Trends in relative abundance of reef fishes in fishery-independent surveys in waters off the southeastern United States

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Standardized CPUE Based on the
Southeast Reef Fish Survey Chevron Trap (1990-2019) and the
MARMAP/ SEAMAP-SA Short Bottom Longline (1996-2019) and
Long Bottom Longline Surveys (1996-2011 and 2015-2016)

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Introduction

This annual trends report is meant to serve as an overview of catches of selected snapper-grouper species from a collaboration of fishery-independent surveys (MARMAP, SEAMAP-SA, and SEFIS) using a variety of gears. As such, it should not be considered an update of stock status. For a full stock status update other inputs including, but not limited to, landings, length and age compositions, and life history parameters are needed. Abundance indices developed for this report are standardized to account for factors that may affect the abundances and have varied over the years such as temperature, depth of sampled stations, etc. (see details below). Note that constraints, stratification, units, years used, and models for standardization of catch per unit effort (CPUE) used in this report may be different from those used in (SEDAR) stock assessments, but for ease of visualization and consistency purposes, abundance indices developed for this report are standardized using similar procedures among species. In addition, it is worth noting that the status of many of the species in this report have not been assessed or updated recently (via SEDAR or other assessment processes), which means there is no pre-existing assessment framework.

Fishery-Independent Monitoring

Fishery-independent measures of catch (abundance) and effort with standardized gear types and deployment strategies are valuable for monitoring the stock trends, interpreting exploitation information, providing data for stock assessments, and providing context for developing management regulations. These data are particularly valuable in light of increasing regulations such as minimum size limits and quotas imposed on many managed species. Fishery-dependent measures of abundance are affected by management actions and industry practices, making it impossible to separate population level responses from changes in fishery behavior and management actions (Williams and Carmichael 2009), thereby limiting the use of fishery-dependent data for population/stock assessment. When fisheries are highly regulated, fishery-independent surveys often become the only method available to adequately characterize population size, age and length compositions, and reproductive parameters, all of which are needed to assess the status of stocks. The use of adequate fishery-independent data also decreases assessment uncertainty over fishery-dependent information alone.

The Marine Resources Monitoring, Assessment and Prediction (MARMAP) program has conducted fishery-independent research on ground fish, reef fish, ichthyoplankton, and coastal pelagic fishes of the continental shelf and shelf edge between Cape Hatteras, North Carolina, and St. Lucie Inlet, Florida, since 1972. A major component of MARMAP activities always has been monitoring work using standardized sampling of fish populations over time and the development of an historical base for comparisons of long-term trends in abundance and size compositions. Over time, the sampling strategy changed to become more focused on economically important reef fishes (e.g. sea basses, snappers, groupers, porgies, and grunts), which are found most commonly in live/hard-bottom habitats of the continental shelf and shelf edge. In addition, MARMAP has a soft-bottom habitat component focused on tilefish off the continental slope. Housed at the Marine Resources Research Institute (MRRI) at the South Carolina Department of Natural Resources (SCDNR), the overall mission of the MARMAP program has been to determine the distribution, relative abundance, critical habitat, and life history parameters of economically and ecologically important fishes off the southeastern US, and relate this information to environmental factors and exploitation activities. MARMAP research provides critical information for stock assessments and evaluation of management plans for the southeast region. Since the mid-1980s, MARMAP has utilized trap and longline gears to sample a diverse array of species and fish sizes throughout the southeastern continental shelf and developed a consistent deployment strategy for each gear by the 1990s.

Until 2009, the MARMAP program was the only long-term fishery-independent program that collected data to develop regional indices of relative abundance and life history analyses for species in the South Atlantic Fisheries Management Council's (SAFMC) snapper-grouper complex. In 2009 and 2010, two complementary fishery-independent programs, the Southeast Area Monitoring and Assessment Program – South Atlantic (SEAMAP-SA) and the Southeast Fishery-Independent Survey (SEFIS), respectively, began cooperating with MARMAP (both in terms of sampling efforts and funding) to enhance MARMAP's traditional survey into a more comprehensive regional survey using the standardized sampling protocols developed by MARMAP. Since 2009, the collective reef fish monitoring in the South Atlantic Bight (SAB) is accomplished via the combined efforts of these three fishery-independent programs and called the Southeast Reef Fish Survey (SERFS).

SEAMAP-SA, which is housed at the MRRI at SCDNR, began participating in reef fish surveys in the 2009 field season. In particular, the SEAMAP-SA Reef Fish Complement has allowed MARMAP to identify and document additional hard-bottom habitat on the fringes of the historic survey area, which in turn allowed for the inclusion of additional sampling sites to the survey (**Error! Reference source not found.**). In addition, the SEAMAP-SA Reef Fish Complement allows for more extensive sampling in marine protected areas (MPAs) for monitoring purposes as well as the continuation of sampling with short and long bottom longlines.

In 2010, the National Oceanographic and Atmospheric Administration's Fisheries program (NOAA Fisheries) initiated the SEFIS program, housed at the Southeast Fishery Science Center (SEFSC) laboratory in Beaufort, NC. This fishery-independent survey was designed to complement the MARMAP / SEAMAP-SA Reef Fish Survey. SEFIS has been pivotal in the further identification of previously un-surveyed hard-bottom habitats, in particular off the coast of Florida, Georgia, and North Carolina. Hard-bottom

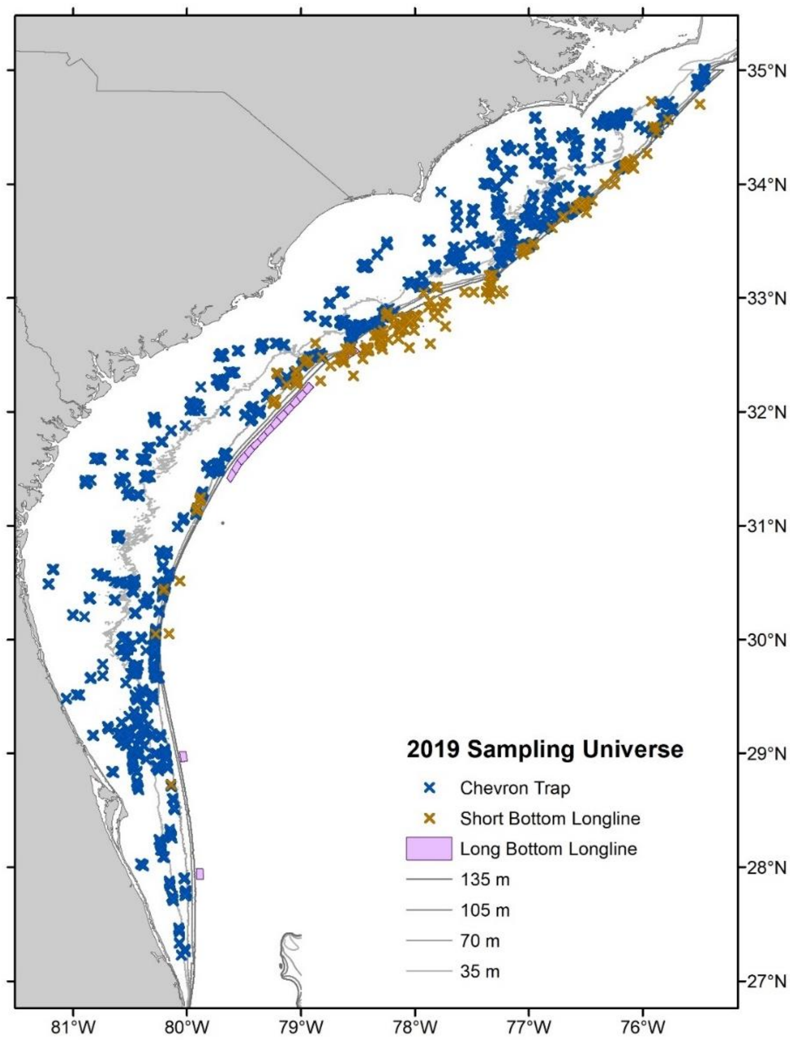


Figure 1. Map of all monitoring stations within the SERFS sampling universe for the 2019 season for chevron traps, SBLLs, and LBLLs

areas identified during SEFIS and SEAMAP-SA cruises have been added to the universe of areas monitored by SERFS (**Error! Reference source not found.**). These sites are now monitored by the three f ishery-independent survey programs for sampling in each subsequent year. In addition, the supplemental funding for reef fish monitoring through SEFIS allowed the introduction monitoring fish population using underwater video. MARMAP utilized underwater TV, video, and photography in the past, but there had not been a consistent, long-term effort to use video for monitoring purposes.

MARMAP and SERFS have been conducting the fishery-independent monitoring using a variety of gears deployed using a highly standardized methodology. Gear deployment is very similar on the various vessels utilized by SERFS, and staff is cross-trained to limit significant differences in deployment methods. Currently, the chevron trap (CHV; 1990-present) is the primary fish sampling gear, while short bottom longline (SBLL; 1996-present) and the long bottom longline (LBLL; 1996-2007, 2009-2011, 2015-2016, and 2019) also have been used. These longline gears are used to sample areas with relatively high vertical relief or soft bottom habitat, respectively. Note that the deployment of the SBLL was mostly suspended and the LBLL fully suspended in 2012 due to funding considerations, but enough opportunistic SBLL samples were obtained in 2012 and 2013 to be included some of the analyses. These funding constraints also restricted the number and geographical scope of the opportunistically deployed SBLL, though these were included in the analyses. Funding provided by the Southeast Area Monitoring and Assessment Program-South Atlantic (SEAMAP-SA, see below) allowed us to resume the SBLL survey in June of 2014. In 2015, additional funding was provided by SEFSC and SERO to continue the SBLL and resume the LBLL survey. Funding restrictions once again halted the use of LBLL in 2017. In 2019, a Cooperative Research Program (CRP) project was funded to enhance the LBLL survey by colloborating with commercial fisherman using standardized gear and methodology. In addition, SERFS deploys equipment to measure oceanographic parameters such as conductivity and temperature using a CTD profiler at locations of capture gear deployment.

<u>Survey Region</u>

The continental shelf off the southeastern U.S. Atlantic coast extends from West Palm Beach, FL to Cape Hatteras, NC, comprising a total area of approximately 90,600 km^2 (Menzel 1993; Fautin et al. 2010). Shelf width varies from 5 km off Palm Beach, FL, and Cape Hatteras, NC, to 150 km off Georgia and South Carolina. Despite the generally subtle slope (~ 1 m/km), ridges and depressions often lead to localized high relief areas (Menzel 1993; Fautin et al. 2010). Hydrographically, the dominant feature of the region is the Gulf Stream, which allows a mix of cold-temperate, warm-temperate, and tropical species to co-exist within the region (Fautin et al. 2010). Immediately inshore of the shelf break, bottom waters are relatively warm (18-22°C) and saline (36.0-36.2 psu) year round, whereas coastal waters and waters offshore of the shelf break vary seasonally due to cool-water upwelling events and warm Gulf Stream intrusions (Fautin et al. 2010).

The dominant geological feature of continental shelf is soft-bottom habitat (mud and sand < 1 m deep) underlain by carbonate sandstone (Henry et al. 1981; Riggs et al. 1996). Secondary to wide expanses of soft-bottom habitat are patchy areas of sand-veneered and rocky outcrop hard-bottom areas (Powles and Barans 1980; Sedberry and Van Dolah 1984), including hard grounds, reefs, and rock outcroppings (Riggs et al. 1996). Hard-bottom is prominent along the shelf break in depths from 45 to 60 m relative to the remainder of the shelf (Fautin et al. 2010). Hard-bottom areas provide substrate for benthic communities, such that hard-bottom habitats often are synonymized with “live-bottom” habitats (Riggs et al. 1996). The term “live-bottom” was first used by Cummins et al. (1962) to describe the most productive trawling areas of hard-bottom between Cape Lookout, NC, to Cape Canaveral, FL. The habitat in these areas was composed of many species of invertebrates, including cnidarians, poriferans, bryozoans and ascidians, attached to naturally occurring hard formations of varying relief and type (Struhsaker 1969; Wenner et al. 1983; Barans and Henry 1984; Sedberry and Van Dolah 1984; Thompson et al. 1999). Though the true percentage of hard-bottom area within the SAB is unknown, various authors have estimated its extent as 4 to 30% of the total shelf area (Fautin et al. 2010).

Hard-bottom areas are ecologically important resources in that they are necessary to the life history of many ecologically and economically important fish communities (Powles and Barans 1980; Grimes et al. 1982; Barans and Henry 1984; Collins and Sedberry 1991; Sedberry et al. 2001; Sedberry et al. 2006). These fish assemblages include economically valuable snappers (Lutjanidae), groupers (Serranidae), grunts (Haemulidae), porgies (Sparidae), as well as a diverse array of tropical fish families such as wrasses (Labridae) and damselfishes (Pomacentridae; Fautin et al. 2010). Managed as the snapper-grouper complex (SAFMC 1991), many of these species are, or have been, subjected to intense fishing pressure. Examples of such species are Red Snapper, Black Sea Bass, Red Porgy, Vermilion Snapper, and Gag Grouper. Due to the extent of management actions in this region, fishery-independent monitoring for these species is essential for assessments. In addition, studies on various aspects of the life history of reef fish species which can often only be obtained through concerted fishery-independent efforts provide essential inputs for increasingly complex stock assessment models (e.g. Sedberry and Van Dolah 1984; Low et al. 1985; Vaughan et al. 1995; Harris and McGovern 1997; McGovern et al. 1998; Harris and Collins 2000; Harris et al. 2002; Harris et al. 2004; Harris et al. 2007; Schobernd and Sedberry 2009; Bubley and Pashuk 2010; Stratton 2011).

Objective

This report presents a summary of the fishery-independent monitoring and analyses for 23 species from the snapper-grouper complex in the region (**Error! Reference source not found.**) derived from chevron t rap and longline catch data collected from 1990 through 2019 by the three monitoring programs (MARMAP, SEAMAP-SA, and SEFIS) involved in SERFS. Specifically, it presents updated annual standardized catch per unit effort (CPUE) for the monitoring gears currently in use (often referred to as an index of abundance). Standardization is applied to account for the effects of potential covariates on the CPUE for a given gear type. Species distribution maps and annual length information of captured fish for each gear type also is provided. Data presented in this report are based on a database maintained by SCDNR which houses data from all SERFS partners that was accessed in February 2020.

Table 1. Species included in this report by gear. CHV = chevron trap, SBLL = short bottom longline, and LBLL = long bottom longline

Common Name	Scientific Name	Gear		
		CHV	SBLL	LBLL
	Balistidae			
Gray Triggerfish	*Balistes capriscus*	X		
	Carangidae			
Almaco Jack	*Seriola rivoliana*	X*	X*	
Greater Amberjack	*Seriola dumerili*	X*	X*	
	Haemulidae			
Tomtate	*Haemulon aurolineatum*	X		
White Grunt	*Haemulon plumierii*	X		
	Lutjanidae			
Red Snapper	*Lutjanus campechanus*	X		
Vermilion Snapper	*Rhomboplites aurorubens*	X		
	Malacanthidae			
Blueline Tilefish	*Caulolatilus microps*	X*	X	
Golden Tilefish	*Lopholatilus chamaeleonticeps*		X*	X*
	Sebastidae			
Blackbelly Rosefish	*Helicolenus dactylopterus*		X	
	Serranidae			
Bank Sea Bass	*Centropristis ocyurus*	X		
Black Sea Bass	*Centropristis striata*	X		
Gag	*Mycteroperca microlepis*	X	X*	
Red Grouper	*Epinephelus morio*	X	X*	
Sand Perch	*Diplectrum formosum*	X		
Scamp	*Mycteroperca phenax*	X	X*	
Snowy Grouper	*Hyporthodus niveatus*	X	X	
Speckled Hind	*Epinephelus drummondhayi*	X*	X*	
	Sparidae			
Knobbed Porgy	*Calamus nodosus*	X		
Pinfish	*Lagodon rhomboides*	X		
Red Porgy	*Pagrus pagrus*	X	X*	
Spottail Pinfish	*Diplodus holbrookii*	X		
Stenotomus spp.	*Stenotomus* spp.	X		

* - Not enough positive gear deployments to provide a standardized index of abundance. Raw catch information provided.

Methods

Sample Collection

Given the close coordination and consistent sampling methodology used by each of the fishery-independent sampling programs involved in SERFS, no adjustments to raw catch, effort, or length data were needed prior to the analyses presented in this report. Note that the number of chevron traps deployed in recent years has increased on average two- to three-fold from historical numbers (**Error! Reference source not found.**). The short and long bottom longline surveys are conducted by MARMAP and SEAMAP-SA only, using identical methodologies as in previous years. **Error! Reference source not found.** summarizes the annual gear deployments for each gear type.

Table 2. Number of gear deployments, by year and gear type, during fishery-independent sampling of live/hard bottom stations or soft-bottom blocks. This includes both randomly and opportunistically selected monitoring stations/reconnaissance converted (“included” collections) and reconnaissance stations.

Year	Chevron Trap	Short Bottom Longline	Long Bottom Longline	Hydrographic
1990	354	–	–	78
1991	305	–	–	62
1992	324	–	–	58
1993	542	–	–	99
1994	468	–	–	72
1995	545	–	–	70
1996	642	20	17	111
1997	532	34	21	104
1998	523	33	10	106
1999	347	44	30	83
2000	383	40	11	81
2001	325	36	14	65
2002	336	22	20	64
2003	286	54	16	64
2004	343	48	5	66
2005	357	58	16	76
2006	332	96	7	75
2007	361	74	25	97
2008	354	58	–	71
2009	464	71	38	113
2010	1051	135	40	270
2011	1010	142	30	178
2012	1393	28	–	249
2013	1561	42	–	285
2014	1520	60	–	286
2015	1523	103	45	498
2016	1537	78	30	325
2017	1574	54	–	292
2018	1784	77	–	322
2019	1745	39	4	299

The current SERFS sampling area includes waters of the continental shelf and shelf edge between Cape Hatteras, NC, and St. Lucie Inlet, FL, though historically, the majority of sampling occurred between Cape Lookout, NC, and Ft. Pierce, FL (**Error! Reference source not found.** and **Error! Reference source not found.**). With the addition of SEFIS and SEAMAP-SA, recent efforts have expanded the range farther north and south towards the desired boundaries at Cape Hatteras, NC and St. Lucie Inlet, FL, respectively. Throughout this range, randomly-selected monitoring stations (confirmed hard bottom) are sampled from May through September each year, though some additional efforts in April and October have been conducted depending on weather conditions. Additionally, reconnaissance locations (suspected hard bottom) are sampled as time and funding allows when potential habitat is identified. If catch or videos indicate live bottom at reconnaissance locations, these deployments can be converted to sampling stations in subsequent years and treated identically as all other stations in the sampling universe in terms of selection, sampling, and analyses. Due to the length of the LBLL gear and target habitat, predetermined areas (so-called "blocks") over soft bottom habitat are used for sampling rather than (point) stations.

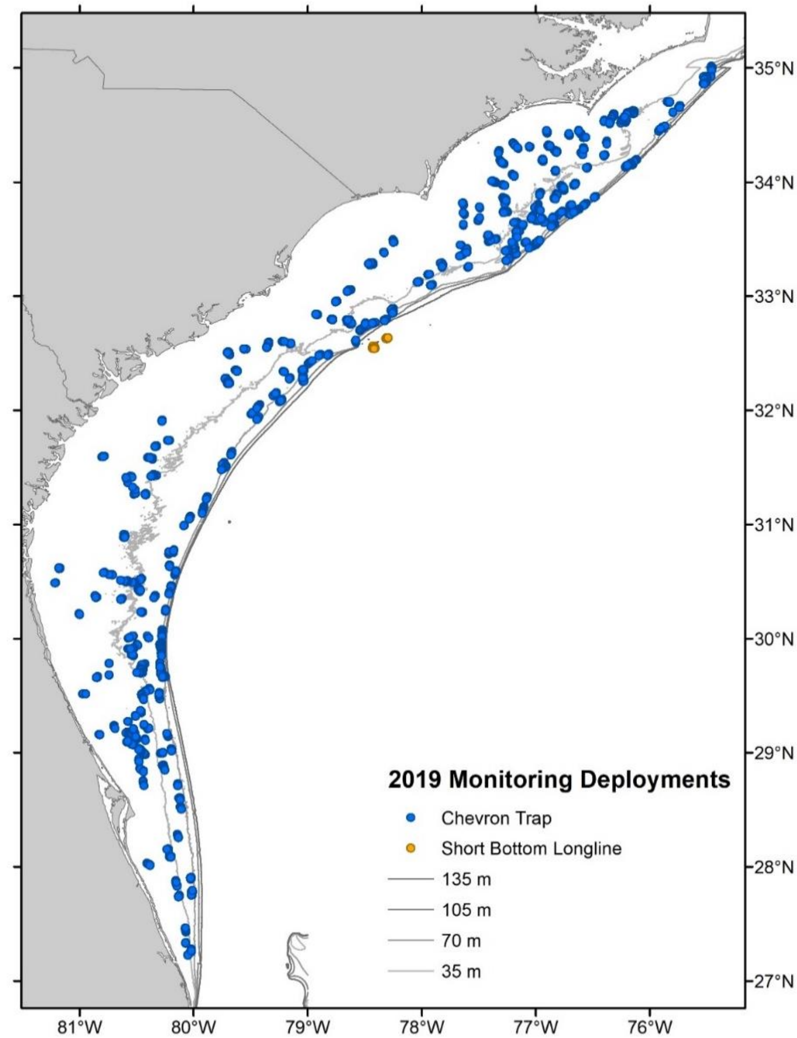


Figure 2. Map of all monitoring stations sampled in 2019, the most recent sampling year. Note that each symbol may represent multiple sampling events due to proximity of locations and scale of the map

Chevron Traps

Background

The MARMAP program began using chevron traps in 1988 after a commercial fisherman introduced the use of this trap design in the Atlantic waters off the Southeastern United States (Collins 1990). Subsequently, in 1988 and 1989, chevron traps were used simultaneously with blackfish and Florida Antillean traps to compare the efficiency of the three different trap designs at capturing reef fishes on hard-bottom habitats (Collins 1990). The chevron trap was considered most effective overall for species of commercial and recreational interest in terms of both total weight and numbers of individuals (Collins 1990).

Beginning in 1990, MARMAP used chevron traps for reef fish monitoring purposes in lieu of blackfish or Florida Antillean traps. Until 2009, each year between 500 and 700 stations were selected randomly from a database of approximately 2,200 known low to moderate hard-bottom areas identified for monitoring via fish traps. Sampling efforts, in particular the number of sea days, were confounded by available MARMAP funding over time. With the inclusion of the two additional fishery-independent groups composing SERFS, and the associated substantial increase in overall survey funding, the number of stations selected has increased, reaching over 1,500 randomly selected stations per year in 2016, while the universe of available trap stations has grown to approximately 4,300. Criteria for random selection include that no station in a given year is closer than 200 m to any other selected station. Station depths range between 14-110 m. In the most recent years, the R/V *Palmetto,* R/V *Savannah,* and NOAA Ship *Pisces* serve as the research platforms for chevron trap deployment.

Gear Description

Chevron traps are arrowhead shaped, with a total interior volume of 0.91 m^3, constructed using 35 x 35 mm square mesh plastic-coated wire, and possess a single entrance funnel ("horse neck"), one release panel to remove the catch, and one release panel with dissolvable ("7-day pop-up") zinc fasteners to prevent ghost fishing (**Error! Reference s ource not found.**; Collins 1990, MARMAP 2009).

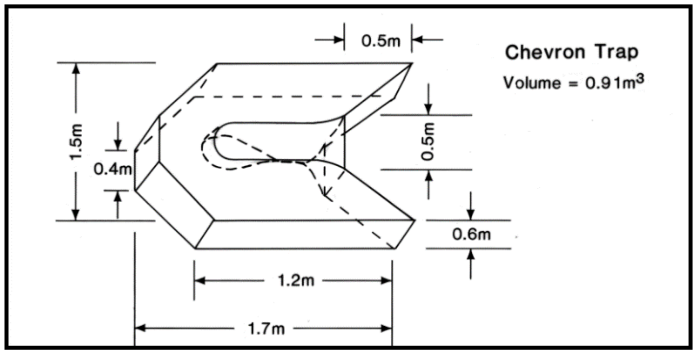


Figure 3. Diagram of the chevron trap used for monitoring purposes by MARMAP/SERFS from 1990-2018 (from Collins 1990)

Prior to deployment, chevron traps are baited with a combination of whole or cut clupeids (*Brevoortia* or *Alosa* spp., family Clupeidae), with menhaden most often used. To bait, four whole clupeids are suspended on each of four stringers within the trap and 8 additional clupeids, with their abdomen sliced open, are placed loose in the trap (**Error! Reference source not found.**). Subsequently, an appropriate length of 8 mm (5/16 in) p olypropylene anchor line is attached to an individual trap and buoyed to the surface using a polyball buoy. A 10m trailer line is attached to this anchor line on one end and to a Hi-Flyer or second polyball buoy on the other. Traps are deployed generally in sets of six, while maintaining the minimum distance of 200 m between traps (MARMAP 2009). Traps are retrieved in chronological order of deployment, using a hydraulic pot hauler, after approximately a 90-minute soak time.

MARMAP and more recently, SERFS, have utilized cameras (still and video) mounted on top of chevron traps intermittently to document bottom habitat, trap behavior, and to observe reef fish species since 1990. Since 2007, chevron traps were increasingly outfitted with cameras, either still or video. By 2009, all survey traps were fitted with at least one type of camera and from 2011 on, all traps had video cameras. Catch data from traps equipped with cameras were treated the same as all other data, as it is assumed that the cameras likely do not impact catchability of the traps.

Figure 4. Chevron trap baited with Menhaden, ready for deployment. Note, iron sashes were used to weigh the trap down, thus promoting the proper orientation, and stabilizing the trap, on the bottom

Short bottom longline

Background

Although there were some trial deployments in 1979, 1987, and 1989, the MARMAP program initiated the SBLL survey in its current configuration in 1996, with an initial goal of sampling snapper-grouper species inhabiting hard-bottom areas with considerable vertical relief, mostly in depths greater than 75 m. This gear replaced the previously used Kali pole longline gear (see Russell et al. 1988) for sampling reef fishes in these habitats. In previous reports, the MARMAP program referred to this gear as a "vertical longline" since it was commonly draped over vertical relief. This name was changed to SBLL in 2009, following the Southeast Area Fisheries-Independent Survey Workshop (Williams and Carmichael 2009) in Beaufort, NC, to avoid confusion with "true" vertical longlines with hooks suspended in the water column.

Due to a lack of funding, the SBLL program was limited to opportunistic sampling in 2012 and 2013 with funding provided by SEAMAP-SA recently (**Error! Reference source not found.**). Annually, SBLL stations a re selected randomly from a sampling universe of ~300 previously identified SBLL monitoring stations with a minimum distance of 200 m between randomly selected stations. Station depths range between 75 and 315 m. Deployment of SBLL gear for monitoring purposes have been made by the MARMAP/SEAMAP-SA Reef Fish program using the R/V *Palmetto* and R/V *Lady Lisa.*

Gear Description

The SBLL consists of 25.6 m (~84 ft) of 6.4-mm diameter treated solid braid Dacron (polyester) ground line dipped in green copper naphthenate. Twenty gangions with non-offset circle hooks (almost exclusively #5 Eagle claw size, but in some years some #7 were used) are placed 1.2 m (~4 ft) apart on the ground line. The gangions consist of an AK snap, 0.5 m of 90 kg monofilament and a non-offset circle hook and are baited with a double-hooked whole squid (*Illex* sp. or *Loligo* sp.). Weights totalling 10-11 kg are clipped to the ground line at either end. The ground line is tethered to the surface using an 8-mm (5/16 in) polypropylene anchor line with a polyball buoy attached at the opposite end. A 10 m trailer line is attached to this anchor line on one end and to a Hi-Flyer or second polyball buoy on the other. Soak time is approximately 90 minutes, and the gear is retrieved utilizing a pot hauler. Up to six SBLLs are deployed at one time, adhering to the 200 m buffer.

Long bottom longline

Background

The LBLL survey was initiated in the early 1980s to sample the snapper-grouper species in soft bottom habitats, which are often inhabited by tilefishes. Only data from the years 1996-2007, 2009-2011, 2015-2016, and 2019 were used in the sampling and length summaries. Annual CPUE was not standardized for LBLL due to sporadic funding.

Due to a reduction in funding, the LBLL program was suspended in 2012 until funding was provided to SEAMAP-SA and MARMAP in 2015 and 2016 to resume sampling, with another suspension in 2017 (**Error! Reference source not found.**). Identification of potential LBLL sampling areas was based on i nformation provided by commercial and recreational fishermen, fathometry data, previous exploratory surveys (Low et al., 1983), and Kali pole surveys conducted during 1985 and 1986. Subsequently, identified sampling locations were divided into sampling blocks (~15 nmi^2) based on the LORAN grid. In 2009, the original LORAN numbers were converted to GPS coordinates due to the imminent shutdown of the LORAN system. Since 1996, the goal has been to deploy the gear parallel at two locations within each block each year with a minimum distance of 200 m between each deployment. Station depths range between 178 and 231 m.

LBLL sampling generally is conducted from August through October, with MARMAP/SEAMAP-SA staff using the R/V *Lady Lisa* as the primary research platform. The number of successful deployments has varied over the years, mostly due to weather conditions and current speeds. Currents exceeding 2 knots can affect safe deployment and retrieval of the gear, as well as catchability. Sampling generally is halted if current speed exceeds 2 knots.

Reduced catchability of Golden Tilefish at low bottom temperatures has been reported and attributed to decreased feeding activity (Bigelow and Schroeder 1953; Low et al. 1983). Due to these observations, from 1996 to 2005 CTD casts were collected prior to each LBLL deployment, rather than during deployment as with other gear types. If the bottom temperature was below 9°C, no sampling was conducted, and the vessel moved to another location either within the block or to an adjacent block to attempt sampling. In 2006, this assumption was revisited by MARMAP staff because of low or no catches in 2004 and 2005, despite temperatures greater than 9°C. Beginning in 2006, MARMAP started sampling tilefish habitat even if the temperature was below 9°C. These efforts indicated that Golden Tilefish are caught, even below this temperature, as long as the appropriate habitat (soft bottom) and depth range (150 - 250 m) was targeted. Highest catches generally occurred between depths of 200 and 230 m. Nevertheless, in the development of CPUE estimates of Golden Tilefish, it is prudent to take into account bottom temperature given the early literature suggesting bottom temperature affects catchability and to account for the change in sampling strategy.

Gear Description

From 1996 on, LBLLs were constructed of 3.2-mm galvanized cable (1,525 m long; approximately 5003 ft), deployed from a longline reel with 1,220 m (~4003 ft) of cable used as ground line and the remaining 305 m (~1,000 ft) buoyed to the surface as an anchor line. When setting the gear, weights totaling 10-11 kg are attached to the ground line, dropped into the water, and 100 gangions (comprised of an AK snap, approximately 0.5 m of 90 kg monofilament and a #5 non-offset circle hook) are attached to the ground line as it pays out. Hooks are baited with double-hooked whole squid (*Illex* sp. or *Loligo* sp.). Gangions are attached in 12 m (~39 ft) intervals to the ground line. After the attachment of all 100 gangions another 10-11 kg of weights are attached at the terminal end of the ground line (buoy end). The anchor line is composed of the remaining 305 m of cable, which is buoyed to the surface with 1 or 2 polyball buoys followed by a 10 m Dacron (polyester) trailer line and another polyball buoy. LBLLs generally are deployed while running with the current at a speed of 4-5 knots, with each line being soaked for 90 minutes and subsequently retrieved using a hydraulic pot hauler. Typically, two LBLLs are deployed at one time.

Hydrographic Data

CTD casts recorded water column depth, temperature, and salinity. Typically, a CTD cast is conducted between the deployment of the last piece of gear in a set and retrieval of the first piece of gear, while the gear soaks. In the case of LBLLs prior to 2005, the single CTD cast was made prior to deployment of the set to check bottom temperature. Data obtained from the single CTD cast is associated with the deployed gear set. A set is composed of up to six (generally six) chevron traps or SBLLs deployed at the same time in the same geographic area. For LBLLs, a set consists of one or two LBLLs deployed at the same time in the same geographic area. Since 2015, Vemco data loggers were used in place of CTD casts to gather bottom temperature data for LBLL. Data loggers were attached to the ground line of each LBLL deployed via a gangion close to the anchor line. These were set to record temperature at 10-minute intervals. Since 2012, data loggers also were attached to 2 or 3 traps or SBLL per set as a backup source of bottom temperature data in the event of CTD failure.

From 1990 through 1992, an Applied Microsystem's STD-12 model CTD was employed (depth, temperature, salinity, and dissolved oxygen) for gear deployments mentioned above. From 1993 through the current sampling year (2019), we used Sea-Bird models SBE-19 or SBE-25 Plus. All CTD's are calibrated by authorized dealers/personnel according to the manufacturer's guidelines annually. For this report, only temperature was included in analyses as it displayed more variability across the region. Specifically for temperature, the value at the deepest point of the cast is included here (bottom temperature). While depth was included in the analyses, it was taken from fathometer readings due to potential variability between stations within a set.

Nominal CPUE Estimation

After collection, all fishes are sorted to species, weighed (total weight in grams, per species, per trap or longline), and all individual fish are measured. Fish lengths are presented in mm maximum total length (TL), meaning that the caudal fin is "pinched" while measuring the fish length. From this length frequency work-up, the number per species per deployment is summed to produce number caught or abundance. Estimates of abundance or catch per unit effort (CPUE) included only gear deployments with a soak time between 45 and 150 minutes. Data from monitoring stations or reconnaissance collections converted to monitoring stations were included, but if a gear malfunctioned or the catch was otherwise compromised, that collection was not included. As such, only trap collections with no catch (catch code 0), catch with finfish (catch code 1), catch with no finfish but other organisms (catch code 2), and sub-sampled finfish catch (catch code 8) were used. The first year that samples from reconnaissance converted stations were included in the indices for the report was 2015 and those nominal CPUE values from previous reports have been adjusted. Tagging efforts in which the full length-frequency work-up was not performed also were excluded from analyses. Continuing quality assurance/quality control of historical data resulted in some adjustments to the database over time to account for data collected during activities other than monitoring, such as these tagging studies, and uncertainties regarding the catch composition of certain traps. Some of these data were included in previous trends reports for CPUE calculations, explaining some minor differences between values found in this report compared to values in prior trends reports. Finally, collections which were missing covariate information were excluded from analyses. The collections under these constraints/criteria are referred to as, "included collections" below. The unit of effort for each gear and species is: chevron trap = # fish* $trap^{-1}$ $*hour^{-1}$ and SBLL = # $fish*line^{-1}*hour^{-1}$ for the nominal indices. Because no LBLL deployments were made 2017-2018, and limited deployments in 2019, please refer to the trends report for the 2016 sampling season to obtain nominal and standardized indices of abundance for Golden Tilefish in this gear.

Annual nominal mean CPUE for each species was calculated by determining the numbers of individuals caught per hour of soak time, divided by the total number of gear deployments for that year (Equation 1).

Equation 1.

$$\text{Annual CPUE}= \sum \frac{\#\, fish\ caught * 60\ minutes}{deployment\ duration\ (minutes)} / \#\ gear\ deployments$$

The CPUE was then normalized by dividing the annual CPUE by the mean CPUE for the time series. This not only normalized trends among species, but also provides a reference point for individual years in relation to the time series as a whole, with a value of 1 being the long-term mean.

CPUE Standardization

Species selected for CPUE standardization had a proportion positive ≥ 1.5% and no more than 3 years with zero catch over the time series. Previous trends reports have utilized a delta-GLM standardization method (Lo et al. 1992), but as with many ecological count data sets (Zuur et al. 2009), CPUE data from these surveys often were zero-inflated. This led us to examine other model structures which may improve fit, reduce bias in the standard errors, and reduce overdispersion caused by excessive zeros (Zuur et a. 2009; see Ballenger et al. 2014, and Ballenger et al., 2017 for a more thorough description of the rationale for using this model structure specific to SERFS data). Model structures considered include Poisson GLM, negative binomial GLM, zero-inflated Poisson GLM (ZIP), and zero-inflated negative binomial GLM (ZINB). Through preliminary analyses, the ZINB performed better than the other 3 model structures in terms of fit and limiting overdispersion in the vast majority of species, so gear-specific CPUE was standardized among years with the ZINB method unless otherwise noted.

Standardization procedures were based on Ballenger et al. (2017), using modified R scripts and methodology. The CPUE was modeled as catch per deployment, compared to the traditional method of calculating catch per deployment per hour that was done with the nominal catch. The natural log of the time the gear was fishing in the water (soak time), was included as an offset term to account for effort. Year was included in the model, as this was the desired response variable to examine temporal trends. The covariates examined were depth, latitude, bottom temperature, and day of year (Table 4 and Table 5). They were included in the models as continuous variables modeled with polynomials. Maximum allowed order for each polynomial was based on preliminary generalized additive models (GAMs). Unless noted otherwise, the polynomial order was limited to a maximum fourth order under the assumption that higher order polynomials would not have biological relevance based on the covariates in this analysis. Because of widely differing scales of the covariates, they were centered by subtracting the individual covariate mean and scaled, by dividing the centered values by their standard deviation prior to the GAMs. This was done to improve model stability for fitting purposes. There were two components of the model: presence/absence and abundance.

Catch abundance was modeled versus all covariates to inform the polynomial order for the count sub-model of the standardization model. The presence/absence data also was modeled versus all covariates for the zero-inflation sub-model. Model selection was based on Bayesian information criteria to increase the penalty associated with adding parameters to the model. A two-step optimization process was utilized due to computational demands. All covariates were removed from the zero-inflation sub-model and the count sub-model was optimized for all covariates. Then, the count sub-model optimal values were fixed, and the covariate structure of the zero-inflation sub-model was optimized. We allowed for the possibility that different covariates can be included in the zero-inflated sub-model and catch sub-model. All analyses were performed in R (Version 2.15.0; R Development Core Team 2012). The zero-inflated models in R were developed using the function zeroinfl available in the package *pscl* (Jackman 2011; Zeileis et al. 2008). Annual year effect coefficients of variation (CVs) were computed using bootstrapping procedures of 5,000 iterations.

The standardized index also was normalized by dividing the annual standardized CPUE by the mean standardized CPUE for the time series. This not only normalized trends among species, but also provides a reference point for individual years in relation to the time series as a whole, with a value of 1 being the mean.

Table 3. Chevron trap sampling summary for all collections included in CPUE analyses

Year	Included Collections	Depth (m)		Latitude (°N)		Temperature (°C)		Day of Year	
		Avg	Range	Avg	Range	Avg	Range	Avg	Range
1990	313	33.9	17-93	32.5	30.4-33.8	22	18.2-27.8	150	114-222
1991	272	34.1	17-95	32.6	30.8-34.6	24.9	15.9-27.5	217	163-268
1992	288	34	17-62	32.8	30.4-34.3	21.3	15.3-24.5	155	92-227
1993	392	34.9	16-94	32.4	30.4-34.3	22.8	17.8-28.5	176	131-226
1994	387	39.2	16-93	32.4	30.7-33.8	22.8	18.2-26.9	174	130-300
1995	361	33.8	16-60	32.1	29.8-33.7	24.6	20.1-28.4	198	124-299
1996	361	38.2	14-100	32.4	27.9-34.3	22	14.2-27.0	188	121-261
1997	406	39.4	15-97	32	27.9-34.6	22.6	15.0-28.0	195	126-273
1998	426	39.6	14-92	32.1	27.4-34.6	21.5	9.5-28.6	178	126-231
1999	233	35.8	15-75	32	27.3-34.6	22.9	17.9-28.8	199	153-272
2000	298	36.3	15-101	32.3	29.0-34.3	23.9	18.0-28.5	201	138-294
2001	245	38.5	14-91	32.3	27.9-34.3	23.5	16.0-29.2	204	144-298
2002	244	37.7	13-94	31.9	27.9-34.0	24.2	15.2-28.3	207	169-268
2003	224	39.8	16-92	32.1	27.4-34.3	18.9	13.4-25.1	203	155-266
2004	282	40.6	14-91	32.3	29.0-34.0	20.9	16.7-25.8	175	127-303
2005	303	38.5	15-69	32.1	27.3-34.3	23	18.0-28.5	191	124-273
2006	297	38.1	15-94	32.3	27.3-34.4	22.4	15.0-26.6	203	158-272
2007	337	37.9	15-92	32.2	27.3-34.3	23.2	15.3-28.9	201	142-268
2008	303	38	15-92	32.2	27.3-34.6	21.9	15.2-27.2	195	127-275
2009	404	36.3	14-91	32.2	27.3-34.6	22.6	15.4-27.2	203	127-282
2010	725	38.5	14-92	31.4	27.3-34.6	22.2	12.3-29.4	221	125-301
2011	726	40.7	14-93	30.9	27.2-34.5	21.6	14.8-28.8	210	140-300
2012	1174	40.8	15-106	31.9	27.2-35.0	22.1	12.9-27.8	195	116-285
2013	1360	38.2	15-110	31.3	27.2-35.0	22.1	12.4-28.1	197	115-278
2014	1472	39.2	15-110	31.9	27.2-35.0	23.3	16.1-29.3	192	114-295
2015	1463	39.2	16-110	31.9	27.3-35.0	22.6	13.6-28.4	187	112-296
2016	1484	40.9	17-115	32.1	27.2-35.0	23.8	15.5-29.3	217	126-302
2017	1541	40.5	15-114	32	27.2-35.0	22.6	14.8-28.2	187	117-273
2018	1736	40.3	16-114	32	27.2-35.0	22.5	13.6-28.4	177	116-278
2019	1624	40.1	16-113	32	27.2-35.0	23.2	15.0-29.5	184	121-269

Table 4. Short bottom longline sampling summary for all collections included in CPUE analyses

		Depth (m)		Latitude (°N)		Temperature (°C)		Day of Year	
Year	Included Collections	Avg	Range	Avg	Range	Avg	Range	Avg	Range
1996	12	155.6	73-220	32.4	32.1-32.7	14.2	7.9-20.8	206	124-236
1997	33	193.2	181-209	32.6	32.5-32.7	15.6	14.2-16.3	261	260-262
1998	31	191.2	174-212	32.7	32.5-32.9	11.3	8.9-15.4	181	126-232
1999	36	119.3	73-198	33.4	32.5-34.2	18.3	14.5-21.2	191	159-273
2000	34	160	70-198	32.9	32.5-33.9	16	12.8-23.7	212	173-230
2001	29	158	75-212	33.1	32.5-34.2	15.4	11.2-20.0	216	171-264
2002	19	85.8	71-113	32.9	32.1-33.4	17.4	16.4-18.6	194	191-200
2003	51	165.2	88-210	32.7	32.2-33.2	12.7	10.8-17.2	229	198-239
2004	21	131.6	72-215	32.1	32.1-32.3	15.5	11.6-18.4	167	128-219
2005	42	114	69-208	33.1	32.1-33.8	17.3	13.6-21.3	181	140-203
2006	50	153.8	65-219	33	32.5-34.2	12.9	9.8-18.6	205	174-271
2007	52	102.2	71-201	33.2	32.1-33.9	19.4	12.5-22.7	189	159-236
2008	29	152.8	72-198	32.5	32.1-32.7	16.8	15.1-20.4	220	172-242
2009	43	102.1	71-200	33.1	32.1-34.2	18.5	12.8-24.7	235	217-261
2010	77	128.4	66-205	32.7	32.1-33.8	14.6	10.2-18.8	170	127-266
2011	61	123.5	66-227	33	32.1-34.2	15.1	8.6-19.9	188	145-243
2012	21	173.8	71-201	32.9	32.7-34.6	14.7	13.7-22.6	218	197-244
2013	41	137.2	83-210	33.2	32.5-33.8	16.4	10.3-20.6	207	176-234
2014	57	148.3	72-212	32.8	32.1-33.8	16	12.7-20.9	198	128-282
2015	75	155.1	65-225	32.8	32.1-34.2	14.6	9.9-19.7	226	140-284
2016	62	144.7	72-218	32.7	32.1-33.5	14.1	10.6-20.0	270	225-295
2017	48	103.7	72-203	32.9	32.1-33.8	19.7	13.6-26.2	199	173-223
2018	66	145.3	65-211	32.8	32.3-33.8	14.8	10.6-22.0	185	125-243
2019	25	191.4	179-210	32.6	32.5-32.6	12	11.2-12.4	177	177-178

Length Compositions

Species mean length, as well as length frequency distribution for each gear were determined using the same collections used in the CPUE calculations. Historically, fish lengths were measured in either maximum total length (TL) or fork length (FL) depending on species. The measurement type, either TL or FL, for a species may have changed over time. Beginning in 2012, all fish were measured in TL. For any species for which measurement type changed over time, lengths were converted to TL based on FL/TL conversion equations compiled from the MARMAP database in 2019 (**Error! Reference source not f ound.**).

Table 5. Length-length conversion equations by species. All conversions are based on individual specimen data from the combined MARMAP and SERFS database (1973-2018). TL = total length (cm) and FL = fork length (cm). Note that Bank Sea Bass, Black Sea Bass, and Snowy Grouper do not have a forked tail, and so there is no conversion for those species

Species	Equation	n	r^2
	Balistidae		
Gray Triggerfish	TL = 1.111 * FL - 1.799	17,321	0.964
	Carangidae		
Almaco Jack	TL = 1.142 * FL + 0.266	112	0.996
Greater Amberjack	TL = 1.103 * FL + 4.037	2,057	0.975
	Haemulidae		
Tomtate	TL = 1.109 * FL + 0.772	4,391	0.983
White Grunt	TL = 1.115 * FL +0.307	13,912	0.995
	Lutjanidae		
Red Snapper	TL = 1.070 * FL + 0.155	9,324	0.999
Vermilion Snapper	TL = 1.110 * FL + 0.044	32,557	0.996
	Malacanthidae		
Blueline Tilefish	TL = 1.047 * FL + 0.680	1,419	0.991
Golden Tilefish	TL = 1.082 * FL - 1.425	3,891	0.998
	Sebastidae		
Blackbelly Rosefish	TL = 1.029 * FL + 0.150	2,349	0.996
	Serranidae		
Bank Sea Bass	**-**	-	-
Black Sea Bass	**-**	-	-
Gag Grouper	TL = 1.036 * FL - 0.126	4,125	0.998
Red Grouper	TL = 1.058 * FL - 0.978	1,906	0.997
Sand Perch	TL = 1.110 * FL + 0.679	1,448	0.974
Scamp Grouper	TL = 1.126 * FL - 2.021	5,143	0.99
Snowy Grouper	**-**	-	-
Speckled Hind	TL = 1.018 * FL + 0.187	1,026	0.998
	Sparidae		
Knobbed Porgy	TL = 1.086 * FL + 1.910	2,000	0.985
Pinfish	TL = 1.173 * FL - 0.549	38	0.994
Red Porgy	TL = 1.132 * FL + 0.719	38,358	0.993
Spottail Pinfish	TL = 1.139 * FL + 0.207	61	0.995

Stenotomus spp.	TL = 1.162 * FL - 0.250	366	0.994

Species Distributions

Individual species distributions within the survey for the most recent 5 years of sampling were produced by interpolation in ArcGIS 10.6.1. Interpolations were fit to nominal CPUE by inverse distance weighting. To minimize representing unsampled areas as sampled, interpolations were fit to a mask developed for either the chevron trap station universe or the SBLL station universe by applying a 10-km buffer around stations. If species did not occur in high enough frequency to develop an index of abundance for a given gear, a distribution was not developed for that gear. Interpolated abundance is represented as quantiles to allow for comparison among species and with previous years' reports.

Results

Gear Summary

Chevron Trap

From 1990 to 2019, a total of 22,821 chevron trap gear deployments were made (**Error! Reference source not found.** and **Error! Reference source not found.**), averaging 761 collections per year (range: 286 – 1,784). Of these collections 19,681 (86.0% of total), were included in the development of annual CPUE estimates, representing an average of 656 collections per year (range: 224 – 1,736, **Error! Reference source not found.**, **Error! Reference source not found.** and **Error! Reference source not found.**). The remaining collections not used in the development of annual CPUE estimates (n = 3,140), were excluded due to isolated, or a combination of, the following factors: reconnaissance trap deployments used to investigate potential new hard-bottom habitats, but were not converted to monitoring stations the following year, made up a large number (n = 1,535 or 7.0% of all collections and 48.9% of excluded collections). Duplicate stations, those sampled more than once a year or too close to another sampled station, constituted a small number of excluded collections (n=114 or 0.5% of all collections and 3.6% of excluded collections). In addition, 523 collections (2.3% of all collections and 16.7% of excluded collections) were removed from CPUE calculations due to very long or short soak times (≥45 or ≤150 m). The reason for excluding the very long or very short soak times a priori was that these indicated a problem with the deployment or retrieval of the gear such as high current and hang-ups on the bottom. Collections were also removed due to damaged or lost gear, or otherwise compromised catches (n=325 or 1.4% of all collections and 10.4% of excluded collections). The analyses included in the 2013 and subsequent trends reports also excluded samples collected during tagging cruises (1990, 1993-2000, 2002, and 2006) due to potential for underestimation of abundance per trap of certain species. During these tagging cruises, a full length-frequency work-up was not done consistently. This impacted 351 monitoring collections from 1990 through 2006 (1.5% of all collections and 11.2% of excluded collections). Collections were also excluded due to a lack of complete environmental data, such as missing temperature, depth, etc. (n= 362 or 1.6% of all collections and 11.53% of excluded collections).

Initially the emphasis of the expansion of sampling efforts since 2009, was to identify previously unsampled reef fish habitats and expand the geographic and depth range coverage. In 2009 and 2010, the increase in total chevron trap deployments was not reflected proportionally in the number of collections included in index development due to the large number of reconnaissance stations, some of which were not selected for inclusion into the sampling universe the following year (**Error! Reference source not found.**). The number of included collections relative to total collections since SEFIS efforts were included was initially lower than the series average, but has been increasing due to fewer reconnaissance collections to identify stations (**Error! Reference source not found.**). The number of included chevron trap collections in 2019 represented a 402% increase in collections included for analyses compared to 2009 (**Error! Reference source not found.** and **Error! Reference source not found.**).

Of the 23 species considered in this report, 17 were caught in numbers sufficient to develop a nominal CPUE and a standardized annual CPUE from chevron traps (**Error! Reference source not found.**). We provide individual CPUE and length summaries for each of these species below. Details and discussion of individual covariates included in the final ZINB models and diagnostic plots can be found in the appendix.

Table 6. Number of chevron trap collections made by the fishery-independent reef fish surveys by year, and the number of included collections in the CPUE analyses. Included collections were from either randomly/opportunistically selected or reconnaissance converted monitoring stations using standard sampling techniques that had a soak time of between 45 and 150 minutes, included all sampling and environmental data, and with catch codes indicative of proper gear and fish processing for monitoring purposes (no catch (catch code 0), catch with finfish (catch code 1), catch with no finfish but other organisms (catch code 2), and sub-sampled finfish catch (catch code 8)). Please note that the SEAMAP-SA Reef Fish and SEFIS fishery-independent research projects did not begin until 2009 and 2010, respectively.

	MARMAP/ SEAMAP-SA Reef Fish		SEFIS		Total	
Year	**All**	**Included**	**All**	**Included**	**All**	**Included**
1990	354	313	–	–	354	313
1991	305	272	–	–	305	272
1992	324	288	–	–	324	288
1993	542	392	–	–	542	392
1994	468	387	–	–	468	387
1995	545	361	–	–	545	361
1996	642	361	–	–	642	361
1997	532	406	–	–	532	406
1998	523	426	–	–	523	426
1999	347	233	–	–	347	233
2000	383	298	–	–	383	298
2001	325	245	–	–	325	245
2002	336	244	–	–	336	244
2003	286	224	–	–	286	224
2004	343	282	–	–	343	282
2005	357	303	–	–	357	303
2006	332	297	–	–	332	297
2007	361	337	–	–	361	337
2008	354	303	–	–	354	303
2009	464	404	–	–	464	404
2010	567	409	484	316	1051	725
2011	464	264	546	462	1010	726
2012	448	368	945	806	1393	1174
2013	544	518	1017	842	1561	1360
2014	519	498	1001	974	1520	1472
2015	577	554	946	909	1523	1463
2016	528	485	1009	999	1537	1484
2017	520	508	1054	1033	1574	1541
2018	680	665	1104	1071	1784	1736
2019	675	605	1070	1019	1745	1624

Short Bottom Longline

From 1996-2019, a total of 1,446 SBLL gear deployments were made (**Error! Reference source not found.** and **Error! Reference source not found.**), averaging 60 collections a year (range: 20 – 142). Catch data from 1015 (70%) collections could be used in the development of annual CPUE estimates (**Error! Reference source not found.**, **Error! Reference source not found.** and **Error! Reference source not found.**), or on average, 42 collections a year (range: 12 – 78). The remaining collections not used in the development of annual CPUE estimates (n= 431) were excluded due to isolated, or a combination of, the following factors: 155 (10.7% of all deployments and 36% of excluded collections) were reconnaissance SBLL deployments used to investigate potential new hard-bottom habitats that were not selected for inclusion into the sampling station universe. Duplicate stations, those sampled more than once a year or too close to another sampled station, constituted a small number of those excluded (n=1 or < 0.1% of all deployments and 0.2% of excluded collections). An additional 108 collections (7.5% of all deployments and 25.1% of excluded collections) were removed from CPUE calculations due to deployment duration times falling outside the 45-150 minute window (see remark above), damaged/lost gear, or otherwise compromised catches. The remaining collections (n= 77 or 5.3% of all collections and 17.9% of excluded collections) were excluded due to a lack of complete environmental data, such as missing temperature, depth, etc.

The number of SBLL collections per year has fluctuated since its inception as a MARMAP gear. Traditionally, all fishery-independent SBLL collections for monitoring purposes were conducted under the MARMAP project, thus all included collections from 1996-2008 were MARMAP collections (**Error! Reference source not found.**). Beginning in 2009, additional fishery-independent reef fish survey funding through SEAMAP-SA resulted in an increase in annual SBLL gear deployments, particularly in 2010 and 2011 (**Error! Reference source not found.**). In 2010 and 2011, the total number of all SBLL deployments was more than double the series average, at 135 and 142, respectively, with the included collection number also increasing (**Error! Reference source not found.**). These increases were followed abruptly by a suspension of the program due to a 40% funding reduction to MARMAP funding in 2012. Although we were able to do some limited opportunistic sampling in 2012 and early 2013, SEAMAP-SA funding allowed resumption of the SBLL survey in July of 2014.

Of the 23 species considered in this report, we caught 3 in sufficient numbers to develop an annual nominal and standardized CPUE estimate through 2019 for SBLL (**Error! Reference source not found.**). We provide individual CPUE and length summaries for each of these species below. Detailed discussion of individual covariates included in the final ZINB/Poisson models, as well as diagnostic plots are found in the appendix.

Table 7. Number of <u>short bottom longline</u> collections made by the fishery-independent Reef Fish surveys by year, and the number of included collections in the CPUE analyses. Included collections were from either randomly/opportunistically selected or reconnaissance converted monitoring stations using standard sampling techniques that had a soak time of between 45 and 150 minutes, included all environmental data, and SBLL collections with no catch (catch code 0), catch with finfish (catch code 1), catch with no finfish but other organisms (catch code 2), and sub-sampled finfish catch (catch code 8). Please note that the SEAMAP-SA Reef Fish and SEFIS fishery-independent research projects did not begin until 2009 and 2010, respectively.

	MARMAP/SEAMAP-SA Reef Fish		SEFIS		Total	
Year	**All**	**Included**	**All**	**Included**	**All**	**Included**
1996	20	15	–	–	20	12
1997	34	33	–	–	34	33
1998	33	31	–	–	33	31
1999	44	36	–	–	44	36
2000	40	34	–	–	40	34
2001	36	29	–	–	36	29
2002	22	19	–	–	22	19
2003	54	51	–	–	54	51
2004	48	34	–	–	48	21
2005	58	42	–	–	58	42
2006	96	50	–	–	96	50
2007	74	53	–	–	74	52
2008	58	29	–	–	58	29
2009	71	43	–	–	71	43
2010	124	83	11	–	135	78
2011	142	109	–	–	142	61
2012	28	21	–	–	28	21
2013	42	41	–	–	42	41
2014	60	57	–	–	60	57
2015	103	75	–	–	103	75
2016	78	62	–	–	78	62
2017	54	48	–	–	54	47
2018	77	66	–	–	77	66
2019	39	25	–	–	39	25

Long Bottom Longline

From 1996-2007, 2009-2011, 2015-2016, and 2019, a total of 379 LBLL deployments were undertaken (**Error! Reference source not found.** and **Error! Reference source not found.**), averaging 21 (range: 4 – 45) collections per year when the survey occurred. Sampling efforts have been concentrated off the South Carolina and Georgia coast. The CRP project allowed for a continuance of sampling in 2019. As minimal additional data were available, we are referring to previous trends reports for indices of abundance for this gear.

Table 8. Number of long bottom longline collections made by the fishery-independent surveys by year, and the number of included collections in the CPUE analyses. Included collections were from either randomly/opportunistically selected or reconnaissance converted monitoring stations using standard sampling techniques that had a soak time of between 45 and 150 minutes, included all environmental data, and LBLL collections with no catch (catch code 0), catch with finfish (catch code 1), catch with no finfish but other organisms (catch code 2), and sub-sampled finfish catch (catch code 8).

	MARMAP/SEAMAP-SA Reef Fish	
Year	**All**	**Included**
1996	17	17
1997	21	20
1998	10	8
1999	30	27
2000	11	8
2001	14	13
2002	20	18
2003	16	13
2004	5	5
2005	16	16
2006	7	7
2007	25	22
2008	–	–
2009	38	36
2010	40	39
2011	30	27
2012	–	–
2013	–	–
2014	–	–
2015	45	37
2016	30	25
2017	–	–
2018	–	–
2019	4	–

Species

For each of the 23 species included in this report, we outline results below for any gear types in which that species was collected. Results also are presented for those species collected in sufficient numbers to develop annual nominal CPUE estimates and ZINB standardized CPUE estimates.

Balistidae

Gray Triggerfish (*Balistes capriscus*)

Chevron Trap

The nominal CPUE of Gray Triggerfish caught with chevron traps in 2019 showed an increase relative to 2018 while the standardized CPUE exhibited a slight decrease, however, both values were below the time series mean (**Error! Reference source not found.** and **Error! Reference source not found.**A). Mean le ngths of Gray Triggerfish were highest in 2005 and lowest in 1991 (5B). The mean length of Gray Triggerfish caught in chevron traps decreased slightly in 2019 compared to 2018 but with a similar spread in the center of the composition in both years. While mean lengths have varied, they have stayed near their current range since the mid 1990's, before which they were lower. The spatial distribution of Gray Triggerfish is widespread and relatively homogeneous throughout the region in recent years (**Error! R eference source not found.**).

Table 9. Chevron trap nominal CPUE and zero-inflated negative binomial (ZINB) standardized CPUE for Gray Triggerfish and information associated with chevron trap sets included in standardized CPUE calculation. Positive = number of included collections positive for the species of interest, Proportion Positive = proportion of included collections positive for the species of interest, Normalized = CPUE (number of fish*trap^{-1}*hr^{-1}) normalized to its mean value over the time series, and CV = coefficient of variation.

					Nominal CPUE	ZINB Standardized CPUE	
Year	Included Collections	Positive	Proportion Positive	Total Fish	Normalized	Normalized	CV
1990	313	35	0.11	70	0.23	0.24	0.2
1991	272	125	0.46	372	1.41	1.26	0.12
1992	288	84	0.29	192	0.69	0.86	0.14
1993	392	114	0.29	284	0.75	0.76	0.11
1994	387	153	0.4	446	1.19	1.08	0.11
1995	361	155	0.43	668	1.91	1.35	0.1
1996	361	144	0.4	729	2.09	1.68	0.1
1997	406	166	0.41	715	1.82	1.99	0.12
1998	426	123	0.29	517	1.25	1.7	0.13
1999	233	60	0.26	188	0.83	0.87	0.16
2000	298	83	0.28	247	0.86	0.66	0.19
2001	245	86	0.35	229	0.97	0.93	0.11
2002	244	98	0.4	320	1.36	1.39	0.14
2003	224	29	0.13	53	0.24	0.6	0.23
2004	282	72	0.26	181	0.66	1.1	0.14
2005	303	93	0.31	331	1.13	0.75	0.12
2006	297	66	0.22	150	0.52	0.63	0.16
2007	337	104	0.31	309	0.95	0.79	0.13
2008	303	65	0.21	323	1.1	0.85	0.15
2009	404	80	0.2	257	0.66	0.62	0.15
2010	725	175	0.24	469	0.67	0.55	0.12
2011	726	149	0.21	537	0.76	0.73	0.11
2012	1174	326	0.28	1082	0.95	1.04	0.08
2013	1360	361	0.27	1250	0.95	1.18	0.08
2014	1472	456	0.31	1645	1.16	1.29	0.07
2015	1463	409	0.28	1100	0.78	0.89	0.07
2016	1484	510	0.34	2101	1.46	1.28	0.09
2017	1541	451	0.29	1558	1.05	1.21	0.07
2018	1736	395	0.23	1261	0.75	0.88	0.08
2019	1624	358	0.22	1324	0.84	0.84	0.09

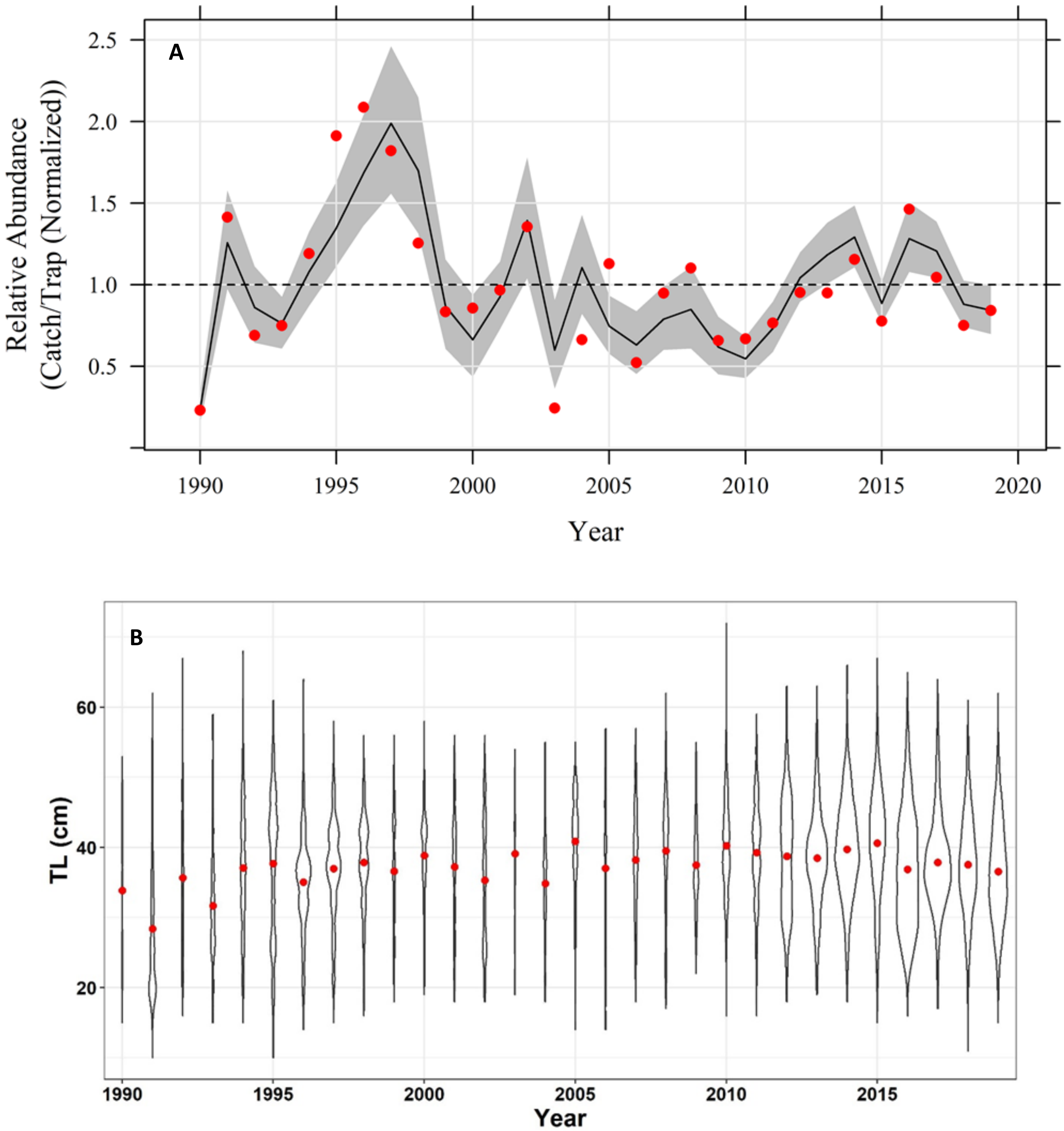


Figure 5. A) Chevron trap normalized nominal (red dot) and zero-inflated negative binomial (black line) standardized CPUE (gray area = 95% CI) for Gray Triggerfish. B) Gray Triggerfish total lengths (cm) caught in chevron traps by year. Red dots represent mean length. Vertical axis of violin represents the range of samples from a given year, while the width represents the numbers caught of that length by year.

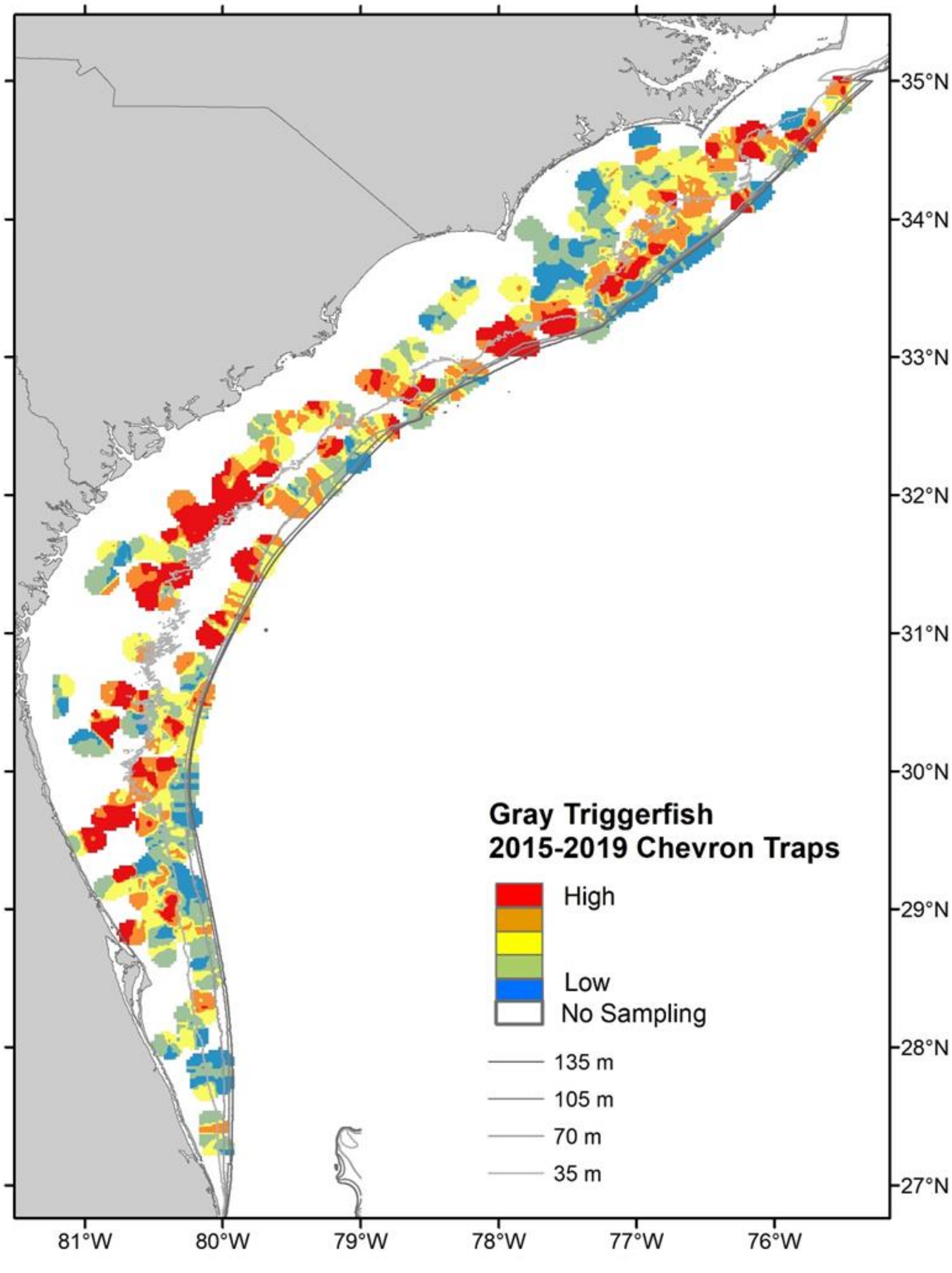


Figure 6. Distribution map of Gray Triggerfish catch by SERFS from 2015-2019. Colors indicate quartiles by catch per trap hour and white indicates areas not sampled by SERFS. The map smoothing was accomplished with inverse distance weighting.

Carangidae

Almaco Jack (*Seriola rivoliana*)

Chevron Trap

Almaco Jack were not caught with chevron traps in large enough numbers or consistently enough for development of an index of relative abundance (**Error! Reference source not found.**). The mean length o f Almaco Jack caught in chevron traps decreased in 2019 from the previous year (**Error! Reference source not found.**).

Table 10. Chevron trap catch of Almaco Jack and information associated with chevron trap sets. Positive = number of included collections positive for the species of interest, Proportion Positive = proportion of included collections positive for the species of interest.

Year	Included Collections	Positive	Proportion Positive	Total Fish
1990	313	1	0.00	1
1991	272	0	0.00	0
1992	288	1	0.00	1
1993	392	0	0.00	0
1994	387	5	0.01	7
1995	361	3	0.01	5
1996	361	1	0.00	1
1997	406	2	0.00	2
1998	426	2	0.00	2
1999	233	0	0.00	0
2000	298	3	0.01	4
2001	245	0	0.00	0
2002	244	0	0.00	0
2003	224	0	0.00	0
2004	282	1	0.00	1
2005	303	1	0.00	2
2006	297	0	0.00	0
2007	337	3	0.01	3
2008	303	2	0.01	2
2009	404	5	0.01	11
2010	725	2	0.00	2
2011	726	0	0.00	0
2012	1174	14	0.01	17
2013	1360	17	0.01	32
2014	1472	13	0.01	14
2015	1463	33	0.02	41
2016	1484	39	0.03	70
2017	1541	46	0.03	74
2018	1736	42	0.02	60
2019	1624	63	0.04	133

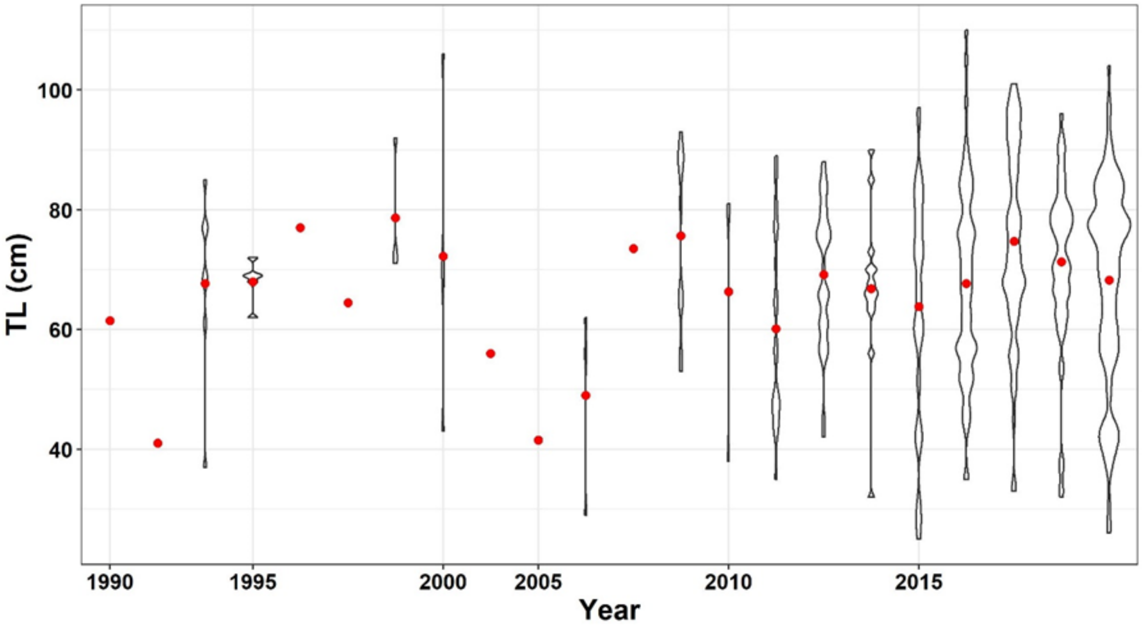


Figure 7. Almaco Jack total lengths (cm) caught with chevron trap by year. Red dots represent mean length. Vertical axis of violin represents the range of samples from a given year, while the width represents the numbers caught of that length by year.

Short Bottom Longline
Almaco Jack were not caught with SBLL in large enough numbers or consistently enough for development of an index of relative abundance (**Error! Reference source not found.**). While mean l engths of Almaco Jack continued to increase 2015-2018, catches of Almaco Jack did not occur in SBLL catches in 2019 (**Error! Reference source not found.**).

Table 11. Short bottom longline catch of Almaco Jack and information associated with SBLL. Positive = number of included collections positive for the species of interest, Proportion Positive = proportion of included collections positive for the species of interest.

Year	Included Collections	Positive	Proportion Positive	Total Fish
1996	15	0	0.00	0
1997	33	0	0.00	0
1998	31	0	0.00	0
1999	36	0	0.00	0
2000	34	0	0.00	0
2001	29	2	0.07	3
2002	19	3	0.16	3
2003	51	2	0.04	3
2004	34	4	0.12	4
2005	42	0	0.00	0
2006	50	1	0.02	2
2007	53	14	0.26	46
2008	29	1	0.03	2
2009	43	7	0.16	10
2010	83	9	0.11	11
2011	109	17	0.16	28
2012	21	0	0.00	0
2013	41	7	0.17	10
2014	57	4	0.07	4
2015	75	1	0.01	1
2016	62	6	0.10	14
2017	48	2	0.04	2
2018	66	6	0.09	8
2019	25	0	0.00	0

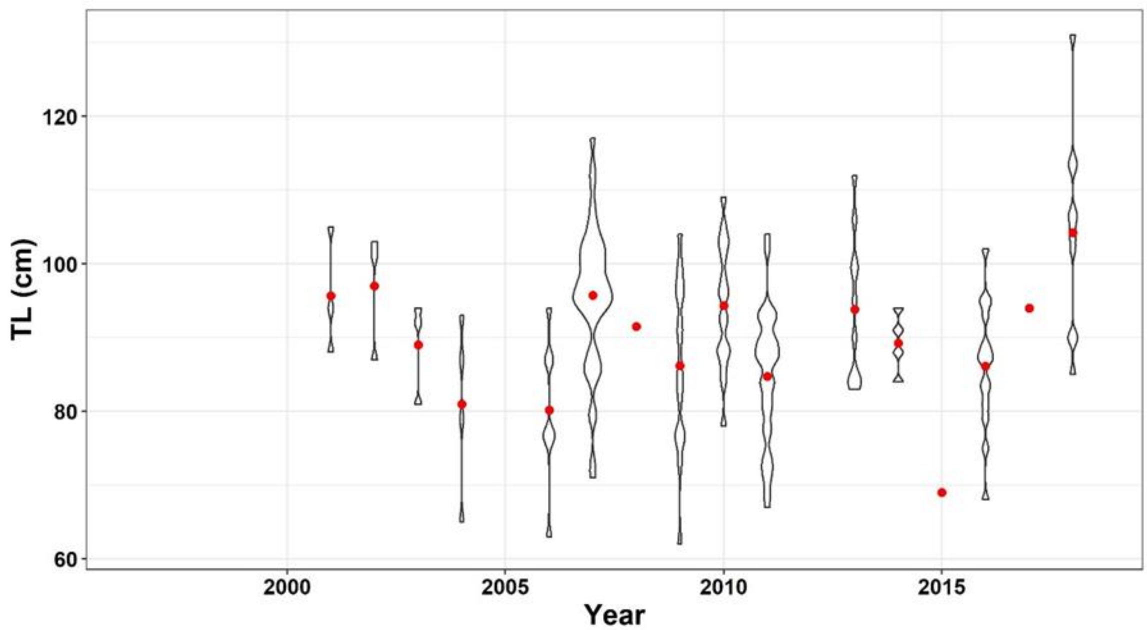


Figure 8. Almaco Jack total lengths (cm) caught with short bottom longline by year. Red dots represent mean length. Vertical axis of violin represents the range of samples from a given year, while the width represents the numbers caught of that length by year.

Greater Amberjack (*Seriola dumerili*)

Chevron Trap

Greater Amberjack were not caught with chevron traps in large enough numbers or consistently enough for development of an index of relative abundance (**Error! Reference source not found.**). The SEDAR 59 P anel also recommended not to use the chevron trap index of abundance or length or age compositions, due to lack of encounters (SEDAR 59 2020). The mean length of Greater Amberjack caught in chevron traps decreased slightly in 2019 from the previous year (**Error! Reference source not found.**).

Table 12. Chevron trap catch of Greater Amberjack and information associated with chevron trap. Positive = number of included collections positive for the species of interest, Proportion Positive = proportion of included collections positive for the species of interest.

Year	Included Collections	Positive	Proportion Positive	Total Fish
1990	313	0	0.00	0
1991	272	0	0.00	0
1992	288	0	0.00	0
1993	392	0	0.00	0
1994	387	0	0.00	0
1995	361	0	0.00	0
1996	361	1	0.00	1
1997	406	6	0.01	7
1998	426	9	0.02	12
1999	233	1	0.00	1
2000	298	3	0.01	4
2001	245	5	0.02	5
2002	244	0	0.00	0
2003	224	2	0.01	2
2004	282	1	0.00	1
2005	303	0	0.00	0
2006	297	1	0.00	1
2007	337	2	0.01	2
2008	303	0	0.00	0
2009	404	0	0.00	0
2010	725	4	0.01	4
2011	726	1	0.00	1
2012	1174	2	0.00	2
2013	1360	8	0.01	9
2014	1472	5	0.00	6
2015	1463	8	0.01	8
2016	1484	13	0.01	16
2017	1541	8	0.01	10
2018	1736	3	0.00	3
2019	1624	10	0.01	10

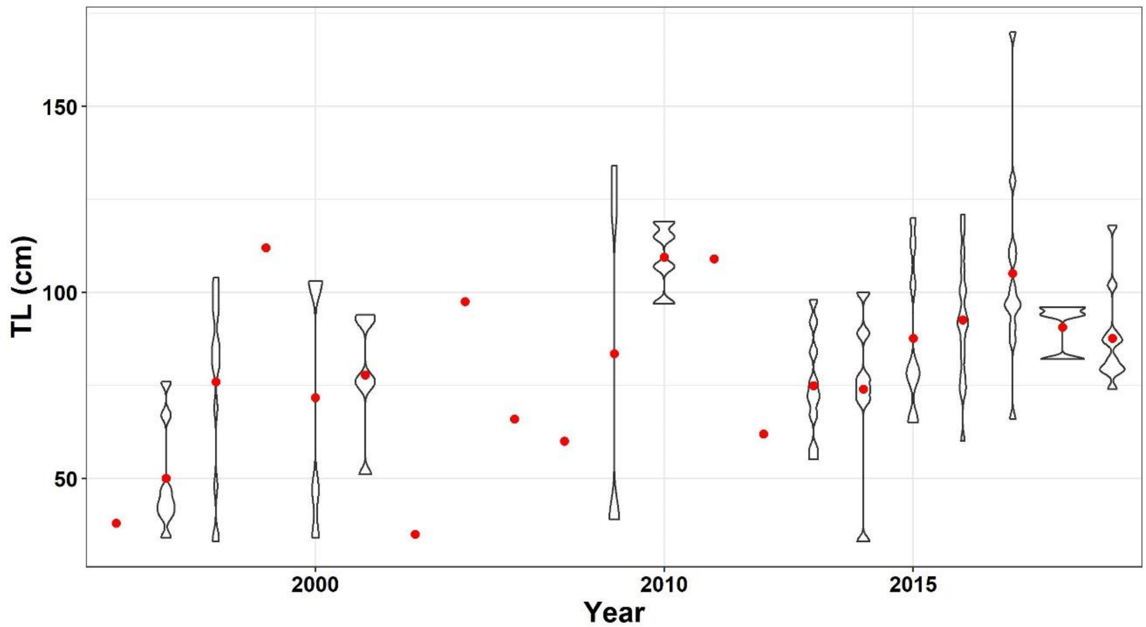


Figure 9. Greater Amberjack total lengths (cm) caught with chevron traps by year. Red dots represent mean length. Vertical axis of violin represents the range of samples from a given year, while the width represents the numbers caught of that length by year.

Short Bottom Longline

Greater Amberjack were not caught with SBLL in large enough numbers or consistently enough for development of an index of relative abundance (**Error! Reference source not found.**). The SEDAR 59 P anel also recommended not to use the short bottom longline index of abundance or length or age compositions, due to lack of encounters (SEDAR 59 2020). The mean length of Greater Amberjack caught on SBLL increased in 2019 from the previous year (**Error! Reference source not found.**).

Table 13. Short bottom longline catch of Greater Amberjack and information associated with SBLL. Positive = number of included collections positive for the species of interest, Proportion Positive = proportion of included collections positive for the species of interest.

Year	Included Collections	Positive	Proportion Positive	Total Fish
1996	15	0	0.00	0
1997	33	0	0.00	0
1998	31	0	0.00	0
1999	36	5	0.14	9
2000	34	4	0.12	9
2001	29	3	0.10	5
2002	19	2	0.11	2
2003	51	2	0.04	2
2004	34	2	0.06	3
2005	42	9	0.21	27
2006	50	3	0.06	5
2007	53	8	0.15	14
2008	29	0	0.00	0
2009	43	8	0.19	11
2010	83	3	0.04	6
2011	109	3	0.03	3
2012	21	0	0.00	0
2013	41	1	0.02	1
2014	57	3	0.05	4
2015	75	1	0.01	1
2016	62	1	0.02	1
2017	48	1	0.02	1
2018	66	7	0.11	11
2019	25	2	0.08	2

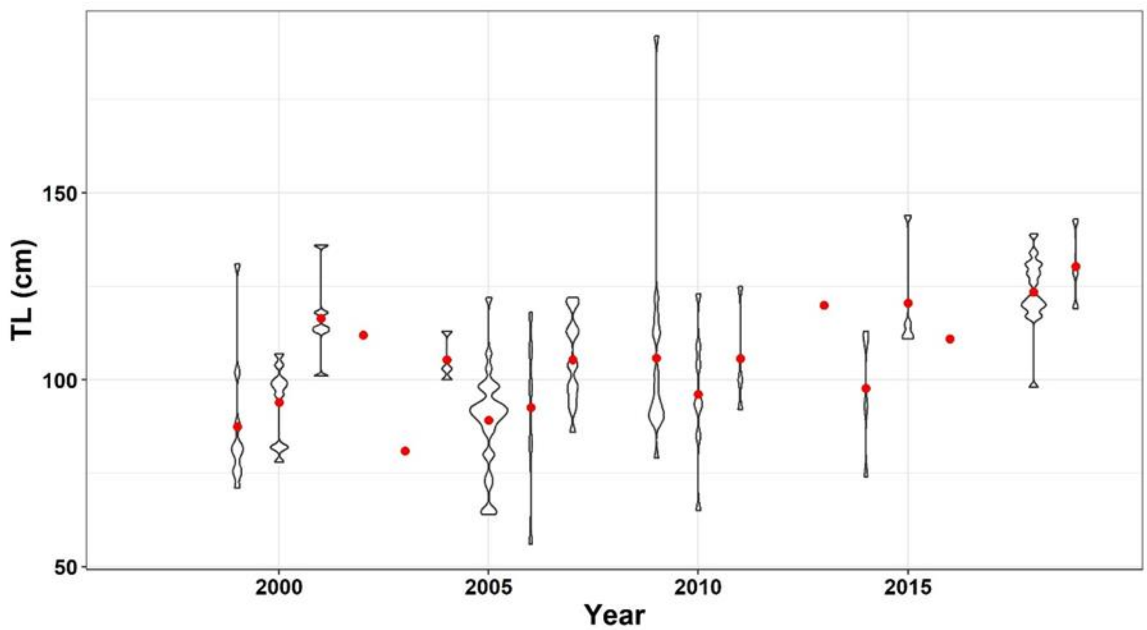


Figure 10. Greater Amberjack total lengths (cm) caught with short bottom longline by year. Red dots represent mean length. Vertical axis of violin represents the range of samples from a given year, while the width represents the numbers caught of that length by year.

Haemulidae

<u>Tomtate (*Haemulon aurolineatum*)</u>

Chevron Trap

Nominal CPUE and standardized CPUE of Tomtate caught with chevron traps decreased in 2019 relative to 2018, but both the nominal and standardized values were above the time series mean in 2019 (**Error! Reference source not found.** and **Error! Reference source not found.**A). Mean lengths of Tomtate caught in chevron traps were highest in 2013 and lowest in 1991 though mean length has remained relatively consistent throughout the time series and the core length composition has not varied since 2010 (**Error! Reference source not found.**B). The spatial distribution of Tomtate is widespread and relatively homogeneous throughout the shallower depths in the region in recent years (**Error! Reference source not found.**).

Table 14. Chevron trap nominal CPUE and zero-inflated negative binomial (ZINB) standardized CPUE for Tomtate and information associated with chevron trap sets included in standardized CPUE calculation. Positive = number of included collections positive for the species of interest, Proportion Positive = proportion of included collections positive for the species of interest, Normalized = CPUE (number of fish*trap^{-1}*hr^{-1}) normalized to its mean value over the time series, and CV = coefficient of variation.

					Nominal CPUE	ZINB Standardized CPUE	
Year	Included Collections	Positive	Proportion Positive	Total Fish	Normalized	Normalized	CV
1990	313	152	0.49	5221	1.43	1.39	0.11
1991	272	167	0.61	6932	2.18	1.38	0.09
1992	288	167	0.58	4564	1.36	1.38	0.1
1993	392	207	0.53	5467	1.19	1.47	0.11
1994	387	218	0.56	6852	1.51	1.3	0.09
1995	361	203	0.56	4401	1.04	0.85	0.11
1996	361	199	0.55	4700	1.11	1.01	0.09
1997	406	163	0.4	4352	0.92	1.06	0.14
1998	426	201	0.47	4640	0.93	1.32	0.09
1999	233	122	0.52	4111	1.51	1.21	0.11
2000	298	143	0.48	4913	1.41	1.04	0.11
2001	245	128	0.52	5061	1.77	1.41	0.13
2002	244	142	0.58	4223	1.48	1.24	0.17
2003	224	79	0.35	903	0.34	1.11	0.24
2004	282	87	0.31	2306	0.7	0.85	0.16
2005	303	109	0.36	1940	0.55	0.47	0.15
2006	297	88	0.3	1235	0.36	0.44	0.18
2007	337	110	0.33	2654	0.67	0.67	0.16
2008	303	114	0.38	2656	0.75	1.03	0.14
2009	404	123	0.3	2503	0.53	0.68	0.15
2010	725	271	0.37	6279	0.74	0.56	0.09
2011	726	278	0.38	5211	0.61	0.55	0.08
2012	1174	385	0.33	7238	0.53	0.65	0.08
2013	1360	471	0.35	8330	0.52	0.67	0.08
2014	1472	598	0.41	13164	0.76	0.7	0.07
2015	1463	573	0.39	15054	0.88	1.12	0.07
2016	1484	588	0.4	18510	1.07	0.83	0.06
2017	1541	580	0.38	17020	0.94	1.18	0.07
2018	1736	634	0.37	23653	1.17	1.33	0.06
2019	1624	592	0.36	19733	1.04	1.1	0.06

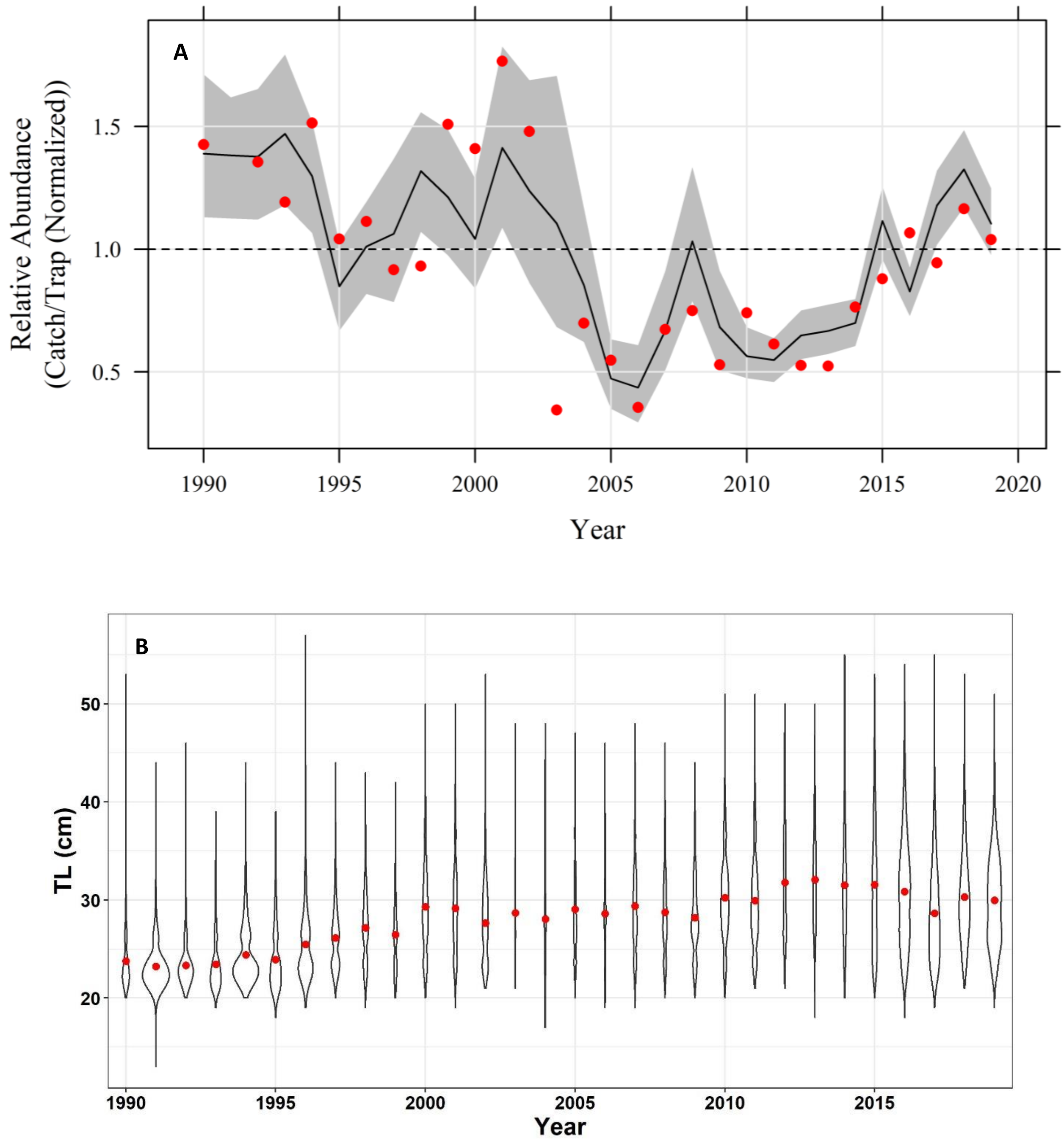


Figure 11. A) Chevron trap normalized nominal (red dot) and zero-inflated negative binomial (black line) standardized CPUE (gray area = 95% CI) for Tomtate. B) Tomtate total lengths (cm) caught in chevron traps by year. Red dots represent mean length. Vertical axis of violin represents the range of samples from a given year, while the width represents the numbers caught of that length by year.

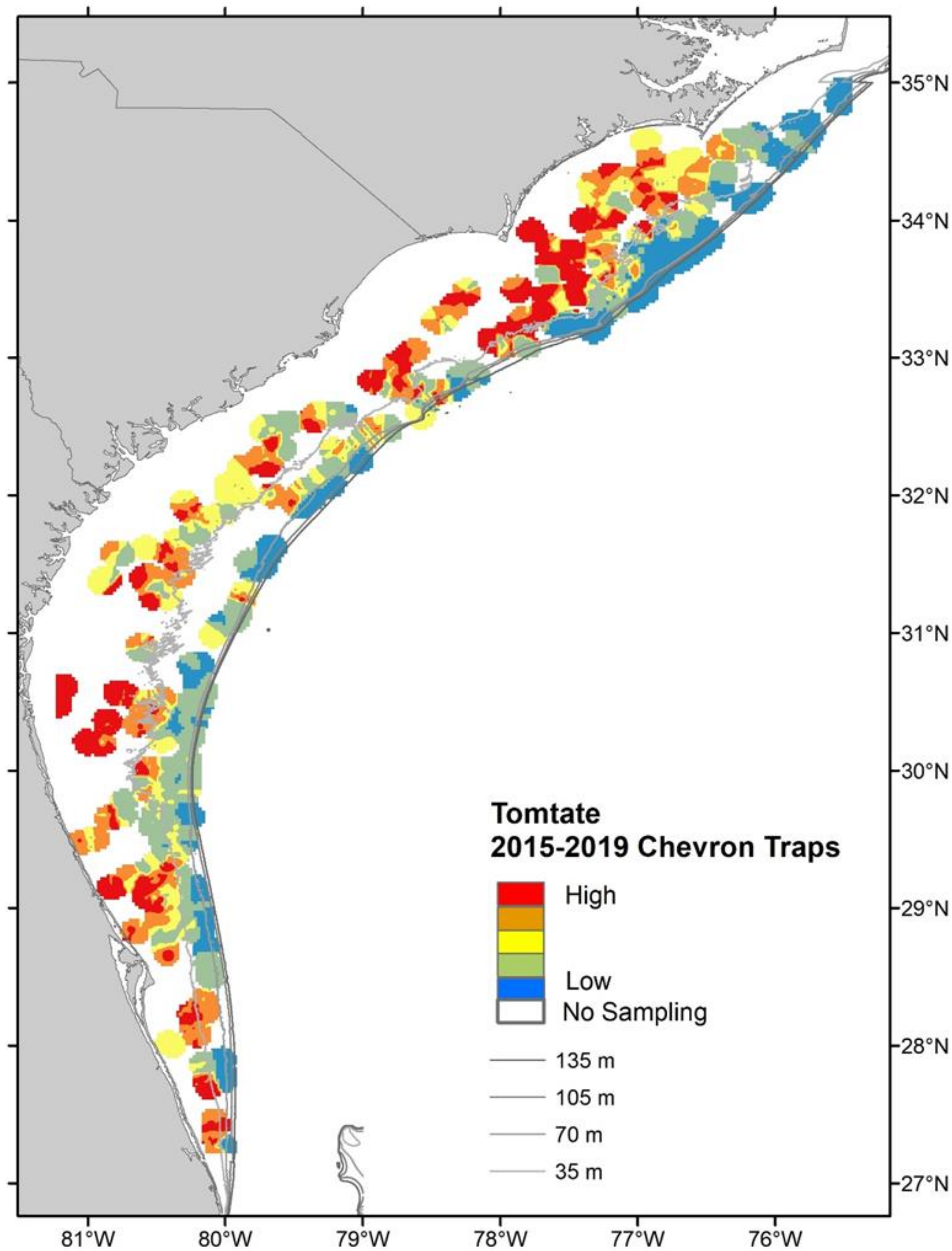


Figure 12. Distribution map of <u>Tomtate</u> catch by SERFS from 2015-2019. Colors indicate quartiles by catch per trap hour and white indicates areas not sampled by SERFS. The map smoothing was accomplished with inverse distance weighting.

White Grunt (*Haemulon plumierii*)

Chevron Trap

The nominal CPUE of White Grunt caught in chevron traps in 2019 showed an increase relative to 2018 while the standardized CPUE exhibited a slight decrease, however, both values were above the time series mean for the third year in a row, which had not happened for even one year since 2004 (**Error! Reference source not found.** and **Error! Reference source not found.**A). Mean lengths of White Grunt caught in chevron traps were highly variable, with the lowest values in 2004 and highest in 2010. The size of White Grunt caught in chevron traps in 2019 increased relative to the previous year while the size composition of catches remained relatively consistent between years (**Error! Reference source not found.**B). The spatial distribution of White Grunt is centered mainly in the shallower waters off the northern portion of the region, with highest abundances off of North Carolina in recent years (**Error! Reference source not found.**).

Table 15. Chevron trap nominal CPUE and zero-inflated negative binomial (ZINB) standardized CPUE for White Grunt and information associated with chevron trap sets included in standardized CPUE calculation. Positive = number of included collections positive for the species of interest, Proportion Positive = proportion of included collections positive for the species of interest, Normalized = CPUE (number of fish*trap^{-1}*hr^{-1}) normalized to its mean value over the time series, and CV = coefficient of variation.

					Nominal CPUE	ZINB Standardized CPUE	
Year	Included Collections	Positive	Proportion Positive	Total Fish	Normalized	Normalized	CV
1990	313	41	0.13	324	1.3	1.13	0.24
1991	272	56	0.21	441	2.04	1.49	0.22
1992	288	82	0.28	487	2.13	2.29	0.23
1993	392	59	0.15	424	1.36	2.03	0.21
1994	387	44	0.11	293	0.95	0.83	0.22
1995	361	49	0.14	207	0.72	1.38	0.21
1996	361	75	0.21	352	1.23	1.5	0.13
1997	406	53	0.13	182	0.56	1.07	0.18
1998	426	68	0.16	356	1.05	0.95	0.15
1999	233	31	0.13	125	0.68	0.65	0.2
2000	298	38	0.13	243	1.03	0.85	0.24
2001	245	44	0.18	259	1.33	1.02	0.17
2002	244	43	0.18	296	1.53	1.08	0.18
2003	224	34	0.15	100	0.56	0.88	0.24
2004	282	37	0.13	391	1.75	1.18	0.17
2005	303	39	0.13	136	0.57	0.91	0.24
2006	297	35	0.12	104	0.44	0.4	0.26
2007	337	39	0.12	130	0.49	0.45	0.17
2008	303	31	0.1	102	0.42	0.44	0.24
2009	404	40	0.1	153	0.48	0.47	0.24
2010	725	38	0.05	90	0.16	0.32	0.18
2011	726	51	0.07	109	0.19	0.56	0.17
2012	1174	102	0.09	327	0.35	0.59	0.12
2013	1360	105	0.08	519	0.48	0.93	0.2
2014	1472	304	0.21	1836	1.57	0.92	0.09
2015	1463	220	0.15	1264	1.09	0.96	0.1
2016	1484	242	0.16	1270	1.08	0.73	0.1
2017	1541	242	0.16	1666	1.36	1.41	0.12
2018	1736	260	0.15	1960	1.42	1.29	0.11
2019	1624	265	0.16	2168	1.68	1.28	0.13

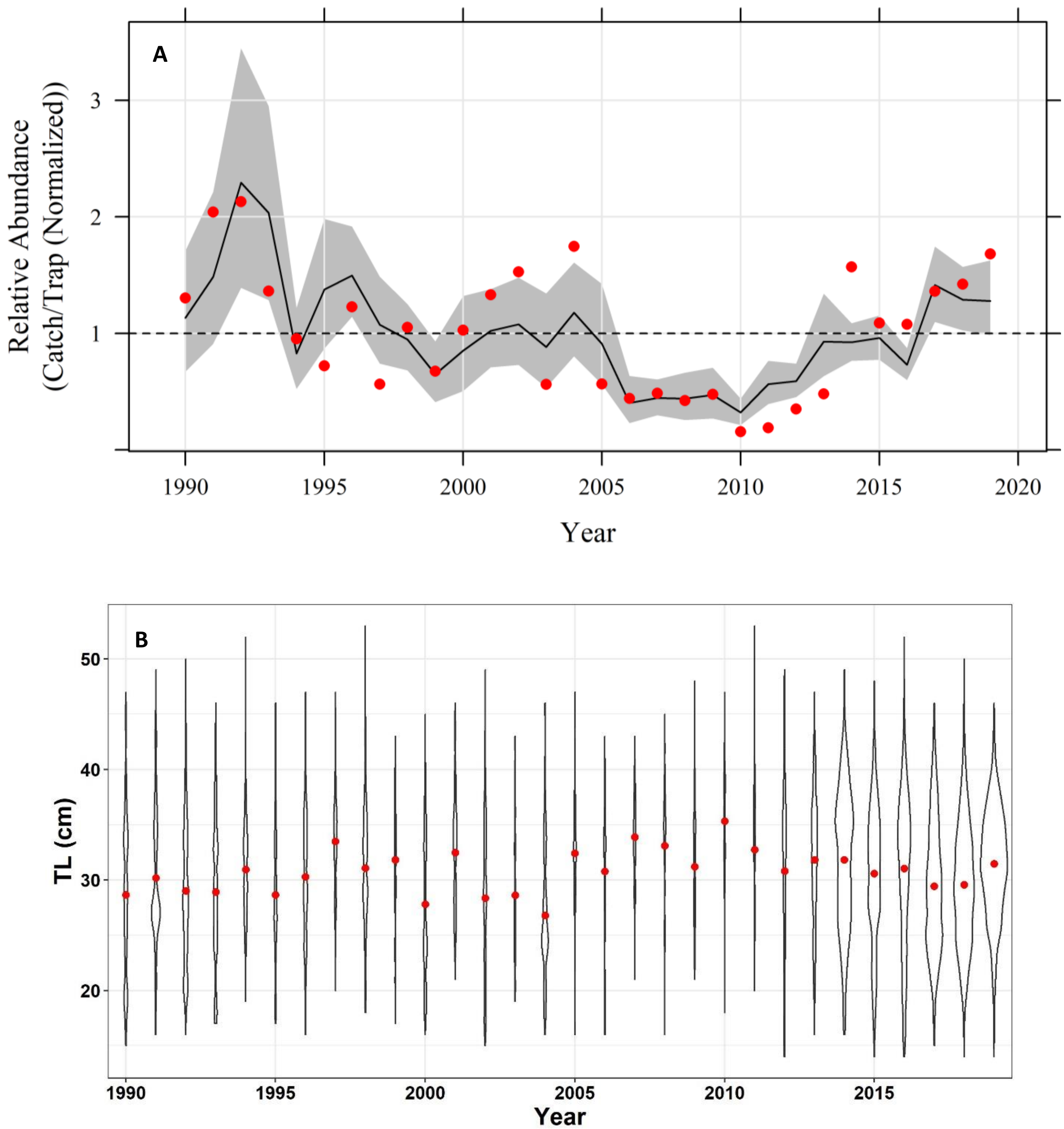


Figure 13. A) Chevron trap normalized nominal (red dot) and zero-inflated negative binomial (black line) standardized CPUE (gray area = 95% CI) for White Grunt. B) White Grunt total lengths (cm) caught in chevron traps by year. Red dots represent mean length. Vertical axis of violin represents the range of samples from a given year, while the width represents the numbers caught of that length by year.

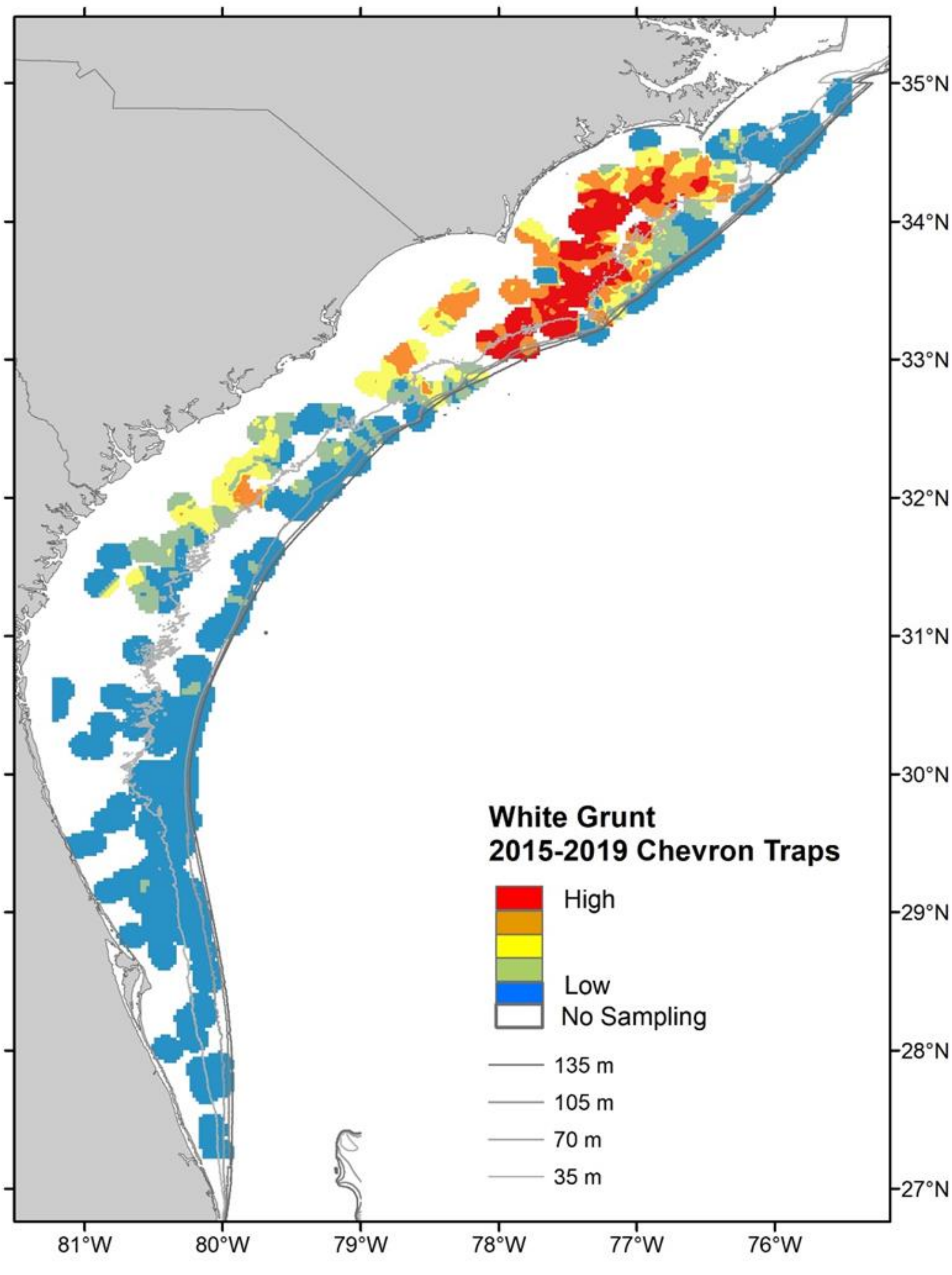


Figure 14. Distribution map of White Grunt catch by SERFS from 2015-2019. Colors indicate quartiles by catch per trap hour and white indicates areas not sampled by SERFS. The map smoothing was accomplished with inverse distance weighting.

Lutjanidae

Red Snapper (*Lutjanus campechanus*)

Chevron Trap

Both nominal and standardized CPUE of Red Snapper caught with chevron traps in 2019 showed a decrease from the time series' highest value in 2018 (**Error! Reference source not found.**6 and **Error! Reference source not found.**5A). This also marked a change from the increasing trend that occurred 2013-2018. Red Snapper lengths were variable during the time series, with a series low in 2003 and a high in 1996 (**Error! Reference source not found.**5B). The size and range of lengths of Red Snapper caught in chevron traps decreased slightly in 2019 from the previous year with fewer larger specimens caught. The spatial distribution of Red Snapper is centered mainly in the southern portion of the region, with highest abundances off Florida. There also are relatively high abundances in the most northerly area in recent years (**Error! Reference source not found.**).

Table 16. Chevron trap nominal CPUE and zero-inflated negative binomial (ZINB) standardized CPUE for Red Snapper and information associated with chevron trap sets included in standardized CPUE calculation. Positive = number of included collections positive for the species of interest, Proportion Positive = proportion of included collections positive for the species of interest, Normalized = CPUE (number of fish*trap^{-1}*hr^{-1}) normalized to its mean value over the time series, and CV = coefficient of variation.

					Nominal CPUE	ZINB Standardized CPUE	
Year	Included Collections	Positive	Proportion Positive	Total Fish	Normalized	Normalized	CV
1990	313	7	0.02	23	0.31	0.65	0.58
1991	272	6	0.02	17	0.27	0.53	0.66
1992	288	8	0.03	20	0.3	1.1	0.48
1993	392	12	0.03	31	0.34	0.76	0.43
1994	387	19	0.05	45	0.5	0.95	0.52
1995	361	7	0.02	13	0.15	0.21	0.5
1996	361	6	0.02	6	0.07	0.13	0.51
1997	406	6	0.01	24	0.25	0.35	0.55
1998	426	8	0.02	25	0.25	0.51	0.65
1999	233	4	0.02	22	0.4	0.78	0.51
2000	298	8	0.03	17	0.24	0.37	0.53
2001	245	7	0.03	9	0.16	0.46	0.55
2002	244	13	0.05	33	0.58	0.84	0.41
2003	224	1	0	7	0.13	0.67	0.84
2004	282	4	0.01	5	0.08	0.3	0.58
2005	303	7	0.02	12	0.17	0.23	0.51
2006	297	5	0.02	6	0.09	0.16	0.47
2007	337	8	0.02	29	0.37	0.56	0.66
2008	303	7	0.02	19	0.27	0.61	0.45
2009	404	8	0.02	10	0.11	0.19	0.37
2010	725	65	0.09	152	0.9	0.64	0.2
2011	726	67	0.09	118	0.7	0.62	0.22
2012	1174	145	0.12	410	1.49	1.16	0.14
2013	1360	140	0.1	367	1.15	0.86	0.15
2014	1472	150	0.1	614	1.78	1.44	0.15
2015	1463	159	0.11	905	2.65	2.15	0.15
2016	1484	213	0.14	1075	3.1	2.8	0.14
2017	1541	245	0.16	1499	4.16	3.13	0.12
2018	1736	275	0.16	1925	4.74	3.95	0.13
2019	1624	276	0.17	1632	4.3	2.89	0.11

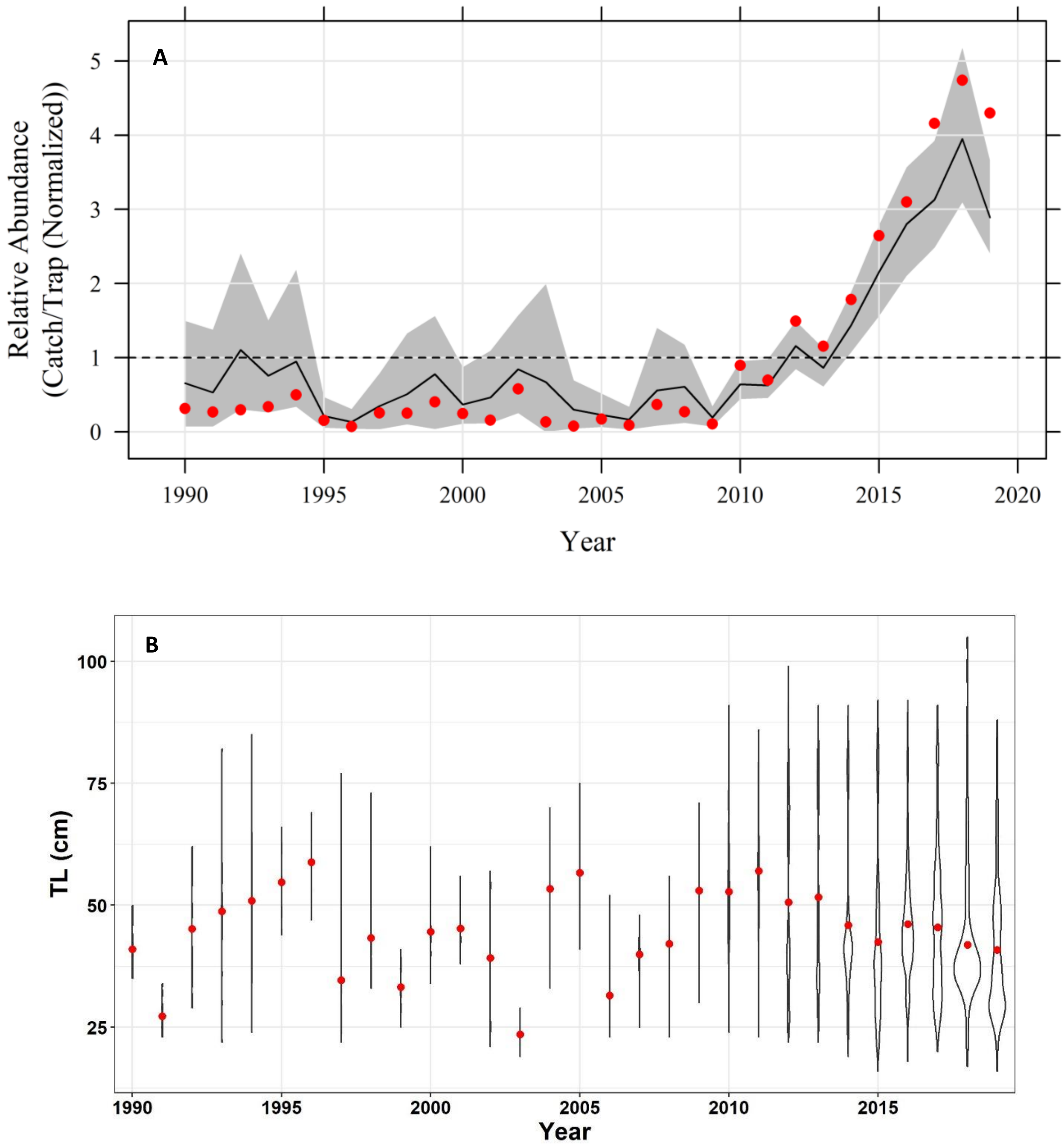


Figure 15. A) <u>Chevron trap</u> normalized nominal (red dot) and zero-inflated negative binomial (black line) standardized CPUE (gray area = 95% CI) for <u>Red Snapper</u>. B) Red Snapper total lengths (cm) caught in chevron traps by year. Red dots represent mean length. Vertical axis of violin represents the range of samples from a given year, while the width represents the numbers caught of that length by year.

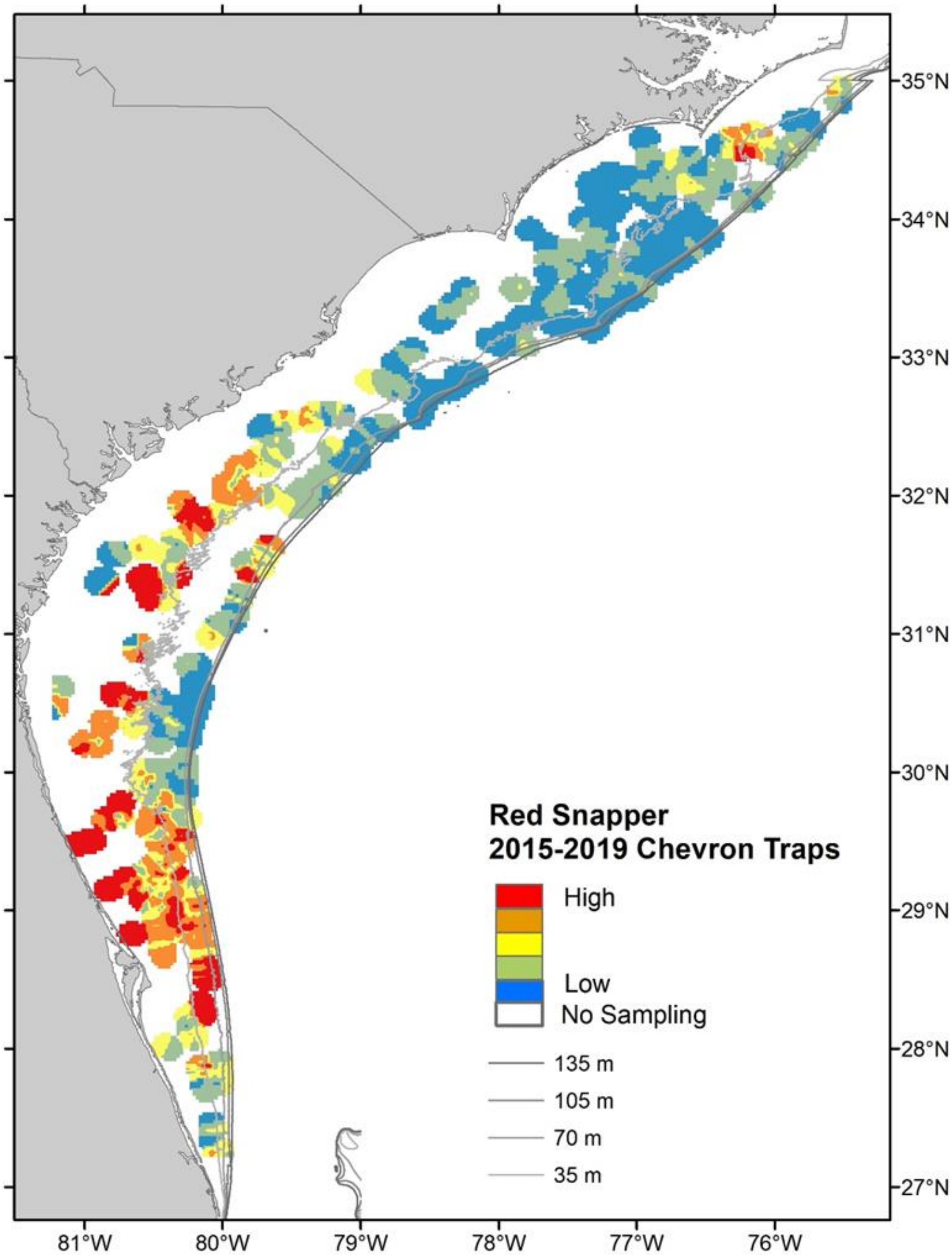


Figure 16. Distribution map of Red Snapper catch by SERFS 2015-2019. Colors indicate quartiles by catch per trap hour and white indicates areas not sampled by SERFS. The map smoothing was accomplished with inverse distance weighting.

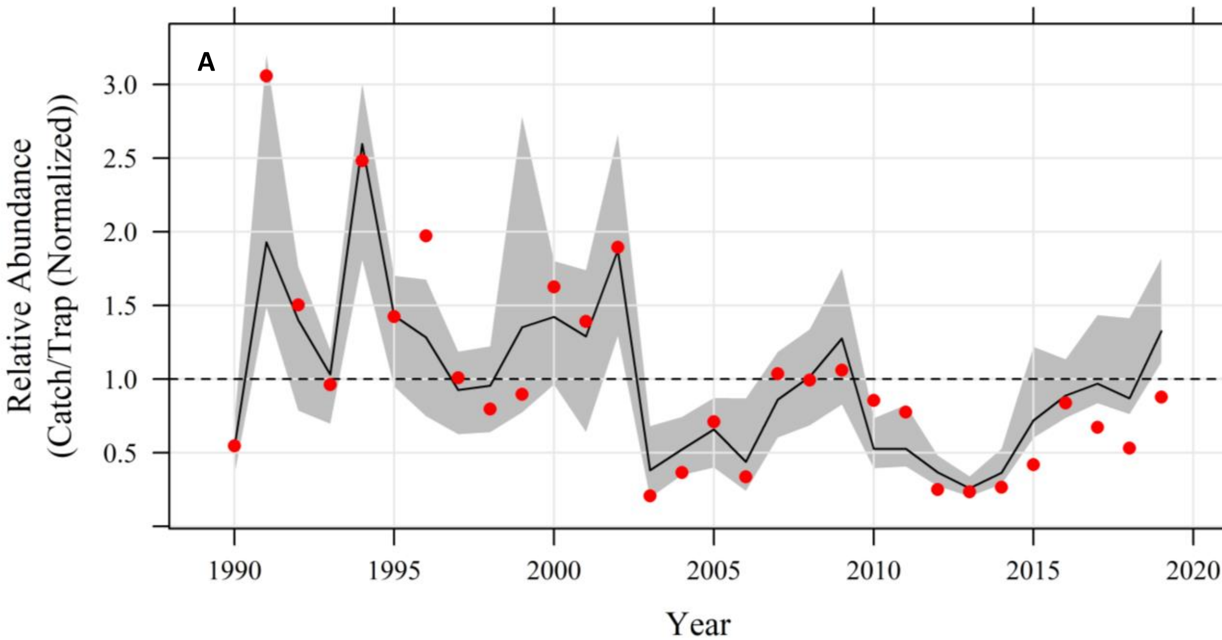
Vermilion Snapper (*Rhomboplites aurorubens*)

Chevron Trap

Nominal CPUE and standardized CPUE of Vermilion Snapper caught with chevron traps increased in 2019 from the previous year. The nominal value was below the time series mean, while the standardized value was above the time series mean for the first time since 2009 (**Error! Reference source not found.** a nd **Error! Reference source not found.**A). The mean length of Vermilion Snapper caught in chevron traps in 2019 decreased slightly from the previous year (**Error! Reference source not found.**B). The spatial distribution of Vermilion Snapper is centered in the middle portion of the region but still prevalent throughout the region in recent years (**Error! Reference source not found.**).

Table 17. Chevron trap nominal CPUE and zero-inflated negative binomial (ZINB) standardized CPUE for Vermilion Snapper and information associated with chevron trap sets included in standardized CPUE calculation. Positive = number of included collections positive for the species of interest, Proportion Positive = proportion of included collections positive for the species of interest, Normalized = CPUE (number of fish*trap^{-1}*hr^{-1}) normalized to its mean value over the time series, and CV = coefficient of variation.

					Nominal CPUE	ZINB Standardized CPUE	
Year	Included Collections	Positive	Proportion Positive	Total Fish	Normalized	Normalized	CV
1990	313	86	0.27	595	0.55	0.54	0.17
1991	272	142	0.52	2891	3.06	1.93	0.23
1992	288	105	0.36	1505	1.5	1.4	0.18
1993	392	126	0.32	1312	0.96	1.03	0.12
1994	387	175	0.45	3338	2.48	2.6	0.12
1995	361	135	0.37	1786	1.42	1.43	0.13
1996	361	122	0.34	2475	1.97	1.28	0.18
1997	406	100	0.25	1424	1.01	0.93	0.15
1998	426	110	0.26	1180	0.8	0.95	0.16
1999	233	74	0.32	726	0.9	1.35	0.38
2000	298	104	0.35	1684	1.63	1.42	0.15
2001	245	83	0.34	1184	1.39	1.29	0.22
2002	244	102	0.42	1606	1.89	1.87	0.19
2003	224	31	0.14	162	0.21	0.38	0.32
2004	282	67	0.24	358	0.37	0.52	0.19
2005	303	80	0.26	749	0.71	0.66	0.18
2006	297	54	0.18	347	0.34	0.44	0.36
2007	337	80	0.24	1214	1.04	0.86	0.17
2008	303	74	0.24	1046	0.99	1.02	0.17
2009	404	97	0.24	1489	1.06	1.28	0.19
2010	725	194	0.27	2156	0.86	0.53	0.17
2011	726	147	0.2	1957	0.78	0.53	0.2
2012	1174	172	0.15	1020	0.25	0.37	0.15
2013	1360	178	0.13	1110	0.23	0.26	0.13
2014	1472	223	0.15	1363	0.27	0.36	0.17
2015	1463	291	0.2	2132	0.42	0.72	0.22
2016	1484	378	0.25	4322	0.84	0.89	0.11
2017	1541	337	0.22	3606	0.67	0.97	0.16
2018	1736	339	0.2	3209	0.53	0.87	0.2
2019	1624	390	0.24	4959	0.88	1.33	0.14



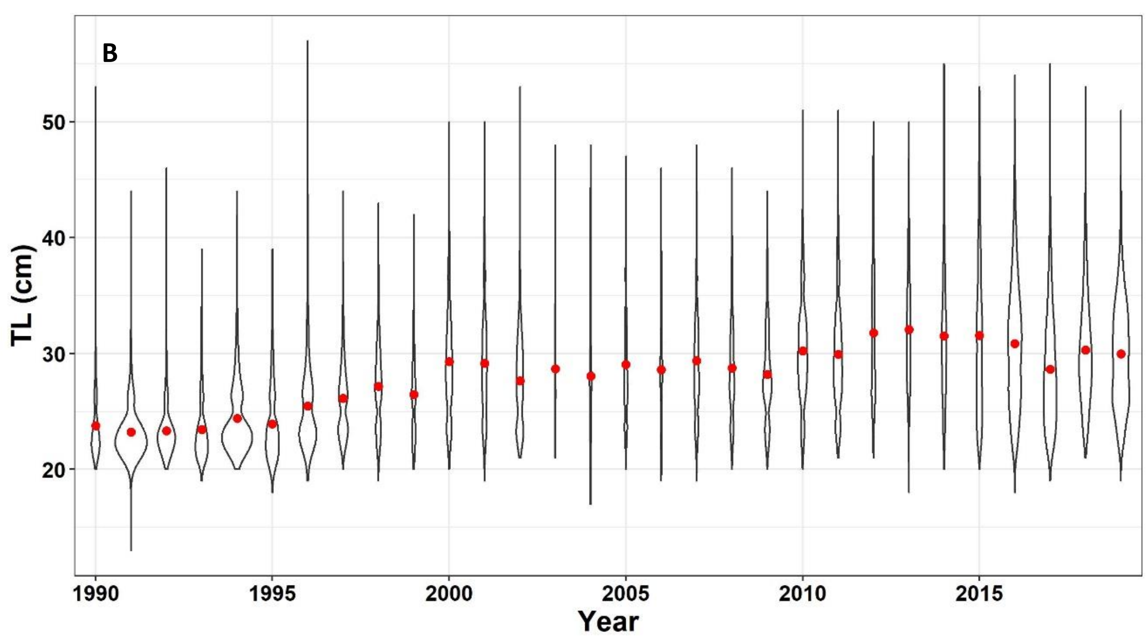


Figure 17. A) Chevron trap normalized nominal (red dot) and zero-inflated negative binomial (black line) standardized CPUE (gray area = 95% CI) for Vermilion Snapper. B) Vermilion Snapper total lengths (cm) caught in chevron traps by year. Red dots represent mean length. Vertical axis of violin represents the range of samples from a given year, while the width represents the numbers caught of that length by year.

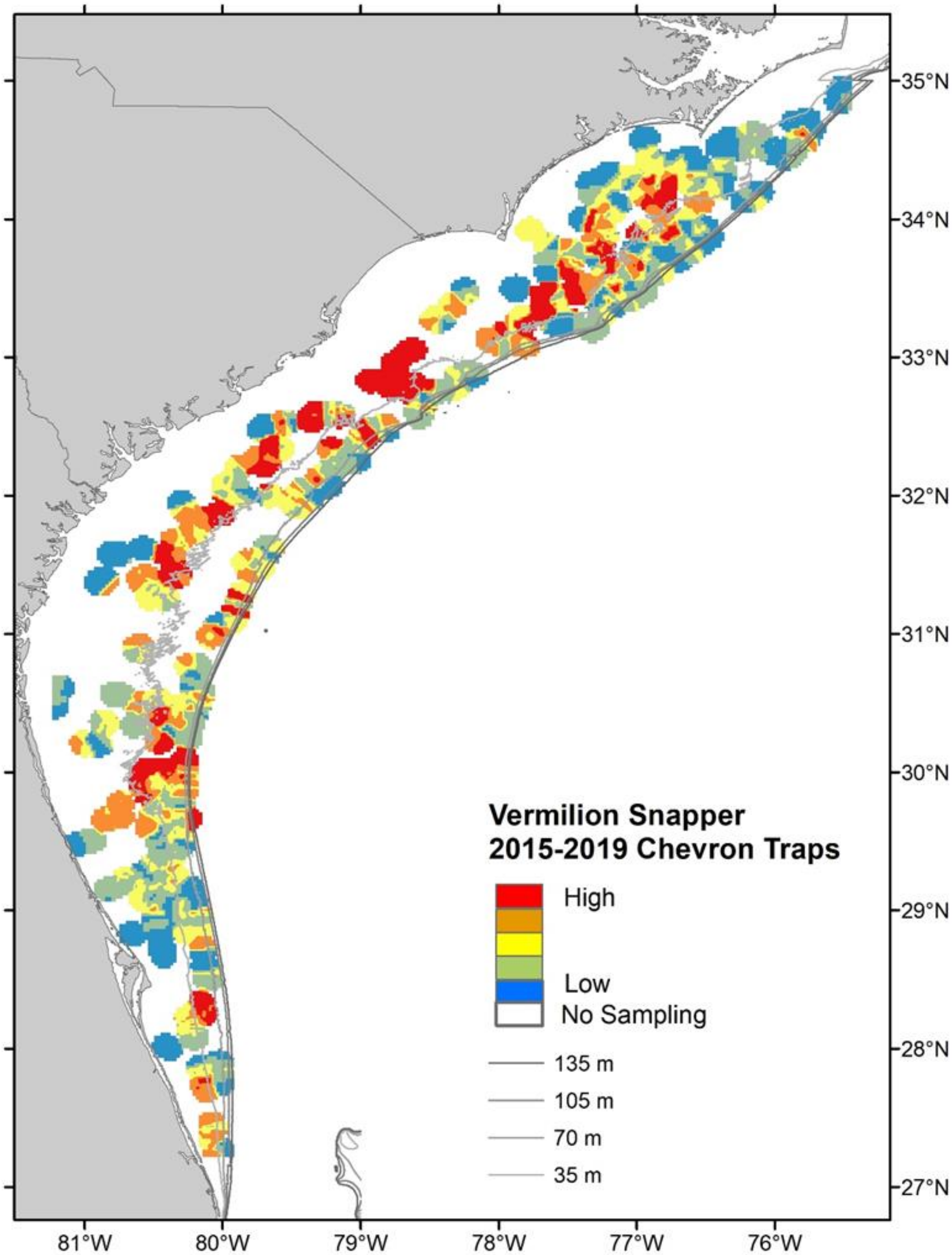


Figure 18. Distribution map of Vermilion Snapper catch by SERFS from 2015-2019. Colors indicate quartiles by catch per trap hour and white indicates areas not sampled by SERFS. The map smoothing was accomplished with inverse distance weighting.

Malacanthidae

Blueline Tilefish (*Caulolatilus microps*)

Chevron Trap
Blueline Tilefish were not caught with chevron traps in large enough numbers or consistently enough for development of an index of relative abundance (**Error! Reference source not found.**). However, in p revious years, the increased proportion positive within the traps along with the increased numbers of traps deployed since the collaboration with SEFIS may make this a viable gear for an index of relative abundance in the future. Blueline Tilefish mean lengths decreased from 2018 (**Error! Reference source n ot found.**).

Table 18. Chevron trap catch of Blueline Tilefish and information associated with chevron trap sets. Positive = number of included collections positive for the species of interest, Proportion Positive = proportion of included collections positive for the species of interest.

Year	Included Collections	Positive	Proportion Positive	Total Fish
1990	313	2	0.01	2
1991	272	1	0.00	1
1992	288	0	0.00	0
1993	392	0	0.00	0
1994	387	2	0.01	2
1995	361	0	0.00	0
1996	361	3	0.01	6
1997	406	0	0.00	0
1998	426	1	0.00	1
1999	233	0	0.00	0
2000	298	1	0.00	1
2001	245	2	0.01	4
2002	244	1	0.00	2
2003	224	2	0.01	3
2004	282	2	0.01	3
2005	303	0	0.00	0
2006	297	2	0.01	2
2007	337	3	0.01	5
2008	303	0	0.00	0
2009	404	1	0.00	1
2010	725	1	0.00	1
2011	726	7	0.01	11
2012	1174	17	0.01	32
2013	1360	9	0.01	13
2014	1472	17	0.01	30
2015	1463	5	0.00	12
2016	1484	13	0.01	31
2017	1541	22	0.01	36
2018	1736	11	0.01	16
2019	1624	6	0.00	11

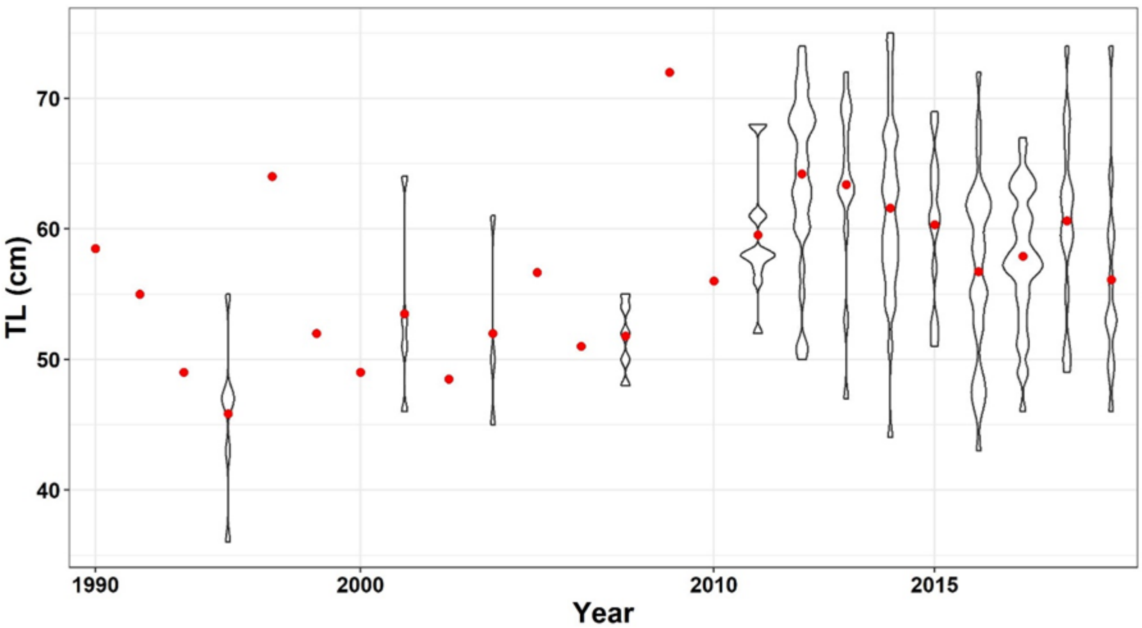


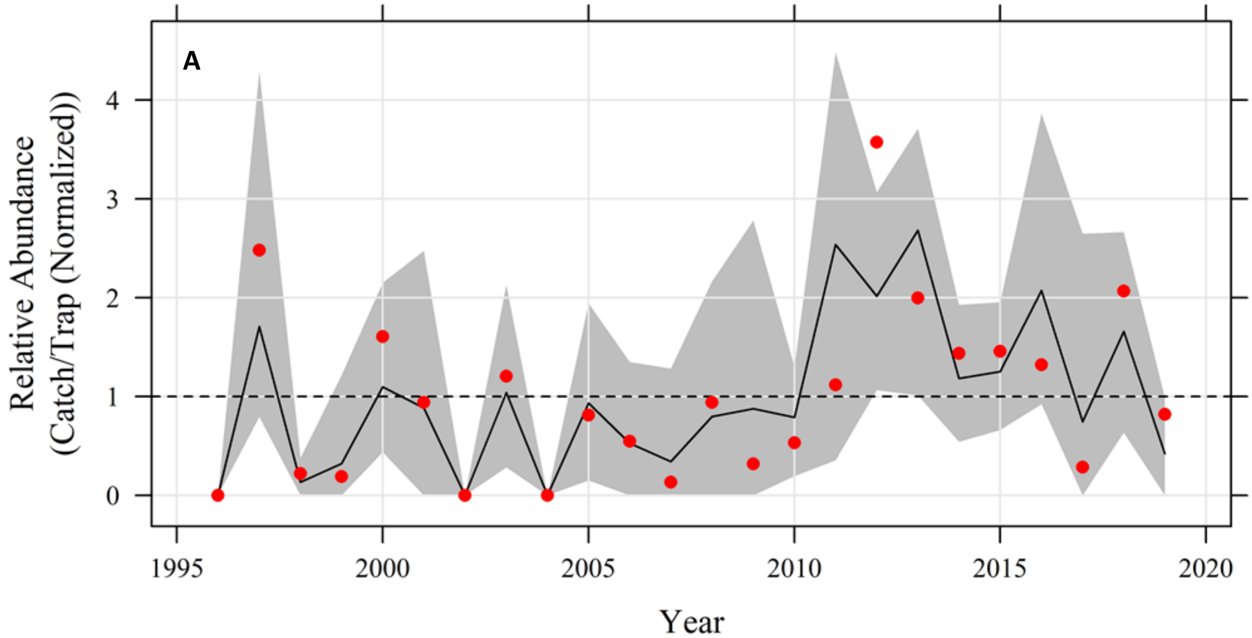
Figure 19. Blueline Tilefish total lengths (cm) caught with chevron trap by year. Red dots represent mean length. Vertical axis of violin represents the range of samples from a given year, while the width represents the numbers caught of that length by year

Short bottom longline

Nominal and standardized (zero-inflated Poisson distribution) CPUE in 2019 of Blueline Tilefish caught with SBLLs decreased from 2018, with both being below the time series mean (**Error! Reference source not found.** and **Error! Reference source not found.**). lueline Tilefish mean lengths increased from 2018, but there were only 3 fish caught in 2019 (Table 19 and **Error! Reference source not found.**). Blueline Tilefish mean lengths increased from 2018 (**Error! Reference source not found.**B). The spatial distribution of Blueline Tilefish is in deeper waters off of South Carolina in recent years, but caution should be taken as that is where the majority of SBLL stations have been sampled in recent years (**Error! Reference source not found.**).

Table 19. Short bottom longline nominal CPUE and zero-inflated poisson (ZIP) standardized CPUE for Blueline Tilefish and information associated with SBLL sets included in standardized CPUE calculation. Positive = number of included collections positive for the species of interest, Proportion Positive = proportion of included collections positive for the species of interest, Normalized = CPUE (number of fish*20 hooks^{-1}*hr^{-1}) normalized to its mean value over the time series, and CV = coefficient of variation.

					Nominal CPUE	ZIP Standardized CPUE	
Year	**Included Collections**	**Positive**	**Proportion Positive**	**Total Fish**	**Normalized**	**Normalized**	**CV**
1996	12	0	0	0	0	0	0.39
1997	33	9	0.27	12	2.48	1.71	0.53
1998	31	1	0.03	1	0.22	0.13	0.85
1999	36	1	0.03	1	0.19	0.32	1.13
2000	34	7	0.21	8	1.61	1.1	0.39
2001	29	3	0.1	4	0.94	0.88	0.7
2002	19	0	0	0	0	0	0.42
2003	51	6	0.12	9	1.2	1.04	0.46
2004	21	0	0	0	0	0	0.37
2005	42	4	0.1	5	0.81	0.93	0.5
2006	50	3	0.06	4	0.55	0.52	0.68
2007	52	1	0.02	1	0.13	0.34	1.13
2008	29	3	0.1	4	0.94	0.8	0.69
2009	43	2	0.05	2	0.32	0.88	0.86
2010	77	6	0.08	6	0.53	0.79	0.36
2011	61	6	0.1	10	1.12	2.54	0.43
2012	21	10	0.48	11	3.57	2.02	0.26
2013	41	10	0.24	12	2	2.68	0.26
2014	57	9	0.16	12	1.44	1.18	0.3
2015	75	14	0.19	16	1.46	1.25	0.26
2016	62	9	0.15	12	1.32	2.07	0.37
2017	48	2	0.04	2	0.28	0.74	1.1
2018	66	14	0.21	20	2.07	1.66	0.31
2019	25	3	0.12	3	0.82	0.42	0.6



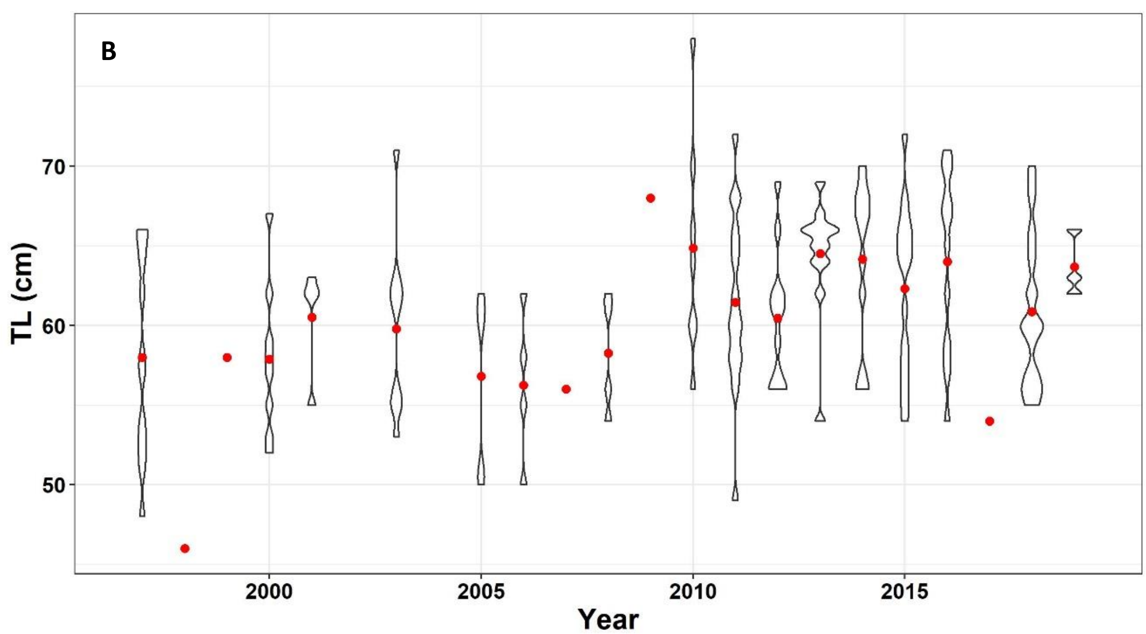


Figure 20. A) Short bottom longline normalized nominal (red dot) and zero-inflated poisson (black line) standardized CPUE (gray area = 95% CI) for Blueline Tilefish. B) Blueline Tilefish total lengths (cm) caught with SBLL by year. Red dots represent mean length. Vertical axis of violin represents the range of samples from a given year, while the width represents the numbers caught of that length by year.

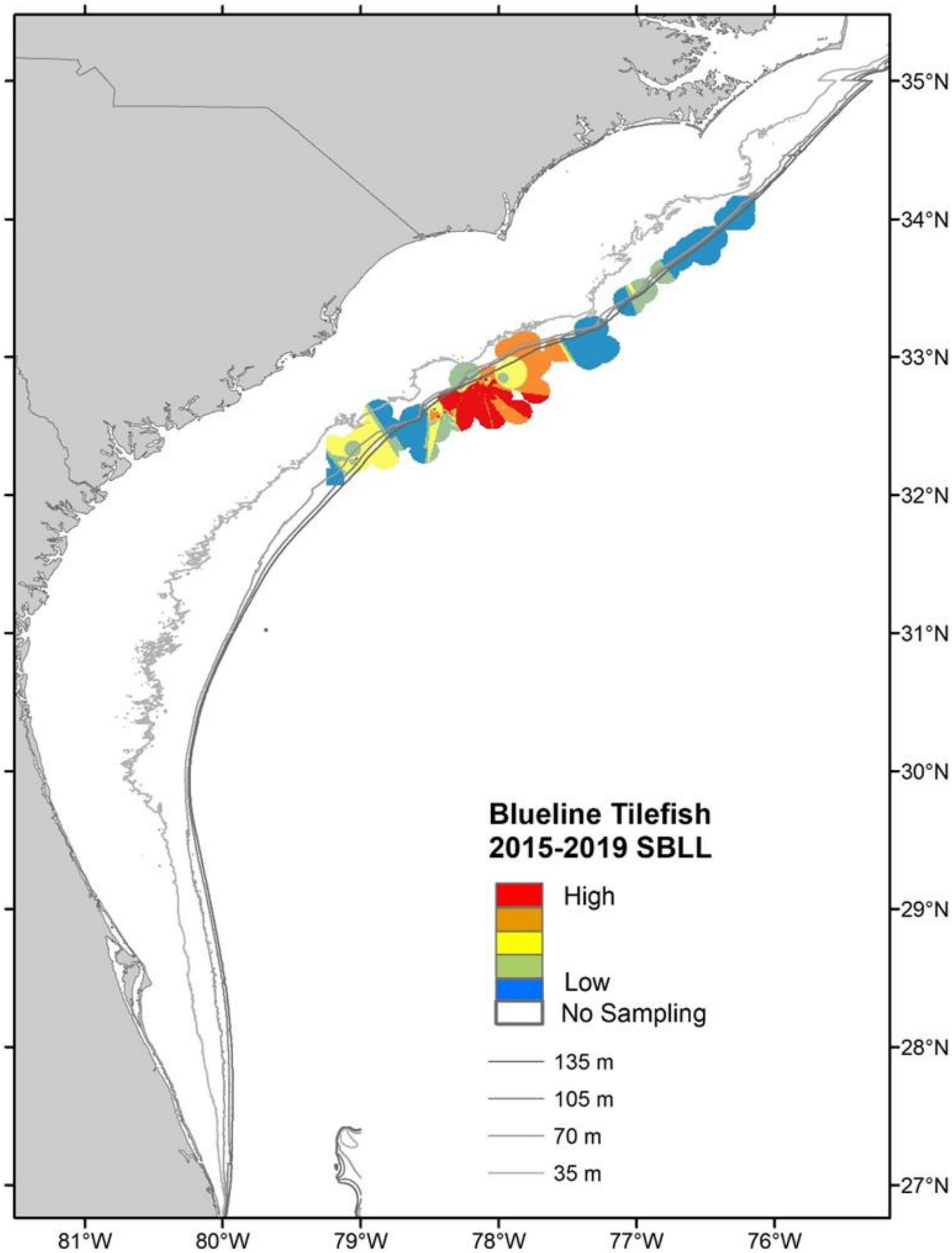


Figure 21. Distribution map of <u>Blueline Tilefish</u> catch by SERFS from 2015-2019. Colors indicate quartiles by catch per trap hour and white indicates areas not sampled by SERFS. The map smoothing was accomplished with inverse distance weighting.

Golden Tilefish (*Lopholatilus chamaeleonticeps*)

Short bottom longline
Golden Tilefish were not caught with SBLL in large enough numbers or consistently enough for development of an index of relative abundance (**Error! Reference source not found.**). Golden Tilefish m ean lengths decrease slightly from previous year, however, it must be noted that only three specimens have been caught since 2016 (Table 20, **Error! Reference source not found.**).

Table 20. Short bottom longline catch of Golden Tilefish and information associated with SBLL sets. Positive = number of included collections positive for the species of interest, Proportion Positive = proportion of included collections positive for the species of interest.

Year	Included Collections	Positive	Proportion Positive	Total Fish
1996	15	2	0.13	2
1997	33	5	0.15	6
1998	31	4	0.13	5
1999	36	2	0.06	5
2000	34	6	0.18	8
2001	29	7	0.24	17
2002	19	0	0.00	0
2003	51	5	0.10	6
2004	34	0	0.00	0
2005	42	1	0.02	1
2006	50	11	0.22	18
2007	53	0	0.00	0
2008	29	1	0.03	1
2009	43	5	0.12	9
2010	83	6	0.07	8
2011	109	8	0.07	8
2012	21	0	0.00	0
2013	41	4	0.10	7
2014	57	4	0.07	5
2015	75	10	0.13	12
2016	62	5	0.08	5
2017	48	0	0.00	0
2018	66	2	0.03	2
2019	25	1	0.04	1

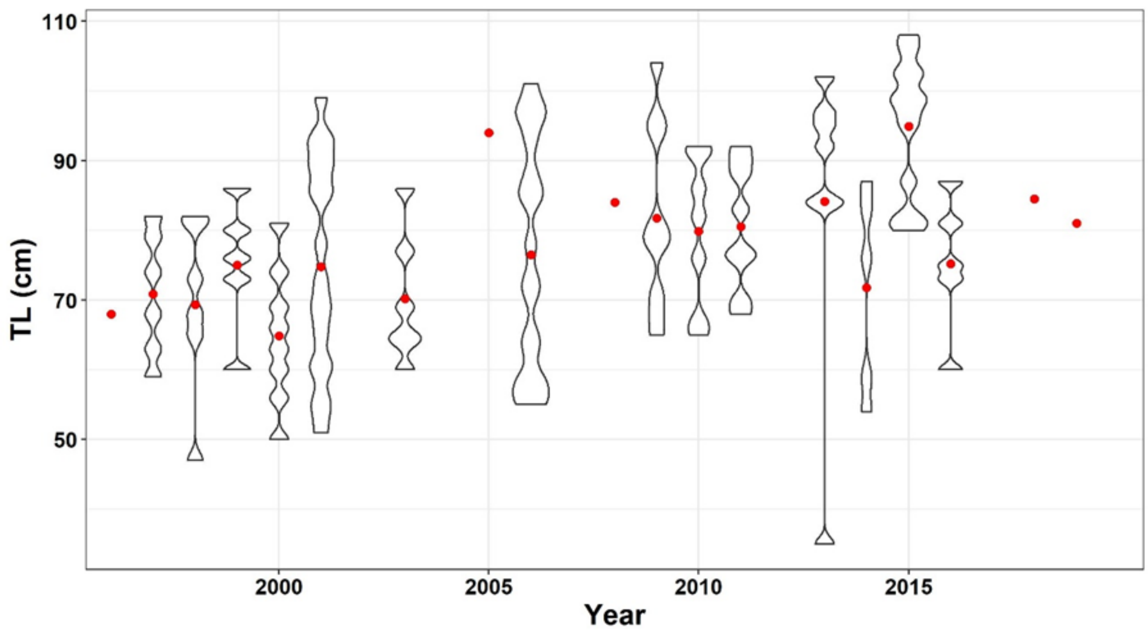


Figure 22. Golden Tilefish total lengths (cm) caught with short bottom longline by year. Red dots represent mean length. Vertical axis of violin represents the range of samples from a given year, while the width represents the numbers caught of that length by year

Long bottom longline

LBLL gear was deployed in 2019 for the first time since 2016 as part of the CRP project, but severe weather limited sampling to one day and so limited catches were recorded of Golden Tilefish (**Error! Reference source not found.**). Golden Tilefish were not caught with LBLL in large enough numbers or consistently enough for development of an index of relative abundance. The previous index is available in the 2016 trends report.

Table 21. Long bottom longline catch of Golden Tilefish and information associated with LBLL sets. Positive = number of included collections positive for the species of interest, Proportion Positive = proportion of included collections positive for the species of interest.

Year	Included Collections	Positive	Proportion Positive	Total Fish
1996	17	4	0.24	48
1997	20	11	0.55	120
1998	8	4	0.50	25
1999	25	15	0.60	123
2000	8	4	0.50	19
2001	13	8	0.62	48
2002	18	8	0.44	18
2003	13	3	0.23	5
2004	5	0	0.00	0
2005	16	7	0.44	41
2006	7	2	0.29	5
2007	22	5	0.23	34
2008	-	-	-	-
2009	36	21	0.58	208
2010	39	23	0.59	125
2011	27	15	0.56	124
2012	-	-	-	-
2013	-	-	-	-
2014	-	-	-	
2015	34	5	0.15	8
2016	24	7	0.29	19
2017	-	-	-	-
2018	-	-	-	-
2019	2	2	1.00	4

Sebastidae

Blackbelly Rosefish (*Helicolenus dactylopterus*)

Short bottom longline
Nominal and zero-inflated negative binomial (ZINB) standardized CPUE in 2019 of Blackbelly Rosefish caught with SBLLs decreased from 2018, with the nominal CPUE above, and standardized CPUE below, the time series mean (**Error! Reference source not found. Error! Reference source not found.**A). Bl ackbelly Rosefish mean lengths in SBLL catches for 2019 decreased from 2018 (**Error! Reference source not found.**B). The spatial distribution of Blackbelly Rosefish is in deeper waters off of South Carolina in recent years, but caution should be taken as that is where the majority of SBLL stations have been sampled in recent years (Table 22, **Error! Reference source not found.**).

Table 22. Short bottom longline nominal CPUE and zero-inflated negative binomial (ZINB) standardized CPUE for Blackbelly Rosefish and information associated with SBLL sets included in standardized CPUE calculation. Positive = number of included collections positive for the species of interest, Proportion Positive = proportion of included collections positive for the species of interest, Normalized = CPUE (number of fish*20 hooks^{-1}*hr^{-1}) normalized to its mean value over the time series, and CV = coefficient of variation.

					Nominal CPUE	ZINB Standardized CPUE	
Year	Included Collections	Positive	Proportion Positive	Total Fish	Normalized	Normalized	CV
1996	12	6	0.5	19	4.07	2.01	0.41
1997	33	12	0.36	21	1.63	2.01	0.31
1998	31	14	0.45	44	3.65	2.01	0.23
1999	36	4	0.11	5	0.36	1.74	0.46
2000	34	14	0.41	29	2.19	3	0.29
2001	29	13	0.45	20	1.77	1.92	0.2
2002	19	0	0	0	0	0	0.79
2003	51	27	0.53	57	2.87	2.13	0.17
2004	21	0	0	0	0	0	0.45
2005	42	0	0	0	0	0	0.49
2006	50	18	0.36	35	1.8	1.42	0.27
2007	52	3	0.06	3	0.15	0.86	0.46
2008	29	4	0.14	5	0.44	0.95	0.5
2009	43	1	0.02	1	0.06	0.23	0.88
2010	77	1	0.01	1	0.03	0.05	1.08
2011	61	9	0.15	14	0.59	0.87	0.33
2012	21	1	0.05	1	0.12	0.23	0.94
2013	41	1	0.02	1	0.06	0.08	0.99
2014	57	4	0.07	4	0.18	0.35	0.48
2015	75	11	0.15	15	0.51	0.53	0.32
2016	62	10	0.16	16	0.66	0.82	0.32
2017	48	1	0.02	1	0.05	0.32	0.91
2018	66	18	0.27	40	1.56	1.66	0.24
2019	25	9	0.36	12	1.23	0.8	0.23

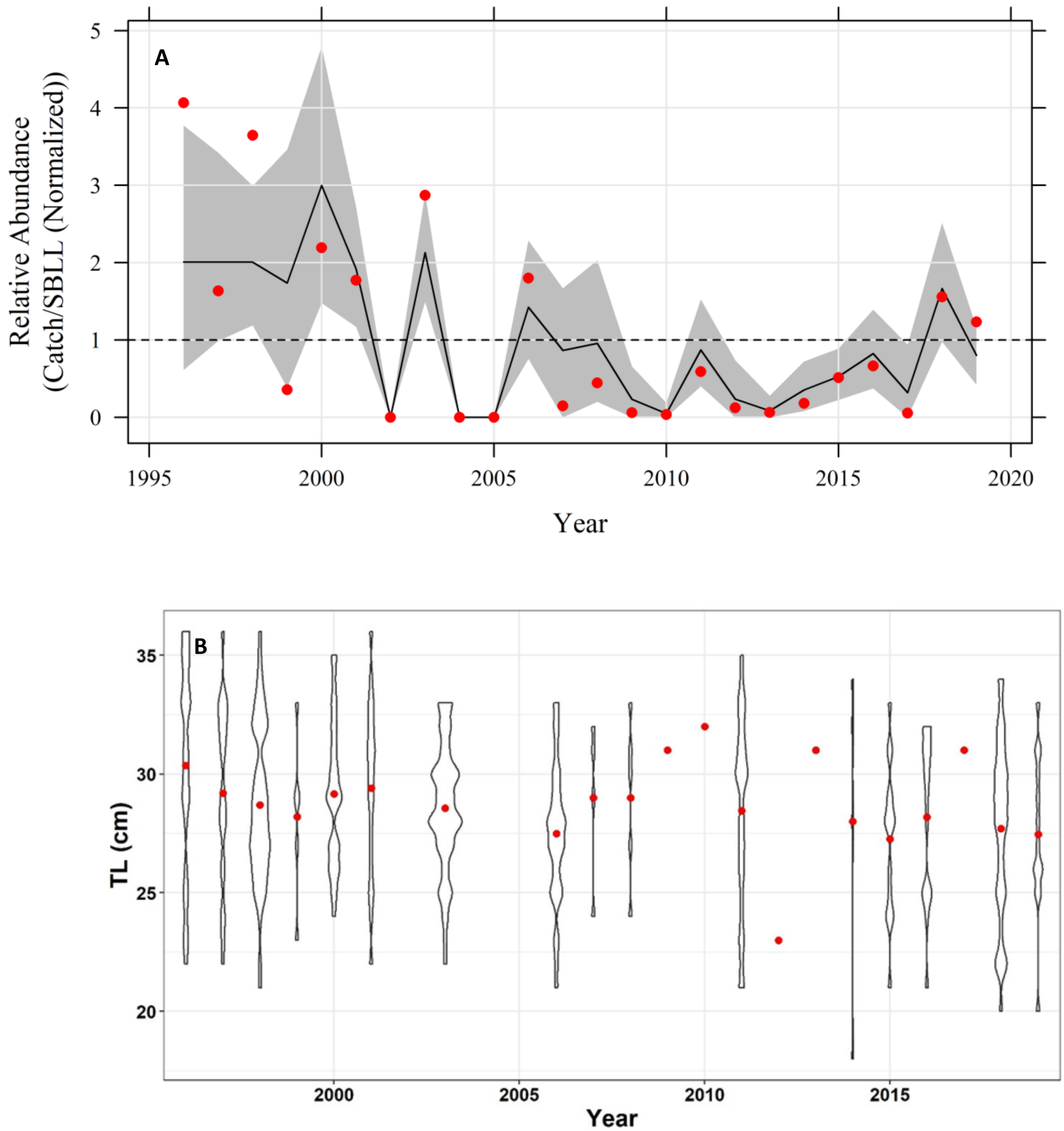


Figure 23. A) Short bottom longline normalized nominal (red dot) and zero-inflated negative binomial (black line) standardized CPUE (gray area = 95% CI) for Blackbelly Rosefish. B) Blackbelly Rosefish total lengths (cm) caught with Short bottom longline by year. Red dots represent mean length. Vertical axis of violin represents the range of samples from a given year, while the width represents the numbers caught of that length by year.

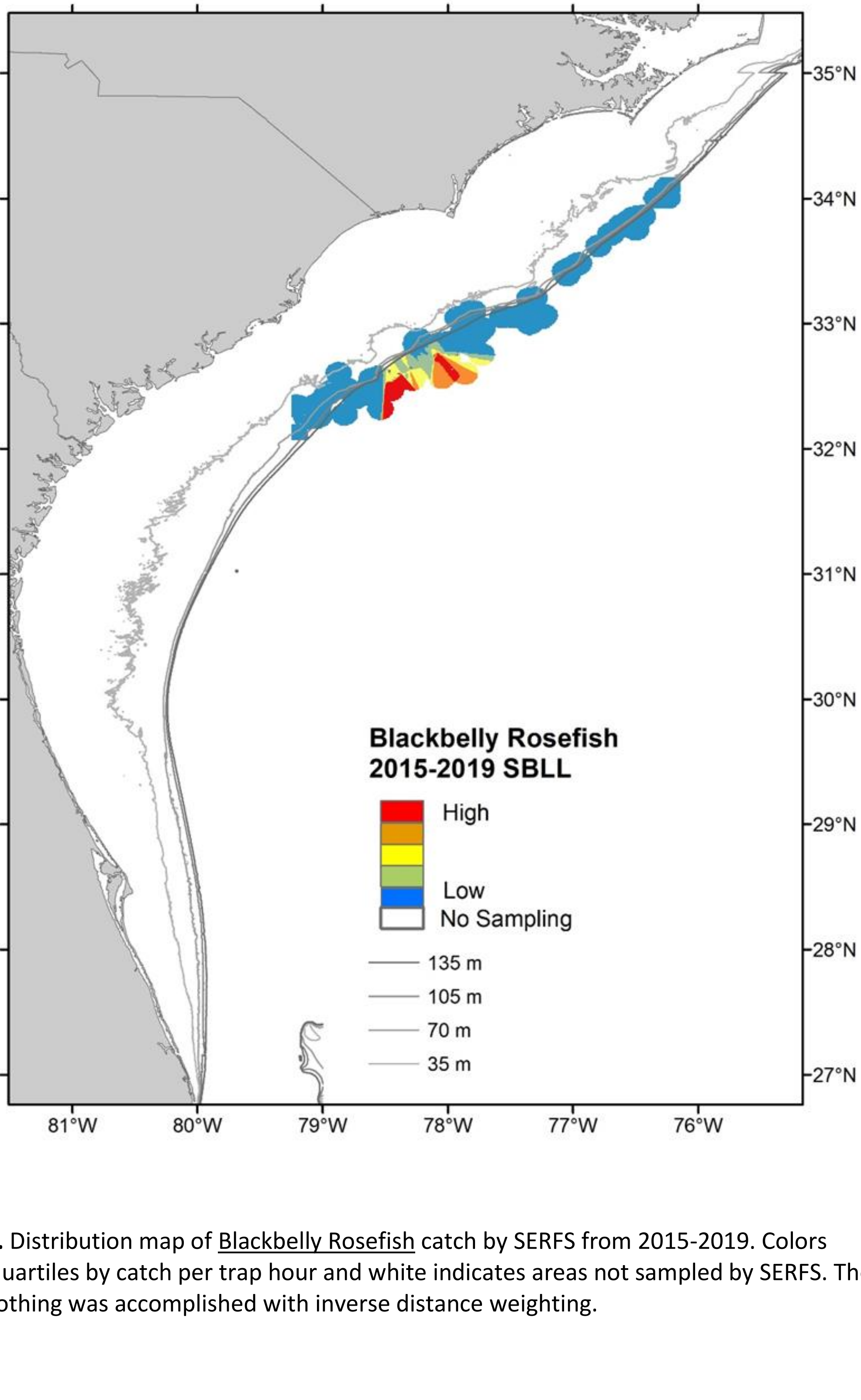


Figure 24. Distribution map of Blackbelly Rosefish catch by SERFS from 2015-2019. Colors indicate quartiles by catch per trap hour and white indicates areas not sampled by SERFS. The map smoothing was accomplished with inverse distance weighting.

Serranidae

Bank Sea Bass (*Centropristis ocyurus*)

Chevron Trap
Nominal and standardized CPUE of Bank Sea Bass caught with chevron traps in 2019 decreased relative to 2018, and was well below the time series mean (Table 23 and **Error! Reference source not found.**A). Bank Sea Bass mean lengths and size composition have been relatively stable throughout the time series, including 2019 (**Error! Reference source not found.**B). The spatial distribution of Bank Sea Bass is r elatively homogeneous in the shallow waters throughout the range, but less frequent in the most southern portion of the sampling region in recent years (**Error! Reference source not found.**).

Table 23. Chevron trap nominal CPUE and zero-inflated negative binomial (ZINB) standardized CPUE for Bank Sea Bass and information associated with chevron trap sets included in standardized CPUE calculation. Positive = number of included collections positive for the species of interest, Proportion Positive = proportion of included collections positive for the species of interest, Normalized = CPUE (number of fish*trap^{-1}*hr^{-1}) normalized to its mean value over the time series, and CV = coefficient of variation.

					Nominal CPUE	ZINB Standardized CPUE	
Year	Included Collections	Positive	Proportion Positive	Total Fish	Normalized	Normalized	CV
1990	313	138	0.44	834	2.2	1.25	0.17
1991	272	133	0.49	571	1.73	1.01	0.1
1992	288	121	0.42	430	1.23	0.69	0.13
1993	392	154	0.39	678	1.43	1.02	0.1
1994	387	169	0.44	798	1.7	1.39	0.09
1995	361	114	0.32	550	1.26	1.21	0.11
1996	361	166	0.46	1010	2.31	1.61	0.1
1997	406	149	0.37	771	1.57	1.68	0.11
1998	426	118	0.28	505	0.98	1.24	0.15
1999	233	74	0.32	315	1.12	2.13	0.18
2000	298	83	0.28	386	1.07	1.63	0.16
2001	245	63	0.26	238	0.8	0.78	0.14
2002	244	54	0.22	139	0.47	0.48	0.15
2003	224	62	0.28	316	1.16	1.27	0.17
2004	282	77	0.27	226	0.66	0.84	0.14
2005	303	79	0.26	275	0.75	0.98	0.17
2006	297	84	0.28	401	1.11	1.09	0.17
2007	337	68	0.2	275	0.67	0.9	0.17
2008	303	71	0.23	224	0.61	0.62	0.15
2009	404	113	0.28	532	1.09	1.13	0.12
2010	725	229	0.32	1087	1.24	1.37	0.13
2011	726	251	0.35	1435	1.63	2.01	0.09
2012	1174	280	0.24	977	0.69	0.75	0.09
2013	1360	215	0.16	639	0.39	0.42	0.1
2014	1472	220	0.15	587	0.33	0.37	0.1
2015	1463	256	0.17	741	0.42	0.42	0.09
2016	1484	225	0.15	719	0.4	0.48	0.11
2017	1541	255	0.17	705	0.38	0.46	0.09
2018	1736	247	0.14	775	0.37	0.47	0.1
2019	1624	217	0.13	486	0.25	0.29	0.09

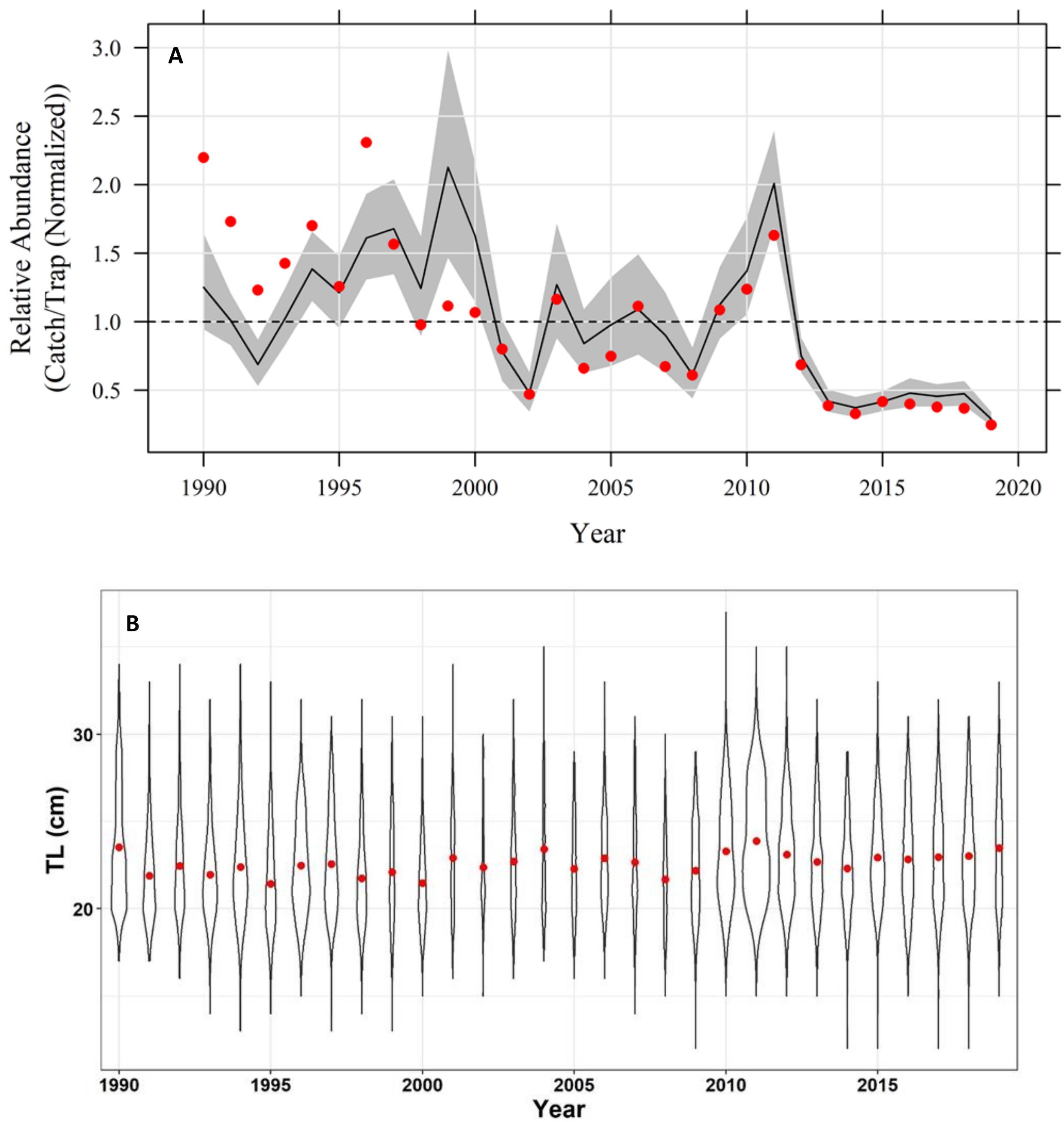


Figure 25. A) Chevron trap normalized nominal (red dot) and zero-inflated negative binomial (black line) standardized CPUE (gray area = 95% CI) for Bank Sea Bass. B) Bank Sea Bass total lengths (cm) caught in chevron traps by year. Red dots represent mean length. Vertical axis of violin represents the range of samples from a given year, while the width represents the numbers caught of that length by year.

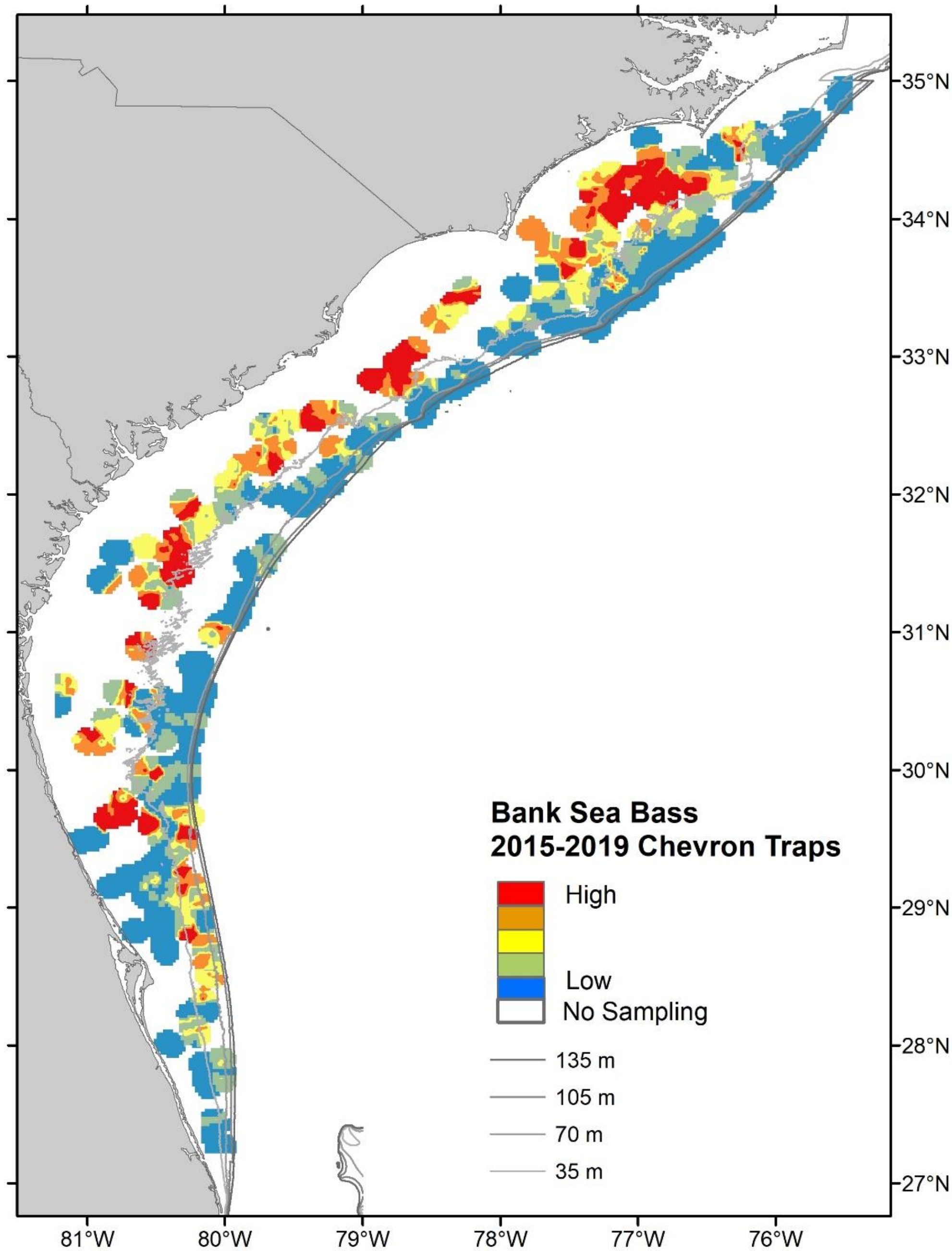


Figure 26. Distribution map of Bank Sea Bass catch by SERFS from 2015-2019. Colors indicate quartiles by catch per trap hour and white indicates areas not sampled by SERFS. The map smoothing was accomplished with inverse distance weighting.

Black Sea Bass (*Centropristis striata*)

Chevron Trap

Nominal and standardized CPUE of Black Sea Bass caught with chevron traps in 2019 have decreased compared to 2018. This is the sixth straight year of continuous decline, and the fourth straight year of historic lows, below the time series mean after historic highs in 2011 (Table 24 and **Error! Reference source not found.**A). Black Sea Bass length composition and mean length in chevron trap catches were nearly identical in 2019 compared to 2018 (**Error! Reference source not found.**B). The spatial d istribution of Black Sea Bass is relatively homogeneous in the shallow waters throughout the range in recent years (**Error! Reference source not found.**).

Table 24. Chevron trap nominal CPUE and zero-inflated negative binomial (ZINB) standardized CPUE for Black Sea Bass and information associated with chevron trap sets included in standardized CPUE calculation. Positive = number of included collections positive for the species of interest, Proportion Positive = proportion of included collections positive for the species of interest, Normalized = CPUE (number of fish*trap^{-1}*hr^{-1}) normalized to its mean value over the time series, and CV = coefficient of variation.

					Nominal CPUE	ZINB Standardized CPUE	
Year	Included Collections	Positive	Proportion Positive	Total Fish	Normalized	Normalized	CV
1990	313	193	0.62	5837	1.67	1.23	0.08
1991	272	158	0.58	3929	1.29	1.05	0.08
1992	288	179	0.62	4176	1.3	0.86	0.1
1993	392	197	0.5	3220	0.73	0.62	0.1
1994	387	160	0.41	3439	0.79	0.78	0.09
1995	361	173	0.48	3353	0.83	0.64	0.08
1996	361	169	0.47	3437	0.85	0.75	0.1
1997	406	167	0.41	4143	0.91	0.83	0.1
1998	426	175	0.41	4318	0.91	0.93	0.08
1999	233	108	0.46	4428	1.7	1.62	0.13
2000	298	114	0.38	4520	1.36	1.14	0.11
2001	245	89	0.36	3812	1.39	1.45	0.15
2002	244	87	0.36	2522	0.92	0.8	0.12
2003	224	68	0.3	1781	0.71	0.63	0.12
2004	282	96	0.34	3788	1.2	1.39	0.13
2005	303	112	0.37	3281	0.97	0.95	0.11
2006	297	123	0.41	3005	0.91	0.94	0.13
2007	337	111	0.33	2786	0.74	0.7	0.12
2008	303	112	0.37	2614	0.77	0.82	0.11
2009	404	162	0.4	3771	0.84	0.61	0.1
2010	725	334	0.46	9130	1.13	1.41	0.1
2011	726	399	0.55	14700	1.81	2.2	0.08
2012	1174	678	0.58	18967	1.45	1.72	0.05
2013	1360	767	0.56	22385	1.47	1.53	0.05
2014	1472	705	0.48	15603	0.95	1.29	0.06
2015	1463	651	0.44	13046	0.8	0.94	0.06
2016	1484	537	0.36	7624	0.46	0.72	0.07
2017	1541	548	0.36	7478	0.43	0.58	0.07
2018	1736	568	0.33	7641	0.39	0.51	0.07

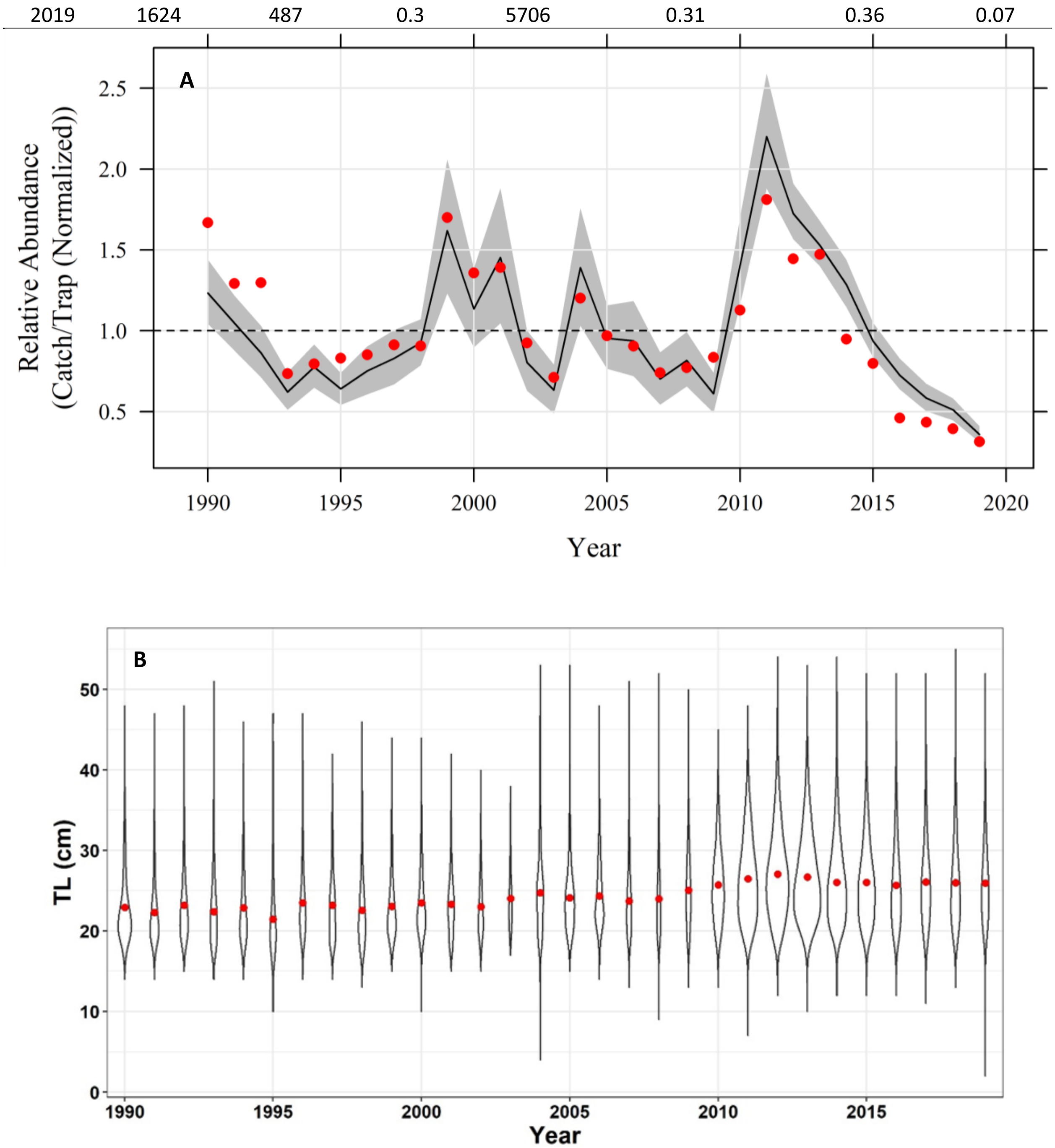


Figure 27. A) Chevron trap normalized nominal (red dot) and zero-inflated negative binomial (black line) standardized CPUE (gray area = 95% CI) for Black Sea Bass. B) Black Sea Bass total lengths (cm) caught in chevron traps by year. Red dots represent mean length. Vertical axis of violin represents the range of samples from a given year, while the width represents the numbers caught of that length by year.

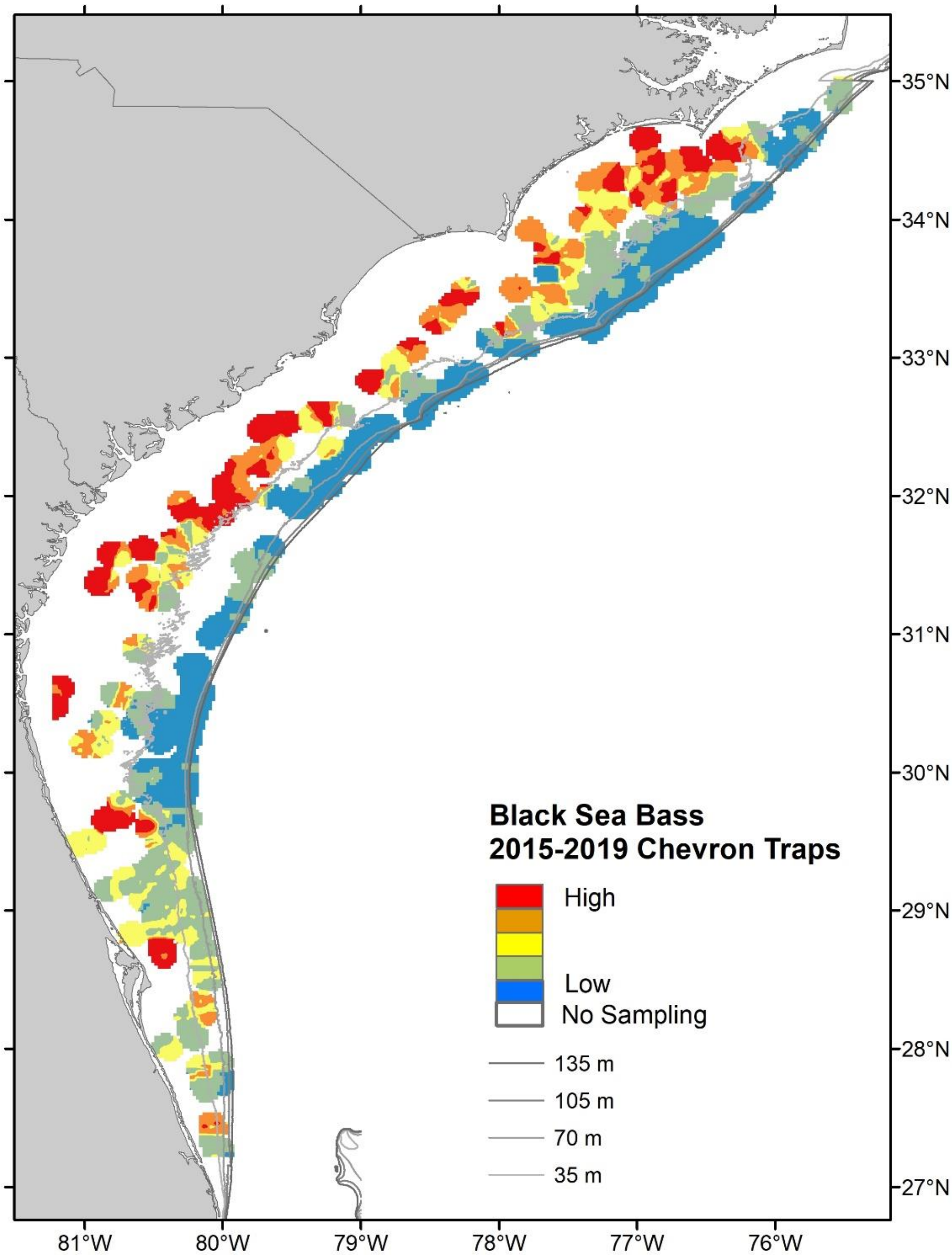


Figure 28. Distribution map of Black Sea Bass catch by SERFS from 2015-2019. Colors indicate quartiles by catch per trap hour and white indicates areas not sampled by SERFS. The map smoothing was accomplished with inverse distance weighting

Gag (*Mycteroperca microlepis*)

Chevron Trap

Nominal and standardized CPUE of Gag caught with chevron trap in 2019 have increased slightly compared to 2018. The nominal CPUE is at the time series mean, while the standardized CPUE is below the time series mean (

Table 25 and **Error! Reference source not found.**A). The mean lengths of Gag caught with chevron traps were smaller than in 2018, but with large, interannual variability in mean length, no trend was apparent (**Error! Reference source not found.**B). More than likely, this variability is due to low catches of i ndividuals each year, with the average catch fewer than 12 and more often than not, fewer than 5. The spatial distribution of Gag is mainly centered in the shallower waters off the northern portion of the region, with highest abundances off of North Carolina in recent years (**Error! Reference source not f ound.**).

Table 25: Chevron trap nominal CPUE and zero-inflated negative binomial (ZINB) standardized CPUE for Gag and information associated with chevron trap sets included in standardized CPUE calculation. Positive = number of included collections positive for the species of interest, Proportion Positive = proportion of included collections positive for the species of interest, Normalized = CPUE (number of fish*trap^{-1}*hr^{-1}) normalized to its mean value over the time series, and CV = coefficient of variation.

					Nominal CPUE	ZINB Standardized CPUE	
Year	Included Collections	Positive	Proportion Positive	Total Fish	Normalized	Normalized	CV
1990	313	16	0.05	22	3.81	3.95	0.28
1991	272	7	0.03	7	1.4	1.16	0.37
1992	288	6	0.02	7	1.32	1.34	0.47
1993	392	7	0.02	9	1.25	1.61	0.4
1994	387	7	0.02	10	1.4	1.79	0.41
1995	361	5	0.01	5	0.75	0.97	0.46
1996	361	9	0.02	12	1.8	2.02	0.39
1997	406	4	0.01	4	0.53	0.45	0.54
1998	426	4	0.01	4	0.51	0.52	0.57
1999	233	5	0.02	5	1.16	0.97	0.45
2000	298	8	0.03	10	1.82	1.93	0.44
2001	245	4	0.02	4	0.89	1.15	0.5
2002	244	1	0	1	0.22	0.33	0.96
2003	224	0	0	0	0	0	0.29
2004	282	2	0.01	2	0.38	0.55	0.65
2005	303	3	0.01	3	0.54	0.58	0.57
2006	297	1	0	1	0.18	0.18	1.04
2007	337	3	0.01	3	0.48	0.53	0.59
2008	303	1	0	1	0.18	0.19	0.88
2009	404	2	0	2	0.27	0.21	0.67
2010	725	15	0.02	16	1.2	1.4	0.34
2011	726	21	0.03	27	2.02	3.09	0.28
2012	1174	30	0.03	39	1.8	0.89	0.28
2013	1360	16	0.01	23	0.92	0.65	0.28
2014	1472	23	0.02	28	1.03	0.96	0.24
2015	1463	15	0.01	17	0.63	0.5	0.3
2016	1484	24	0.02	31	1.13	0.68	0.25
2017	1541	19	0.01	20	0.7	0.38	0.28
2018	1736	17	0.01	21	0.66	0.42	0.29
2019	1624	21	0.01	30	1	0.6	0.25

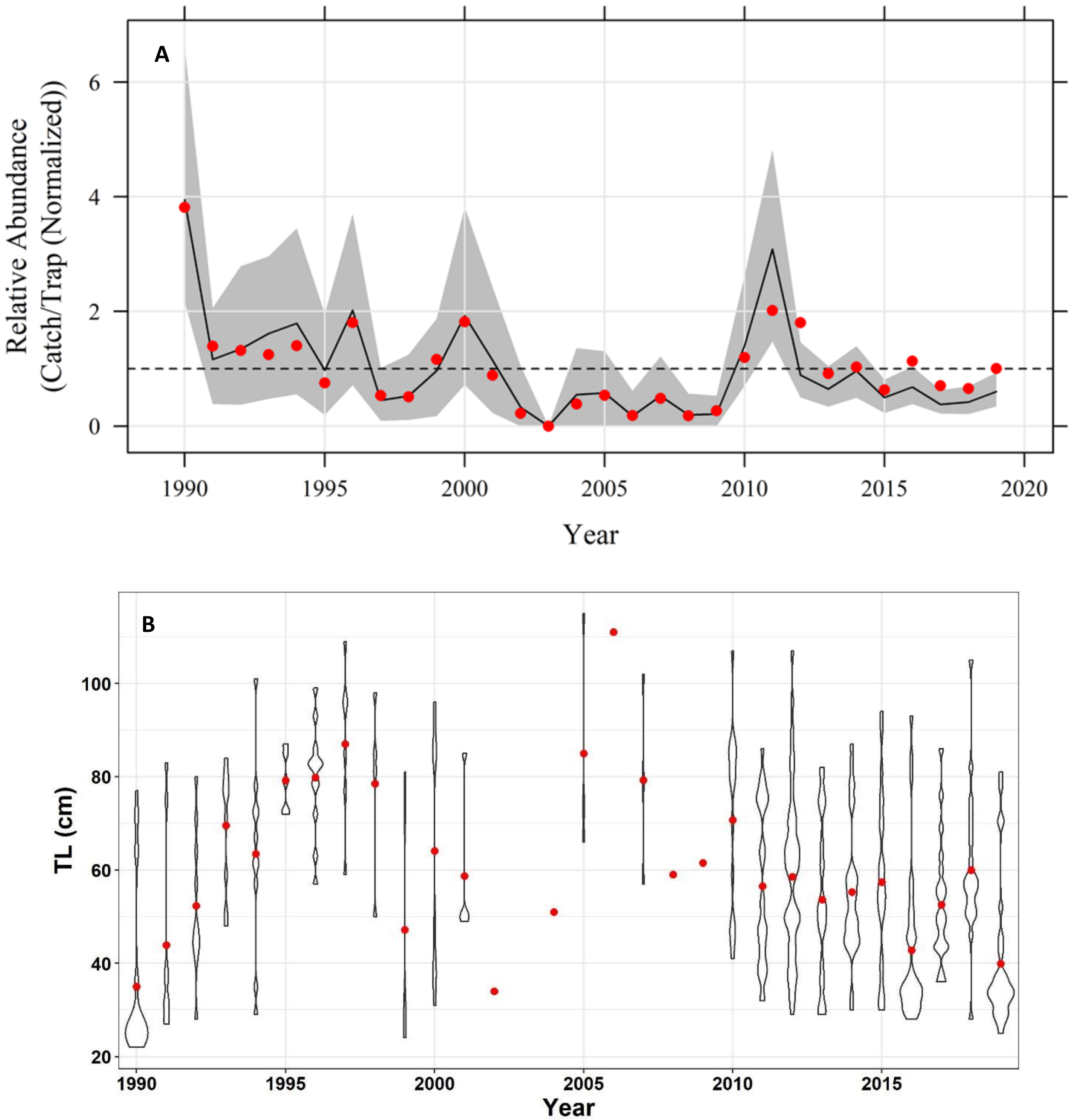


Figure 29. A) Chevron trap normalized nominal (red dot) and zero-inflated negative binomial (black line) standardized CPUE (gray area = 95% CI) for Gag. B) Gag total lengths (cm) caught in chevron traps by year. Red dots represent mean length. Vertical axis of violin represents the range of samples from a given year, while the width represents the numbers caught of that length by year.

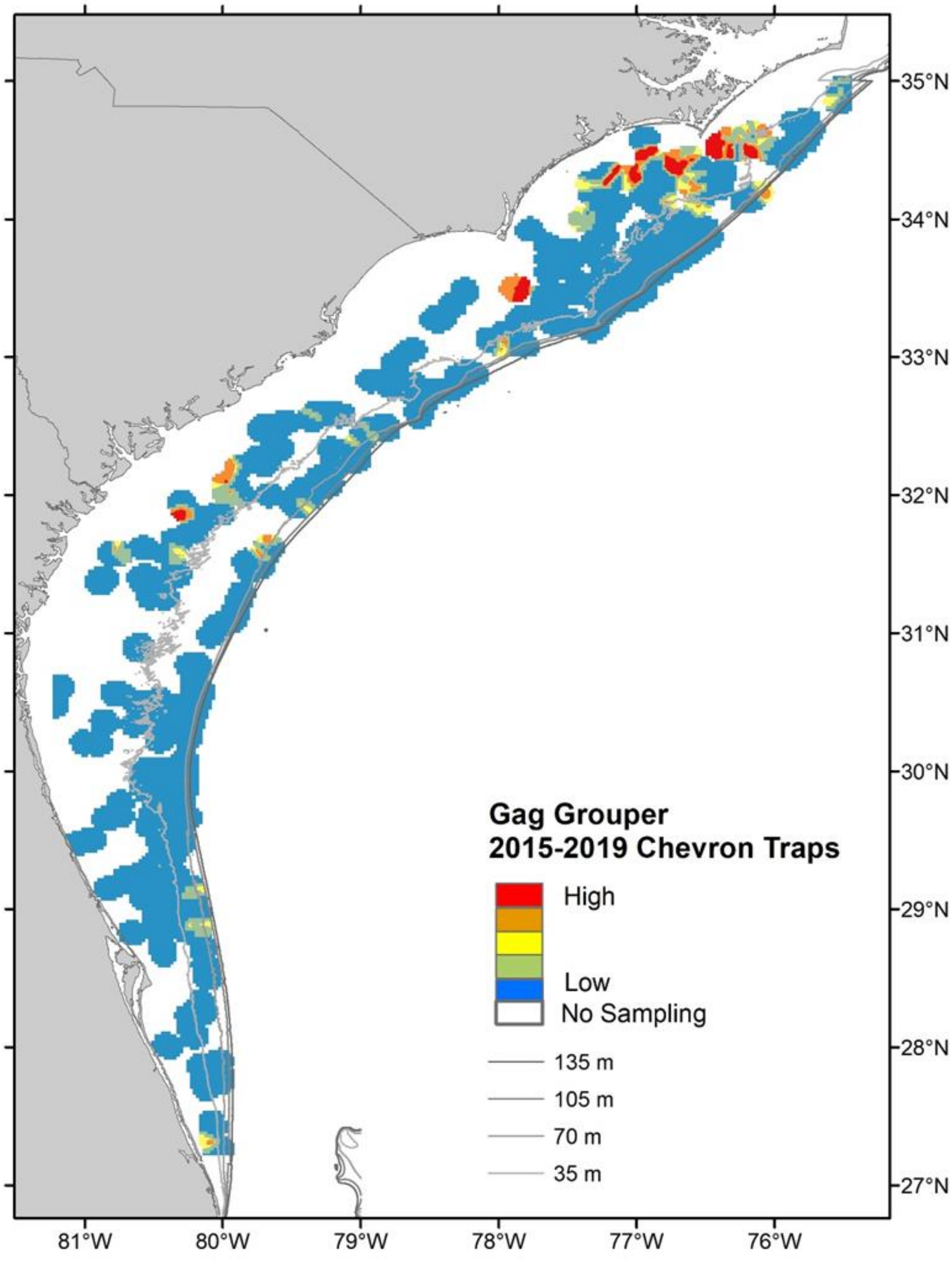


Figure 30. Distribution map of <u>Gag</u> catch by SERFS from 2015-2019. Colors indicate quartiles by catch per trap hour and white indicates areas not sampled by SERFS. The map smoothing was accomplished with inverse distance weighting.

Short bottom longline

Gag were not caught with SBLL in large enough numbers or consistently enough for development of an index of relative abundance (Table 26). The SEDAR 59 Panel also recommended not to use the short bottom longline index of abundance or length or age compositions, due to lack of encounters (SEDAR 59 2020).

Table 26. Short bottom longline catch of Gag and information associated with SBLL sets. Positive = number of included collections positive for the species of interest, Proportion Positive = proportion of included collections positive for the species of interest.

Year	Included Collections	Positive	Proportion Positive	Total Fish
1996	15	0	0.00	0
1997	33	0	0.00	0
1998	31	0	0.00	0
1999	36	3	0.08	3
2000	34	0	0.00	0
2001	29	0	0.00	0
2002	19	2	0.11	2
2003	51	1	0.02	1
2004	34	0	0.00	0
2005	42	4	0.10	4
2006	50	0	0.00	0
2007	53	6	0.11	8
2008	29	0	0.00	0
2009	43	1	0.02	1
2010	83	2	0.02	2
2011	109	4	0.04	4
2012	21	0	0.00	0
2013	41	2	0.05	3
2014	57	0	0.00	0
2015	75	0	0.00	0
2016	62	1	0.02	1
2017	48	1	0.02	1
2018	66	1	0.02	1
2019	25	0	0.00	0

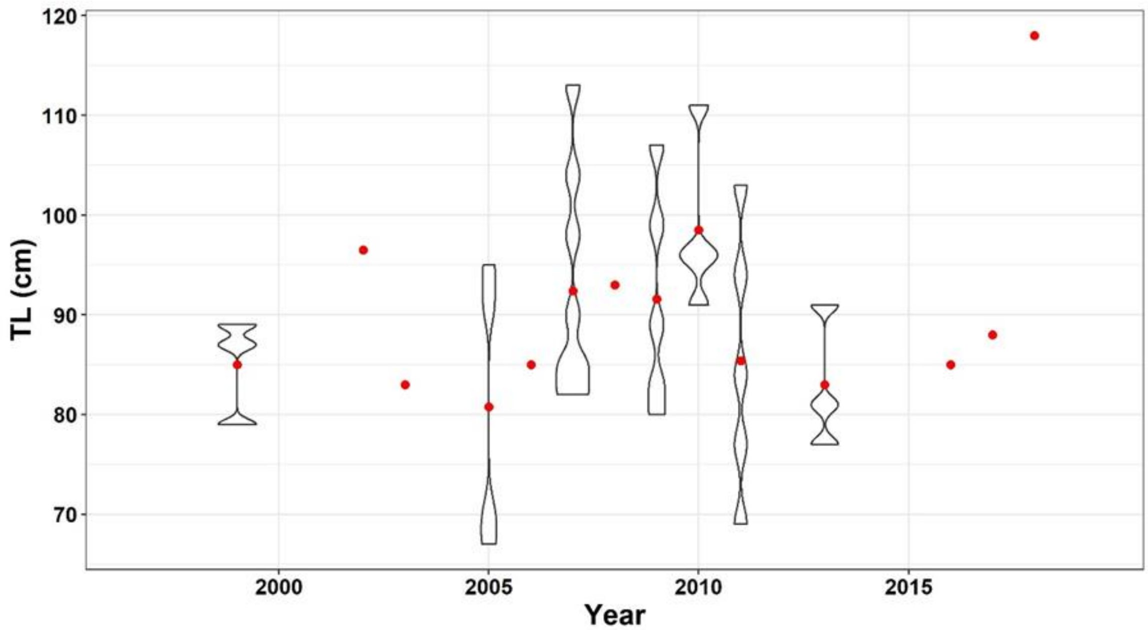


Figure 31. Gag total lengths (cm) caught with short bottom longline by year. Red dots represent mean length. Vertical axis of violin represents the range of samples from a given year, while the width represents the numbers caught of that length by year.

Red Grouper (*Epinephelus morio*)

Chevron Trap

Nominal and standardized CPUE of Red Grouper caught with chevron traps decreased slightly to a all-time low in 2019 following a pronounced decline to below the time series mean starting in 2009 (Table 27 and **Error! Reference source not found.**A). Red Grouper mean lengths caught in chevron traps i ncreased in 2019 from 2018, but not to all-time highs from 2014 to 2016 (**Error! Reference source not found.**B). Red Grouper show a disjunct population with nearly all catches in chevron traps occurring off of North Carolina and Florida in recent years (**Error! Reference source not found.**).

Table 27. Chevron trap nominal CPUE and zero-inflated negative binomial (ZINB) standardized CPUE for Red Grouper and information associated with chevron trap sets included in standardized CPUE calculation. Positive = number of included collections positive for the species of interest, Proportion Positive = proportion of included collections positive for the species of interest, Normalized = CPUE (number of fish*trap^{-1}*hr^{-1}) normalized to its mean value over the time series, and CV = coefficient of variation.

					Nominal CPUE	ZINB Standardized CPUE	
Year	Included Collections	Positive	Proportion Positive	Total Fish	Normalized	Normalized	CV
1990	313	3	0.01	3	0.14	0.24	0.62
1991	272	4	0.01	4	0.21	0.25	0.45
1992	288	5	0.02	17	0.84	0.67	0.43
1993	392	8	0.02	20	0.73	1.11	0.37
1994	387	10	0.03	30	1.1	1.16	0.32
1995	361	6	0.02	9	0.35	0.96	0.4
1996	361	8	0.02	9	0.35	1.23	0.37
1997	406	19	0.05	37	1.3	1.34	0.26
1998	426	25	0.06	70	2.34	1.52	0.26
1999	233	19	0.08	46	2.81	2.78	0.27
2000	298	22	0.07	35	1.67	1.01	0.25
2001	245	18	0.07	35	2.03	1.28	0.29
2002	244	20	0.08	36	2.1	1.52	0.25
2003	224	17	0.08	35	2.22	2.19	0.25
2004	282	21	0.07	40	2.02	1.92	0.21
2005	303	23	0.08	27	1.27	2.02	0.25
2006	297	18	0.06	44	2.11	2.44	0.29
2007	337	19	0.06	41	1.73	1.86	0.23
2008	303	12	0.04	23	1.08	1.48	0.33
2009	404	16	0.04	17	0.6	0.57	0.23
2010	725	21	0.03	27	0.53	0.63	0.26
2011	726	11	0.02	11	0.22	0.29	0.34
2012	1174	37	0.03	41	0.5	0.49	0.22
2013	1360	39	0.03	42	0.44	0.4	0.2
2014	1472	37	0.03	38	0.37	0.16	0.19
2015	1463	21	0.01	27	0.26	0.14	0.24
2016	1484	18	0.01	19	0.18	0.08	0.25
2017	1541	15	0.01	16	0.15	0.08	0.28
2018	1736	26	0.01	28	0.23	0.12	0.24
2019	1624	15	0.01	15	0.13	0.06	0.28

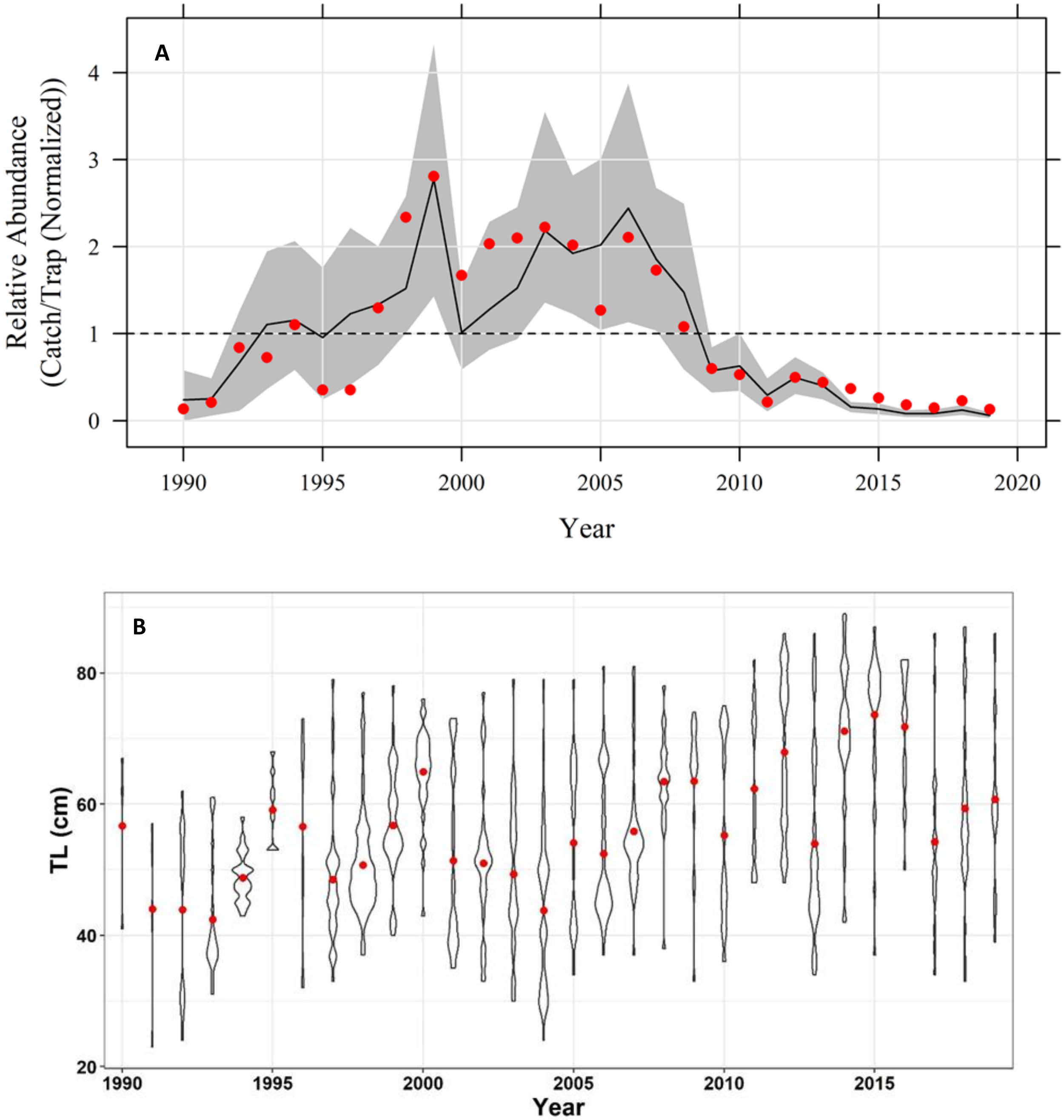


Figure 32. A) Chevron trap normalized nominal (red dot) and zero-inflated negative binomial (black line) standardized CPUE (gray area = 95% CI) for Red Grouper. B) Red Grouper total lengths (cm) caught in chevron traps by year. Red dots represent mean length. Vertical axis of violin represents the range of samples from a given year, while the width represents the numbers caught of that length by year.

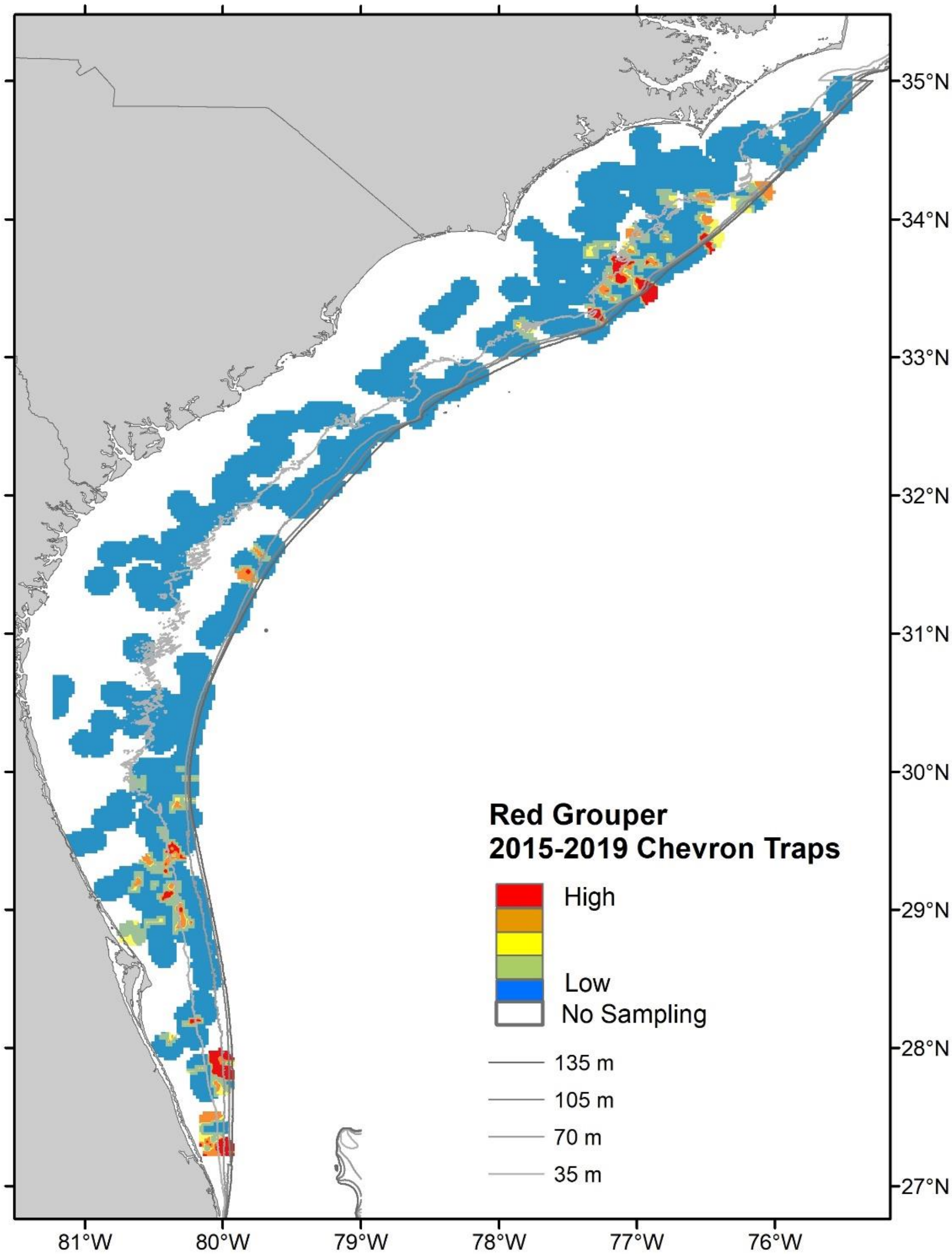


Figure 33. Distribution map of Red Grouper catch by SERFS from 2015-2019. Colors indicate quartiles by catch per trap hour and white indicates areas not sampled by SERFS. The map smoothing was accomplished with inverse distance weighting.

Short bottom longline
Red Grouper were not caught with SBLL in large enough numbers or consistently enough for development of an index of relative abundance (

Table **28**). The SEDAR 53 Panel also recommended not to use the short bottom longline index of abundance or length or age compositions, due to lack of encounters (SEDAR 53 2020). Red Grouper mean lengths were greatest in 2013 and lowest in 1999 (**Error! Reference source not found.**). The mean l ength had increased throughout the time series as with those caught in chevron traps, but no individuals have been caught on SBLL since 2013.

Table 28. Short bottom longline catch of Red Grouper and information associated with SBLL sets. Positive = number of included collections positive for the species of interest, Proportion Positive = proportion of included collections positive for the species of interest.

Year	Included Collections	Positive	Proportion Positive	Total Fish
1996	15	0	0.00	0
1997	33	0	0.00	0
1998	31	0	0.00	0
1999	36	4	0.11	7
2000	34	3	0.09	5
2001	29	0	0.00	0
2002	19	0	0.00	0
2003	51	0	0.00	0
2004	34	3	0.09	4
2005	42	4	0.10	6
2006	50	1	0.02	2
2007	53	12	0.23	23
2008	29	0	0.00	0
2009	43	4	0.09	4
2010	83	0	0.00	0
2011	109	10	0.09	18
2012	21	0	0.00	0
2013	41	4	0.10	4
2014	57	0	0.00	0
2015	75	0	0.00	0
2016	62	0	0.00	0
2017	48	0	0.00	0
2018	66	0	0.00	0
2019	25	0	0.00	0

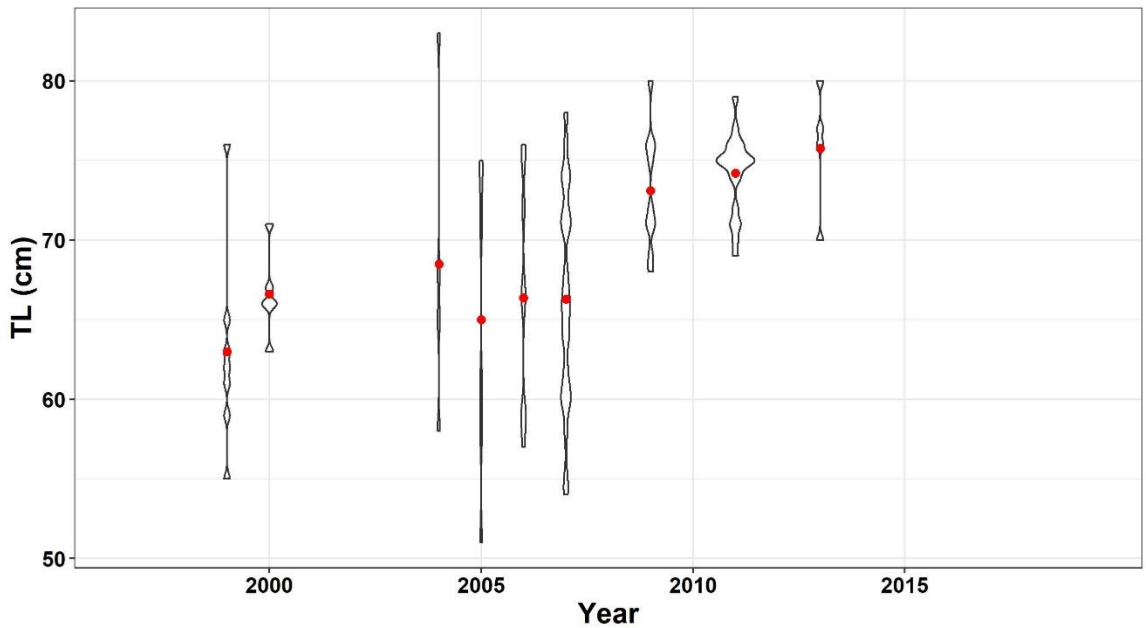


Figure 34. Red Grouper total lengths (cm) caught with short bottom longline by year. Red dots represent mean length. Vertical axis of violin represents the range of samples from a given year, while the width represents the numbers caught of that length by year.

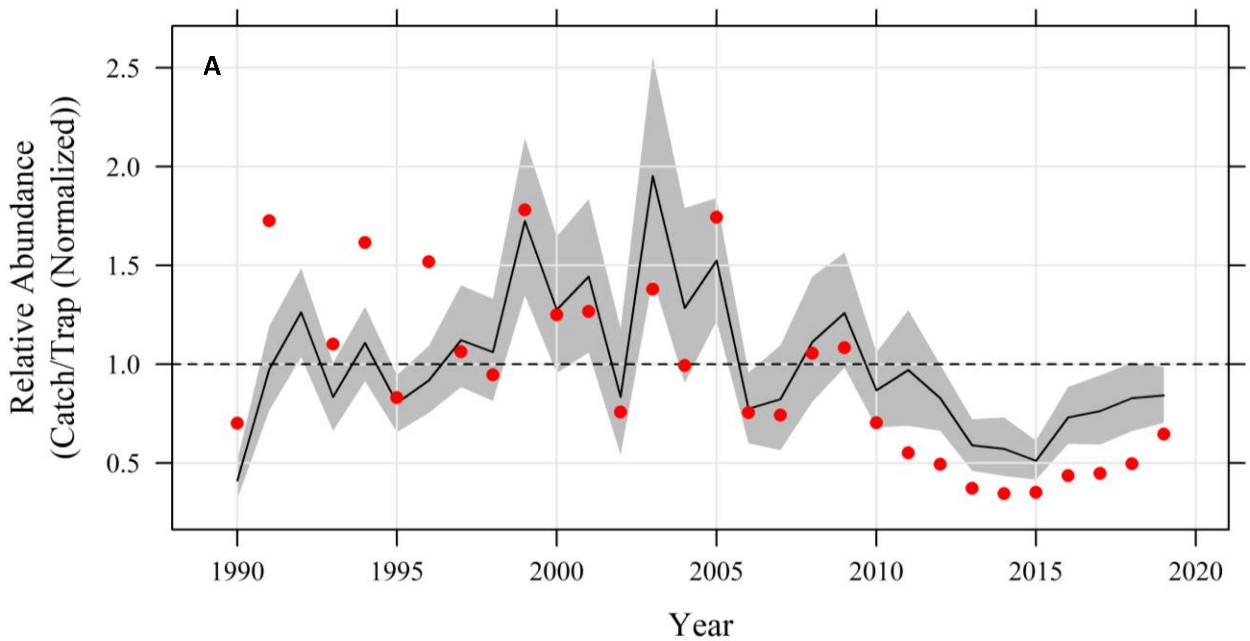
Sand Perch (*Diplectrum formosum*)

Chevron Trap

Nominal and standardized CPUE of Sand Perch caught with chevron traps in 2019 increased from 2018, though both were below the time series mean (**Error! Reference source not found.** and **Error! Reference source not found.**A). Sand Perch mean lengths caught in chevron traps increased slightly in 2019 from 2018, but were relatively constant over the previous 8 years (**Error! Reference source not found.**B). The spatial distribution of Sand Perch is patchy in the shallow waters throughout the range in recent years (**Error! Reference source not found.**).

Table 29. Chevron trap nominal CPUE and zero-inflated negative binomial (ZINB) standardized CPUE for Sand Perch and information associated with chevron trap sets included in standardized CPUE calculation. Positive = number of included collections positive for the species of interest, Proportion Positive = proportion of included collections positive for the species of interest, Normalized = CPUE (number of fish*trap^{-1}*hr^{-1}) normalized to its mean value over the time series, and CV = coefficient of variation.

					Nominal CPUE	ZINB Standardized CPUE	
Year	Included Collections	Positive	Proportion Positive	Total Fish	Normalized	Normalized	CV
1990	313	63	0.2	145	0.7	0.41	0.12
1991	272	82	0.3	310	1.73	0.97	0.11
1992	288	109	0.38	544	2.86	1.26	0.09
1993	392	95	0.24	285	1.1	0.83	0.11
1994	387	111	0.29	413	1.62	1.11	0.09
1995	361	77	0.21	198	0.83	0.8	0.09
1996	361	105	0.29	362	1.52	0.92	0.1
1997	406	95	0.23	285	1.06	1.12	0.12
1998	426	84	0.2	266	0.95	1.06	0.13
1999	233	59	0.25	274	1.78	1.72	0.12
2000	298	69	0.23	246	1.25	1.28	0.14
2001	245	45	0.18	205	1.27	1.44	0.14
2002	244	41	0.17	122	0.76	0.83	0.19
2003	224	44	0.2	204	1.38	1.95	0.15
2004	282	49	0.17	185	0.99	1.28	0.18
2005	303	76	0.25	349	1.74	1.52	0.11
2006	297	58	0.2	148	0.75	0.77	0.12
2007	337	50	0.15	165	0.74	0.82	0.17
2008	303	60	0.2	211	1.05	1.11	0.15
2009	404	79	0.2	289	1.08	1.26	0.12
2010	725	109	0.15	337	0.7	0.87	0.11
2011	726	67	0.09	264	0.55	0.97	0.16
2012	1174	110	0.09	382	0.49	0.83	0.1
2013	1360	121	0.09	333	0.37	0.59	0.11
2014	1472	131	0.09	335	0.34	0.57	0.13
2015	1463	138	0.09	339	0.35	0.51	0.1
2016	1484	156	0.11	427	0.44	0.73	0.1
2017	1541	133	0.09	455	0.45	0.76	0.12
2018	1736	172	0.1	568	0.5	0.83	0.11
2019	1624	201	0.12	693	0.65	0.84	0.09



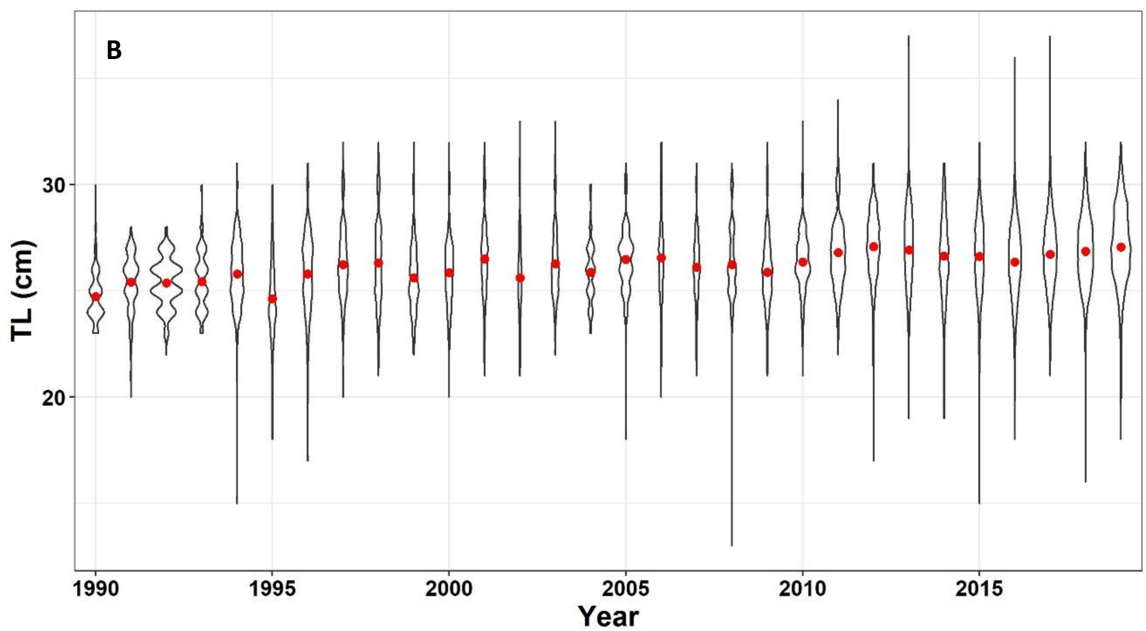


Figure 35. A) Chevron trap normalized nominal (red dot) and zero-inflated negative binomial (black line) standardized CPUE (gray area = 95% CI) for Sand Perch. B) Sand Perch total lengths (cm) caught in chevron traps by year. Red dots represent mean length. Vertical axis of violin represents the range of samples from a given year, while the width represents the numbers caught of that length by year.

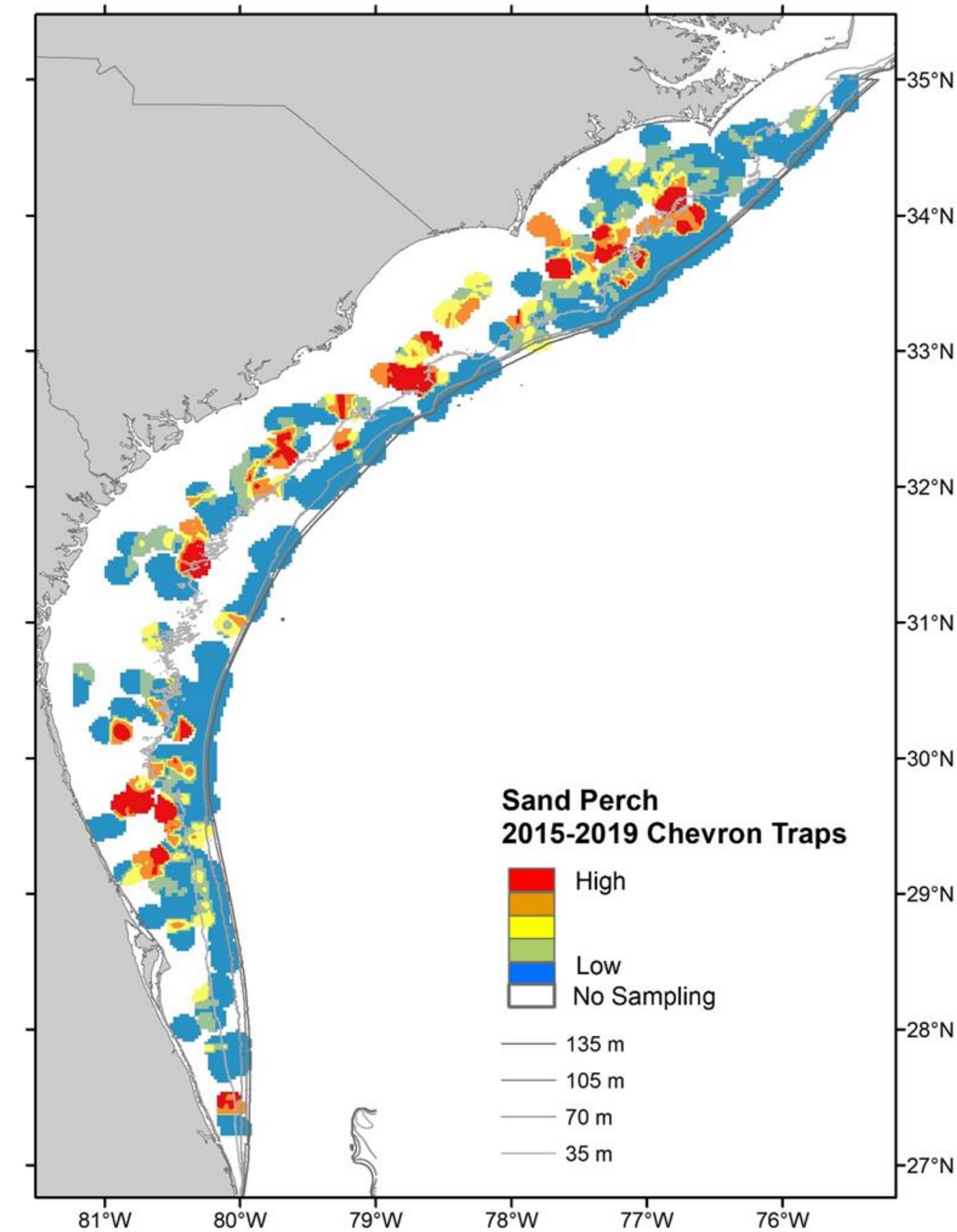


Figure 36. Distribution map of Sand Perch catch by SERFS from 2015-2019. Colors indicate quartiles by catch per trap hour and white indicates areas not sampled by SERFS. The map smoothing was accomplished with inverse distance weighting.

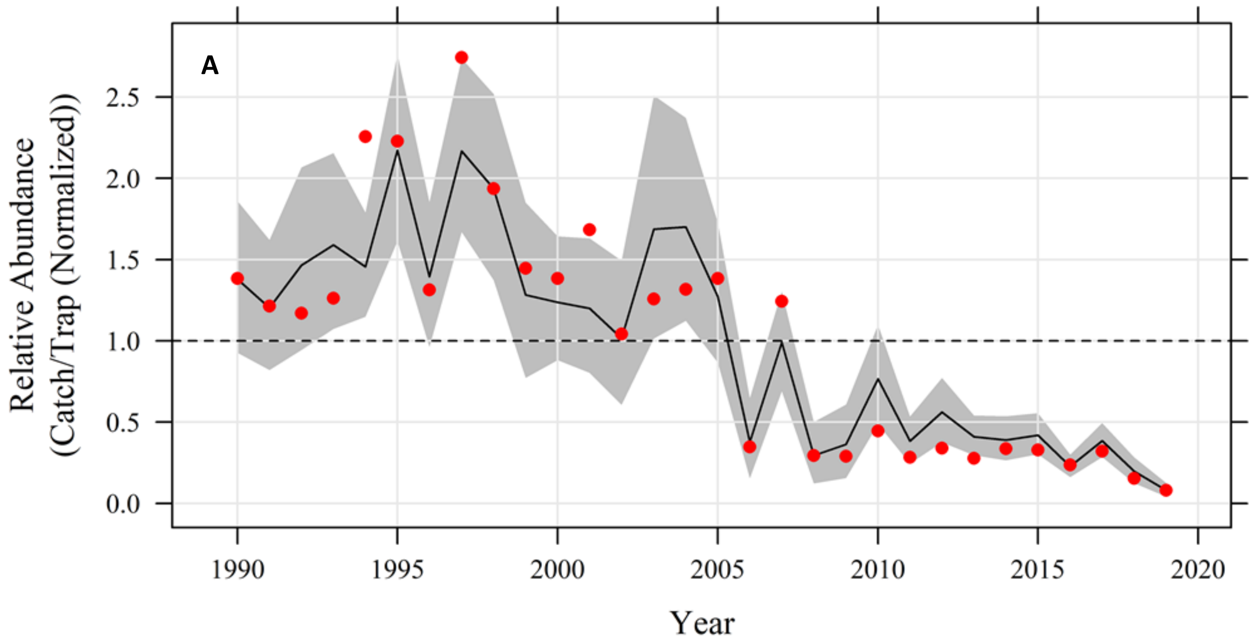
Scamp (*Mycteroperca phenax*)

Chevron Trap

Nominal and standardized CPUE of Scamp caught with chevron traps in 2019 decreased from 2018 to a new all-time low continuing a declining trend below the time series mean starting in 2007 (**Error! Reference source not found.** and **Error! Reference source not found.**A). Scamp mean lengths caught in chevron traps decreased slightly from 2018 although a wider range of smaller sizes were encountered in 2019 relative to 2018 (**Error! Reference source not found.**B). The spatial distribution of Scamp catches in all gears is highest in the central to northern portion of the region and in deeper waters while catches are more limited off the southern portion in recent years (**Error! Reference source not found.**).

Table 30. Chevron trap nominal CPUE and zero-inflated negative binomial (ZINB) standardized CPUE for Scamp and information associated with chevron trap sets included in standardized CPUE calculation. Positive = number of included collections positive for the species of interest, Proportion Positive = proportion of included collections positive for the species of interest, Normalized = CPUE (number of fish*trap^{-1}*hr^{-1}) normalized to its mean value over the time series, and CV = coefficient of variation.

					Nominal CPUE	ZINB Standardized CPUE	
Year	Included Collections	Positive	Proportion Positive	Total Fish	Normalized	Normalized	CV
1990	313	32	0.1	63	1.38	1.38	0.17
1991	272	30	0.11	48	1.21	1.2	0.17
1992	288	29	0.1	49	1.17	1.46	0.19
1993	392	41	0.1	72	1.26	1.59	0.17
1994	387	71	0.18	127	2.26	1.46	0.11
1995	361	52	0.14	117	2.23	2.17	0.14
1996	361	41	0.11	69	1.31	1.39	0.16
1997	406	69	0.17	162	2.74	2.17	0.12
1998	426	51	0.12	120	1.94	1.94	0.15
1999	233	25	0.11	49	1.45	1.28	0.22
2000	298	43	0.14	60	1.38	1.24	0.16
2001	245	35	0.14	60	1.68	1.2	0.18
2002	244	25	0.1	37	1.04	1.02	0.22
2003	224	24	0.11	41	1.26	1.69	0.23
2004	282	36	0.13	54	1.32	1.7	0.19
2005	303	33	0.11	61	1.38	1.27	0.17
2006	297	10	0.03	15	0.35	0.38	0.34
2007	337	40	0.12	61	1.24	0.99	0.16
2008	303	10	0.03	13	0.29	0.29	0.33
2009	404	12	0.03	17	0.29	0.36	0.32
2010	725	31	0.04	47	0.45	0.77	0.2
2011	726	27	0.04	30	0.28	0.38	0.2
2012	1174	42	0.04	58	0.34	0.56	0.18
2013	1360	49	0.04	55	0.28	0.41	0.15
2014	1472	53	0.04	72	0.34	0.39	0.18
2015	1463	55	0.04	70	0.33	0.42	0.15
2016	1484	41	0.03	51	0.24	0.23	0.16
2017	1541	58	0.04	72	0.32	0.38	0.14
2018	1736	29	0.02	39	0.15	0.2	0.2
2019	1624	16	0.01	19	0.08	0.08	0.26



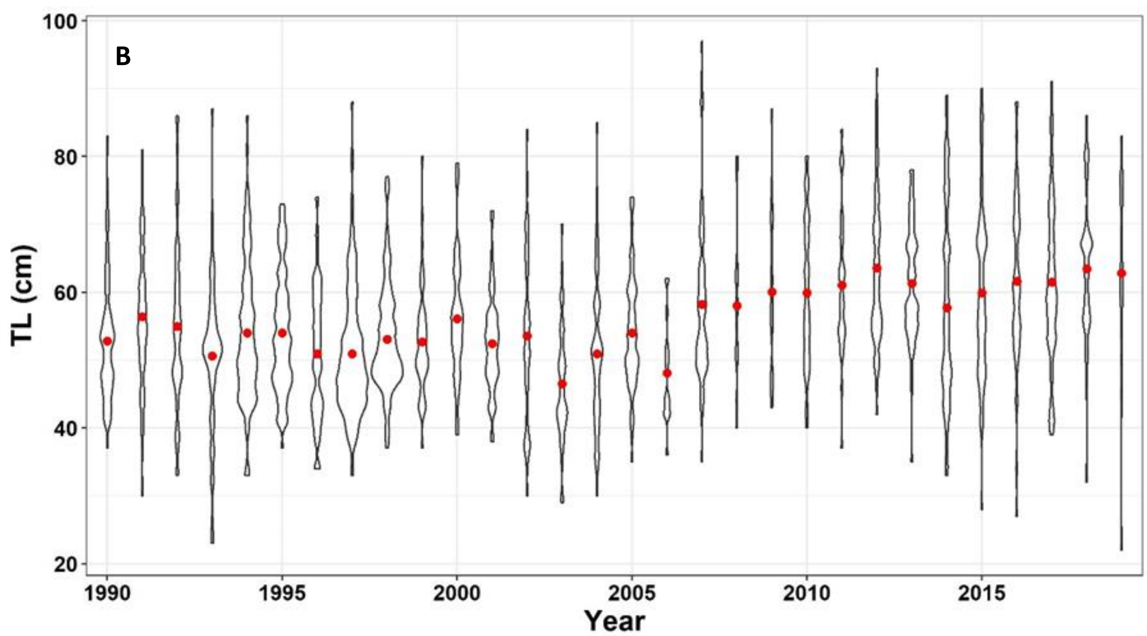


Figure 37. A) Chevron trap normalized nominal (red dot) and zero-inflated negative binomial (black line) standardized CPUE (gray area = 95% CI) for Scamp. B) Scamp total lengths (cm) caught in chevron traps by year. Red dots represent mean length. Vertical axis of violin represents the range of samples from a given year, while the width represents the numbers caught of that length by year.

Short bottom longline

Scamp were not caught with SBLL in large enough numbers or consistently enough for development of an index of relative abundance. There were no catches of Scamp on SBLL in 2019 (**Error! Reference s ource not found.**). In previous years, Scamp mean lengths caught with SBLL decreased in 2018 compared to 2017, but an expanded size composition from the previous year (**Error! Reference source n ot found.**).

Table 31. Short bottom longline catch of Scamp and information associated with SBLL sets. Positive = number of included collections positive for the species of interest, Proportion Positive = proportion of included collections positive for the species of interest.

Year	Included Collections	Positive	Proportion Positive	Total Fish
1996	15	1	0.07	1
1997	33	0	0.00	0
1998	31	0	0.00	0
1999	36	10	0.28	19
2000	34	1	0.03	2
2001	29	9	0.31	32
2002	19	4	0.21	9
2003	51	5	0.10	8
2004	34	10	0.29	14
2005	42	9	0.21	10
2006	50	10	0.20	18
2007	53	17	0.32	25
2008	29	3	0.10	3
2009	43	9	0.21	11
2010	83	7	0.08	8
2011	109	15	0.14	25
2012	21	0	0.00	0
2013	41	7	0.17	14
2014	57	6	0.11	9
2015	75	4	0.05	5
2016	62	3	0.05	4
2017	48	9	0.19	10
2018	66	4	0.06	4
2019	25	0	0.00	0

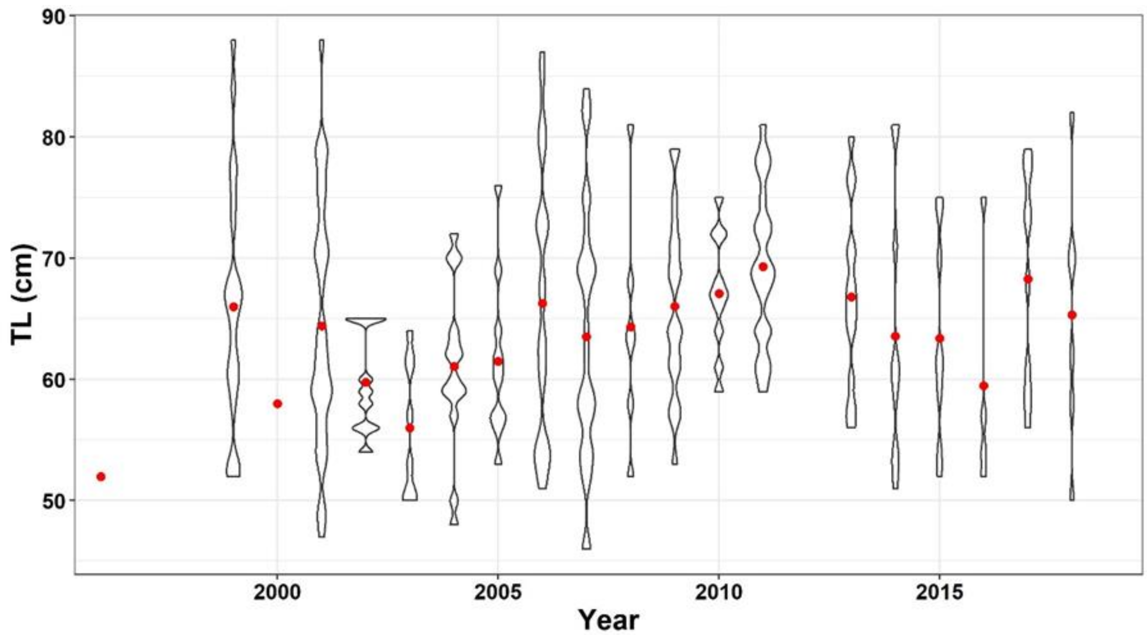


Figure 38. Scamp total lengths (cm) caught with short bottom longline by year. Red dots represent mean length. Vertical axis of violin represents the range of samples from a given year, while the width represents the numbers caught of that length by year.

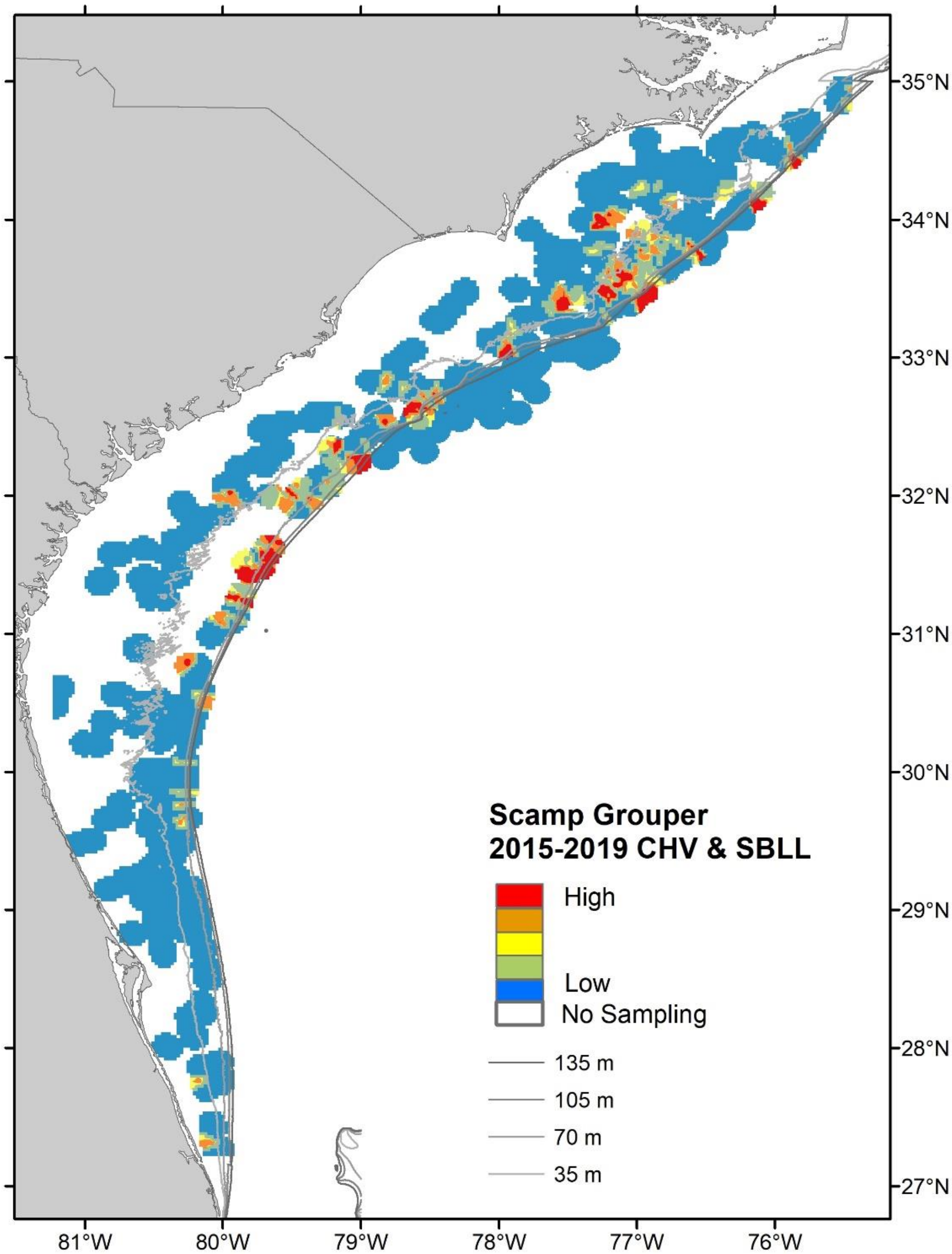


Figure 39. Distribution map of Scamp catch by SERFS from 2015-2019. Colors indicate quartiles by catch per trap hour and white indicates areas not sampled by SERFS. The map smoothing was accomplished with inverse distance weighting.

Snowy Grouper (*Hyporthodus niveatus*)

Chevron Trap

Nominal and standardized CPUE of Snowy Grouper caught with chevron traps in 2019 decreased from 2018 and both were below the time series mean (Table 32 and **Error! Reference source not found.**A). Snowy Grouper mean lengths of fish caught in chevron traps increased from the previous year (**Error! Reference source not found.**B). The spatial distribution of Snowy Grouper catches using chevron traps and SBLL is focused in the deeper waters off the coast of South Carolina in recent years (**Error! Reference source not found.**). This may be misleading in terms of latitudinal variation as the majority of SBLL stations sampled over this time period were located in this area and the majority of SBLL stations occur in this area as well.

Table 32. Chevron trap nominal CPUE and zero-inflated negative binomial (ZINB) standardized CPUE for Snowy Grouper and information associated with chevron trap sets included in standardized CPUE calculation. Positive = number of included collections positive for the species of interest, Proportion Positive = proportion of included collections positive for the species of interest, Normalized = CPUE (number of fish*trap^{-1}*hr^{-1}) normalized to its mean value over the time series, and CV = coefficient of variation.

					Nominal CPUE	ZINB Standardized CPUE	
Year	Included Collections	Positive	Proportion Positive	Total Fish	Normalized	Normalized	CV
1990	313	5	0.02	9	0.71	3.02	0.6
1991	272	1	0	1	0.09	0.18	1.02
1992	288	0	0	0	0	0	1.64
1993	392	3	0.01	19	1.19	1.79	0.4
1994	387	9	0.02	59	3.75	2.84	0.21
1995	361	0	0	0	0	0	1.41
1996	361	12	0.03	40	2.73	1.18	0.26
1997	406	16	0.04	59	3.58	1.48	0.23
1998	426	8	0.02	22	1.27	1.07	0.27
1999	233	3	0.01	3	0.32	1.26	0.38
2000	298	2	0.01	4	0.33	2.51	0.79
2001	245	12	0.05	35	3.52	2.01	0.37
2002	244	5	0.02	18	1.82	1.79	0.28
2003	224	7	0.03	18	1.98	0.95	0.24
2004	282	13	0.05	22	1.92	1.1	0.38
2005	303	3	0.01	4	0.32	0.99	0.56
2006	297	8	0.03	10	0.83	0.54	0.29
2007	337	6	0.02	11	0.8	0.66	1.11
2008	303	2	0.01	2	0.16	0.14	1.11
2009	404	5	0.01	6	0.37	0.34	0.5
2010	725	9	0.01	13	0.44	0.6	0.57
2011	726	10	0.01	18	0.61	0.58	0.24
2012	1174	21	0.02	38	0.8	1.07	0.19
2013	1360	6	0	13	0.24	0.38	0.42
2014	1472	12	0.01	17	0.28	0.55	0.21
2015	1463	11	0.01	16	0.27	0.55	0.28
2016	1484	14	0.01	27	0.45	0.68	0.25
2017	1541	23	0.01	46	0.73	0.83	0.25
2018	1736	11	0.01	23	0.33	0.64	0.39
2019	1624	8	0	11	0.17	0.28	0.35

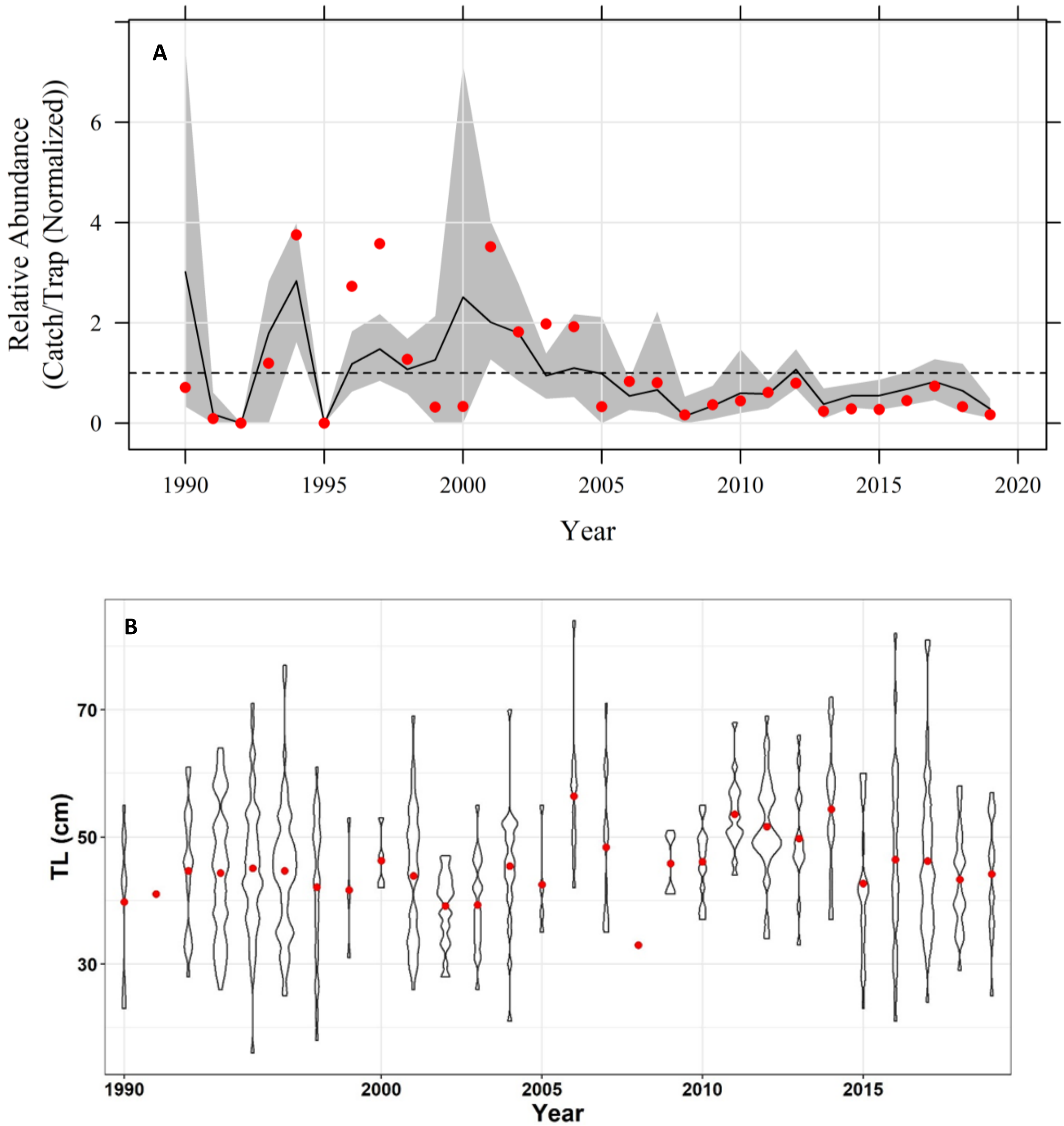


Figure 40. A) Chevron trap normalized nominal (red dot) and zero-inflated negative binomial (black line) standardized CPUE (gray area = 95% CI) for Snowy Grouper. B) Snowy Grouper total lengths (cm) caught in chevron traps by year. Red dots represent mean length. Vertical axis of violin represents the range of samples from a given year, while the width represents the numbers caught of that length by year.

Short bottom longline

Nominal and standardized CPUE of Snowy Grouper caught with SBLL in 2019 has increased from 2018. The nominal CPUE was above the time series mean, while the standardized CPUE remained below the time series mean (**Error! Reference source not found.** and **Error! Reference source not found.**A). Snowy Gr ouper mean lengths of fish caught using SBLL increased slightly from 2018 likely due to truncation of the length composition with fewer larger and smaller specimens caught (**Error! Reference source not found.**B).

Table 33. Short bottom longline nominal CPUE and zero-inflated negative binomial (ZINB) standardized CPUE for Snowy Grouper and information associated with SBLL sets included in standardized CPUE calculation. Positive = number of included collections positive for the species of interest, Proportion Positive = proportion of included collections positive for the species of interest, Normalized = CPUE (number of fish*20 hooks^{-1}*hr^{-1}) normalized to its mean value over the time series, and CV = coefficient of variation.

					Nominal CPUE	ZINB Standardized CPUE	
Year	Included Collections	Positive	Proportion Positive	Total Fish	Normalized	Normalized	CV
1996	12	4	0.33	5	0.39	0.56	0.54
1997	33	14	0.42	38	1.08	0.72	0.3
1998	31	13	0.42	27	0.82	0.57	0.41
1999	36	14	0.39	33	0.86	1.05	0.26
2000	34	17	0.5	34	0.94	0.65	0.27
2001	29	17	0.59	42	1.36	1.3	0.26
2002	19	10	0.53	27	1.33	2.29	0.33
2003	51	25	0.49	52	0.95	0.66	0.2
2004	21	4	0.19	8	0.36	0.65	0.58
2005	42	18	0.43	35	0.78	0.94	0.25
2006	50	13	0.26	30	0.56	0.51	0.32
2007	52	6	0.12	15	0.27	0.67	0.4
2008	29	20	0.69	61	1.97	1.62	0.19
2009	43	5	0.12	21	0.46	1.61	0.37
2010	77	39	0.51	72	0.88	0.77	0.17
2011	61	26	0.43	66	1.01	1.15	0.18
2012	21	17	0.81	76	3.39	1.89	0.19
2013	41	13	0.32	49	1.12	1.55	0.25
2014	57	28	0.49	66	1.08	0.96	0.2
2015	75	37	0.49	101	1.26	0.93	0.16
2016	62	28	0.45	71	1.07	1.17	0.2
2017	48	7	0.15	13	0.25	0.57	0.52
2018	66	20	0.3	44	0.62	0.47	0.29
2019	25	14	0.56	32	1.2	0.75	0.29

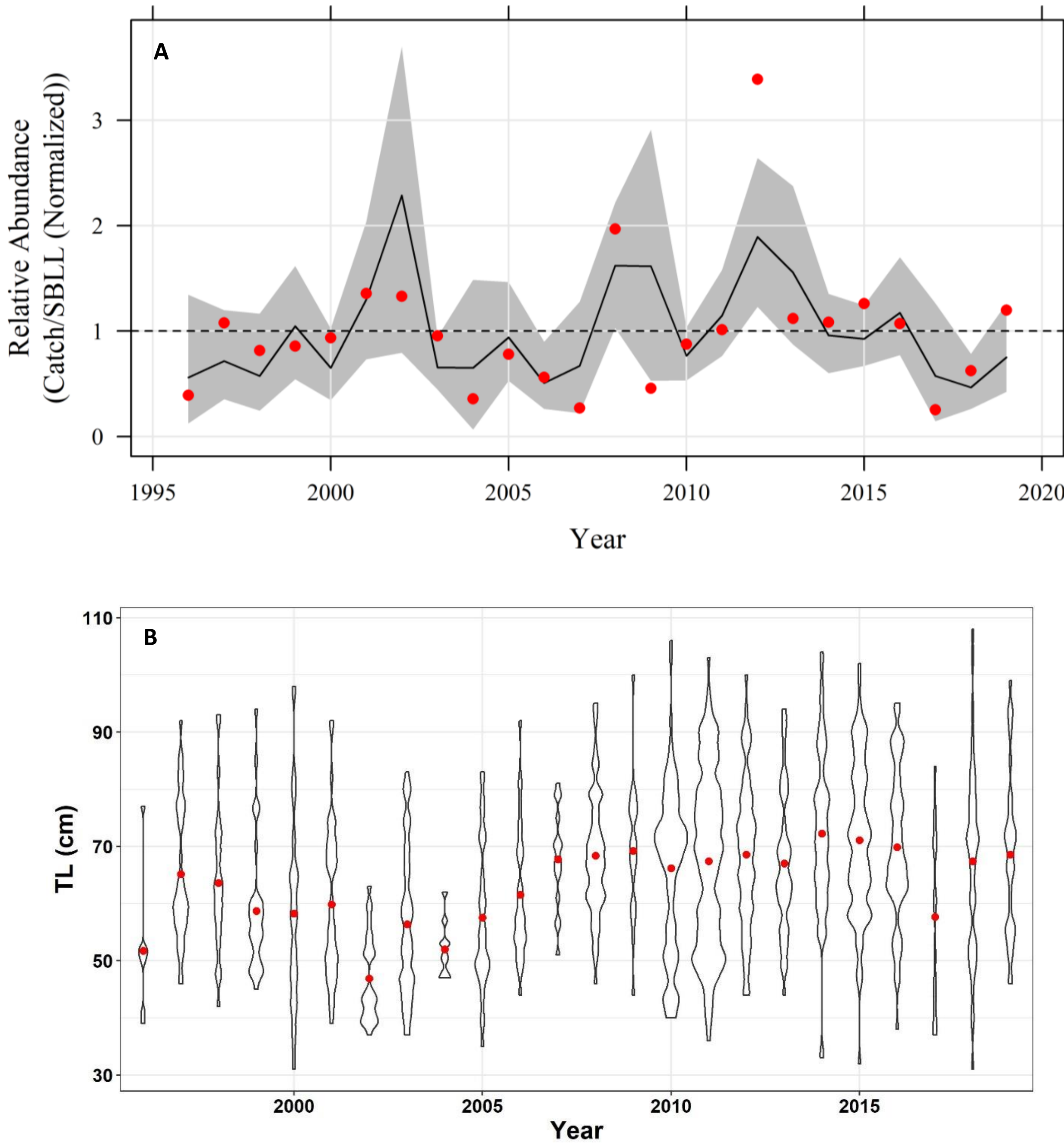


Figure 41. A) Short bottom longline normalized nominal (red dot) and zero-inflated negative binomial (black line) standardized CPUE (gray area = 95% CI) for Snowy Grouper. B) Snowy Grouper total lengths (cm) caught with SBLL by year. Red dots represent mean length. Vertical axis of violin represents the range of samples from a given year, while the width represents the numbers caught of that length by year.

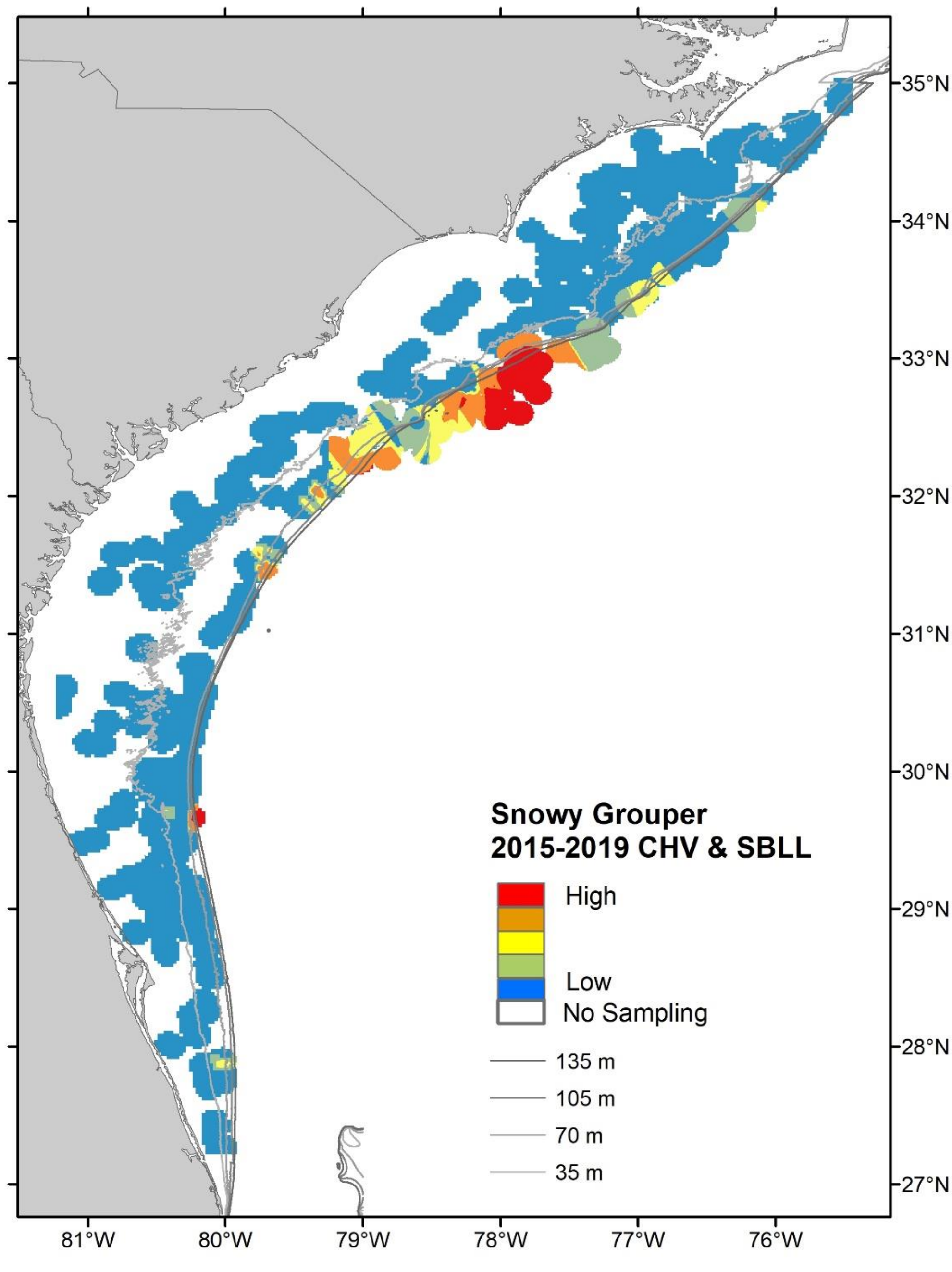


Figure 42. Distribution map of Snowy Grouper catch by SERFS from 2015-2019. Colors indicate quartiles by catch per trap hour and white indicates areas not sampled by SERFS. The map smoothing was accomplished with inverse distance weighting.

Speckled Hind (*Epinephelus drummondhayi*)

Chevron Trap
Speckled Hind were not caught with chevron traps in large enough numbers or consistently enough for development of an index of relative abundance (

Table **34**). No Speckled Hind was caught in chevron traps in 2019, and although the mean length of Speckled Hind in chevron traps decreased in 2018 compared to 2017, though only one fish was caught in 2018 (**Error! Reference source not found.**).

Table 34: Chevron Trap catch of Speckled Hind and information associated with chevron trap sets. Positive = number of included collections positive for the species of interest, Proportion Positive = proportion of included collections positive for the species of interest.

Year	Included Collections	Positive	Proportion Positive	Total Fish
1991	272	1	0.00	1
1992	288	3	0.01	4
1993	392	4	0.01	5
1994	387	2	0.01	4
1995	361	0	0.00	0
1996	361	4	0.01	5
1997	406	5	0.01	8
1998	426	5	0.01	5
1999	233	6	0.03	6
2000	298	10	0.03	17
2001	245	5	0.02	7
2002	244	12	0.05	15
2003	224	4	0.02	6
2004	282	3	0.01	5
2005	303	1	0.00	2
2006	297	0	0.00	0
2007	337	3	0.01	8
2008	303	1	0.00	1
2009	404	0	0.00	0
2010	725	1	0.00	1
2011	726	2	0.00	2
2012	1174	2	0.00	2
2013	1360	5	0.00	5
2014	1472	6	0.00	7
2015	1463	3	0.00	3
2016	1484	0	0.00	0
2017	1541	2	0.00	2
2018	1736	0	0.00	0
2019	1624	0	0.00	0

Short bottom longline
Speckled Hind were not caught with SBLL in large enough numbers or consistently enough for development of an index of relative abundance (Table 35). No Speckled Hind was caught by SBLL in 2019 and although the mean length of Speckled Hind caught with SBLLs increased in 2018 compared to 2017, only two fish were caught in 2018 (**Error! Reference source not found.**).

Table 35: Short bottom longline catch of Speckled Hind and information associated with SBLL sets. Positive = number of included collections positive for the species of interest, Proportion Positive = proportion of included collections positive for the species of interest.

Year	Included Collections	Positive	Proportion Positive	Total Fish
1996	15	0	0.00	0
1997	33	0	0.00	0
1998	31	0	0.00	0
1999	36	4	0.11	4
2000	34	2	0.06	3
2001	29	2	0.07	2
2002	19	0	0.00	0
2003	51	0	0.00	0
2004	34	5	0.15	6
2005	42	6	0.14	9
2006	50	1	0.02	2
2007	53	6	0.11	8
2008	29	0	0.00	0
2009	43	3	0.07	3
2010	83	2	0.02	2
2011	109	6	0.06	7
2012	21	0	0.00	0
2013	41	3	0.07	4
2014	57	0	0.00	0
2015	75	0	0.00	0
2016	62	0	0.00	0
2017	48	1	0.02	1
2018	66	2	0.03	2
2019	25	0	0.00	0

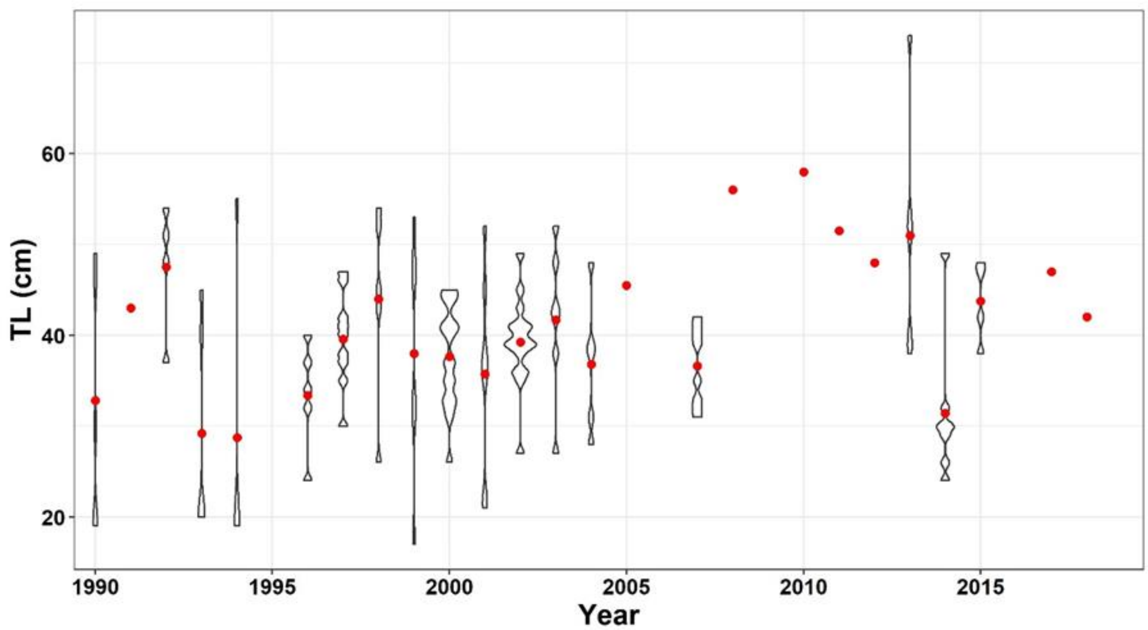


Figure 43. Speckled Hind total lengths (cm) caught in chevron traps by year. Red dots represent mean length. Vertical axis of violin represents the range of samples from a given year, while the width represents the numbers caught of that length by year.

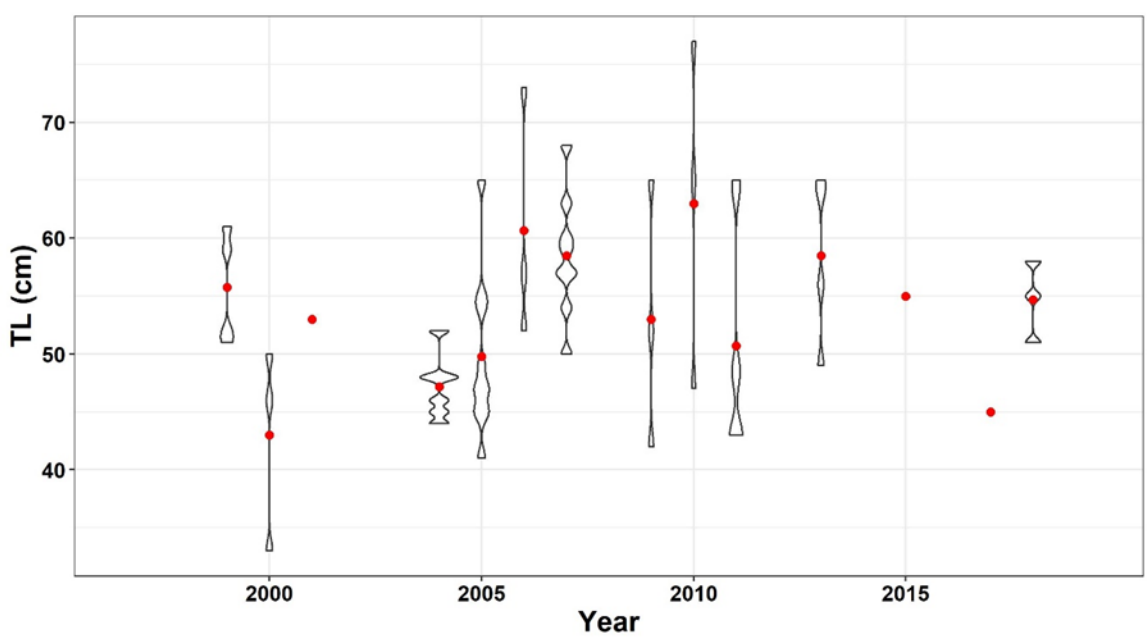


Figure 44. Speckled Hind total lengths (cm) caught with short bottom longline by year. Red dots represent mean length. Vertical axis of violin represents the range of samples from a given year, while the width represents the numbers caught of that length by year.

Sparidae

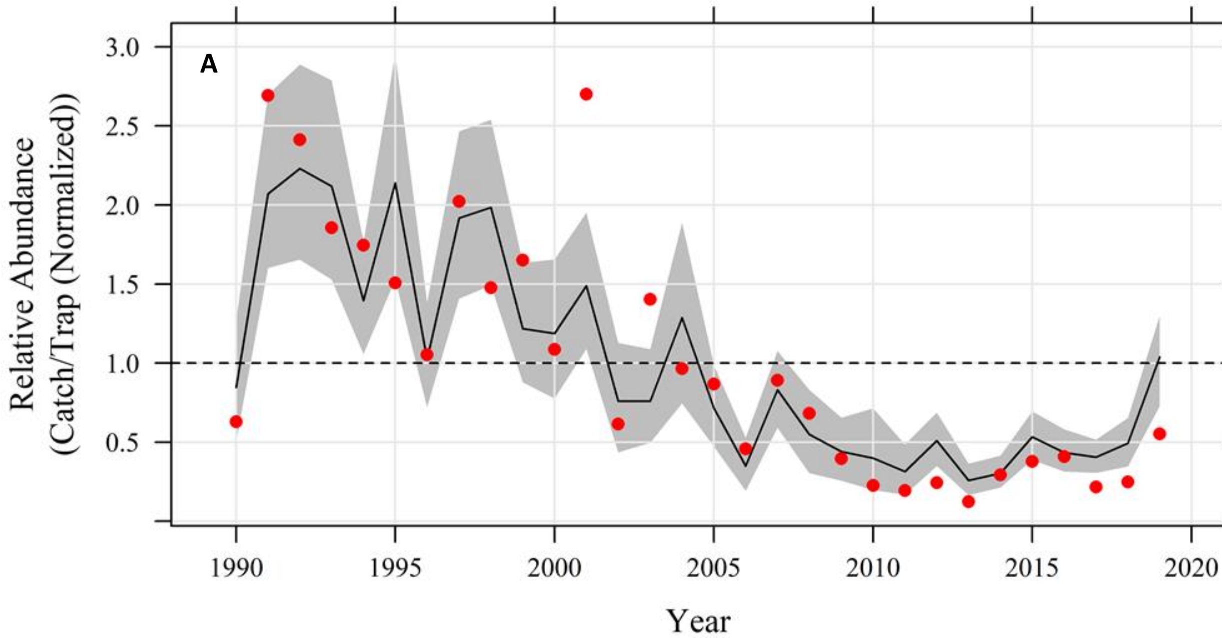
<u>Knobbed Porgy (*Calamus nodosus*)</u>

Chevron Trap

Nominal and standardized CPUE of Knobbed Porgy caught with chevron traps in 2019 increased from 2018. Although the standardized CPUE was just above the time series mean, the nominal CPUE remained below the time series mean (Table 36 and **Error! Reference source not found.**A). Knobbed Porgy mean lengths caught in chevron traps in 2019 remained similar to the previous year (**Error! R eference source not found.**B). The spatial distribution of Knobbed Porgy catches from chevron traps is focused on the northern portion of the region and in deeper waters and is relatively limited off the southern portion in recent years (**Error! Reference source not found.**).

Table 36: Chevron trap nominal CPUE and zero-inflated negative binomial (ZINB) standardized CPUE for Knobbed Porgy and information associated with chevron trap sets included in standardized CPUE calculation. Positive = number of included collections positive for the species of interest, Proportion Positive = proportion of included collections positive for the species of interest, Normalized = CPUE (number of fish*trap^{-1}*hr^{-1}) normalized to its mean value over the time series, and CV = coefficient of variation.

					Nominal CPUE	ZINB Standardized CPUE	
Year	Included Collections	Positive	Proportion Positive	Total Fish	Normalized	Normalized	CV
1990	313	27	0.09	42	0.63	0.85	0.23
1991	272	60	0.22	156	2.69	2.07	0.13
1992	288	62	0.22	148	2.41	2.23	0.14
1993	392	73	0.19	155	1.86	2.12	0.15
1994	387	74	0.19	144	1.75	1.4	0.13
1995	361	59	0.16	116	1.51	2.14	0.17
1996	361	45	0.12	81	1.05	1.02	0.16
1997	406	51	0.13	175	2.02	1.92	0.14
1998	426	70	0.16	134	1.48	1.98	0.13
1999	233	35	0.15	82	1.65	1.22	0.16
2000	298	33	0.11	69	1.09	1.19	0.19
2001	245	50	0.2	141	2.7	1.49	0.15
2002	244	15	0.06	32	0.62	0.76	0.23
2003	224	32	0.14	67	1.4	0.76	0.2
2004	282	25	0.09	58	0.97	1.29	0.23
2005	303	35	0.12	56	0.87	0.72	0.19
2006	297	18	0.06	29	0.46	0.35	0.25
2007	337	35	0.1	64	0.89	0.83	0.15
2008	303	22	0.07	44	0.68	0.55	0.24
2009	404	21	0.05	34	0.39	0.44	0.24
2010	725	20	0.03	35	0.23	0.4	0.33
2011	726	16	0.02	30	0.19	0.31	0.26
2012	1174	36	0.03	61	0.24	0.51	0.17
2013	1360	28	0.02	36	0.12	0.26	0.2
2014	1472	58	0.04	92	0.29	0.3	0.17
2015	1463	73	0.05	118	0.38	0.53	0.14
2016	1484	86	0.06	129	0.41	0.43	0.16
2017	1541	60	0.04	71	0.22	0.41	0.13
2018	1736	65	0.04	92	0.25	0.49	0.16
2019	1624	103	0.06	191	0.55	1.04	0.14



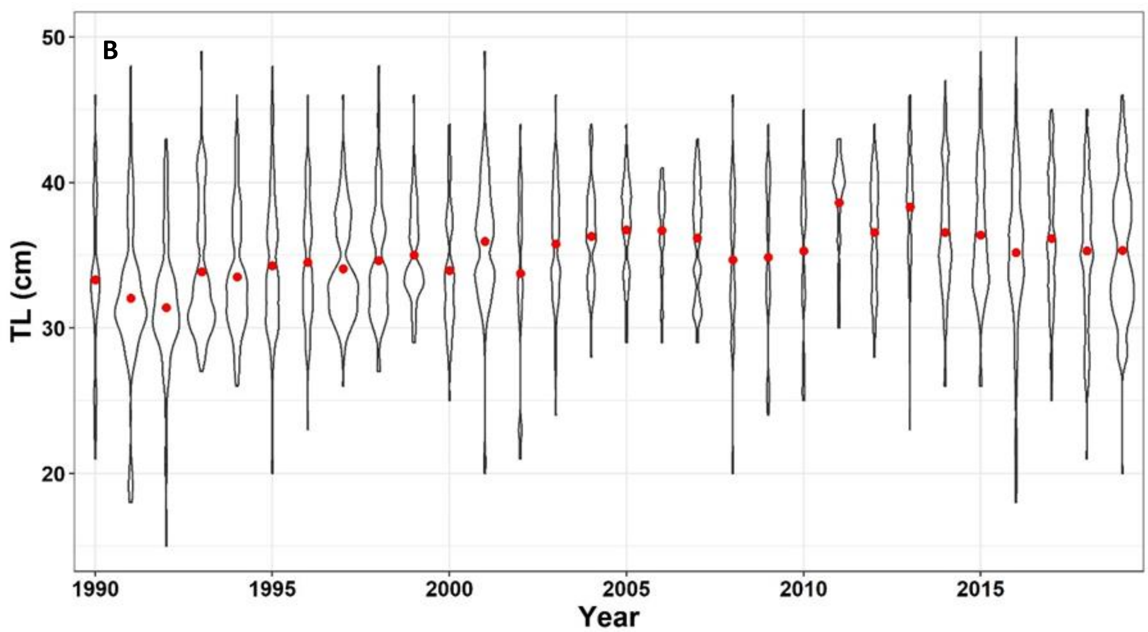


Figure 45. A) Chevron trap normalized nominal (red dot) and zero-inflated negative binomial (black line) standardized CPUE (gray area = 95% CI) for Knobbed Porgy. B) Knobbed Porgy total lengths (cm) caught in chevron traps by year. Red dots represent mean length. Vertical axis of violin represents the range of samples from a given year, while the width represents the numbers caught of that length by year.

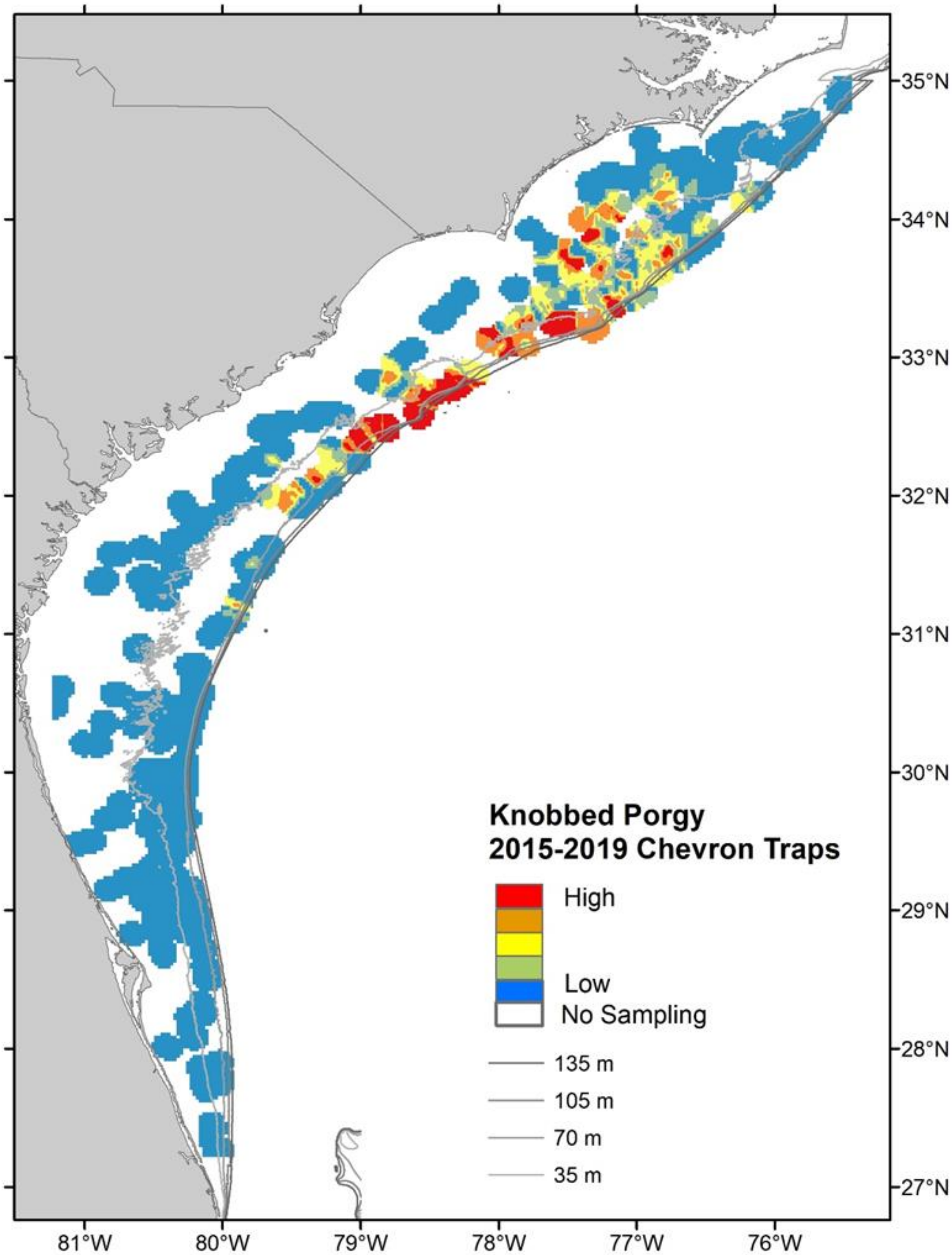


Figure 46. Distribution map of Knobbed Porgy catch by SERFS from 2015-2019. Colors indicate quartiles by catch per trap hour and white indicates areas not sampled by SERFS. The map smoothing was accomplished with inverse distance weighting.

Pinfish (*Lagodon rhomboides*)

Chevron Trap

Nominal and standardized CPUE of Pinfish caught with Chevron traps have remained below the long-term mean since 2013. (Table 37 and **Error! Reference source not found.**A). Pinfish mean lengths caught in chevron traps increased slightly in 2019 compared to the previous year, with truncated size composition and fewer larger fish collected (**Error! Reference source not found.**B). The spatial d istribution of Pinfish catches from chevron traps is focused on the southern portion of the region in shallow waters, with limited catches in the central and northern portion in recent years (**Error! R eference source not found.**).

Table 37. Chevron trap nominal CPUE and zero-inflated negative binomial (ZINB) standardized CPUE for Pinfish and information associated with chevron trap sets included in standardized CPUE calculation. Positive = number of included collections positive for the species of interest, Proportion Positive = proportion of included collections positive for the species of interest, Normalized = CPUE (number of fish*trap^{-1}*hr^{-1}) normalized to its mean value over the time series, and CV = coefficient of variation.

					Nominal CPUE	ZINB Standardized CPUE	
Year	**Included Collections**	**Positive**	**Proportion Positive**	**Total Fish**	**Normalized**	**Normalized**	**CV**
1990	313	22	0.07	168	1.95	2.96	0.68
1991	272	18	0.07	36	0.48	0.56	0.62
1992	288	30	0.1	175	2.21	2.83	0.29
1993	392	13	0.03	23	0.21	0.15	0.37
1994	387	6	0.02	10	0.09	0.11	0.8
1995	361	31	0.09	60	0.6	0.4	0.27
1996	361	31	0.09	187	1.88	2.01	0.47
1997	406	36	0.09	509	4.55	2.07	0.29
1998	426	57	0.13	434	3.7	2.43	0.23
1999	233	25	0.11	66	1.03	1.32	0.57
2000	298	29	0.1	119	1.45	0.79	0.34
2001	245	27	0.11	170	2.52	2.46	0.33
2002	244	11	0.05	80	1.19	0.53	0.67
2003	224	12	0.05	18	0.29	2.89	0.68
2004	282	19	0.07	66	0.85	1.88	0.46
2005	303	17	0.06	132	1.58	1.87	0.48
2006	297	11	0.04	74	0.9	0.52	0.44
2007	337	2	0.01	2	0.02	0.02	1.03
2008	303	9	0.03	22	0.26	0.34	0.63
2009	404	13	0.03	107	0.96	0.54	0.53
2010	725	35	0.05	88	0.44	0.31	0.3
2011	726	41	0.06	192	0.96	1.1	0.37
2012	1174	28	0.02	176	0.54	0.58	0.34
2013	1360	19	0.01	58	0.15	0.12	0.49
2014	1472	11	0.01	32	0.08	0.14	0.49
2015	1463	18	0.01	126	0.31	0.24	0.53
2016	1484	12	0.01	30	0.07	0.09	0.53
2017	1541	25	0.02	116	0.27	0.33	0.47
2018	1736	33	0.02	100	0.21	0.24	0.27
2019	1624	16	0.01	98	0.22	0.18	0.39

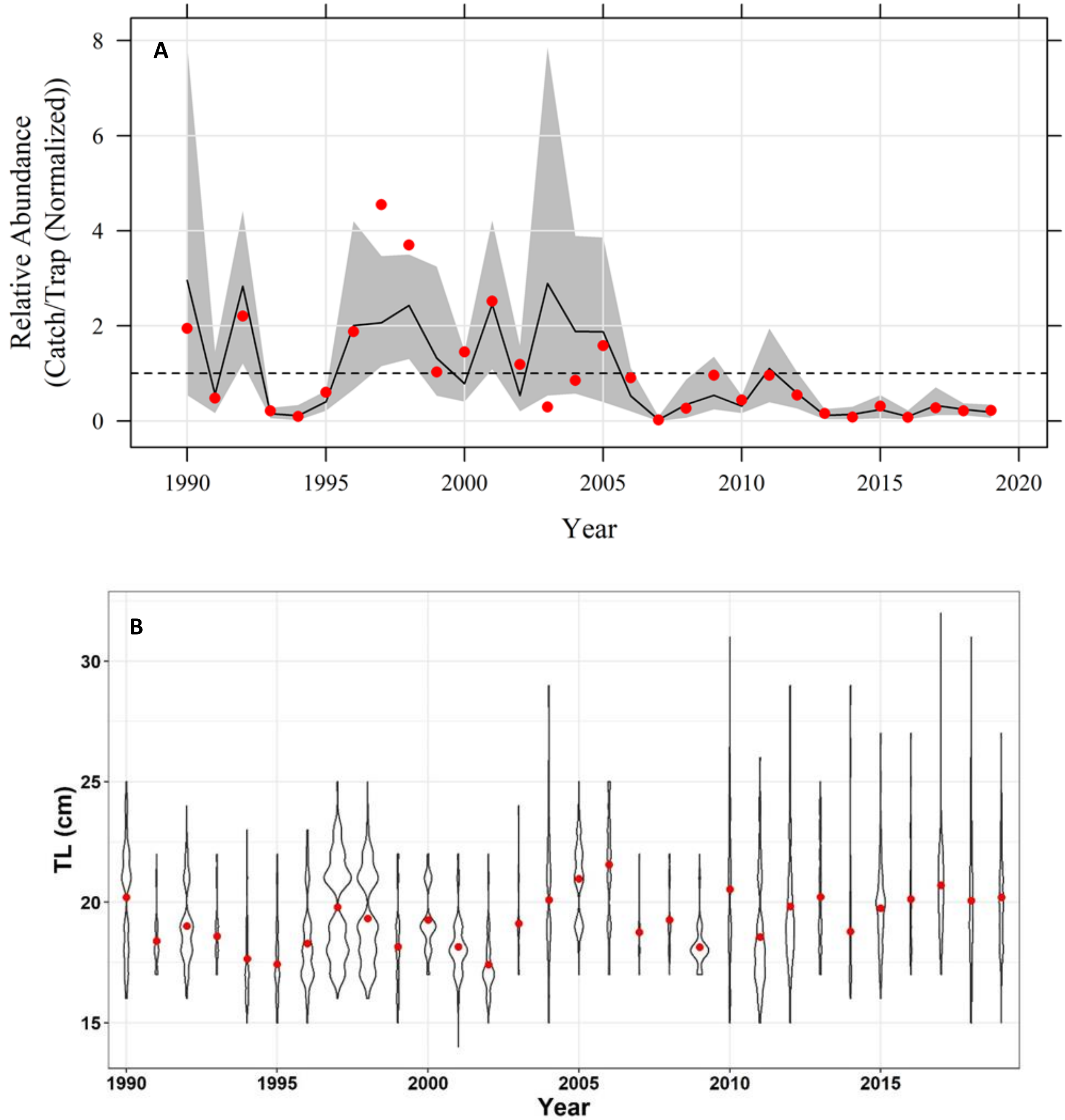


Figure 47. A) Chevron trap normalized nominal (red dot) and zero-inflated negative binomial (black line) standardized CPUE (gray area = 95% CI) for Pinfish. B) Pinfish total lengths (cm) caught in chevron traps by year. Red dots represent mean length. Vertical axis of violin represents the range of samples from a given year, while the width represents the numbers caught of that length by year.

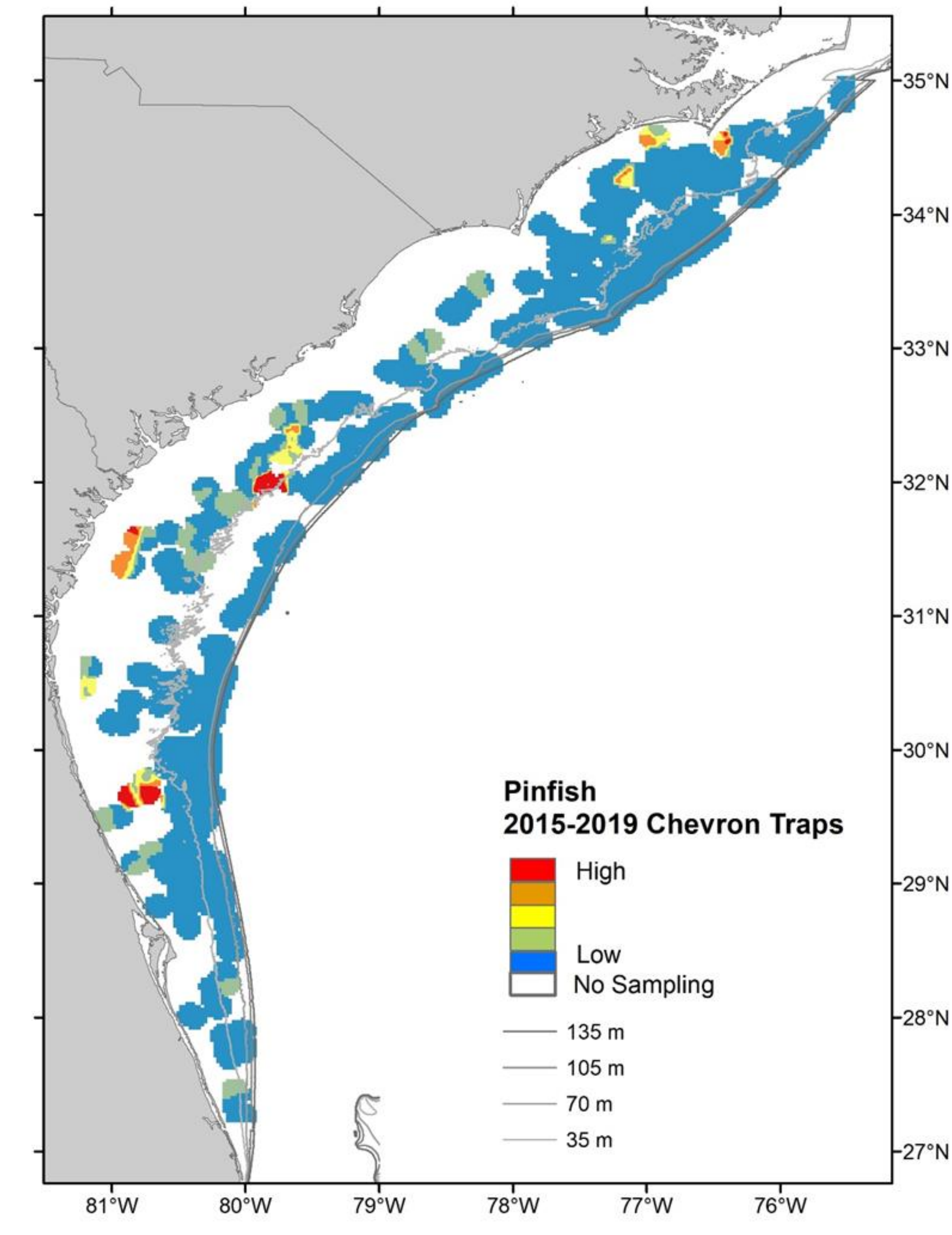


Figure 48. Distribution map of Pinfish catch by SERFS from 2015-2019. Colors indicate quartiles by catch per trap hour and white indicates areas not sampled by SERFS. The map smoothing was accomplished with inverse distance weighting.

Red Porgy (*Pagrus pagrus*)

Chevron Trap

Nominal and standardized CPUE of Red Porgy caught with chevron traps in 2019 has decreased from 2018 to a new all-time low, which continued their CPUE being below the time series mean since 2008 (Table 38 and **Error! Reference source not found.**A). Red Porgy mean lengths from chevron traps in 2019 stayed relatively the same as the previous two years, with 2017 being the highest on record during this time series, although 2019 mean lengths had a truncated size composition with a slight decrease in larger size fish (**Error! Reference source not found.**B). The spatial distribution of Red Porgy catches from c hevron traps is focused in the mid to northern portion of the region in deeper waters, with limited catches in the southern portion in recent years (**Error! Reference source not found.**).

Table 38. Chevron trap nominal CPUE and zero-inflated negative binomial (ZINB) standardized CPUE for Red Porgy and information associated with chevron trap sets included in standardized CPUE calculation. Positive = number of included collections positive for the species of interest, Proportion Positive = proportion of included collections positive for the species of interest, Normalized = CPUE (number of fish*trap^{-1}*hr^{-1}) normalized to its mean value over the time series, and CV = coefficient of variation.

					Nominal CPUE	ZINB Standardized CPUE	
Year	**Included Collections**	**Positive**	**Proportion Positive**	**Total Fish**	**Normalized**	**Normalized**	**CV**
1990	313	159	0.51	715	1.12	0.9	0.09
1991	272	135	0.5	796	1.44	1.49	0.11
1992	288	178	0.62	1086	1.85	1.43	0.1
1993	392	160	0.41	702	0.88	0.75	0.09
1994	387	166	0.43	1101	1.4	0.88	0.11
1995	361	148	0.41	872	1.18	1.18	0.17
1996	361	160	0.44	843	1.15	0.87	0.1
1997	406	126	0.31	546	0.66	0.64	0.13
1998	426	154	0.36	683	0.79	0.75	0.11
1999	233	98	0.42	423	0.89	0.94	0.12
2000	298	111	0.37	462	0.76	0.73	0.14
2001	245	100	0.41	663	1.33	1.24	0.13
2002	244	104	0.43	512	1.03	1.09	0.13
2003	224	94	0.42	437	0.96	0.85	0.13
2004	282	140	0.5	1028	1.79	1.47	0.1
2005	303	162	0.53	1097	1.78	1.58	0.1
2006	297	119	0.4	745	1.23	1.15	0.12
2007	337	153	0.45	1124	1.64	1.57	0.1
2008	303	100	0.33	520	0.84	0.79	0.12
2009	404	112	0.28	513	0.62	0.72	0.12
2010	725	212	0.29	1056	0.71	1.01	0.09
2011	726	204	0.28	1146	0.77	1.09	0.1
2012	1174	321	0.27	2146	0.9	1.26	0.09
2013	1360	330	0.24	1864	0.67	0.96	0.09
2014	1472	447	0.3	2677	0.89	1.1	0.08
2015	1463	395	0.27	1979	0.66	0.88	0.08
2016	1484	382	0.26	1786	0.59	0.8	0.08
2017	1541	337	0.22	1599	0.51	0.67	0.09
2018	1736	354	0.2	1824	0.52	0.65	0.08
2019	1624	334	0.21	1501	0.45	0.56	0.09

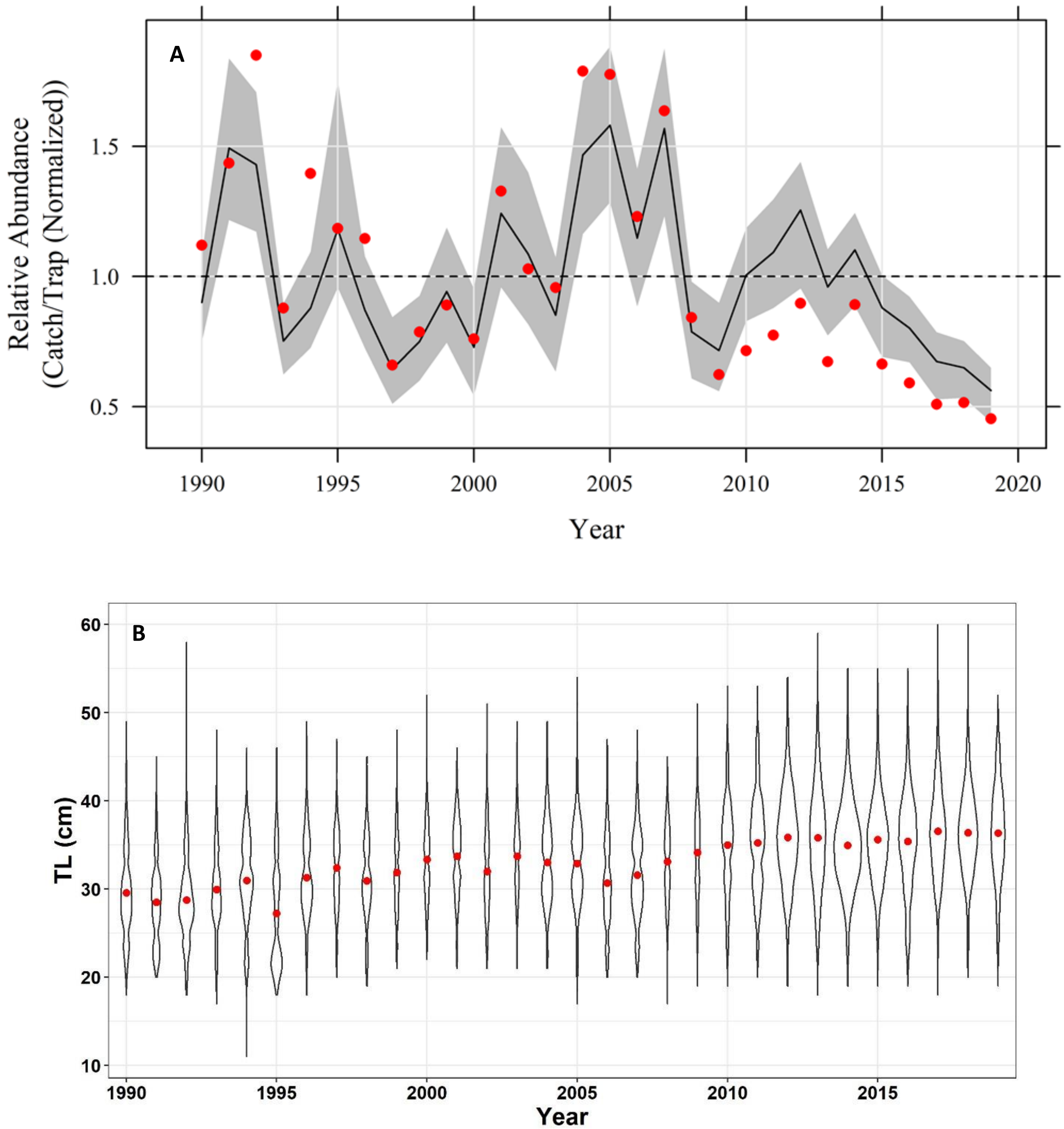


Figure 49. A) Chevron trap normalized nominal (red dot) and zero-inflated negative binomial (black line) standardized CPUE (gray area = 95% CI) for Red Porgy. B) Red Porgy total lengths (cm) caught in chevron traps by year. Red dots represent mean length. Vertical axis of violin represents the range of samples from a given year, while the width represents the numbers caught of that length by year

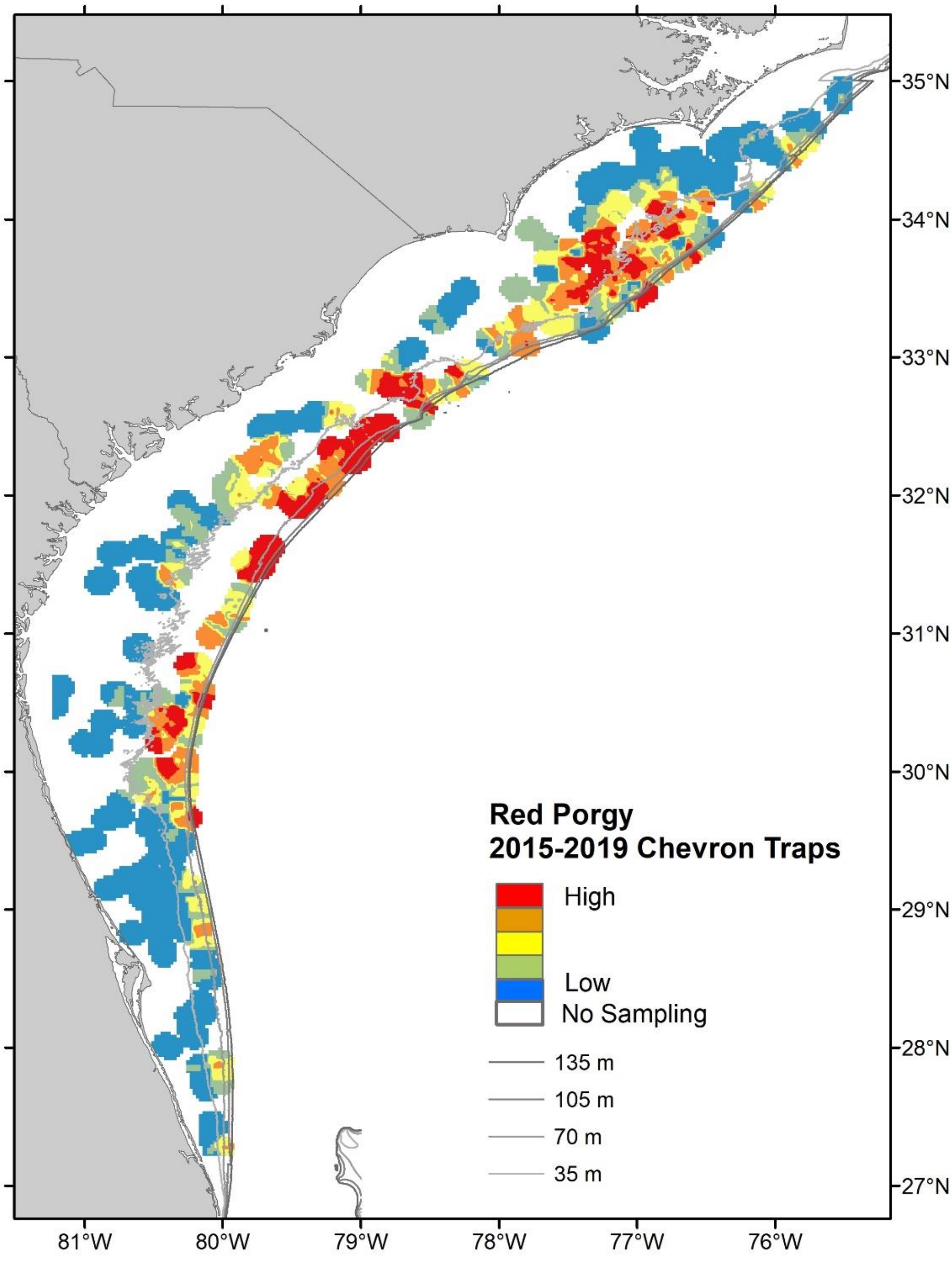


Figure 50. Distribution map of Red Porgy catch by SERFS from 2015-2019. Colors indicate quartiles by catch per trap hour and white indicates areas not sampled by SERFS. The map smoothing was accomplished with inverse distance weighting.

Short bottom longline

Red Porgy were not caught with SBLL in large enough numbers or consistently enough for development of an index of relative abundance (**Error! Reference source not found.**). The SEDAR 60 Panel also r ecommended not to utilize an SBLL index or length or age composition due to lack of encounters (SEDAR 60, 2020). There were no Red Porgy catches by SBLL in 2019, and although mean lengths from SBLL increased in 2018 from the previous year, only 1 fish was caught in 2018, therefore, caution should be taken attributing any meaning to this (**Error! Reference source not found.**).

Table 39. Short bottom longline catch of Red Porgy and information associated with SBLL sets. Positive = number of included collections positive for the species of interest, Proportion Positive = proportion of included collections positive for the species of interest.

Year	Included Collections	Positive	Proportion Positive	Total Fish
1996	15	0	0.00	0
1997	33	0	0.00	0
1998	31	0	0.00	0
1999	36	3	0.08	4
2000	34	3	0.09	3
2001	29	0	0.00	0
2002	19	3	0.16	4
2003	51	5	0.10	6
2004	34	5	0.15	7
2005	42	2	0.05	2
2006	50	2	0.04	2
2007	53	0	0.00	0
2008	29	1	0.03	1
2009	43	3	0.07	4
2010	83	1	0.01	1
2011	109	6	0.06	6
2012	21	1	0.05	1
2013	41	5	0.12	8
2014	57	1	0.02	1
2015	75	2	0.03	2
2016	62	6	0.10	6
2017	48	3	0.06	3
2018	66	1	0.02	1
2019	25	0	0.00	0

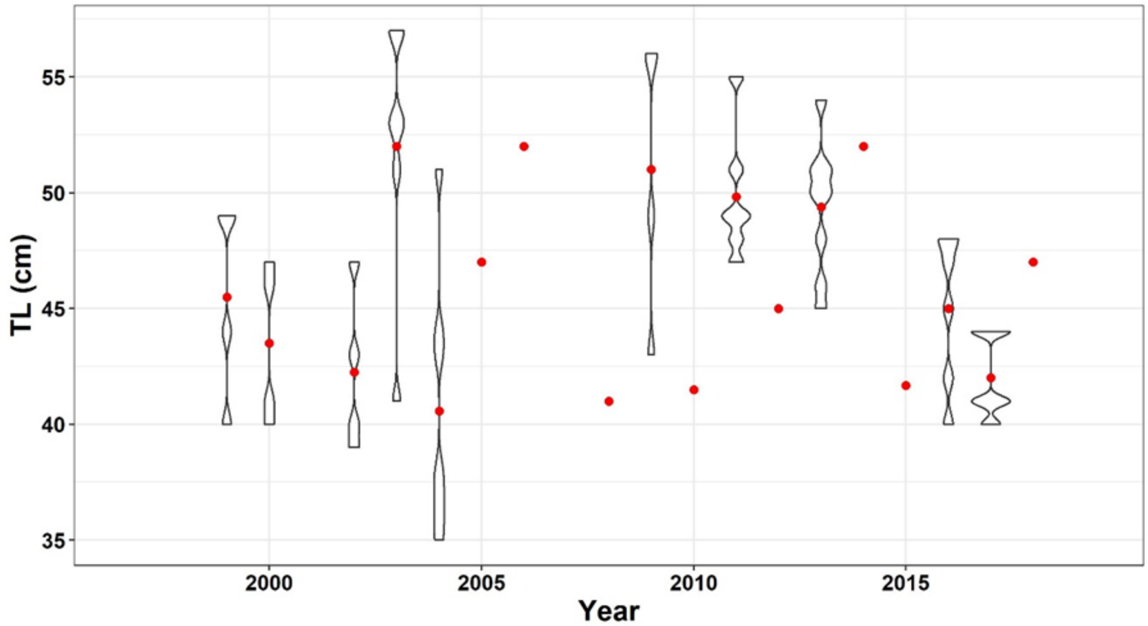


Figure 51. Red Porgy total lengths (cm) caught with short bottom longline by year. Red dots represent mean length. Vertical axis of violin represents the range of samples from a given year, while the width represents the numbers caught of that length by year.

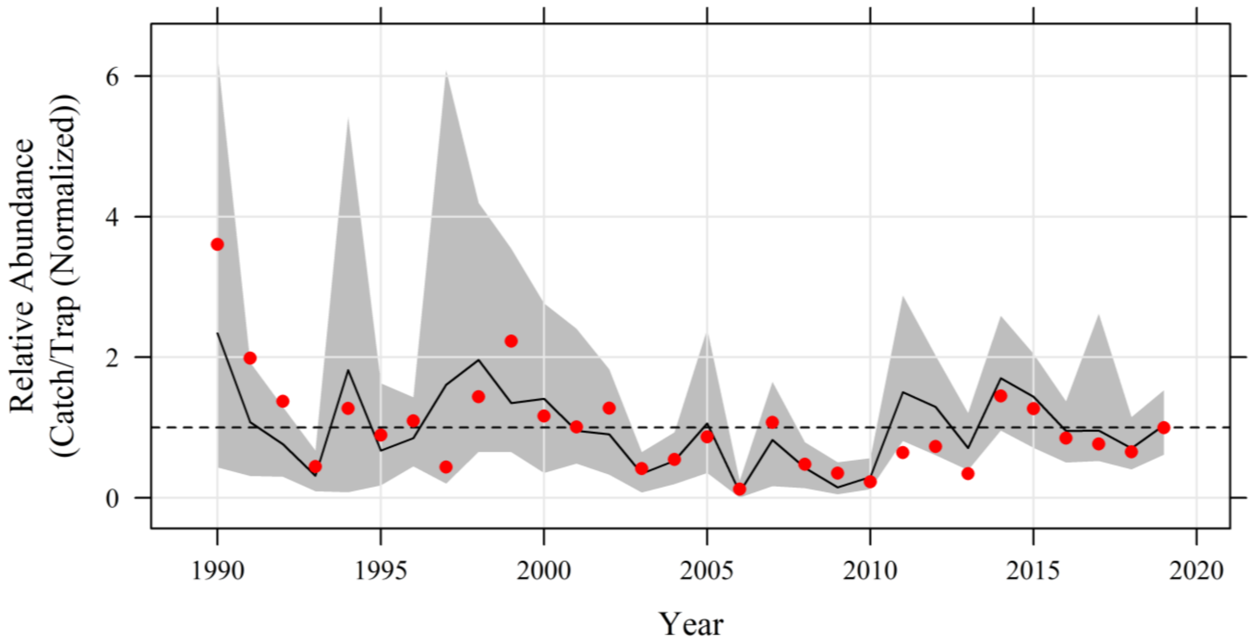
Spottail Pinfish (*Diplodus holbrookii*)

Chevron Trap

Nominal and standardized CPUE of Spottail Pinfish caught with chevron traps in 2019 increased from 2018 with both at and above the time series mean (Table 40 and **Error! Reference source not found.**A). Spottail Pinfish mean lengths from chevron traps in 2019 decreased from the previous year, with a similar length compositions encountered (**Error! Reference source not found.**B). The spatial distribution o f Spottail Pinfish catches from chevron traps is focused in the northern portion of the region in shallower waters, with limited catches in the southern portion in recent years (**Error! Reference source not found.**).

Table 40. Chevron trap nominal CPUE and zero-inflated negative binomial (ZINB) standardized CPUE for Spottail Pinfish and information associated with chevron trap sets included in standardized CPUE calculation. Positive = number of included collections positive for the species of interest, Proportion Positive = proportion of included collections positive for the species of interest, Normalized = CPUE (number of fish*trap^{-1}*hr^{-1}) normalized to its mean value over the time series, and CV = coefficient of variation.

					Nominal CPUE	ZINB Standardized CPUE	
Year	Included Collections	Positive	Proportion Positive	Total Fish	Normalized	Normalized	CV
1990	313	20	0.06	374	3.6	2.34	0.69
1991	272	16	0.06	179	1.99	1.08	0.39
1992	288	18	0.06	131	1.37	0.76	0.33
1993	392	13	0.03	58	0.45	0.31	0.48
1994	387	7	0.02	163	1.27	1.82	0.84
1995	361	15	0.04	107	0.89	0.67	0.56
1996	361	24	0.07	131	1.09	0.85	0.3
1997	406	16	0.04	59	0.44	1.61	0.96
1998	426	27	0.06	203	1.44	1.96	0.45
1999	233	17	0.07	172	2.23	1.35	0.6
2000	298	15	0.05	115	1.16	1.41	0.44
2001	245	22	0.09	82	1.01	0.96	0.49
2002	244	14	0.06	103	1.27	0.9	0.42
2003	224	8	0.04	31	0.42	0.35	0.43
2004	282	13	0.05	51	0.55	0.53	0.37
2005	303	14	0.05	87	0.87	1.06	0.51
2006	297	4	0.01	12	0.12	0.08	0.9
2007	337	8	0.02	120	1.07	0.82	0.46
2008	303	11	0.04	48	0.48	0.43	0.4
2009	404	14	0.03	47	0.35	0.15	0.85
2010	725	17	0.02	55	0.23	0.3	0.39
2011	726	38	0.05	155	0.64	1.5	0.36
2012	1174	68	0.06	284	0.73	1.29	0.28
2013	1360	41	0.03	155	0.34	0.71	0.3
2014	1472	110	0.07	706	1.45	1.7	0.25
2015	1463	115	0.08	615	1.27	1.44	0.24
2016	1484	100	0.07	418	0.85	0.95	0.23
2017	1541	85	0.06	392	0.77	0.96	0.58
2018	1736	89	0.05	376	0.65	0.71	0.27



2019	1624	111	0.07	536	1	1.03	0.23

A
B

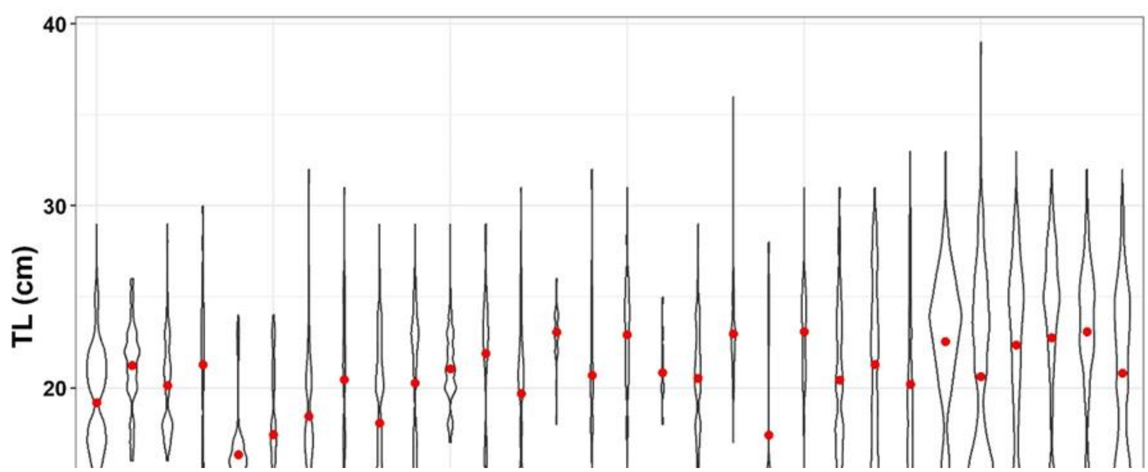


Figure 52. A) Chevron trap normalized nominal (red dot) and zero-inflated negative binomial (black line) standardized CPUE (gray area = 95% CI) for Spottail Pinfish. B) Spottail Pinfish total lengths (cm) caught in chevron traps by year. Red dots represent mean length. Vertical axis of violin represents the range of samples from a given year, while the width represents the numbers caught of that length by year.

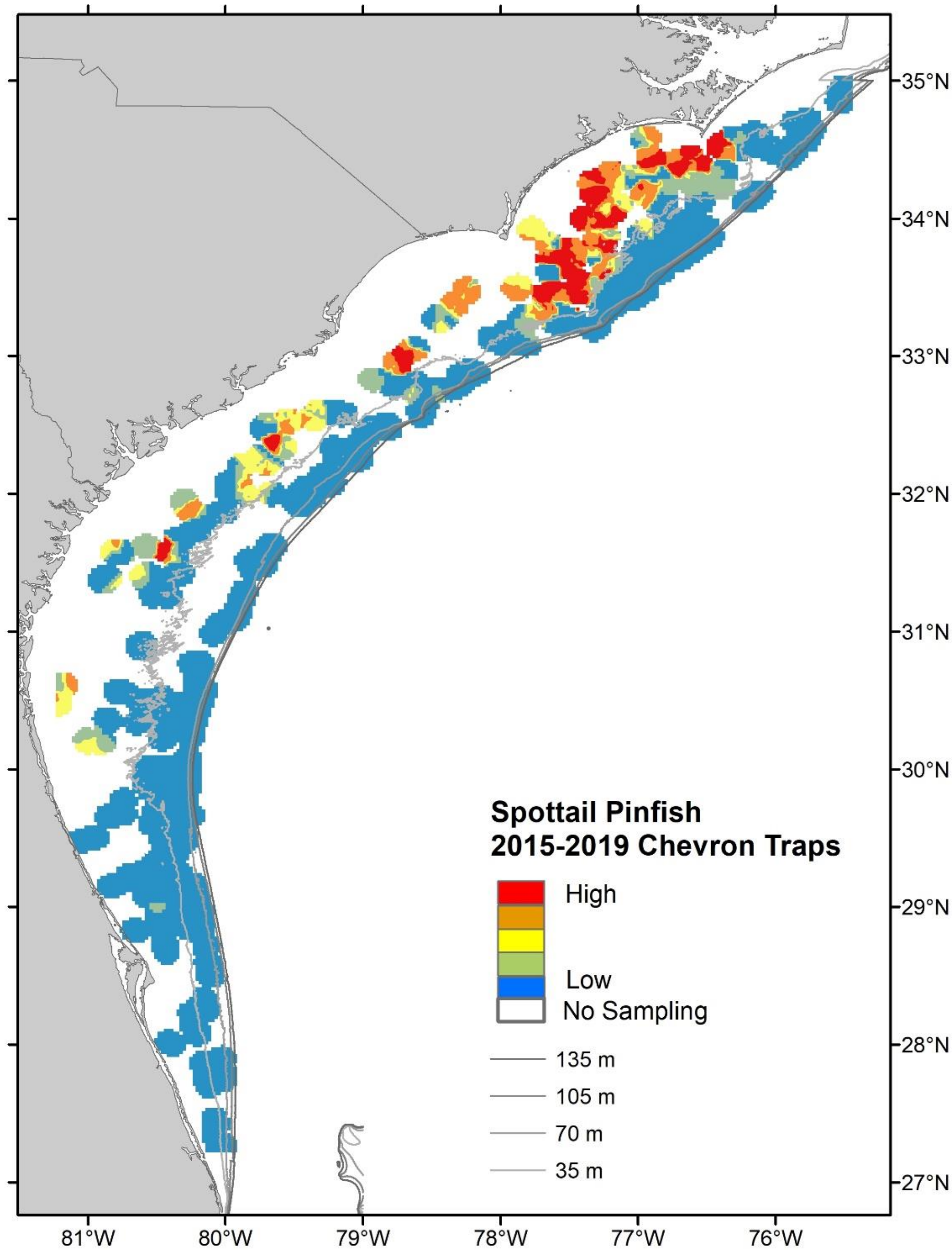


Figure 53. Distribution map of Spottail Pinfish catch by SERFS from 2015-2019. Colors indicate quartiles by catch per trap hour and white indicates areas not sampled by SERFS. The map smoothing was accomplished with inverse distance weighting.

Stenotomus spp.

Chevron Trap

Nominal and standardized CPUE of *Stenotomus* spp. caught with chevron traps in 2019 were similar to 2018, with both below the time series mean (Table 41 and **Error! Reference source not found.**A). *Stenotomus* spp. mean lengths from chevron trap catch in 2019 remained the same as the previous year, although there was a broader size composition collected with more small fish than previous years (**Error! Reference source not found.**B). The spatial distribution of *Stenotomus* spp. catches from chevron t raps is relatively evenly disbursed throughout the region in shallower waters, with slightly limited catches in the southern portion in recent years (**Error! Reference source not found.**).

Table 41. Chevron trap nominal CPUE and zero-inflated negative binomial (ZINB) standardized CPUE for *Stenotomus* spp. and information associated with chevron trap sets included in standardized CPUE calculation. Positive = number of included collections positive for the species of interest, Proportion Positive = proportion of included collections positive for the species of interest, Normalized = CPUE (number of fish*trap^{-1}*hr^{-1}) normalized to its mean value over the time series, and CV = coefficient of variation.

					Nominal CPUE	ZINB Standardized CPUE	
Year	Included Collections	Positive	Proportion Positive	Total Fish	Normalized	Normalized	CV
1990	313	122	0.39	3598	1.37	0.66	0.13
1991	272	101	0.37	3816	1.67	1.14	0.19
1992	288	123	0.43	3810	1.57	0.71	0.18
1993	392	87	0.22	2109	0.64	0.49	0.2
1994	387	91	0.24	3645	1.12	1	0.19
1995	361	153	0.42	5946	1.96	1.12	0.16
1996	361	129	0.36	5710	1.88	1.48	0.18
1997	406	120	0.3	6333	1.85	1.98	0.15
1998	426	139	0.33	5552	1.55	1.7	0.18
1999	233	73	0.31	3354	1.71	1.93	0.21
2000	298	82	0.28	4113	1.64	1.73	0.21
2001	245	67	0.27	2862	1.39	1.68	0.24
2002	244	61	0.25	1714	0.83	1.18	0.36
2003	224	40	0.18	3463	1.84	1.43	0.55
2004	282	74	0.26	3984	1.68	1.44	0.21
2005	303	83	0.27	4173	1.64	1.57	0.2
2006	297	63	0.21	1839	0.74	1.02	0.32
2007	337	52	0.15	2012	0.71	0.99	0.26
2008	303	56	0.18	2794	1.1	1.21	0.21
2009	404	68	0.17	1503	0.44	0.54	0.23
2010	725	129	0.18	3535	0.58	0.78	0.21
2011	726	137	0.19	2959	0.48	0.88	0.18
2012	1174	206	0.18	3847	0.39	0.54	0.17
2013	1360	151	0.11	1767	0.15	0.31	0.2
2014	1472	122	0.08	1392	0.11	0.25	0.19
2015	1463	136	0.09	2128	0.17	0.36	0.19
2016	1484	131	0.09	2737	0.22	0.5	0.2
2017	1541	108	0.07	2526	0.19	0.54	0.19
2018	1736	145	0.08	2735	0.19	0.43	0.21

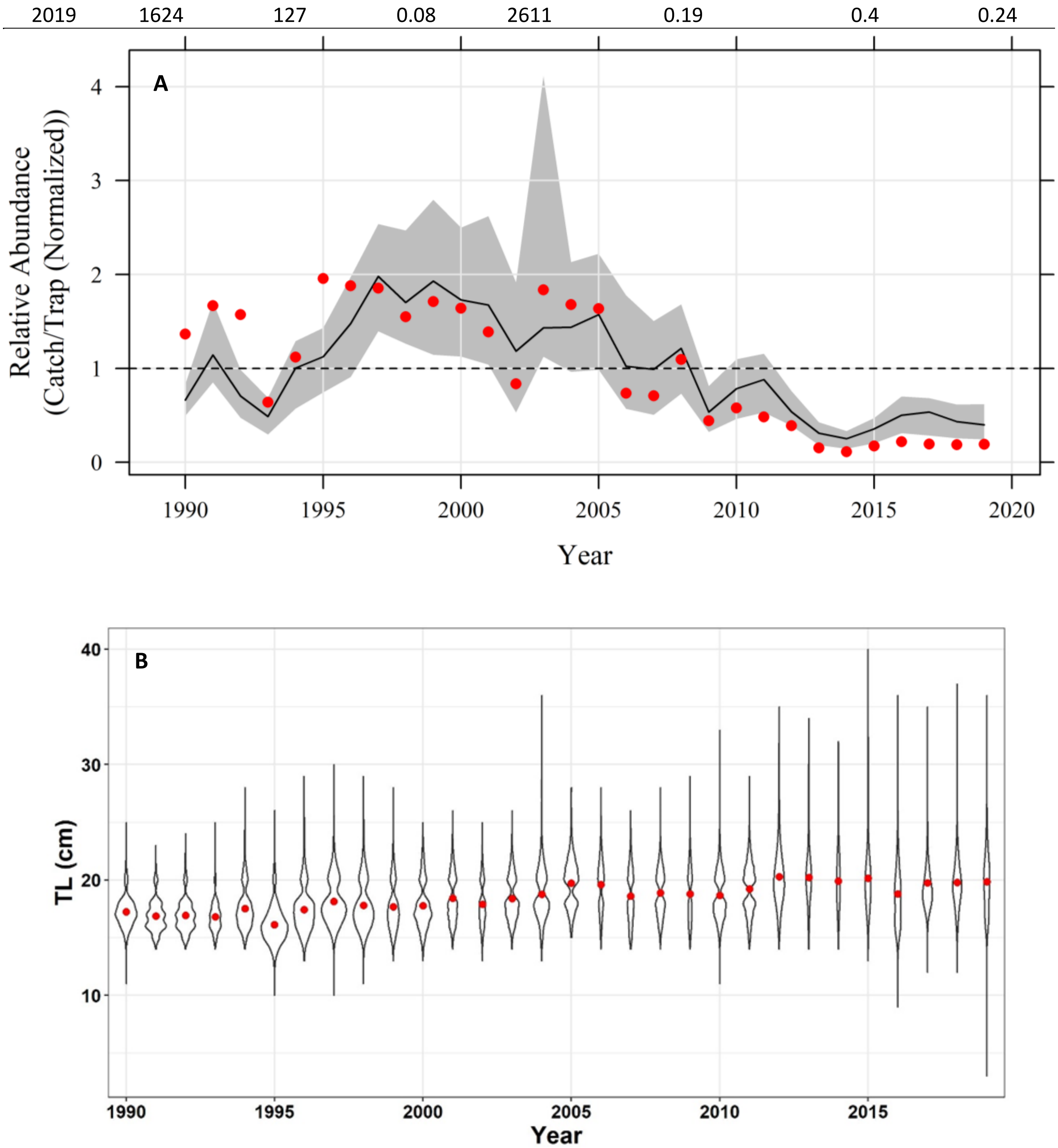


Figure 54. A) Chevron trap normalized nominal (red dot) and zero-inflated negative binomial (black line) standardized CPUE (gray area = 95% CI) for *Stenotomus* spp. B) *Stenotomus* spp. total lengths (cm) caught in chevron traps by year. Red dots represent mean length. Vertical axis of violin represents the range of samples from a given year, while the width represents the numbers caught of that length by year.

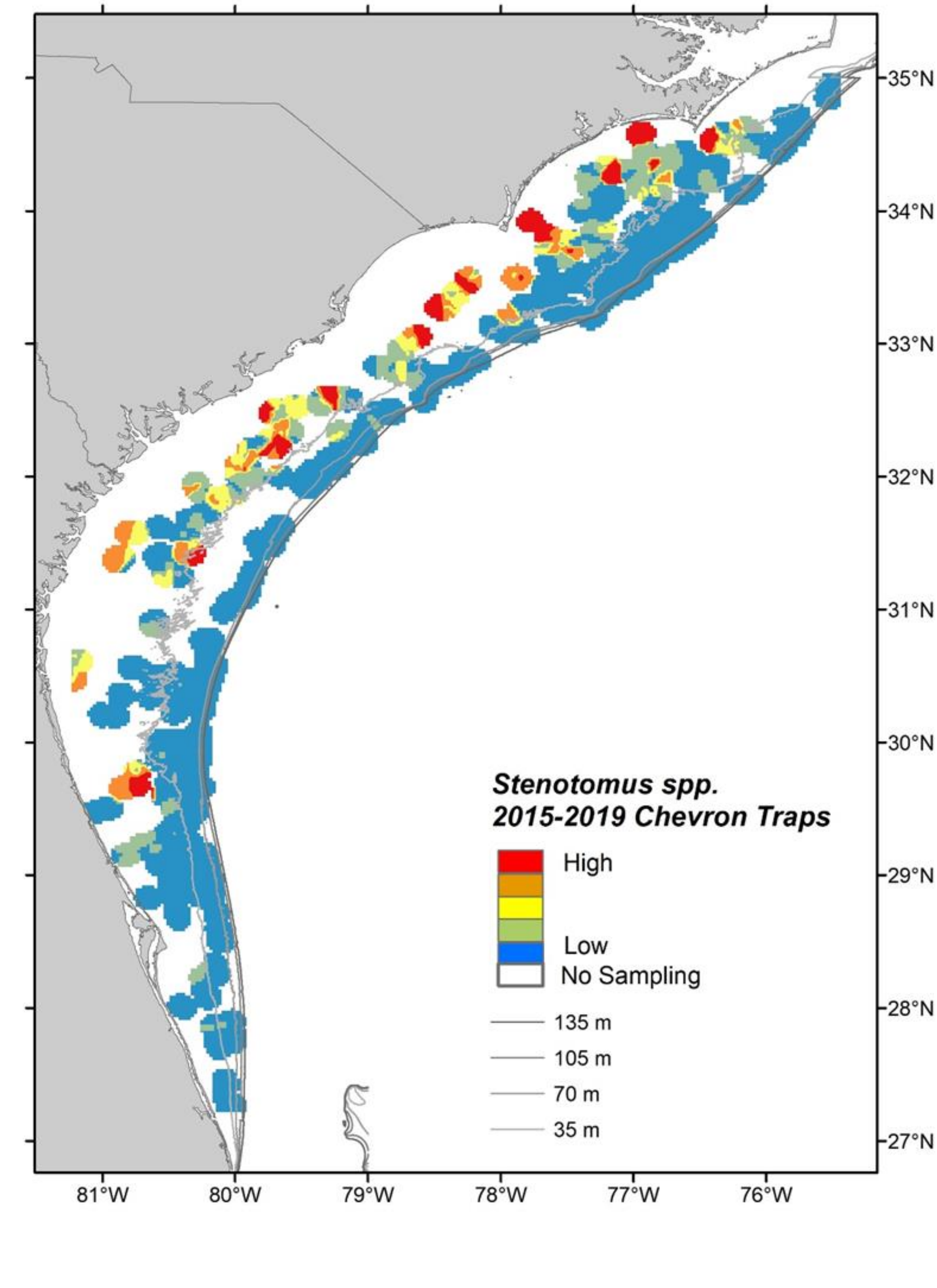


Figure 55. Distribution map of *Stenotomus* spp. catch by SERFS from 2015-2019. Colors indicate quartiles by catch per trap hour and white indicates areas not sampled by SERFS. The map smoothing was accomplished with inverse distance weighting.

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