The Directed Shark Gillnet Fishery: Non-Right Whale Season, 2002 (Catch, Bycatch and Estimates of Sample Size)

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Introduction

The Atlantic Large Whale Take Reduction Plan and The Biological Opinion issued under Section 7 of the Endangered Species Act mandate that, 100% observer coverage of the southeast shark gillnet fishery is required during the Right Whale Season (15 Nov-31 Mar) for vessels operating from West Palm Beach, FL to Sebastian Inlet, FL. Outside the right whale season (1 Apr-14 Nov), an interim final rule published in March 2001 (March 30, 2001; 66 FR 17370) to the Fishery Management Plan for Highly Migratory Species (NMFS, 1999) established a level of observer coverage equal to that which would attain a sample size needed to provide estimates of sea turtle or marine mammal interactions with an expected coefficient of variation of 0.3.

The last assessment of sample size calculations performed to provide estimates of sea turtle or marine mammal interactions was conducted in 2000. The conclusion was that a 52.8% sampling fraction outside the right whale season would be required. There are now two additional years of data to update the estimate of required sample size.

The objectives of this report are to update activities in the directed shark gillnet fishery by providing estimates of the catch and bycatch for the non-right whale season, 2002. In addition, sample size estimates will be calculated for achieving a sea turtle or marine mammal interaction based on updated incidental take information.

Methods

Observer protocol

Vessels were randomly selected from a universe of 6 vessels for a series of 2-week coverage periods. Selection letters requiring observer coverage were issued by the SEFSC observer coordinator beginning on 1 April 2001. After the fisher made initial contact with the observer coordinator, an observer was deployed to the port where the vessel was currently active. The last assessment of sample size found that a 52.8% level of coverage is required to attain a sample size needed to provide estimates of a sea turtle or marine mammal interaction with an expected coefficient of variation of 0.3. However, due to a high number of sea turtle strandings in May 2002 along the coast of Georgia and at the request of the state of Georgia and the National Marine Fisheries Service/Southeast Regional Office, 100% observer coverage was provided for all shark gillnet vessels fishing in the north Florida/Georgia area from May 8-June 15, 2002.

Catch and bycatch estimation

Details of the methods used to obtain data can be found in Carlson and Lee (1999). In general, observations were made as the net was hauled aboard. The observer remained about 3-8 m forward of the net reel in a position with an unobstructed view, and recorded species, numbers and lengths (±30 cm) of sharks and other species caught as they were suspended in the net just after passing over the power roller. Weights (in kg) were estimated from these estimated lengths using length-weight relationships provided in Kohler et al. (1994), and Carlson (unpublished data). When species identification was questionable, the crew stopped the reel so that the observer could examine the animal(s) for positive identification. Disposition of each species brought onboard was recorded as kept, discarded alive, or discarded dead. When time permitted after the haulback was complete, observers randomly measured sharks when the vessel was returning to port. Fork length (FL, measured on a straight line), sex, and maturity state were determined for each shark. Biological samples (e.g. vertebrae, reproductive organs, stomach) were removed and placed on ice after collection. Data were submitted to the NMFS/SEFSC Sustainable Fisheries Division on a weekly basis. The data were examined and entered by NMFS/SEFSC Sustainable Fisheries Division staff, and reviewed with Johnson Controls contract observer staff to resolve any questions.

Estimation of sample size

Sample size estimates for catching at least one sea turtle or marine mammal were based on a binomial distribution assuming an infinite population from which the sample is drawn. The sample-based estimate of the probability of catching a protected resource (p_i) is:

$$(1) \qquad p_i = {}^{t_i}\!/_{f_i}$$

where:
t_i = the number of sets where at least one protected resource was captured, and
f_i = total number of sets observed.

The associated coefficient of variation (CV_p) is calculated as:

$$(2) \qquad CV_p = \frac{\sqrt{\dfrac{(t_i / f_i)(1 - t_i / f)}{f_i}}}{(t_i / f_i)}$$

To determine the number of sets required (n) with a CV=0.3 under the probability (p_i) calculated in equation (1), 0.3 is substituted for CV_p, and n is substituted for f_i in equation (2), then one can solve for n such that:

$$(3) \qquad n = \frac{(p_i(1 - p_i))}{(0.3 p_i)^2}$$

Taking the population size (i.e. total number of expected sets, N) through the finite population correction (1-n/N; Kendall and Stuart 1979) allows for the further evaluation of the expected variability of the estimated probability of catching a protected resource in a given set as a function of sample size (n):

$$(4) \qquad n = \frac{N}{\dfrac{(1 + CV_p^2)N(p_i^2)}{p_i(1 - p_i)}}$$

One of the principal sources of bias in the above estimates is the predicted level of effort. Variability in effort from year to year and the uncertainties between observed effort and that reported in the NMFS fishing vessel logbook database has been reported by Garrison (2001) and Yeung (2001). To account for this variability, Monte Carlo simulation consisting of randomly selecting values from a probability distribution assumed to describe the level of effort (number of sets/year) was performed. Effort was assumed to follow a uniform distribution with an estimated mean of 225 sets/year and lower and upper bounds of 88 and 337 reflecting the range of annual effort determined by Garrison (2001) and Carlson (unpublished). The process was repeated 10,000 times, yielding frequency distributions, means, medians, and confidence intervals (calculated as the 2.5th and 97.5th percentiles) for the sampling estimates. All simulations were run with Microsoft Excel spreadsheet software equipped with add-in simulation software (Crystal Ball 2000, Decisioneering, Inc.).

Results and Discussion

Strikenet fishery

Strikenet fishing techniques have been previously described (Carlson and Baremore 2001). Set times during the non-right whale season 2002 averaged 0.1 hrs (±0.0 S.D.) and soak times (time net was first set minus time haulback began) averaged 0.1 hrs (±0.1 S.D.). Haulback averaged 0.2 hrs (±0.0 S.D.). The entire strikenetting process (time net was first set minus time haulback was completed) averaged 0.4 hrs (±0.1 S.D.). For strikenetting, vessels used nets 364.8 m long, 30.4 m deep and included stretched mesh size 22.9 cm. This type of fishing technique occurred during day and nighttime hours.

Observed strikenet catches

A total of 14 strikenet sets were observed from April-October between approximately 28° 27' N and 31° 07' N (Figure 1). An additional 3 trips (19 attempted sets) were not made when the observer departed with the vessel but no strike was made. Reasons for not striking for sharks included the inability to locate the school, sharks located in state waters, and poor weather conditions. Observed catch consisted of 3 species of sharks (100.0% of total number caught) (Table 1). No teleosts, marine mammals, or sea turtles were observed caught.

Driftnet fishery

A total of 28 driftnet sets were observed from April-October between approximately 28° 27' N and 31° 07' N (Figure 1). Driftnet vessels carried nets ranging in length from 456-2,280 m, depths from 6.1-15.2 m, and stretch mesh sizes from 12.7-22.9 cm. Set duration averaged 0.4 hrs (±0.1 S.D.). Haulback and processing of the catch averaged 3.9 hrs (±1.4 S.D.). Average soak time for the driftnet (time net was first set minus time haulback began) was 5.0 hrs (±2.3 S.D.). The entire driftnetting process (time net was first set minus time haulback was completed) averaged 8.9 hrs (±2.8 S.D.).

Observed driftnet catches

The observed driftnet catch consisted of 12 species of sharks, 26 species of teleosts and rays, and 1 species of marine mammal. Total observed catch composition (percent of numbers caught) were 84.9% sharks, 15.0% teleosts, 0.1% rays, 0.0% sea turtles and 0.01% marine mammals. Four species of sharks made up 96.5% (by number) of the observed shark catch (Table 2). These species were the Atlantic sharpnose shark (67.4%), finetooth shark (13.7%), blacknose shark (7.9%), and blacktip shark (5.4%). By weight, the shark catch was made up primarily of Atlantic sharpnose shark (39.3 %), finetooth shark (23.2%), blacktip shark (10.7%), and blacknose shark (15.0 %).

Five species of teleosts made up 90.6% by number of the overall non-shark species. Little tunny (44.1%), king mackerel (20.8%), great barracuda (12.5%), Atlantic moonfish (9.4%), and cobia (3.8%) dominated the bycatch (Table 3).

Disposition of catch

Portions of both the targeted catch (sharks) and incidental catch were discarded. The proportions discarded varied between strikenet and driftnet catches. In the strikenet fishery, 0.0% of sharks were discarded (Table 1). Shark discards for vessels drift gillnetting were highest for hammerheads and blacktip sharks. Discards of sharks were related to fishing activity that occurred during the large coastal season closure and the poor quality and low market value of hammerhead flesh. For incidental driftnet catch species, the highest proportions discarded dead (with observed catch greater than 10 specimens) were for tarpon, crevalle jack, king mackerel, and red drum (Table 3). Cownose rays and red drum had the highest proportions discarded alive, 100.0 and 48%, respectively.

Av*erage size*

When time permitted after the haulback was complete, observers randomly measured sharks (cm fork length) when the vessel was returning to port. Observers measured 1.1% of the total catch of sharks. By species, 0.7% of Atlantic sharpnose shark, 1.2% of blacknose, 3.9% of finetooth, and 0.8% of blacktip shark were measured. Average sizes based on these measurements are found in Table 4.

Protected resource interactions

Interactions with protected resources (1 individual) occurred with 1 bottlenose dolphin. The animal was discarded dead at approximately 28° 45’ 11” N and 085° 29’ 44” W. The discard was reported to the Marine Mammal Stranding Network in Miami, FL.

Estimation of sample size

Observations from this fishery (1993-1995 and 1998-2002) have reported 30 protected resource interactions in 340 observed gillnet sets (Table 5; Trent et al. 1997; Carlson and Baremore, 2001 and references therein; Carlson, unpublished). Using these estimates resulted in the probability of catching a sea turtle or marine mammal of 0.088 with a corresponding coefficient of variation of 0.174. Sample size estimates required for a CV=0.3 were calculated as 115 sets/year. Further, the sample size required assuming a finite population of N sets was calculated at 76 sets/year. Thus assuming a total of 225 sets/year would result in a required sampling fraction of 33.8% to provide an estimate of a protected resource interaction with an expected coefficient of variation of 0.3. Results of the Monte Carlo simulation indicated a mean sampling fraction of 37.1%, median=35.4%, standard deviation=8.6%, lower confidence limit of 25.8% and upper confidence limit of 55.1%.

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Table 1. Total strikenet shark catch and bycatch by species and species disposition in order of decreasing abundance for all observed trips during the non-right whale season, 2002.

Species	Common name	Total number caught	Kept (%)	Discarded alive (%)	Discarded dead (%)
Carcharhinus acronotus	Blacknose shark	620	100.0	0.0	0.0
Carcharhinus limbatus	Blacktip shark	547	99.8	0.2	0.0
Sphyrna tiburo	Bonnethead	1	100.0	0.0	0.0

Table 2. Total directed driftnet shark catch by species and species disposition in order of decreasing abundance for all observed trips during the non-right whale season, 2002.

Species	Common name	Total number caught	Kept (%)	Discarded alive (%)	Discarded dead (%)
Rhizoprionodon terraenovae	Atlantic sharpnose shark	7332	98.9	0.4	0.7
Carcharhinus isodon	Finetooth shark	1490	100.0	0.0	0.0
C. acronotus	Blacknose shark	859	100.0	0.0	0.0
C. limbatus	Blacktip shark	572	1.2	30.9	67.8
Sphyrna tiburo	Bonnethead	305	100.0	0.0	0.0
S. lewini	Scalloped hammerhead shark	37	2.7	5.4	91.9
C. brevipinna	Spinner shark	17	23.6	5.8	70.6
S. mokarran	Great hammerhead shark	18	0.0	0.0	100.0
Galeocerdo cuvieri	Tiger shark	2	50.0	50.0	0.0
C. plumbeus	Sandbar shark	2	0.0	0.0	100.0
Negaprion brevirostris	Lemon shark	1	0.0	0.0	100.0

Table 3. Total driftnet teleost and ray bycatch by species in order of decreasing abundance and species disposition for all observed trips during the non-right whale season, 2002.

Species	Common name	Total number caught	Kept (%)	Discarded alive (%)	Discarded dead (%)
Euthynnus alletteratus	Little tunny	817	94.5	0.0	5.5
Scomberomorus cavalla	King mackerel	386	41.7	1.0	57.3
Sphyraena barracuda	Great barracuda	231	100.0	0.0	0.0
Selene setapinnis	Atlantic moonfish	174	72.4	22.4	5.2
Rachycentron canadum	Cobia	72	80.5	7.0	12.5
Caranx hippos	Crevalle jack	29	3.5	24.1	72.4
Sciaenops ocellatus	Red drum	28	0.0	50.0	50.0
Megalops atlanticus	Tarpon	22	0.0	22.7	77.3
Auxis rochei	Bullet mackerel	21	100.0	0.0	0.0
Caranx crysos	Blue runner	21	100.0	0.0	0.0
Echeneididae	Remora	21	0.0	90.5	9.5
Rhinoptera bonasus	Cownose ray	32	0.0	78.1	21.9
Trachinotus falcatus	Permit	6	0.0	16.6	83.4
Istiophorus platypterus	Atlantic sailfish	4	0.0	0.0	100.0
Manta birostris	Manta ray	3	0.0	100.0	0.0
Scomberomorus maculatus	Spanish mackerel	3	100.0	0.0	0.0
Alectis ciliaris	African pompano	2	100.0	0.0	0.0
Coryphaena hippurus	Dolphin	2	100.0	0.0	0.0
Lobotes surinamensis	Tripletail	2	100.0	0.0	0.0
Aetobatus narinari	Spotted eagle ray	1	0.0	100.0	0.0
Acipenser oxyrhyncus	Atlantic sturgeon	1	0.0	100.0	0.0
Diodon holocanthus	Balloonfish	1	100.0	0.0	0.0
Euthynnus pelamis	Skipjack tuna	1	100.0	0.0	0.0
Manta birostris	Atlantic manta ray	1	0.0	0.0	100.0
Mobula hypostoma	Devil ray	1	100.0	0.0	0.0
Thunnus atlanticus	Blackfin tuna	1	100.0	0.0	0.0

Table 4. Average size of sharks measured for all observed trips during the non-right whale season, 2002.

Species	N	Size (cm FL)	S.D.	Percentage measured of the catch by species
Atlantic sharpnose shark	49	75.0	6.9	0.7
Blacknose shark	10	101.8	6.0	1.2
Finetooth shark	59	107.8	14.7	3.9
Blacktip shark	10	122.4	6.4	0.8

Table 5. Observed sampling effort in the shark drift gillnet fishery for 1993-2002 and associated interactions with protected species.

Year	Known number of vessels	Observed sets	Number of sets with interaction
1993	n/a	5	0
1994	6	40	1
1995	11	7	0
1996	n/a	0	-
1997	n/a	0	-
1998	11	9	0
1999	9	51	2
2000	8	67	4
2001	6	92	19
2002	6	69	4

Figure 1. Distribution of observed strikenet and drift gillnet sets during the non-right whale season, 2002. Squares=strikenet sets, circles=driftnet sets, and triangles=driftnet sets with protected species interactions.