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Introduction

The Southeast Gillnet Observer Program (SGOP) has adapted to the changes of the Florida-Georgia shark gillnet fishery since the program began in 1993 (e.g. Carlson and Bethea 2007 and references therein, Mathers et al. 2017). There are currently about 420 total directed and incidental shark permits issued for the southeastern U.S. Atlantic coast and Gulf of Mexico, while the number of gillnet fishers changes from year to year. Gillnet effort targeting large coastal (LCS) and small coastal (SCS) sharks declined as a result of Amendments 2 and 3 to the Consolidated Atlantic Highly Migratory Species Fishery Management Plan (NMFS 2007, 2010). LCS and SCS targeted gillnet effort has continued to decline. Fishers have consequently increased effort targeting finfish, including Spanish mackerel *Scomberomorus maculatus*, king mackerel *Scomberomorus cavalla*, and bluefish *Pomatomus saltatrix*, with varying types of gillnet gear. However, a small amount of shark targeted gillnet effort continues to be observed. The Southeast Gillnet Observer Program, in its continuing efforts to adapt to the fishery, currently covers anchored (sink and stab), strike, or drift gillnet fishing, regardless of target, by vessels that fish year-round from Florida to North Carolina and the Gulf of Mexico.

Herein, we summarize fishing effort and catch and bycatch in these fisheries during January 2018 - December 2018, collectively referred to as '2018'.

Methods

Observer protocol

Vessels were randomly selected on a quarterly basis (January, April, July, and October) from a pool of vessels that had reported fishing with gillnet gear during the same quarter in the previous year in the NMFS Coastal Fisheries Logbook. Selection letters notifying permit holders

of required observer coverage were issued via U.S. Certified mail approximately one month prior to the upcoming selection period. Receipt of selection letters was confirmed via signature upon acceptance by the permit holder or their proxy. Once the permit holder received the selection letter, he or she was required to make contact with the observer coordinator and indicate intent to fish during the upcoming selection period. Contact was usually made by phone, and the observer coordinator gathered information concerning the vessel's name, captain, contact persons and phone numbers, communications and safety equipment available aboard the vessel, and information about the vessel's location, dates, and times of departure and return. Additional information collected included whether the vessel was active in another fishery, under repair, or no longer fishing. Upon notification of the intention to fish, the observer coordinator deployed an observer to the reported port of departure of the permit holder's vessel. Because gillnet trips are generally 24 hours or less (from the time of departure from port to the time of return), the observer remained assigned to the vessel for a minimum of 3 trips.

Observations were made as the net was hauled aboard. The haul target species was determined by the captain and recorded by the observer. The observer remained on the deck of the vessel in a position with an unobstructed view and recorded species and numbers of individuals caught. When species identification was questionable, the crew stopped hauling so that the observer could examine the animal(s) for positive identification. Status (alive or dead when boated) of individuals was recorded, and disposition of individuals brought onboard was recorded as kept, discarded alive, or discarded dead. Fork lengths (cm FL) were estimated for the entire catch. When time permitted after the haulback was complete, observers directly measured a random group of 10 individuals from each species for fork length (FL, measured on a straight line) in cm. Sex (sharks only) was determined when possible. Biological samples (e.g. otoliths,

vertebrae, reproductive organs, stomach), when taken, were removed and placed on ice after collection. Data and samples were submitted to the NMFS Southeast Fisheries Science Center (SEFSC) Panama City staff immediately upon completion of observed trips. The data were entered and proofed by SEFSC staff, examined by NMFS/SEFSC Sustainable Fisheries Division staff, and reviewed with observer contract staff to resolve any questions.

Results

A total of 87 sets comprising various gillnet fisheries was observed in 2018. Set locations occurred along the Florida coast in the Atlantic Ocean, as well as the Gulf of Mexico (Figures 1-2). Location-specific reports of trips cannot be documented herein due to vessel confidentiality laws, therefore observations are summarized by gear type. Weights for shark and teleost catch referenced herein (Tables 3 and 4) were back-calculated using estimated length (cm FL) measurements and length-weight conversions (Wigley et al. 2003; NMFS, unpublished data).

Drift gillnet fishery

One gillnet vessel was observed making 23 driftnet sets on 3 trips in 2018. Due to vessel confidentiality, these sets cannot be further described. There were no protected resource interactions observed in driftnet sets.

Strike gillnet fishery

A total of 4 gillnet vessels were observed making 9 strike sets on 8 trips in 2018. Trips were made targeting king mackerel exclusively.

King mackerel targeted strike gillnet

Vessels fished with nets ranging 182.9 – 731.5 m (600 - 2400 ft) long, net depths of 30.2 – 30.5 m (99.0 – 100.0 ft) and 11.4 – 12.1 cm (4.5 – 4.75 in) stretched mesh size. Set duration averaged 0.05 hr (0.02 S.D.), while hauls averaged 2.0 hr (1.25 S.D.). The entire fishing process (time net was first set until time haul back was completed) averaged 10.37 hr (4.8 S.D.). Sets were made in waters averaging 17.9 m (3.3 S.D.) deep. The distribution of observed strike gillnet fishing effort is illustrated in Figure 1.

Observed king mackerel strike gillnet fishery catches

Catch composition by number of all king mackerel targeted sets was 99.9 % teleosts and 0.05 % elasmobranchs as well as invertebrates (Table 1). Teleost catch was mostly composed of king mackerel (98.94 %). Other teleost catch by number included bluefish, *Pomatomus saltatrix* (0.71 %) and Spanish mackerel (0.21 %). Shark catch by number was blacktip shark, *Carcharhinus limbatus* (54.55 %), and Requiem shark, *Carcharhinidae* and Atlantic sharpnose shark, *Rhizoprionodon terraenovae* both were 18.18 %. Shark catch by weight was made up of blacktip shark (52.5 %) and Requiem shark (46.44 %). Catches by weight of commercially important teleosts are given in Table 4.

Average size from king mackerel targeted strike gillnet sets

Average (S.D.) fork lengths of teleosts caught in king mackerel targeted sets ranged from 30.0 cm (0.0) for Florida pompano, *Trachinotus carolinus*, to 75.97 cm (8.7) for king mackerel. Average (S.D.) lengths of teleosts ($n \geq 5$) measured by target can be found in Table 6.

Protected resources interactions from king mackerel targeted sets

One interaction with protected resources was documented in 9 sets observed targeting king mackerel with strike gillnets in 2018. One seabird, *Aves sp.*, was caught and released dead (0.004 % of the total catch; Table 1).

Sink gillnet fishery

A total of 12 trips totaling 55 sink net sets on 4 vessels were observed in 2018. Trips were made targeting Spanish mackerel exclusively.

Spanish mackerel targeted sink gillnet

Vessels fished with nets ranging 165.0 – 731.5 m (540 - 2400 ft) long, net depths of 3.0 – 4.8 m (10.0 – 15.0 ft) and stretched mesh sizes of 8.3 - 8.9 cm (3.25 - 3.5 in). Set duration averaged 0.08 hr (0.04 S.D.), while hauls averaged 0.56 hr (0.42 S.D.). The entire fishing process (time net was first set until time haul back was completed) averaged 1.26 hr (0.73 S.D.). Sets were made in waters averaging 8.6 m (2.9 S.D.) deep. Observed Spanish mackerel targeted sink gillnet fishing effort is illustrated in Figure 2.

Observed Spanish mackerel targeted sink gillnet catches

Catch composition by number of all Spanish mackerel targeted sets was 91.35 % teleosts, 8.33 % elasmobranchs, 0.3 % invertebrates, and 0.02 % batoids (Table 2). By number, shark catch was made up of Atlantic sharpnose shark, *Rhizoprionodon terraenovae* (52.78 %), bonnethead shark, *Sphyrna tiburo* (34.72 %), and scalloped hammerhead shark, *Sphyrna lewini*

(5.95 %). By weight, the shark catch was made up of Atlantic sharpnose shark (36.79 %), scalloped hammerhead shark (16.80 %), and spinner shark (13.80 %). Catches by weight of sharks are given in Table 3. Spanish mackerel made up 42.73 % of the teleost catch by number, followed by Atlantic bumper, *Chloroscombrus chrysurus* (32.77 %), and bluerunner jack, *Caranx crysos* (10.54 %). Catches by weight of commercially important teleosts can be found in Table 4.

Average size from Spanish mackerel targeted sets

Average (S.D.) fork lengths of sharks caught in Spanish mackerel targeted sets ranged from 50.6 cm (12.9) for Atlantic sharpnose shark, to 91.3 cm (11.6) for blacktip shark. The average (S.D.) lengths of sharks measured by target can be found in Table 5. Average (S.D.) fork lengths of teleosts caught in Spanish mackerel targeted sets ranged from 16.0 cm (0.0) for Atlantic butterfish, *Peprilus triacanthus*, to 67.4 cm (16.4) for king mackerel. Average (S.D.) lengths of teleosts ($n \geq 5$) measured by target can be found in Table 6.

Discussion

The trend of declining effort in the LCS targeted gillnet fishery continued to be observed in 2018. Strike gillnet gear was observed exclusively in teleost-targeted (king mackerel) sets. The majority of sink gillnet fishers continued to target teleost species. Incidental take of protected species, such as sea turtles and marine mammals, remained a rare occurrence, with one seabird observed in 2018.

The general gillnet fishing effort continues to decrease. During the 2018 hurricane season, sixteen named storms and eight hurricanes made landfall in the U.S., invariably impacting fishing effort in the southeast gillnet fisheries.

The SGOP continues to monitor catch and bycatch as the Southeast US gillnet fishery continues to adapt to changing regulations.

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Table 1. Total strike gillnet catch from king mackerel targeted sets by species, and species disposition in order of decreasing abundance for all observed trips, 2018. Catch disposition is by percent kept (Kept %), percent discarded alive (D.A. %), and percent discarded dead (D.D. %).

Species Caught	Common Name	Total Number Caught	Kept (%)	D.A. (%)	D.D. (%)
<i>Scomberomorus cavalla</i>	King Mackerel	23434	98.96	0	1.04
<i>Pomatomus saltatrix</i>	Bluefish	169	100	0	0
<i>Scomberomorus maculatus</i>	Spanish Mackerel	49	100	0	0
<i>Caranx crysos</i>	Bluerunner Jack	9	100	0	0
<i>Anthozoa</i>	Coral	6	0	100	0
<i>Carcharhinus limbatus</i>	Blacktip Shark	6	0	83.33	16.67
<i>Euthynnus alletteratus</i>	Little Tunny	4	100	0	0
<i>Sarda sarda</i>	Atlantic Bonito	4	0	0	100
<i>Carangidae</i>	Jacks	3	0	0	100
<i>Porifera</i>	Sponges	3	0	100	0
<i>Carcharhinidae</i>	Requiem Shark	2	0	100	0
<i>Epinephelus morio</i>	Red Grouper	2	0	100	0
<i>Lutjanus analis</i>	Mutton Snapper	2	0	100	0
<i>Lutjanus synagris</i>	Lane Snapper	2	0	100	0
<i>Mellita quinquiesperforata</i>	Keyhole Sand Dollar	2	0	100	0
<i>Pomacanthidae</i>	Angelfish Family	2	0	0	100
<i>Rhizoprionodon terraenovae</i>	Atlantic Sharpnose Shark	2	0	100	0
<i>Trachinotus carolinus</i>	Florida Pompano	2	100	0	0
<i>Asteroidea</i>	Sea Stars	1	0	100	0
<i>Aves</i>	Birds	1	0	0	100
<i>Calamus arctifrons</i>	Grass Porgy	1	0	100	0
<i>Carangidae</i>	Jack Family	1	0	0	100
<i>Elasmobranchii</i>	Sharks	1	0	100	0
<i>Sparidae</i>	Porgy Family	1	0	0	100

Table 2. Total sink gillnet catch from Spanish mackerel targeted sets by species, and species disposition in order of decreasing abundance for all observed trips, 2018. Catch disposition is by percent kept (Kept %), percent discarded alive (D.A. %), and percent discarded dead (D.D. %).

Species Caught	Common Name	Total Number Caught	Kept (%)	D.A. (%)	D.D. (%)
<i>Scomberomorus maculatus</i>	Spanish Mackerel	2364	98.14	0	1.86
<i>Chloroscombrus chrysurus</i>	Atlantic Bumper	1813	13.73	29.07	57.2
<i>Caranx crysos</i>	Bluerunner Jack	583	97.94	0	2.06
<i>Pomatomus saltatrix</i>	Bluefish	297	97.31	0	2.69
<i>Rhizoprionodon terraenovae</i>	Atlantic Sharpnose Shark	266	3.76	47.37	48.87
<i>Sphyrna tiburo</i>	Bonnethead Shark	175	1.71	61.71	36.57
<i>Caranx hippos</i>	Crevalle Jack	96	98.96	0	1.04
<i>Brevoortia</i>	Menhadens	87	0	39.08	60.92
<i>Larimus fasciatus</i>	Banded Drum	56	0	12.5	87.5
<i>Menticirrhus americanus</i>	Southern Kingfish	44	90.91	0	9.09
<i>Sphyrna lewini</i>	Scalloped Hammerhead Shark	30	0	60	40
<i>Bagre marinus</i>	Gafftopsail Catfish	23	0	78.26	21.74
<i>Selene setapinnis</i>	Moonfish	21	80.95	4.76	14.29
<i>Carcharhinus brevipinna</i>	Spinner Shark	20	55	35	10
<i>Decapoda</i>	Crabs	18	0	11.11	88.89
<i>Menticirrhus littoralis</i>	Gulf Kingfish	17	94.12	0	5.88
<i>Elops saurus</i>	Ladyfish	16	87.5	0	12.5
<i>Aluterus monoceros</i>	Unicorn Filefish	14	0	100	0
<i>Arius felis</i>	Hardhead Catfish	14	0	100	0
<i>Brevoortia smithi</i>	Yellowfin Menhaden	13	0	69.23	30.77
<i>Peprilus paru</i>	Harvestfish	10	100	0	0
<i>Leiostomus xanthurus</i>	Spot	9	100	0	0
<i>Scomberomorus cavalla</i>	King Mackerel	7	57.14	14.29	28.57
<i>Cynoscion regalis</i>	Weakfish Seatrout	6	0	33.33	66.67
<i>Carcharhinus limbatus</i>	Blacktip Shark	5	20	60	20
<i>Carcharhinus acronotus</i>	Blacknose Shark	4	25	50	25
<i>Micropogonias undulatus</i>	Atlantic Croaker	4	100	0	0
<i>Opisthonema oglinum</i>	Atlantic Thread Herring	4	0	100	0
<i>Oligoplites saurus</i>	Leatherjacket Jack	3	0	0	100
<i>Cynoscion nothus</i>	Silver Seatrout	2	0	100	0
<i>Peprilus triacanthus</i>	Atlantic Butterfish	2	100	0	0
<i>Prionotus</i>	Searobins	2	0	50	50
<i>Sphyrna mokarran</i>	Great Hammerhead Shark	2	0	100	0
<i>Trichiurus lepturus</i>	Atlantic Cutlassfish	2	100	0	0
<i>Cynoscion arenarius</i>	Sand Seatrout	1	100	0	0
<i>Echeneis naucrates</i>	Sharksucker	1	0	0	100

<i>Galeocerdo cuvier</i>	Tiger Shark	1	0	100	0
<i>Lobotes surinamensis</i>	Tripletail	1	0	100	0
<i>Manta birostris</i>	Manta Ray	1	0	100	0
<i>Synodus foetens</i>	Inshore Lizardfish	1	0	100	0
<i>Trachinotus carolinus</i>	Florida Pompano	1	0	100	0

Table 3. Estimated shark catch by weight (kg), back-calculated from estimated lengths of all sharks observed caught in sink and strike (king mackerel) gillnet gear by target, 2018.

Target Species	Species Caught	Common Name	Total Number Caught	kg	%
King Mackerel	<i>Carcharhinus limbatus</i>	Blacktip Shark	6	118.80	52.95
	<i>Carcharhinidae</i>	Requiem Shark	2	104.19	46.44
	<i>Rhizoprionodon terraenovae</i>	Atlantic Sharpnose Shark	2	1.34	0.60
	<i>Elasmobranchii</i>	Sharks	1	0.04	0.02
		Total		11	224.36
Spanish mackerel	<i>Rhizoprionodon terraenovae</i>	Atlantic Sharpnose Shark	266	352.41	36.79
	<i>Sphyrna tiburo</i>	Bonnethead Shark	175	129.35	13.50
	<i>Sphyrna lewini</i>	Scalloped Hammerhead Shark	30	160.91	16.80
	<i>Carcharhinus brevipinna</i>	Spinner Shark	20	132.18	13.80
	<i>Carcharhinus limbatus</i>	Blacktip Shark	5	41.78	4.36
	<i>Carcharhinus acronotus</i>	Blacknose Shark	4	10.52	1.10
	<i>Sphyrna mokarran</i>	Great Hammerhead Shark	2	121.02	12.63
	<i>Galeocerdo cuvier</i>	Tiger Shark	1	9.83	1.03
	Total		503	958.00	

Table 4. Estimated catch by weight (kg) of commercially important teleosts, back-calculated from estimated lengths of all individuals observed caught in sink and strike (king mackerel) gillnet gear by target, 2018.

Target Species	Species Caught	Common Name	Total Number Caught	kg
King Mackerel	<i>Scomberomorus cavalla</i>	King Mackerel	23434	103532.70
	<i>Pomatomus saltatrix</i>	Bluefish	169	140.26
	<i>Scomberomorus maculatus</i>	Spanish Mackerel	49	43.23
	<i>Euthynnus alletteratus</i>	Little Tunny	4	5.75
Spanish Mackerel	<i>Scomberomorus maculatus</i>	Spanish Mackerel	2364	2225.49
	<i>Chloroscombrus chrysurus</i>	Atlantic Bumper	1813	108.73
	<i>Pomatomus saltatrix</i>	Bluefish	297	361.21
	<i>Larimus fasciatus</i>	Banded Drum	56	2.70
	<i>Menticirrhus americanus</i>	Southern Kingfish	44	47.48
	<i>Leiostomus xanthurus</i>	Spot	9	0.51
	<i>Scomberomorus cavalla</i>	King Mackerel	7	14.38
	<i>Cynoscion regalis</i>	Weakfish Seatrout	6	0.20
	<i>Micropogonias undulatus</i>	Atlantic Croaker	4	0.16
	<i>Cynoscion nothus</i>	Silver Seatrout	2	0.07
	<i>Peprilus triacanthus</i>	Atlantic Butterfish	2	0.13

Table 5. Average size (fork length, FL) and standard deviation (S.D.) of sharks measured for all observed sink gillnet trips by target, 2018.

Target Species	Species	Common Name	n	Avg FL (cm)	S.D.
Spanish mackerel	<i>Rhizoprionodon terraenovae</i>	Atlantic Sharpnose Shark	154	50.6	12.9
	<i>Sphyrna tiburo</i>	Bonnethead Shark	73	55.2	19.7
	<i>Carcharhinus brevipinna</i>	Spinner Shark	16	69.9	11.4
	<i>Sphyrna lewini</i>	Scalloped Hammerhead Shark	9	65.8	20.8
	<i>Carcharhinus acronotus</i>	Blacknose Shark	4	78.0	7.4
	<i>Carcharhinus limbatus</i>	Blacktip Shark	3	91.3	11.6

Table 6. Average size (fork length, FL) and standard deviation (S.D.) of non-sharks measured for all observed sink and strike (king mackerel) gillnet trips by target, 2018, where sample size ≥ 5 .

Target Species	Species	Common Name	n	Avg FL (cm)	S.D.
King Mackerel	<i>Scomberomorus cavalla</i>	King Mackerel	159	76.0	8.7
Spanish Mackerel	<i>Scomberomorus maculatus</i>	Spanish Mackerel	441	42.8	8.0
	<i>Caranx crysos</i>	Bluerunner Jack	202	26.1	1.8
	<i>Pomatomus saltatrix</i>	Bluefish	201	38.3	4.1
	<i>Rhizoprionodon terraenovae</i>	Atlantic Sharpnose Shark	154	50.6	12.9
	<i>Sphyrna tiburo</i>	Bonnethead Shark	73	55.2	19.7
	<i>Caranx hippos</i>	Crevalle Jack	63	26.2	9.8
	<i>Menticirrhus americanus</i>	Southern Kingfish	34	32.9	3.4
	<i>Chloroscombrus chrysurus</i>	Atlantic Bumper	19	19.5	1.6
	<i>Carcharhinus brevipinna</i>	Spinner Shark	16	69.9	11.4
	<i>Elops saurus</i>	Ladyfish	15	45.6	3.4
	<i>Menticirrhus littoralis</i>	Gulf Kingfish	11	33.7	1.4
	<i>Sphyrna lewini</i>	Scalloped Hammerhead Shark	9	65.8	20.8
	<i>Scomberomorus cavalla</i>	King Mackerel	5	67.4	16.4

Figure 1. Distribution of observed strike gillnet sets targeting king mackerel, *Scomberomorus cavalla*, 2018 (n=9 sets).

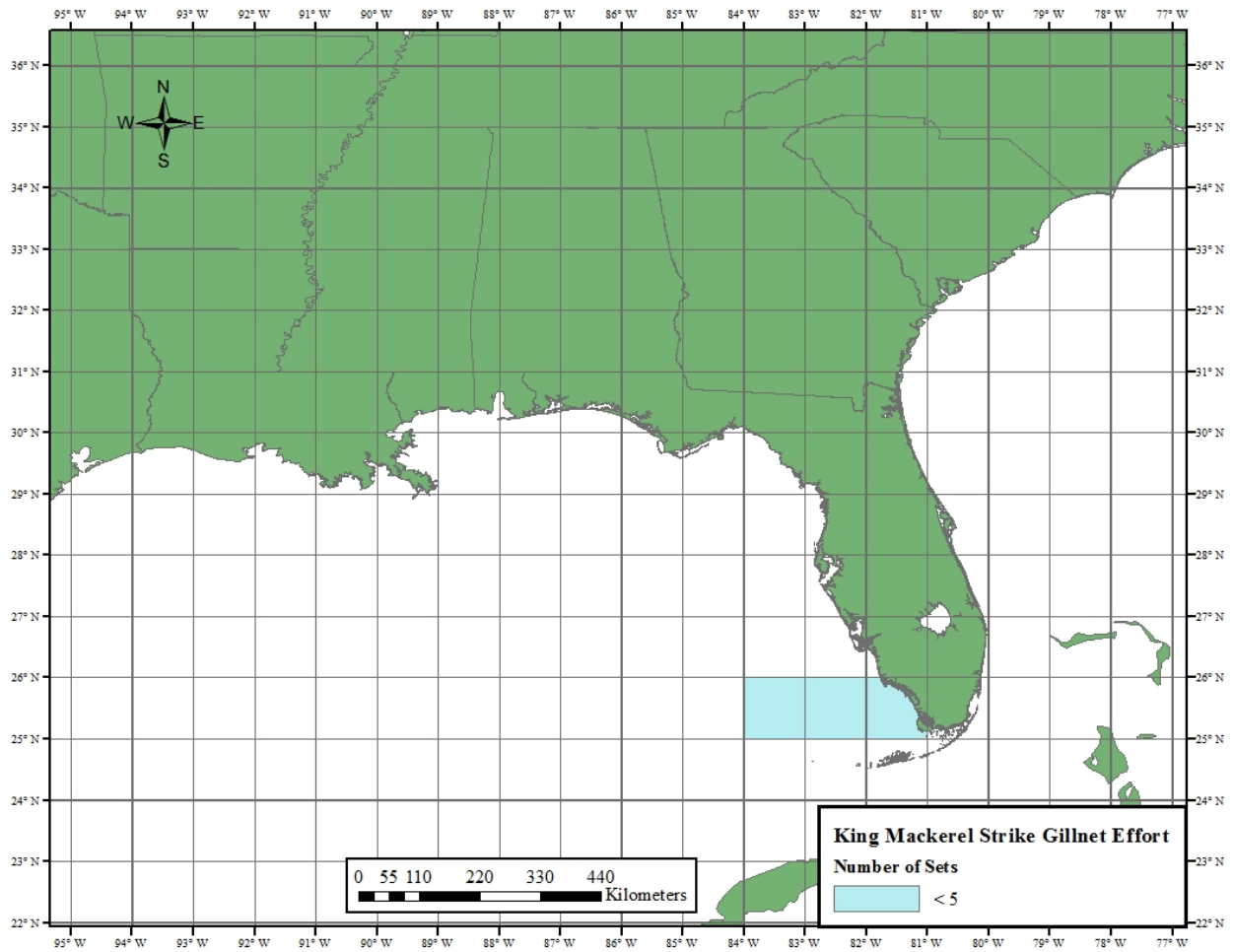


Figure 2. Distribution of observed sink gillnet sets targeting Spanish mackerel, *Scomberomorus maculatus*, 2018 (n=55 sets).

