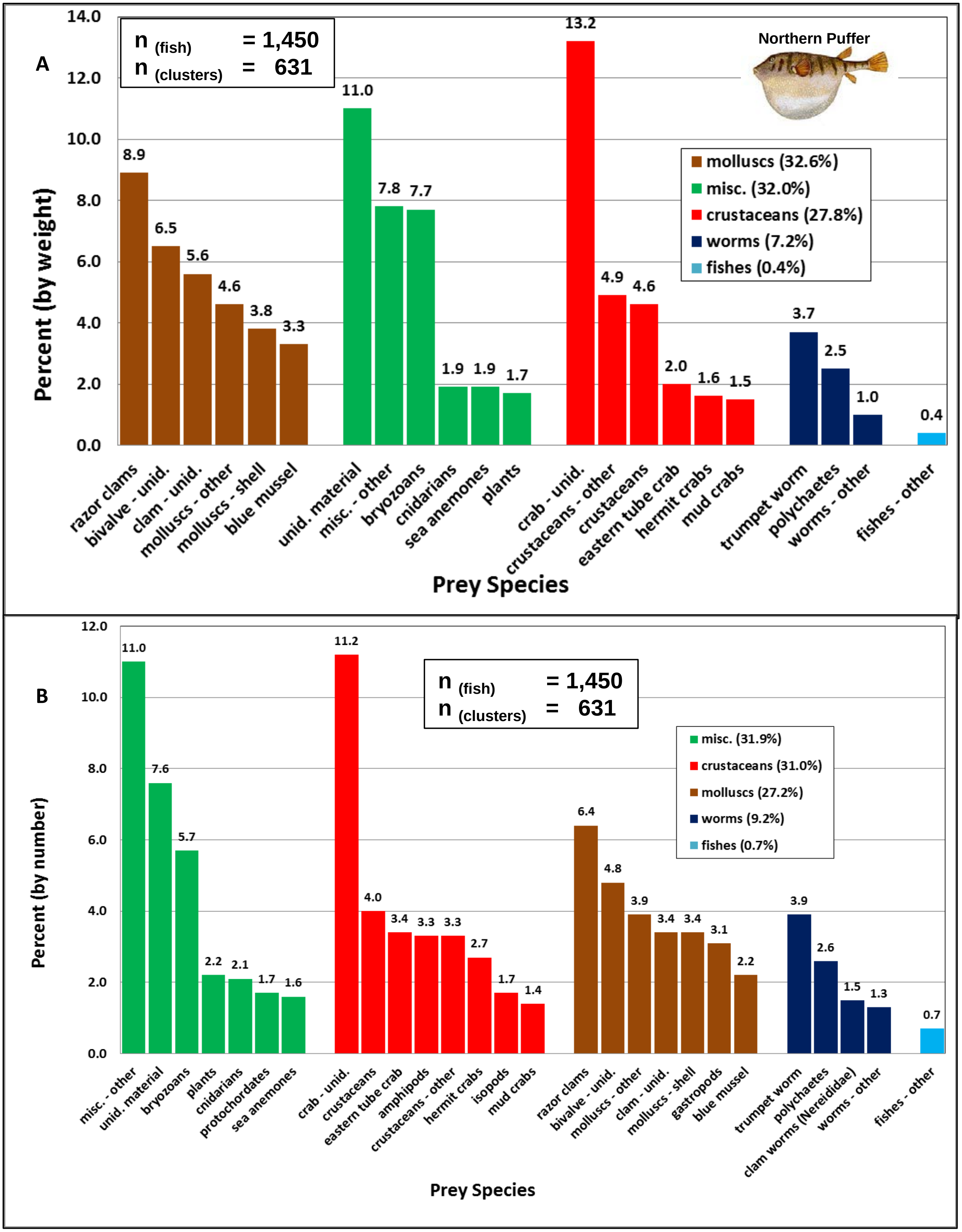


Table 18. Scup sampling rates and preserved specimen analysis status by year.

Year	Number Caught	Biomass Caught (kg)	Presence at Index Stations (%)	Number Measured	Age Specimens	Ages Read	Stomach Specimens	Stomachs Analyzed
2002	107	7.8	17.9	84	40	40	39	34
2003	192	11.1	22.7	192	100	100	99	90
2004	475	26.0	42.7	475	155	155	150	142
2005	674	30.6	25.0	674	86	86	85	83
2006	317	12.7	30.1	317	115	115	112	111
2007	211	6.5	44.7	211	128	128	121	119
2008	56	4.1	11.1	56	42	0	42	42
2009	201	6.6	23.1	201	97	0	92	91
2010	853	29.2	29.1	653	126	0	125	123
2011	72	2.7	21.6	72	56	0	51	51
2012	12	0.4	3.6	12	12	0	12	12
2013	49	1.8	8.6	49	28	28	25	24
2014	63	2.6	7.7	63	26	26	19	19
2015	988	45.6	35.0	988	186	186	88	87
2016	65	2.0	9.4	65	40	40	20	20
2017	25	0.4	4.3	25	20	20	12	12
2018	386	12.2	28.2	386	94	94	58	58
2019	1,126	35.1	39.3	883	196	196	135	135

Figure 32. Station specific biomass of Scup in Chesapeake Bay, 2019.

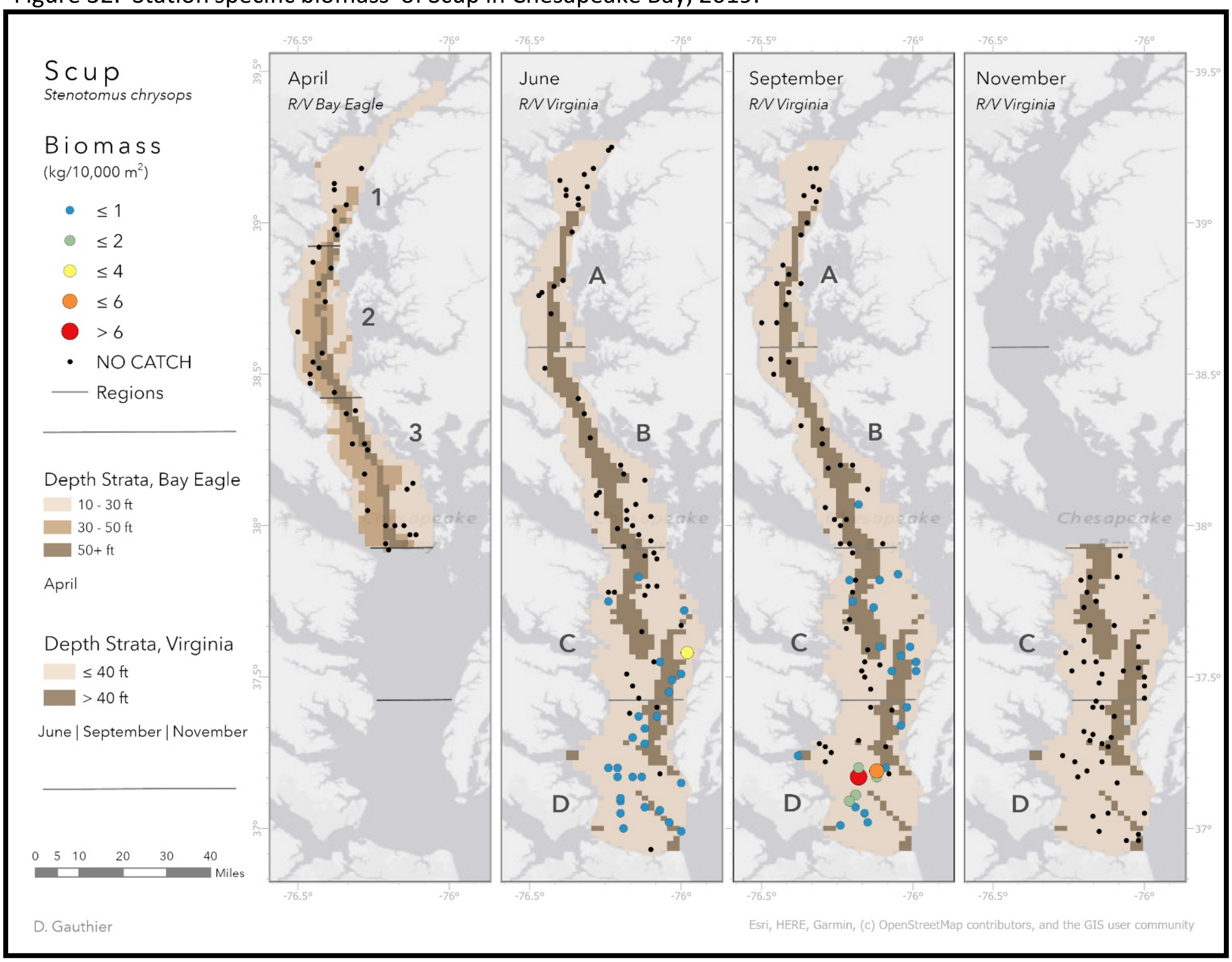


Table 19. Scup geometric mean indices of abundance, by number and biomass, overall and by age-class.

Year	Age	n	Numerical Index			Biomass Index		
			LCI	**Index**	UCI	LCI	**Index**	UCI
2002	All	106	0.12	0.26	0.41	0.01	0.04	0.08
2003		127	0.26	0.44	0.65	0.03	0.06	0.09
2004		109	0.46	0.74	1.08	0.06	0.13	0.20
2005		112	0.37	0.71	1.14	0.06	0.14	0.23
2006		103	0.48	0.83	1.25	0.05	0.10	0.15
2007		76	0.64	1.05	1.56	0.04	0.08	0.11
2008		117	0.06	0.16	0.27	0.00	0.03	0.05
2009		117	0.33	0.58	0.86	0.03	0.06	0.09
2010		117	0.63	1.06	1.60	0.07	0.15	0.24
2011		116	0.17	0.31	0.46	0.01	0.02	0.04
2012		111	0.00	0.05	0.10	0.00	0.00	0.01
2013		116	0.04	0.13	0.24	0.00	0.01	0.03
2014		117	0.03	0.14	0.25	0.00	0.02	0.03
2015		117	0.71	1.17	1.77	0.09	0.18	0.28
2016		117	0.04	0.14	0.24	0.00	0.01	0.03
2017		117	0.01	0.08	0.15	0.00	0.00	0.01
2018		117	0.32	0.57	0.88	0.01	0.05	0.10
2019		105	0.82	1.34	1.99	0.07	0.14	0.23
2020								
2002	0	65	0.01	0.16	0.33	0.00	0.04	0.10
2003		85	0.17	0.32	0.48	0.02	0.04	0.05
2004		80	0.01	0.10	0.19	0.00	0.01	0.03
2005		73	0.42	0.92	1.58	0.07	0.18	0.30
2006		68	0.36	0.79	1.36	0.05	0.12	0.21
2007		38	0.13	0.35	0.62	0.02	0.05	0.09
2008		78	0.02	0.11	0.21	0.00	0.02	0.05
2009		78	0.09	0.25	0.44	0.00	0.03	0.06
2010		78	0.41	0.85	1.44	0.05	0.14	0.23
2011		77	0.07	0.19	0.33	0.00	0.02	0.03
2012		72	0.00	0.00	0.00	0.00	0.00	0.00
2013		77	0.01	0.09	0.18	0.00	0.01	0.01
2014		78	0.03	0.17	0.34	0.00	0.02	0.05
2015		78	0.49	1.03	1.76	0.08	0.20	0.34
2016		78	0.00	0.06	0.13	0.00	0.01	0.01
2017		78	0.00	0.01	0.02	0.00	0.00	0.00
2018		78	0.14	0.41	0.75	0.01	0.07	0.13
2019		70	0.22	0.51	0.86	0.02	0.06	0.11
2020								

Year	Age	n	Numerical Index			Biomass Index		
			LCI	**Index**	UCI	LCI	**Index**	UCI
2002	1	106	0.08	0.20	0.33	0.00	0.03	0.06
2003		127	0.23	0.38	0.56	0.03	0.05	0.08
2004		109	0.40	0.64	0.92	0.05	0.11	0.17
2005		112	0.22	0.44	0.69	0.03	0.07	0.11
2006		103	0.18	0.33	0.51	0.01	0.02	0.03
2007		76	0.45	0.73	1.05	0.02	0.04	0.05
2008		117	0.05	0.14	0.23	0.00	0.02	0.04
2009		117	0.23	0.40	0.60	0.01	0.03	0.05
2010		117	0.44	0.74	1.10	0.04	0.09	0.14
2011		116	0.11	0.21	0.30	0.01	0.01	0.02
2012		111	0.00	0.05	0.09	0.00	0.00	0.01
2013		116	0.03	0.12	0.21	0.00	0.01	0.02
2014		117	0.02	0.07	0.13	0.00	0.00	0.01
2015		117	0.07	0.19	0.32	0.01	0.03	0.05
2016		117	0.00	0.08	0.16	0.00	0.01	0.02
2017		117	0.01	0.08	0.15	0.00	0.00	0.01
2018		117	0.03	0.12	0.22	0.00	0.01	0.02
2019		105	0.58	0.96	1.44	0.05	0.11	0.18
2020								
2002	2+	106	0.03	0.11	0.21	0.00	0.02	0.04
2003		127	0.02	0.06	0.10	0.00	0.01	0.01
2004		109	0.02	0.10	0.19	0.00	0.01	0.03
2005		112	0.01	0.11	0.21	0.00	0.02	0.04
2006		103	0.00	0.05	0.10	0.00	0.00	0.01
2007		76	0.06	0.14	0.23	0.00	0.01	0.02
2008		117	0.01	0.08	0.16	0.00	0.01	0.03
2009		117	0.02	0.08	0.14	0.00	0.01	0.01
2010		117	0.06	0.13	0.22	0.00	0.01	0.01
2011		116	0.01	0.05	0.09	0.00	0.00	0.01
2012		111	0.00	0.04	0.08	0.00	0.00	0.00
2013		116	0.01	0.05	0.09	0.00	0.00	0.01
2014		117	0.01	0.04	0.08	0.00	0.00	0.00
2015		117	0.00	0.07	0.13	0.00	0.01	0.02
2016		117	0.00	0.07	0.15	0.00	0.01	0.01
2017		117	0.00	0.03	0.07	0.00	0.00	0.00
2018		117	0.01	0.07	0.13	0.00	0.00	0.01
2019		105	0.05	0.18	0.33	0.00	0.03	0.06
2020								

Figure 33. Scup geometric mean indices of abundance, by number and biomass, for all ages combined and by age-class.

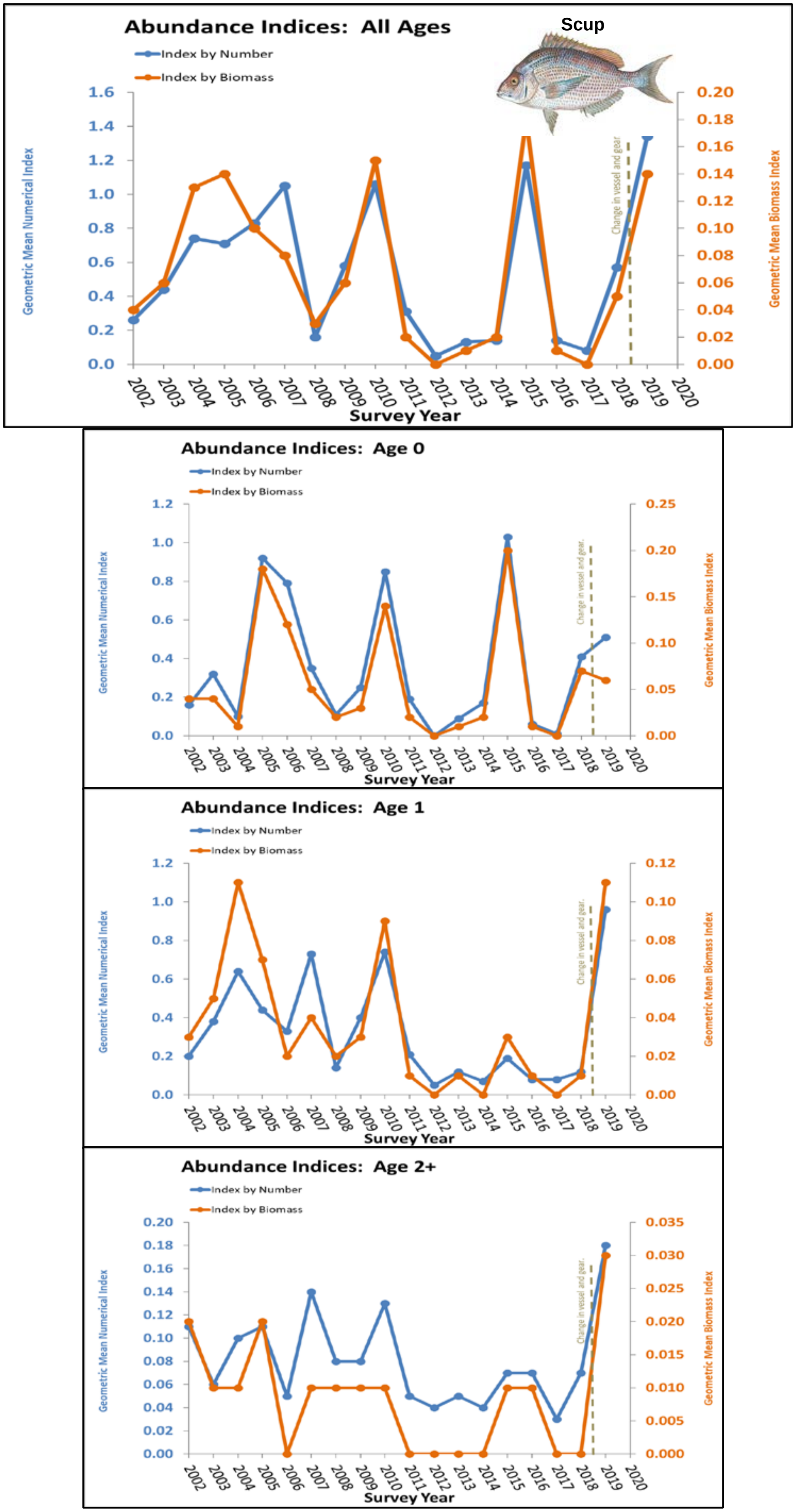


Figure 34. Scup length-frequency in Chesapeake Bay 2002-2019, overall (A) and by sex (B).

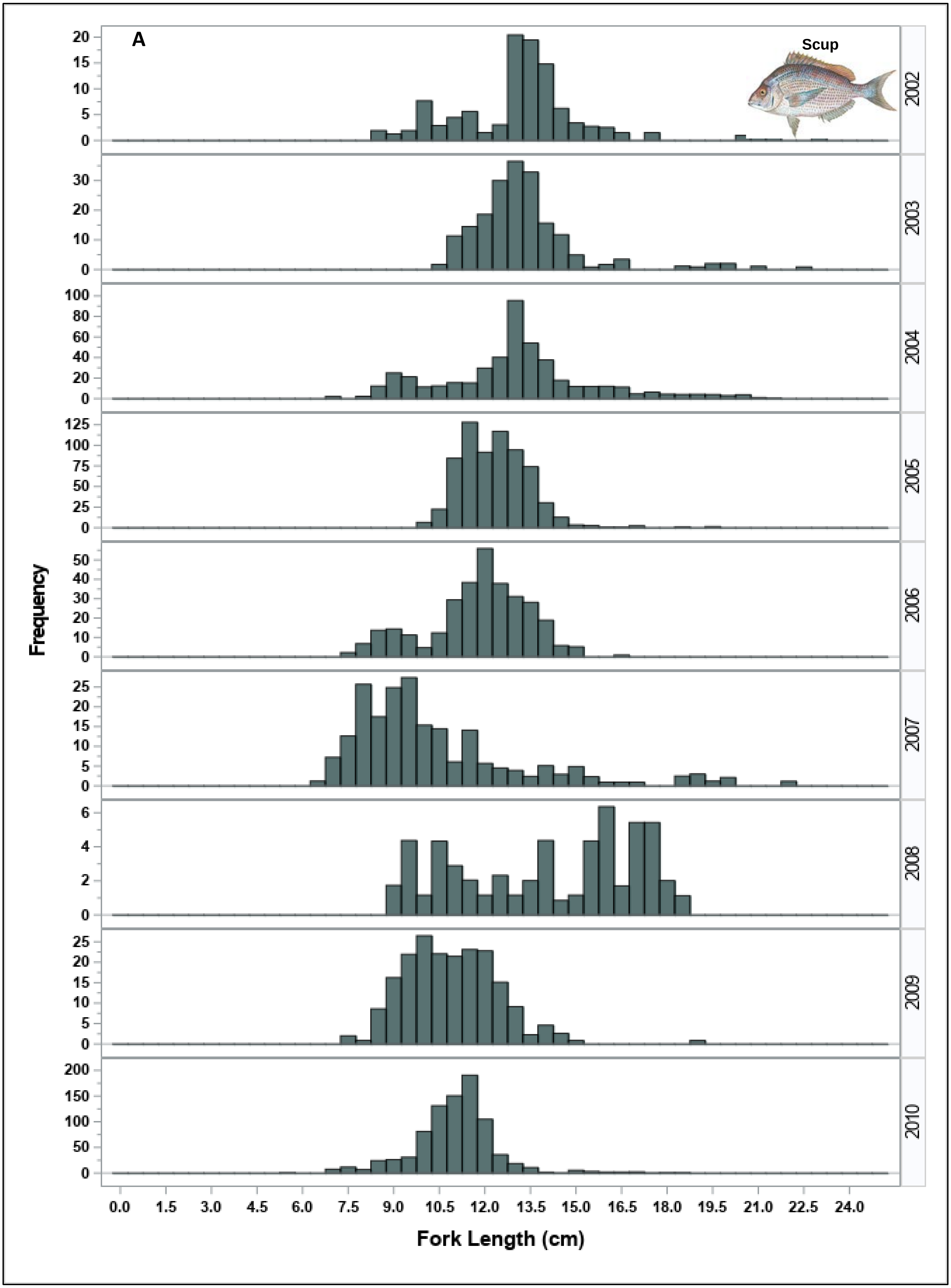


Figure 34. cont.

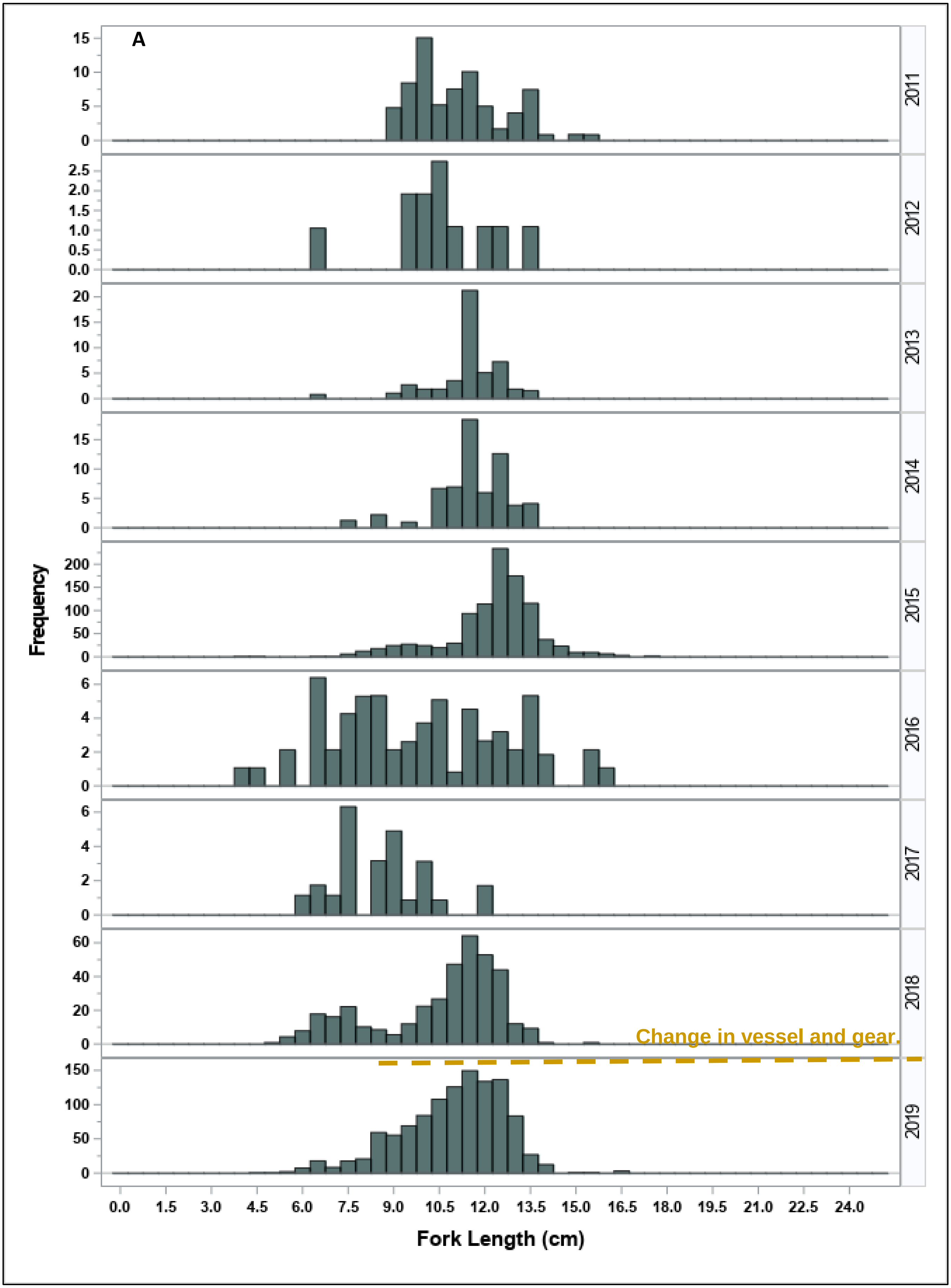


Figure 34. cont.

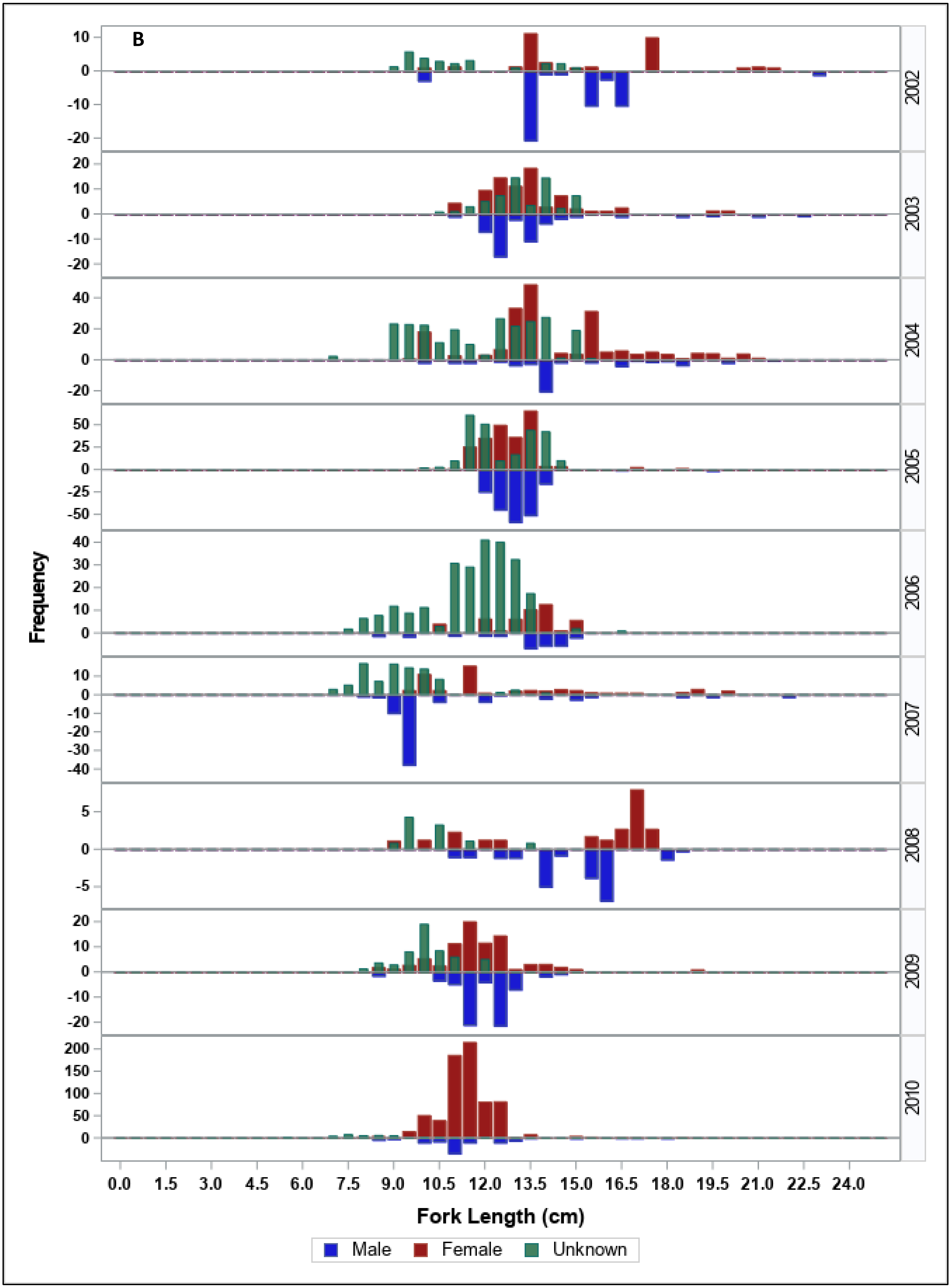


Figure 34. cont.

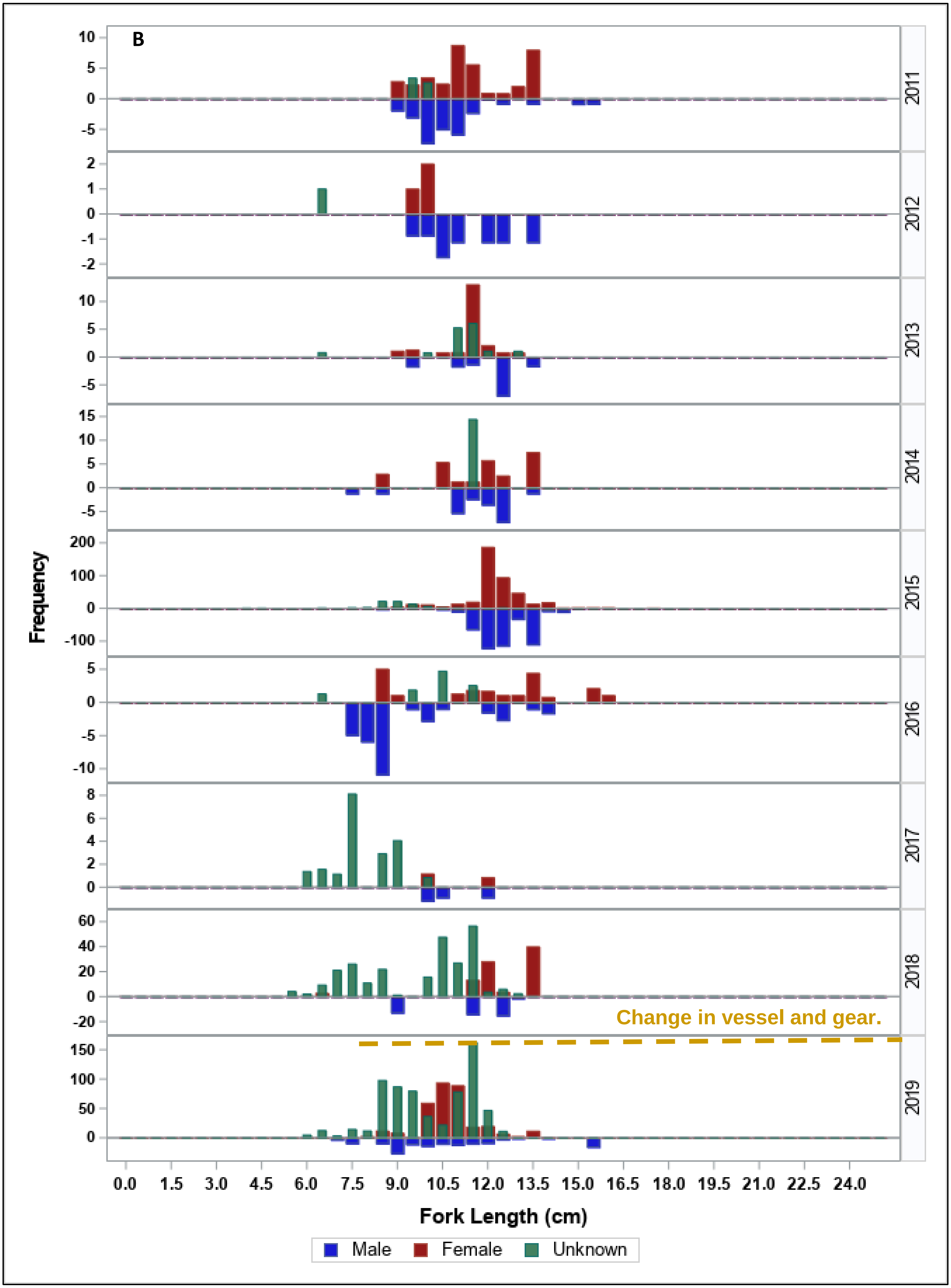


Figure 35. Scup age-frequency by year, 2002-2019.

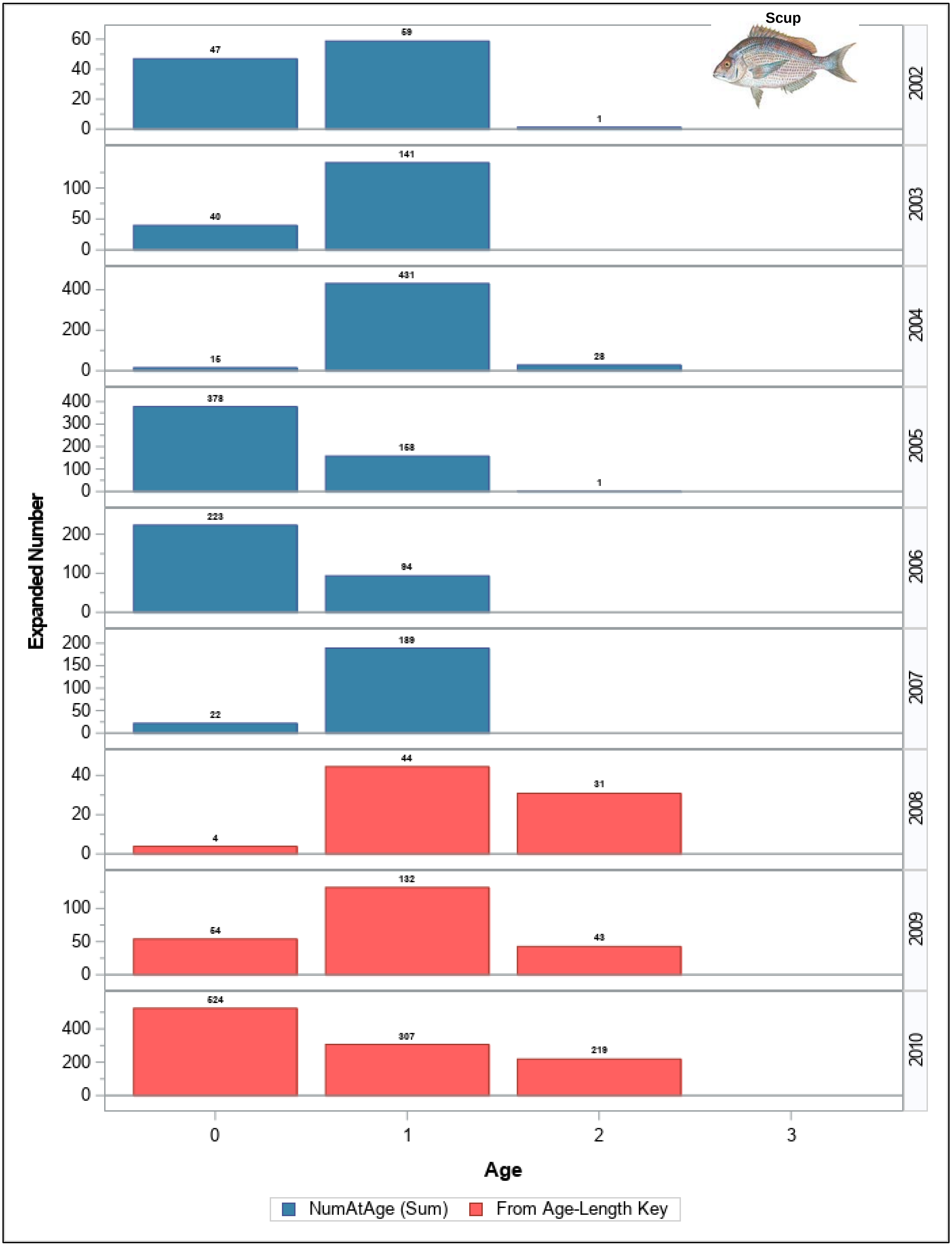


Figure 35. cont.

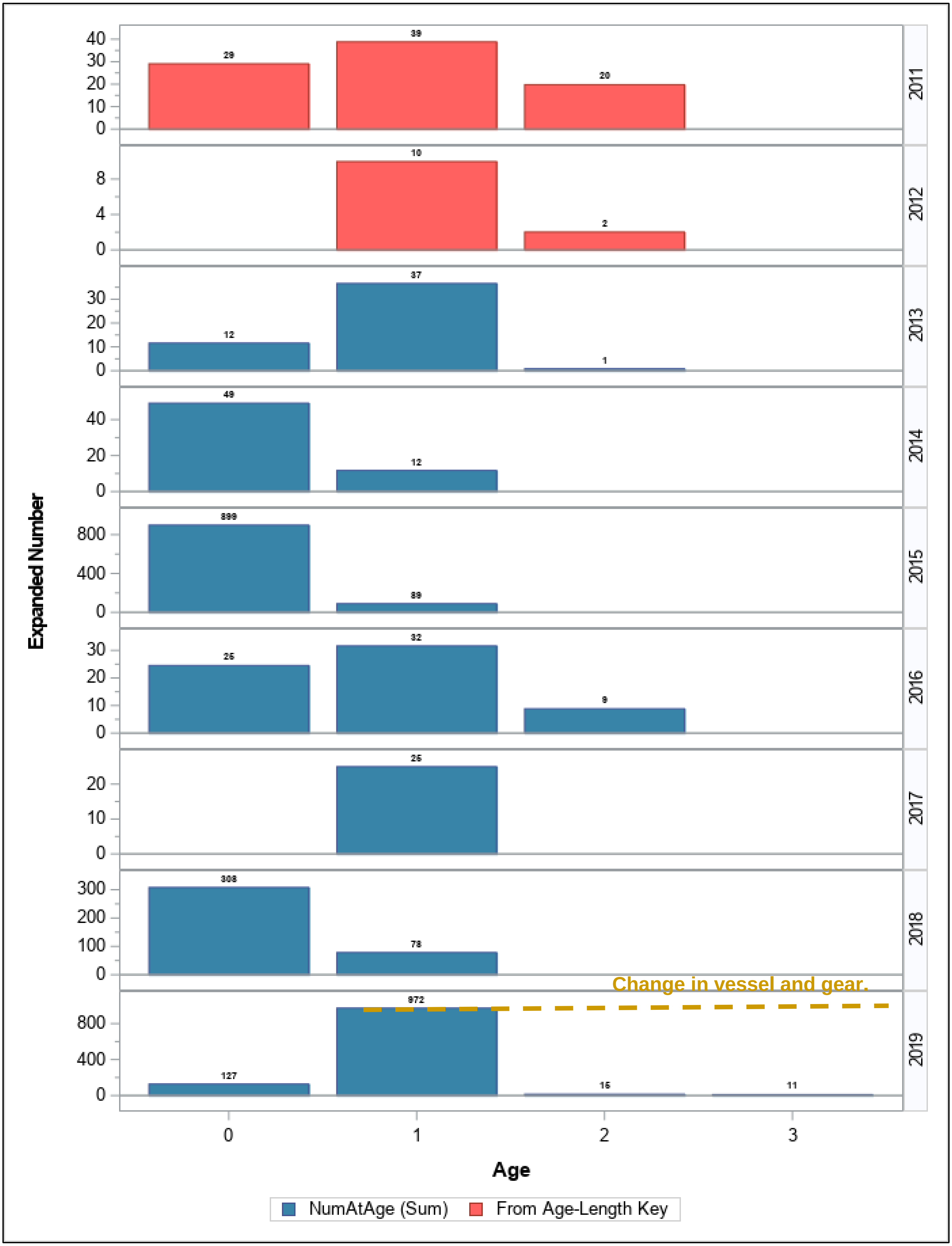


Figure 36. Scup age-frequency by year, 2002-2019 standardized to 8,000 (4,800 for 2019) annual trawl minutes.

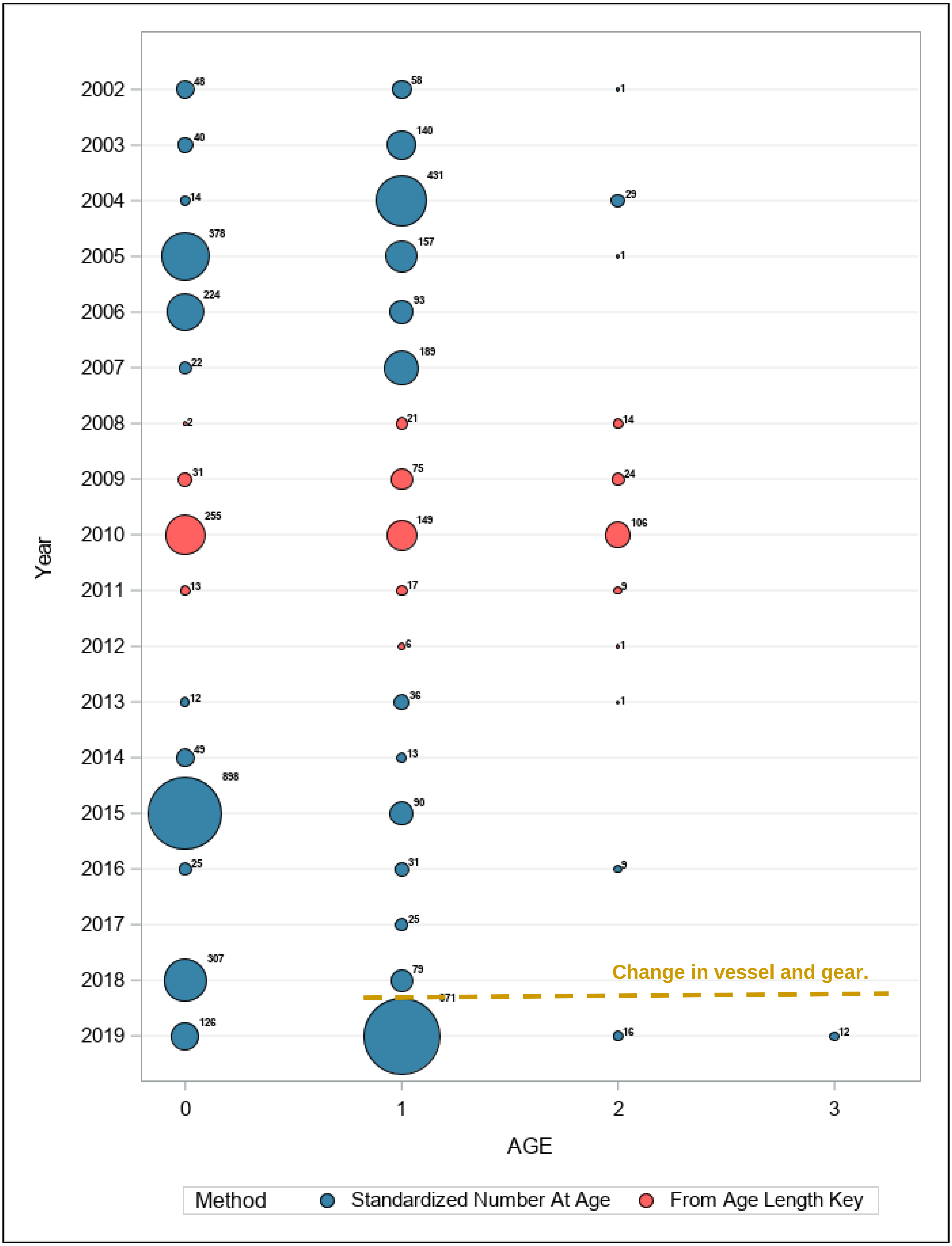


Figure 37. Diet composition, expressed as percent by weight (A) and percent by number (B) of Scup collected during ChesMMAP cruises in 2002-2018 combined.

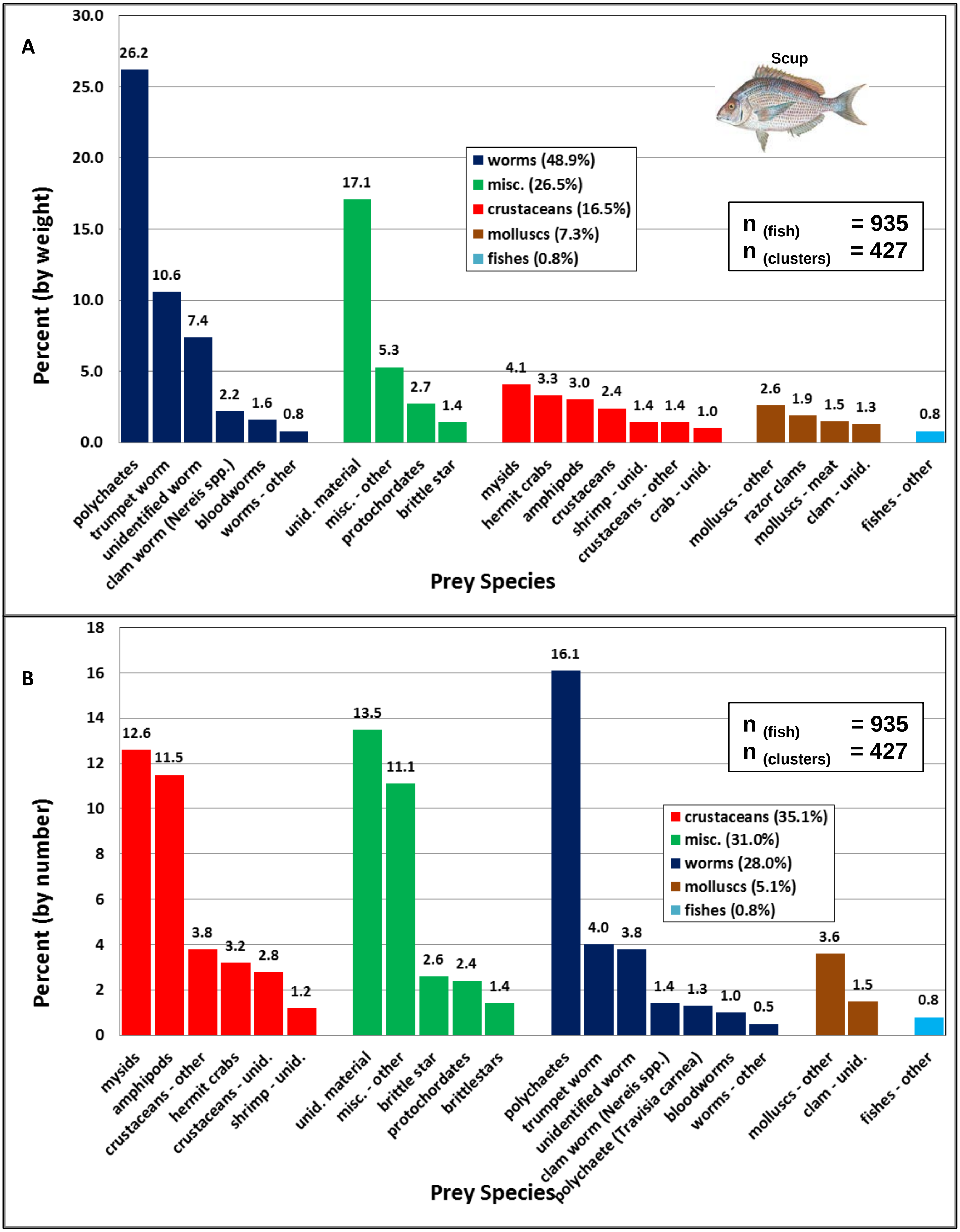


Table 20. Spot sampling rates and preserved specimen analysis status by year.

Year	Number Caught	Biomass Caught (kg)	Presence at Index Stations (%)	Number Measured	Age Specimens	Ages Read	Stomach Specimens	Stomachs Analyzed
2002	3,122	443.2	49.8	3,034	672	666	647	19
2003	4,081	568.8	51.7	3,102	414	395	396	4
2004	4,131	419.6	64.4	4,089	619	619	578	18
2005	11,561	1,011.2	73.2	10,690	1,030	1,030	979	3
2006	7,080	700.4	71.0	6,439	680	656	632	7
2007	5,729	462.8	72.3	5,396	626	626	602	4
2008	6,256	417.5	63.3	5,197	785	785	742	735
2009	5,191	682.6	47.1	3,481	465	449	447	442
2010	6,744	255.3	67.2	6,336	687	687	652	623
2011	2,867	278.0	39.0	2,867	352	352	320	315
2012	2,161	114.5	35.9	1,758	345	345	259	253
2013	4,087	316.0	44.4	3,430	428	428	289	280
2014	939	117.3	23.3	939	188	188	89	88
2015	401	54.0	15.4	401	102	102	11	11
2016	1,059	67.2	27.1	835	167	167	43	40
2017	1,586	116.4	26.8	1,586	213	213	105	101
2018	1,635	77.0	32.7	1,635	204	204	101	99
2019	67,938	3,529.2	78.4	22,694	556	556	229	227

Figure 38. Station specific biomass of Spot in Chesapeake Bay, 2019.

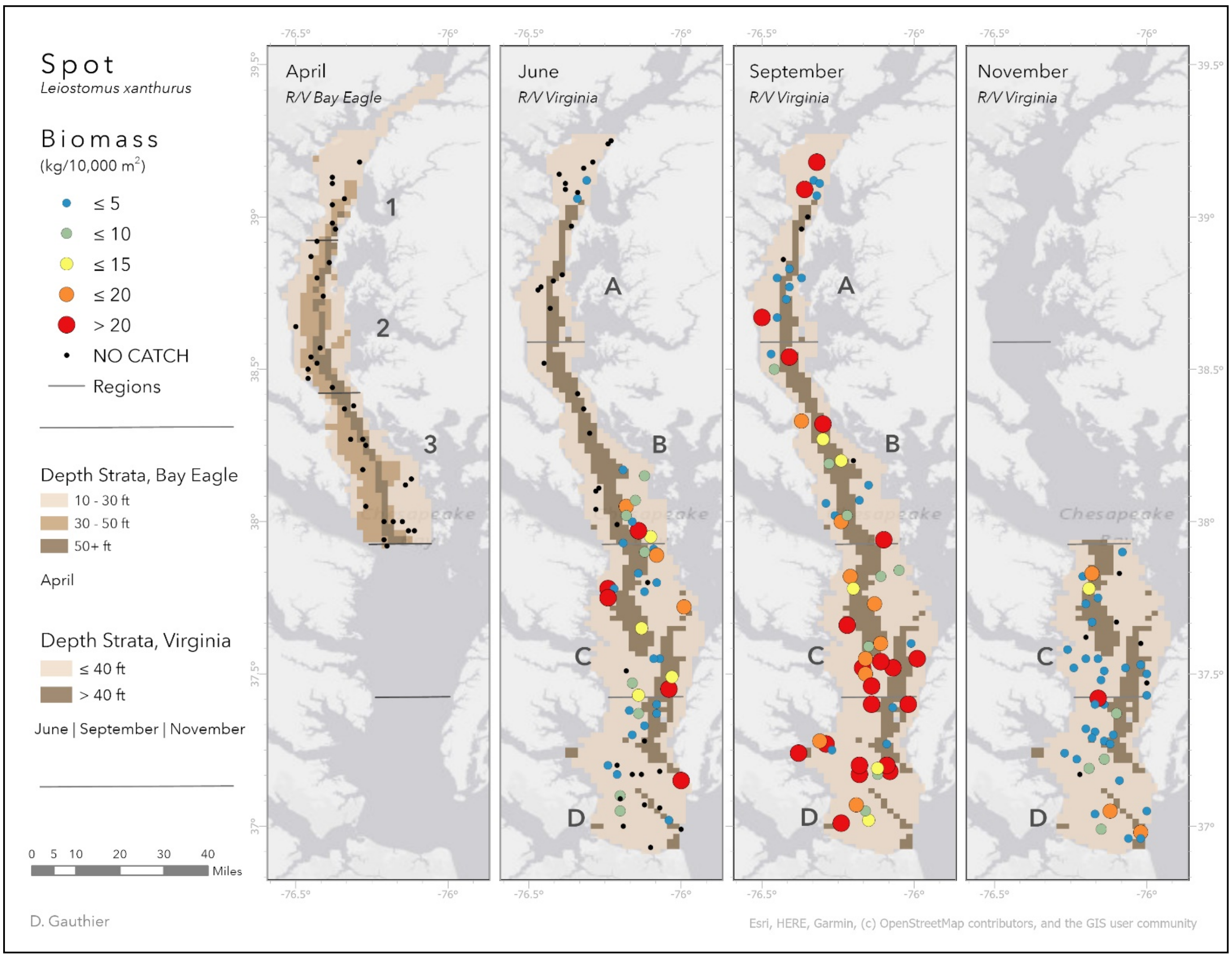


Table 21. Spot geometric mean indices of abundance, by number and biomass, overall and by age-class.

Year	Age	n	Numerical Index			Biomass Index		
			LCI	**Index**	UCI	LCI	**Index**	UCI
2002	All	227	1.9	2.5	3.3	0.5	0.6	0.8
2003		240	1.8	2.4	3.1	0.5	0.6	0.8
2004		224	3.3	4.2	5.3	0.7	0.8	1.0
2005		235	9.3	12.0	15.4	1.5	1.8	2.2
2006		217	5.9	7.8	10.3	1.1	1.3	1.6
2007		155	6.1	8.4	11.3	1.0	1.3	1.7
2008		240	4.3	5.6	7.2	0.7	0.8	1.0
2009		238	2.9	3.9	5.1	0.7	1.0	1.3
2010		204	4.6	6.2	8.2	0.5	0.6	0.8
2011		236	1.4	1.9	2.5	0.4	0.5	0.7
2012		231	0.9	1.3	1.8	0.2	0.2	0.3
2013		239	1.7	2.3	3.0	0.4	0.5	0.6
2014		240	0.5	0.7	1.0	0.2	0.3	0.4
2015		240	0.2	0.3	0.5	0.0	0.1	0.2
2016		240	0.6	0.8	1.0	0.1	0.2	0.2
2017		239	0.8	1.1	1.5	0.2	0.3	0.4
2018		217	0.8	1.1	1.5	0.1	0.2	0.3
2019		204	26.9	39.1	56.5	3.5	4.6	6.0
2020								
2002	0	227	1.5	2.0	2.6	0.4	0.5	0.6
2003		240	1.4	1.9	2.4	0.3	0.5	0.6
2004		224	2.7	3.5	4.4	0.5	0.6	0.8
2005		235	7.8	10.0	12.8	1.1	1.3	1.6
2006		217	4.8	6.3	8.2	0.8	1.0	1.3
2007		155	5.1	7.0	9.6	0.9	1.2	1.5
2008		240	3.8	5.0	6.4	0.6	0.7	0.9
2009		238	1.4	1.9	2.4	0.3	0.4	0.5
2010		204	4.2	5.7	7.6	0.4	0.5	0.7
2011		236	0.4	0.5	0.7	0.1	0.1	0.2
2012		231	0.9	1.2	1.7	0.1	0.2	0.3
2013		239	1.1	1.4	1.9	0.2	0.3	0.4
2014		240	0.2	0.3	0.5	0.0	0.1	0.1
2015		240	0.0	0.1	0.2	0.0	0.0	0.1
2016		240	0.5	0.8	1.0	0.1	0.2	0.2
2017		239	0.7	1.1	1.5	0.2	0.3	0.4
2018		217	0.8	1.1	1.5	0.1	0.2	0.2
2019		204	22.2	32.2	46.4	3.0	3.9	5.0
2020								

Year	Age	n	Numerical Index			Biomass Index		
			LCI	**Index**	UCI	LCI	**Index**	UCI
2002	1	227	0.65	0.89	1.17	0.18	0.26	0.35
2003		240	0.42	0.64	0.89	0.14	0.25	0.37
2004		224	0.80	1.05	1.34	0.20	0.27	0.35
2005		235	1.28	1.72	2.24	0.39	0.53	0.68
2006		217	1.48	1.93	2.48	0.32	0.44	0.56
2007		155	0.75	1.07	1.44	0.16	0.24	0.32
2008		240	0.64	0.89	1.19	0.15	0.22	0.29
2009		238	1.98	2.70	3.61	0.56	0.78	1.03
2010		204	0.49	0.66	0.84	0.08	0.11	0.15
2011		236	1.27	1.69	2.20	0.35	0.47	0.60
2012		231	0.19	0.29	0.40	0.02	0.04	0.05
2013		239	1.09	1.46	1.91	0.22	0.31	0.41
2014		240	0.36	0.55	0.76	0.12	0.20	0.29
2015		240	0.18	0.30	0.44	0.04	0.09	0.15
2016		240	0.04	0.08	0.12	0.00	0.01	0.02
2017		239	0.11	0.19	0.27	0.02	0.04	0.07
2018		217	0.15	0.23	0.32	0.01	0.03	0.04
2019		204	7.8	10.7	14.4	1.2	1.5	1.9
2020								
2002	2	153	0.09	0.18	0.28	0.02	0.06	0.11
2003		150	0.04	0.13	0.24	0.00	0.06	0.12
2004		139	0.15	0.29	0.45	0.03	0.09	0.14
2005		156	0.32	0.48	0.66	0.07	0.12	0.17
2006		143	0.13	0.24	0.36	0.02	0.05	0.09
2007		78	0.20	0.32	0.45	0.04	0.07	0.09
2008		160	0.07	0.20	0.34	0.01	0.05	0.10
2009		160	0.04	0.21	0.40	0.00	0.09	0.20
2010		125	0.04	0.11	0.18	0.00	0.02	0.03
2011		158	0.09	0.19	0.30	0.01	0.05	0.10
2012		159	0.04	0.12	0.21	0.00	0.02	0.03
2013		160	0.00	0.10	0.22	0.00	0.04	0.10
2014		160	0.13	0.25	0.39	0.02	0.08	0.13
2015		160	0.03	0.10	0.19	0.00	0.03	0.07
2016		160	0.01	0.06	0.11	0.00	0.01	0.02
2017		159	0.05	0.14	0.25	0.00	0.03	0.07
2018		137	0.01	0.09	0.17	0.00	0.02	0.04
2019		159	0.2	0.4	0.6	0.0	0.1	0.2
2020								

Figure 39. Spot geometric mean indices of abundance, by number and biomass, for all ages combined and by age-class.

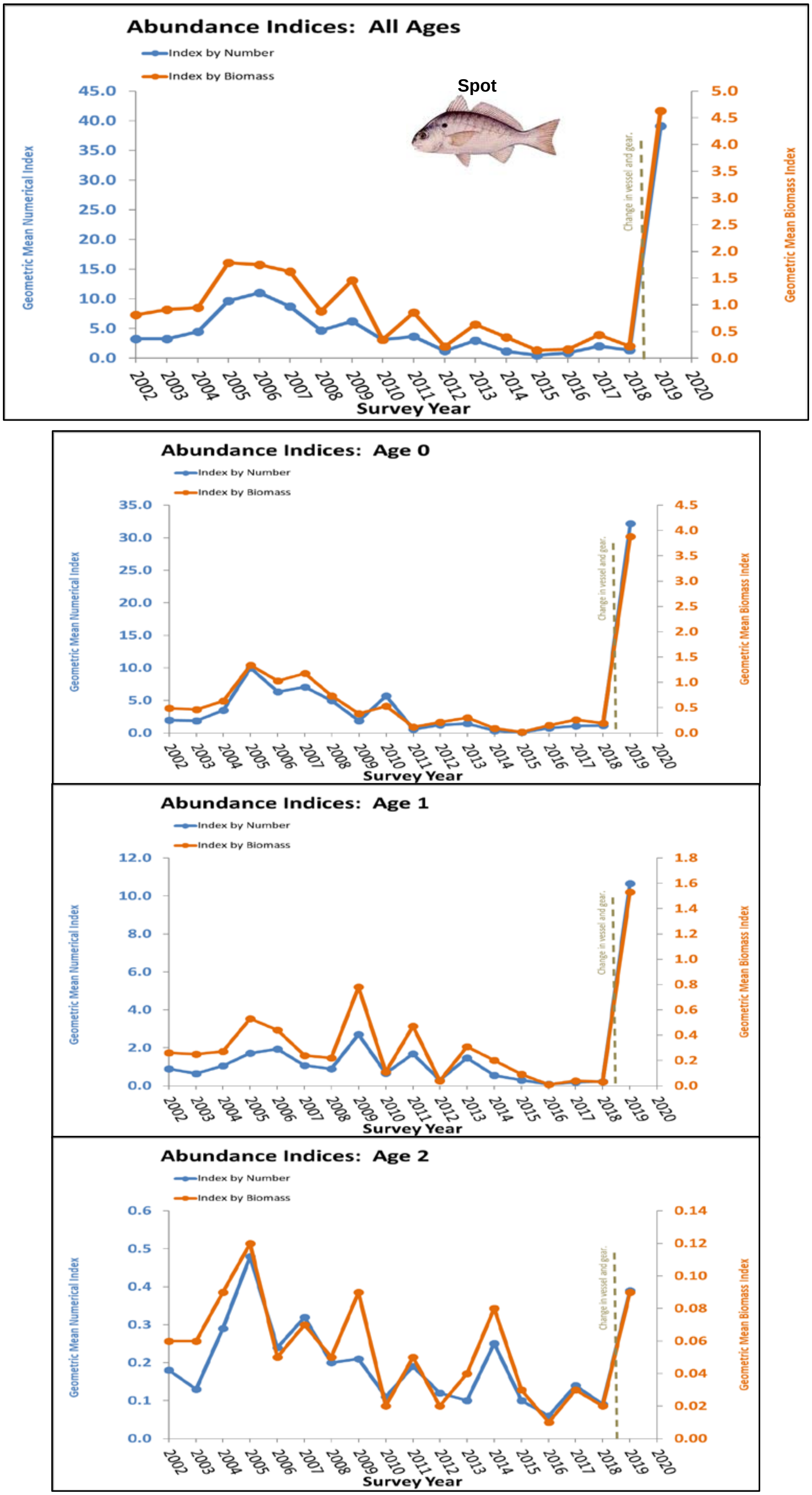


Figure 40. Spot length-frequency in Chesapeake Bay 2002-2019, overall (A) and by sex (B).

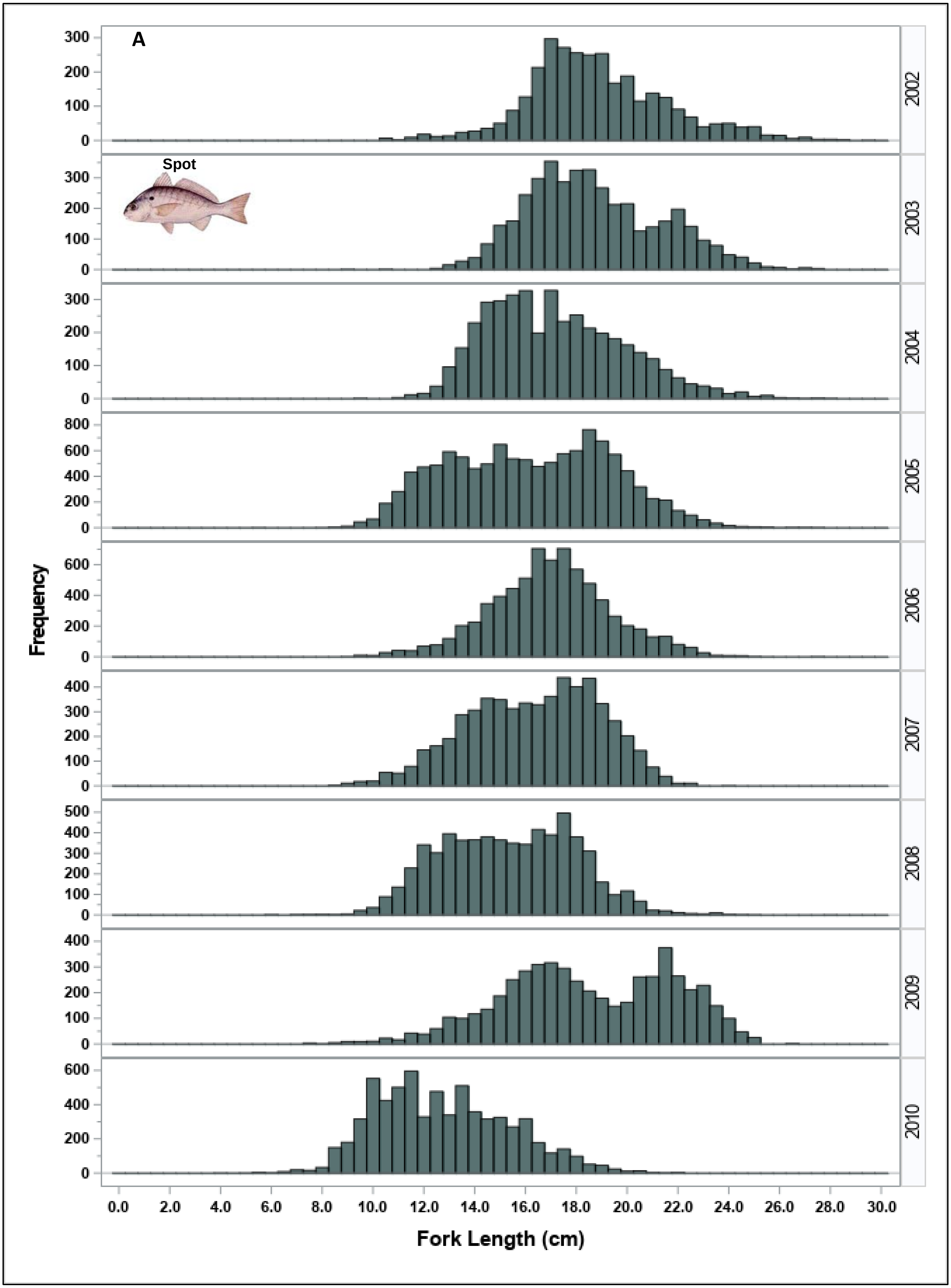


Figure 40. cont.

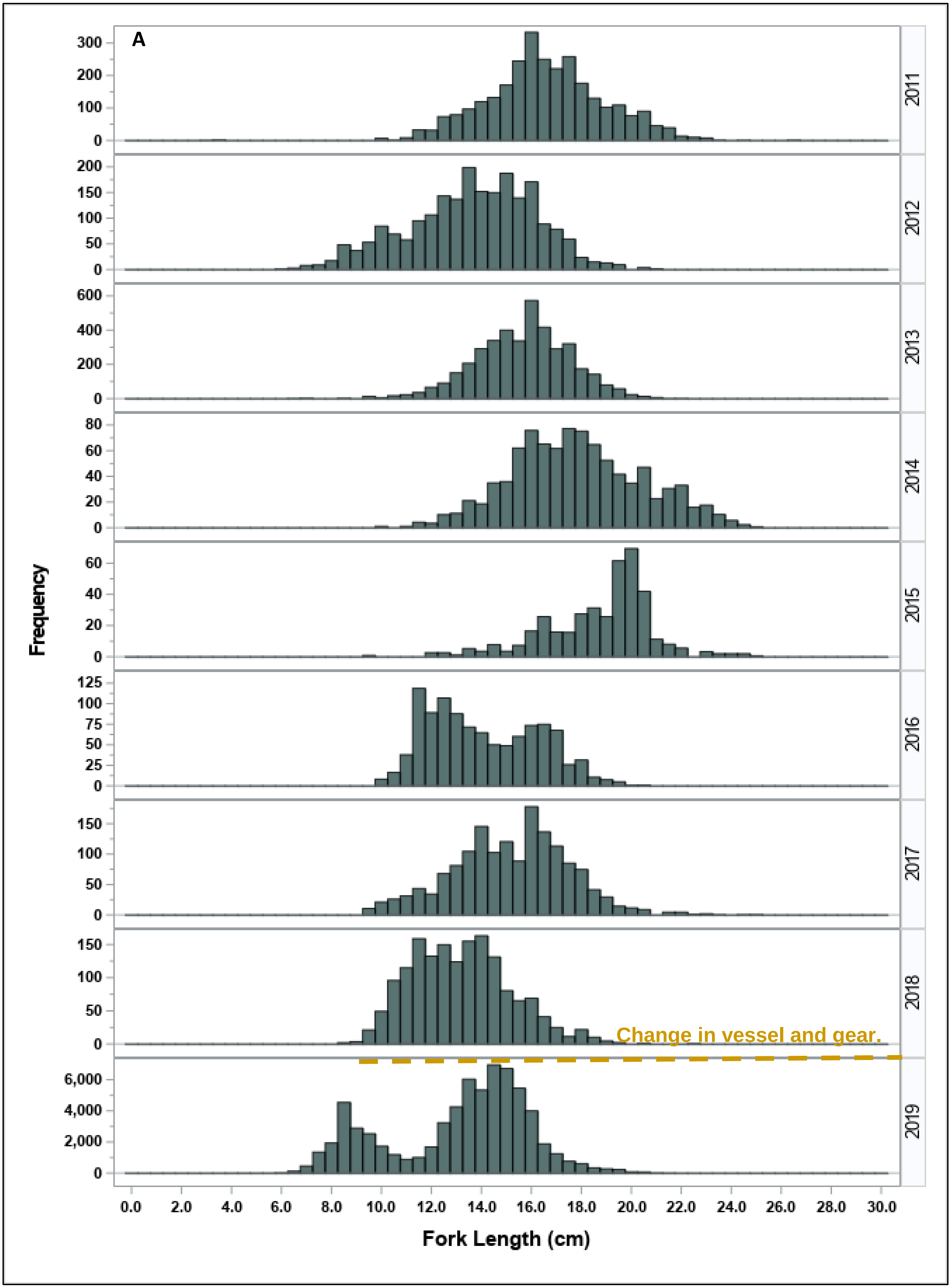


Figure 40. cont.

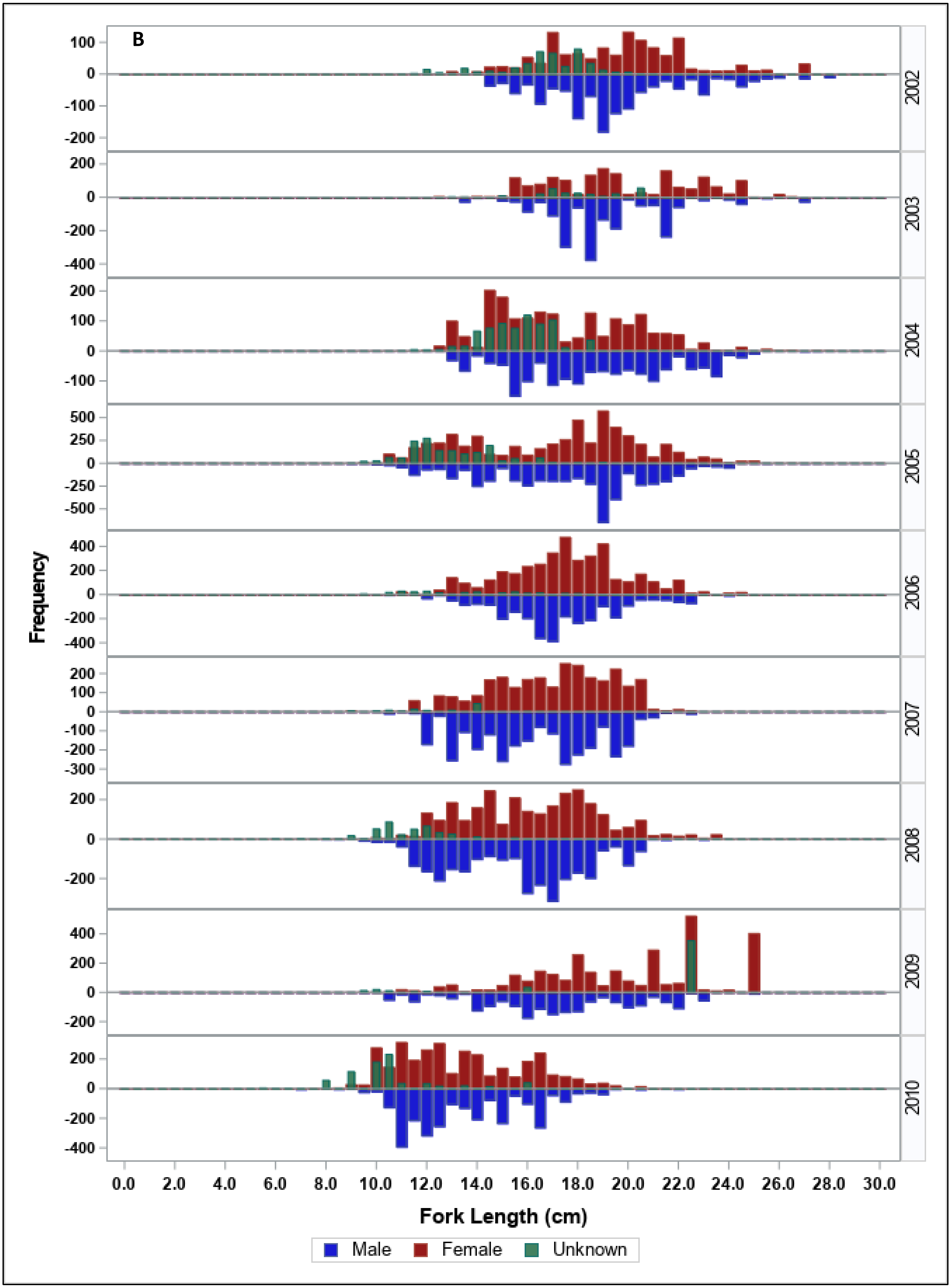


Figure 40. cont.

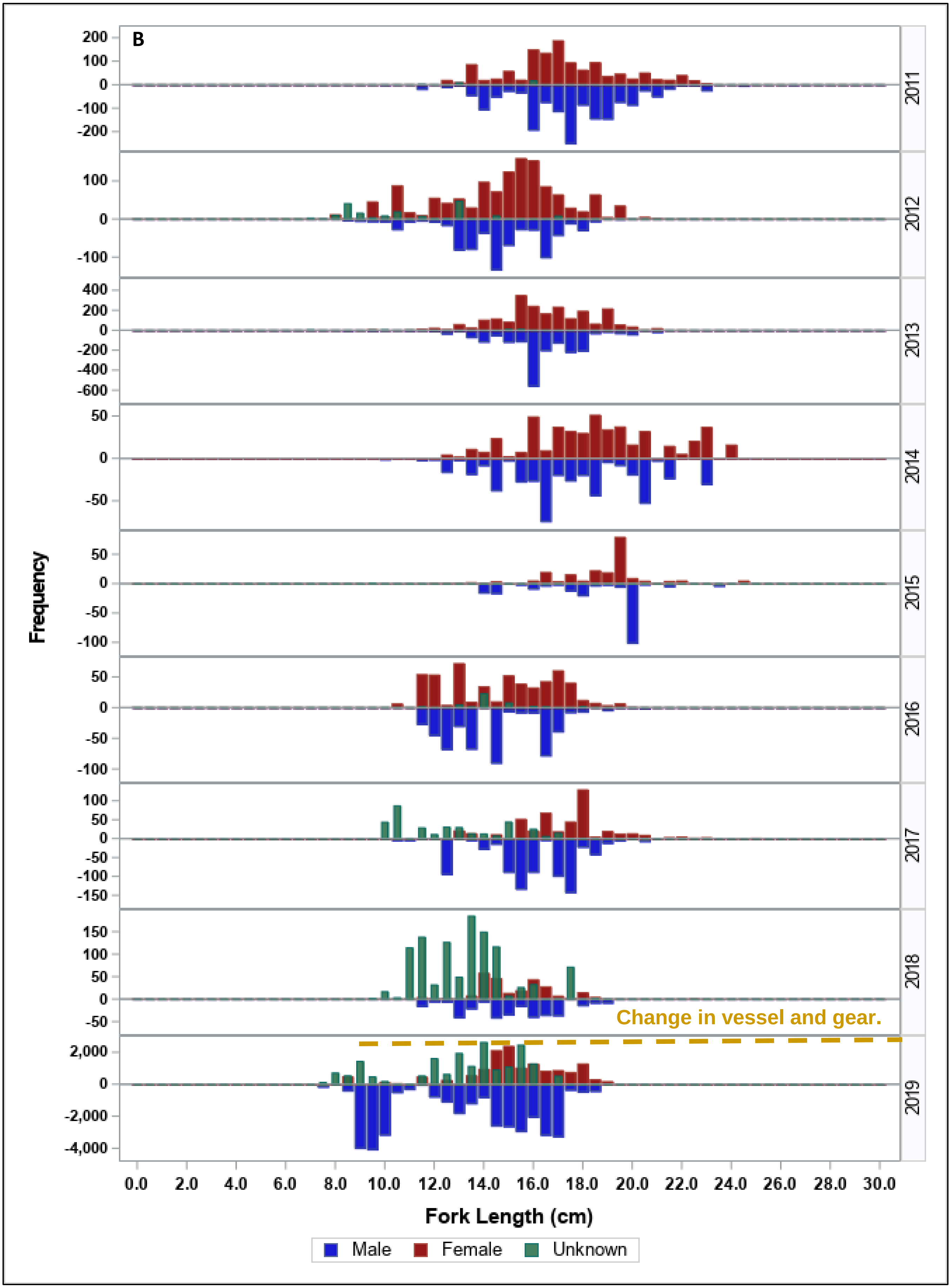


Figure 41. Spot age-frequency by year, 2002-2019.

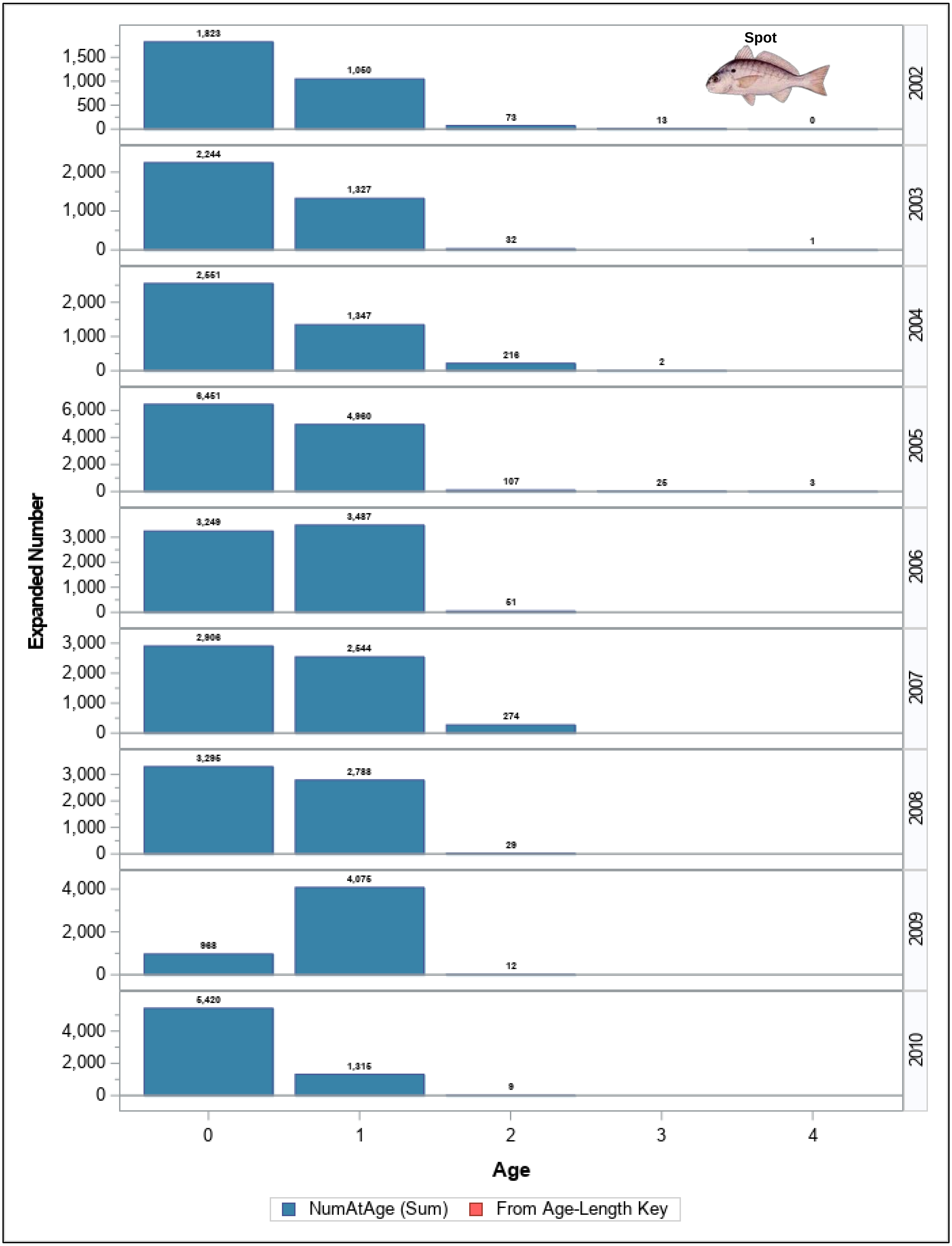


Figure 41. cont.

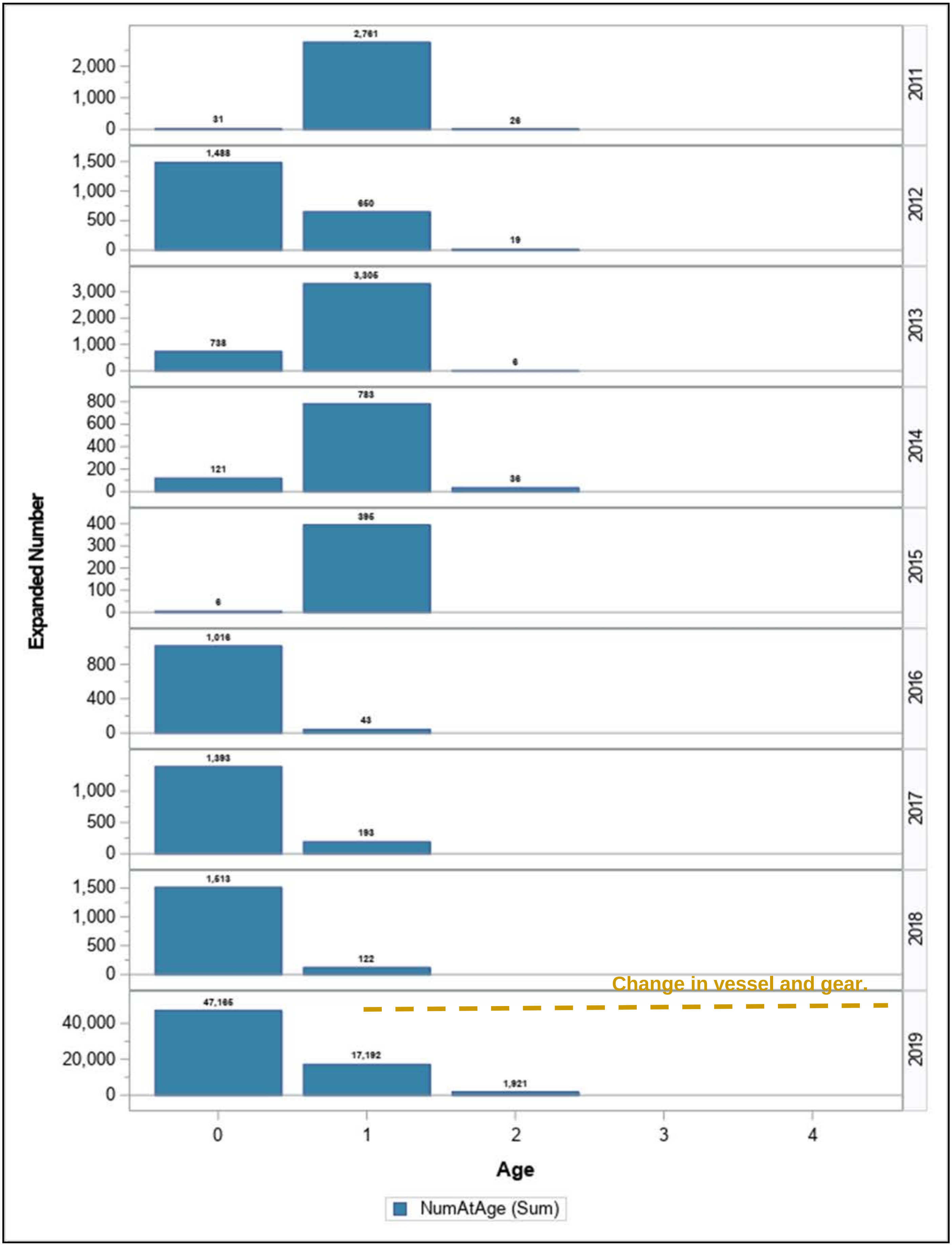


Figure 42. Spot age-frequency by year, 2002-2019 standardized to 8,000 (4,800 for 2019) annual trawl minutes.

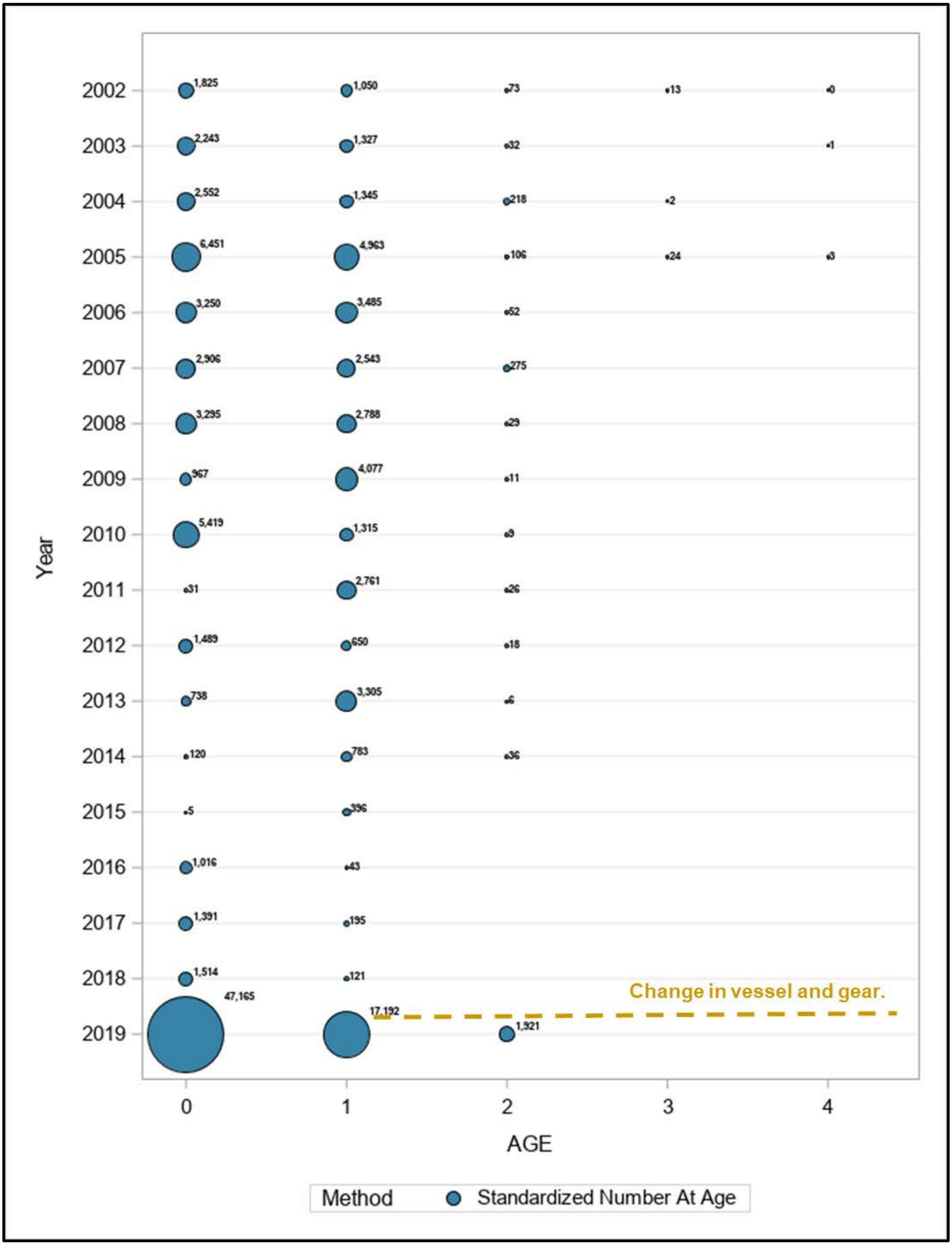


Figure 43. Diet composition, expressed as percent by weight (A) and percent by number (B) of Spot collected during ChesMMAP cruises in 2002-2018 combined.

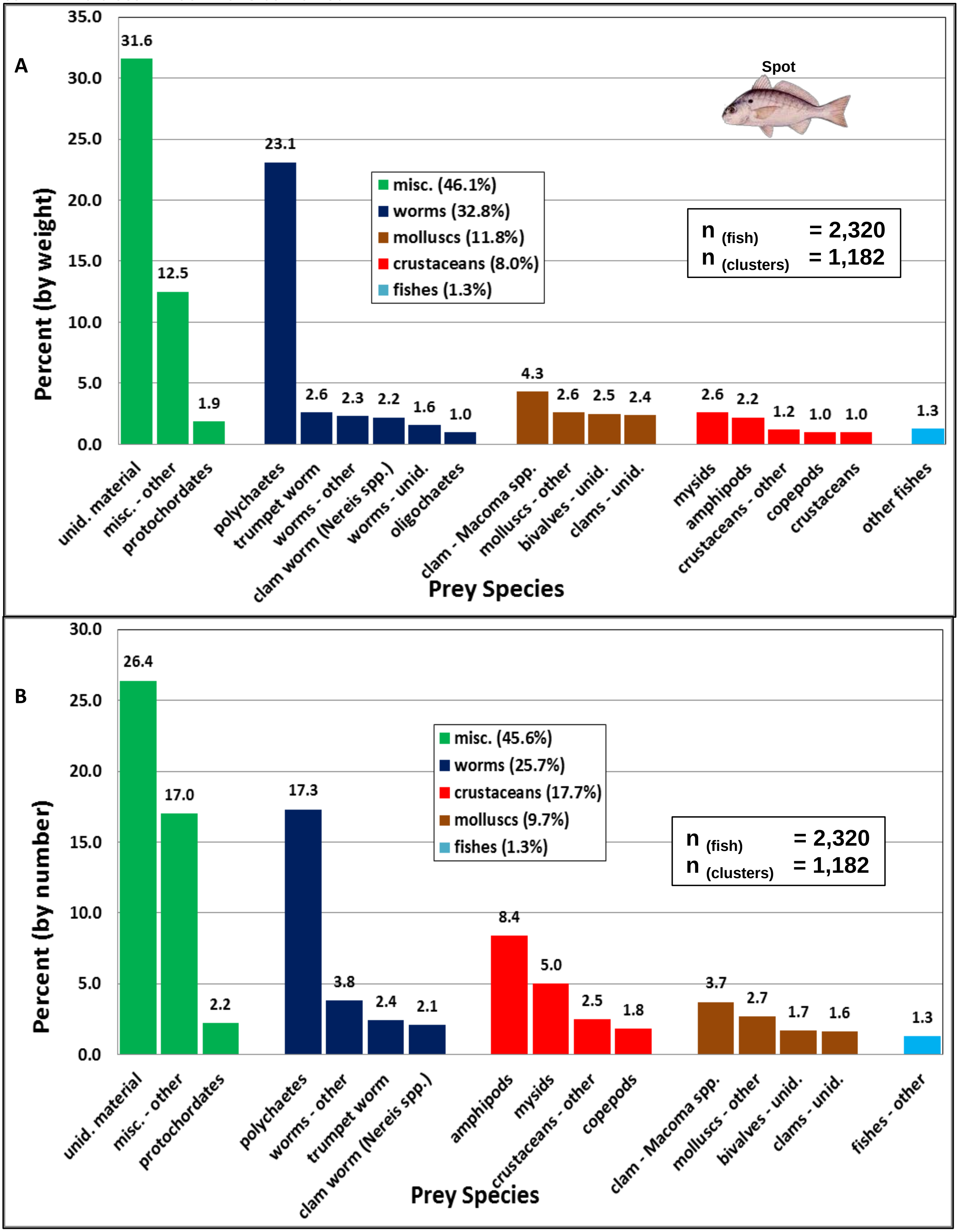


Table 22. Striped Bass sampling rates and preserved specimen analysis status by year.

Year	Number Caught	Biomass Caught (kg)	Presence at Index Stations (%)	Number Measured	Age Specimens	Ages Read	Stomach Specimens	Stomachs Analyzed
2002	495	313.9	40.2	495	337	337	248	230
2003	765	710.1	55.6	765	501	501	367	354
2004	918	668.9	66.7	918	590	590	476	468
2005	2,245	982.4	63.5	1,919	724	724	528	513
2006	911	839.1	60.6	911	535	535	412	407
2007	579	423.4	47.3	579	389	389	246	241
2008	472	476.9	52.2	472	380	380	317	309
2009	315	243.1	37.2	315	198	198	152	149
2010	288	285.4	29.2	288	205	205	147	144
2011	287	231.6	46.9	284	237	237	178	178
2012	935	330.5	52.8	935	257	257	197	196
2013	695	482.3	50.9	695	373	373	259	124
2014	578	355.8	39.1	578	255	255	186	183
2015	718	398.5	38.3	718	319	319	133	131
2016	1,266	530.2	70.4	1,266	534	534	280	279
2017	1,466	829.0	43.0	1,313	426	426	270	268
2018	313	157.2	35.0	313	173	173	100	100
2019	2,559	679.0	50.0	1,134	265	265	200	200

Figure 44. Station specific biomass of Striped Bass in Chesapeake Bay, 2019.

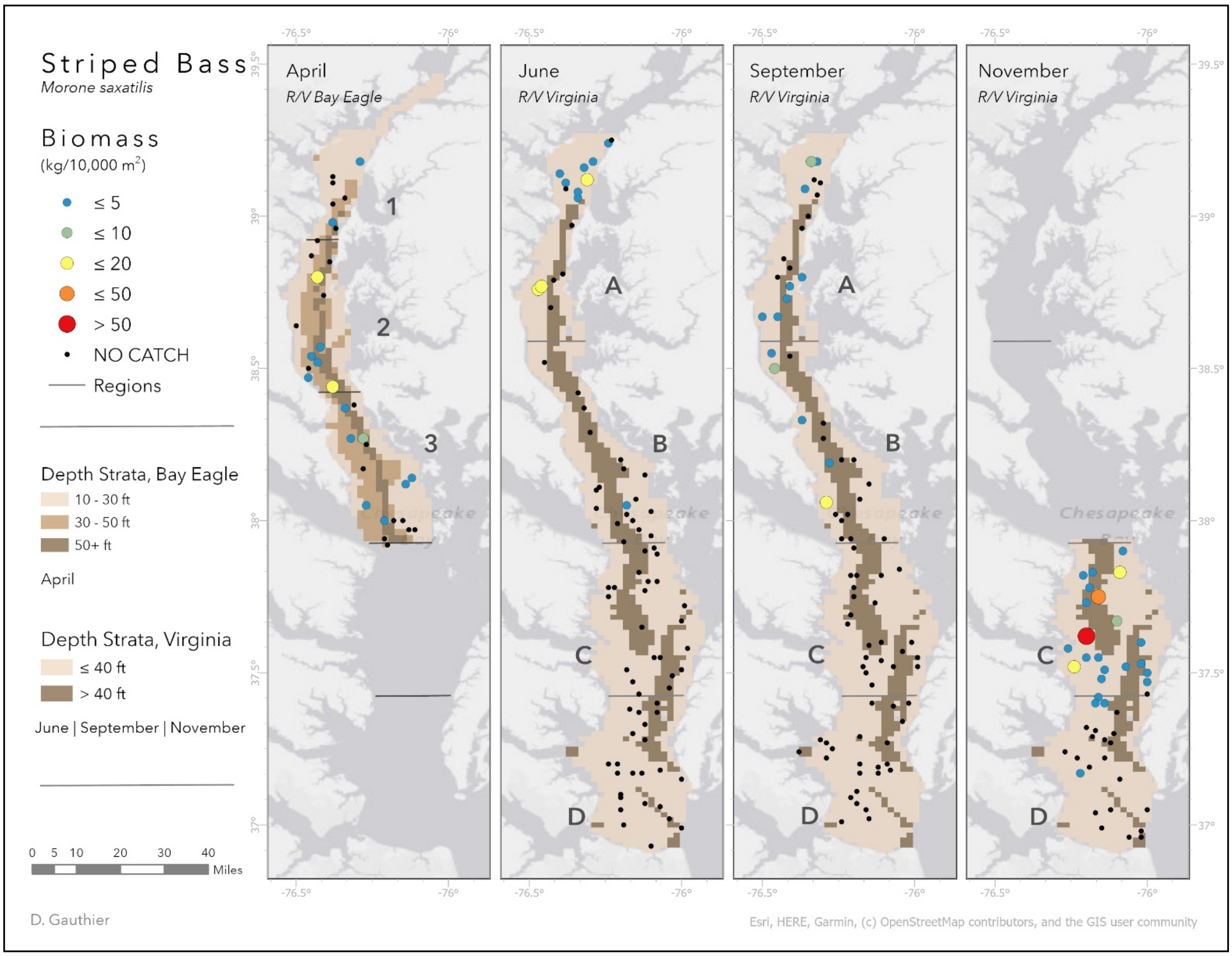


Table 23. Striped Bass (March) geometric mean indices of abundance, by number and biomass, overall and by age-class.

Year	Age	n	Numerical Index			Biomass Index		
			LCI	Index	UCI	LCI	Index	UCI
2002	All	28	0.0	0.4	1.0	0.0	0.4	0.8
2003		34	2.5	4.1	6.3	1.3	2.5	4.3
2004		40	5.0	6.6	8.5	3.4	4.7	6.4
2005		35	2.7	4.4	6.9	1.4	2.3	3.5
2006		35	1.6	2.6	4.1	1.3	2.3	3.7
2007		33	2.5	3.8	5.6	1.5	2.2	3.2
2008		35	3.7	5.1	6.9	2.9	4.5	6.9
2009		35	0.8	1.4	2.2	0.8	1.5	2.4
2010		34	0.7	1.3	2.1	0.7	1.4	2.6
2011		35	0.9	1.5	2.4	0.6	1.2	1.9
2012								
2013		35	2.1	3.4	5.3	2.1	3.4	5.2
2014		35	0.5	1.4	2.7	0.3	0.8	1.5
2015		35	0.2	0.8	1.7	0.0	0.4	1.0
2016		35	3.3	4.9	7.0	1.7	2.4	3.4
2017		34	1.0	1.8	3.1	0.6	1.0	1.5
2018								
2019		35	0.1	0.2	0.3	0.1	0.3	0.5
2020								
2002	1	28	0.0	0.3	0.8	0.0	0.2	0.6
2003		34	0.4	0.7	1.0	0.2	0.6	1.0
2004		40	0.5	0.9	1.4	0.3	0.6	0.9
2005		35	0.2	0.6	1.1	0.1	0.3	0.5
2006		35	0.1	0.5	0.9	0.2	0.4	0.8
2007		33	0.3	0.7	1.3	0.2	0.5	0.8
2008		35	0.3	0.8	1.4	0.1	0.6	1.2
2009		35	0.3	0.5	0.8	0.2	0.4	0.7
2010		34	0.1	0.4	0.8	0.1	0.5	1.0
2011		35	0.4	0.8	1.3	0.2	0.5	0.9
2012								
2013		35	0.5	0.8	1.1	0.5	0.8	1.1
2014		35	0.2	0.5	1.0	0.1	0.3	0.6
2015		35	0.1	0.5	1.2	0.0	0.3	0.7
2016		35	1.0	1.6	2.4	0.6	0.9	1.2
2017		34	0.2	0.7	1.3	0.1	0.3	0.5
2018								
2019		35	0.1	0.2	0.2	0.0	0.1	0.3
2020								
2002	2	28	0.0	0.4	0.9	0.0	0.3	0.6
2003		34	1.6	2.4	3.5	0.8	1.4	2.1
2004		40	0.9	1.4	1.9	0.6	1.0	1.4
2005		35	1.8	3.1	5.1	0.9	1.5	2.3
2006		35	0.5	0.9	1.5	0.3	0.6	1.0
2007		33	1.2	2.0	3.0	0.6	1.0	1.5
2008		35	0.5	1.1	1.9	0.2	0.7	1.3
2009		35	0.4	0.8	1.2	0.3	0.6	1.1
2010		34	0.1	0.4	0.8	0.1	0.5	1.0
2011		35	0.5	0.9	1.6	0.3	0.6	1.1
2012								
2013		35	1.2	1.9	2.9	1.0	1.5	2.2
2014		35	0.2	0.6	1.0	0.1	0.3	0.6
2015		35	0.1	0.6	1.3	0.0	0.3	0.8
2016		35	2.5	3.6	5.1	1.3	1.8	2.4
2017		34	0.7	1.5	2.6	0.4	0.7	1.1
2018								
2019		35	0.1	0.2	0.3	0.0	0.2	0.3
2020								
2002	3	28	0.0	0.3	0.8	0.0	0.2	0.6
2003		34	1.2	2.0	3.1	0.8	1.4	2.4
2004		40	2.1	3.1	4.4	1.6	2.4	3.4
2005		35	0.5	1.1	1.8	0.3	0.6	0.9
2006		35	1.2	2.1	3.2	0.9	1.4	2.1
2007		33	1.2	1.8	2.7	0.7	1.1	1.6
2008		35	1.8	2.7	3.9	1.0	1.7	2.7
2009		35	0.3	0.6	1.0	0.2	0.5	0.8
2010		34	0.5	1.0	1.7	0.4	1.0	1.8
2011		35	0.6	1.0	1.5	0.3	0.7	1.1
2012								
2013		35	0.8	1.3	2.0	0.8	1.2	1.7
2014		35	0.5	1.4	2.7	0.3	0.8	1.5
2015		35	0.1	0.6	1.2	0.0	0.3	0.7
2016		35	0.8	1.3	1.8	0.6	0.8	1.2
2017		34	0.4	1.0	1.7	0.2	0.5	0.7
2018								
2019		35	0.1	0.2	0.2	0.0	0.1	0.3
2020								
2002	4+	28	0.0	0.3	0.8	0.0	0.2	0.6
2003		34	0.5	0.8	1.2	0.3	0.6	1.1
2004		40	1.1	1.5	1.9	1.0	1.5	2.0
2005		35	0.3	0.8	1.4	0.2	0.5	0.8
2006		35	0.2	0.6	1.1	0.2	0.6	1.1
2007		33	1.0	1.7	2.7	0.7	1.2	1.8
2008		35	0.9	1.4	2.1	0.7	1.2	1.9
2009		35	0.4	0.7	1.1	0.3	0.7	1.1
2010		34	0.2	0.5	0.9	0.1	0.5	1.1
2011		35	0.6	1.1	1.6	0.4	0.7	1.2
2012								
2013		35	1.1	1.6	2.2	1.1	1.5	1.9
2014		35	0.2	0.6	1.0	0.2	0.4	0.6
2015		35	0.1	0.6	1.4	0.0	0.4	0.9
2016		35	0.6	1.0	1.4	0.5	0.7	1.0
2017		34	0.2	0.7	1.3	0.1	0.3	0.5
2018								
2019		35	0.1	0.2	0.3	0.1	0.3	0.5
2020								

Figure 45. Striped Bass (March) geometric mean indices of abundance, by number and biomass, for all ages combined and by age-class.

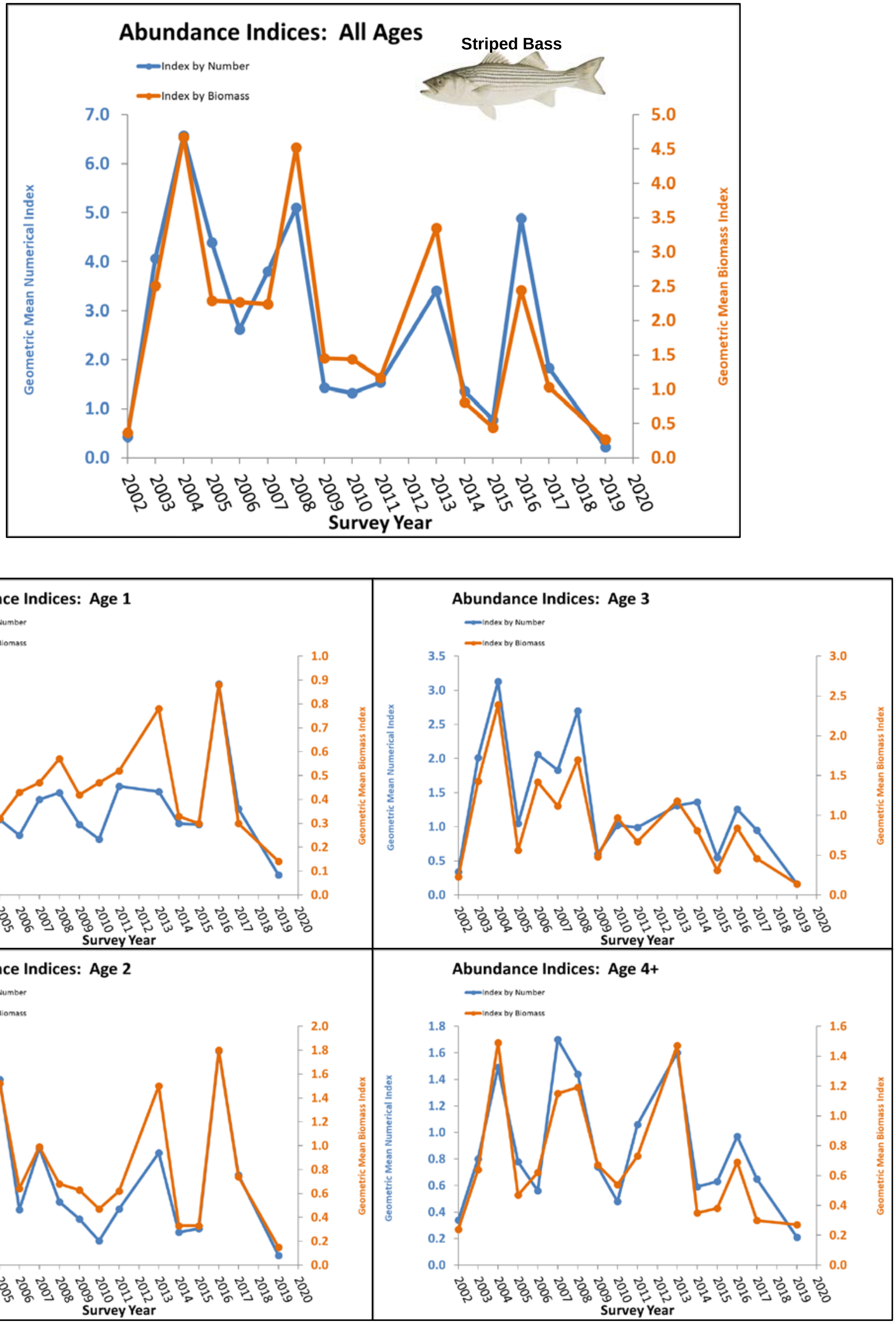


Table 24. Striped Bass (November) geometric mean indices of abundance, by number and biomass, overall and by age-class.

Year	Age	n	Numerical Index			Biomass Index		
			LCI	**Index**	UCI	LCI	**Index**	UCI
2002	All	74	0.7	1.0	1.4	0.5	0.8	1.1
2003		90	0.6	0.9	1.3	0.4	0.7	1.0
2004		85	0.9	1.3	1.7	0.4	0.6	0.9
2005		79	0.9	1.4	2.1	0.6	0.9	1.4
2006		74	1.2	1.8	2.6	0.7	1.2	1.7
2007		77	0.3	0.6	1.0	0.3	0.5	0.9
2008		80	0.5	0.8	1.1	0.4	0.7	1.1
2009		78	0.4	0.7	1.0	0.2	0.5	0.8
2010		79	0.2	0.4	0.6	0.1	0.4	0.6
2011		78	0.7	1.0	1.4	0.4	0.6	0.9
2012		72	1.2	2.0	3.0	0.8	1.2	1.8
2013		79	0.9	1.5	2.3	0.6	0.9	1.3
2014		80	0.7	1.2	1.9	0.6	1.0	1.5
2015		80	0.8	1.3	1.9	0.4	0.6	0.9
2016		80	2.3	3.2	4.3	1.2	1.6	2.1
2017		80	1.3	2.1	3.2	0.7	1.2	1.8
2018		80	0.6	0.9	1.2	0.3	0.5	0.7
2019		45	1.5	3.0	5.2	0.8	1.6	2.7
2020								
2002	1	74	0.1	0.3	0.4	0.1	0.1	0.2
2003		90	0.0	0.0	0.1	0.0	0.0	0.0
2004		85	0.5	0.8	1.1	0.2	0.3	0.4
2005		79	0.1	0.3	0.5	0.1	0.2	0.3
2006		74	0.3	0.4	0.6	0.1	0.2	0.3
2007		77	0.0	0.0	0.1	0.0	0.0	0.1
2008		80	0.1	0.3	0.5	0.1	0.2	0.4
2009		78	0.1	0.2	0.4	0.0	0.1	0.3
2010		79	0.1	0.2	0.3	0.0	0.1	0.2
2011		78	0.4	0.6	0.8	0.2	0.3	0.4
2012		72	0.7	1.2	2.0	0.3	0.6	0.9
2013		79	0.0	0.1	0.2	0.0	0.1	0.1
2014		80	0.3	0.5	0.7	0.2	0.3	0.5
2015		80	0.4	0.7	1.1	0.2	0.3	0.4
2016		80	1.3	2.0	2.9	0.6	0.9	1.2
2017		80	0.2	0.4	0.7	0.1	0.2	0.3
2018		80	0.3	0.5	0.8	0.2	0.3	0.4
2019		45	0.8	2.0	3.8	0.4	0.9	1.7
2020								
2002	2	74	0.3	0.5	0.7	0.2	0.3	0.4
2003		90	0.3	0.5	0.7	0.2	0.3	0.5
2004		85	0.1	0.2	0.4	0.1	0.1	0.2
2005		79	0.6	1.0	1.5	0.3	0.6	0.9
2006		74	0.4	0.6	0.9	0.2	0.4	0.6
2007		77	0.1	0.2	0.4	0.1	0.2	0.3
2008		80	0.1	0.2	0.4	0.0	0.2	0.4
2009		78	0.3	0.6	0.9	0.2	0.4	0.6
2010		79	0.1	0.2	0.3	0.0	0.1	0.3
2011		78	0.3	0.4	0.6	0.1	0.2	0.3
2012		72	0.3	0.5	0.8	0.2	0.3	0.5
2013		79	0.8	1.3	2.0	0.5	0.8	1.1
2014		80	0.1	0.2	0.4	0.0	0.2	0.3
2015		80	0.3	0.5	0.7	0.1	0.2	0.3
2016		80	0.7	1.0	1.4	0.4	0.5	0.7
2017		80	0.9	1.5	2.2	0.5	0.8	1.2
2018		80	0.2	0.4	0.6	0.1	0.2	0.4
2019		45	0.4	1.0	1.8	0.2	0.5	0.8
2020								
2002	3	74	0.1	0.2	0.3	0.1	0.1	0.2
2003		90	0.2	0.3	0.5	0.1	0.2	0.3
2004		85	0.1	0.3	0.4	0.1	0.2	0.3
2005		79	0.0	0.2	0.3	0.0	0.1	0.2
2006		74	0.7	1.1	1.7	0.5	0.8	1.1
2007		77	0.1	0.2	0.4	0.0	0.2	0.3
2008		80	0.1	0.3	0.5	0.1	0.3	0.5
2009		78	0.1	0.3	0.5	0.0	0.2	0.3
2010		79	0.1	0.2	0.4	0.1	0.2	0.4
2011		78	0.2	0.3	0.5	0.1	0.2	0.3
2012		72	0.2	0.3	0.5	0.1	0.3	0.5
2013		79	0.2	0.4	0.6	0.1	0.2	0.3
2014		80	0.4	0.8	1.4	0.3	0.7	1.1
2015		80	0.1	0.2	0.3	0.0	0.1	0.1
2016		80	0.1	0.2	0.4	0.0	0.1	0.2
2017		80	0.5	0.8	1.3	0.3	0.5	0.7
2018		80	0.3	0.5	0.7	0.2	0.3	0.4
2019		45	0.0	0.2	0.3	0.0	0.1	0.3
2020								
2002	4+	74	0.1	0.2	0.4	0.1	0.2	0.3
2003		90	0.1	0.1	0.2	0.1	0.1	0.2
2004		85	0.1	0.2	0.3	0.1	0.1	0.2
2005		79	0.1	0.3	0.4	0.1	0.2	0.3
2006		74	0.1	0.3	0.4	0.1	0.2	0.3
2007		77	0.1	0.3	0.5	0.1	0.2	0.4
2008		80	0.1	0.3	0.4	0.1	0.3	0.5
2009		78	0.1	0.2	0.4	0.0	0.2	0.3
2010		79	0.0	0.1	0.2	0.0	0.1	0.2
2011		78	0.2	0.3	0.5	0.1	0.2	0.3
2012		72	0.0	0.1	0.2	0.0	0.1	0.2
2013		79	0.0	0.1	0.2	0.0	0.1	0.1
2014		80	0.2	0.4	0.6	0.2	0.3	0.5
2015		80	0.3	0.5	0.7	0.2	0.3	0.5
2016		80	0.0	0.1	0.3	0.0	0.1	0.1
2017		80	0.1	0.3	0.5	0.1	0.2	0.3
2018		80	0.2	0.3	0.5	0.1	0.2	0.3
2019		45	0.5	0.9	1.4	0.4	0.7	1.2
2020								

Figure 46. Striped Bass (November) geometric mean indices of abundance, by number and biomass, for all ages combined and by age-class.

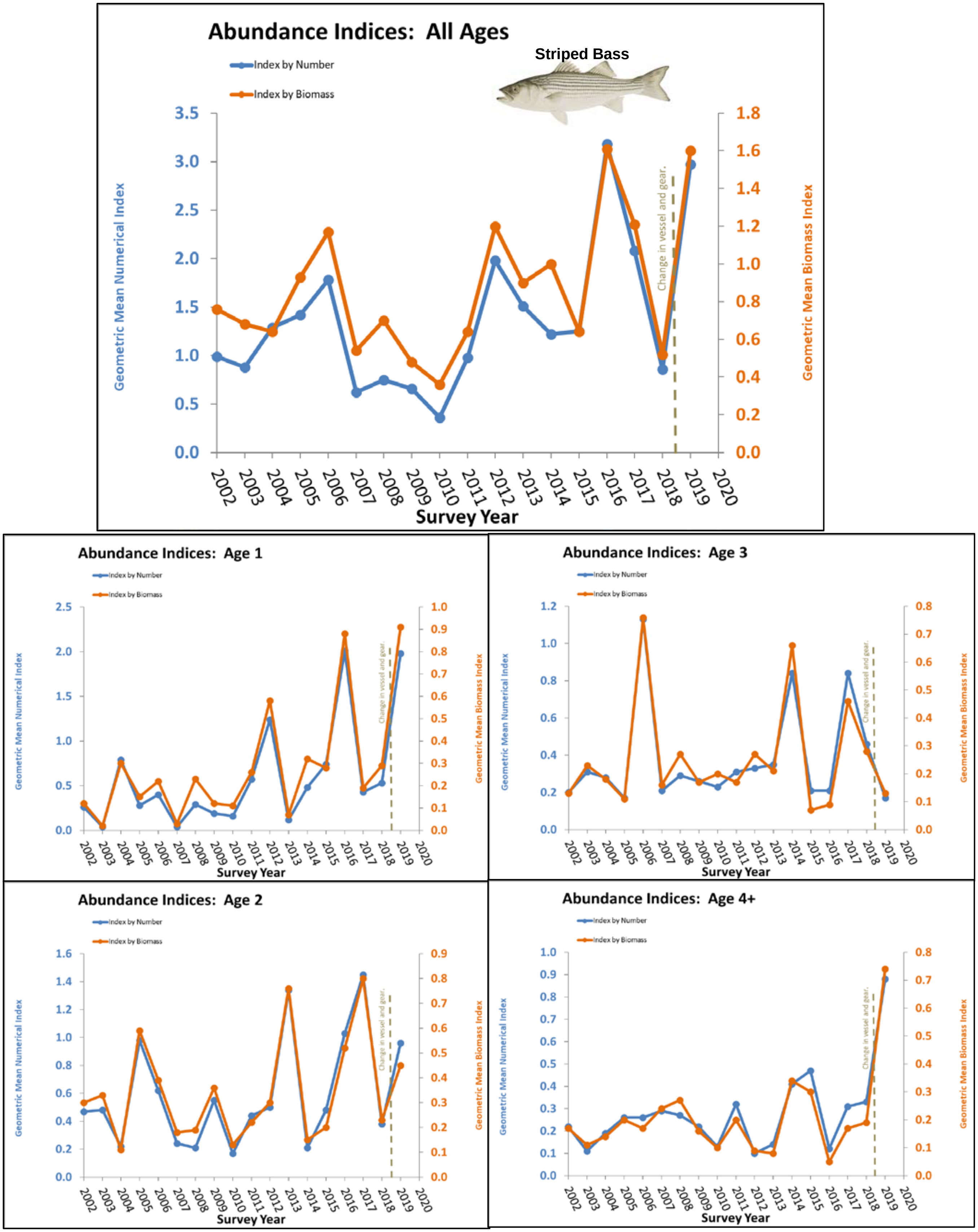


Figure 47. Striped Bass length-frequency in Chesapeake Bay 2002-2019, overall (A) and by sex (B).

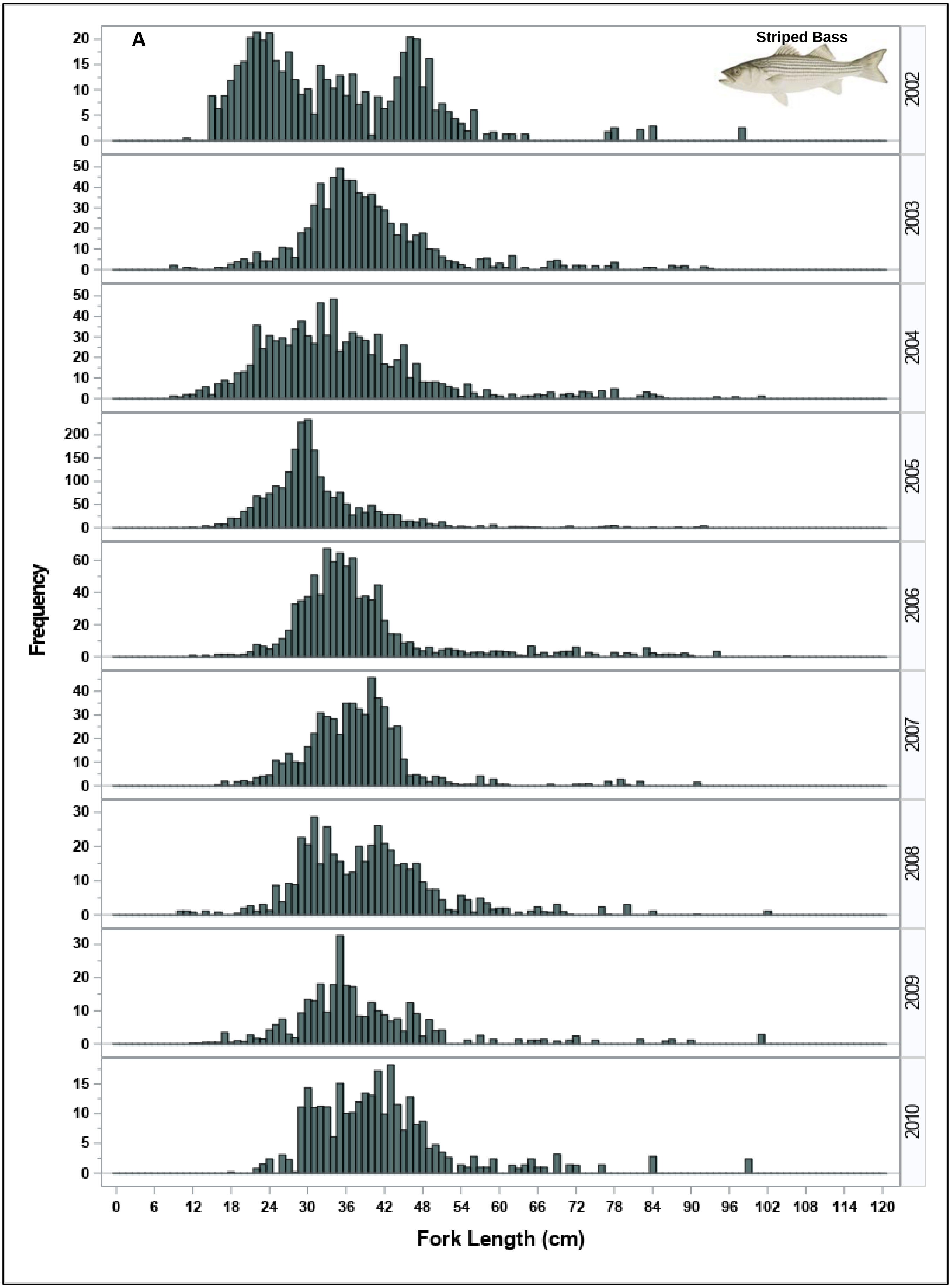


Figure 47. cont.

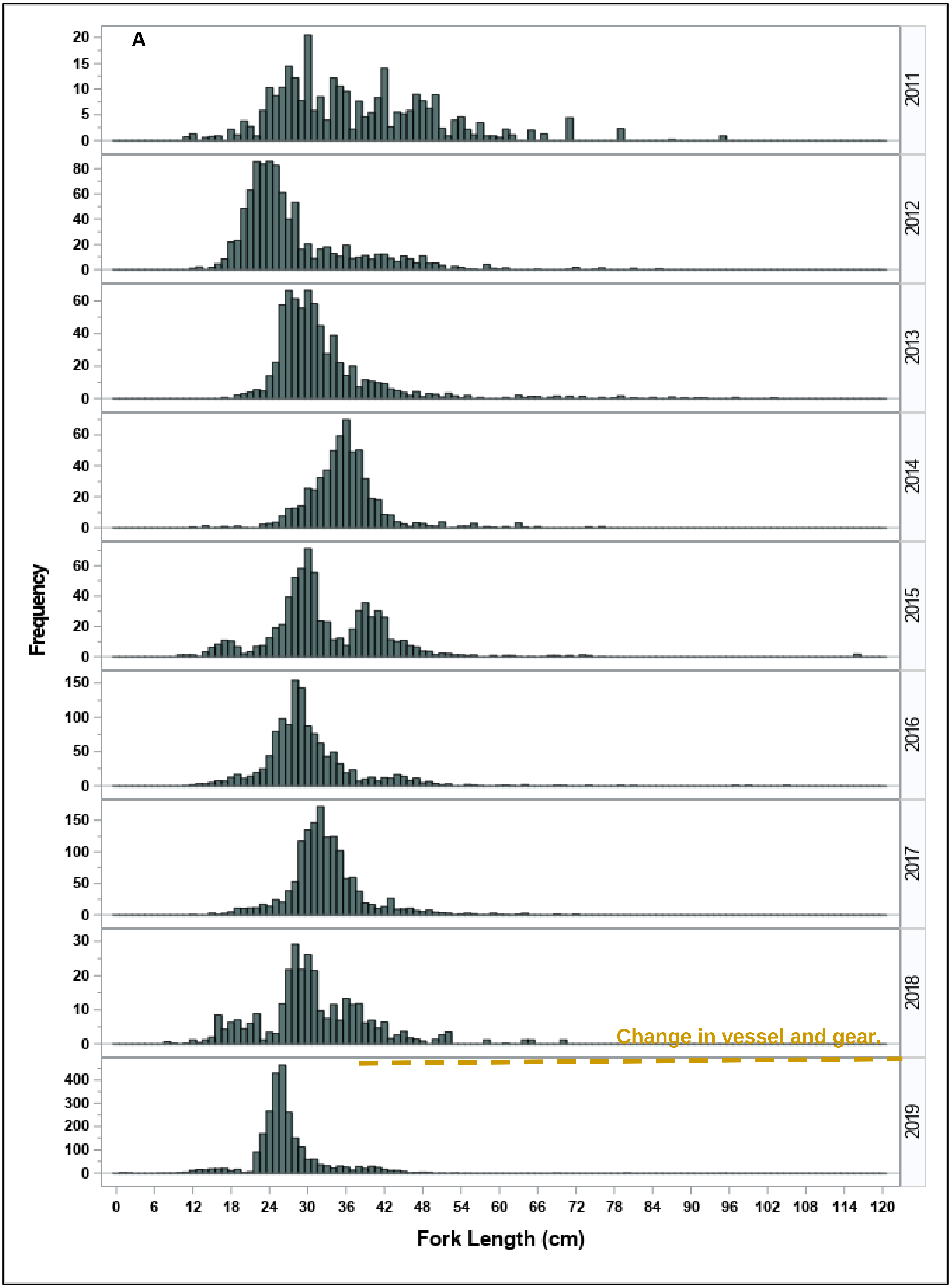


Figure 47. cont.

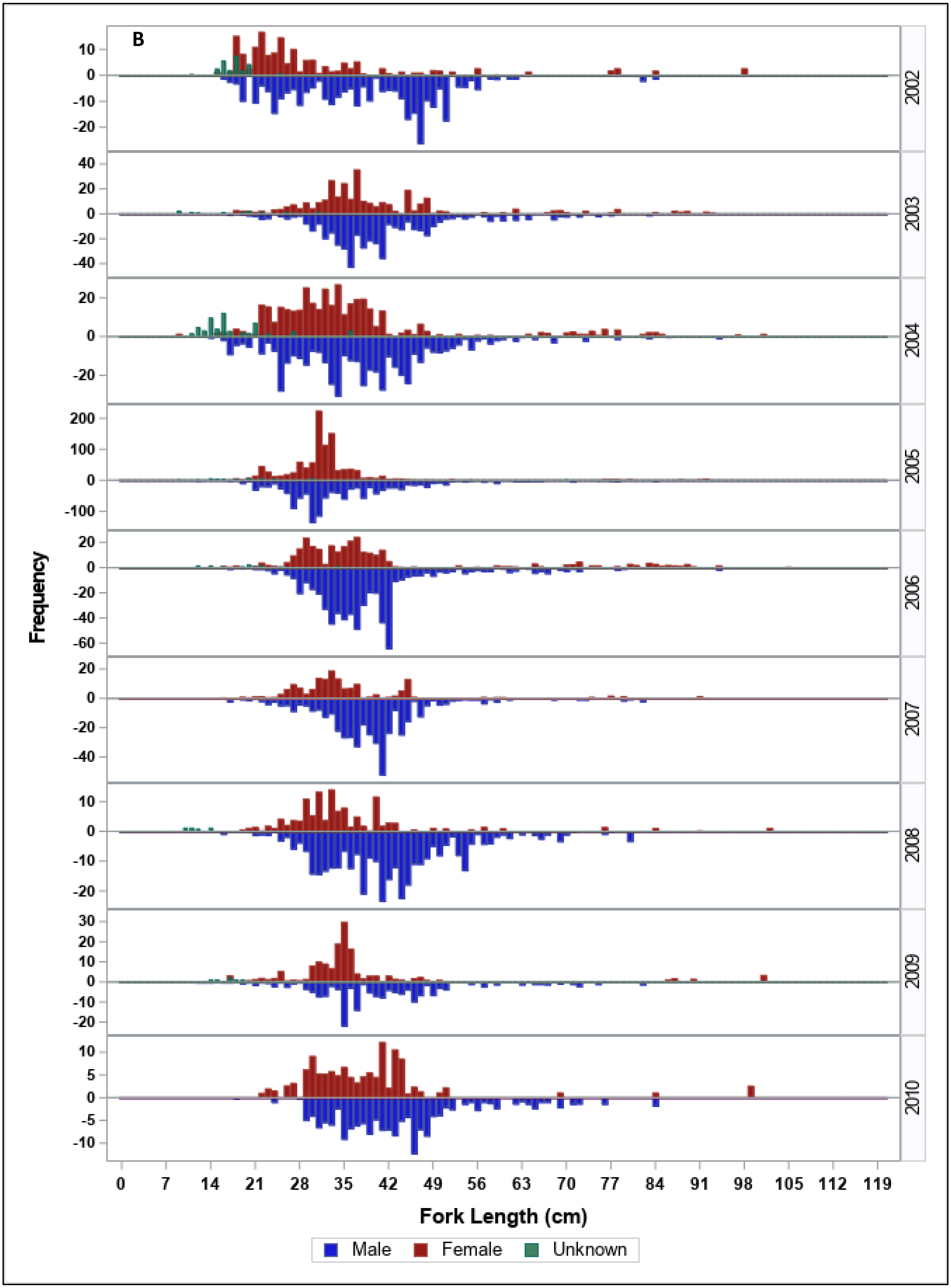


Figure 47. cont.

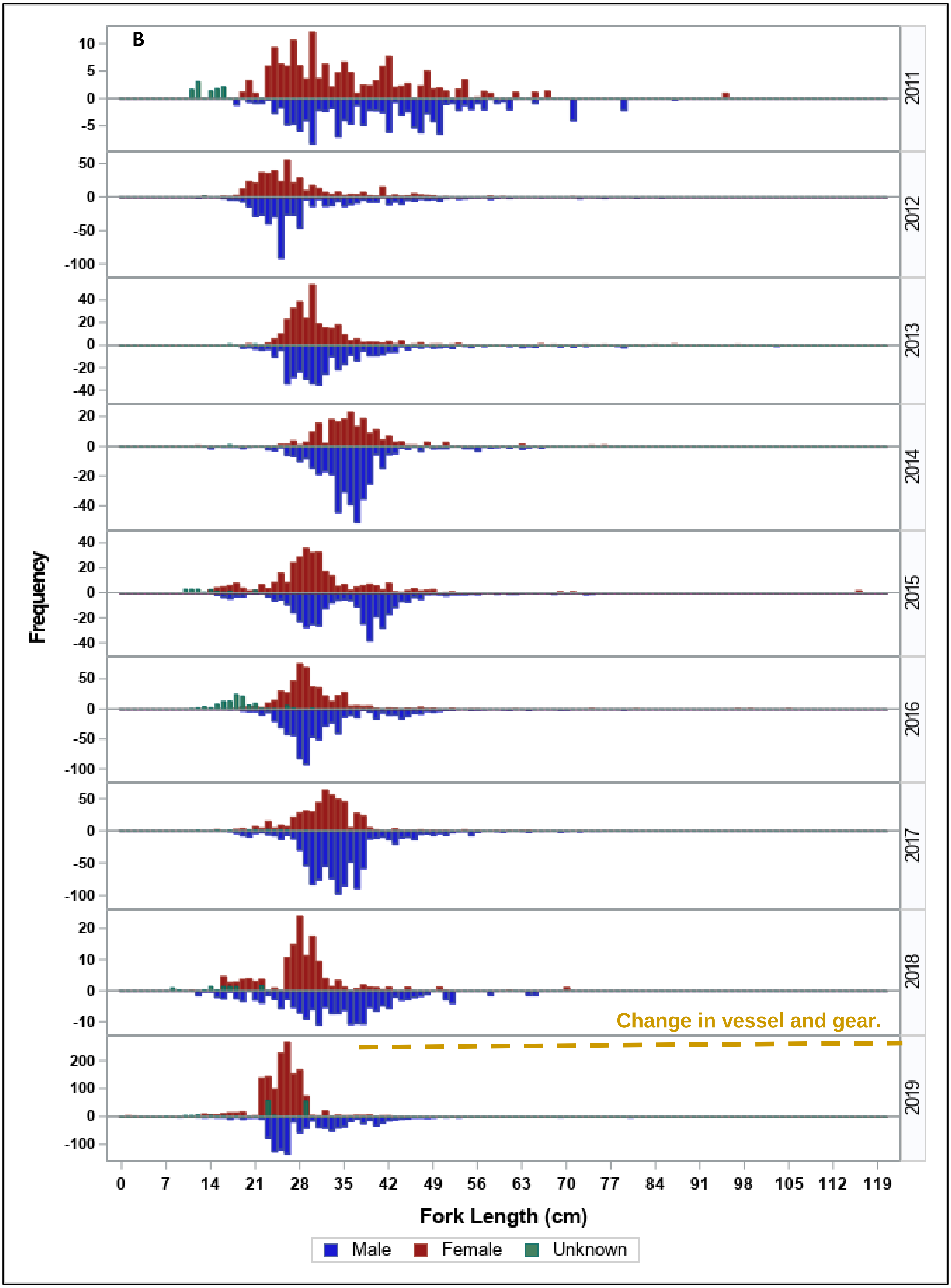


Figure 48. Striped Bass total age-frequency, 2002-2019.

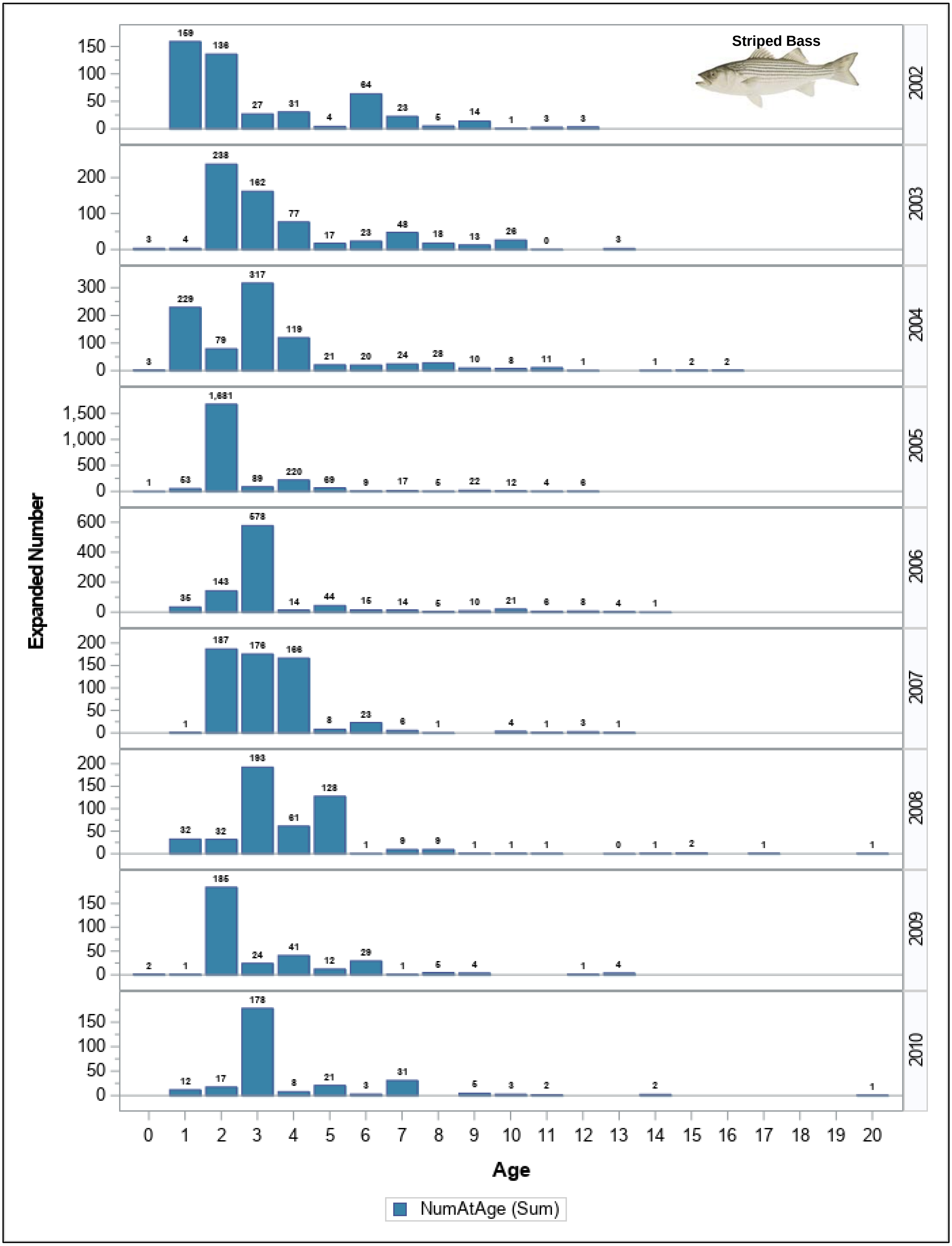


Figure 48. cont.

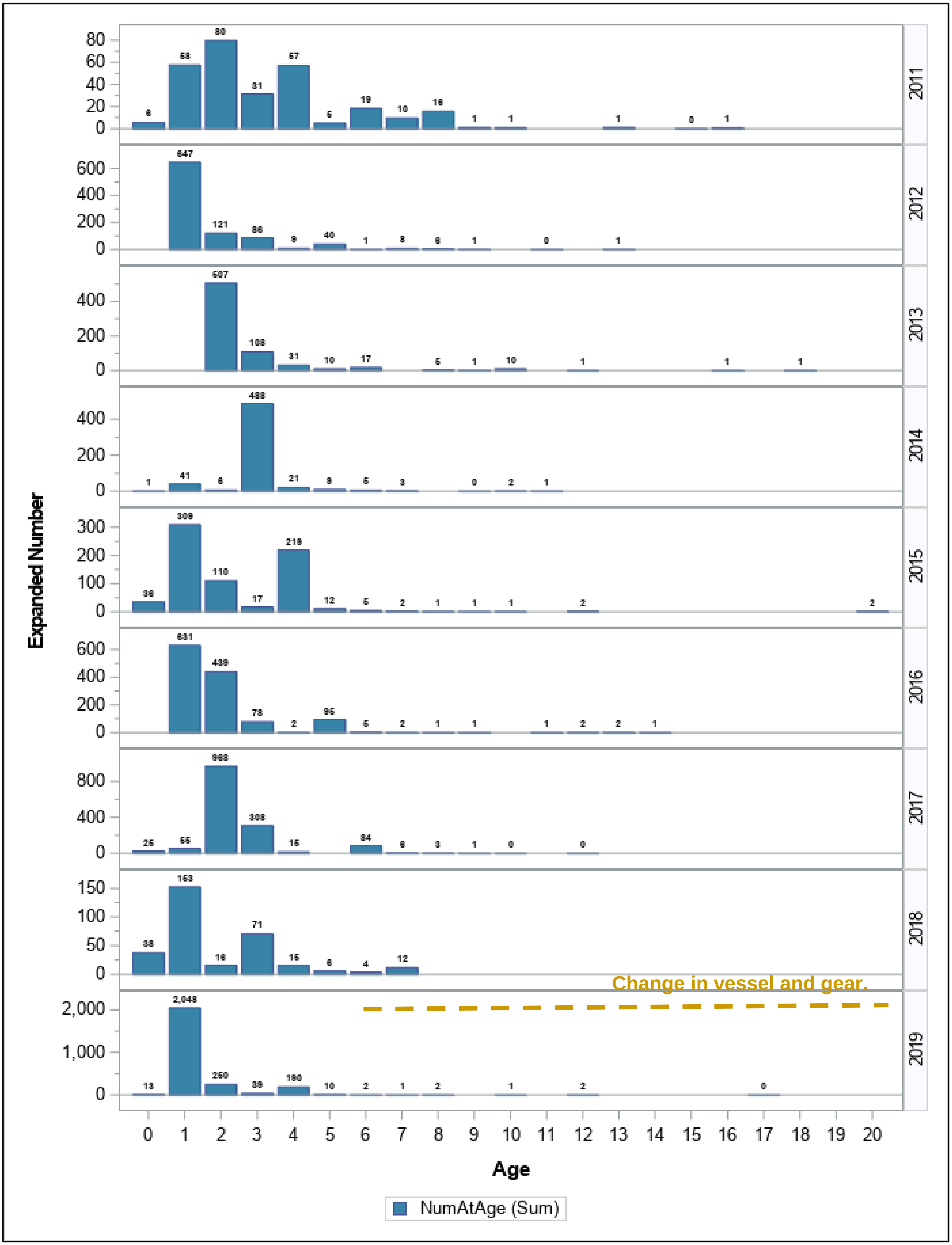


Figure 49. Striped Bass age-frequency by year, 2002-2019 standardized to 8,000 (4,800 for 2019) annual trawl minutes.

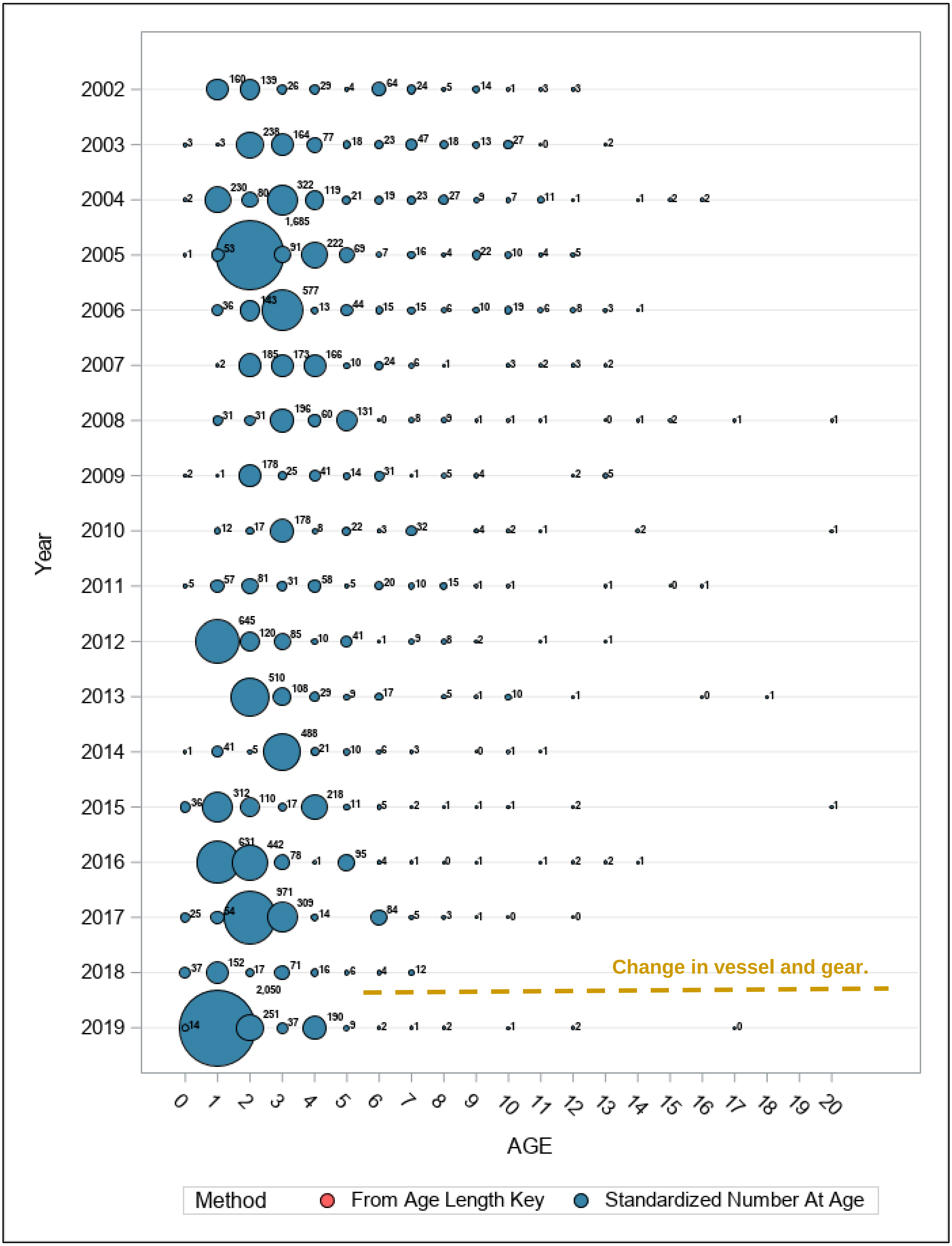


Figure 50. Diet composition, expressed as percent by weight (A) and percent by number (B) of Striped Bass collected during ChesMMAP cruises in 2002-2018 combined.

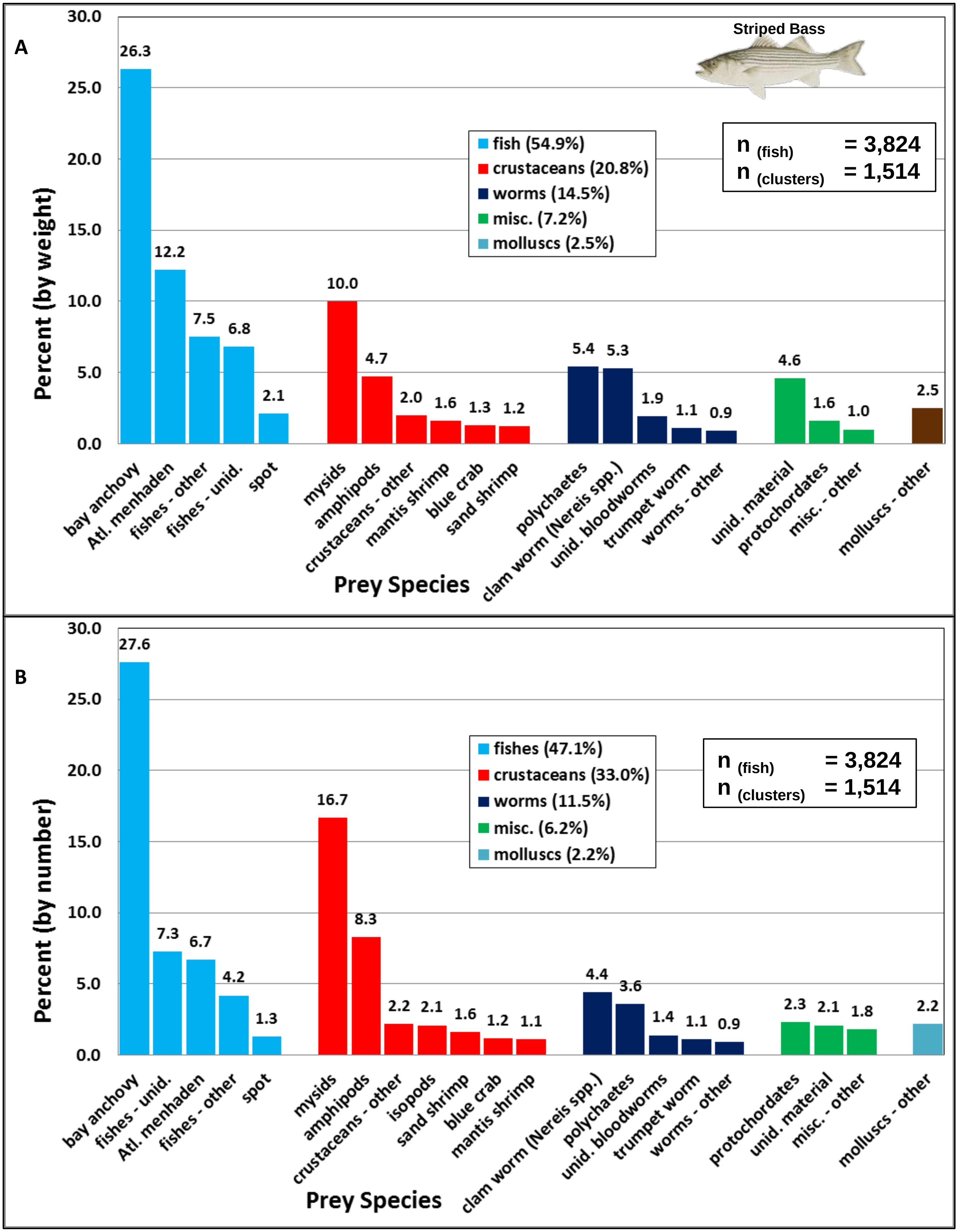


Table 25. Summer Flounder sampling rates and preserved specimen analysis status by year.

Year	Number Caught	Biomass Caught (kg)	Presence at Index Stations (%)	Number Measured	Age Specimens	Ages Read	Stomach Specimens	Stomachs Analyzed
2002	770	430.5	84.0	770	649	649	425	409
2003	563	341.5	67.6	562	441	441	325	316
2004	728	309.7	72.0	728	565	565	377	372
2005	759	386.7	89.5	759	669	669	420	409
2006	932	453.1	88.6	932	755	755	444	430
2007	567	259.1	81.8	563	489	489	317	313
2008	636	280.9	77.8	638	543	543	354	346
2009	393	187.1	66.7	393	369	369	243	239
2010	385	180.0	67.8	385	354	354	215	209
2011	211	126.3	62.9	211	208	208	111	107
2012	92	33.4	31.0	92	91	91	57	53
2013	110	35.7	33.7	110	107	107	51	45
2014	63	16.7	30.0	63	63	63	40	40
2015	129	41.9	35.6	129	127	127	72	72
2016	77	21.8	30.0	77	77	77	40	39
2017	135	35.3	28.9	135	128	128	85	85
2018	105	26.5	15.6	105	96	96	44	44
2019	623	78.7	90.0	623	385	385	220	216

Figure 51. Station specific biomass of Summer Flounder in Chesapeake Bay, 2019.

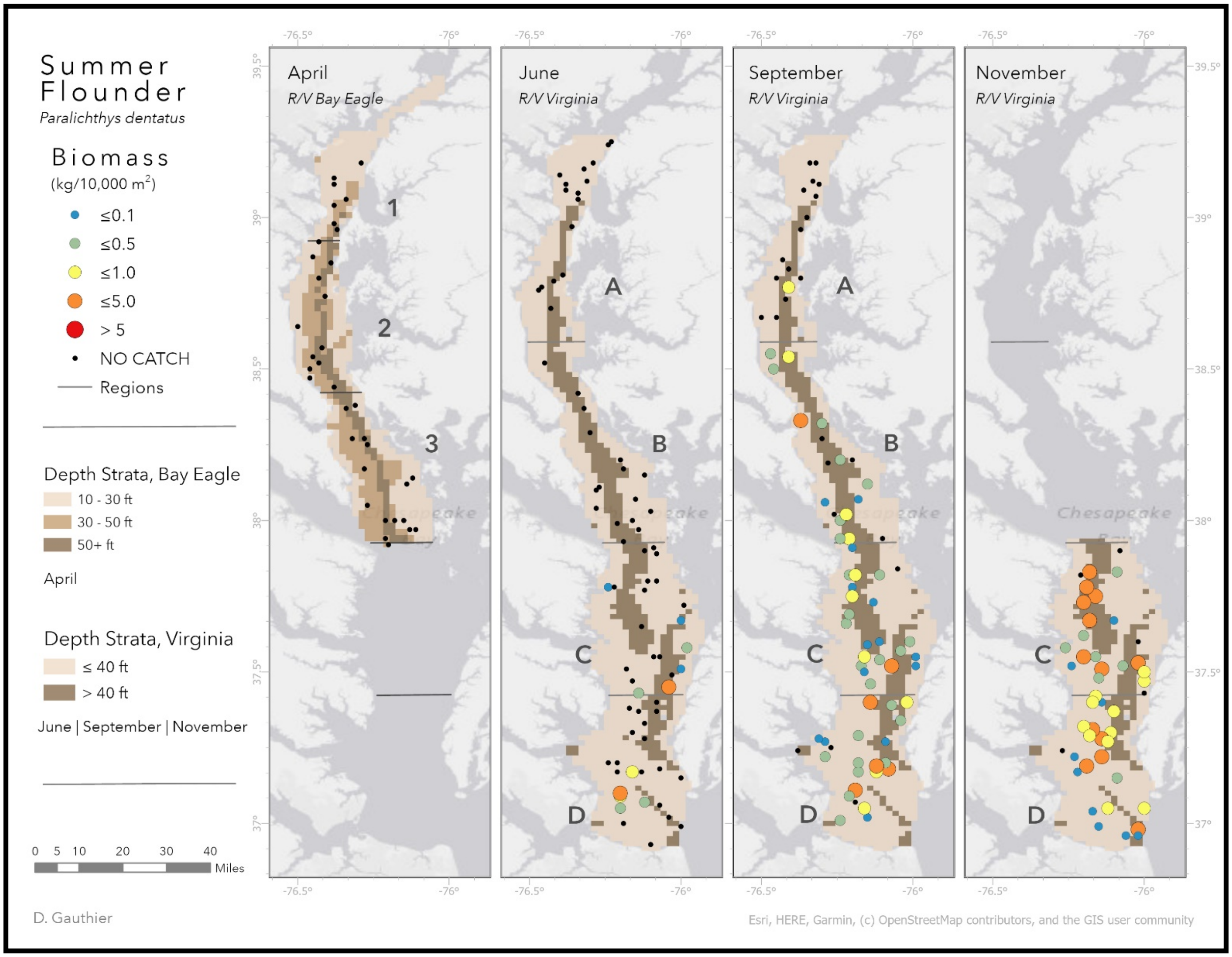


Table 26. Summer Flounder geometric mean indices of abundance, by number and biomass, overall and by age-class.

Year	Age	n	Numerical Index LCI	Numerical Index Index	Numerical Index UCI	Biomass Index LCI	Biomass Index Index	Biomass Index UCI
2002	All	75	2.48	3.34	4.42	1.21	1.65	2.16
2003		101	1.35	1.84	2.44	0.76	1.04	1.36
2004		92	1.49	1.97	2.55	0.59	0.77	0.98
2005		86	2.78	3.45	4.25	1.16	1.46	1.80
2006		79	3.42	4.36	5.52	1.23	1.59	2.01
2007		44	2.35	3.31	4.53	0.81	1.13	1.52
2008		90	2.25	3.04	4.01	0.87	1.21	1.60
2009		90	1.19	1.61	2.10	0.54	0.74	0.96
2010		90	1.22	1.63	2.12	0.48	0.65	0.83
2011		89	0.84	1.13	1.46	0.48	0.66	0.86
2012		84	0.19	0.32	0.47	0.06	0.12	0.17
2013		89	0.28	0.44	0.63	0.07	0.14	0.21
2014		90	0.21	0.33	0.47	0.05	0.10	0.15
2015		90	0.35	0.54	0.75	0.13	0.22	0.31
2016		90	0.20	0.32	0.45	0.07	0.12	0.18
2017		90	0.24	0.40	0.58	0.08	0.15	0.21
2018		90	0.08	0.17	0.27	0.02	0.07	0.11
2019		90	3.02	3.80	4.74	0.45	0.57	0.70
2020								

Year	Age	n	Numerical Index LCI	Numerical Index Index	Numerical Index UCI	Biomass Index LCI	Biomass Index Index	Biomass Index UCI
2002	0	75	1.48	2.07	2.80	0.55	0.73	0.94
2003		101	0.47	0.68	0.91	0.19	0.27	0.35
2004		92	0.97	1.36	1.84	0.30	0.42	0.54
2005		86	1.11	1.47	1.90	0.39	0.50	0.63
2006		79	2.04	2.71	3.54	0.54	0.68	0.84
2007		44	1.74	2.47	3.39	0.54	0.72	0.93
2008		90	1.45	2.00	2.66	0.39	0.55	0.72
2009		90	0.56	0.82	1.11	0.21	0.32	0.45
2010		90	0.77	1.09	1.45	0.26	0.36	0.46
2011		89	0.32	0.46	0.62	0.16	0.24	0.33
2012		84	0.15	0.27	0.41	0.03	0.08	0.13
2013		89	0.21	0.36	0.52	0.05	0.11	0.17
2014		90	0.19	0.31	0.44	0.05	0.09	0.13
2015		90	0.31	0.47	0.66	0.11	0.18	0.25
2016		90	0.17	0.28	0.40	0.06	0.11	0.16
2017		90	0.17	0.30	0.46	0.05	0.10	0.15
2018		90	0.06	0.15	0.24	0.01	0.05	0.09
2019		90	2.83	3.59	4.50	0.39	0.49	0.60
2020								

Year	Age	n	Numerical Index LCI	Numerical Index Index	Numerical Index UCI	Biomass Index LCI	Biomass Index Index	Biomass Index UCI
2002	1	75	0.37	0.55	0.75	0.21	0.34	0.47
2003		101	0.26	0.39	0.55	0.13	0.21	0.29
2004		92	0.30	0.44	0.58	0.15	0.23	0.32
2005		86	0.88	1.18	1.54	0.40	0.54	0.69
2006		79	0.44	0.62	0.82	0.21	0.32	0.44
2007		44	0.36	0.62	0.92	0.14	0.25	0.38
2008		90	0.40	0.60	0.83	0.23	0.37	0.52
2009		90	0.37	0.55	0.76	0.17	0.27	0.38
2010		90	0.19	0.31	0.44	0.09	0.16	0.24
2011		89	0.28	0.44	0.62	0.17	0.29	0.42
2012		84	0.05	0.11	0.17	0.02	0.05	0.09
2013		89	0.07	0.14	0.22	0.03	0.08	0.13
2014		90	0.05	0.12	0.20	0.01	0.04	0.08
2015		90	0.08	0.17	0.26	0.04	0.09	0.15
2016		90	0.08	0.16	0.25	0.04	0.08	0.12
2017		90	0.08	0.16	0.25	0.04	0.08	0.13
2018		90	0.00	0.04	0.08	0.00	0.03	0.07
2019		90	0.23	0.32	0.42	0.08	0.13	0.18
2020								

Year	Age	n	Numerical Index LCI	Numerical Index Index	Numerical Index UCI	Biomass Index LCI	Biomass Index Index	Biomass Index UCI
2002	2	75	0.15	0.28	0.42	0.13	0.25	0.39
2003		101	0.03	0.08	0.13	0.03	0.08	0.13
2004		92	0.10	0.18	0.26	0.07	0.14	0.21
2005		86	0.29	0.44	0.60	0.21	0.32	0.45
2006		79	0.21	0.35	0.51	0.15	0.28	0.42
2007		44	0.11	0.23	0.36	0.05	0.11	0.18
2008		90	0.31	0.47	0.65	0.22	0.35	0.51
2009		90	0.09	0.18	0.28	0.07	0.16	0.25
2010		90	0.07	0.16	0.25	0.04	0.10	0.16
2011		89	0.18	0.30	0.42	0.14	0.23	0.33
2012		84	0.04	0.10	0.17	0.02	0.06	0.10
2013		89	0.03	0.07	0.13	0.01	0.06	0.10
2014		90	0.06	0.13	0.22	0.01	0.05	0.09
2015		90	0.04	0.11	0.18	0.02	0.06	0.11
2016		90	0.06	0.12	0.19	0.03	0.07	0.10
2017		90	0.04	0.11	0.18	0.01	0.06	0.11
2018		90	0.01	0.05	0.09	0.00	0.04	0.09
2019		90	0.11	0.19	0.27	0.05	0.10	0.14
2020								

Year	Age	n	Numerical Index LCI	Numerical Index Index	Numerical Index UCI	Biomass Index LCI	Biomass Index Index	Biomass Index UCI
2002	3	75	0.16	0.30	0.46	0.15	0.31	0.48
2003		101	0.04	0.08	0.13	0.04	0.09	0.15
2004		92	0.05	0.11	0.17	0.04	0.10	0.15
2005		86	0.16	0.27	0.39	0.11	0.20	0.29
2006		79	0.12	0.21	0.30	0.10	0.19	0.28
2007		44	0.04	0.11	0.18	0.01	0.07	0.12
2008		90	0.14	0.25	0.38	0.10	0.19	0.30
2009		90	0.07	0.16	0.25	0.06	0.14	0.24
2010		90	0.03	0.09	0.15	0.01	0.05	0.10
2011		89	0.08	0.16	0.25	0.07	0.15	0.23
2012		84	0.04	0.10	0.16	0.01	0.05	0.09
2013		89	0.03	0.07	0.13	0.01	0.06	0.10
2014		90	0.05	0.12	0.19	0.01	0.04	0.07
2015		90	0.04	0.10	0.16	0.02	0.06	0.10
2016		90	0.06	0.12	0.19	0.03	0.07	0.10
2017		90	0.03	0.09	0.15	0.01	0.05	0.09
2018		90	0.00	0.03	0.07	0.00	0.03	0.07
2019		90	0.08	0.15	0.23	0.03	0.07	0.11
2020								

Year	Age	n	Numerical Index LCI	Numerical Index Index	Numerical Index UCI	Biomass Index LCI	Biomass Index Index	Biomass Index UCI
2002	4	75	0.07	0.14	0.22	0.06	0.14	0.22
2003		101	0.02	0.08	0.15	0.03	0.09	0.16
2004		92	0.05	0.10	0.16	0.04	0.09	0.15
2005		86	0.04	0.11	0.18	0.02	0.08	0.14
2006		79	0.10	0.19	0.30	0.07	0.18	0.31
2007		44	0.02	0.10	0.18	0.00	0.07	0.13
2008		90	0.08	0.16	0.25	0.04	0.12	0.20
2009		90	0.02	0.08	0.14	0.01	0.07	0.14
2010		90	0.06	0.13	0.21	0.04	0.10	0.17
2011		89	0.07	0.16	0.25	0.06	0.14	0.23
2012		84	0.03	0.09	0.14	0.01	0.04	0.08
2013		89	0.03	0.08	0.14	0.01	0.06	0.12
2014		90	0.05	0.12	0.19	0.01	0.04	0.07
2015		90	0.04	0.10	0.16	0.02	0.06	0.10
2016		90	0.06	0.12	0.19	0.03	0.07	0.10
2017		90	0.03	0.09	0.15	0.01	0.05	0.09
2018		90	0.00	0.03	0.07	0.00	0.03	0.07
2019		90	0.08	0.15	0.22	0.03	0.07	0.11
2020								

Year	Age	n	Numerical Index LCI	Numerical Index Index	Numerical Index UCI	Biomass Index LCI	Biomass Index Index	Biomass Index UCI
2002	5	75	0.02	0.09	0.16	0.03	0.12	0.22
2003		101	0.00	0.03	0.06	0.00	0.04	0.08
2004		92	0.04	0.10	0.16	0.03	0.09	0.16
2005		86	0.04	0.10	0.17	0.02	0.08	0.13
2006		79	0.01	0.06	0.11	0.00	0.07	0.15
2007		44	0.03	0.11	0.19	0.01	0.05	0.09
2008		90	0.08	0.16	0.25	0.04	0.12	0.20
2009		90	0.02	0.07	0.12	0.01	0.07	0.14
2010		90	0.02	0.07	0.13	0.01	0.04	0.08
2011		89	0.07	0.15	0.23	0.06	0.14	0.22
2012		84	0.03	0.09	0.14	0.01	0.04	0.08
2013		89	0.03	0.07	0.13	0.01	0.06	0.10
2014		90	0.05	0.12	0.19	0.01	0.04	0.07
2015		90	0.04	0.10	0.16	0.02	0.06	0.10
2016		90	0.06	0.12	0.19	0.03	0.07	0.10
2017		90	0.03	0.09	0.15	0.01	0.05	0.09
2018		90	0.00	0.03	0.07	0.00	0.03	0.07
2019		90	0.08	0.15	0.22	0.03	0.07	0.11
2020								

Year	Age	n	Numerical Index LCI	Numerical Index Index	Numerical Index UCI	Biomass Index LCI	Biomass Index Index	Biomass Index UCI
2002	6	75	0.02	0.09	0.15	0.03	0.10	0.18
2003		101	0.00	0.02	0.05	0.00	0.03	0.06
2004		92	0.03	0.08	0.14	0.02	0.07	0.13
2005		86	0.02	0.08	0.14	0.01	0.05	0.10
2006		79	0.02	0.07	0.13	0.02	0.09	0.17
2007		44	0.00	0.06	0.13	0.00	0.02	0.05
2008		90	0.07	0.14	0.22	0.03	0.09	0.16
2009		90	0.00	0.05	0.09	0.00	0.05	0.11
2010		90	0.01	0.05	0.10	0.00	0.03	0.06
2011		89	0.06	0.12	0.20	0.04	0.11	0.18
2012		84	0.03	0.09	0.14	0.01	0.04	0.08
2013		89	0.03	0.07	0.13	0.01	0.06	0.10
2014		90	0.05	0.12	0.19	0.01	0.04	0.07
2015		90	0.04	0.10	0.16	0.02	0.06	0.10
2016		90	0.06	0.12	0.19	0.03	0.07	0.10
2017		90	0.03	0.09	0.15	0.01	0.05	0.09
2018		90	0.00	0.03	0.07	0.00	0.03	0.07
2019		90	0.08	0.15	0.22	0.03	0.07	0.11
2020								

Year	Age	n	Numerical Index LCI	Numerical Index Index	Numerical Index UCI	Biomass Index LCI	Biomass Index Index	Biomass Index UCI
2002	7+	75	0.00	0.03	0.08	0.00	0.04	0.10
2003		101	0.00	0.02	0.05	0.00	0.04	0.09
2004		92	0.02	0.07	0.11	0.02	0.06	0.11
2005		86	0.01	0.07	0.13	0.00	0.04	0.08
2006		79	0.01	0.06	0.12	0.01	0.07	0.15
2007		44	0.01	0.08	0.15	0.00	0.04	0.08
2008		90	0.06	0.13	0.21	0.03	0.09	0.16
2009		90	0.00	0.05	0.09	0.00	0.05	0.11
2010		90	0.01	0.06	0.11	0.00	0.04	0.07
2011		89	0.06	0.12	0.20	0.04	0.11	0.18
2012		84	0.03	0.09	0.14	0.01	0.04	0.08
2013		89	0.03	0.07	0.13	0.01	0.06	0.10
2014		90	0.05	0.12	0.19	0.01	0.04	0.07
2015		90	0.04	0.10	0.16	0.02	0.06	0.10
2016		90	0.06	0.12	0.19	0.03	0.07	0.10
2017		90	0.03	0.09	0.15	0.01	0.05	0.09
2018		90	0.00	0.03	0.07	0.00	0.03	0.07
2019		90	0.08	0.15	0.22	0.03	0.07	0.11
2020								

Figure 52. Summer Flounder geometric mean indices of abundance, by number and biomass, for all ages combined and by age-class.

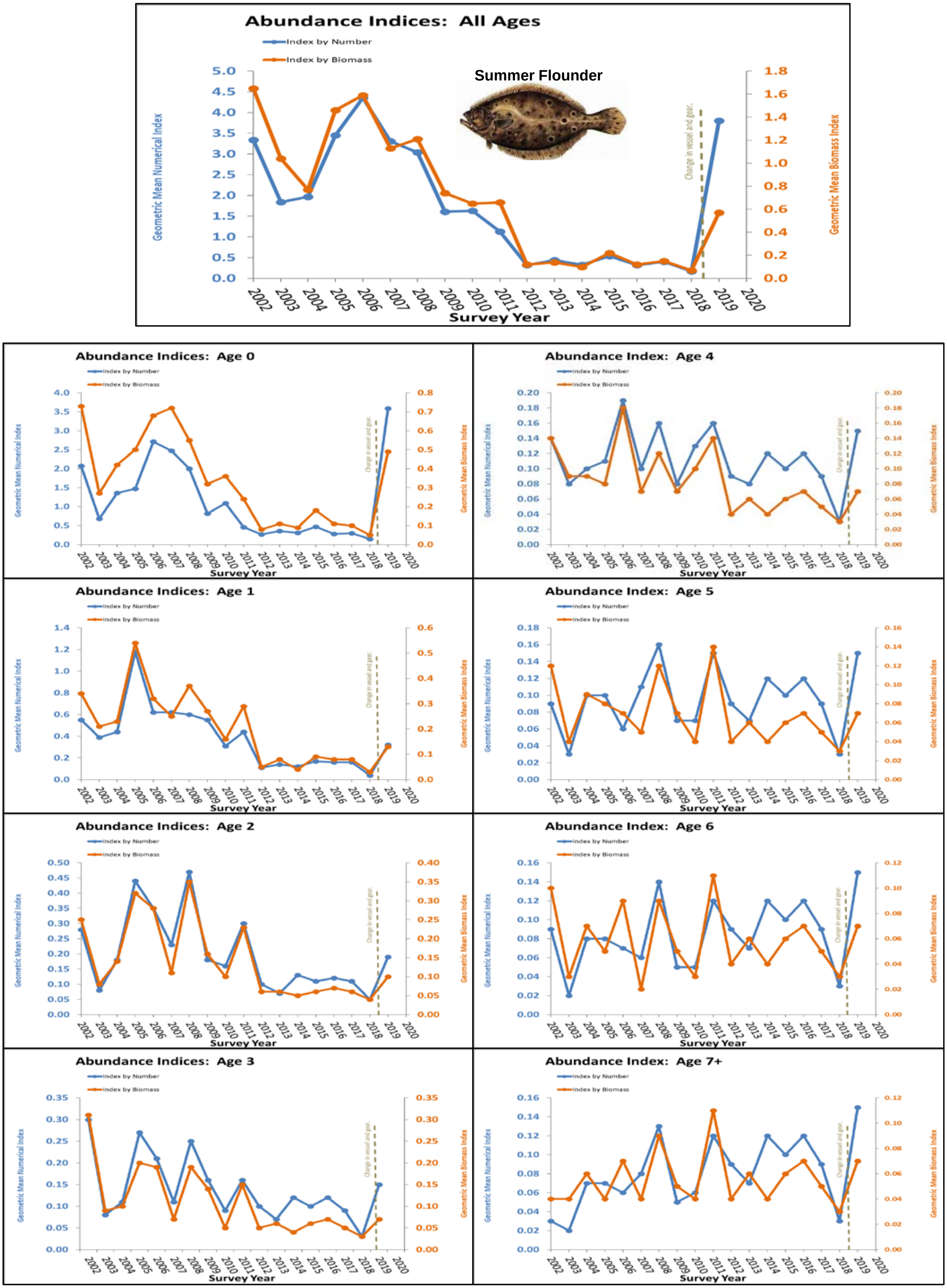


Figure 53. Summer Flounder length-frequency in Chesapeake Bay 2002-2019, overall (A) and by sex (B).

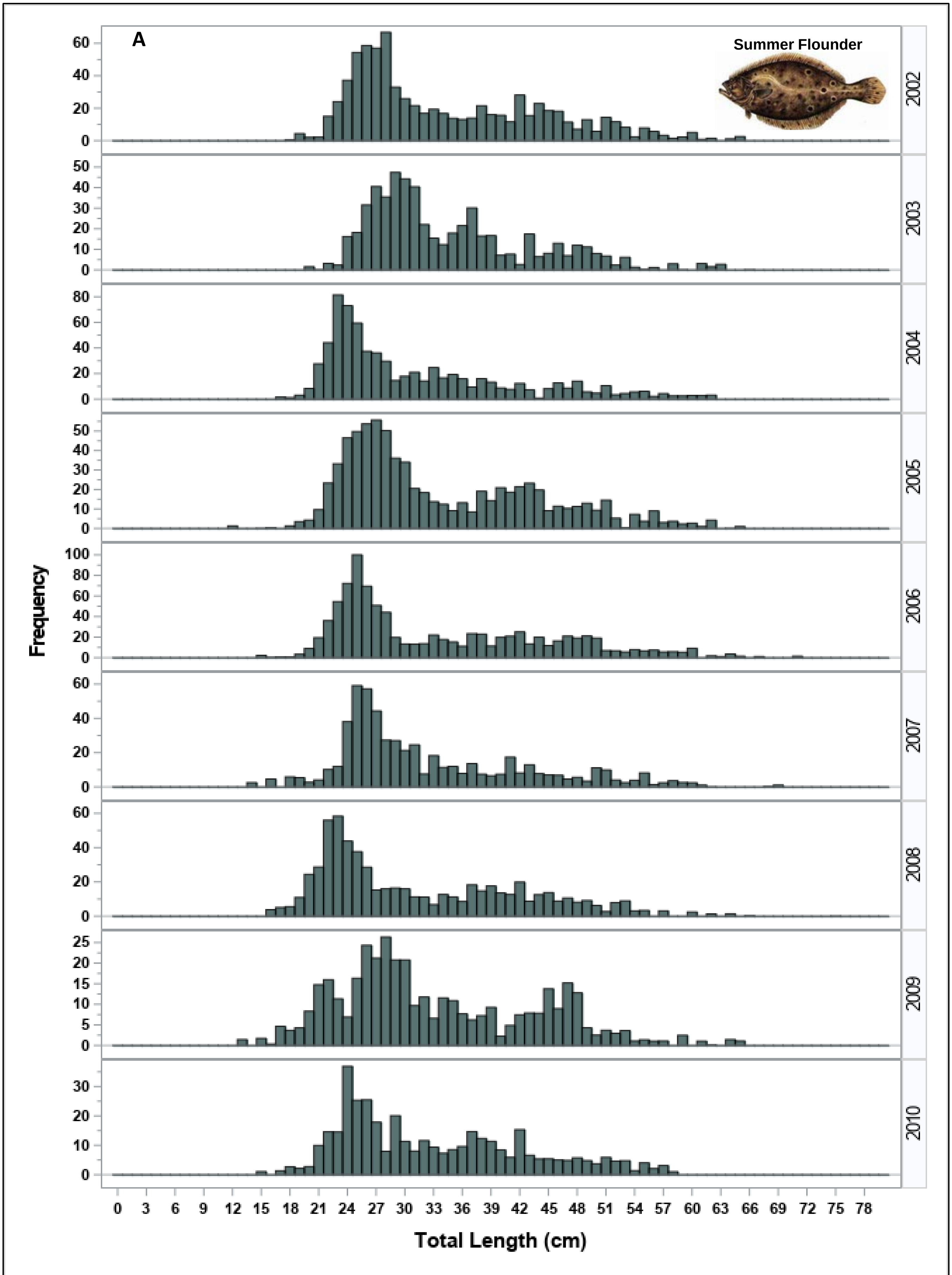


Figure 53. cont.

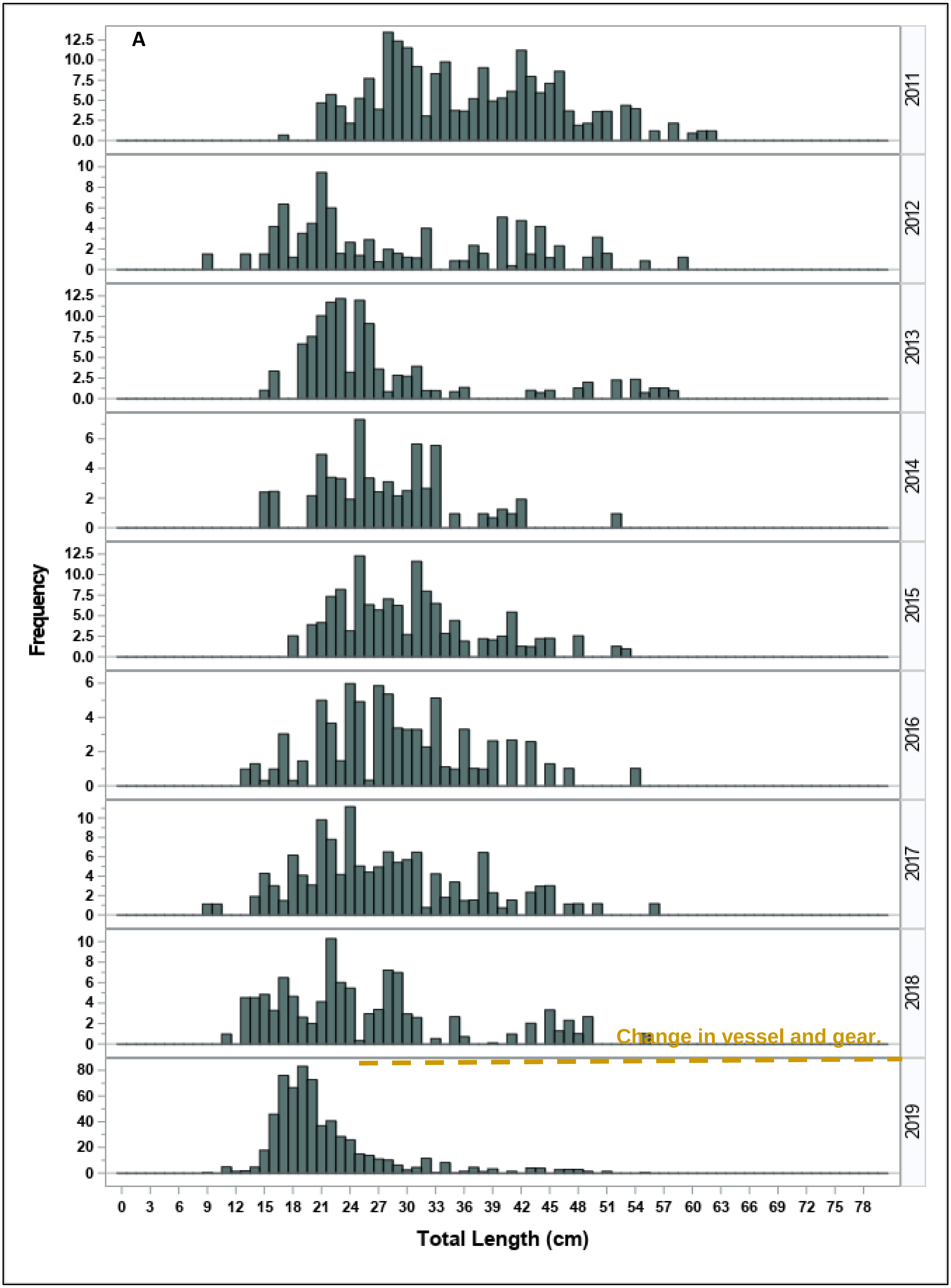


Figure 53. cont.

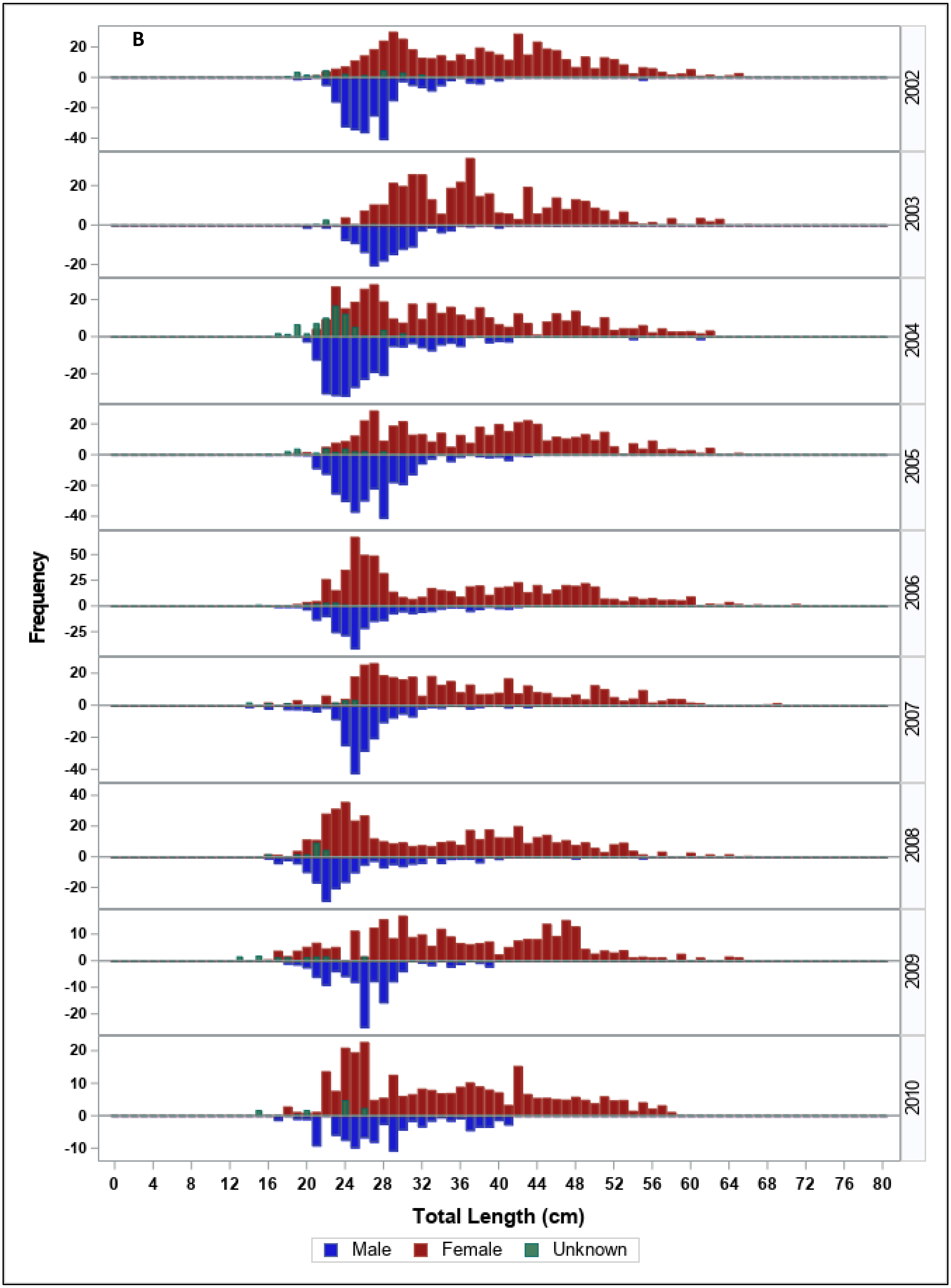


Figure 53. cont.

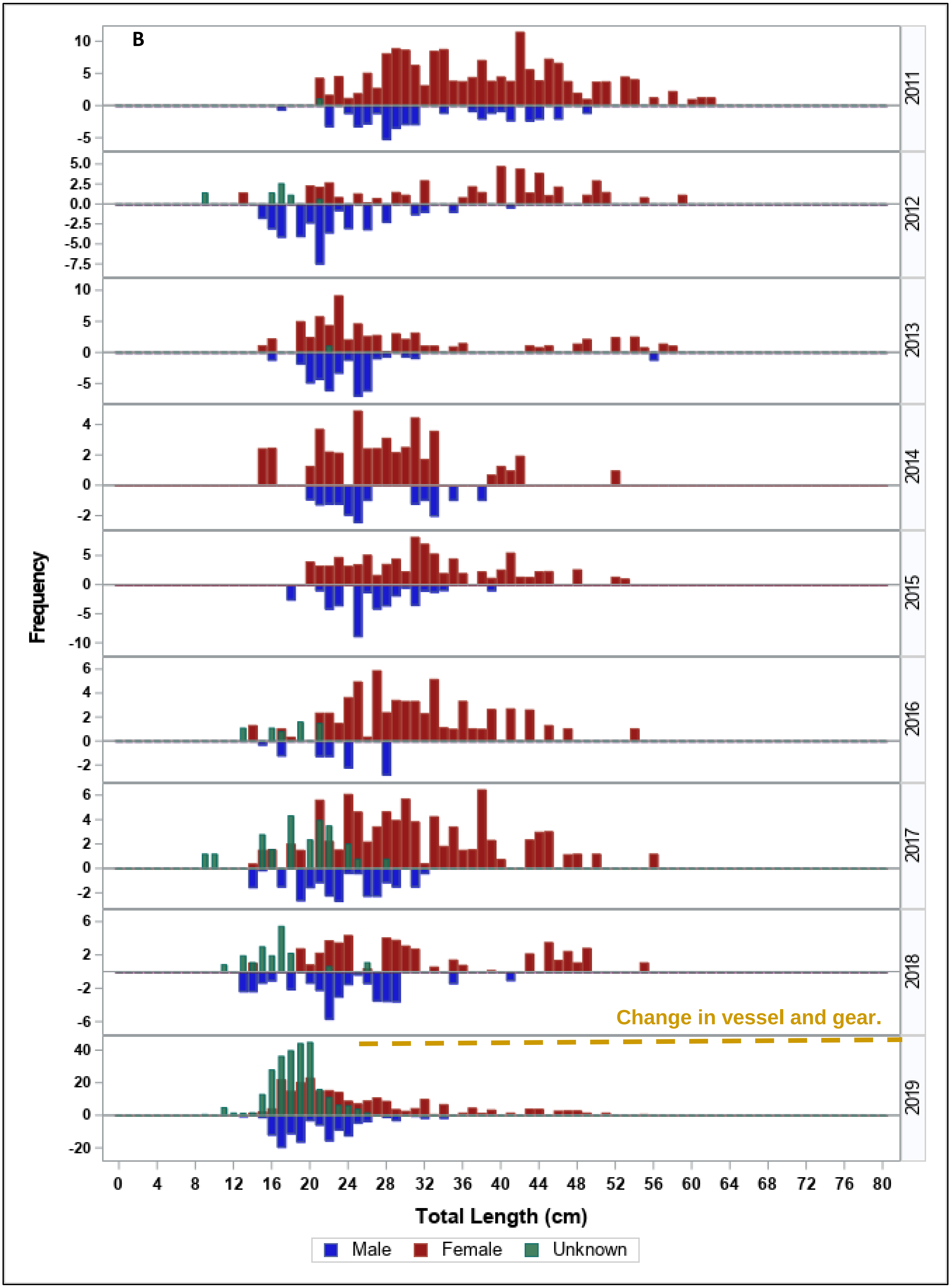


Figure 54. Summer Flounder total age-frequency, 2002-2019.

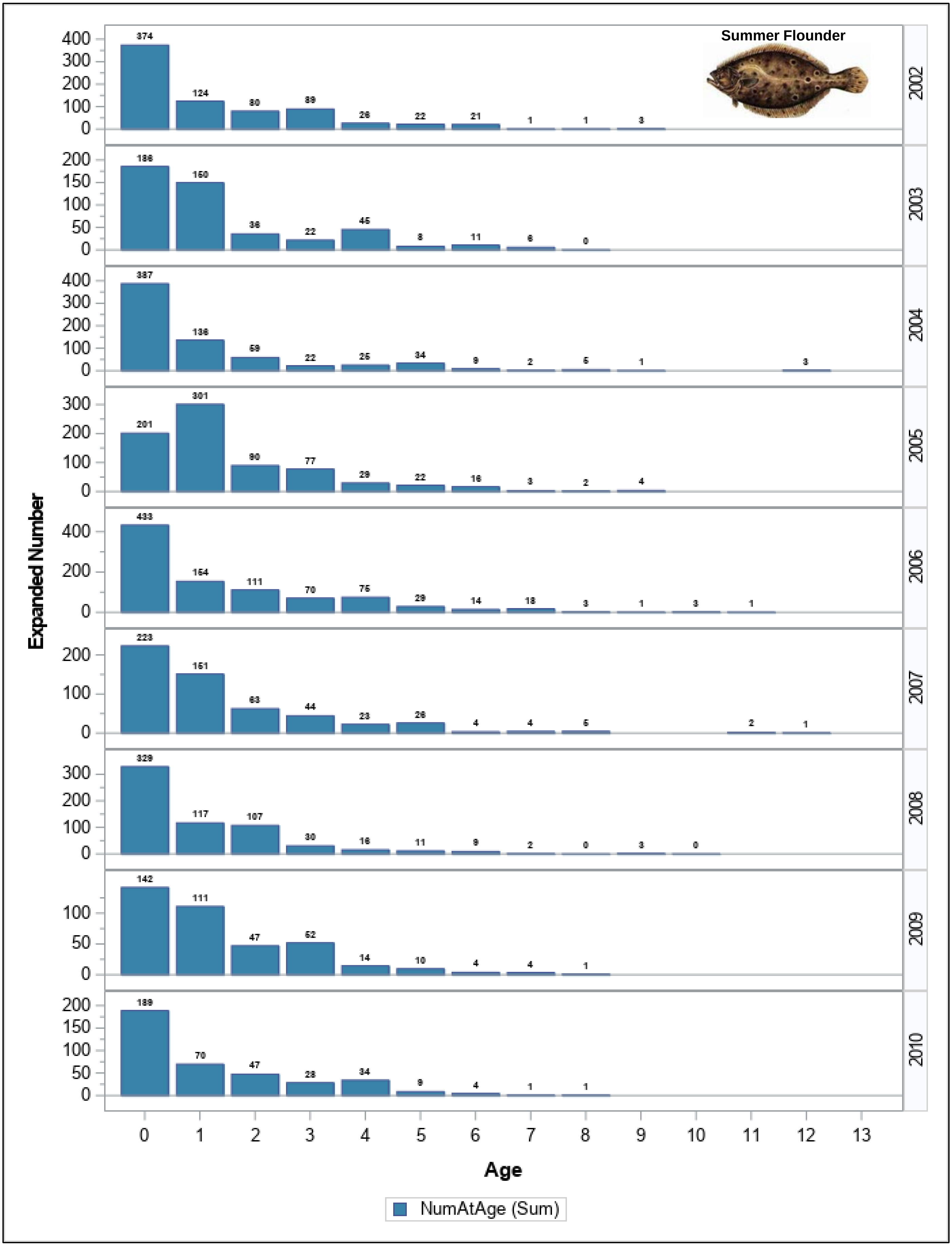


Figure 54. cont.

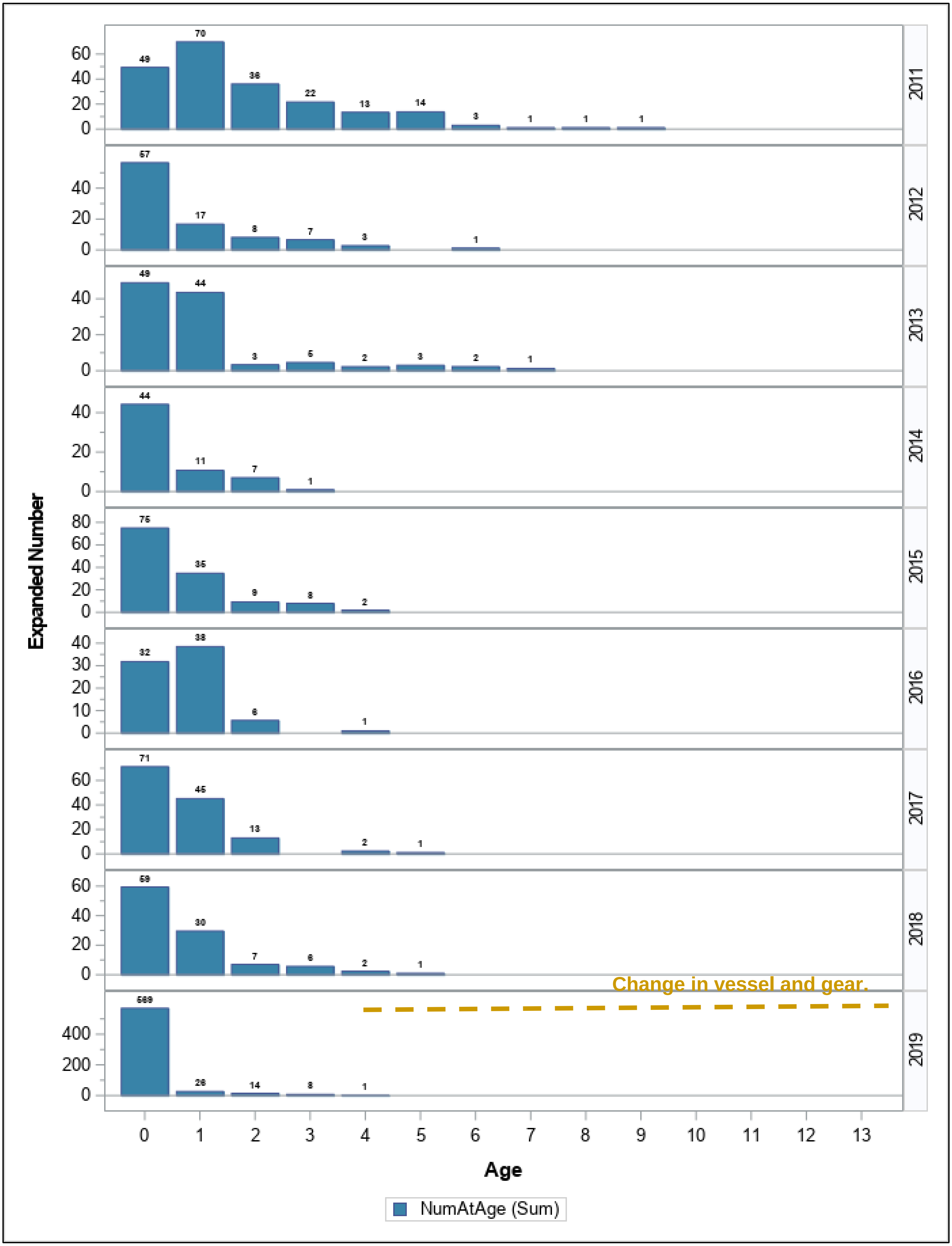


Figure 55. Summer Flounder age-frequency by year, 2002-2019 standardized to 8,000 (4,800 for 2019) annual trawl minutes.

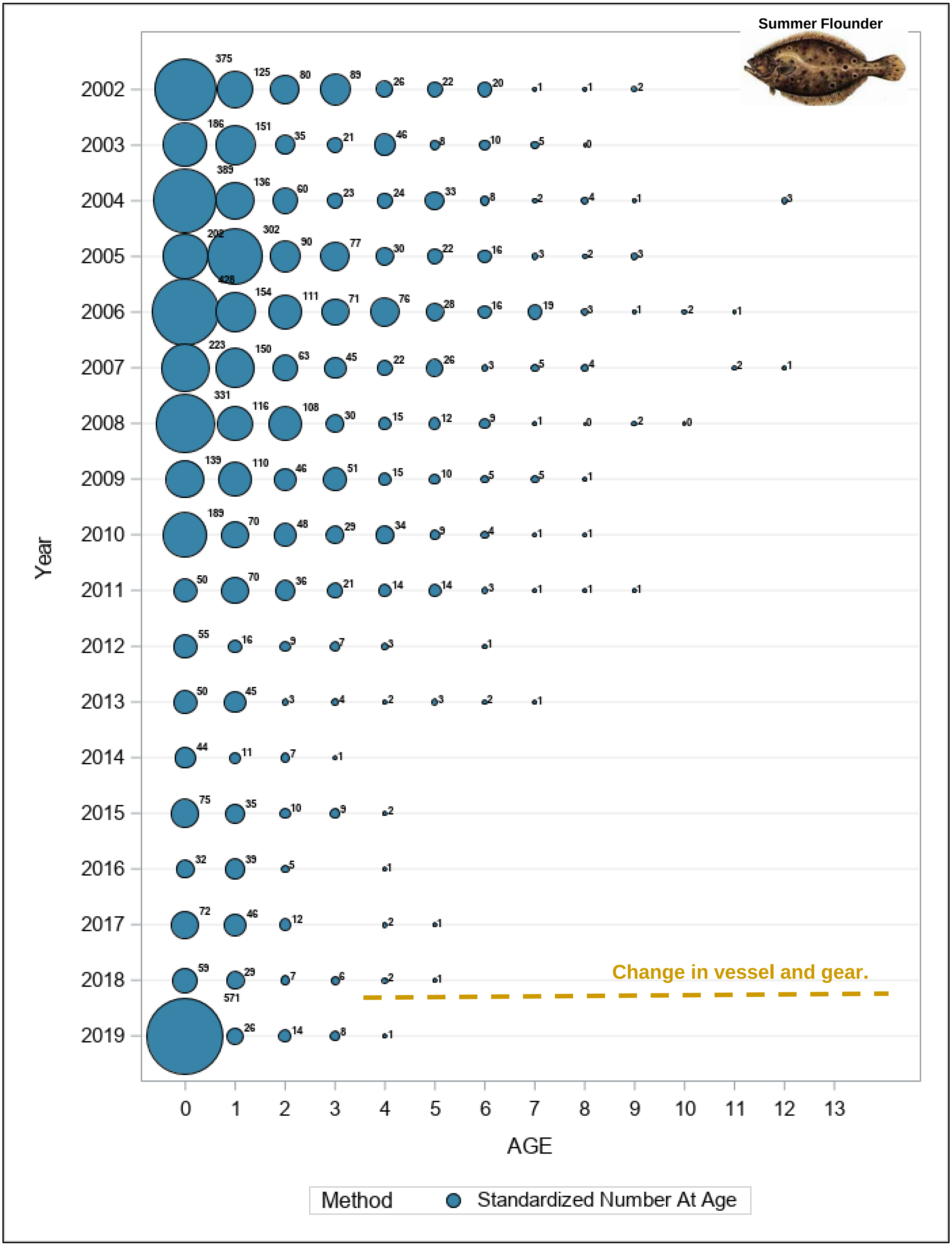


Figure 56. Diet composition, expressed as percent by weight (A) and percent by number (B) of Summer Flounder collected during ChesMMAP cruises in 2002-2018 combined.

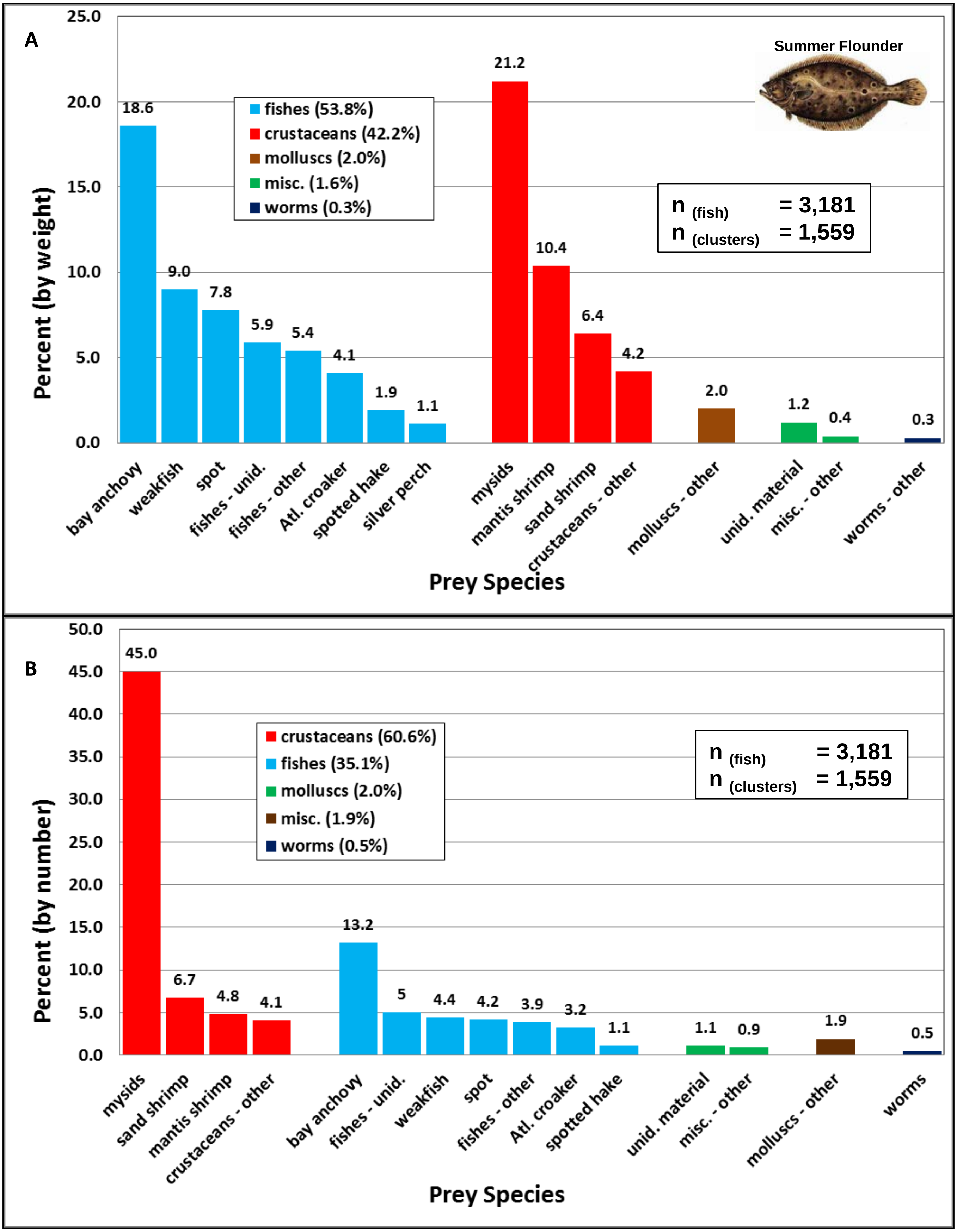


Table 27. Weakfish sampling rates and preserved specimen analysis status by year.

Year	Number Caught	Biomass Caught (kg)	Presence at Index Stations (%)	Number Measured	Age Specimens	Ages Read	Stomach Specimens	Stomachs Analyzed
2002	1,734	304.7	47.5	1,692	803	803	607	583
2003	2,315	400.0	58.0	2,198	707	707	654	642
2004	3,851	561.9	69.5	3,551	1,108	1,108	901	889
2005	2,715	378.5	65.6	2,711	1,119	1,119	918	906
2006	1,476	159.5	60.8	1,462	728	728	561	554
2007	1,214	128.0	55.7	1,210	554	554	439	435
2008	812	83.8	42.2	812	368	368	330	324
2009	873	46.2	60.0	873	478	478	387	384
2010	1,207	76.8	60.7	1,207	607	607	542	531
2011	918	57.5	55.2	918	454	454	323	322
2012	886	72.2	35.7	886	328	328	260	256
2013	301	42.0	28.4	301	187	187	130	129
2014	172	8.6	23.0	172	126	126	72	72
2015	688	51.9	26.7	688	285	285	141	140
2016	1,115	91.2	38.5	1,115	281	281	143	141
2017	943	68.3	36.3	943	335	335	194	191
2018	1,621	61.5	43.7	1,621	273	273	173	171
2019	18,987	1,327.2	80.7	11,355	661	0	387	382

Figure 57. Station specific biomass of Weakfish in Chesapeake Bay, 2019.

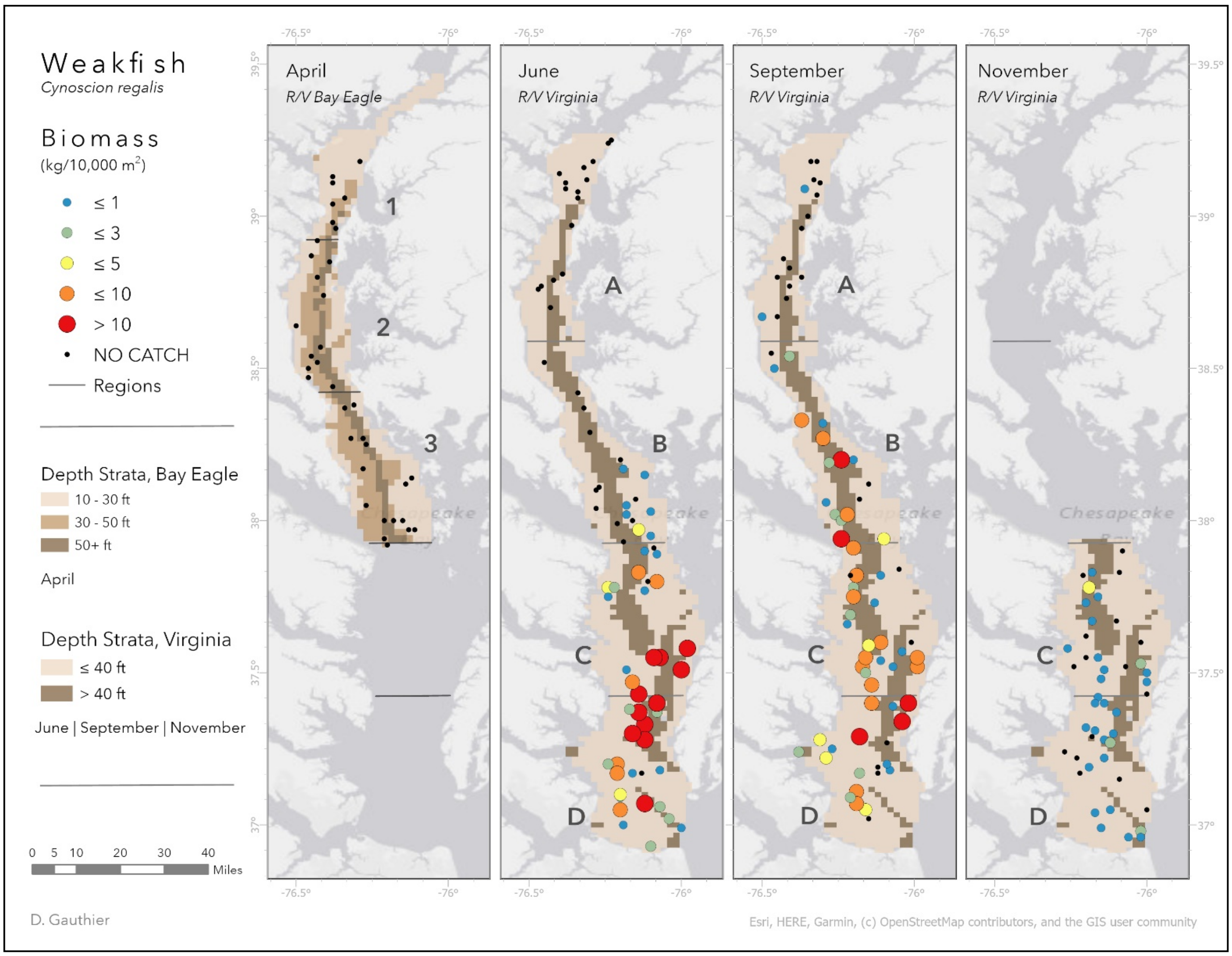


Table 28. Weakfish geometric mean indices of abundance, by number and biomass, overall and by age-class.

Year	Age	n	Numerical Index LCI	Numerical Index Index	Numerical Index UCI	Biomass Index LCI	Biomass Index Index	Biomass Index UCI
2002	All	122	1.26	1.81	2.50	0.34	0.50	0.69
2003		149	1.82	2.53	3.41	0.50	0.69	0.91
2004		127	3.12	4.39	6.05	0.75	1.03	1.36
2005		131	3.49	4.87	6.67	0.83	1.10	1.41
2006		120	2.06	2.99	4.21	0.40	0.57	0.75
2007		88	1.67	2.41	3.35	0.31	0.45	0.60
2008		135	0.80	1.18	1.64	0.16	0.25	0.34
2009		135	1.92	2.66	3.60	0.21	0.29	0.38
2010		135	1.99	2.65	3.46	0.24	0.33	0.41
2011		134	1.47	2.03	2.72	0.19	0.28	0.37
2012		129	0.59	0.94	1.38	0.12	0.20	0.29
2013		134	0.39	0.63	0.91	0.07	0.14	0.22
2014		135	0.20	0.34	0.50	0.02	0.04	0.06
2015		135	0.40	0.64	0.92	0.08	0.13	0.18
2016		135	0.81	1.19	1.66	0.17	0.26	0.35
2017		135	0.70	1.07	1.52	0.12	0.20	0.28
2018		135	0.85	1.32	1.93	0.11	0.19	0.28
2019		135	14.42	21.14	30.79	1.88	2.58	3.45
2020								

Year	Age	n	Numerical Index LCI	Numerical Index Index	Numerical Index UCI	Biomass Index LCI	Biomass Index Index	Biomass Index UCI
2002	0	122	0.51	0.76	1.04	0.09	0.14	0.19
2003		149	0.98	1.36	1.82	0.17	0.25	0.33
2004		127	1.04	1.43	1.88	0.13	0.19	0.25
2005		131	1.38	1.91	2.55	0.17	0.23	0.29
2006		120	0.90	1.36	1.92	0.11	0.16	0.22
2007		88	0.74	1.16	1.69	0.11	0.18	0.25
2008		135	0.26	0.41	0.57	0.02	0.04	0.06
2009		135	1.19	1.71	2.34	0.10	0.14	0.19
2010		135	1.10	1.53	2.05	0.10	0.13	0.17
2011		134	0.65	0.92	1.23	0.05	0.07	0.09
2012		129	0.26	0.43	0.62	0.04	0.06	0.09
2013		134	0.14	0.26	0.39	0.01	0.03	0.06
2014		135	0.16	0.28	0.41	0.01	0.02	0.04
2015		135	0.28	0.46	0.67	0.04	0.07	0.10
2016		135	0.39	0.59	0.83	0.06	0.10	0.14
2017		135	0.32	0.49	0.69	0.04	0.06	0.08
2018		135	0.62	1.02	1.50	0.07	0.14	0.20
2019		135						
2020								

Year	Age	n	Numerical Index LCI	Numerical Index Index	Numerical Index UCI	Biomass Index LCI	Biomass Index Index	Biomass Index UCI
2002	1	122	0.67	1.00	1.39	0.19	0.31	0.43
2003		149	0.74	1.03	1.37	0.21	0.30	0.40
2004		127	1.91	2.77	3.89	0.55	0.78	1.04
2005		131	1.45	1.99	2.65	0.35	0.47	0.60
2006		120	0.90	1.34	1.89	0.21	0.30	0.41
2007		88	0.87	1.29	1.81	0.18	0.26	0.35
2008		135	0.52	0.82	1.17	0.11	0.19	0.27
2009		135	0.61	0.92	1.29	0.11	0.17	0.23
2010		135	0.83	1.14	1.51	0.15	0.22	0.29
2011		134	0.84	1.21	1.66	0.14	0.21	0.28
2012		129	0.38	0.63	0.93	0.08	0.14	0.20
2013		134	0.22	0.39	0.58	0.04	0.09	0.16
2014		135	0.08	0.17	0.26	0.01	0.02	0.04
2015		135	0.28	0.45	0.65	0.06	0.10	0.14
2016		135	0.58	0.88	1.24	0.12	0.20	0.28
2017		135	0.40	0.65	0.94	0.08	0.13	0.19
2018		135	0.35	0.60	0.88	0.06	0.10	0.15
2019		135						
2020								

Year	Age	n	Numerical Index LCI	Numerical Index Index	Numerical Index UCI	Biomass Index LCI	Biomass Index Index	Biomass Index UCI
2002	2	122	0.39	0.59	0.83	0.11	0.18	0.26
2003		149	0.68	0.96	1.29	0.24	0.35	0.47
2004		127	0.78	1.11	1.49	0.20	0.30	0.40
2005		131	1.55	2.12	2.81	0.46	0.63	0.81
2006		120	0.77	1.11	1.52	0.16	0.24	0.32
2007		88	0.41	0.62	0.87	0.08	0.13	0.18
2008		135	0.19	0.30	0.43	0.03	0.06	0.09
2009		135	0.18	0.30	0.44	0.02	0.05	0.07
2010		135	0.14	0.23	0.32	0.02	0.04	0.05
2011		134	0.28	0.41	0.55	0.03	0.05	0.07
2012		129	0.26	0.43	0.63	0.05	0.08	0.12
2013		134	0.14	0.26	0.40	0.02	0.07	0.11
2014		135	0.04	0.10	0.16	0.00	0.01	0.02
2015		135	0.06	0.13	0.20	0.01	0.02	0.04
2016		135	0.11	0.20	0.29	0.01	0.03	0.05
2017		135	0.21	0.34	0.50	0.03	0.06	0.09
2018		135	0.07	0.17	0.28	0.01	0.02	0.04
2019		135						
2020								

Year	Age	n	Numerical Index LCI	Numerical Index Index	Numerical Index UCI	Biomass Index LCI	Biomass Index Index	Biomass Index UCI
2002	3	122	0.15	0.26	0.37	0.04	0.07	0.11
2003		149	0.15	0.24	0.33	0.04	0.07	0.11
2004		127	0.14	0.26	0.40	0.03	0.08	0.12
2005		131	0.37	0.50	0.65	0.10	0.13	0.17
2006		120	0.24	0.38	0.53	0.05	0.08	0.12
2007		88	0.09	0.19	0.30	0.01	0.03	0.06
2008		135	0.08	0.15	0.23	0.01	0.02	0.04
2009		135	0.07	0.15	0.25	0.01	0.03	0.04
2010		135	0.04	0.10	0.16	0.00	0.02	0.03
2011		134	0.08	0.16	0.23	0.01	0.01	0.02
2012		129	0.06	0.12	0.18	0.01	0.02	0.03
2013		134	0.06	0.15	0.24	0.00	0.04	0.07
2014		135	0.03	0.09	0.16	0.00	0.01	0.02
2015		135	0.05	0.12	0.19	0.01	0.02	0.04
2016		135	0.03	0.08	0.14	0.00	0.01	0.03
2017		135	0.03	0.08	0.13	0.00	0.01	0.02
2018		135	0.05	0.14	0.24	0.00	0.02	0.04
2019		135						
2020								

Figure 58. Weakfish geometric mean indices of abundance, by number and biomass, for all ages combined and by age-class.

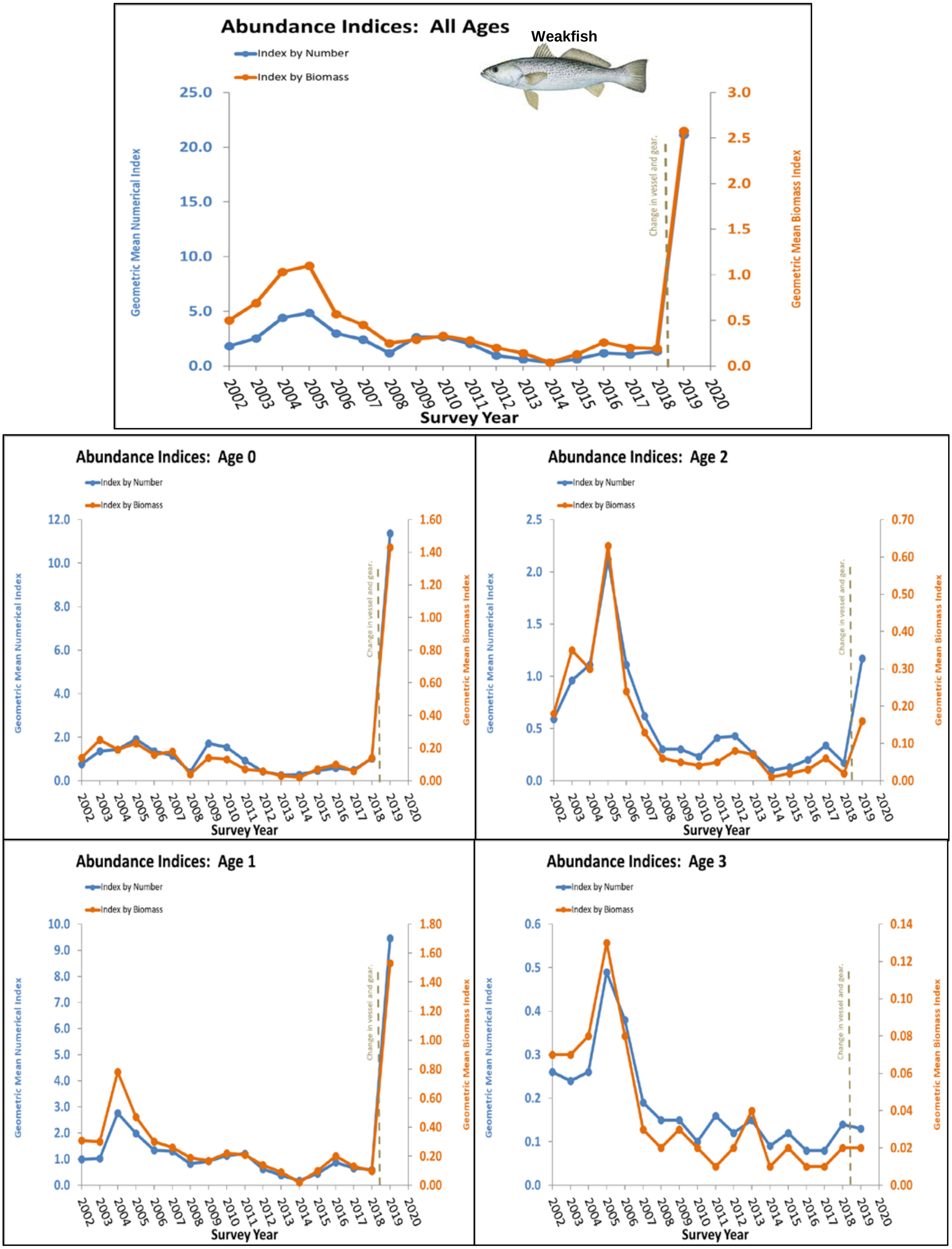


Figure 59. Weakfish length-frequency in Chesapeake Bay 2002-2019, overall (A) and by sex (B).

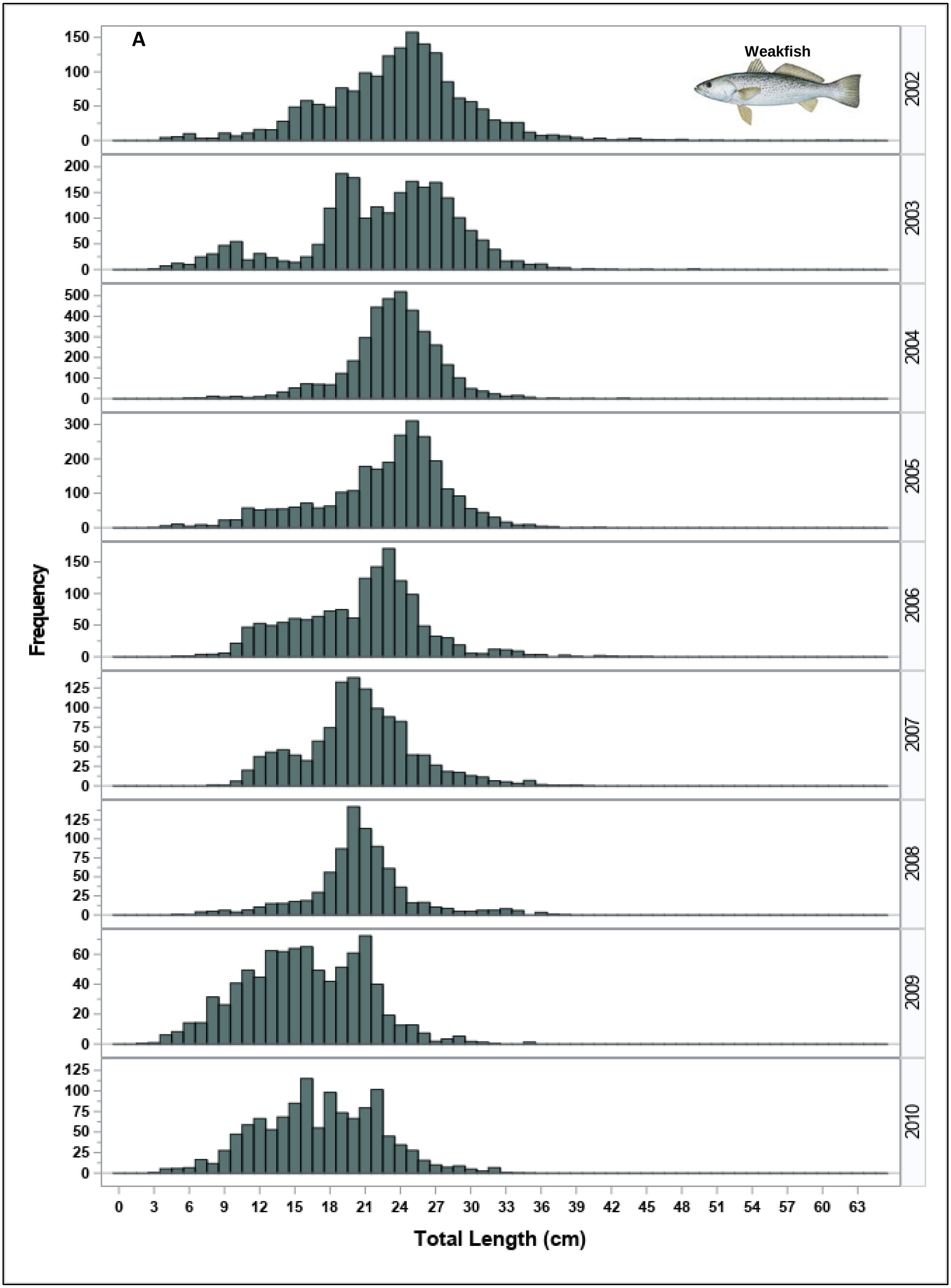


Figure 59. cont.

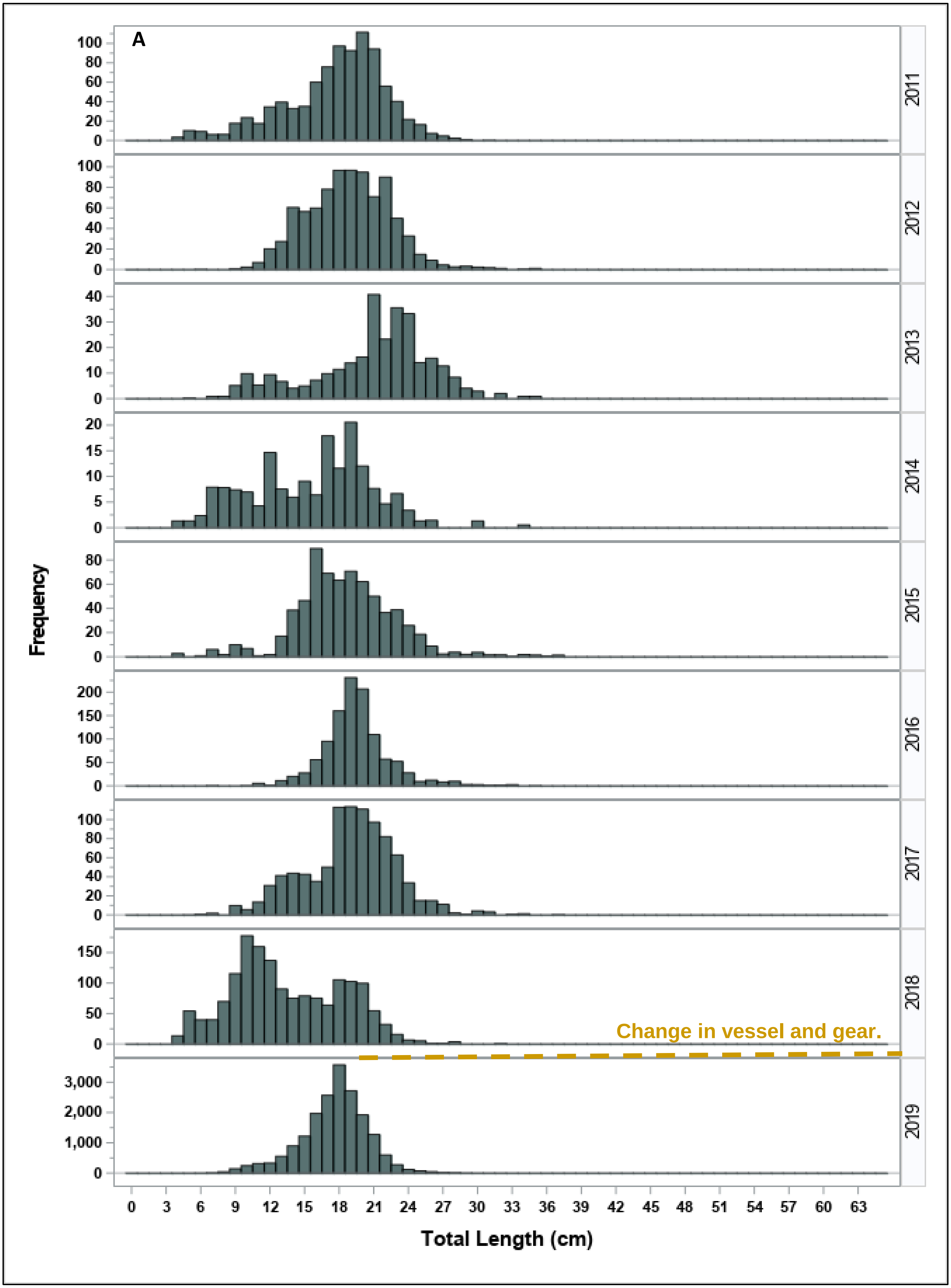


Figure 59. cont.

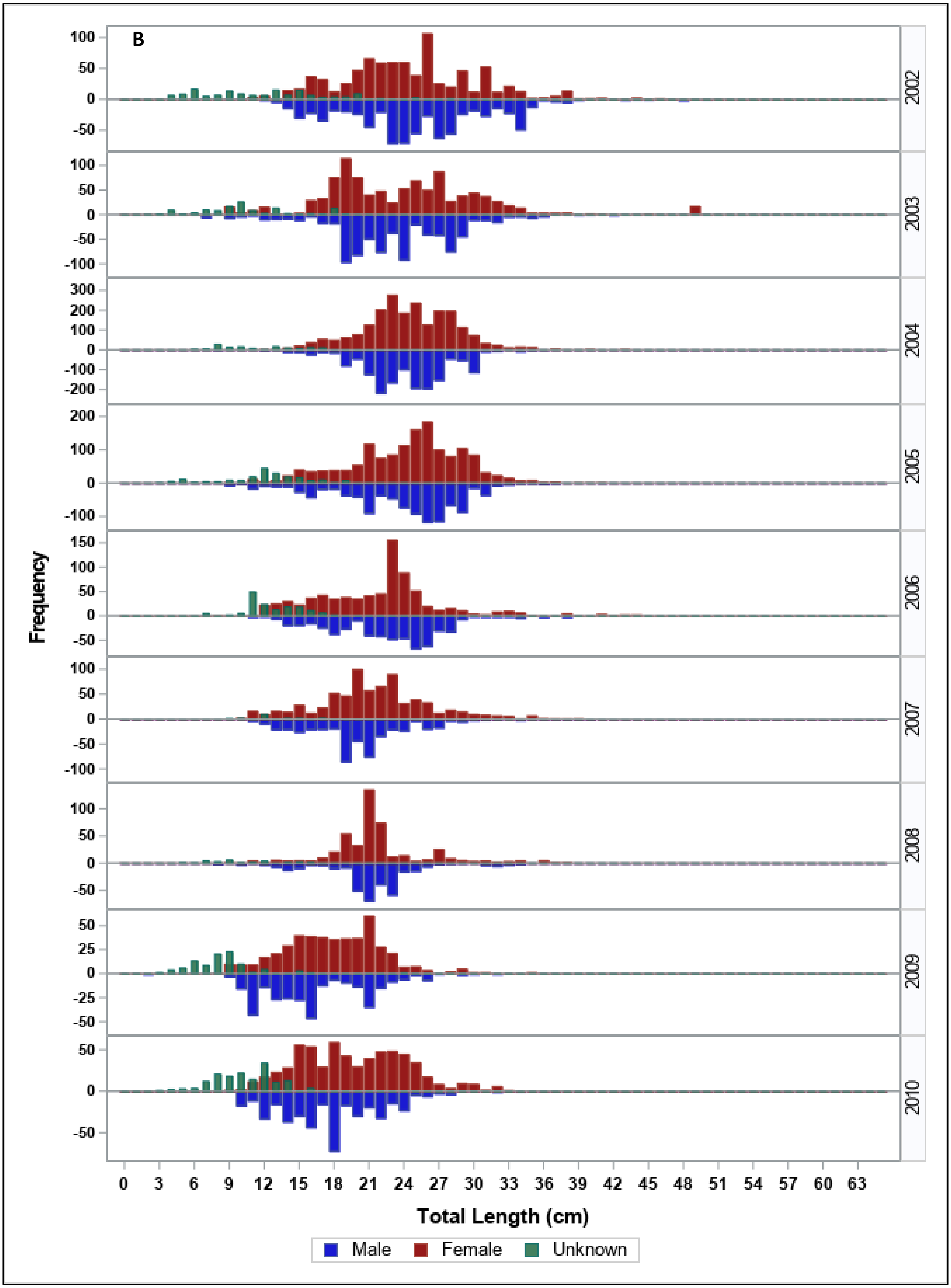


Figure 59. cont.

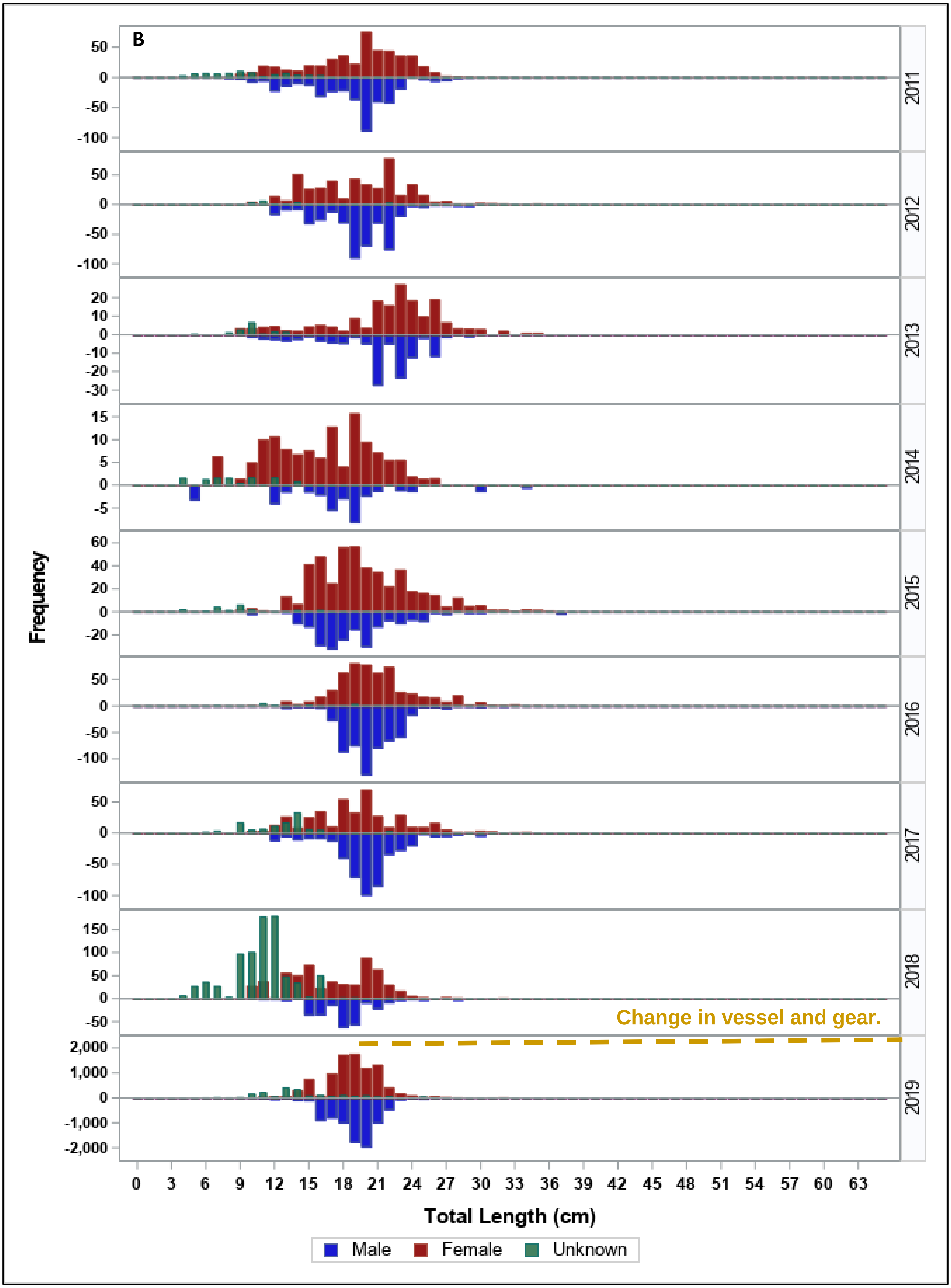


Figure 60. Weakfish total age-frequency, 2002-2019.

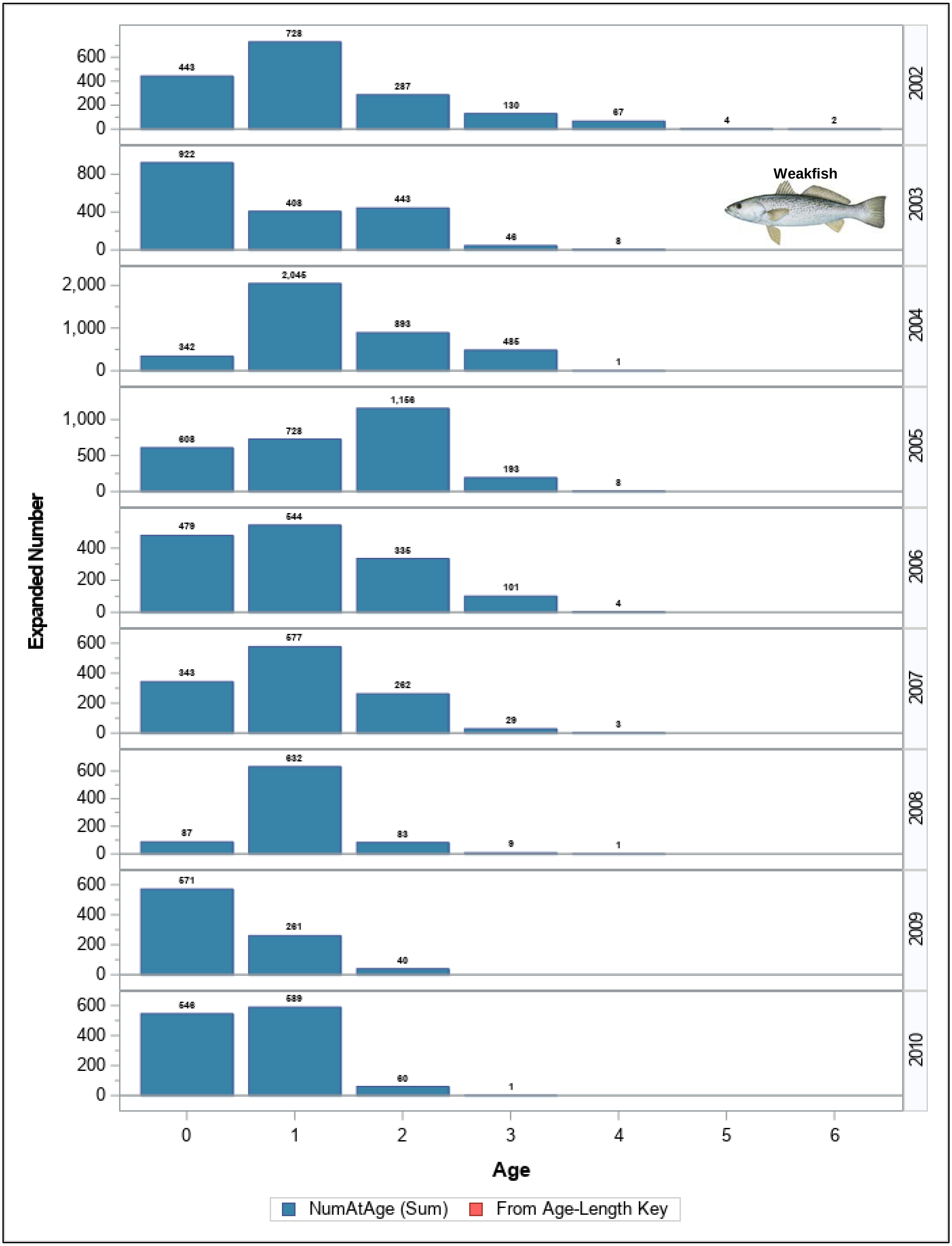


Figure 60. cont.

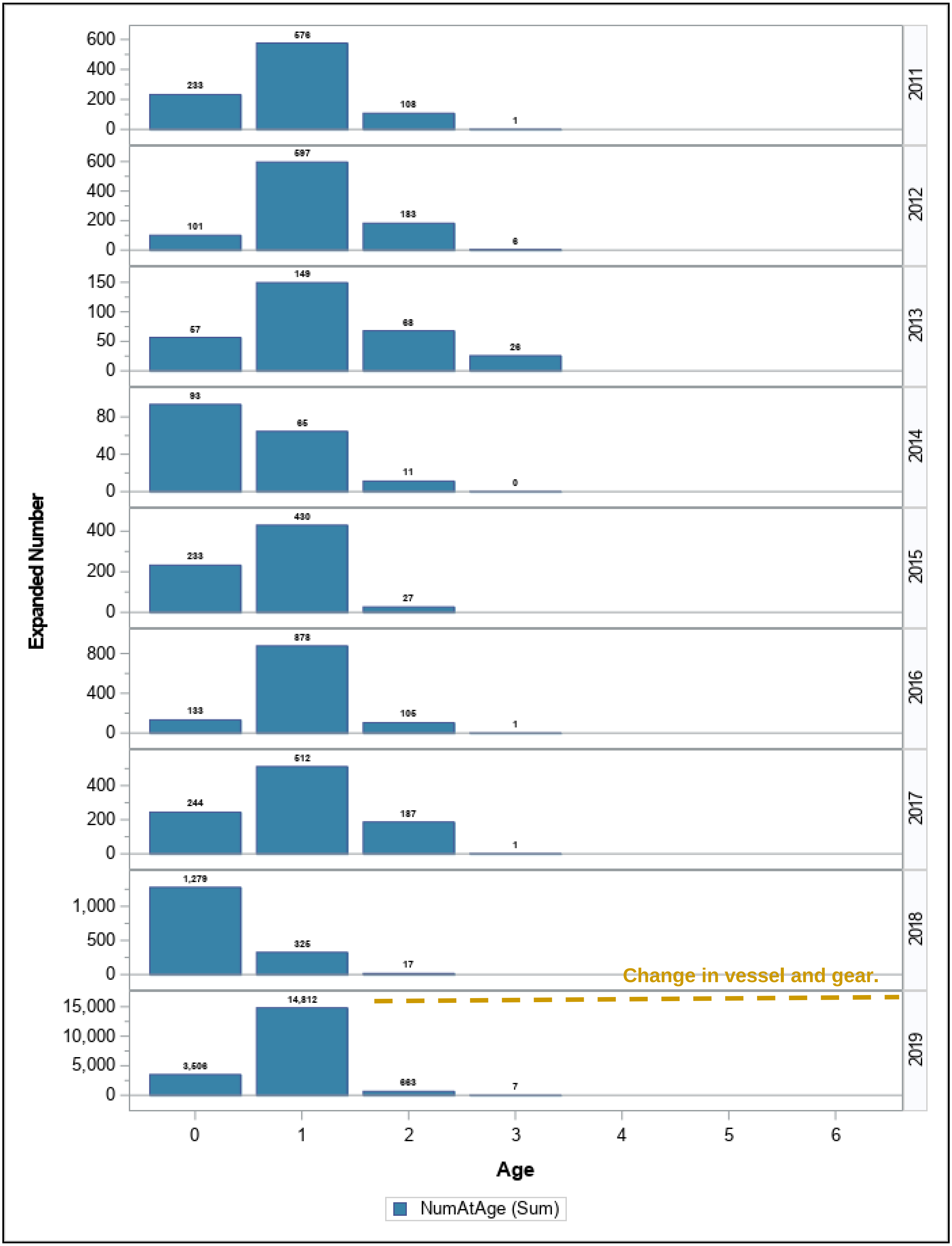


Figure 61. Weakfish age-frequency by year, 2002-2019 standardized to 8,000 (4,800 for 2019) annual trawl minutes.

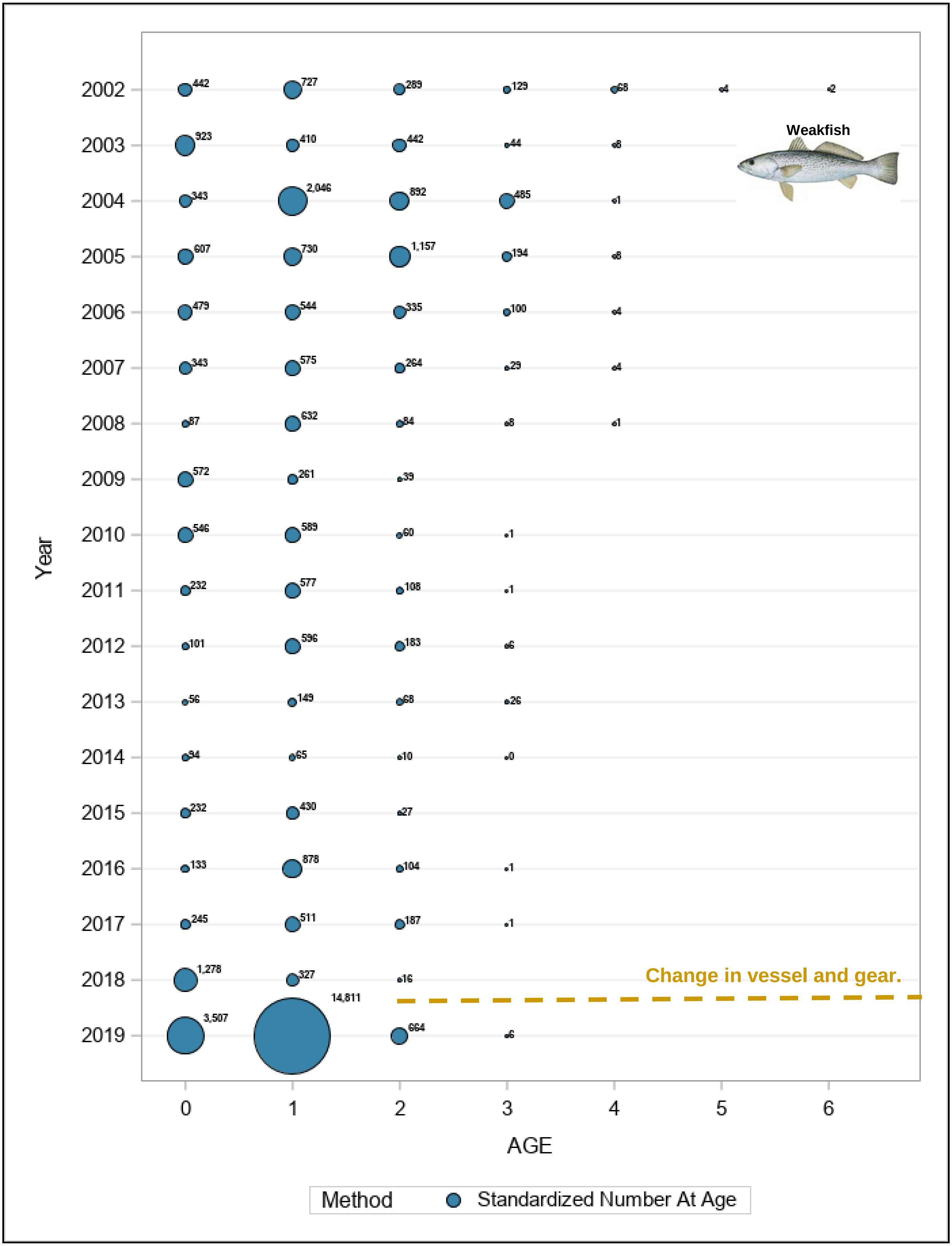


Figure 62. Diet composition, expressed as percent by weight (A) and percent by number (B) of Weakfish collected during ChesMMAP cruises in 2002-2018 combined.

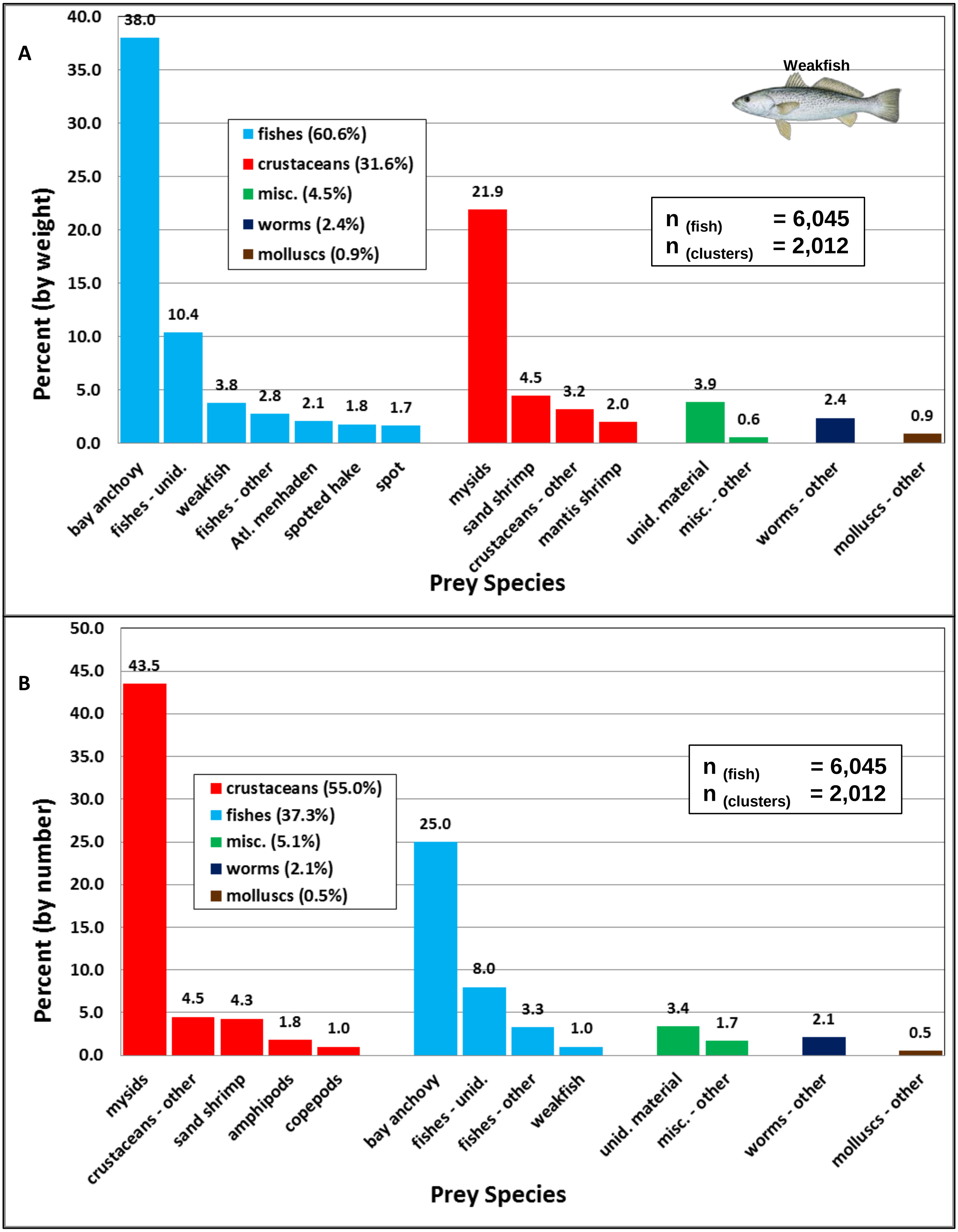


Table 29. White Perch sampling rates and preserved specimen analysis status by year.

Year	Number Caught	Biomass Caught (kg)	Presence at Index Stations (%)	Number Measured	Age Specimens	Ages Read	Stomach Specimens	Stomachs Analyzed
2002	6,625	995.3	50.0	4,020	552	551	471	401
2003	3,782	511.5	53.8	1,882	177	168	147	126
2004	11,021	1,727.4	66.7	6,677	356	356	270	267
2005	7,243	843.0	60.0	5,884	429	429	287	280
2006	11,980	1,611.0	60.7	5,899	385	385	263	254
2007	4,915	517.9	62.8	3,194	318	318	277	277
2008	2,923	339.7	52.5	2,359	259	257	227	224
2009	5,130	686.2	47.5	1,749	158	151	126	126
2010	2,999	454.1	50.8	1,627	207	207	158	156
2011	4,619	675.1	45.8	2,392	231	231	177	174
2012	3,737	459.9	58.1	2,423	151	151	111	109
2013	3,249	421.1	59.0	2,469	199	199	109	55
2014	3,208	341.6	55.7	1,844	153	153	94	92
2015	13,708	2,157.4	44.3	4,098	188	188	80	81
2016	11,406	979.5	55.7	2,935	208	208	104	103
2017	7,957	1,113.9	51.7	4,517	159	159	84	81
2018	3,777	522.7	75.0	2,131	102	102	47	46
2019	9,870	888.5	38.8	3,367	129	129	80	80

Figure 63. Station specific biomass of White Perch in Chesapeake Bay, 2019.

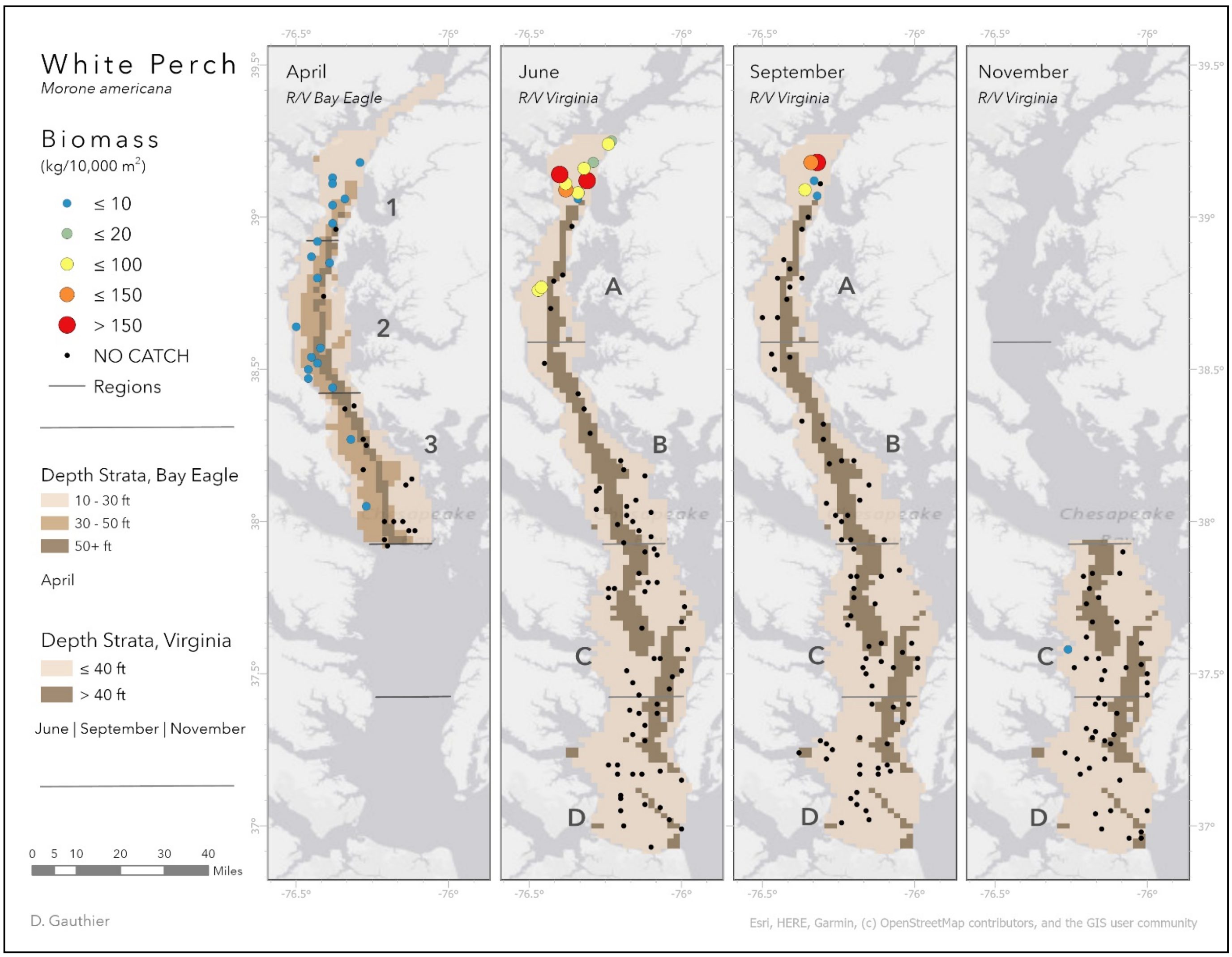
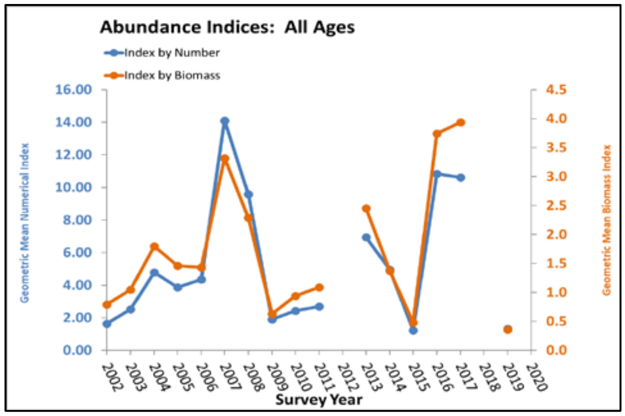


Table 30. White Perch geometric mean indices of abundance for March by number and biomass, overall and by age class.

Year	Age	n	Numerical Index LCI	Numerical Index Index	Numerical Index UCI	Biomass Index LCI	Biomass Index Index	Biomass Index UCI
2002	All	23	0.87	1.63	2.70	0.37	0.79	1.34
2003		27	1.20	2.52	4.63	0.51	1.05	1.78
2004		33	2.97	4.79	7.47	1.07	1.80	2.80
2005		28	1.44	3.87	8.71	0.51	1.46	3.00
2006		28	1.60	4.35	10.03	0.41	1.43	3.18
2007		28	6.51	14.11	29.39	1.65	3.32	6.03
2008		29	5.69	9.58	15.72	1.40	2.29	3.51
2009		29	1.30	1.91	2.67	0.37	0.63	0.93
2010		28	1.25	2.43	4.23	0.37	0.94	1.76
2011		29	1.32	2.70	4.90	0.48	1.09	1.94
2012								
2013		29	2.49	6.94	17.05	1.00	2.45	4.94
2014		29	3.23	4.96	7.40	0.88	1.37	2.00
2015		29	0.45	1.24	2.46	0.16	0.48	0.89
2016		29	7.29	10.84	15.91	2.46	3.74	5.49
2017		28	5.62	10.62	19.43	2.09	3.94	6.90
2018								
2019		25	0.69	1.32	2.18	0.17	0.36	0.58
2020								
2002	4	23	0.19	0.59	1.11	0.04	0.24	0.48
2003		27	0.20	0.58	1.08	0.06	0.22	0.40
2004		33	0.61	1.45	2.74	0.25	0.65	1.19
2005		28	0.51	1.66	3.70	0.15	0.59	1.19
2006		28	0.29	1.31	3.16	0.01	0.48	1.18
2007		28	3.11	7.37	16.06	0.79	1.70	3.08
2008		29	1.22	2.23	3.69	0.32	0.60	0.94
2009		29	0.25	0.80	1.60	0.03	0.26	0.53
2010		28	0.00	0.71	2.07	0.00	0.35	0.92
2011		29	0.09	1.02	2.75	0.00	0.48	1.22
2012								
2013		29	0.64	2.00	4.46	0.24	0.79	1.58
2014		29	1.14	2.18	3.72	0.25	0.69	1.30
2015		29	0.30	0.94	1.89	0.09	0.36	0.69
2016		29	0.49	1.66	3.76	0.05	0.69	1.70
2017		28	0.07	1.86	6.65	0.00	0.75	2.62
2018								
2019		25	0.18	0.54	1.02	0.02	0.15	0.30
2020								
2002	5	23	0.26	0.67	1.21	0.06	0.27	0.52
2003		27	0.41	0.85	1.44	0.12	0.31	0.52
2004		33	0.50	1.30	2.54	0.19	0.55	1.04
2005		28	0.69	1.82	3.72	0.20	0.66	1.28
2006		28	0.43	1.65	3.93	0.05	0.59	1.40
2007		28	1.16	2.58	4.93	0.31	0.67	1.13
2008		29	2.69	4.70	7.80	0.70	1.20	1.85
2009		29	0.25	0.78	1.55	0.04	0.27	0.54
2010		28	0.00	0.66	1.95	0.00	0.34	0.90
2011		29	0.22	1.27	3.21	0.05	0.57	1.34
2012								
2013		29	0.40	1.48	3.37	0.09	0.56	1.25
2014		29	0.28	1.24	2.91	0.00	0.43	1.10
2015		29	0.28	0.79	1.51	0.05	0.27	0.53
2016		29	4.11	6.48	9.97	1.36	2.29	3.57
2017		28	0.41	2.12	5.90	0.00	0.82	2.48
2018								
2019		25	0.20	0.58	1.07	0.02	0.16	0.31
2020								
2002	6	23	0.49	1.09	1.93	0.19	0.50	0.89
2003		27	0.56	1.22	2.15	0.22	0.49	0.81
2004		33	0.83	1.67	2.90	0.30	0.70	1.21
2005		28	0.41	1.42	3.18	0.13	0.55	1.13
2006		28	0.58	1.95	4.49	0.08	0.64	1.50
2007		28	1.53	3.38	6.57	0.42	0.87	1.46
2008		29	0.94	1.88	3.27	0.22	0.53	0.91
2009		29	0.70	1.23	1.93	0.21	0.43	0.69
2010		28	0.63	1.61	3.16	0.14	0.63	1.34
2011		29	0.44	1.39	2.96	0.09	0.58	1.29
2012								
2013		29	0.78	2.31	5.17	0.30	0.90	1.76
2014		29	0.14	1.04	2.65	0.00	0.39	1.06
2015		29	0.19	0.69	1.40	0.02	0.26	0.54
2016		29	2.10	3.88	6.70	0.62	1.40	2.53
2017		28	3.20	6.93	13.99	1.13	2.60	5.08
2018								
2019		25	0.14	0.47	0.90	0.00	0.13	0.28
2020								

Year	Age	n	Numerical Index LCI	Numerical Index Index	Numerical Index UCI	Biomass Index LCI	Biomass Index Index	Biomass Index UCI
2002	7	23	0.36	0.85	1.52	0.11	0.36	0.67
2003		27	0.43	0.94	1.64	0.13	0.32	0.54
2004		33	0.31	0.99	2.04	0.10	0.43	0.87
2005		28	0.28	1.13	2.53	0.07	0.44	0.94
2006		28	0.39	1.52	3.58	0.05	0.57	1.33
2007		28	1.52	3.30	6.32	0.42	0.86	1.44
2008		29	1.99	3.33	5.27	0.48	0.86	1.33
2009		29	0.30	0.84	1.60	0.06	0.28	0.53
2010		28	0.25	0.92	1.96	0.02	0.40	0.92
2011		29	0.73	1.75	3.35	0.21	0.71	1.41
2012								
2013		29	0.46	1.58	3.56	0.13	0.62	1.32
2014		29	0.62	1.64	3.32	0.09	0.55	1.20
2015		29	0.13	0.55	1.15	0.00	0.19	0.44
2016		29	1.70	3.34	5.98	0.44	1.18	2.29
2017		28	1.92	4.65	9.92	0.63	1.78	3.74
2018								
2019		25	0.03	0.34	0.73	0.00	0.10	0.24
2020								
2002	8	23	0.06	0.44	0.96	0.00	0.19	0.44
2003		27	0.42	0.97	1.74	0.16	0.39	0.67
2004		33	1.13	2.00	3.23	0.43	0.84	1.36
2005		28	0.30	1.15	2.58	0.07	0.44	0.94
2006		28	0.38	1.51	3.57	0.05	0.56	1.33
2007		28	1.50	2.54	4.03	0.37	0.62	0.92
2008		29	1.38	2.64	4.55	0.36	0.76	1.29
2009		29	0.56	0.99	1.53	0.13	0.33	0.55
2010		28	0.10	0.87	2.17	0.00	0.39	0.95
2011		29	0.21	1.22	3.09	0.05	0.56	1.32
2012								
2013		29	0.70	2.09	4.63	0.25	0.80	1.59
2014		29	0.14	1.05	2.70	0.00	0.40	1.07
2015		29	0.19	0.69	1.40	0.03	0.25	0.53
2016		29	0.64	1.97	4.38	0.03	0.70	1.81
2017		28	1.61	4.37	10.05	0.44	1.61	3.73
2018								
2019		25	0.29	0.68	1.20	0.04	0.18	0.33
2020								
2002	9	23	0.48	0.94	1.54	0.15	0.41	0.72
2003		27	0.55	1.17	2.03	0.22	0.46	0.75
2004		33	0.77	1.52	2.60	0.28	0.65	1.12
2005		28	0.50	1.65	3.68	0.19	0.68	1.38
2006		28	0.18	1.11	2.79	0.00	0.43	1.07
2007		28	1.29	2.27	3.68	0.32	0.56	0.85
2008		29	0.28	0.97	2.04	0.07	0.33	0.66
2009		29	0.64	1.11	1.70	0.15	0.35	0.59
2010		28	0.17	0.99	2.38	0.01	0.45	1.06
2011		29	0.15	1.14	2.97	0.02	0.53	1.29
2012								
2013		29	0.53	1.74	3.92	0.17	0.68	1.42
2014		29	0.15	1.09	2.80	0.00	0.40	1.08
2015		29	0.13	0.57	1.17	0.00	0.20	0.45
2016		29	1.29	2.93	5.75	0.25	0.99	2.17
2017		28	0.56	2.76	8.09	0.02	1.04	3.07
2018								
2019		25	0.18	0.53	0.98	0.01	0.14	0.29
2020								
2002	10+	23	0.10	0.49	1.03	0.00	0.21	0.47
2003		27	0.25	0.66	1.20	0.07	0.24	0.43
2004		33	0.78	1.59	2.76	0.31	0.71	1.22
2005		28	0.46	1.50	3.30	0.16	0.60	1.22
2006		28	0.54	1.81	4.11	0.12	0.71	1.60
2007		28	1.06	2.18	3.93	0.31	0.61	0.96
2008		29	1.47	2.65	4.39	0.36	0.71	1.14
2009		29	0.20	0.70	1.42	0.03	0.24	0.49
2010		28	0.00	0.80	2.25	0.00	0.40	1.03
2011		29	0.17	1.15	2.94	0.04	0.54	1.29
2012								
2013		29	1.65	4.47	10.28	0.70	1.68	3.23
2014		29	0.38	1.36	3.05	0.00	0.47	1.14
2015		29	0.22	0.73	1.43	0.04	0.27	0.55
2016		29	0.83	2.38	5.22	0.11	0.84	2.06
2017		28	1.26	4.24	11.15	0.29	1.54	4.01
2018								
2019		25	0.17	0.52	0.97	0.01	0.14	0.29
2020								

Figure 64. White Perch geometric mean indices of abundance, by number and biomass, for all ages combined and by age-class for March.



White Perch

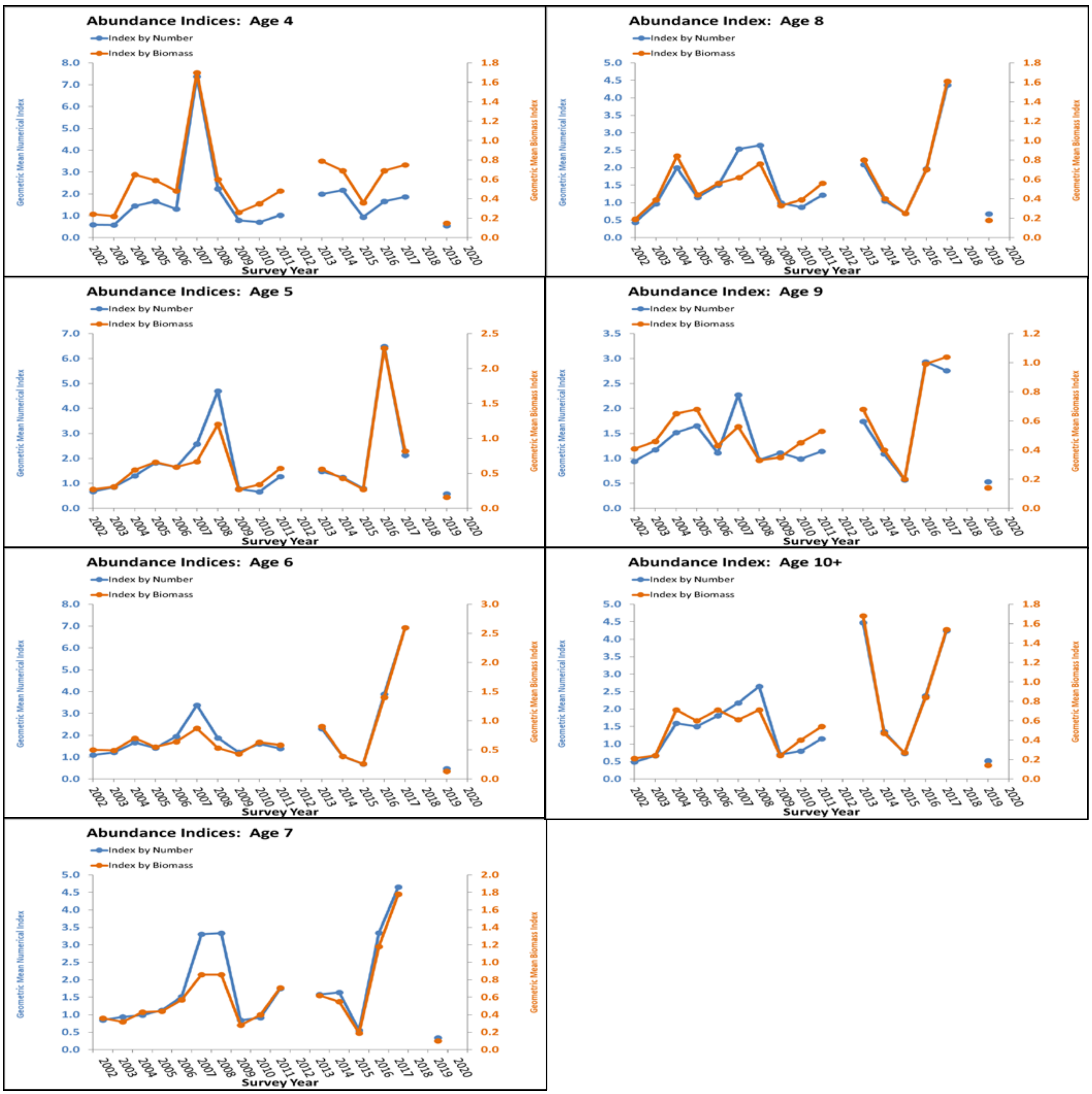


Table 31. White Perch geometric mean indices of abundance for fall by number and biomass, overall and by age class.

Year	Age	n	Numerical Index LCI	Numerical Index Index	Numerical Index UCI	Biomass Index LCI	Biomass Index Index	Biomass Index UCI
2002	All	41	6.4	11.2	19.1	1.9	3.3	5.5
2003		24	4.0	10.3	24.4	1.0	2.9	6.6
2004		36	12.1	31.1	78.1	3.4	7.6	16.1
2005		30	9.0	19.5	40.9	2.0	3.9	7.0
2006		28	16.5	42.1	105.1	3.5	8.1	17.1
2007		15	3.8	8.3	17.3	0.9	2.0	3.6
2008		32	1.3	3.5	8.1	0.3	0.9	1.8
2009		32	7.9	19.7	47.4	2.4	5.7	12.3
2010		31	6.1	15.8	38.7	1.7	4.0	8.3
2011		30	6.6	17.6	44.5	2.1	4.6	9.0
2012		31	5.1	13.3	32.4	1.4	3.3	6.7
2013		32	5.2	10.6	21.0	1.1	2.1	3.6
2014		32	4.5	11.3	26.4	1.4	3.1	6.0
2015		32	14.9	35.7	83.6	5.0	10.7	21.7
2016		32	8.2	17.9	37.8	2.5	4.9	8.9
2017		32	7.2	19.7	51.1	2.1	5.2	11.3
2018		16	15.6	52.6	172.7	3.8	10.9	28.3
2019		24	0.2	2.0	6.6	0.1	1.0	2.7
2020								
2002	4	41	1.1	1.9	3.1	0.3	0.5	0.8
2003		24	1.0	2.3	4.3	0.1	0.5	1.0
2004		36	3.9	8.8	18.7	1.0	2.1	3.8
2005		30	2.6	5.0	8.9	0.4	0.9	1.5
2006		28	1.7	3.7	7.1	0.3	0.7	1.1
2007		15	2.0	4.1	7.4	0.3	0.8	1.4
2008		32	0.4	1.3	2.6	0.1	0.3	0.5
2009		32	1.5	3.4	6.8	0.4	1.0	1.8
2010		31	0.2	1.4	4.0	0.0	0.5	1.4
2011		30	2.3	5.4	11.4	0.6	1.3	2.5
2012		31	0.3	1.1	2.2	0.1	0.3	0.6
2013		32	0.7	1.5	2.6	0.1	0.3	0.4
2014		32	1.8	4.3	9.0	0.5	1.2	2.0
2015		32	7.7	15.9	31.7	2.5	4.8	8.4
2016		32	0.8	2.1	4.5	0.2	0.6	1.1
2017		32	0.0	0.4	0.9	0.0	0.1	0.2
2018		16	5.3	14.8	38.6	1.2	3.0	6.5
2019		24	0.1	1.6	5.0	0.0	0.7	2.0
2020								
2002	5	41	1.3	2.3	3.8	0.3	0.6	1.0
2003		24	0.7	1.7	3.3	0.1	0.4	0.7
2004		36	3.2	7.0	14.0	0.8	1.7	3.0
2005		30	2.9	5.7	10.5	0.6	1.1	1.9
2006		28	3.2	7.5	16.3	0.6	1.5	2.8
2007		15	0.2	1.0	2.3	0.0	0.2	0.3
2008		32	0.6	1.8	4.0	0.1	0.4	0.8
2009		32	1.4	2.7	4.8	0.3	0.7	1.2
2010		31	1.3	4.0	10.0	0.3	1.1	2.4
2011		30	0.0	0.4	1.0	0.0	0.1	0.1
2012		31	1.2	2.8	5.7	0.3	0.7	1.3
2013		32	1.1	2.3	4.1	0.2	0.4	0.7
2014		32	1.5	3.0	5.4	0.4	0.7	1.1
2015		32	5.2	10.9	21.9	1.8	3.4	5.9
2016		32	3.8	8.4	17.6	1.1	2.3	4.3
2017		32	0.7	2.2	5.1	0.2	0.7	1.3
2018		16	2.7	7.6	19.3	0.5	1.5	3.2
2019		24	0.1	1.3	3.9	0.0	0.6	1.5
2020								
2002	6	41	3.2	5.5	9.1	1.0	1.7	2.6
2003		24	1.0	2.7	5.7	0.2	0.7	1.5
2004		36	3.4	7.2	14.3	0.9	1.9	3.3
2005		30	1.6	3.1	5.5	0.3	0.6	1.0
2006		28	4.1	10.1	22.8	0.9	2.2	4.4
2007		15	1.1	2.2	4.0	0.1	0.4	0.6
2008		32	0.4	0.9	1.5	0.0	0.1	0.3
2009		32	3.8	9.4	21.7	1.2	2.9	5.9
2010		31	1.2	4.0	10.1	0.3	1.1	2.5
2011		30	1.9	4.4	8.8	0.5	1.0	1.9
2012		31	0.7	1.7	3.4	0.1	0.4	0.8
2013		32	1.0	2.1	4.0	0.2	0.4	0.7
2014		32	1.1	2.4	4.3	0.3	0.5	0.8
2015		32	5.7	11.9	23.9	1.9	3.6	6.5
2016		32	2.8	5.9	11.5	0.8	1.6	2.7
2017		32	3.0	7.7	18.0	0.9	2.1	4.0
2018		16	1.7	3.8	7.6	0.3	0.6	1.1
2019		24	0.0	0.8	2.2	0.0	0.3	0.7
2020								

Year	Age	n	Numerical Index LCI	Numerical Index Index	Numerical Index UCI	Biomass Index LCI	Biomass Index Index	Biomass Index UCI
2002	7	41	1.2	2.3	3.7	0.4	0.7	1.1
2003		24	1.4	3.6	8.0	0.3	1.1	2.3
2004		36	2.6	5.7	11.5	0.7	1.5	2.8
2005		30	1.7	3.3	5.8	0.4	0.7	1.0
2006		28	2.2	5.1	10.7	0.4	1.1	2.1
2007		15	1.6	3.2	5.9	0.4	0.7	1.1
2008		32	0.3	1.0	1.9	0.0	0.2	0.4
2009		32	1.8	4.5	9.9	0.5	1.4	2.8
2010		31	2.8	7.6	18.4	0.8	2.0	4.2
2011		30	1.5	3.0	5.5	0.3	0.7	1.1
2012		31	1.0	2.7	5.7	0.3	0.7	1.4
2013		32	0.6	1.4	2.6	0.1	0.3	0.5
2014		32	1.5	3.0	5.6	0.4	0.8	1.2
2015		32	4.3	8.7	17.0	1.3	2.6	4.4
2016		32	1.4	3.2	6.3	0.3	0.9	1.6
2017		32	1.5	3.5	7.3	0.3	0.9	1.7
2018		16	4.5	12.2	30.5	0.8	2.3	4.8
2019		24	0.0	0.1	0.2	0.0	0.0	0.1
2020								
2002	8	41	1.0	1.8	3.0	0.3	0.6	0.9
2003		24	1.1	2.7	5.7	0.2	0.8	1.7
2004		36	2.9	6.6	13.9	0.8	1.9	3.6
2005		30	1.3	2.7	4.8	0.3	0.6	1.0
2006		28	2.6	6.1	13.0	0.6	1.5	2.9
2007		15	0.4	1.6	3.9	0.1	0.3	0.7
2008		32	0.4	1.0	2.0	0.0	0.2	0.5
2009		32	2.0	5.3	12.0	0.6	1.7	3.4
2010		31	1.2	3.8	9.7	0.3	1.1	2.5
2011		30	3.4	7.4	15.0	0.9	1.8	2.9
2012		31	0.7	1.9	3.8	0.2	0.5	0.9
2013		32	0.7	1.5	2.8	0.1	0.3	0.5
2014		32	0.8	1.2	1.7	0.2	0.2	0.3
2015		32	2.8	5.7	11.0	0.8	1.7	3.0
2016		32	0.1	0.8	2.1	0.0	0.3	0.6
2017		32	1.6	4.2	9.1	0.4	1.1	2.0
2018		16	2.6	7.3	17.9	0.5	1.2	2.2
2019		24	0.0	0.5	1.2	0.0	0.2	0.3
2020								
2002	9	41	2.2	3.9	6.5	0.7	1.3	2.1
2003		24	0.7	2.0	4.4	0.1	0.6	1.3
2004		36	2.0	4.4	8.7	0.5	1.2	2.3
2005		30	2.0	3.8	6.5	0.4	0.8	1.2
2006		28	0.7	2.0	4.2	0.1	0.5	1.1
2007		15	0.2	1.0	2.2	0.0	0.2	0.4
2008		32	0.2	0.4	0.8	0.0	0.1	0.2
2009		32	2.2	5.8	13.7	0.7	1.9	4.0
2010		31	1.8	5.1	12.3	0.5	1.4	3.0
2011		30	1.1	2.3	4.2	0.2	0.5	0.8
2012		31	1.3	3.4	7.3	0.3	0.9	1.7
2013		32	0.6	1.4	2.5	0.1	0.3	0.5
2014		32	1.0	1.8	3.0	0.2	0.4	0.7
2015		32	1.8	3.5	6.3	0.5	1.0	1.7
2016		32	1.2	2.8	5.4	0.3	0.8	1.4
2017		32	1.1	2.8	5.8	0.3	0.7	1.4
2018		16	2.7	7.3	17.6	0.5	1.2	2.3
2019		24	0.0	0.8	2.2	0.0	0.3	0.7
2020								
2002	10+	41	0.7	1.3	2.2	0.2	0.4	0.7
2003		24	1.2	3.5	8.3	0.3	1.2	2.6
2004		36	2.0	4.6	9.5	0.6	1.4	2.7
2005		30	1.0	2.1	3.8	0.2	0.5	0.9
2006		28	3.7	9.8	23.6	0.9	2.4	5.2
2007		15	0.2	1.5	3.9	0.0	0.4	0.8
2008		32	0.3	0.7	1.4	0.0	0.2	0.4
2009		32	1.9	5.4	13.0	0.7	1.9	3.9
2010		31	1.3	4.3	11.5	0.4	1.4	3.1
2011		30	2.3	4.9	9.3	0.6	1.1	1.9
2012		31	0.7	2.0	4.4	0.2	0.6	1.1
2013		32	1.4	3.1	5.8	0.3	0.7	1.2
2014		32	1.6	3.2	5.8	0.4	0.8	1.4
2015		32	6.0	13.7	30.0	2.0	4.2	8.1
2016		32	1.4	3.3	6.7	0.4	0.9	1.7
2017		32	2.3	6.0	14.0	0.7	1.7	3.2
2018		16	4.2	12.2	32.3	0.8	2.3	4.9
2019		24	0.1	0.7	1.7	0.0	0.2	0.5
2020								

Figure 65. White Perch geometric mean indices of abundance, by number and biomass, for all ages combined and by age-class for November.

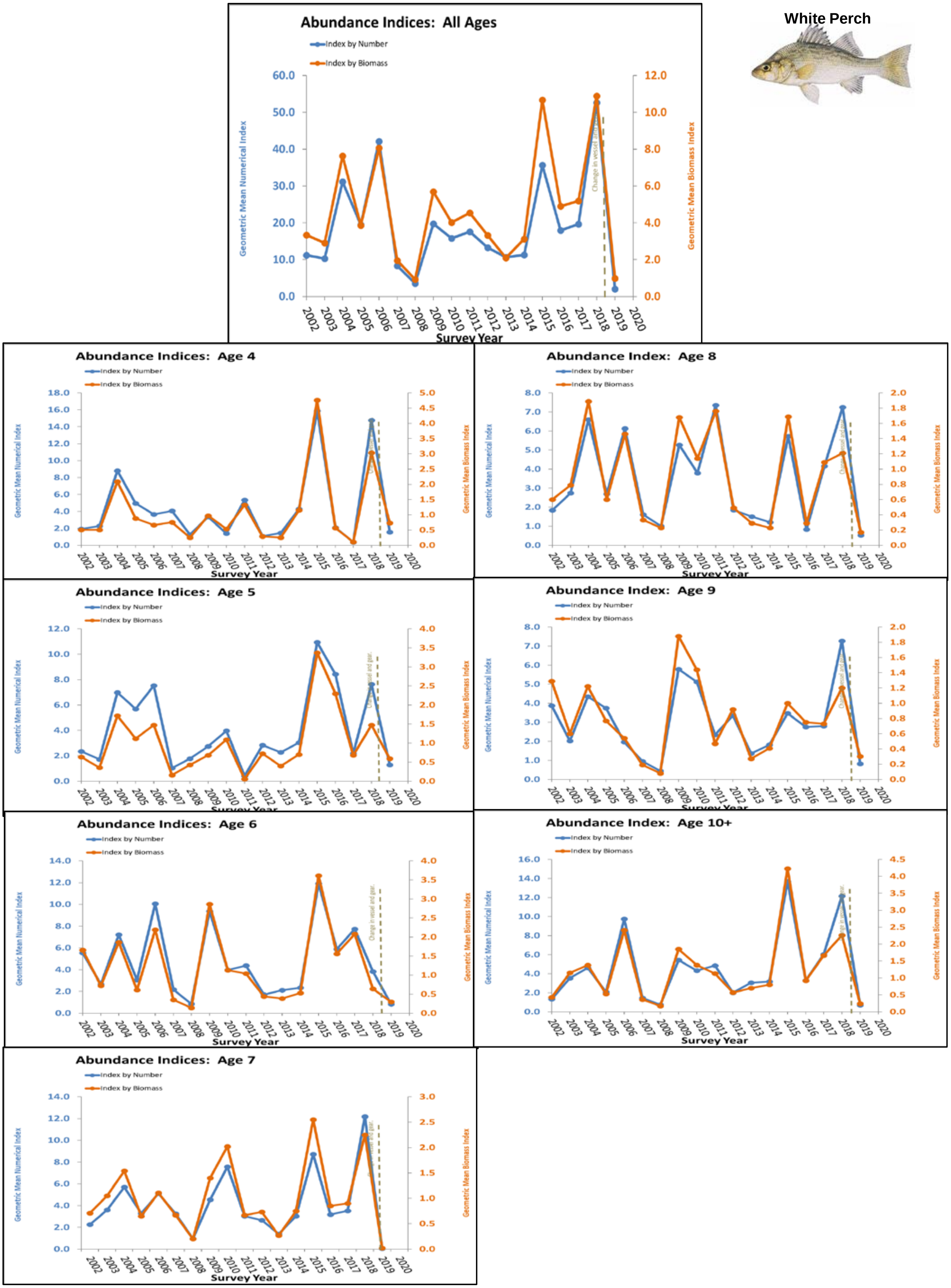


Figure 66. White Perch length-frequency in Chesapeake Bay 2002-2019, overall (A) and by sex (B).

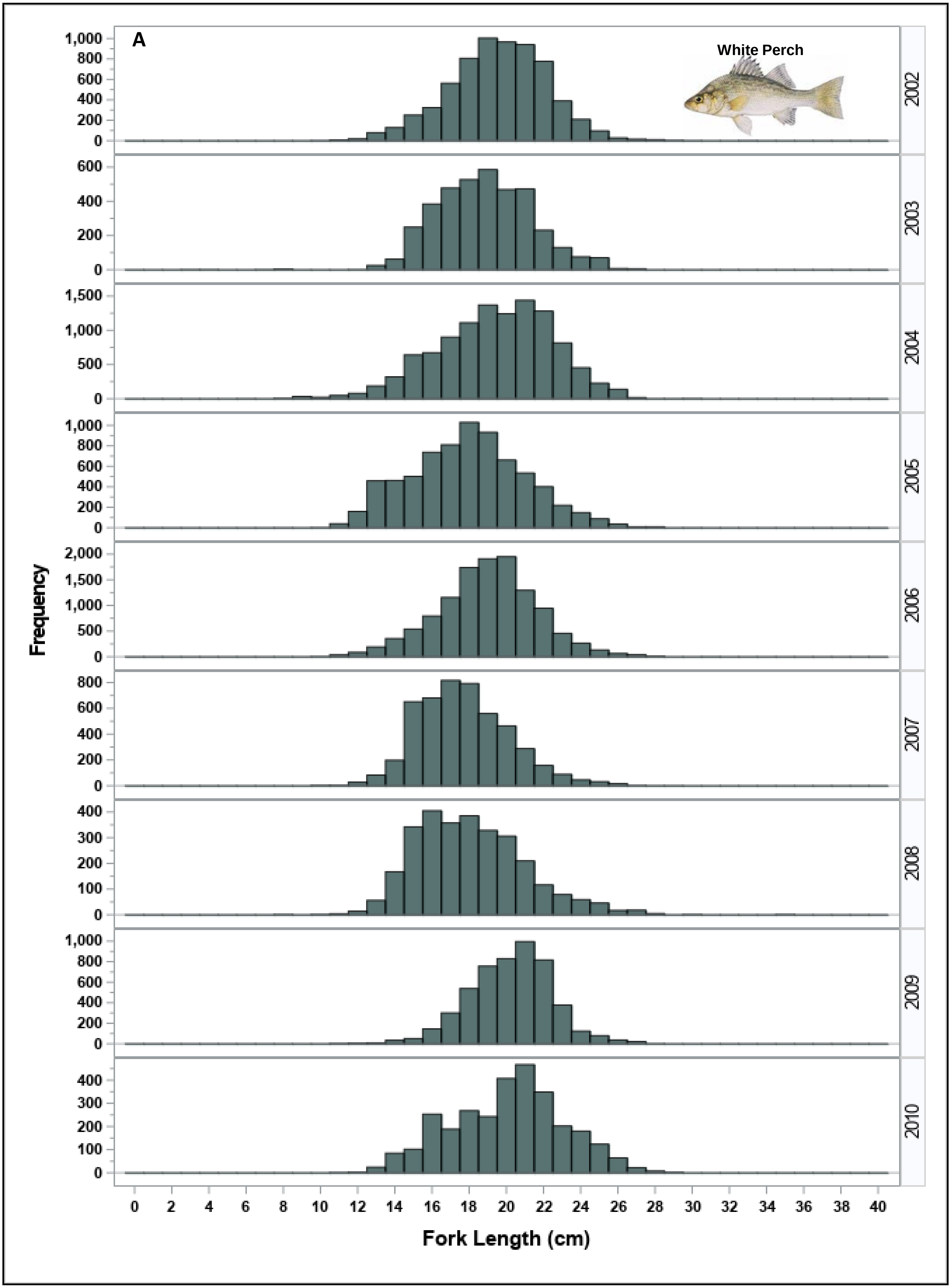


Figure 66. cont.

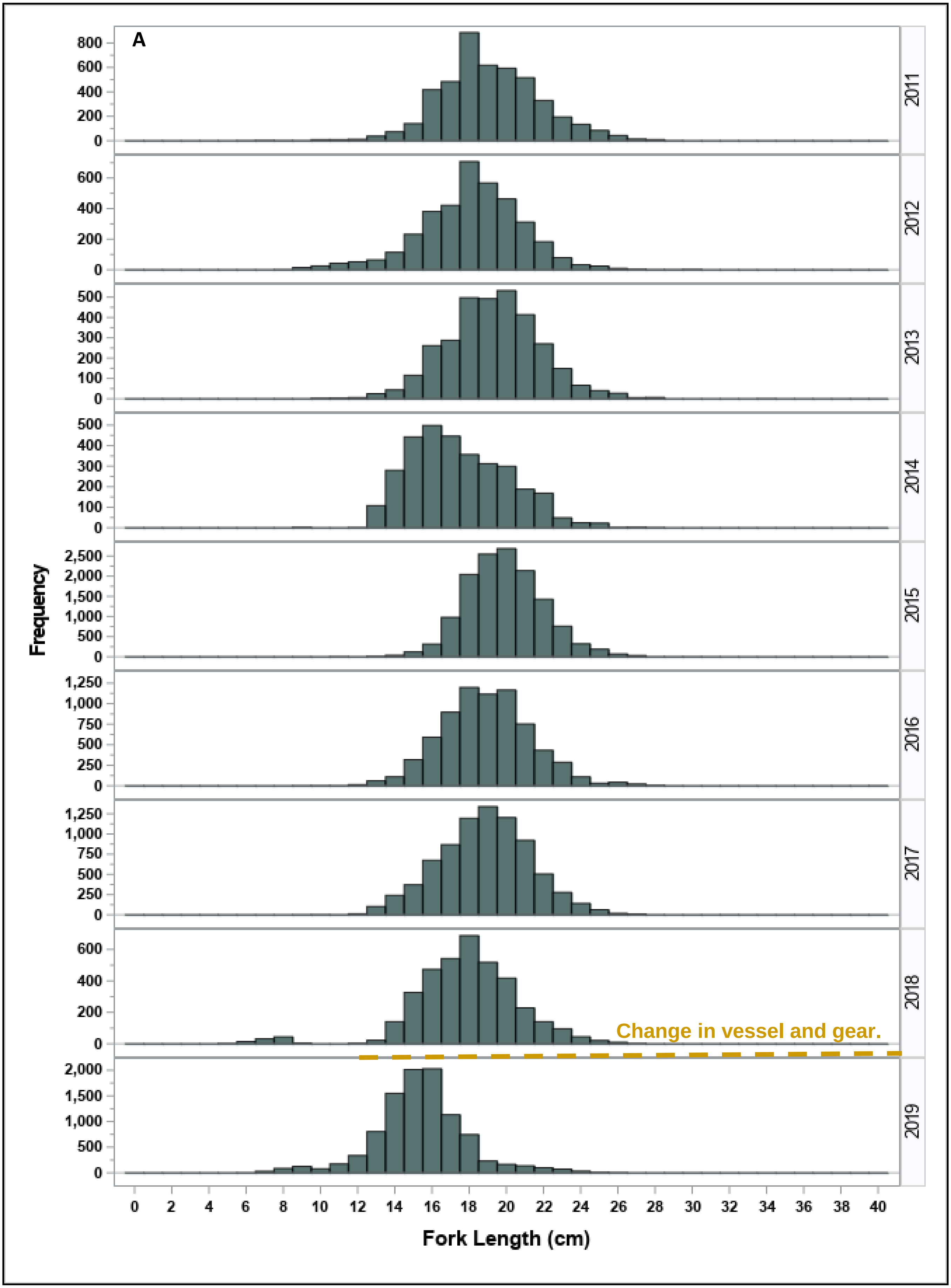


Figure 66. cont.

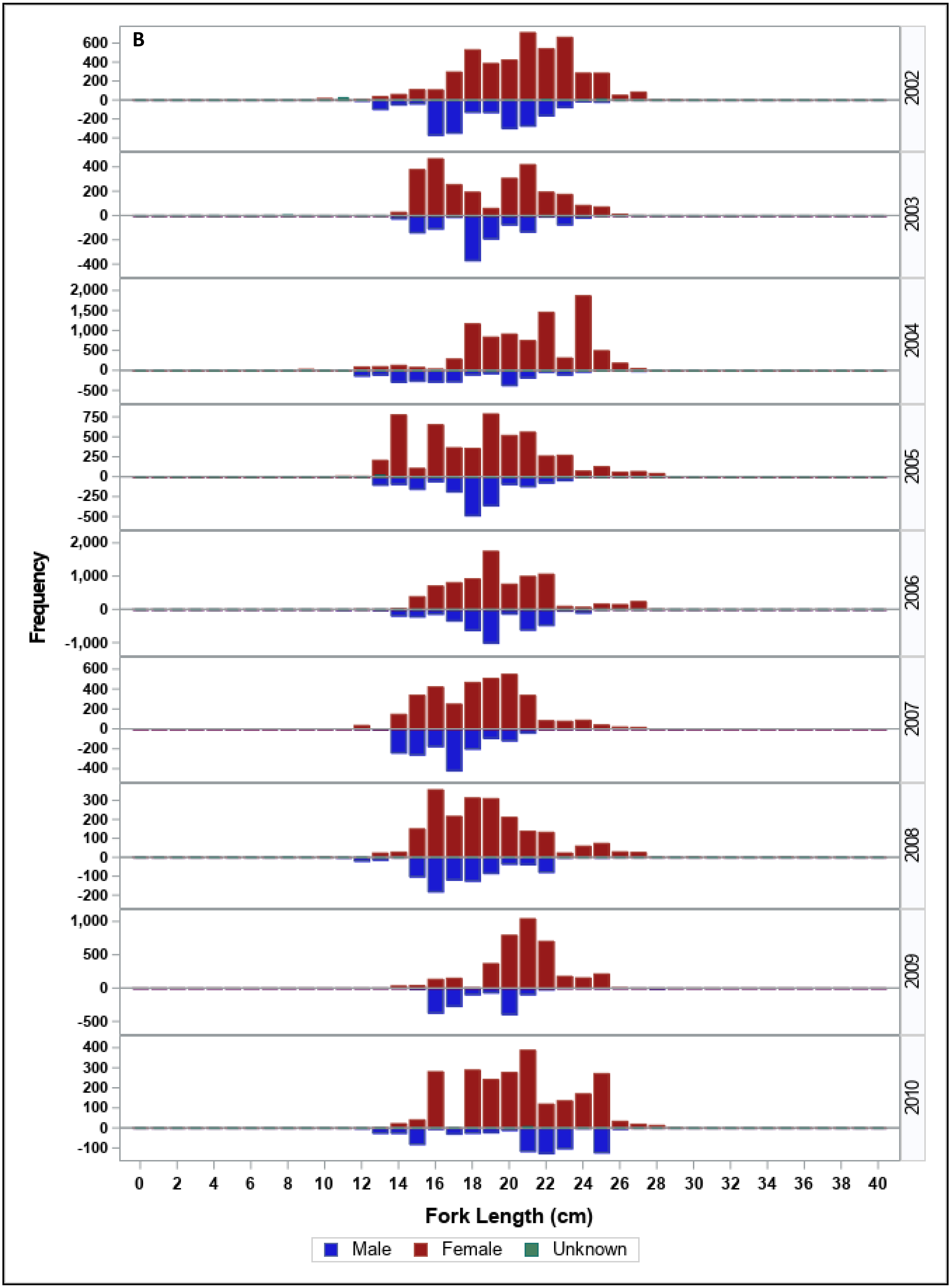


Figure 66. cont.

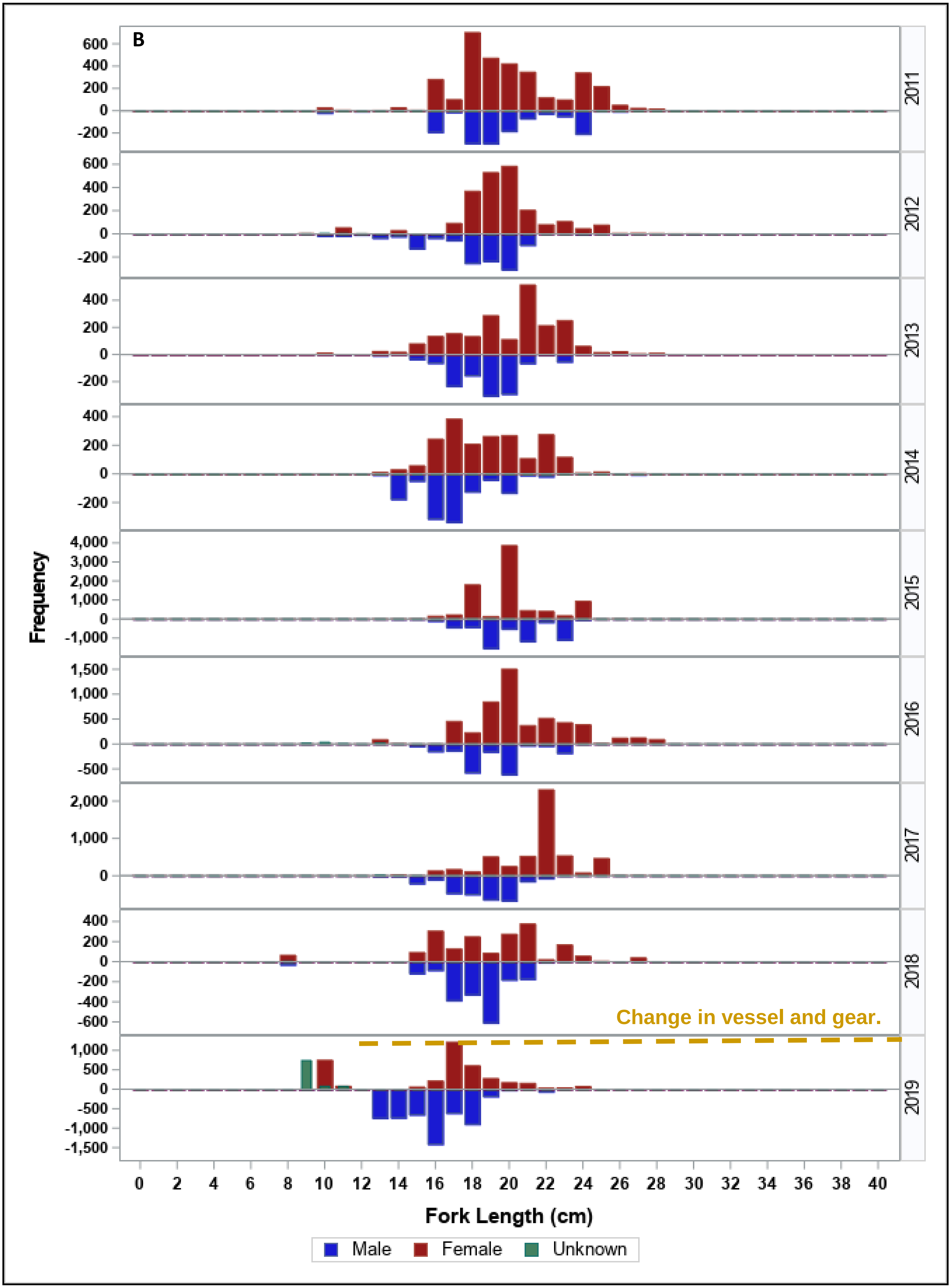


Figure 67. White Perch total age-frequency, 2002-2019.

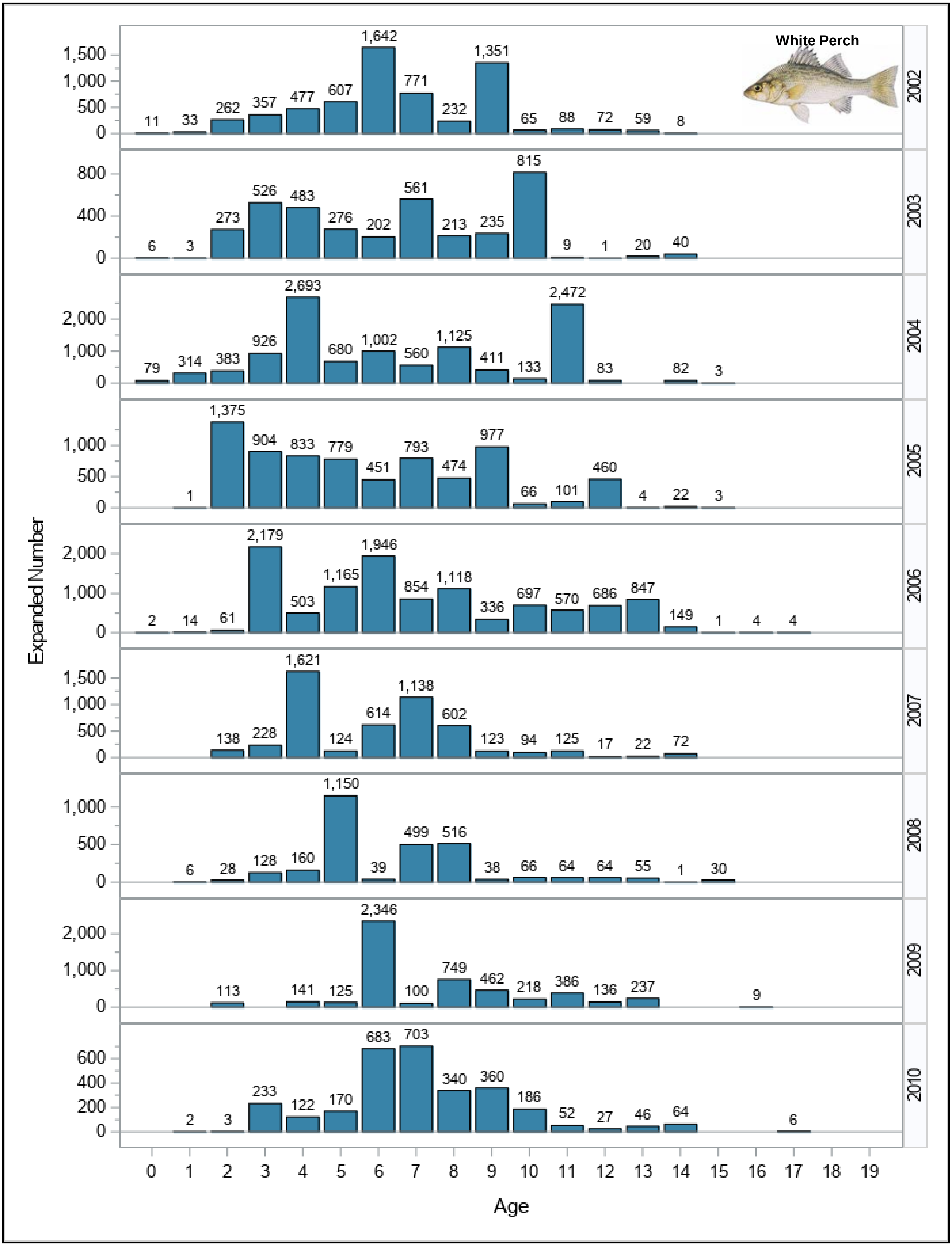


Figure 67. cont.

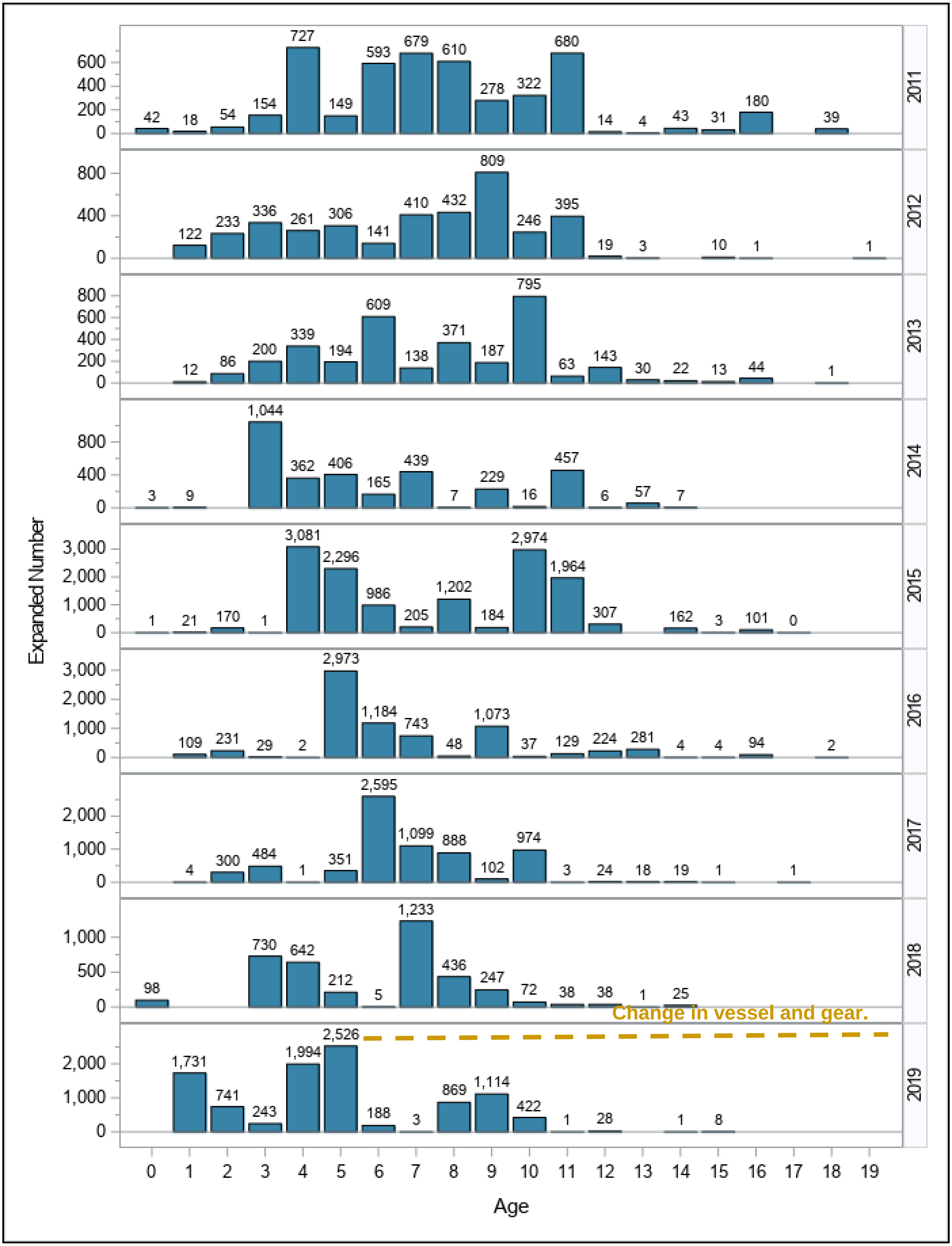


Figure 68. White Perch age-frequency by year, 2002-2019 standardized to 8,000 (4,800 for 2019) annual trawl minutes.

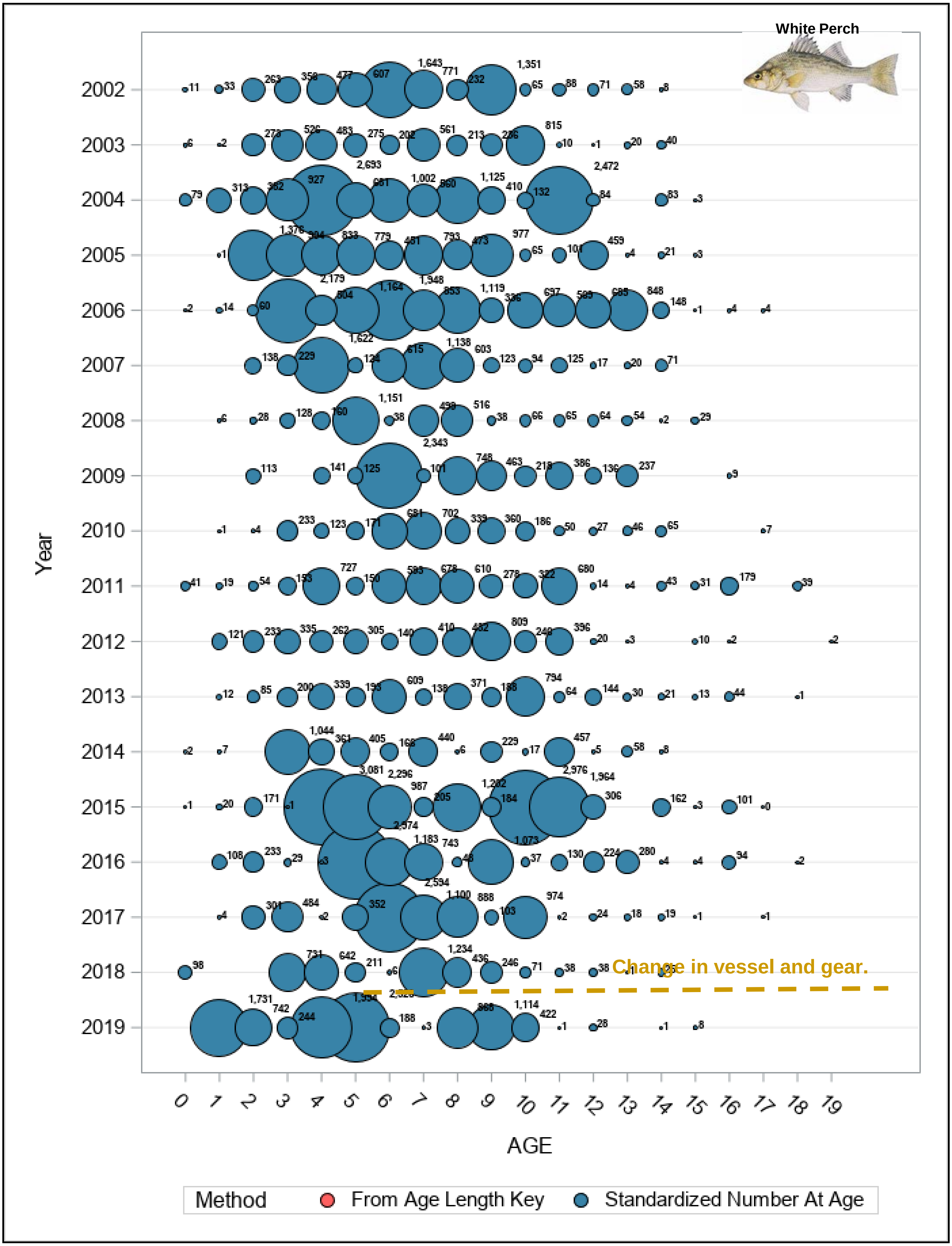
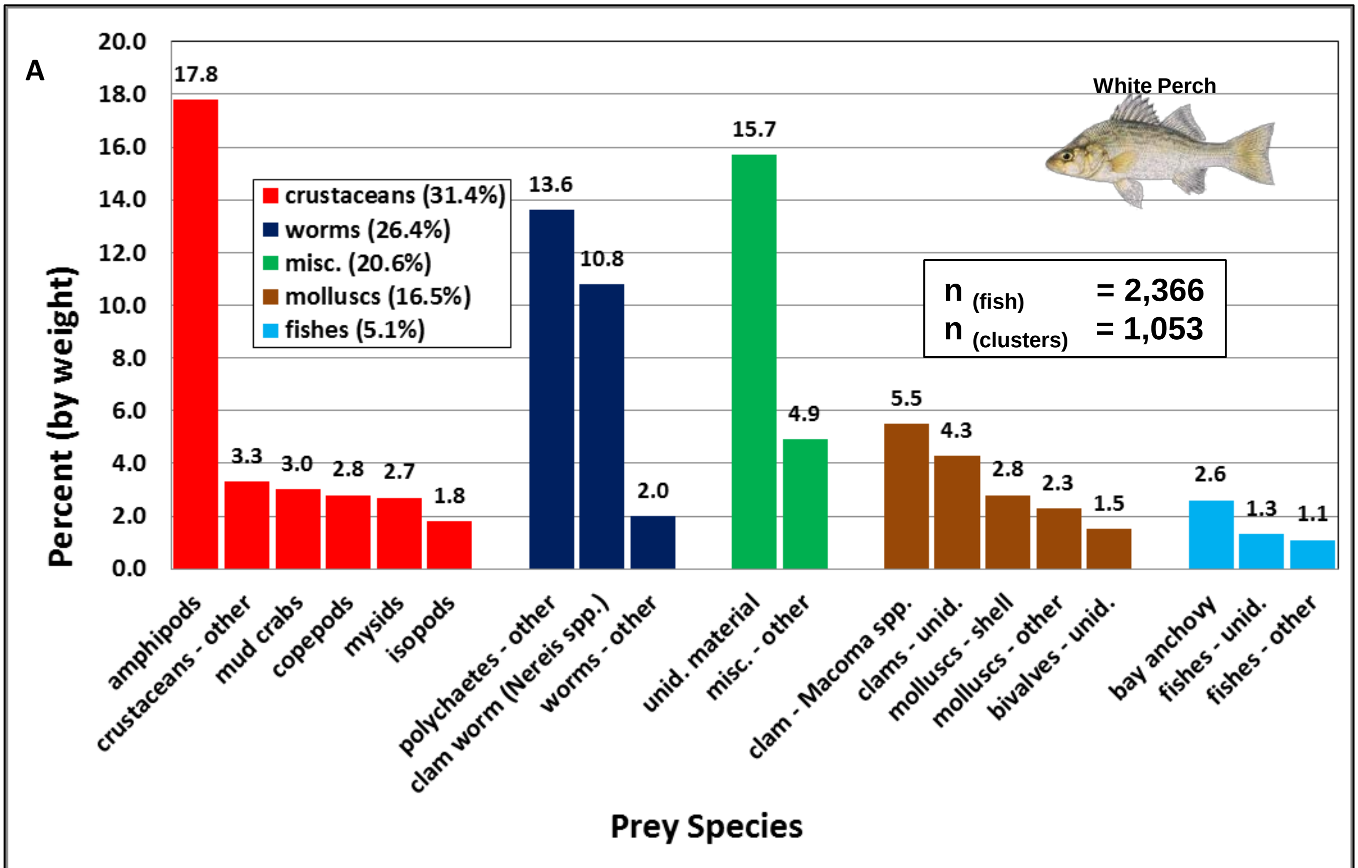


Figure 69. Diet composition, expressed as percent by weight (A) and percent by number (B) of White Perch collected during ChesMMAP cruises in 2002-2018 combined.



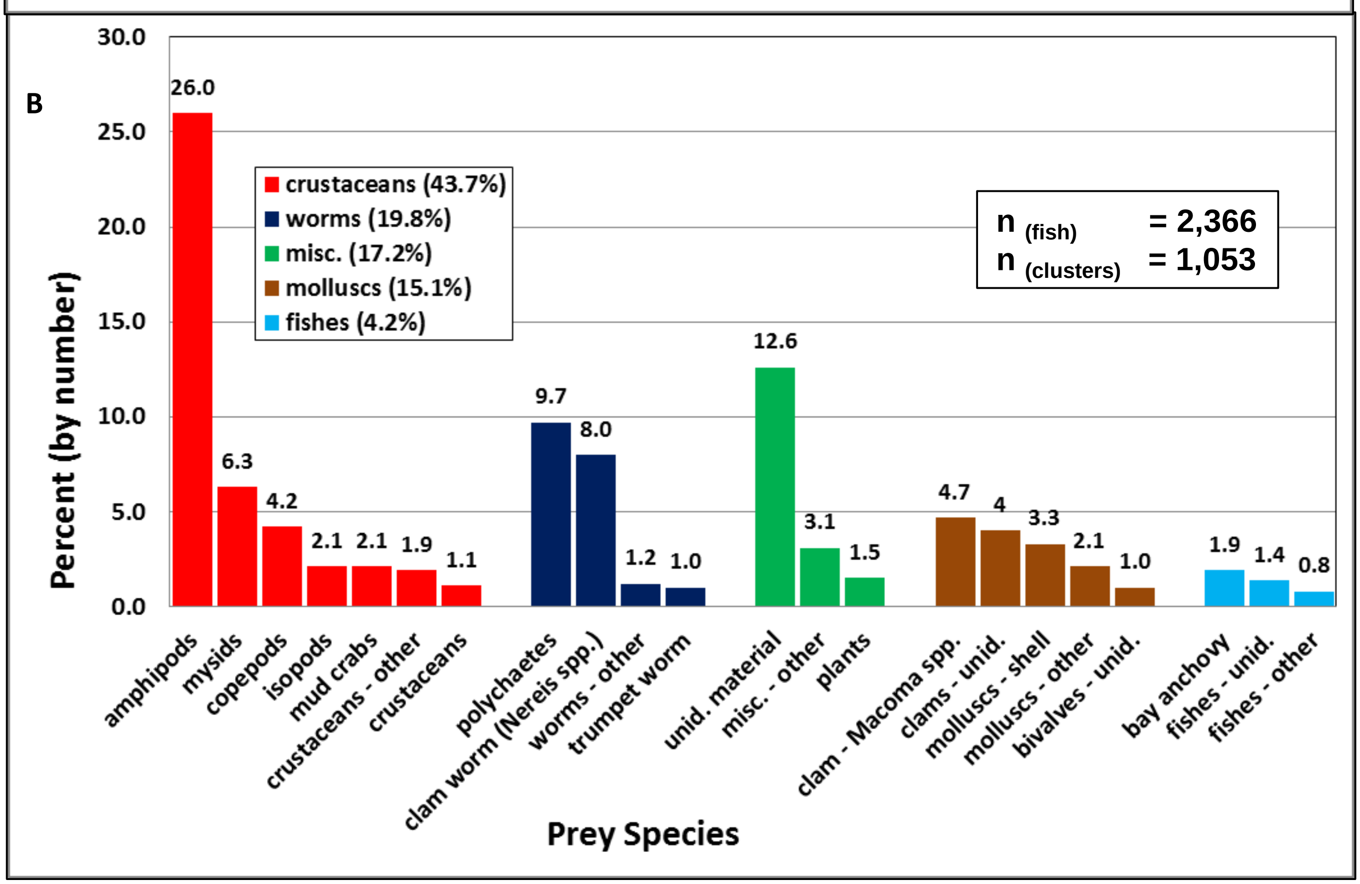


Figure 70. The *R/V Bay Eagle* and the *R/V Virginia* preparing to conduct a calibration tow (A) and the *R/V Virginia* travelling towards the next site upon completion of a tow (B).

Figure 71. Preliminary comparison of catch rates during calibration tows for Atlantic Croaker, 0 – 125mm.

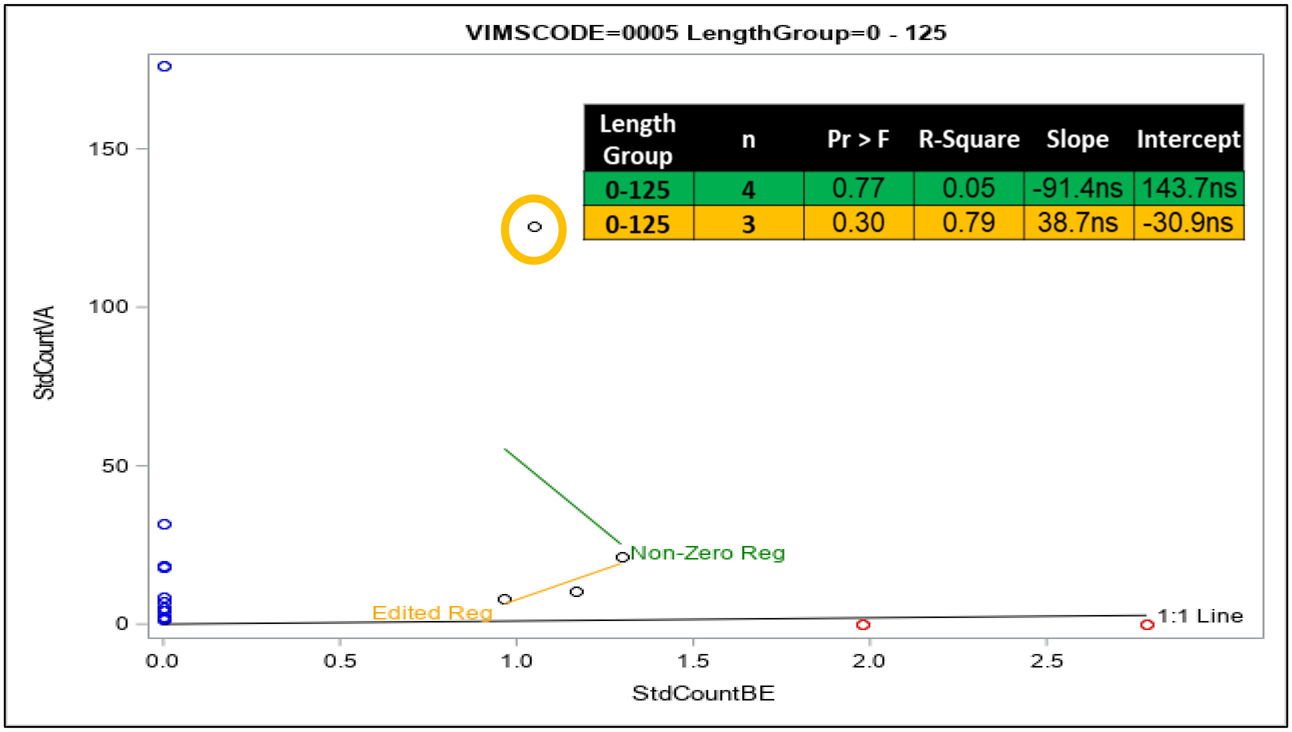


Figure 72. Preliminary comparison of catch rates during calibration tows for Atlantic Croaker, 126 – 180mm.

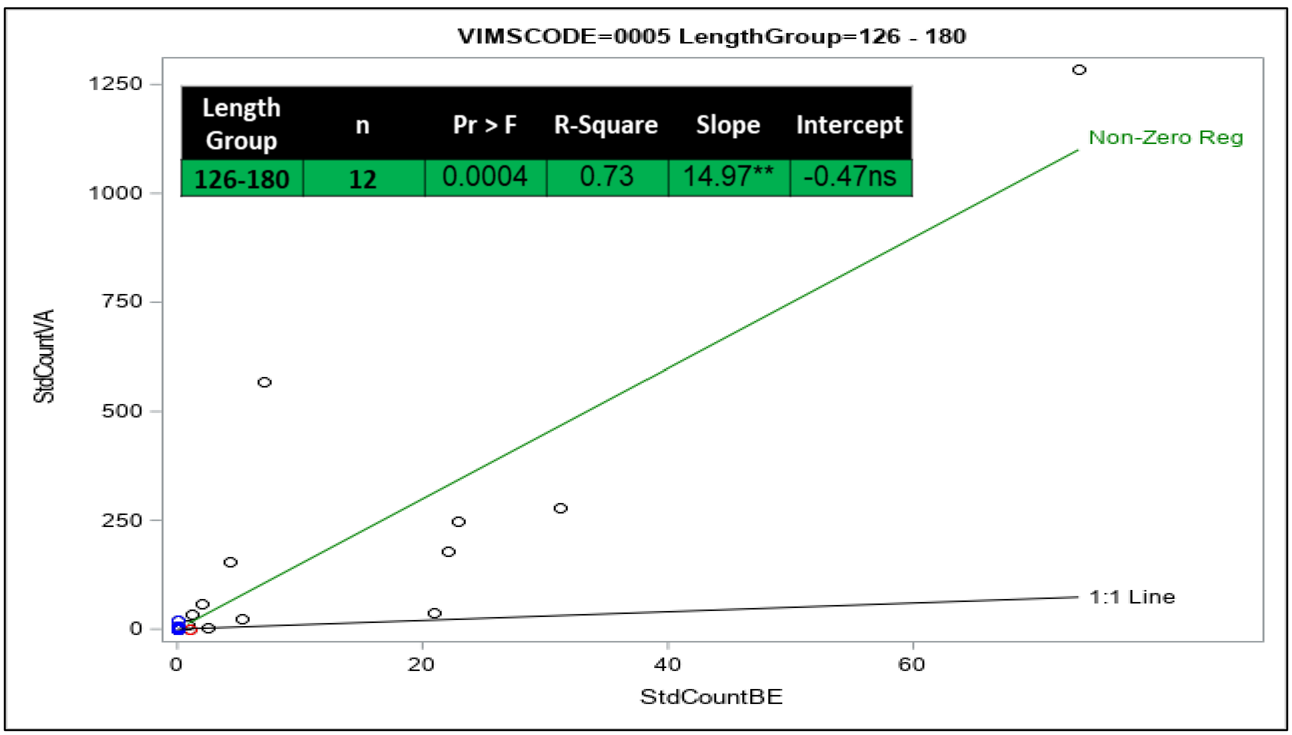


Figure 73. Preliminary comparison of catch rates during calibration tows for Atlantic Croaker, 181+mm.

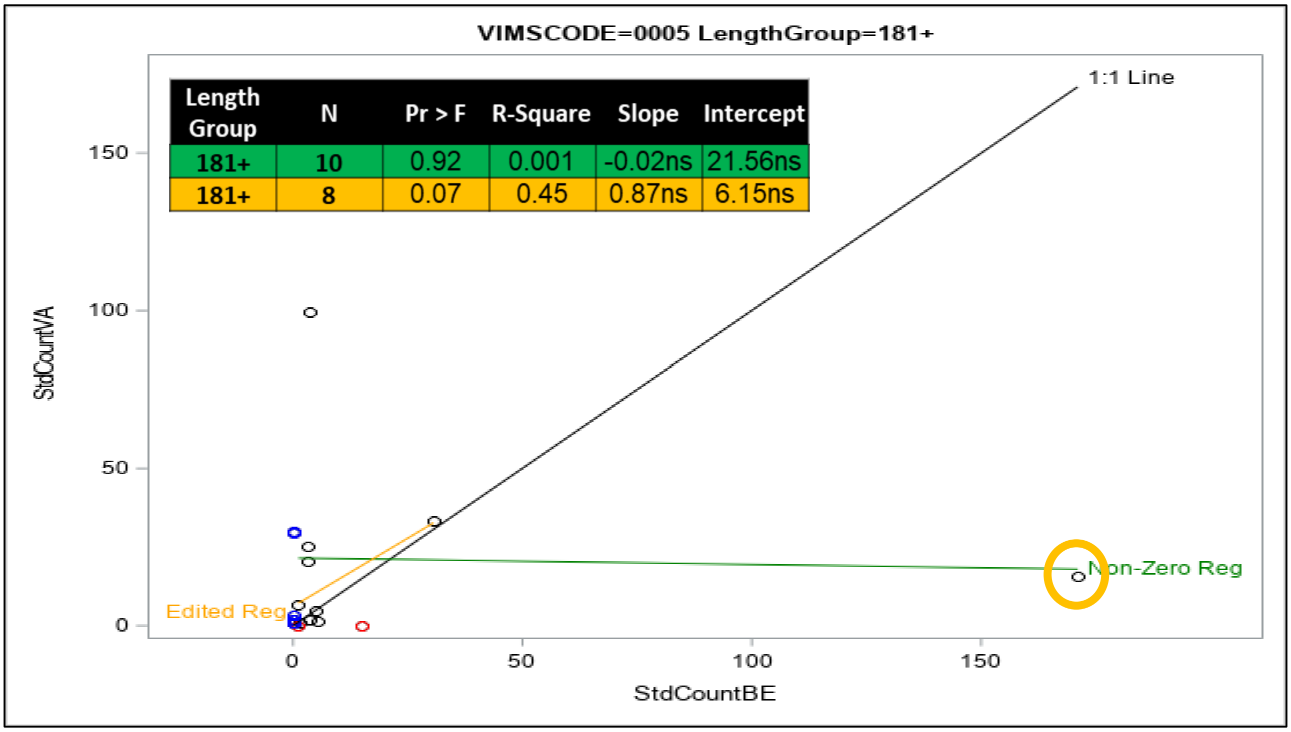


Figure 74. Comparison of length frequency distributions during calibration tows for Atlantic Croaker.

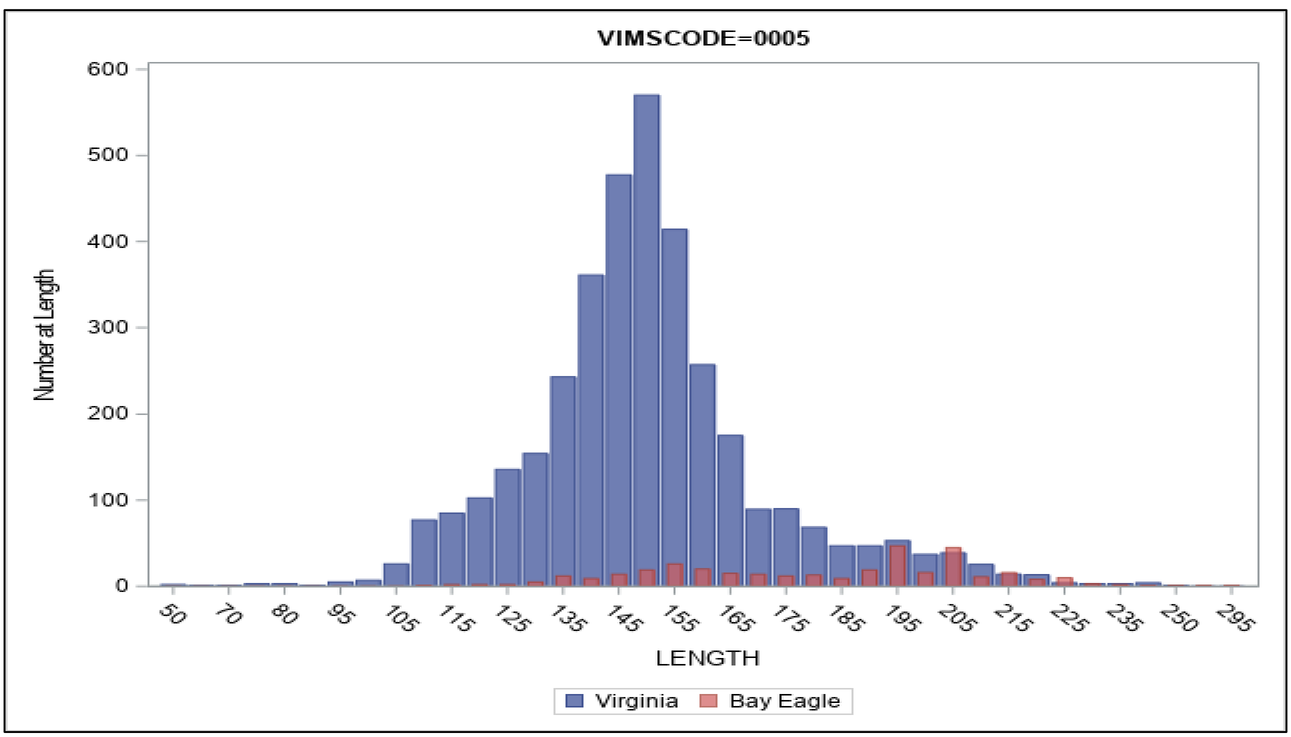


Figure 75. Preliminary comparison of catch rates during calibration tows for Black Sea Bass, all sizes.

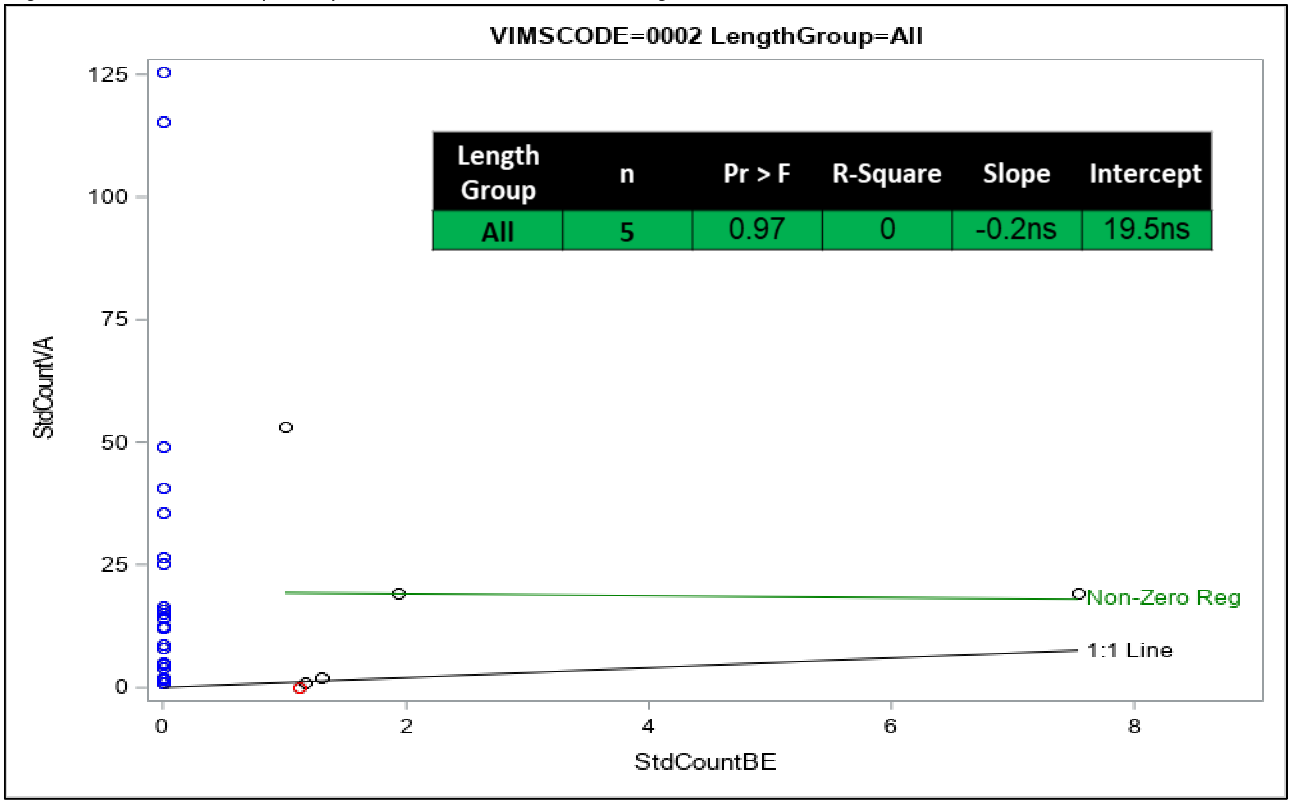


Figure 76. Comparison of length frequency distributions during calibration tows for Black Sea Bass.

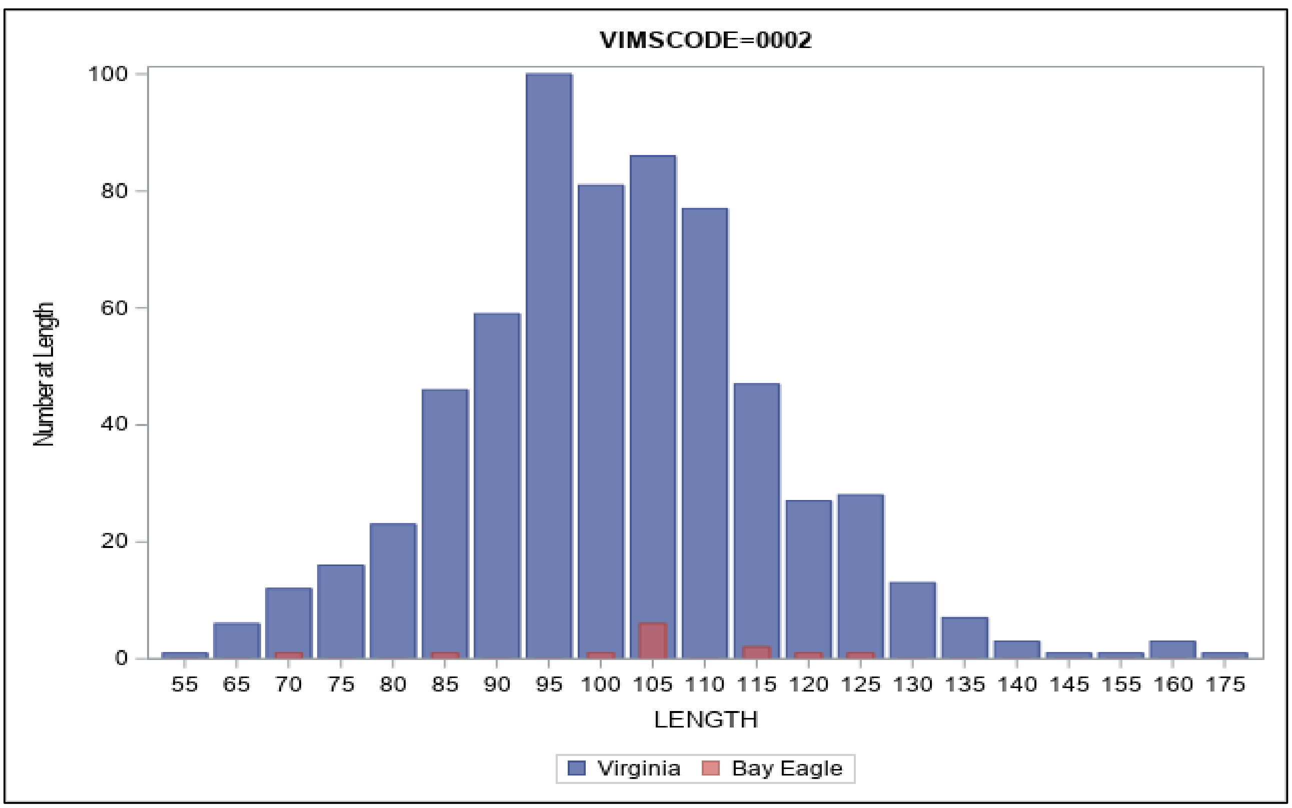


Figure 77. Preliminary comparison of catch rates during calibration tows for Butterfish, 0 – 95mm.

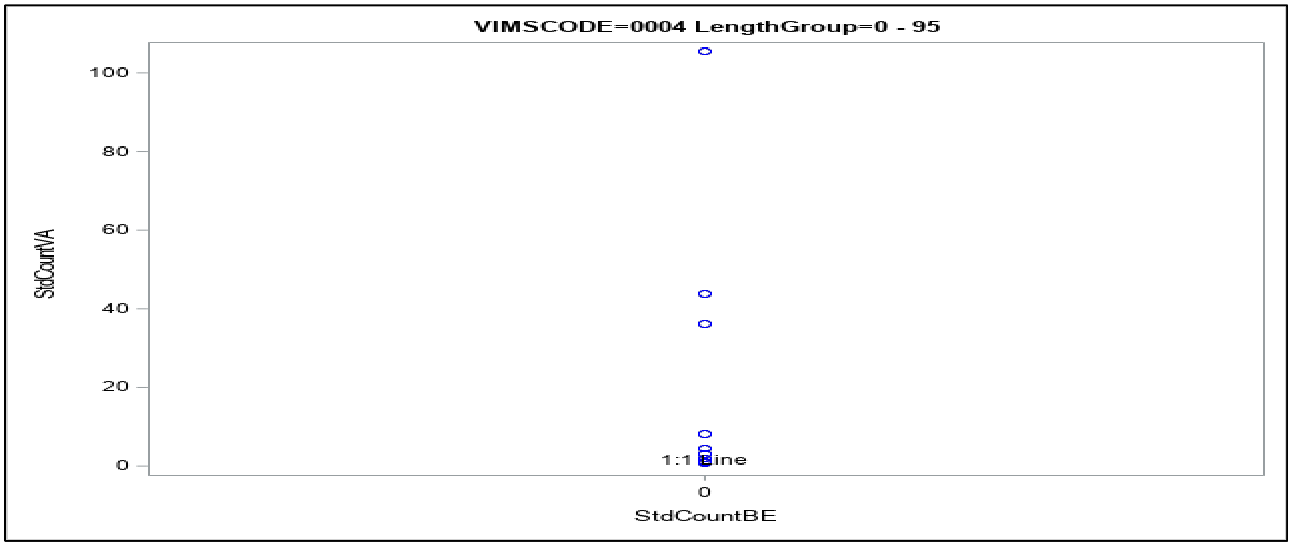


Figure 78. Preliminary comparison of catch rates during calibration tows for Butterfish, 96+mm.

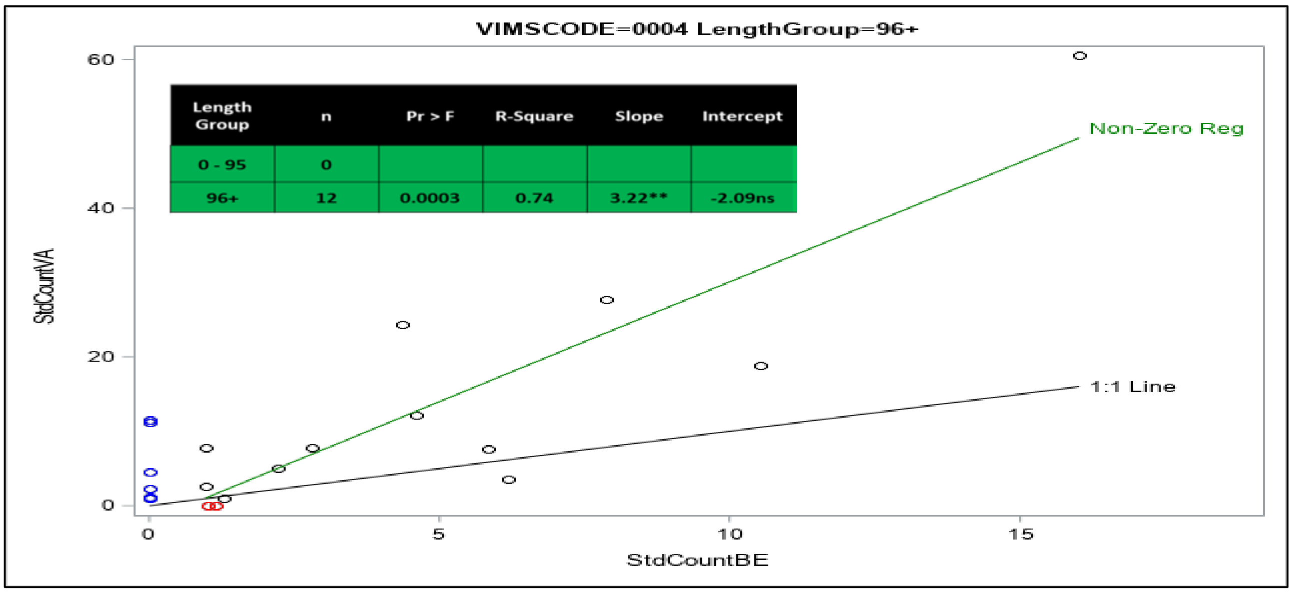


Figure 79. Comparison of length frequency distributions during calibration tows for Butterfish.

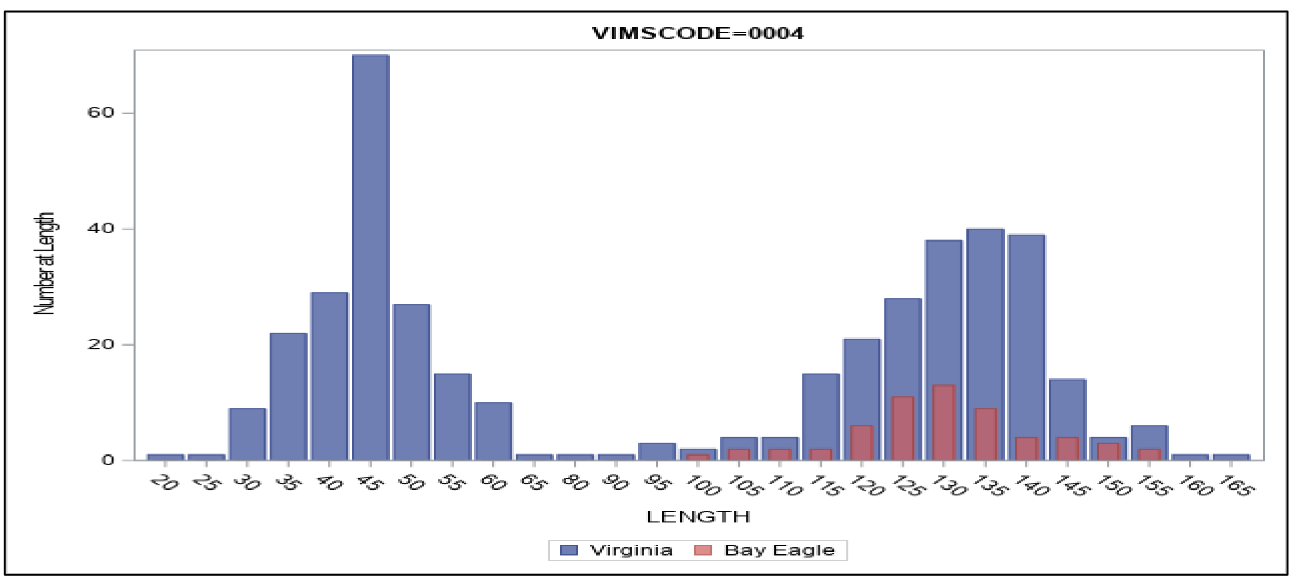


Figure 80. Preliminary comparison of catch rates during calibration tows for Kingfish, 0 – 200mm.

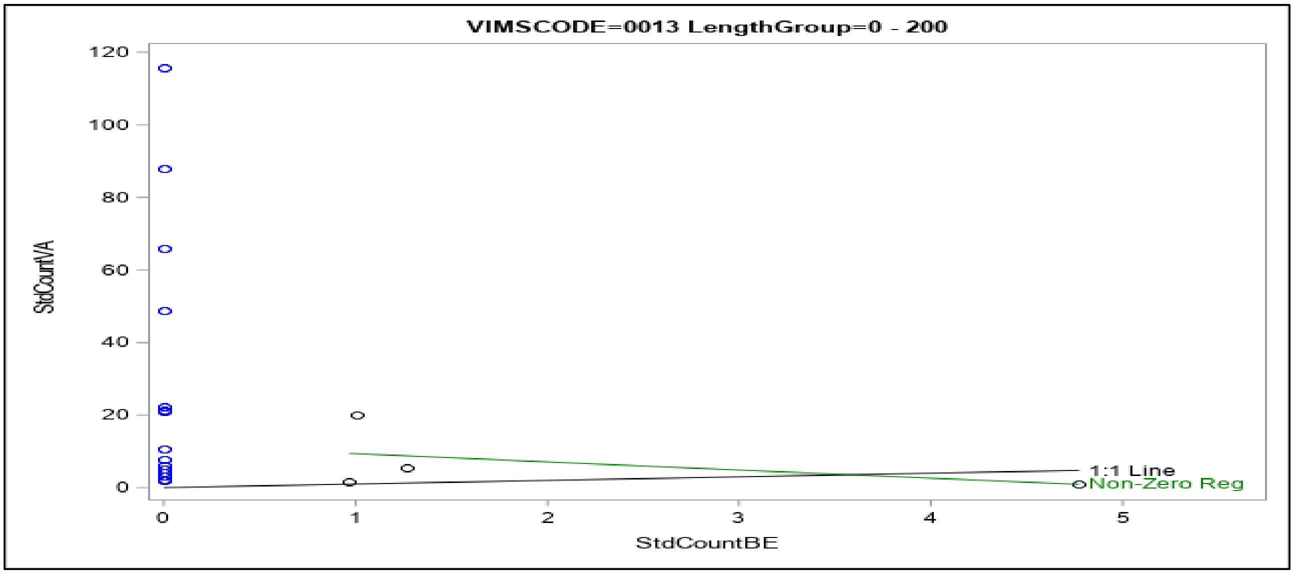
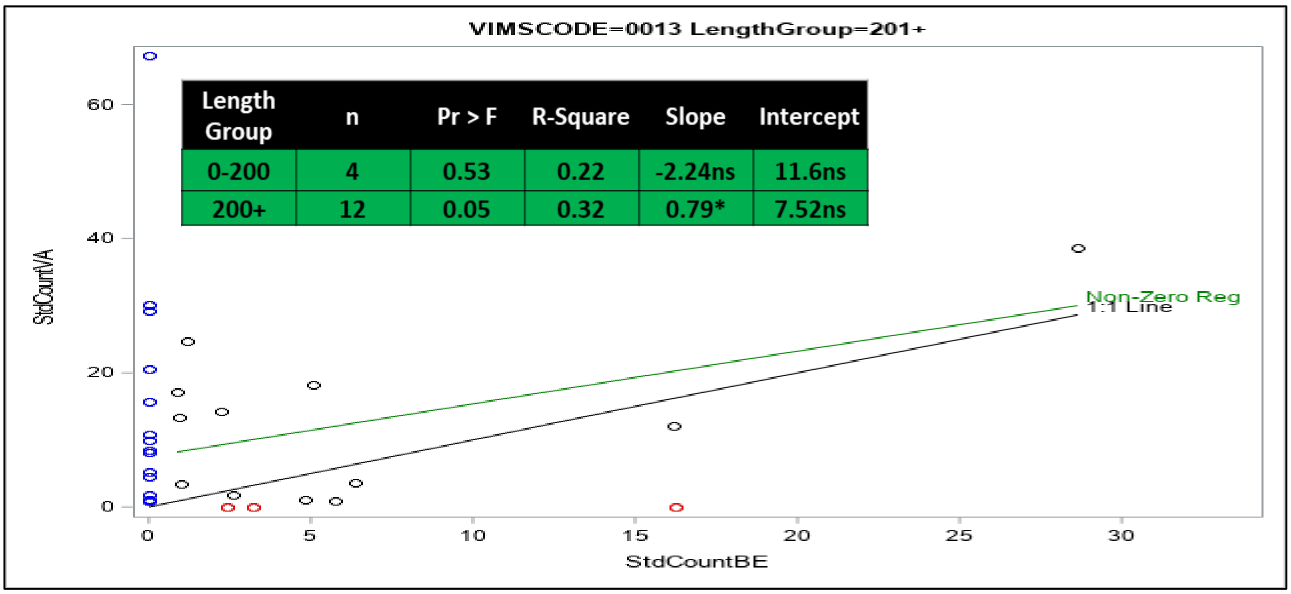


Figure 81. Preliminary comparison of catch rates during calibration tows for Kingfish, 201+mm.



Length Group	n	Pr > F	R-Square	Slope	Intercept
0-200	4	0.53	0.22	-2.24ns	11.6ns
200+	12	0.05	0.32	0.79*	7.52ns

Figure 82. Comparison of length frequency distributions during calibration tows for Kingfish.

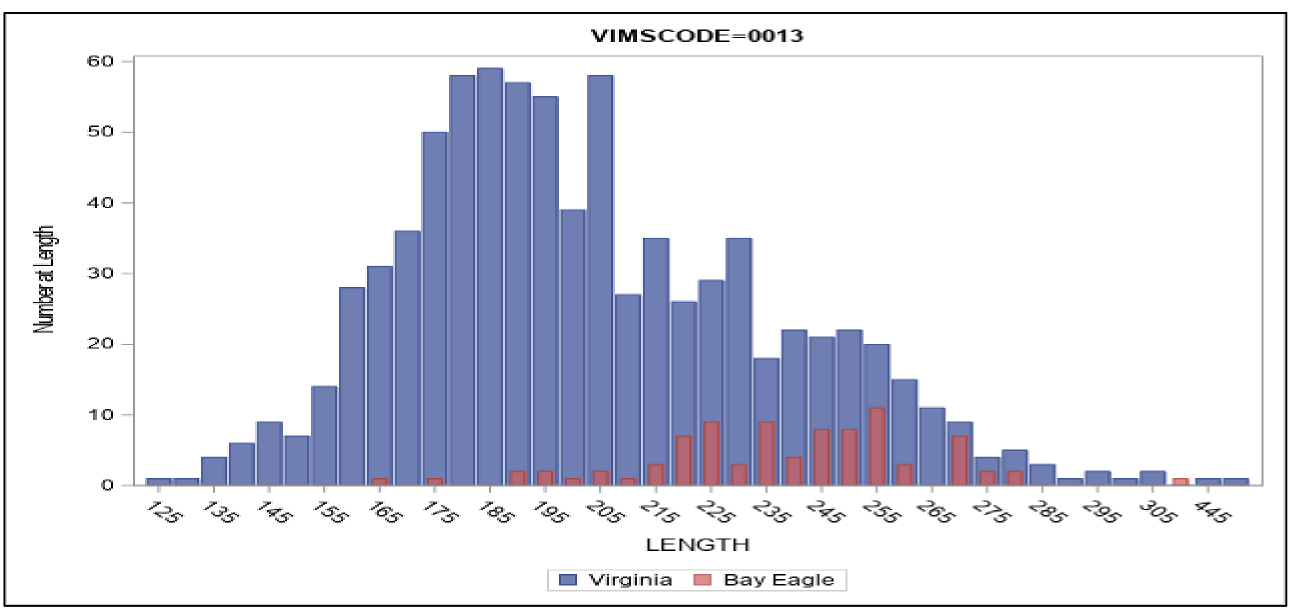
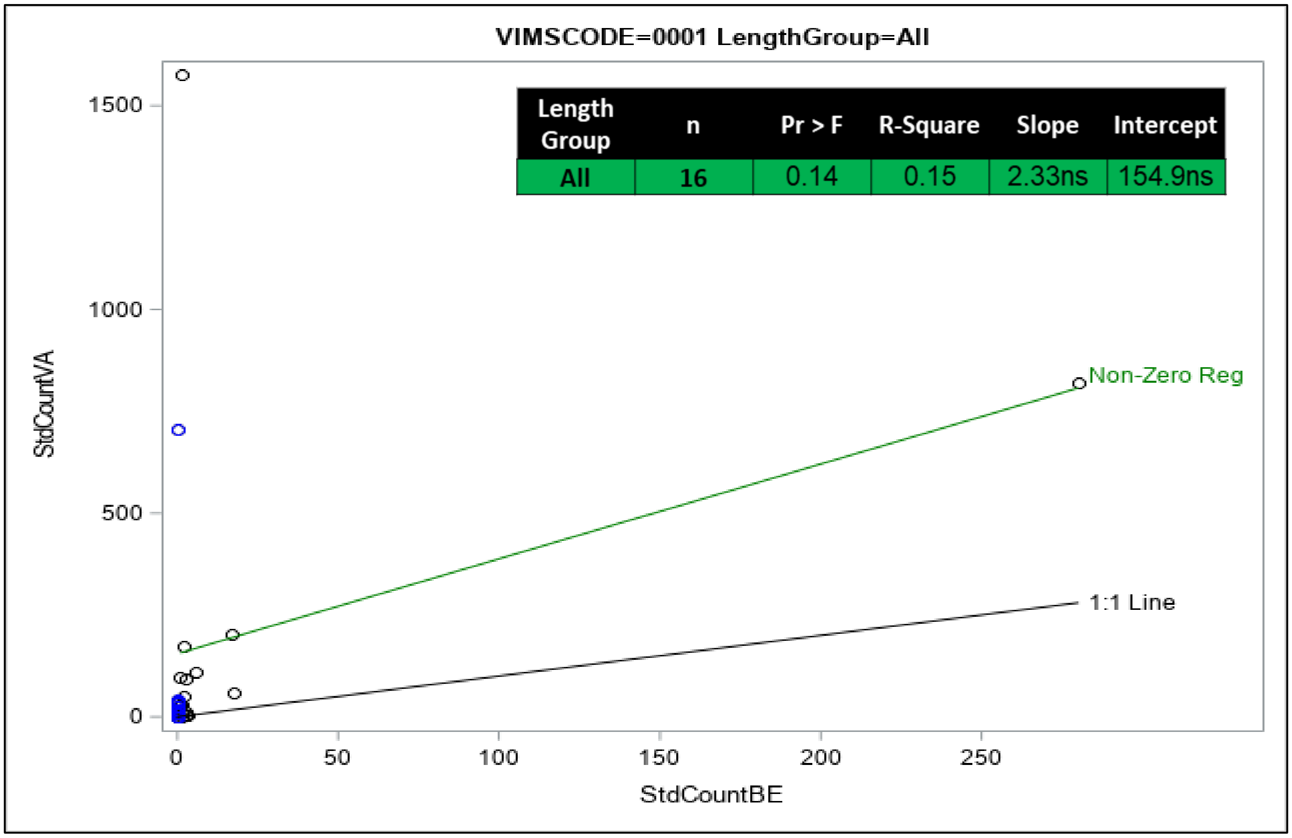


Figure 83. Preliminary comparison of catch rates during calibration tows for Scup, all sizes.



Length Group	n	Pr > F	R-Square	Slope	Intercept
All	16	0.14	0.15	2.33ns	154.9ns

Figure 84. Comparison of length frequency distributions during calibration tows for Scup.

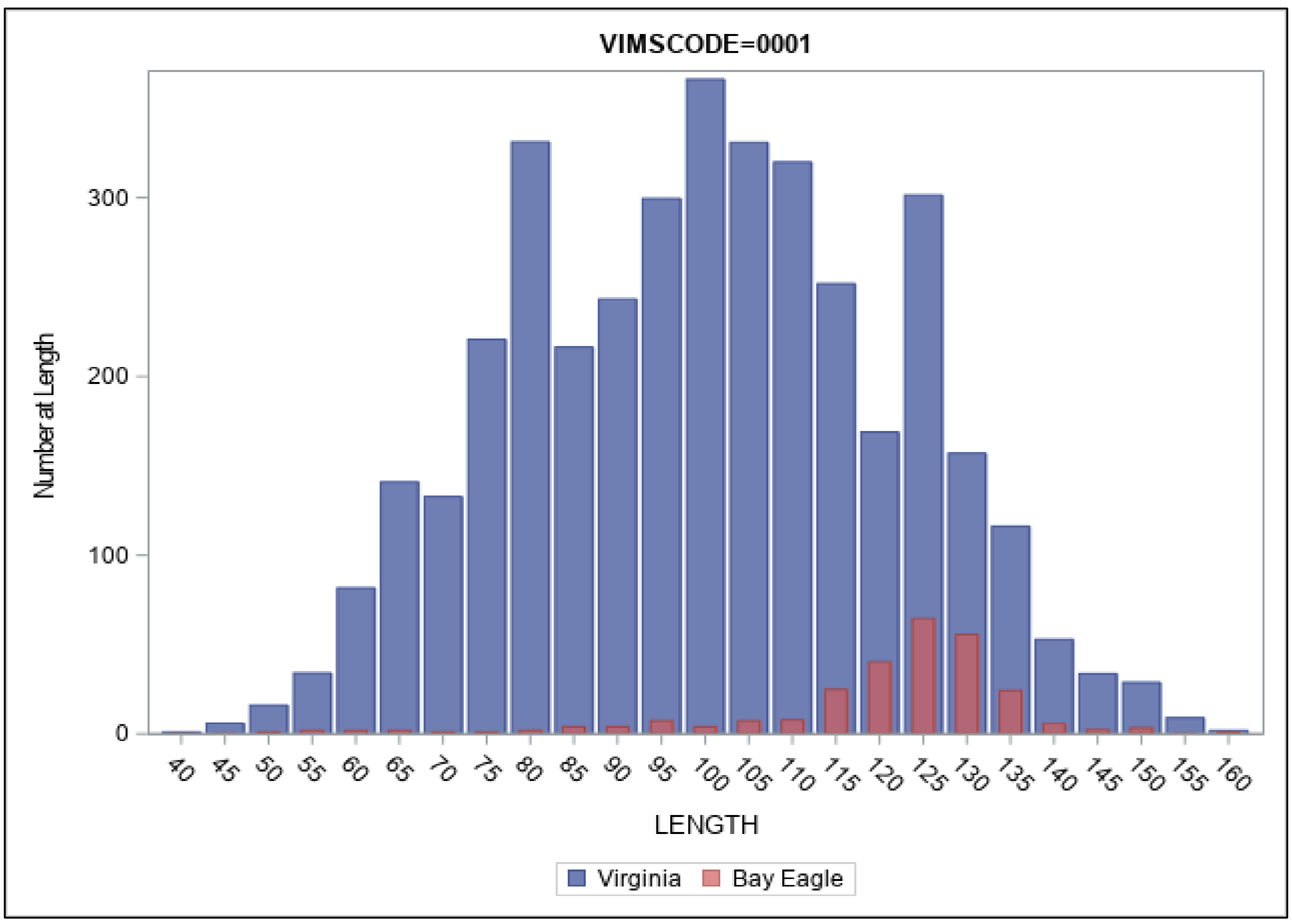


Figure 85. Preliminary comparison of catch rates during calibration tows for Spot, 0 – 140mm.

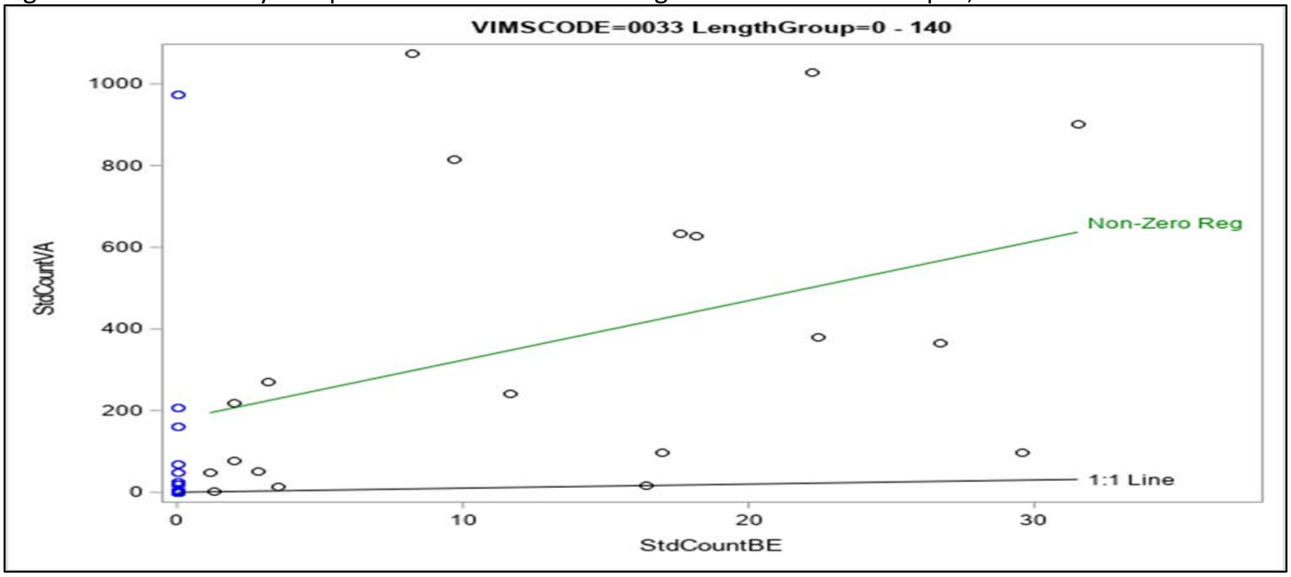
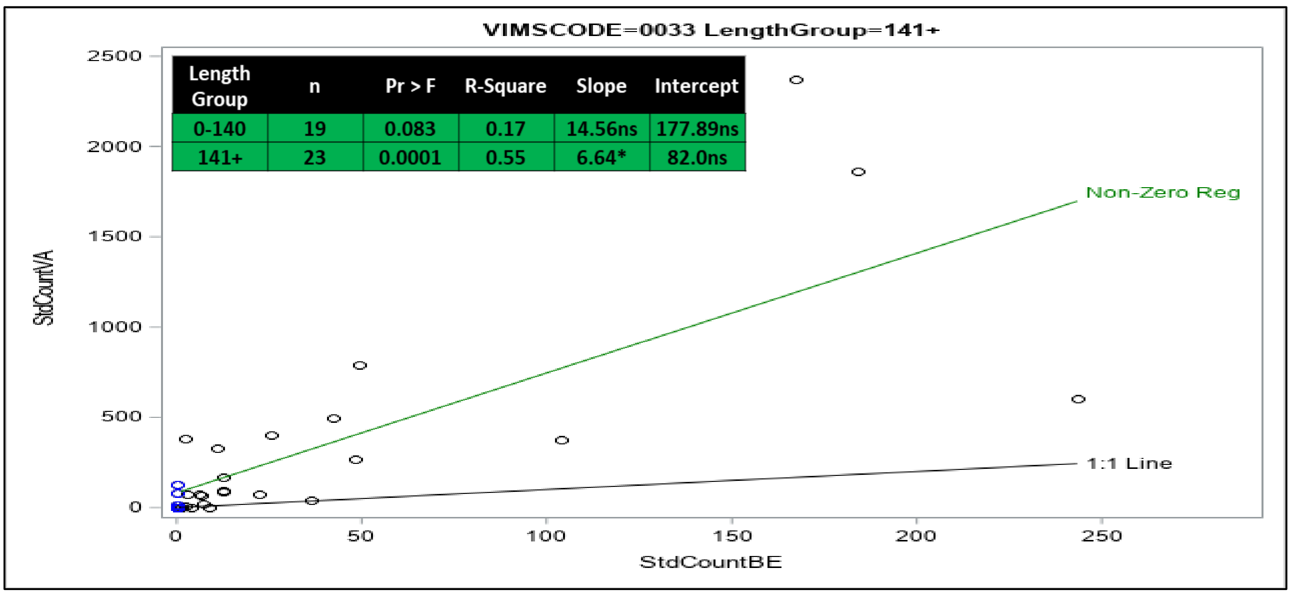


Figure 86. Preliminary comparison of catch rates during calibration tows for Spot, 141+mm.



Length Group	n	Pr > F	R-Square	Slope	Intercept
0-140	19	0.083	0.17	14.56ns	177.89ns
141+	23	0.0001	0.55	6.64*	82.0ns

Figure 87. Comparison of length frequency distributions during calibration tows for Spot.

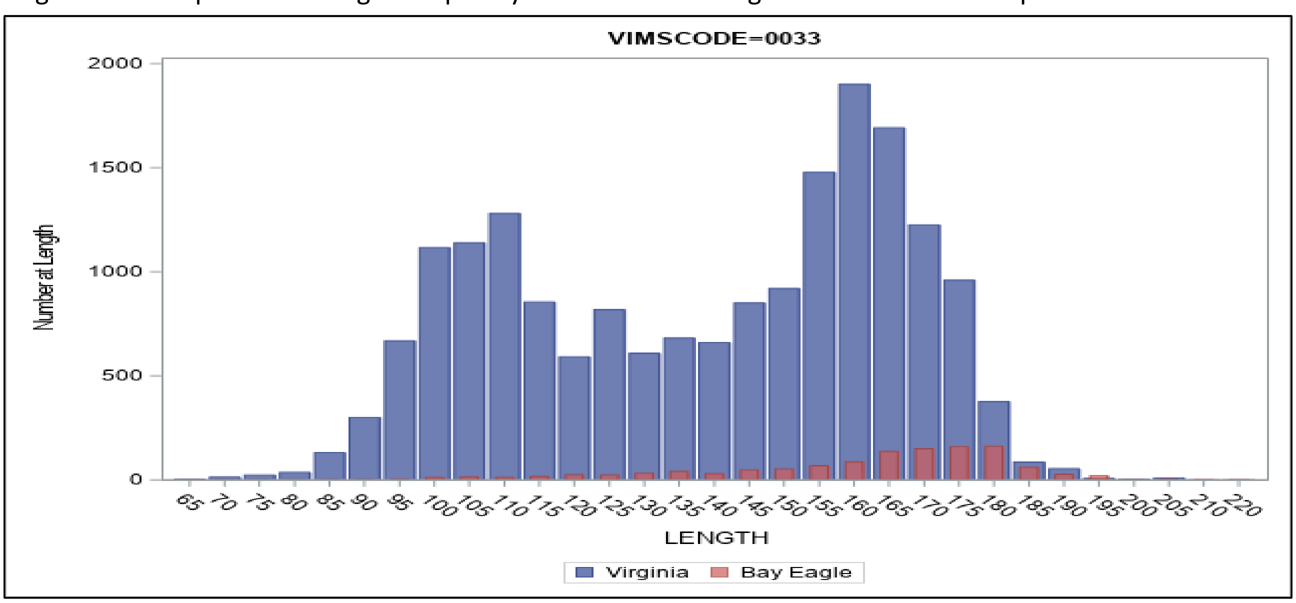
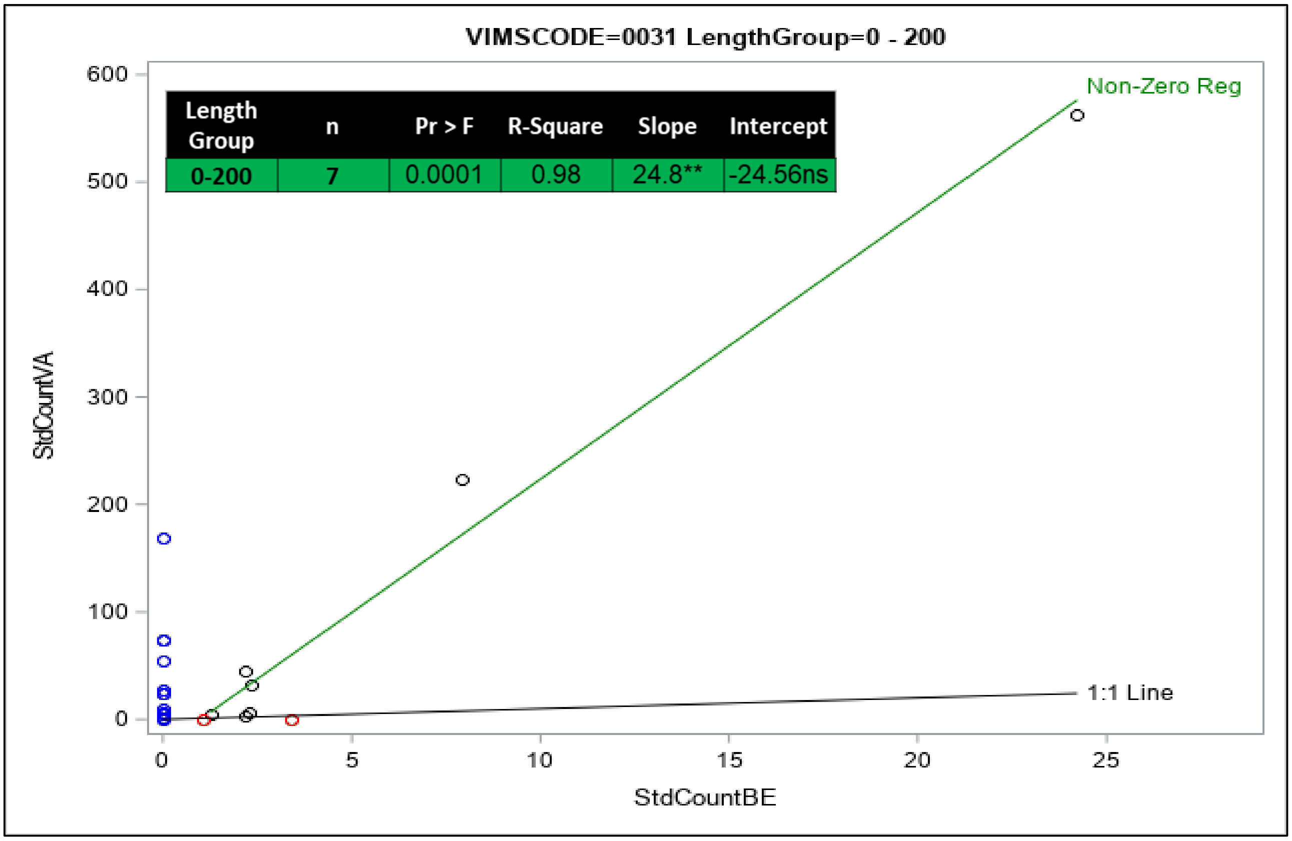
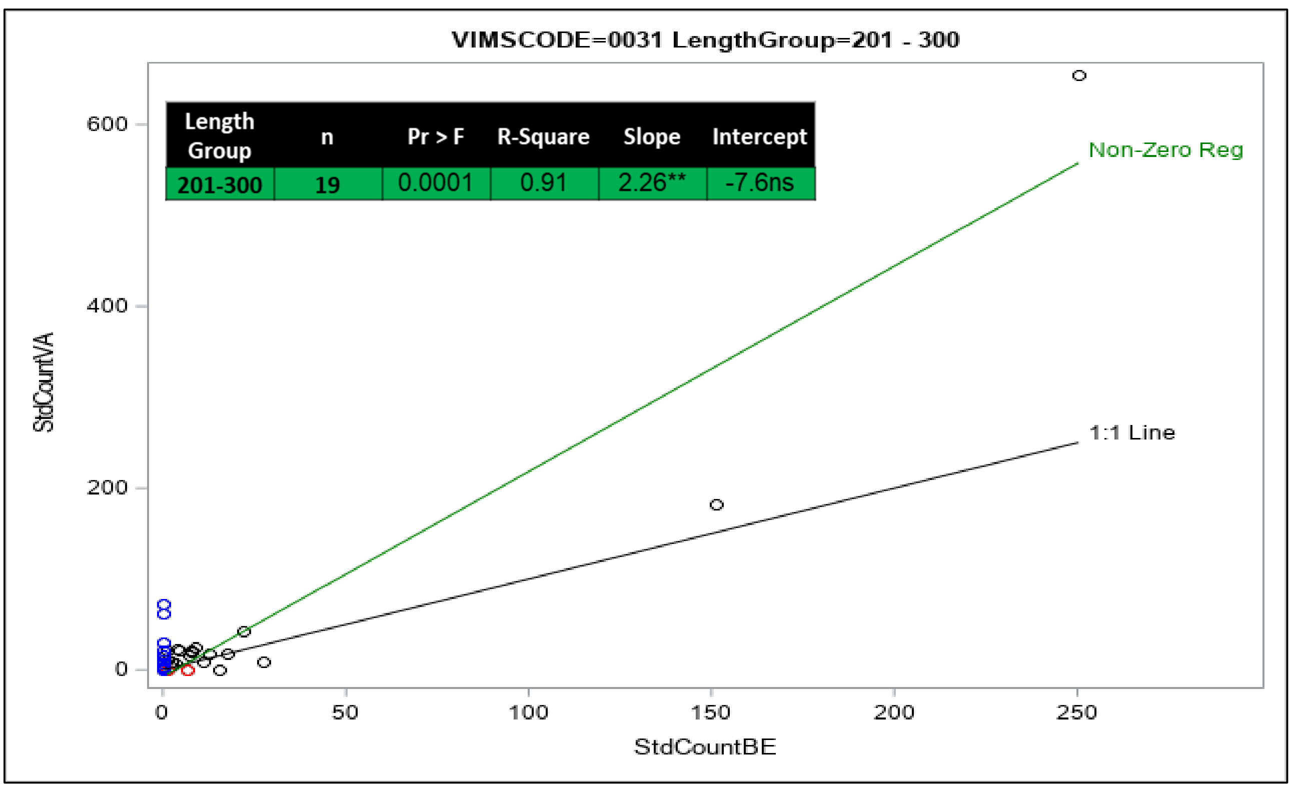


Figure 88. Preliminary comparison of catch rates during calibration tows for Striped Bass, 0- 200mm.



Length Group	n	Pr > F	R-Square	Slope	Intercept
0-200	7	0.0001	0.98	24.8**	-24.56ns

Figure 89. Preliminary comparison of catch rates during calibration tows for Striped Bass, 201- 300mm.



Length Group	n	Pr > F	R-Square	Slope	Intercept
201-300	19	0.0001	0.91	2.26**	-7.6ns

Figure 90. Preliminary comparison of catch rates during calibration tows for Striped Bass, 301+mm.

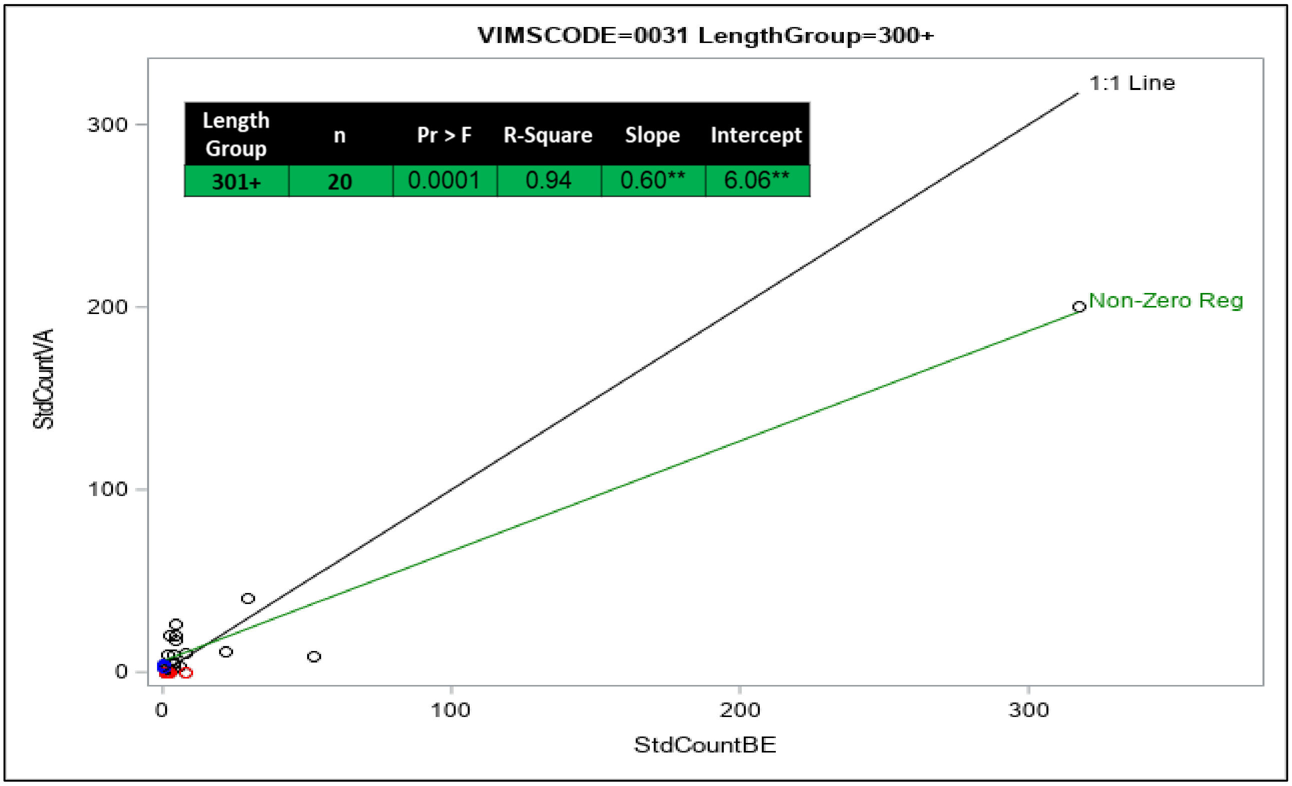


Figure 91. Comparison of length frequency distributions during calibration tows for Scup.

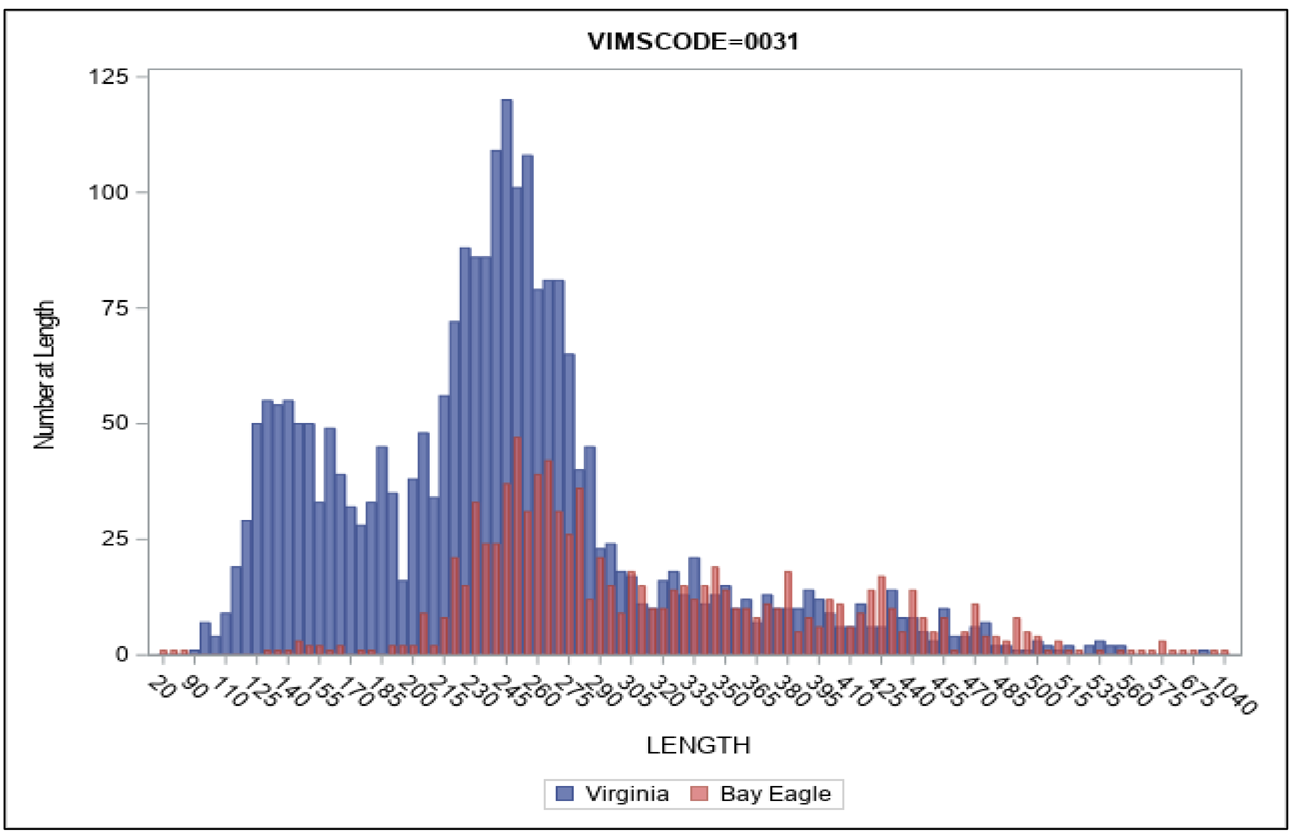
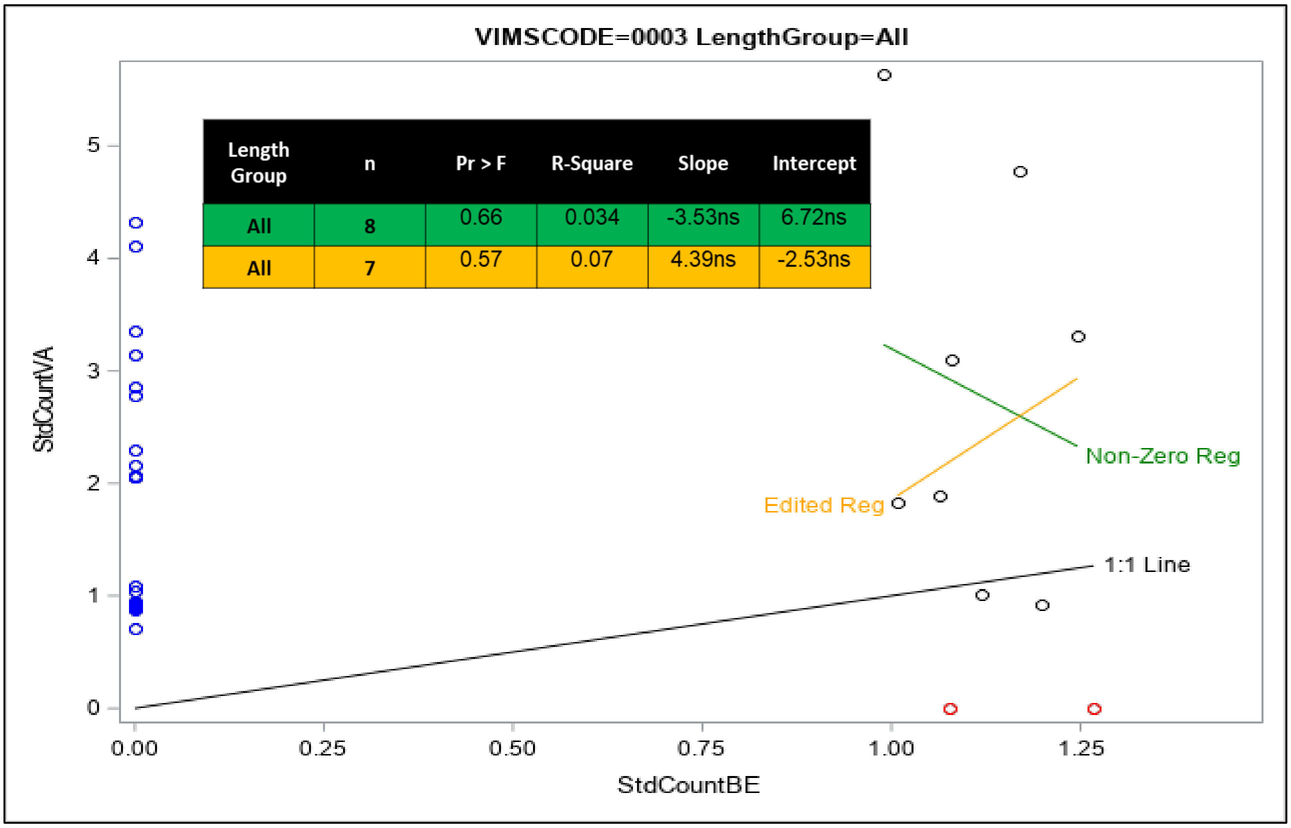


Figure 92. Preliminary comparison of catch rates during calibration tows for Summer Flounder, all sizes.



Length Group	n	Pr > F	R-Square	Slope	Intercept
All	8	0.66	0.034	-3.53ns	6.72ns
All	7	0.57	0.07	4.39ns	-2.53ns

Figure 93. Comparison of length frequency distributions during calibration tows for Summer Flounder.

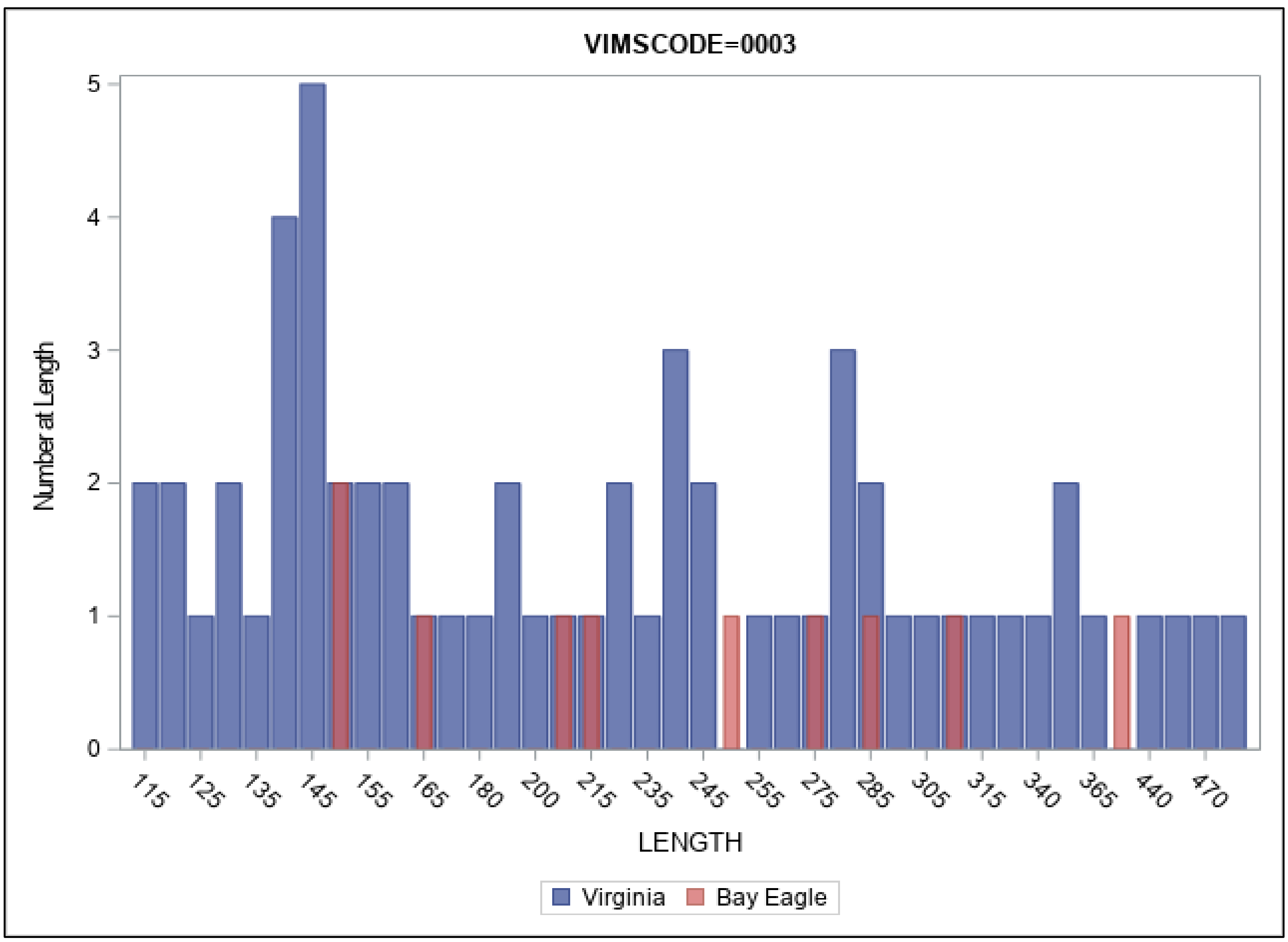


Figure 94. Preliminary comparison of catch rates during calibration tows for Weakfish, all sizes.

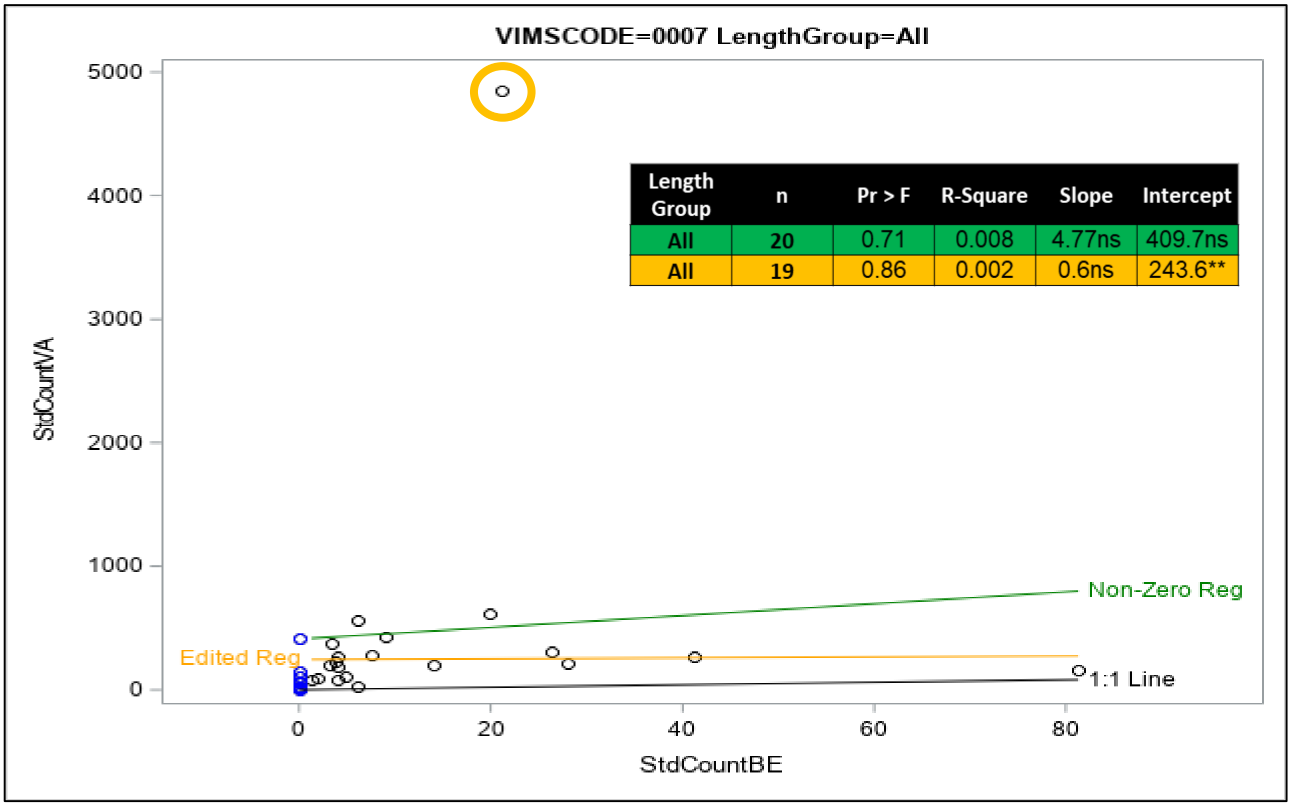


Figure 95. Comparison of length frequency distributions during calibration tows for Weakfish.

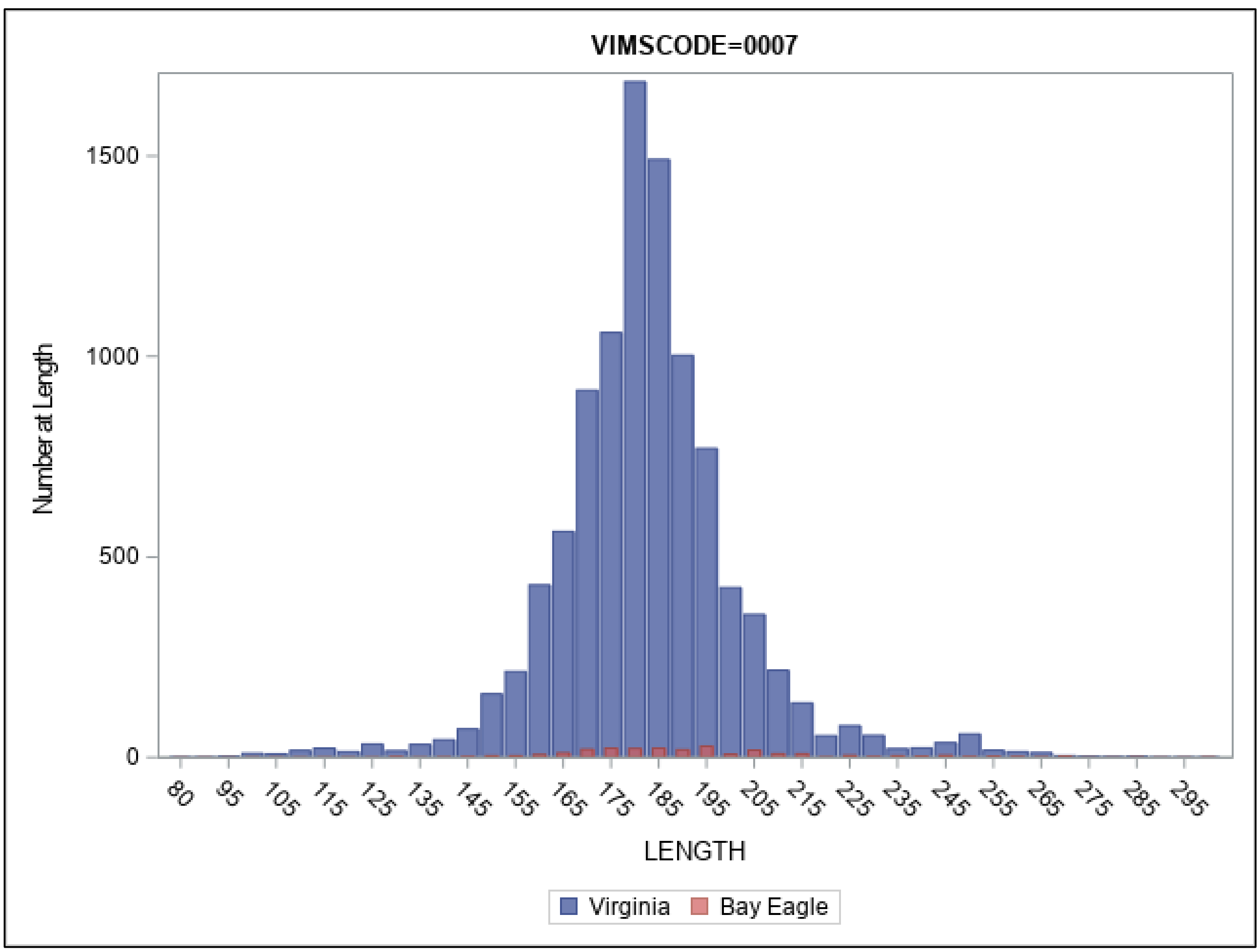


Figure 96. Preliminary comparison of catch rates during calibration tows for White Perch, 0 – 190mm.

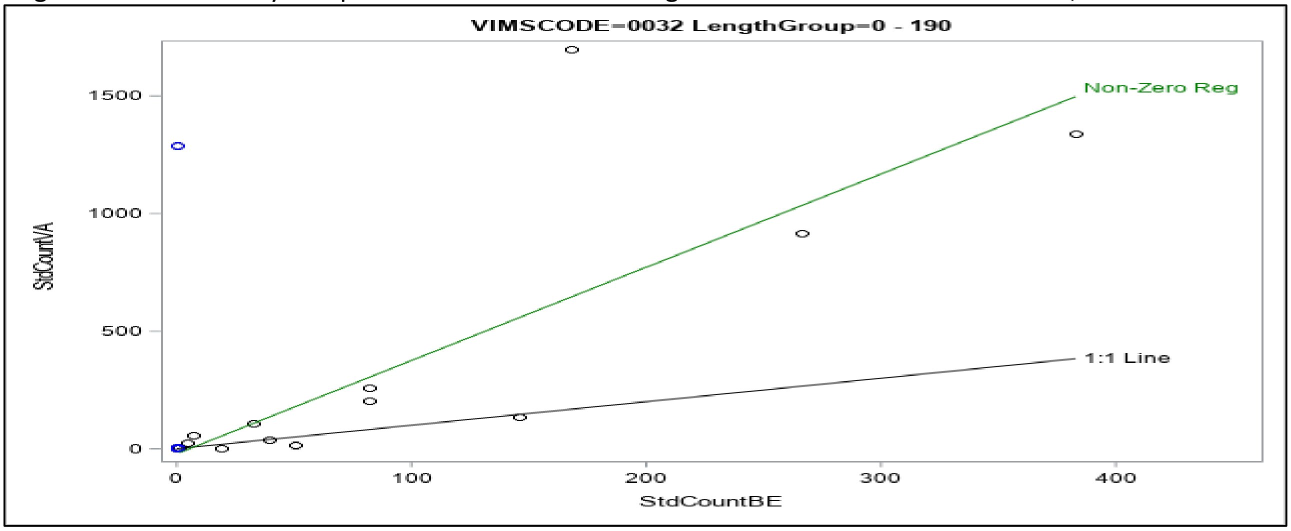


Figure 97. Preliminary comparison of catch rates during calibration tows for White Perch, 0 – 190mm.

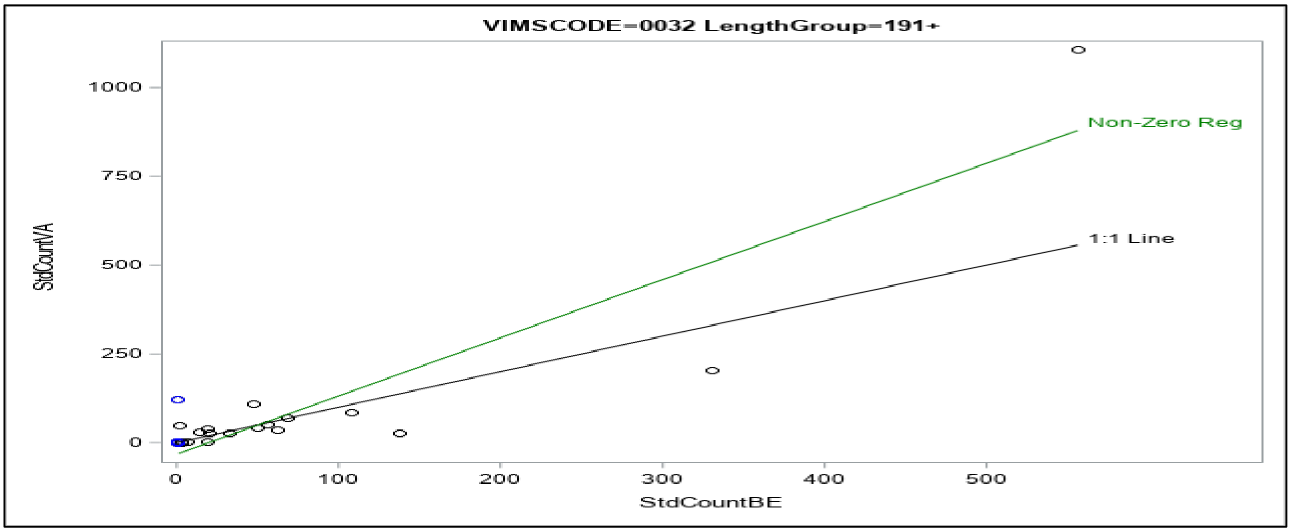


Figure 98. Comparison of length frequency distributions during calibration tows for White Perch.

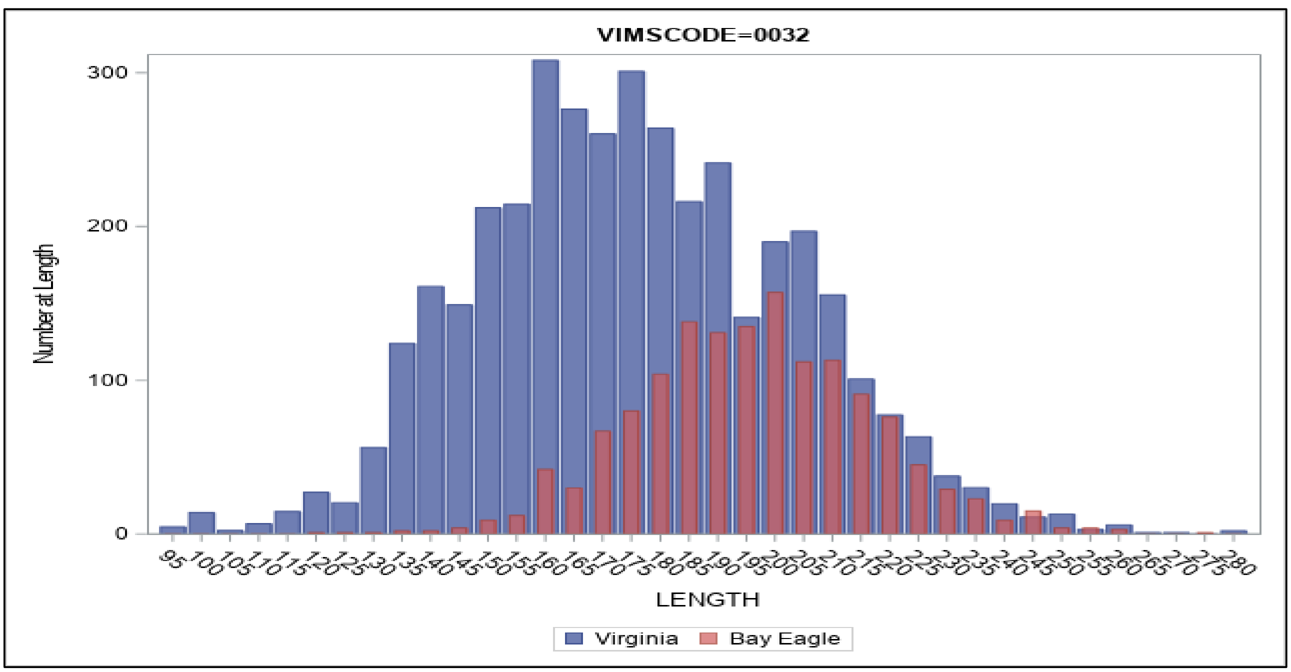


Figure 99. Interpolated Chesapeake Bay bottom water temperature by cruise for 2019 (A), averaged over 2002 through 2019 (B), and 2019 deviation from average (C).

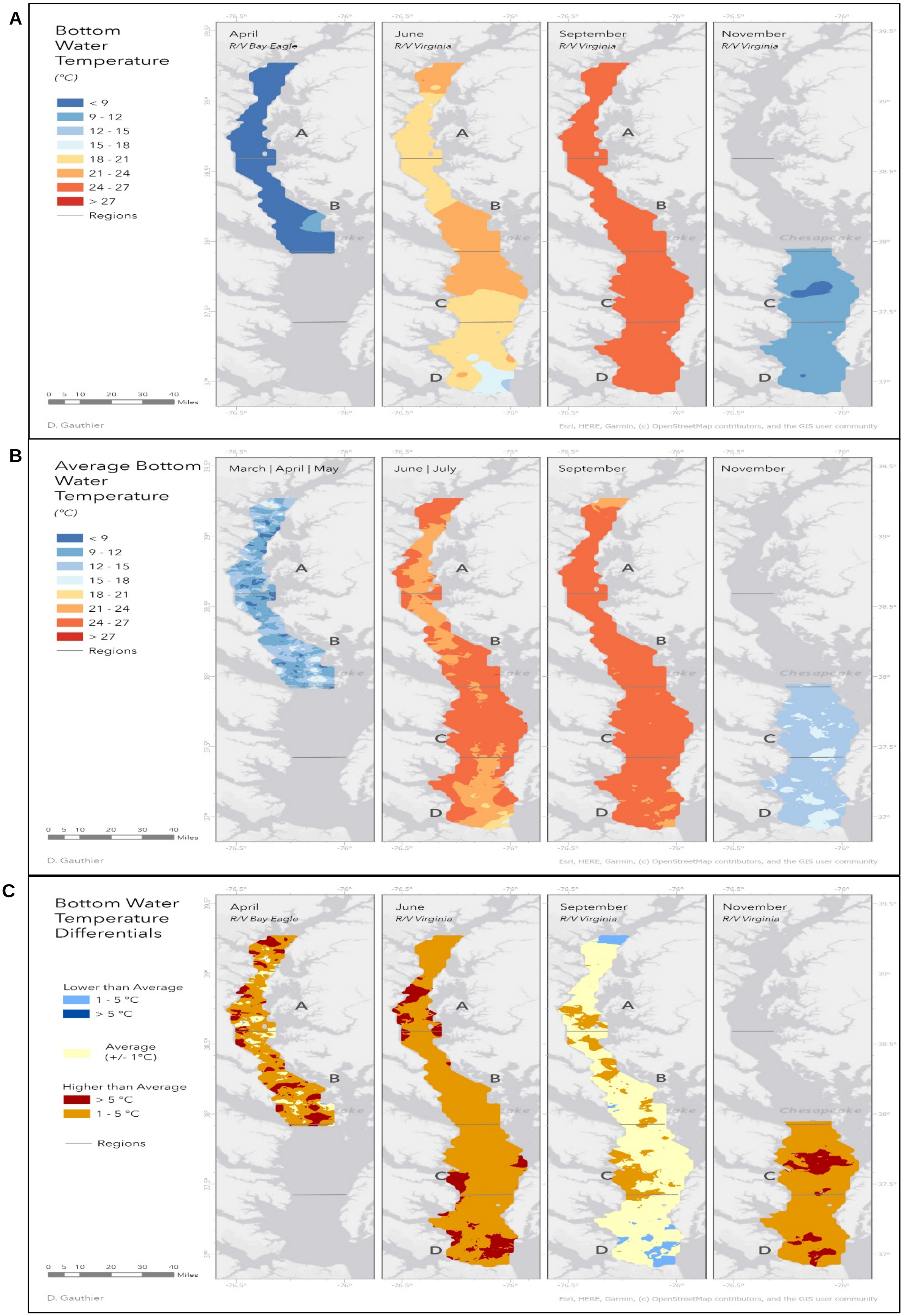


Figure 100. Interpolated Chesapeake Bay bottom salinity by cruise for 2019 (A), averaged over 2002 through 2019 (B), and 2019 deviation from average (C).

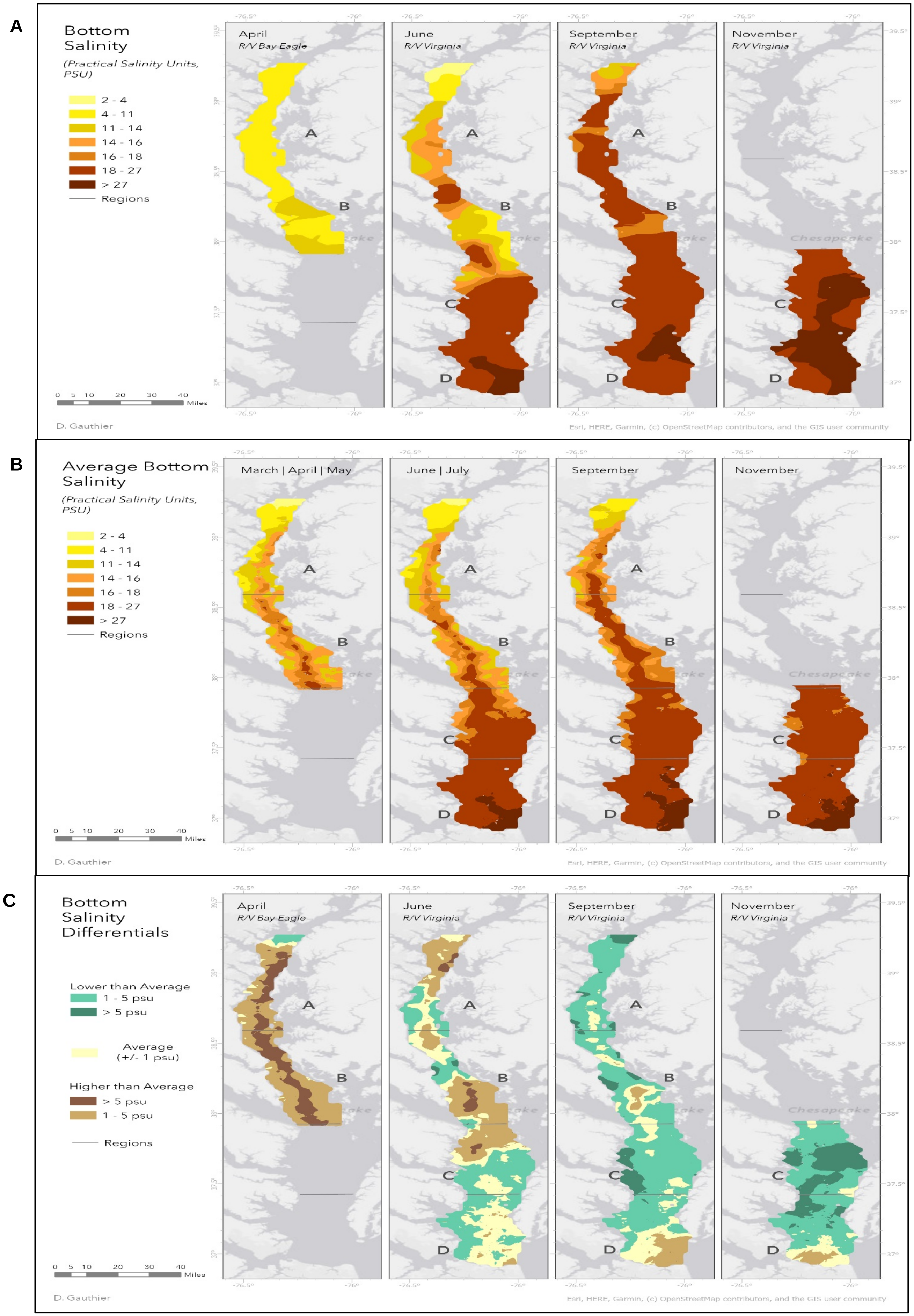


Figure 101. Interpolated Chesapeake Bay bottom dissolved oxygen by cruise for 2019 (A), averaged over 2002 through 2019 (B), and 2019 deviation from average (C).

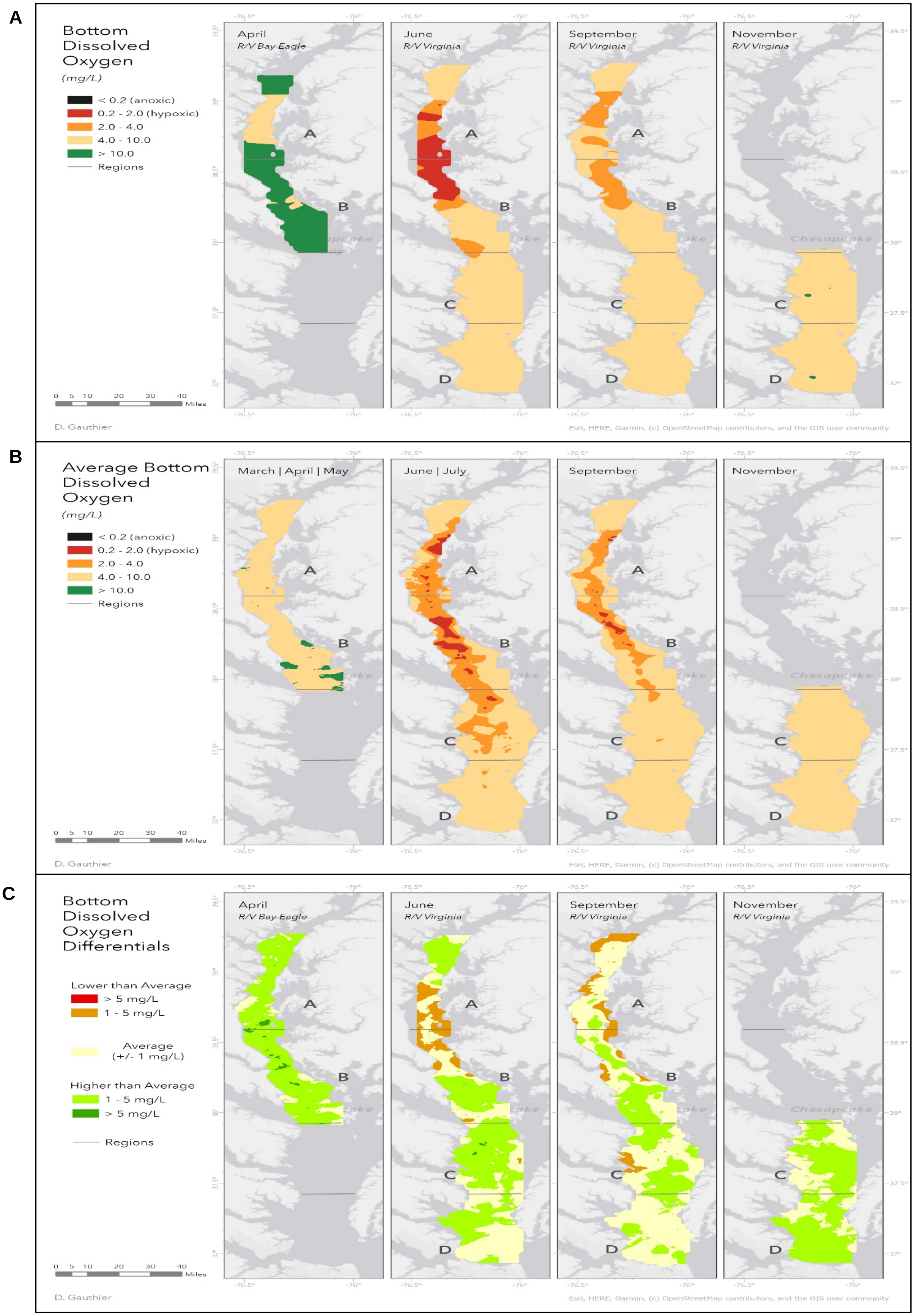


Figure 102. Interpolated bi-monthly water temperature profiles in Chesapeake Bay, 2019.

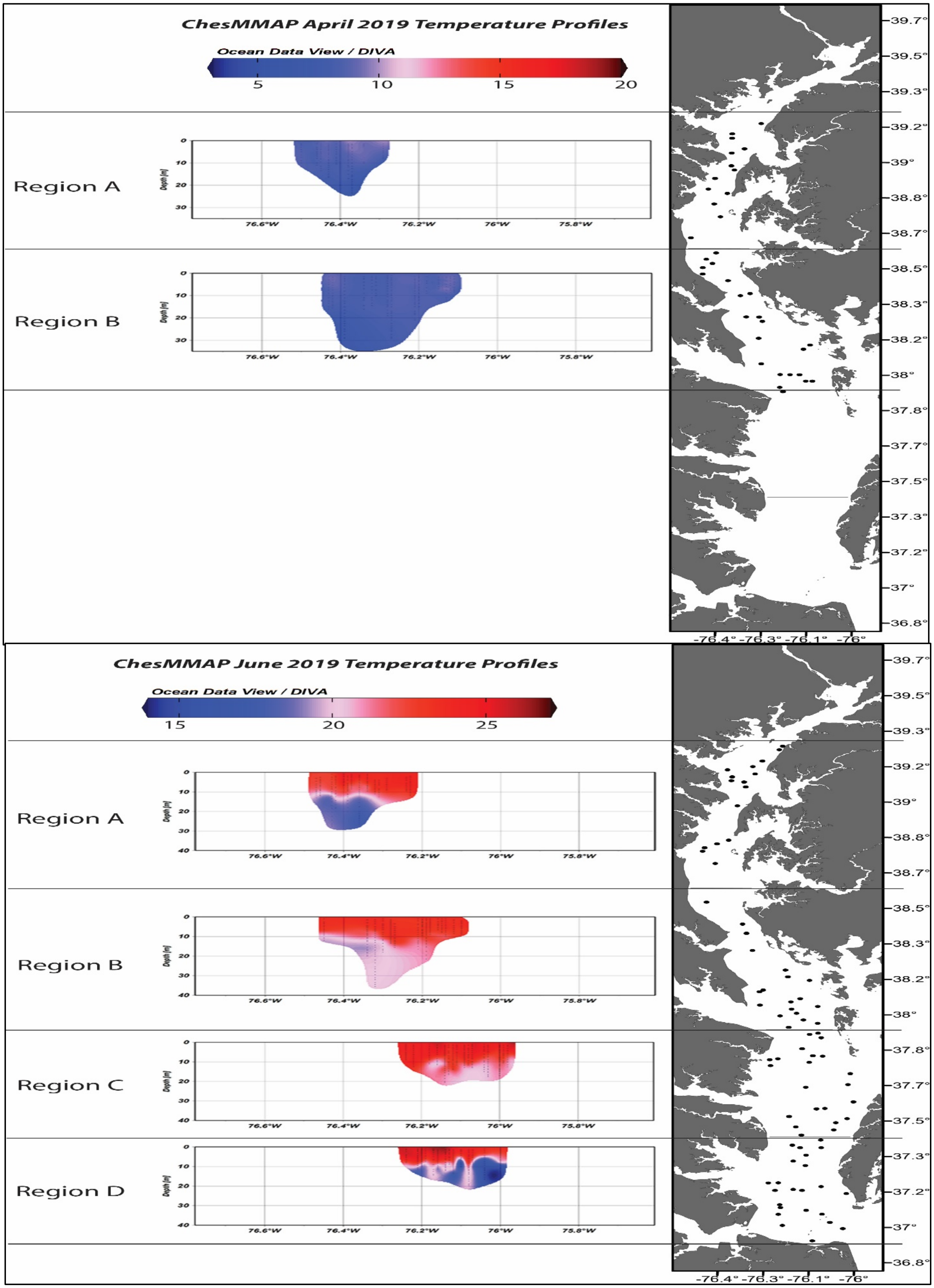
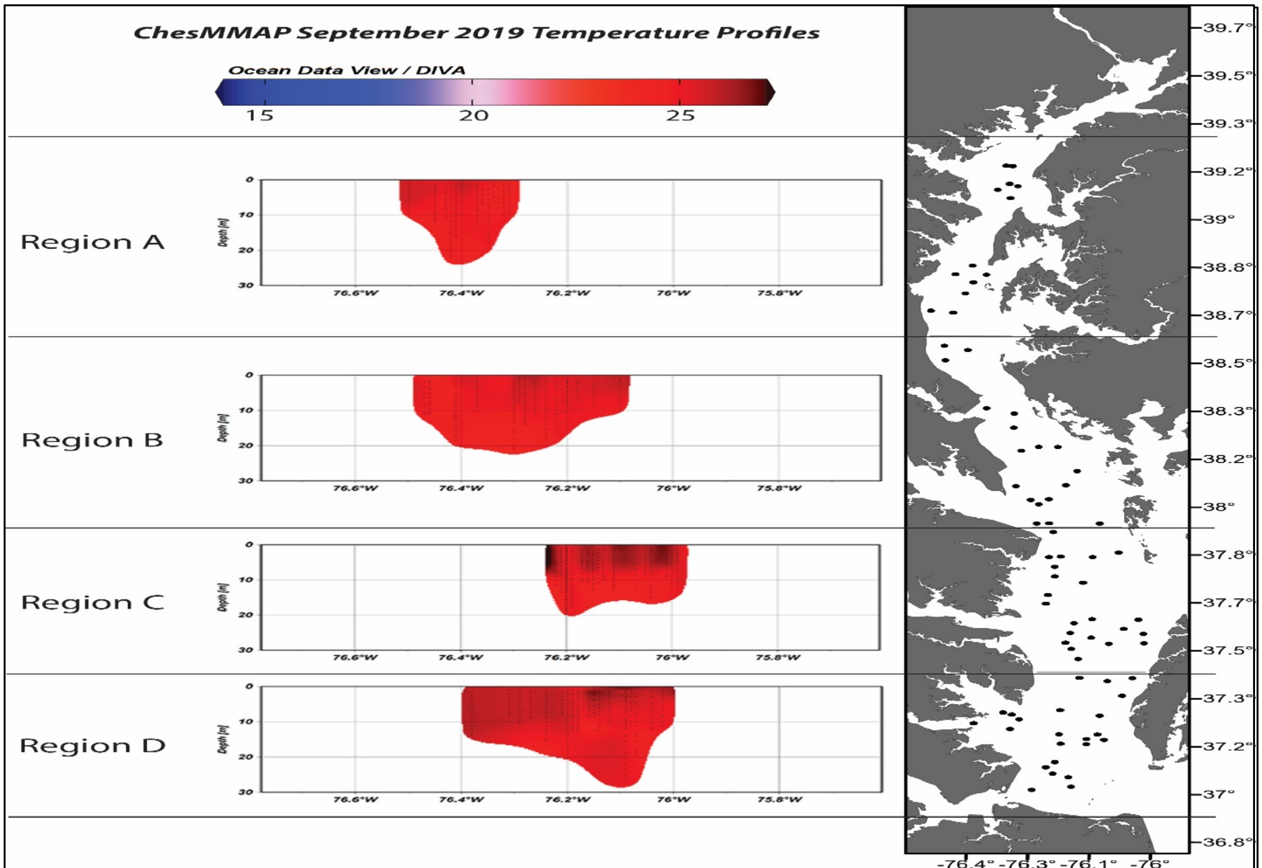


Figure 102. cont.



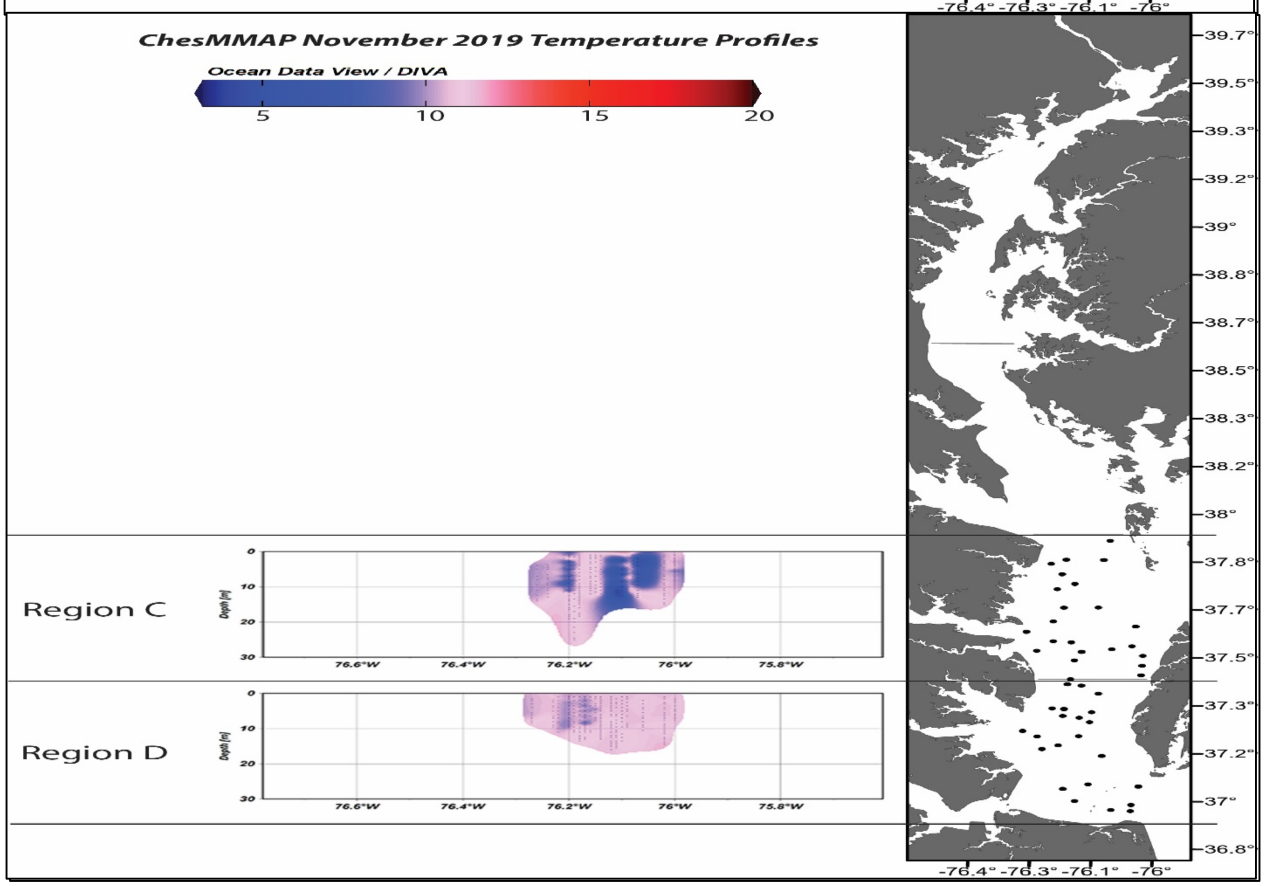


Figure 103. Interpolated bi-monthly salinity profiles in Chesapeake Bay, 2019.

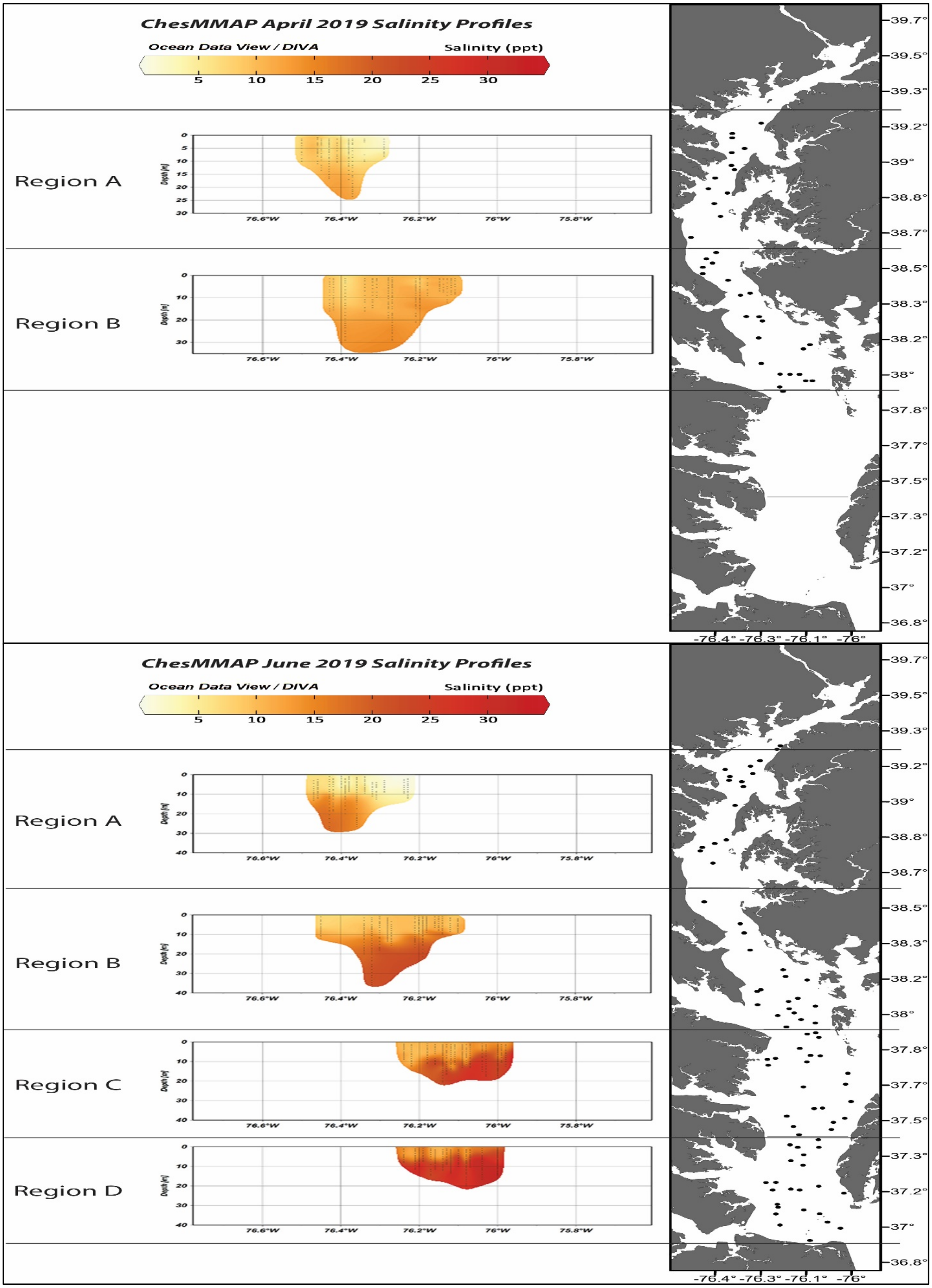


Figure 103. cont.

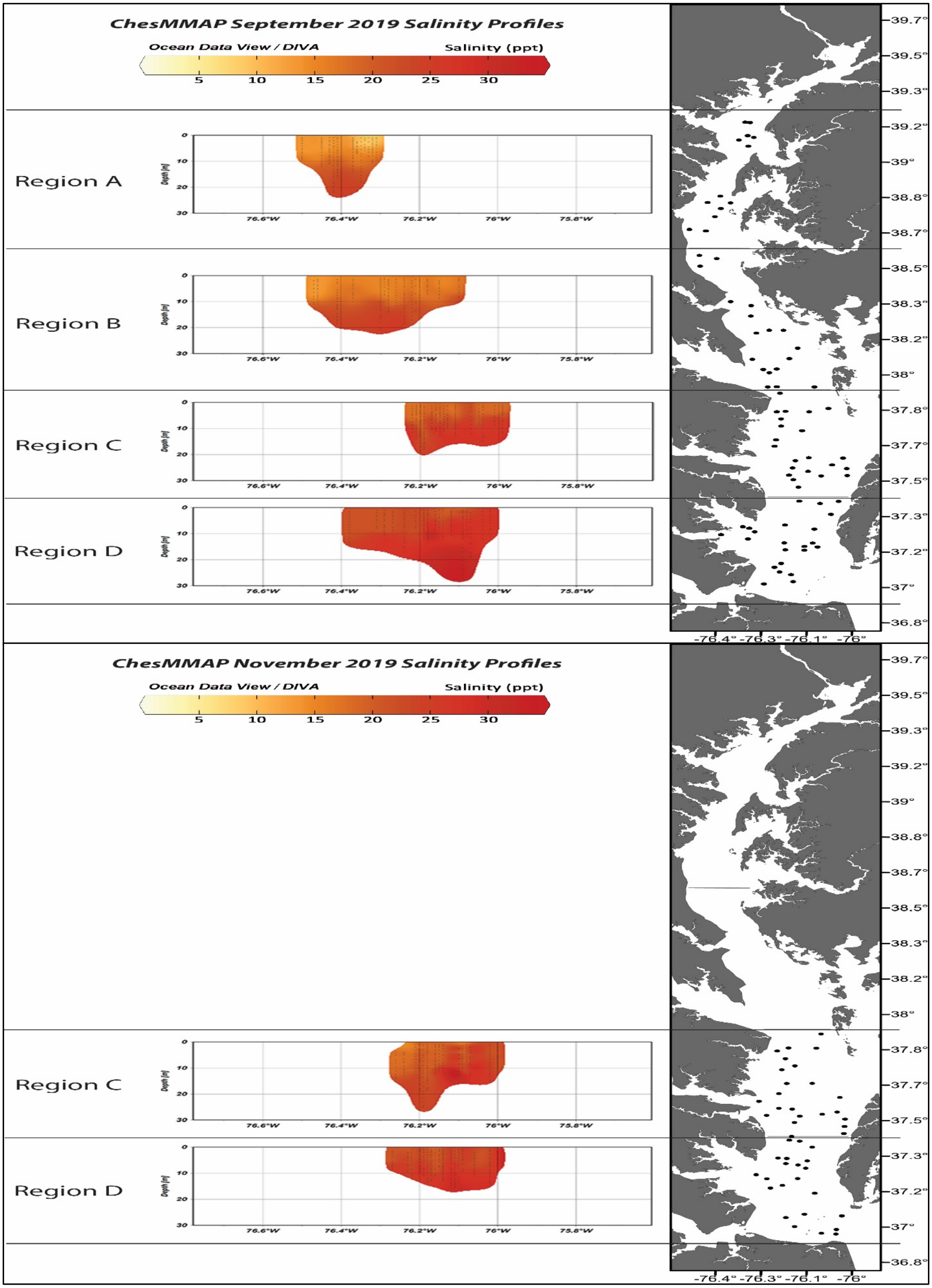


Figure 104. Interpolated bi-monthly dissolved oxygen profiles in Chesapeake Bay, 2019.

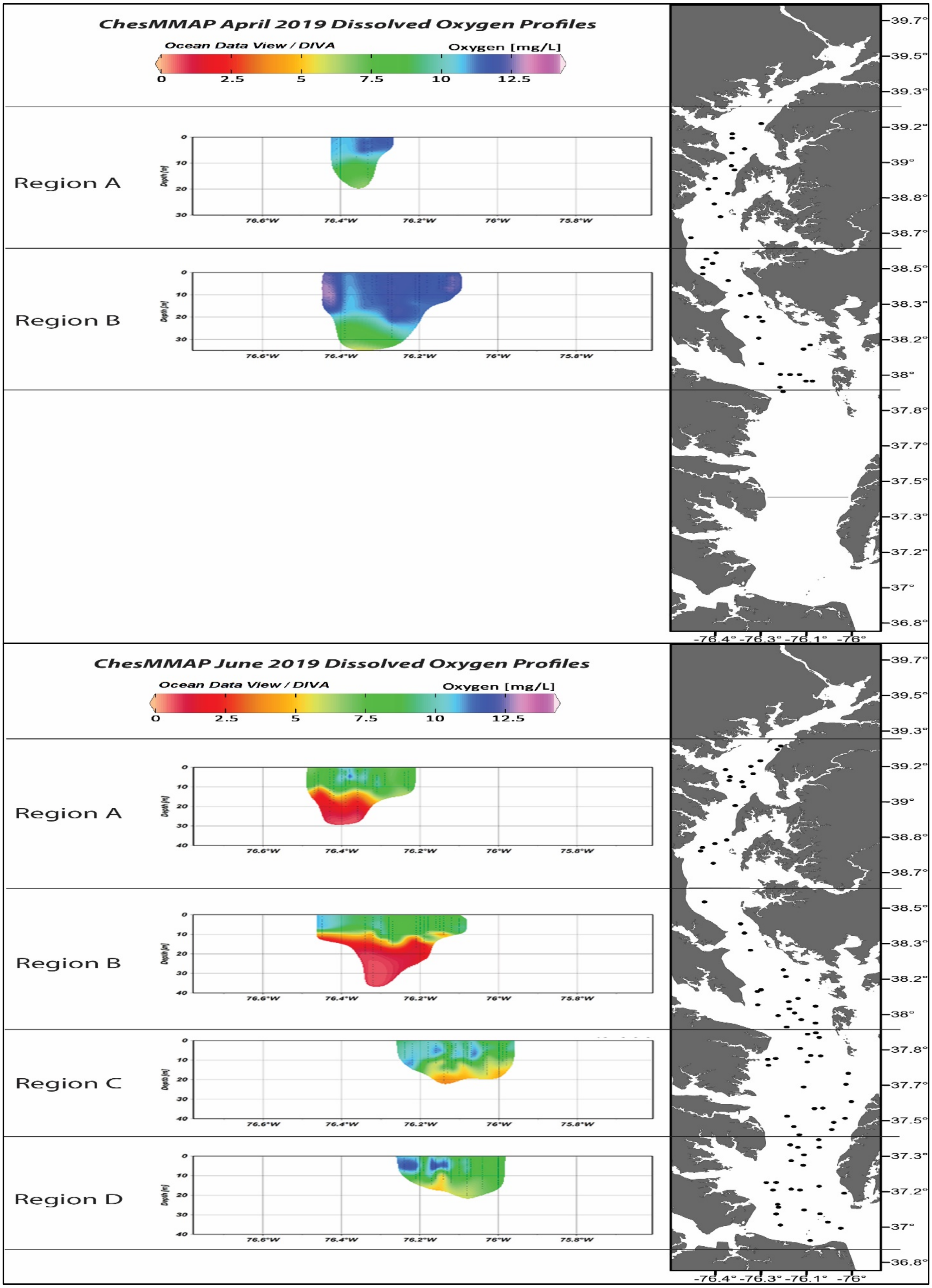
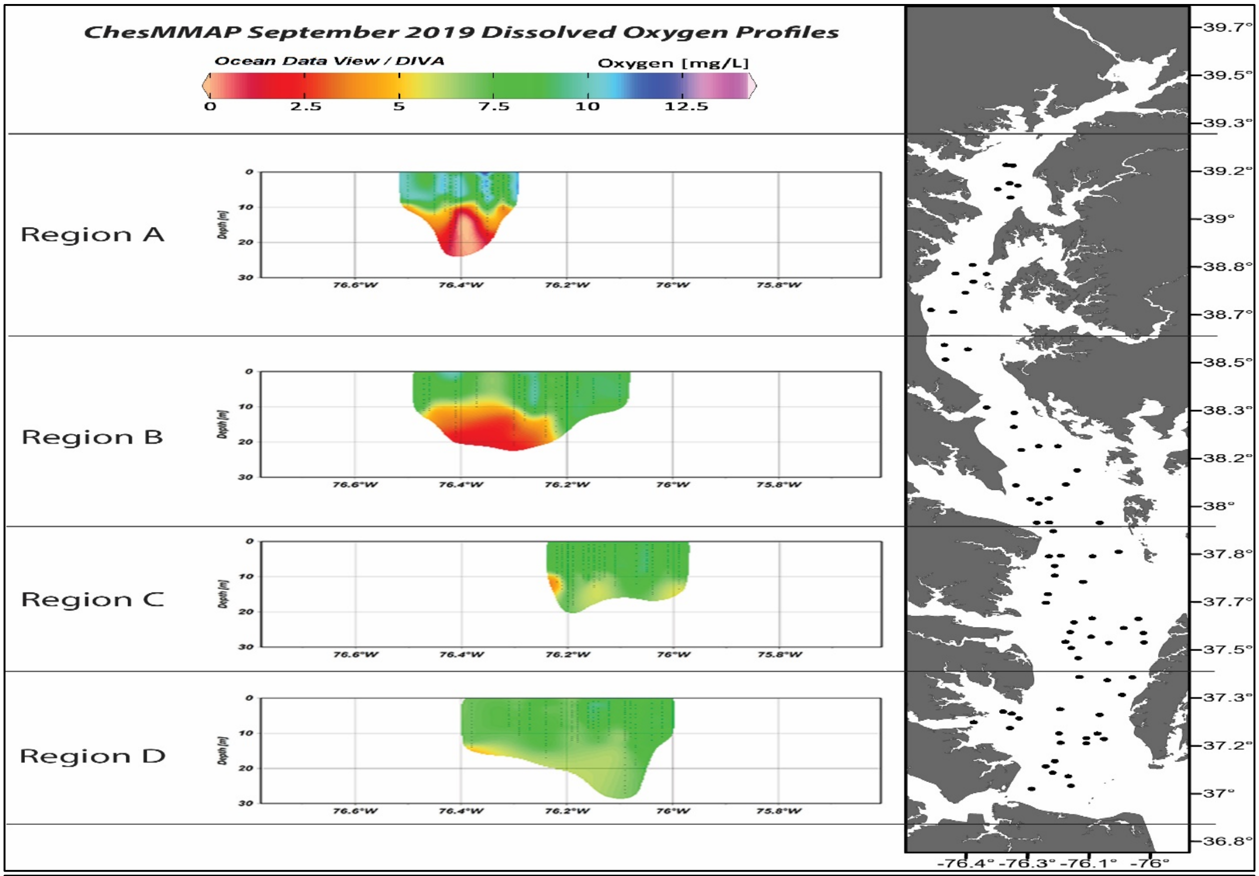
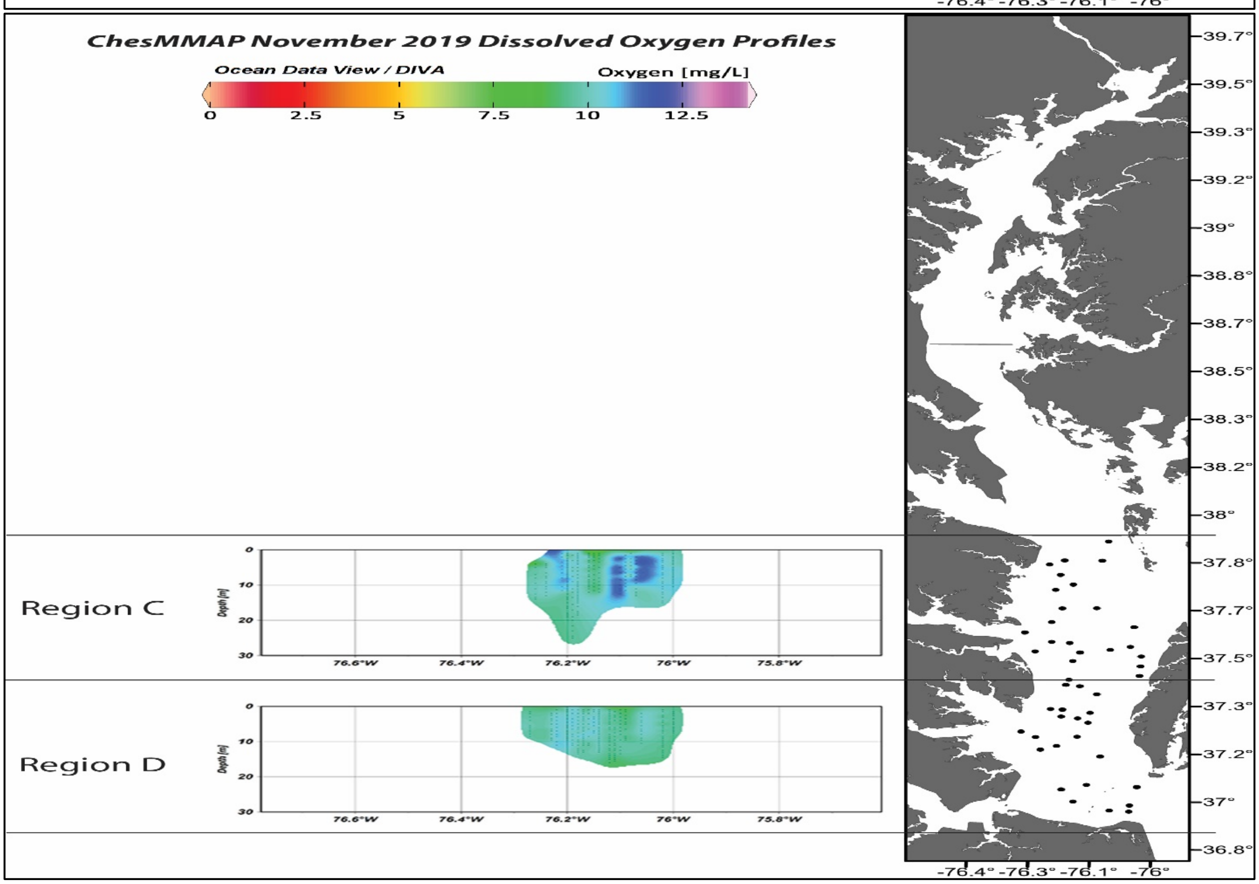


Figure 104. cont.





Appendix

Blue Crab and Clearnose Skate Abundance

Table A1. Blue Crab male (A) and mature female (B) geometric mean indices of abundance, by number and biomass, overall .

A

Year	Age	n	Numerical Index			Biomass Index		
			LCI	**Index**	UCI	LCI	**Index**	UCI
2002	All	116	0.740	1.000	1.290	0.180	0.250	0.320
2003		110	0.720	1.010	1.360	0.190	0.280	0.370
2004		117	0.430	0.620	0.830	0.100	0.160	0.220
2005		115	0.830	1.230	1.710	0.220	0.360	0.510
2006		108	1.150	1.510	1.920	0.250	0.340	0.440
2007		56	0.340	0.610	0.950	0.080	0.150	0.230
2008		118	1.000	1.390	1.850	0.210	0.350	0.490
2009		116	0.730	1.040	1.420	0.190	0.280	0.380
2010		117	1.690	2.230	2.870	0.430	0.580	0.740
2011		116	0.990	1.430	1.970	0.240	0.350	0.470
2012		112	0.400	0.640	0.930	0.100	0.170	0.240
2013		118	0.030	0.080	0.150	0.000	0.020	0.030
2014		118	0.090	0.200	0.310	0.020	0.050	0.090
2015		118	0.640	0.910	1.230	0.170	0.250	0.330
2016		118	0.870	1.290	1.820	0.260	0.390	0.520
2017		118	0.220	0.370	0.550	0.060	0.110	0.160
2018		95	0.430	0.680	0.960	0.110	0.170	0.240
2019		78	0.140	0.250	0.380	0.030	0.060	0.090
2020								

B

Year	Age	n	Numerical Index			Biomass Index		
			LCI	**Index**	UCI	LCI	**Index**	UCI
2002	All	40	2.24	4.1	7.14	0.50	1.0	1.64
2003		60	2.95	4.4	6.31	0.62	0.9	1.25
2004		46	1.33	2.2	3.33	0.31	0.5	0.77
2005		45	4.91	7.7	11.83	1.04	1.6	2.22
2006		41	3.80	5.6	8.17	0.67	1.0	1.29
2007		44	0.83	1.5	2.54	0.21	0.4	0.60
2008		45	7.40	10.4	14.44	1.35	1.9	2.51
2009		45	2.54	4.3	6.85	0.57	1.0	1.43
2010		45	4.95	7.8	12.04	1.14	1.7	2.36
2011		44	3.16	4.7	6.76	0.64	0.9	1.21
2012		39	1.66	3.2	5.55	0.39	0.8	1.20
2013		44	0.92	1.7	2.83	0.22	0.4	0.70
2014		45	0.50	0.9	1.43	0.11	0.2	0.30
2015		45	4.03	6.5	10.06	0.86	1.3	1.91
2016		45	3.97	6.5	10.37	0.95	1.5	2.27
2017		45	0.46	1.0	1.62	0.13	0.3	0.44
2018		45	2.07	3.9	6.66	0.53	1.1	1.73
2019		45	3.14	4.4	6.02	0.52	0.7	0.93
2020								

Figure A1. Blue Crab male (A) and mature female (B) geometric mean indices of abundance, by number and biomass.

A **B**

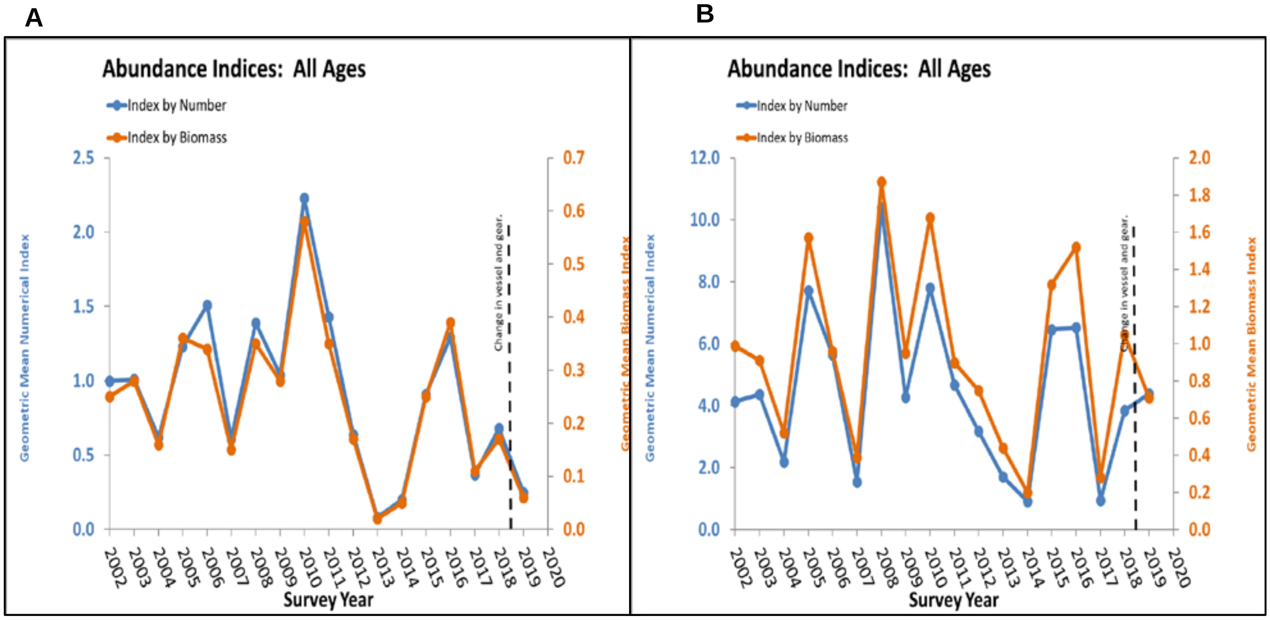
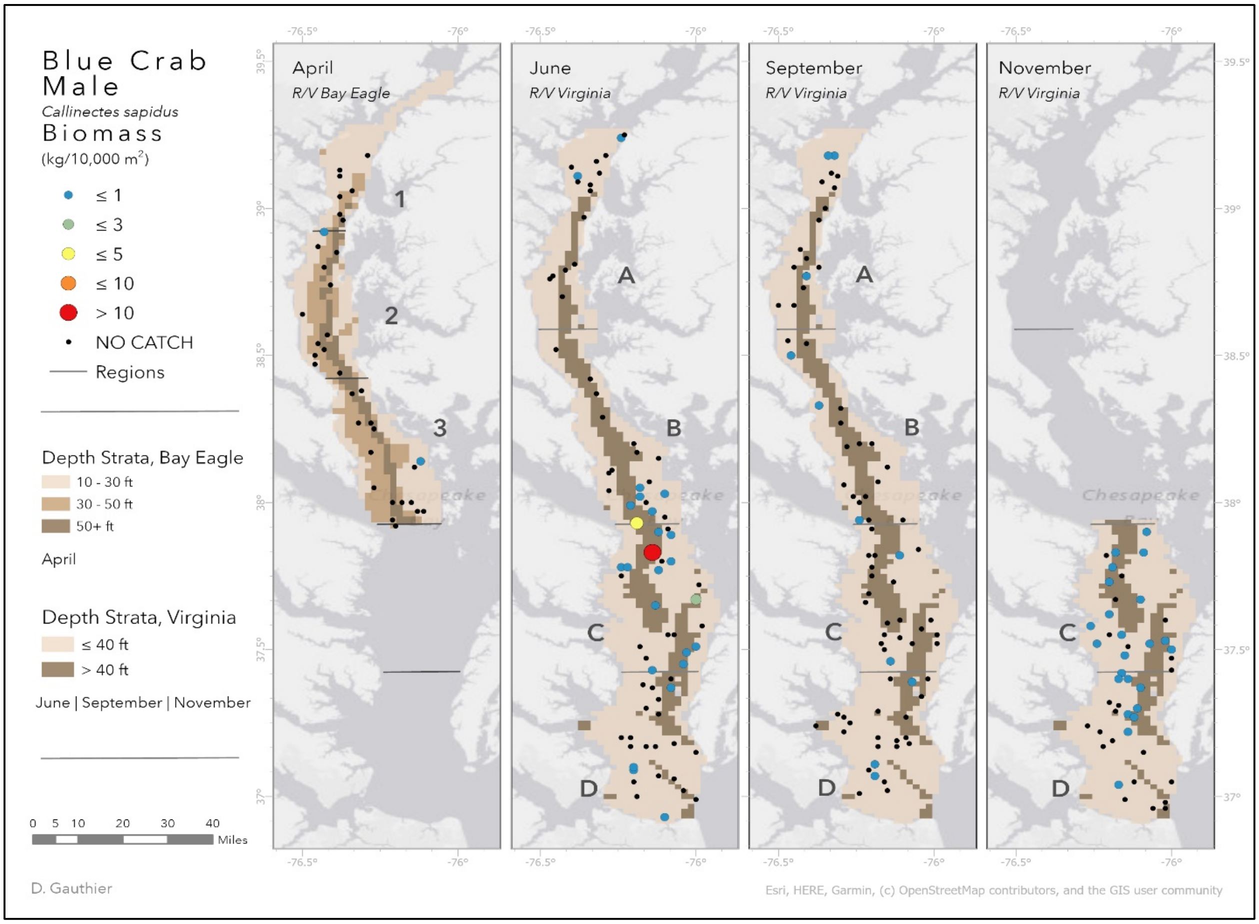


Figure A2. Abundance (kg per hectare swept) of Blue Crab males (A) and mature females (B) in Chesapeake Bay, 2019.

A



B

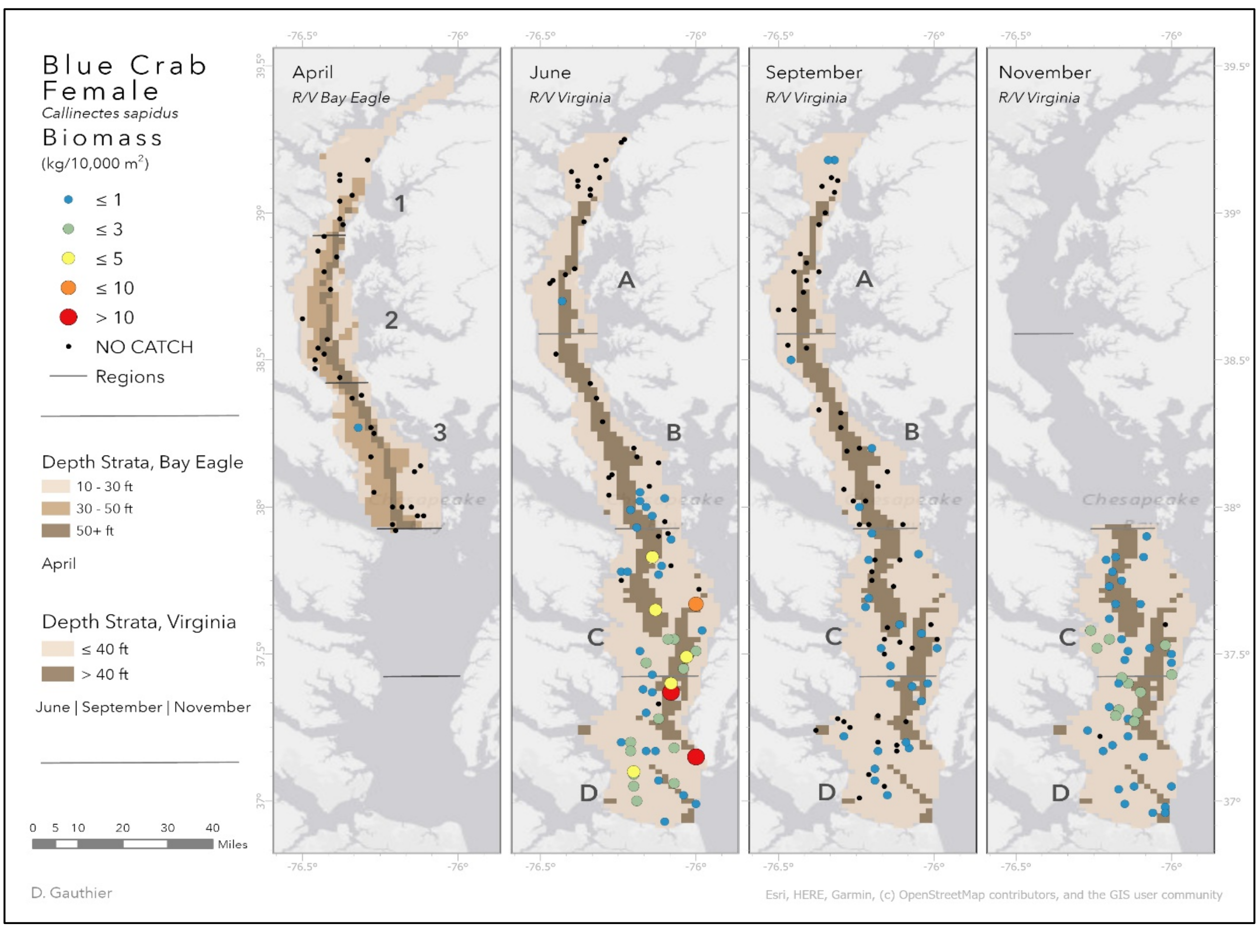


Figure A3. Clearnose Skate geometric mean indices of abundance, by number and biomass.

Year	Age	n	Numerical Index			Biomass Index		
			LCI	**Index**	UCI	LCI	**Index**	UCI
2002	All	79	0.32	0.5	0.76	0.42	0.7	1.04
2003		75	0.28	0.4	0.60	0.33	0.5	0.75
2004		94	0.09	0.2	0.39	0.12	0.3	0.47
2005		82	0.26	0.5	0.67	0.31	0.6	0.85
2006		75	0.79	1.2	1.77	1.02	1.6	2.29
2007		62	0.56	1.1	1.77	0.75	1.4	2.28
2008		84	0.45	0.7	1.08	0.62	1.0	1.49
2009		63	0.57	1.0	1.58	0.80	1.4	2.26
2010		84	0.63	1.0	1.48	0.84	1.4	2.02
2011		83	0.71	1.1	1.66	0.97	1.5	2.29
2012		82	0.24	0.5	0.76	0.32	0.6	1.00
2013		83	0.18	0.4	0.58	0.22	0.4	0.71
2014		84	0.08	0.3	0.44	0.11	0.3	0.57
2015		84	0.26	0.5	0.75	0.32	0.6	0.91
2016		84	0.41	0.7	1.12	0.49	0.9	1.34
2017		84	0.21	0.4	0.67	0.26	0.5	0.82
2018		84	0.17	0.3	0.54	0.20	0.4	0.65
2019		69	0.32	0.6	0.88	0.39	0.7	1.07
2020								

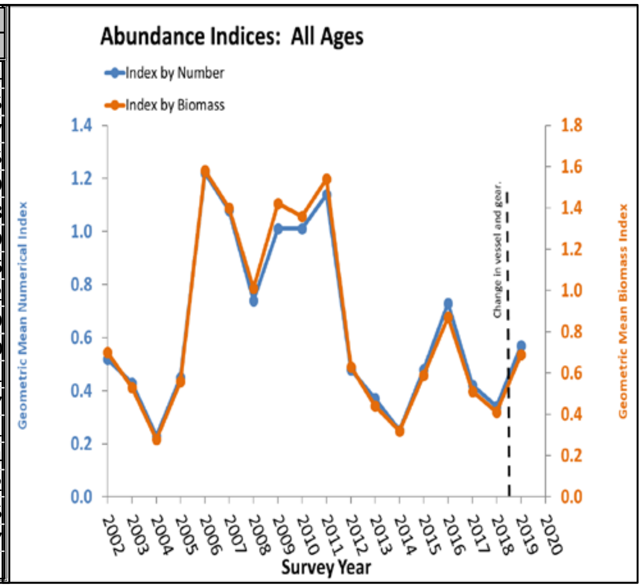


Figure A4. Abundance (kg per hectare swept) of Clearnose Skate in Chesapeake Bay, 2019.