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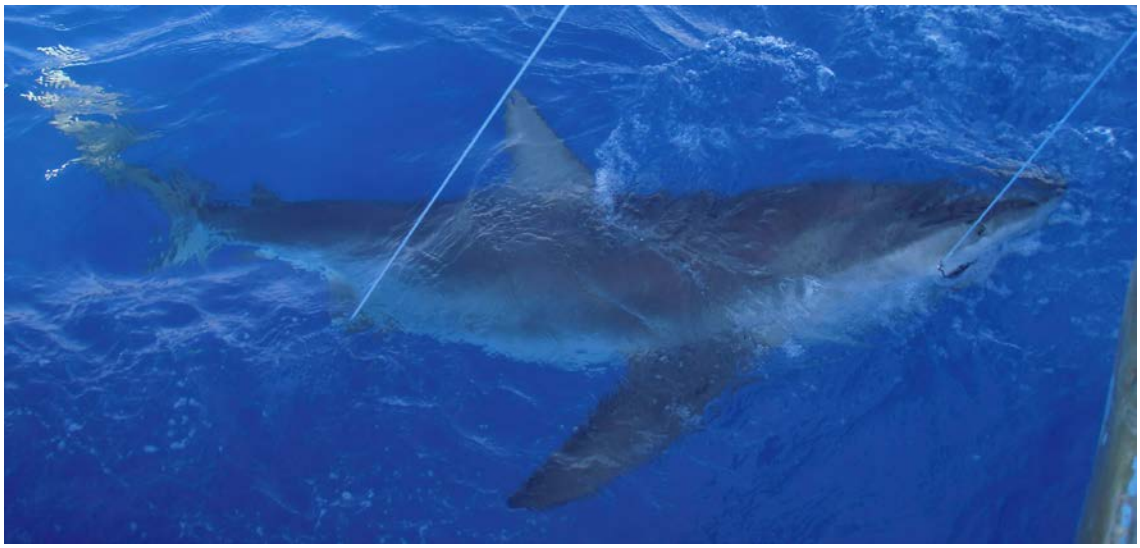

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Introduction

Observations of the shark-directed bottom longline fishery in the Atlantic Ocean and Gulf of Mexico have been conducted since 1994 (Morgan et al. 2009, Mathers et al. 2018 and references therein). Currently about 229 U.S. fishers are permitted to target sharks in the Atlantic Ocean and Gulf of Mexico, and an additional 190 fishers are permitted to land sharks incidentally. Amendments to the Consolidated Atlantic Highly Migratory Species Fishery Management Plan implemented a shark research fishery, which allows NMFS to select a limited number of commercial shark vessels on an annual basis to collect life history data and catch data for future stock assessments (NMFS, 2007). Specifically, only commercial shark fishers participating in the research fishery are allowed to land sandbar sharks, *Carcharhinus plumbeus*, and must carry an observer on 100% of all trips (compared to a target coverage level of 5-10% outside the research fishery). Outside the research fishery, fishers are permitted to land other large coastal sharks (e.g. blacktip shark, *Carcharhinus limbatus*, and bull shark, *Carcharhinus leucas*). Herein, we report on observed fishing activities in the shark bottom longline fishery for the 2018 fishing season, including coverage of the 2018 Shark Research Fishery.

Methods

In November 2017, NMFS announced its request for applications for the Shark Research Fishery from commercial shark fishers with a directed or incidental permit for 2018. Commercial shark fishers submitted applications to the Highly Migratory Species (HMS) Management Division. The HMS Management Division provided a list of qualified applicants to the Panama City Laboratory. Based on the temporal and spatial needs of the research objectives, the availability of qualified applicants, available funding and the available quota, six (6) qualified

applicants were selected for observer coverage. These vessels carried observers on 100% of trips. In 2018 there were six (6) regions for the Research Fishery: North Atlantic, North Carolina, South Atlantic, Florida Keys, Eastern Gulf of Mexico, and Western Gulf of Mexico (Figure 1).

Shark targeted bottom longline observer coverage not related to the shark research fishery depended on the time of year, available funding, and fishing seasons. Vessels were randomly selected for coverage if they possessed a valid directed shark permit, and reported fishing with longline gear in the previous year. There are three fishing zones designated for shark targeted bottom longline observer coverage: northern Atlantic, southern Atlantic and Gulf of Mexico. References to the "northern Atlantic" refer to the coastal waters off the eastern U.S. states from Maine to Virginia, the "southern Atlantic" refers to the coastline from North Carolina to Florida, and the "Gulf of Mexico" refers to the coastline from the Florida Keys to Texas. Because no vessels fished the previous year in the northern Atlantic, vessels were selected from two fishing zones: southern Atlantic and Gulf of Mexico.

Selection letters requiring observer coverage were issued to the permit holder via U.S. Certified mail approximately one month prior to the upcoming fishing season. Upon receipt of the selection letter, the permit holder is required to make contact with the observer coordinator and indicate intent to fish during the upcoming fishing season. If the permit holder intended to fish, the observer coordinator deployed an observer to the port of departure. Vessels were required to pass a Coast Guard Vessel Safety Examination, as well as a safety evaluation by the observer prior to coverage.

While onboard the vessel, the observer completes three data forms: Longline Gear Log, Longline Haul Log, and Animal Log. The Longline Gear Log is used to record gear characteristics. The Longline Haul Log is used to record the information on set and haulback, as

well as environmental information. The Animal Log records all species caught, condition of the catch (e.g. alive, dead, damaged, or unknown), and the final disposition of the catch (e.g. kept, released alive, discarded dead, etc.).

In 2012, HMS Management Division changed the regulations for Shark Research Fishery trips to minimize unnecessary discard of dead sharks. Fishers were required to land all catch of shark species that were legal under a directed shark permit (including sandbar shark, which is otherwise prohibited) unless they could be released alive. In 2018, HMS continued the 2012 amended model which allows one 150 hook 'feeler' set (a short set that allows the fisher to get a 'feel' for what the catch will be like) with a soak time of no more than two hours and one 300 hook set with no soak limit. This model was created to reduce catch of dusky shark, *Carcharhinus obscurus,* which is prohibited. There were six fishing regions assigned by HMS to help manage interactions of dusky shark throughout the research fishery (Figure 1). A bycatch quota of at least three (3) dead dusky shark interactions per region was implemented. Every vessel had the option to move between regions to allow some flexibility for the fisherman to avoid seasonal dusky shark areas where catches were high. If the total allowable number of dead dusky sharks in a specified region was observed, new guidelines to reduce soak times to less than 3 hours were enforced to decrease dusky shark mortality. For all regions, if two (2) additional dusky shark interactions (alive or dead) occurred, the region would be completely closed to fishing for the remainder of the year unless otherwise permitted by HMS. The number of hooks permitted on board remained at 500 hooks total, which accounted for any lost hooks during a feeler set and provided fishers flexibility to use different types of hooks while fishing for non-HMS species within the same trip.

Observers continued to opportunistically sample sharks for biological samples, ideally systematically sampling each n^{th} specimen. Observer discretion is advised as *n* might vary based on vessel, catch rates, weather conditions or other situations. These samples are used for updates to life history studies. Vertebrae were collected from sandbar shark, blacktip shark and other select species to maintain time series of age distribution from within the fishery. Increased sampling of vertebrae and reproductive tissue of blacktip sharks occurred to aid with upcoming assessments. Observers were still required to obtain trip weigh out forms, which were compared to shark dealer reports by quota monitoring personnel to manage the sandbar shark quota within the research fishery.

Results and Discussion

From January to December 2018, a total of 97 trips (defined as from the time a vessel leaves the port until the vessel returns to port and lands catch, including multiple hauls therein) on 11 vessels with a total of 159 bottom longline hauls (defined as setting gear, soaking gear for some duration of time, and retrieving gear) were observed (Table 1). The Shark Research Fishery commenced in February with six participants. Two vessels withdrew from the Research Fishery later in the year, one each in the Florida Keys and North Atlantic regions, forfeiting their remaining quota, which was reallocated to the remaining participants. Gear characteristics varied by area (Gulf of Mexico or southern Atlantic) and target species (non-sandbar large coastal shark or sandbar shark). For the Shark Research Fishery, if less than three vessels fished in each area, the observed data were summarized for the Gulf of Mexico, southern Atlantic, and northern Atlantic to protect vessel confidentiality. The data were grouped into two groups: a) Shark Bottom Longline Fishery trips in the southern Atlantic and the Gulf of Mexico, and b) Shark Research Fishery trips in the Gulf of Mexico, southern Atlantic, and northern Atlantic (Figure 2).

a) Shark Bottom Longline Fishery - southern Atlantic and Gulf of Mexico

i) Gear and haul characteristics

There were 51 hauls on 32 trips observed targeting coastal sharks in the southern Atlantic and Gulf of Mexico. Trips averaged 1.5 days in length. The mainline length ranged from 0.2 to 9.8 km, with an average of 3.6 km. The bottom depth fished ranged from 3.1 to 42.7 m, with an average of 17.5 m. The number of hooks ranged from 23 to 441 hooks, with an average of 209 hooks fished. The most commonly used hook was the 16.0 circle hook (42.3 %). The next commonly used hook was the 14.0 circle hook (25.0 %), followed by the 20.0 circle hook (21.2 %), and the 18.0 circle hook (11.5 %). The predominant bait used was ladyfish, *Elops saurus* (26.9 %). The average soak duration was 10.5 hr.

ii) Catch and bycatch

There were 1,989 individual animals caught on observed bottom longline hauls in the Gulf of Mexico and southern Atlantic (Table 2). Sharks comprised 98.2 % of the catch, teleost 1.6 %, and batoids 0.2 %. Large coastal shark species (excluding sandbar shark) comprised 69.3 % of the shark catch and small coastal shark species comprised 23.8 %. Prohibited shark species were also caught, including sandbar shark (5.9 %). Deep water species comprised 1.0 % of shark catch. Red snapper, *Lutjanus campechanus,* was the most frequent species of teleost caught (1.1 %) and blacktip shark, *Carcharhinus limbatus*, was the most frequently caught species of shark (34.7 %). Length frequencies of shark species are presented in Figure 3.

iii) Protected resources interactions

There were no interactions with protected resources observed for bottom longline vessels fishing in the Gulf of Mexico and southern Atlantic.

b) Shark Research Fishery

i) Gear and haul characteristics

There were 108 hauls on 65 trips observed in the Shark Research Fishery in the Gulf of Mexico, the southern Atlantic, and northern Atlantic. Trips averaged 1.7 days in length. The mainline length ranged from 0.6 to 10.3 km with an average of 4.5 km. The bottom depth fished ranged from 7.3 to 96.3 m with an average of 33.3 m, and the number of hooks ranged from 80 to 300 hooks with an average of 226 hooks fished. The most commonly used hook was the 20.0 circle hook (53.7 %) and the second most common hook was the 18.0 circle hook (25.9 %), followed by the 16.0 circle hook (20.4 %). The predominant bait used was jacks, *Caranx sp.* (29.6 %). The average soak duration was 5.3 hr.

ii) Catch and bycatch

There were 4,883 individual animals caught on observed bottom longline hauls within the Research Fishery (Table 3). Sharks comprised 98.3 % of the catch, followed by teleosts (1.4 %), and turtles and batoids (0.1 %). Sandbar shark comprised 63.0 % of the shark catch, other large coastal shark species comprised 29.4 % of the shark catch, and small coastal shark species comprised 6.7 %. Prohibited shark species were also caught including dusky shark (3.1 %), sand tiger shark, *Carcharhias taurus* (1.2 %), and white shark, *Carcharodon carcharias* (0.1 %). Red drum, *Sciaenops ocellatus*, was the most frequently caught species of teleost (0.6 %), and sandbar shark was the most frequently caught species of shark (61.6 %). Length frequencies of shark species are presented in Figure 4.

iii) *Protected resources interactions*

Interactions with protected resources were observed for the research fishery (Table 3). Five (5) loggerhead sea turtles, *Caretta caretta,* were caught, with 80.0 % released alive and 20.0 % released dead. There were no other protected resource interactions observed.

In August 2015, HMS implemented Amendment 6 to the 2006 Consolidated HMS Fishery Management Plan which reduced the sandbar Shark Research Fishery quota from 116.6 mt dw (257,056 lb dw) to 90.7 mt dw (199,943 lb dw). This reduction was reallocated outside the research fishery to account for dead discards of sandbar sharks since the large coastal shark retention limits increased from 36 to 55 landed per trip, with a default of 45 (NMFS 2015). The sandbar quota remained in effect through the 2018 fishing season. The regional dusky catch limit, which was implemented in 2013, was designed to reduce the impact of this fishery on the dusky shark. In 2013, the 2012 HMS regulations did produce a decline in interactions (24 sharks from 93 hauls; 0.7% of the shark catch), but resulted in a loss of fishing activity from all months in all regions (Gulak et al. 2014). This year, the dusky shark catch remained low, at 3.1% for 2018. Only one region, the northern Atlantic, exceeded the dead dusky limit, resulting in the closure of that region for the remainder of the year.

To prevent dusky shark mortality, the North Carolina region has a limited soak time while any fishing is conducted within the Mid-Atlantic closed area. The Mid-Atlantic closed area is an area off of North Carolina that is closed from January 1- July 31 to bottom longline fishing. This area is a nursery and pupping site for sandbar and dusky sharks. While fishing is permitted, research is also being conducted to evaluate the importance of the closed area and determine post-release survivorship for dusky sharks. Sampling in this area allowed for seven (7) dusky shark to be tagged with a satellite pop-up archival transmitting (SPAT) tag. In addition, thirteen (13) conventional dart tags were deployed on dusky sharks in this area. Three

SPATs were deployed on dusky sharks in the Gulf of Mexico and two in the Florida Keys regions. One conventional dart tag was deployed on a dusky shark in the North Atlantic region. This research is scheduled to continue in 2019.

The Shark Bottom Longline Observer Program collects and provides vital data on temporal and spatial catch, release mortality, bycatch species, and updates to quota monitoring. Continued observer funding will permit the program to maintain this important time series.

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National Marine Fisheries Service (NMFS). 2015. Amendment 6 to the Consolidated Atlantic Highly Migratory Species Fishery Management Plan. NOAA/NMFS, Office of Sustainable Fisheries, Highly Migratory Species Management Division, Silver Spring, MD. 726 p.

Table 1. Number of vessels, trips, hauls, and hook hours observed in the Gulf of Mexico and South Atlantic Ocean. Vessels observed total in parenthesis are unique vessels.

Fishery	Vessels Observed	Trips Observed	Hauls Observed	Hook Hours
Shark Bottom Longline Fishery	5	32	51	80221.73
Shark Research Fishery	6	65	108	143444.60
Total	11 (9)	97	159	223666.33

Table 2. Number caught (n) and disposition of catch in percentage for all observed hauls in the Shark Bottom Longline Fishery. Disposition of catch is divided into kept (K), discard dead (DD), discard alive (DA), and unknown (U).

Scientific Name	**Common Name**	**n**	**%K**	**%DA**	**%DD**	**%U**
Carcharhinus limbatus	Blacktip Shark	691	86.1	4.8	8.8	0.3
Rhizoprionodon terraenovae	Atlantic Sharpnose Shark	351	87.5	0.0	12.3	0.3
Carcharhinus leucas	Bull Shark	157	89.2	6.4	0.6	3.8
Carcharhinus brevipinna	Spinner Shark	127	92.1	5.5	2.4	0.0
Carcharhinus plumbeus	Sandbar Shark	115	0.0	96.5	3.5	0.0
Carcharhinus acronotus	Blacknose Shark	112	0.9	40.2	58.9	0.0
Ginglymostoma cirratum	Nurse Shark	104	1.0	99.0	0.0	0.0
Negaprion brevirostris	Lemon Shark	90	86.7	4.4	1.1	7.8
Galeocerdo cuvier	Tiger Shark	81	35.8	63.0	0.0	1.2
Sphyrna lewini	Scalloped Hammerhead Shark	52	30.8	40.4	25.0	3.9
Sphyrna mokarran	Great Hammerhead Shark	49	63.3	14.3	20.4	2.0
Lutjanus campechanus	Red Snapper	21	0.0	52.4	47.6	0.0
Mustelus canis	Smooth Dogfish	19	94.7	0.0	5.3	0.0
Sciaenops ocellatus	Red Drum	2	0.0	0.0	100.0	0.0
Dasyatis	Stingrays	2	0.0	100.0	0.0	0.0
Sphyrna tiburo	Bonnethead Shark	2	0.0	0.0	100.0	0.0
Arius felis	Hardhead Catfish	2	0.0	100.0	0.0	0.0
Carcharhinidae	Requiem Shark	2	0.0	0.0	0.0	100.0
Epinephelus itajara	Goliath Grouper	2	0.0	100.0	0.0	0.0
Ophichthus rex	King Snake Eel	2	0.0	0.0	100.0	0.0
Echeneis naucrates	Sharksucker	2	0.0	100.0	0.0	0.0
Mobula hypostoma	Devil Ray	1	0.0	0.0	100.0	0.0
Centropristis ocyurus	Bank Sea Bass	1	100.0	0.0	0.0	0.0
Carcharhinus isodon	Finetooth Shark	1	100.0	0.0	0.0	0.0
Carcharhinus obscurus	Dusky Shark	1	0.0	100.0	0.0	0.0

Table 3. Number caught (n) and disposition of catch in percentage for all observed hauls in the Shark Research Fishery. Disposition of catch is divided into kept (K), discard dead (DD), discard alive (DA), and unknown (U).

Scientific Name	Common Name	n	%K	%DA	%DD	%U
Carcharhinus plumbeus	Sandbar Shark	2975	98.5	0.3	0.3	0.9
Carcharhinus limbatus	Blacktip Shark	383	99.2	0.0	0.3	0.5
Galeocerdo cuvier	Tiger Shark	344	30.2	68.0	0.9	0.9
Rhizoprionodon terraenovae	Atlantic Sharpnose Shark	271	69.7	1.5	28.4	0.4
Carcharhinus brevipinna	Spinner Shark	173	100.0	0.0	0.0	0.0
Carcharhinus obscurus	Dusky Shark	149	0.0	59.1	39.6	1.3
Carcharhinus leucas	Bull Shark	111	91.0	7.2	0.0	1.8
Negaprion brevirostris	Lemon Shark	62	98.4	0.0	0.0	1.6
Sphyrna lewini	Scalloped Hammerhead Shark	60	68.3	21.7	6.7	3.3
Ginglymostoma cirratum	Nurse Shark	59	1.7	98.3	0.0	0.0
Carcharias taurus	Sand Tiger Shark	55	0.0	100.0	0.0	0.0
Sphyrna mokarran	Great Hammerhead Shark	52	92.3	7.7	0.0	0.0
Carcharhinus acronotus	Blacknose Shark	42	28.6	42.9	28.6	0.0
Sciaenops ocellatus	Red Drum	30	3.3	93.3	0.0	3.3
Seriola dumerili	Greater Amberjack	17	82.4	5.9	11.8	0.0
Lutjanus campechanus	Red Snapper	5	0.0	100.0	0.0	0.0
Caretta caretta	Loggerhead Sea Turtle	5	0.0	80.0	20.0	0.0
Carcharhinus isodon	Finetooth Shark	5	100.0	0.0	0.0	0.0
Sphyraena	Barracudas	5	80.0	0.0	20.0	0.0
Carcharodon carcharias	Great White Shark	4	0.0	100.0	0.0	0.0
Epinephelus morio	Red Grouper	4	0.0	50.0	50.0	0.0
Raja eglanteria	Clearnose Skate	3	0.0	0.0	100.0	0.0
Seriola rivoliana	Almaco Jack	3	100.0	0.0	0.0	0.0
Ophichthus rex	King Snake Eel	3	0.0	0.0	100.0	0.0
Triakidae	Houndsharks	3	0.0	66.7	33.3	0.0
Carcharhinus falciformis	Silky Shark	2	0.0	50.0	50.0	0.0
Elasmobranchii	Sharks	2	0.0	0.0	50.0	50.0
Epinephelus itajara	Goliath Grouper	1	0.0	100.0	0.0	0.0
Centropristis ocyurus	Bank Sea Bass	1	100.0	0.0	0.0	0.0
Bathytoshia centroura	Roughtail Stingray	1	0.0	100.0	0.0	0.0
Hypanus americanus	Southern Stingray	1	0.0	100.0	0.0	0.0
Dasyatis	Stingrays	1	0.0	0.0	100.0	0.0
Sphyrna zygaena	Smooth Hammerhead Shark	1	0.0	100.0	0.0	0.0

Figure 1. The designated Shark Research Fishery regions are: North Atlantic (north of 36.3 N lat.), North Carolina (south of 36.3 N lat. and north of 34.0 N lat.), South Atlantic (south of 33.5 N lat. and north of 26.0 N lat.), the Florida Keys (south of 26.0 N lat. and east of 85.0 W long.), the Eastern Gulf of Mexico (north of 26.0 N lat. and east of 88.0 W long.), and the Western Gulf of Mexico (north of 26.0 N lat. and west of 88.0 W long.).

Figure 2. Distribution of all observed hauls by target in 2018. (a) distribution of effort for the Shark Bottom Longline Fishery.

(a)

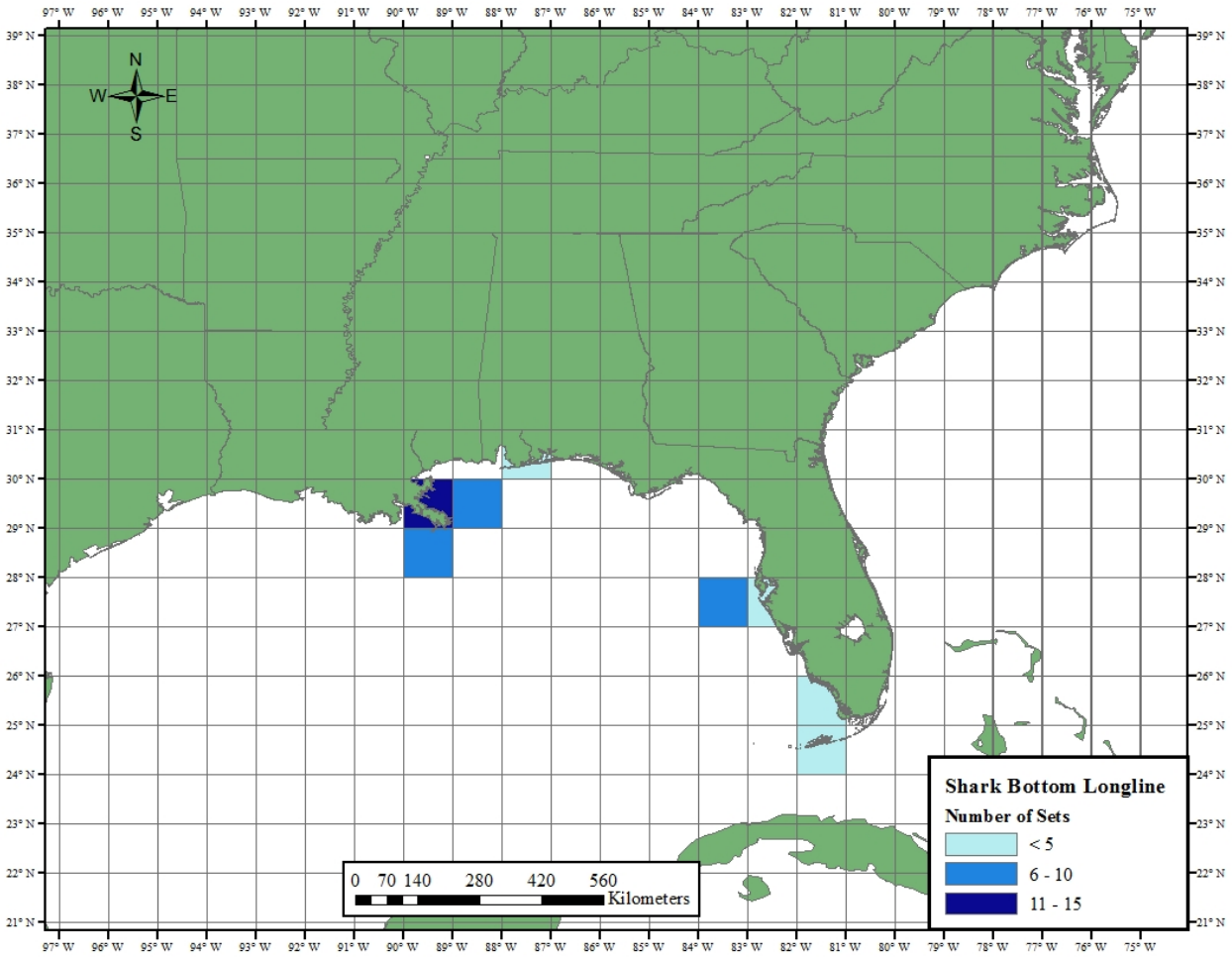


Figure 2 cont'd. Distribution of all observed hauls by target in 2018. (b) distribution of effort for the Shark Research Fishery.

(b)

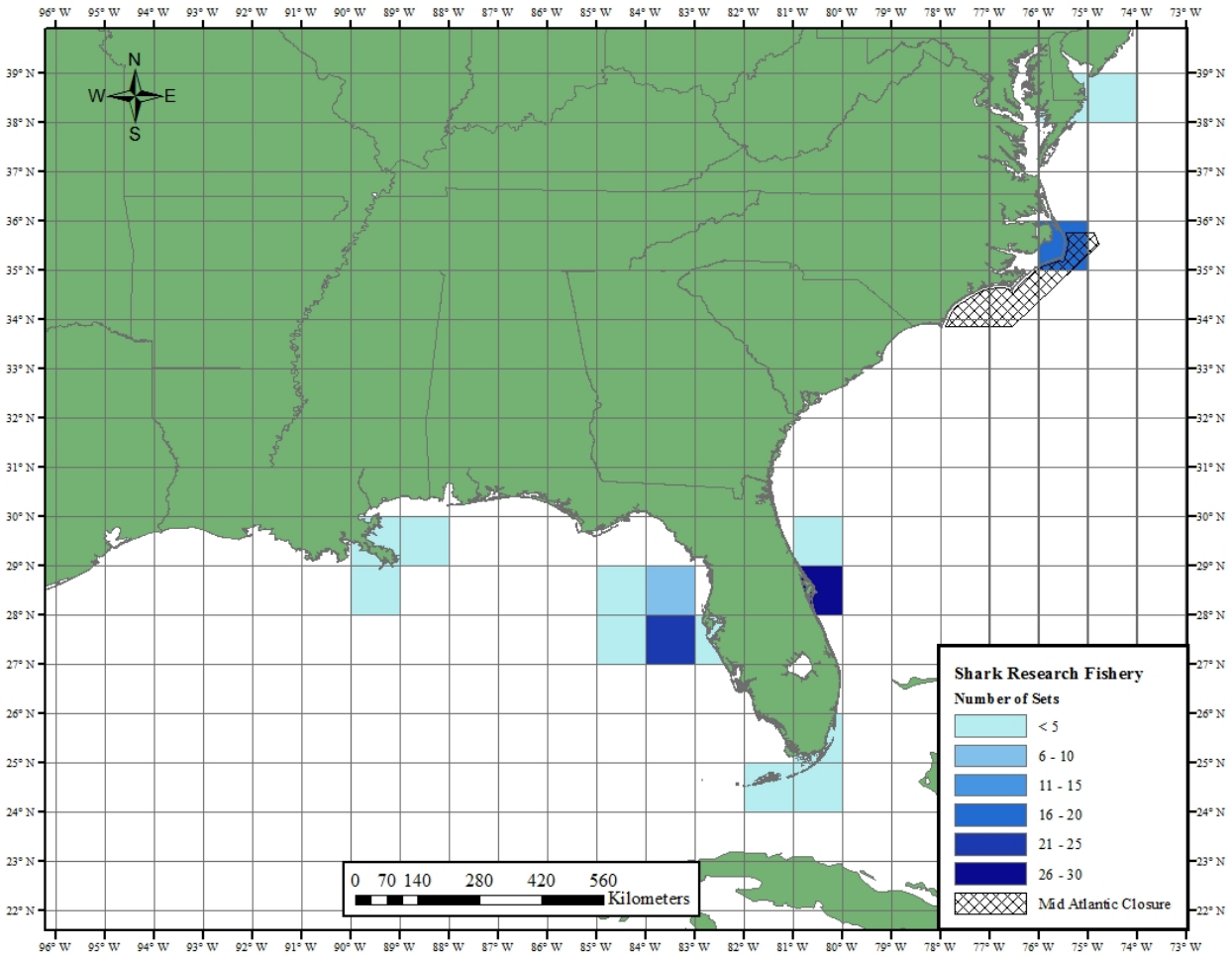
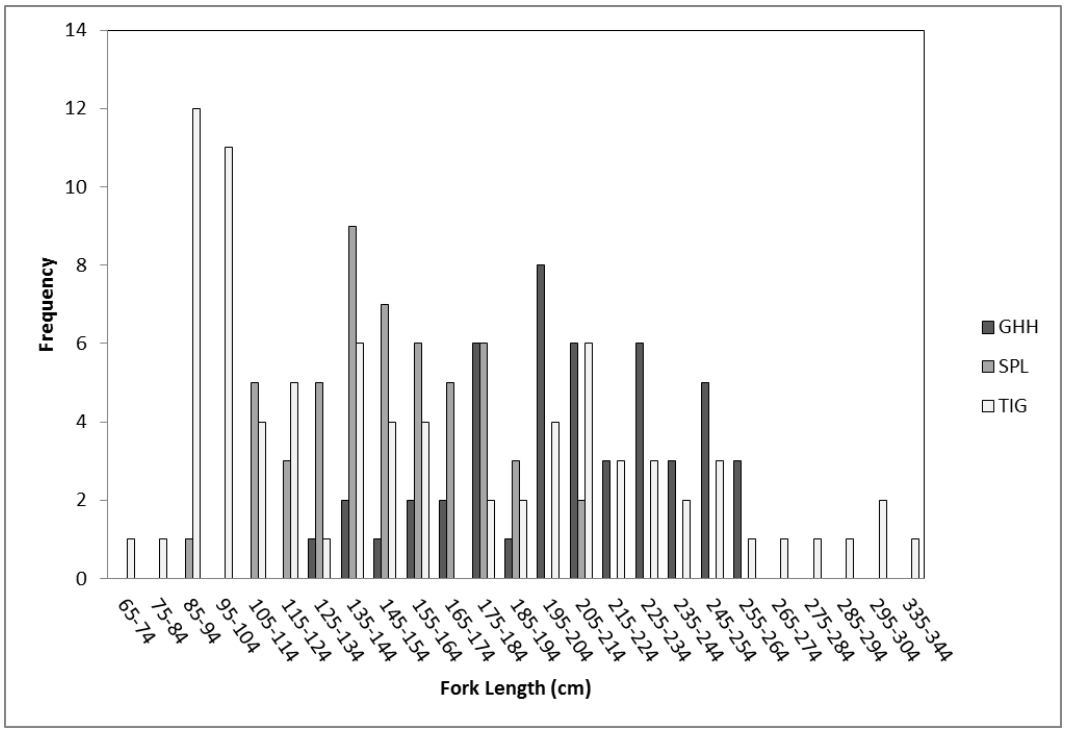


Figure 3. Length frequency (cm fork length) of (a) great hammerhead (GHH), scalloped hammerhead (SPL), and tiger (TIG) sharks; (b) lemon (LEM), nurse, (NUR), bull (SBU), and spinner (SSP) sharks observed caught on bottom longline sets in the Shark Bottom Longline Fishery.

(a)



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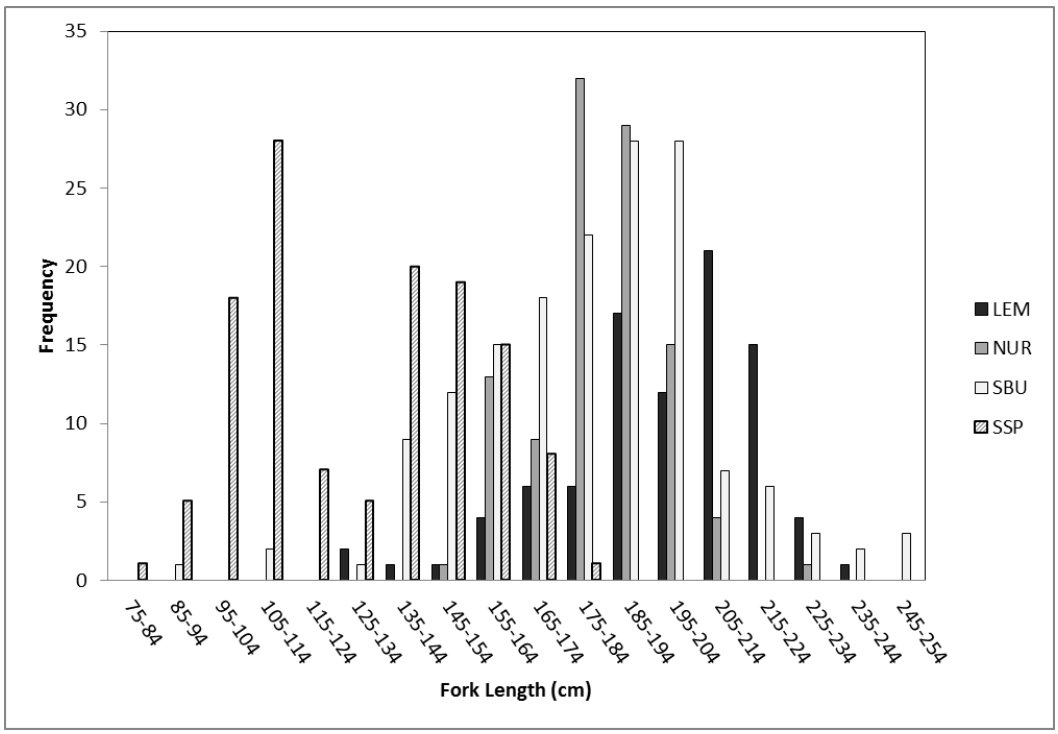
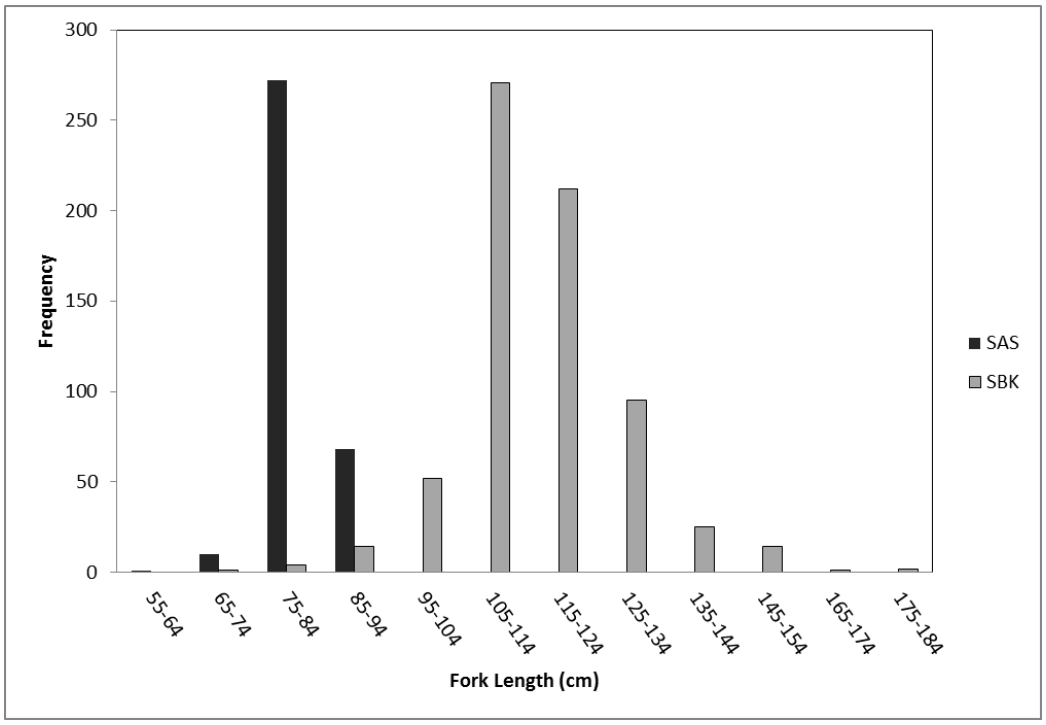


Figure 3 cont'd. Length frequency (cm fork length) of (c) Atlantic sharpnose (SAS), and blacktip (SBK) sharks; (d) bonnethead (BHH), smooth dogfish (DGS), blacknose (SBN), and finetooth (SFT) sharks observed caught on bottom longline sets in the Shark Bottom Longline Fishery.

(c)



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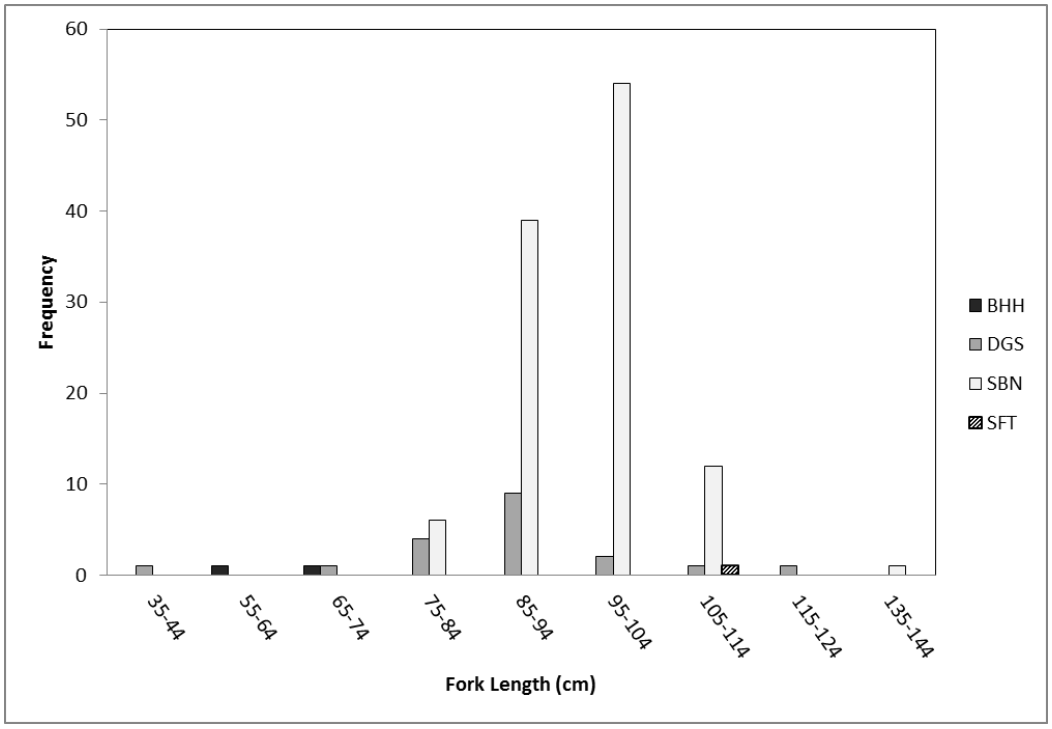


Figure 3 cont'd. Length frequency (cm fork length) of (e) devil ray (DEV), dusky (DUS) requiem shark family (SRQ), and sandbar (SSB) sharks observed caught on bottom longline sets in the Shark Bottom Longline Fishery.

(e)

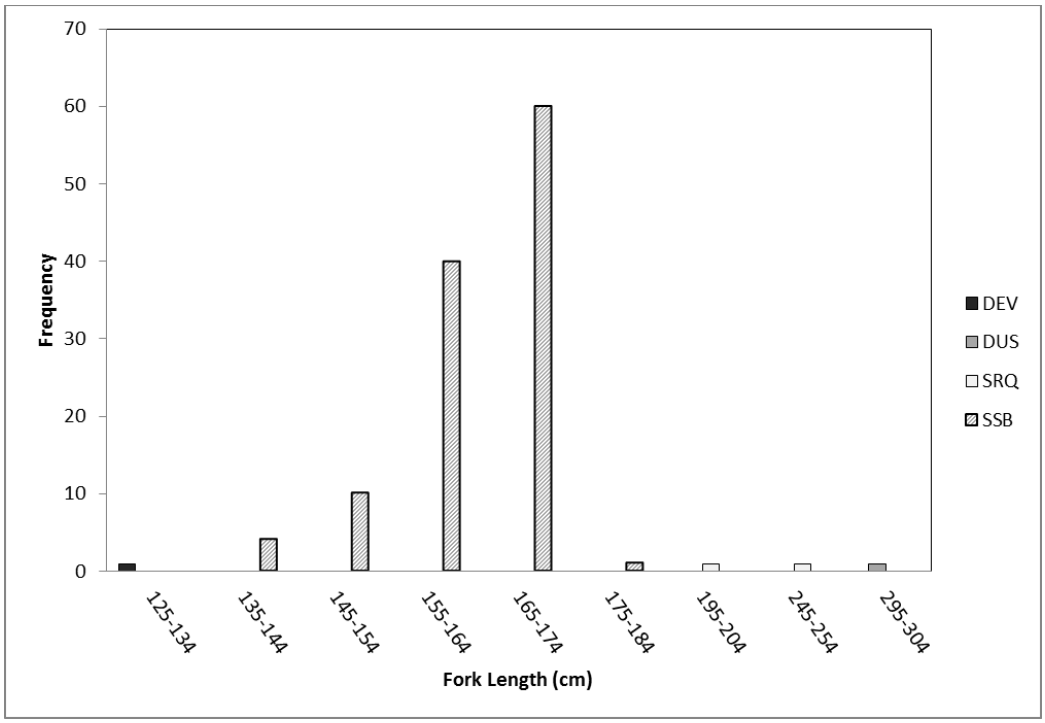
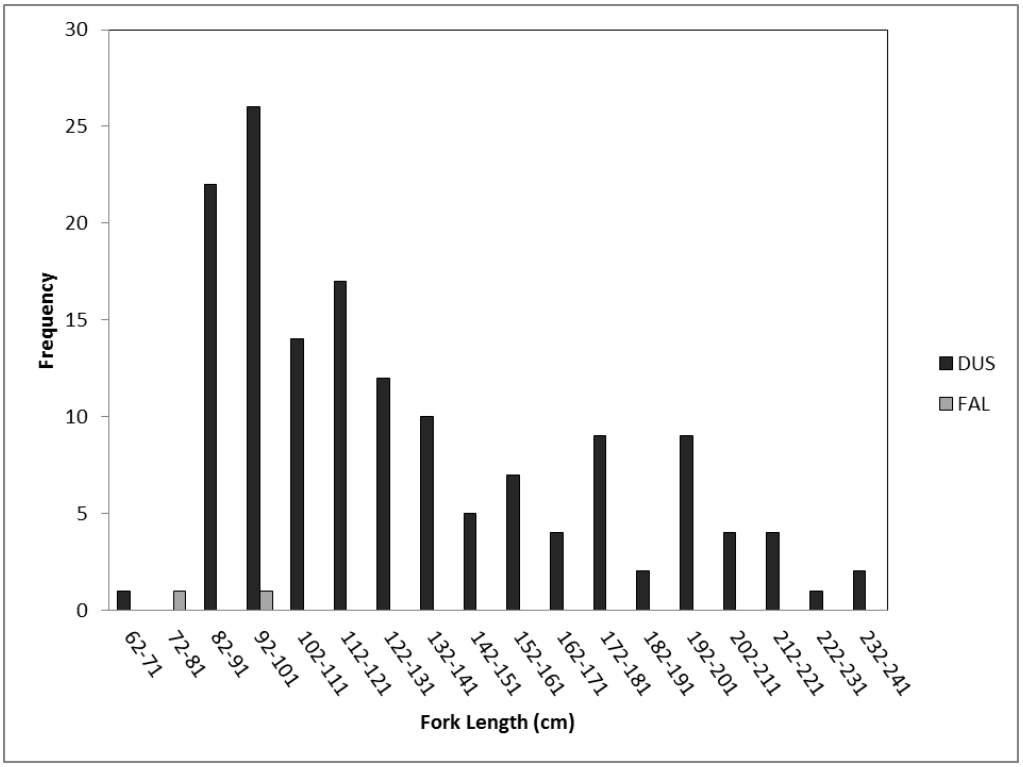


Figure 4. Length frequency (cm fork length) of (a) dusky (DUS) and silky (FAL) sharks; (b) sandbar shark (SSB) observed caught on bottom longline sets in the Shark Research Fishery.

(a)



(b)

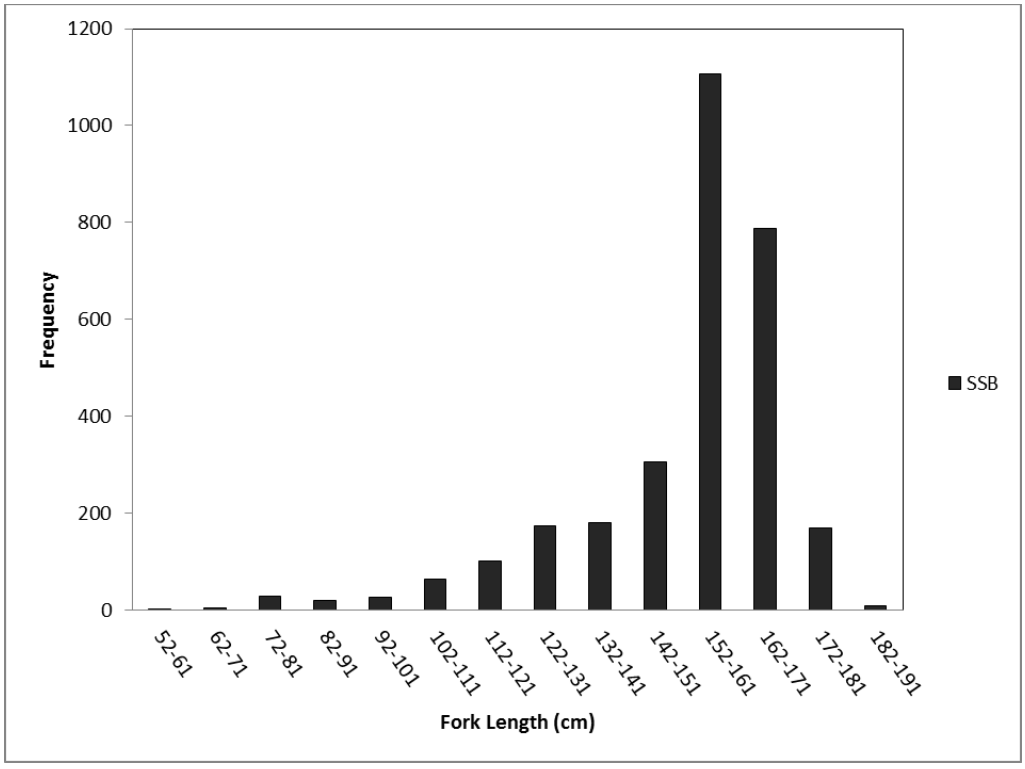
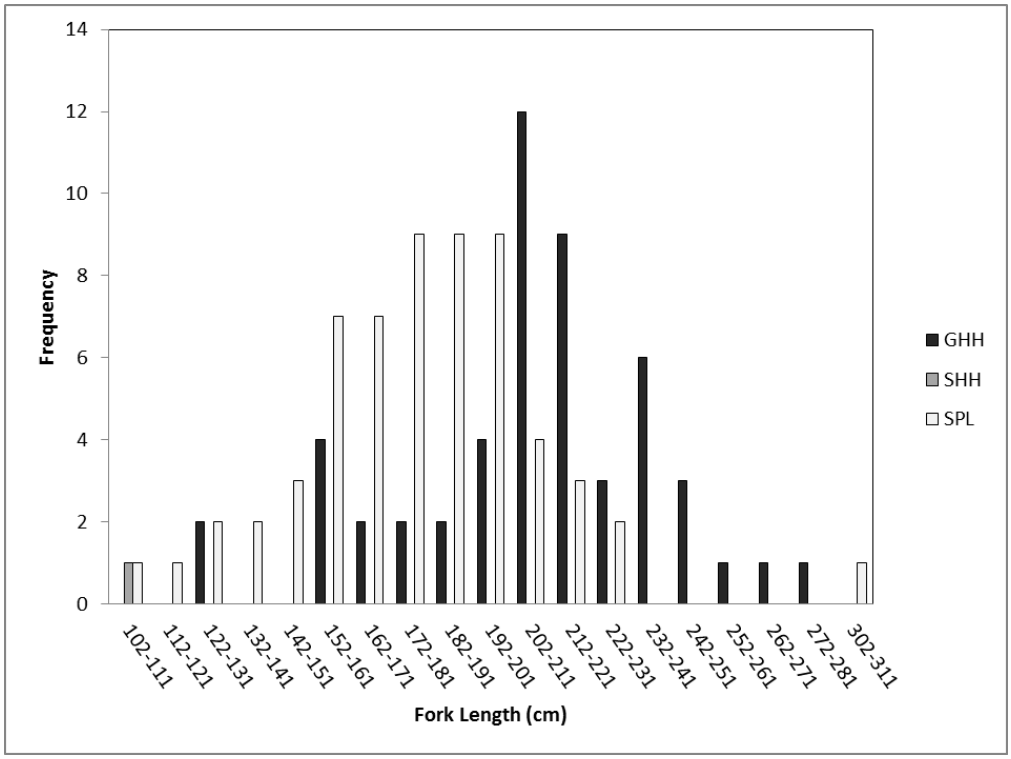


Figure 4 cont'd. Length frequency (cm fork length) of (c) great hammerhead (GHH), smooth hammerhead (SHH), and scalloped hammerhead (SPL) sharks; (d) lemon (LEM), bull (SBU), spinner (SSP), and tiger (TIG) sharks observed caught on bottom longline sets in the Shark Research Fishery.

(c)



(d)

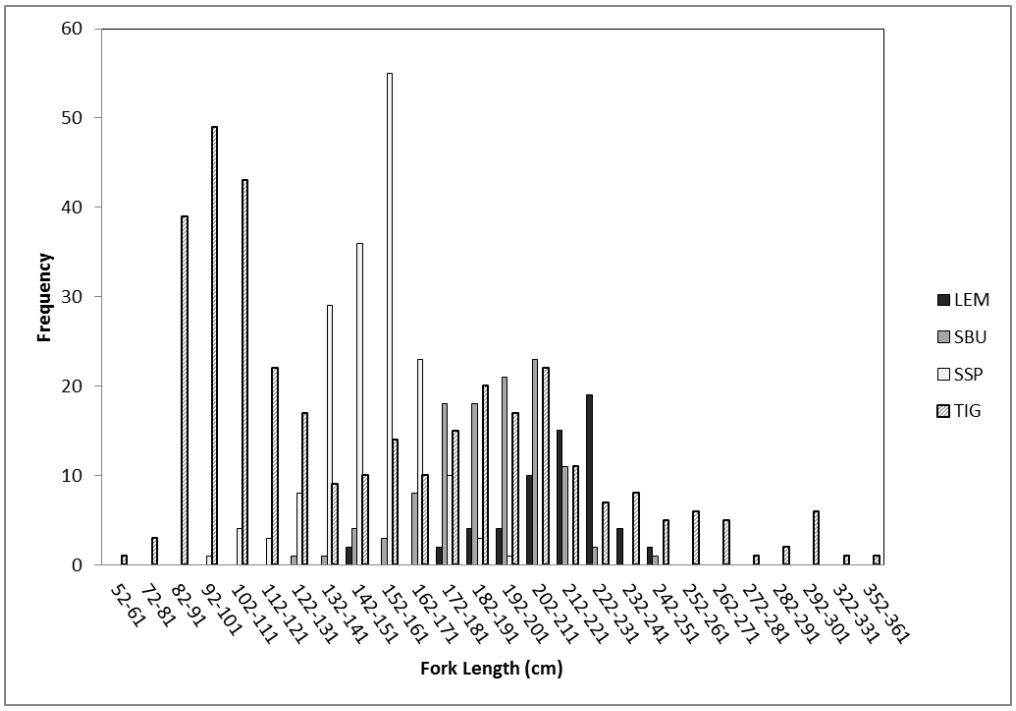
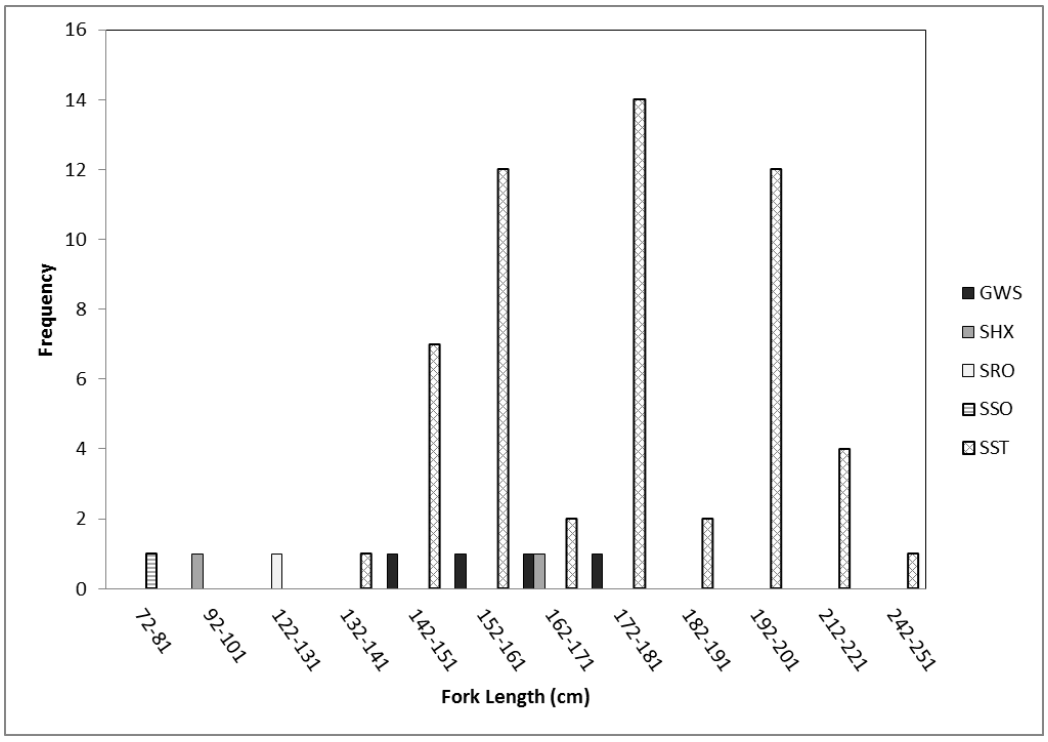


Figure 4 cont'd. Length frequency (cm fork length) of (e) great white (GWS) sharks, *Elasmobranchii* (SHX), roughtail stingray (SRO), southern stingray (SSO), and sand tiger (SST) sharks; (f) Atlantic sharpnose (SAS), and blacktip (SBK) sharks observed caught on bottom longline sets in the Shark Research Fishery.

(e)



(f)

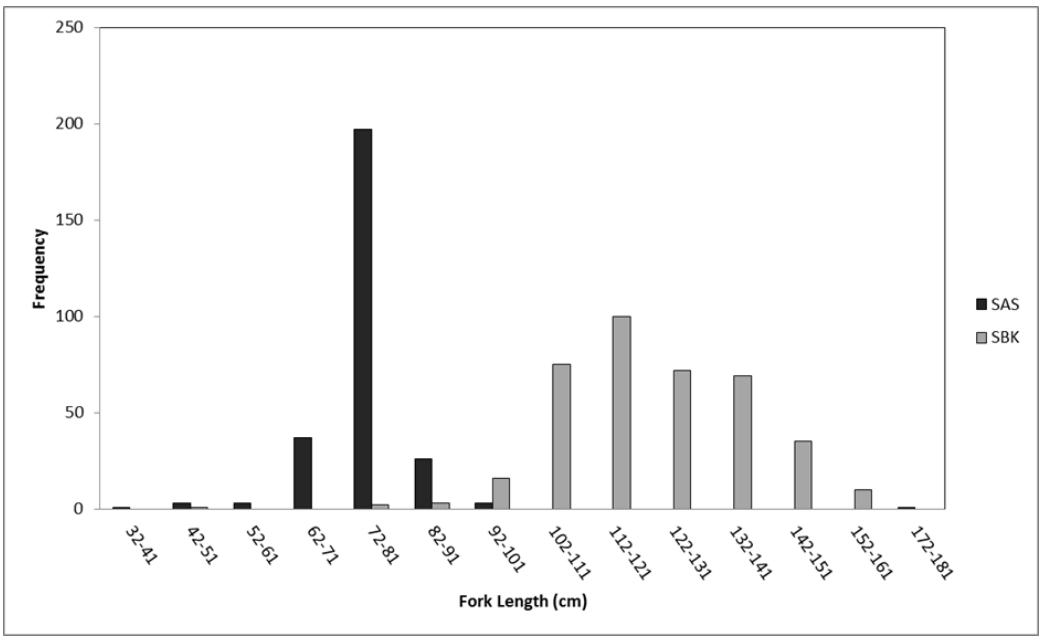


Figure 4 cont'd. Length frequency (cm fork length) of (g) nurse (NUR), blacknose (SBN) and finetooth (SFT) sharks observed caught on bottom longline sets in the Shark Research Fishery.

(g)