Revised Estimation of Observer Coverage Required in the Reef Fish Bottom Longline Fishery based on Interactions with Sea Turtles

John Carlson

National Marine Fisheries Service
Southeast Fisheries Science Center
3500 Delwood Beach Road
Panama City, FL 32408

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Introduction

NOAA Fisheries Service-Southeast Fisheries Science Center (SEFSC) began placing observers on Gulf of Mexico reef fish fishery vessels in the second half of 2006, and continues to sample the fishery to date. Two SEFSC observer programs, the Galveston Laboratory reef fish observer program (RFOP) and the Panama City Laboratory shark bottom longline observer program (SBLOP) each independently designed and implemented sampling regimes for different, but overlapping portions of the Gulf of Mexico reef fish fishery.

Protected sea turtles have been captured in this fishery and resulting estimates of takes have been calculated (SEFSC 2009). In this report, SEFSC (2009) noted that the relatively low observer coverage coupled with the small magnitude of coverage and rarity of turtle captures (less than 5 captures per strata) is problematic. SEFSC (2009) recommended increased observer effort at least 3 to 5 times 2007 effort, or about a 3% to 5% observer coverage would improve confidence in the sea turtle take estimates. This results in a recommended magnitude observer coverage of ~60 to ~100 trips per year of between 1,116 to 1,860 sets. A previous estimate of sample size was calculated in SFD Contribution PCB- 09-18, however the number of sets in 2009 provided in that report was in error. Using revised number of sets observed in 2009, estimates of observer coverage with a level equal to that which would attain a sample size needed to provide estimates of sea turtle bycatch with an expected coefficient of variation are provided, herein.

Methods

Sample size estimates for catching at least one sea turtle 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 sea turtle (p_i) is:

$$(1) \qquad p_i = t_i / f_i$$

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

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

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

To determine the number of sets required (n) with a CV=0.3, for example, 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:

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

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 sea turtle in a given set as a function of sample size (*n*):

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

Sample size with 2 levels of CV (30% and 20%) was calculated using information taken from SEFSC (2009) and unpublished observer and sea turtle take information through July 2009 (Elizabeth Scott-Denton RFOP, unpublished; Lori Hale-SBLOP, unpublished). Table 1 reports the updated takes of sea turtles recorded by bottom longline observers and Table 2 is updated observer effort.

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. SEFSC (2009) calculated total effort in the longline reef fish fishery based upon self-reported effort from SEFSC logbooks. To determine participation in the GOM reef fish fishery from the trip based coastal logbook program, SEFSC assumed that effort was a part of the fishery if the fishers reported using bottom longline gear and were not in possession of a directed shark permit, or if they were in possession of a directed shark permit, then if landings were greater than 2/3 by weight of species other than sharks. SEFSC (2009) estimated bi-annual effort for the GOM ranged from about 9,000 to 14,000 sets.

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^{-1}) was performed. In Scenario 1, total effort was assumed to follow a normal distribution with an estimated mean of 24,000 sets year^{-1} and a standard deviation of 2,000. In addition, Gulf of Mexico Fishery Management Council is recommending a reduction in bottom longline effort inside 50 fathoms by approximately 40% for the 2010 season. Thus in Scenario 2, mean effort will be reduce by 40% (14,000 sets year^{-1}) and a standard deviation of 1,200. Monte Carlo simulation was repeated as previously described.

Results

Estimation of sample size

Observations from this fishery have reported 25 sets with a sea turtle interaction in 1,887 observed sets. Using these estimates resulted in the probability of catching a sea turtle of 0.0132 with a corresponding coefficient of variation of 0.1987.

Scenario 1
Sample size estimates required for a CV=0.3 assuming a finite population of N sets was calculated at 800 sets year^{-1}. Thus assuming a mean of 24,000 sets year^{-1} would result in a required sampling fraction of 3.3% to provide an estimate of a sea turtle interaction with an expected coefficient of variation of 0.3. Results of the Monte Carlo simulation indicated a mean sampling fraction of 3.4%, with lower confidence limit of 2.9% and upper confidence limit of 4.0%.

Sample size estimates required for a CV=0.2 assuming a finite population of N sets was calculated at 1,728 sets year^{-1}. Thus assuming a mean of 24,000 sets year^{-1} would result in a required sampling fraction of 7.2% to provide an estimate of a sea turtle interaction with an expected coefficient of variation of 0.2. Results of the Monte Carlo simulation indicated a mean sampling fraction of 7.2%, with lower confidence limit of 6.3% and upper confidence limit of 8.5%.

Scenario 2
Sample size estimates required for a CV=0.3 assuming a finite population of N sets was calculated at 781 sets year^{-1}. Thus assuming a mean of 14,000 sets/year would result in a required sampling fraction of 5.6% to provide an estimate of a sea turtle interaction with an expected coefficient of variation of 0.3. Results of the Monte Carlo simulation indicated a mean sampling fraction of 5.6%, with lower confidence limit of 4.8% and upper confidence limit of 6.6%.

Sample size estimates required for a CV=0.2 required assuming a finite population of N sets was calculated at 1,643 sets year^{-1}. Thus assuming a mean of 14,000 sets year^{-1} would result in a required sampling fraction of 11.7% to provide an estimate of a sea turtle interaction with an expected coefficient of variation of 0.2. Results of the Monte Carlo simulation indicated a mean sampling fraction of 11.8%, with lower confidence limit of 10.2% and upper confidence limit of 13.8%.

Discussion
It should be noted that several caveats are associated with this analysis. The CV based sample size estimates assume (1) constant catch rates, (2) no stratification of the sampling design, and (3) a standard binomial estimator will be used for bycatch estimates. Assumption (1) will presumably be violated if new regulations are adopted in 2010 and assumption (2) is violated due to the nature of the observer coverage. However, the analysis presented herein represents the best available science and estimates of sample size should be used as a baseline in future planning for observer coverage.

Although this document represents an update to sample sizes calculated in Carlson (2009), sample size estimates provided herein are not considerably different than those in Carlson (2009). Based on current encounter rates of sea turtles, the estimated levels of coverage needed based on predicted fleet effort vary between 2.9% and 6.5% for a CV=0.3 and between 6.2% and 13.4% for a CV=0.2 (Table 3). SEFSC (2009) recommended increased observer effort at least 3 to 5 times 2007 effort and observer coverage in 2007 was estimated at 1.3% overall. Thus, estimates in this analysis appear to support those recommendations.

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References

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Table 1. Observed takes of sea turtles by bottom longline trip and set in the Gulf of Mexico by fishers targeting reef fish. Season 1 is January through June and Season 2 is July through December. RFOP is the Galveston Laboratory's reef fish observer program, SBLOP is the Panama City Laboratory's shark bottom longline observer program, and RFEM is reef fish electronic monitoring

YEAR	SEASON	TRIP	SET	NUMBER OF TURTLES CAUGHT	PROGRAM
2006	2	1	1	1	SBLOP
2006	2	1	5	1	SBLOP
2006	2	1	6	1	SBLOP
2006	2	1	11	1	SBLOP
2006	2	1	17	2	SBLOP
2006	2	1	21	1	SBLOP
2006	2	2	5	1	RFOP
2006	2	3	1	2	RFOP
2007	1	4	1	1	RFOP
2007	1	5	4	1	RFOP
2007	1	5	5	1	RFOP
2007	1	5	16	1	RFOP
2007	2	6	8	1	RFOP
2007	2	6	15	1	RFOP
2007	2	7	7	1	RFOP
2007	2	8	3	1	SBLOP
2008	1	9	43	1	RFEM
2008	1	9	49	1	RFEM
2008	1	10	13	1	RFEM
2009	1	1	16	1	RFOP
2009	1	1	18	1	RFOP
2009	1	1	22	1	RFOP
2009	1	1	24	1	RFOP
2009	1	1	26	1	RFOP
2009	1	2	4	1	RFOP

Table 2. Observed reef fish bottom longline effort for the eastern and western Gulf of Mexico in sets from the Panama City Laboratory shark bottom longline observer program (SBLOP) and Galveston Laboratory reef fish observer program (RFOP) and RFEM is reef fish electronic monitoring by year and season.

		EASTERN GULF OF MEXICO		WESTERN GULF OF MEXICO	
YEAR	SEASON	SBLOP	RFOP	SBLOP	RFOP
2006	2	27	201	0	0
2007	1	99	55	0	0
2007	2	79	139	0	0
2008	1	96	15	10	49
2008	2	19	46	22	0
2008-RFEM	-	0	245	0	0
2009	1	70	544	0	171

Table 3. Estimated range of sampling fractions with predicted fleet effort and expected coefficient of variation.

CV	**Fleet Sets**	**Observed sets**	**Sampling fraction**
0.2	28000	1746	6.2
0.2	24000	1728	7.2
0.2	19500	1700	8.7
0.3	28000	804	2.9
0.3	24000	800	3.3
0.3	19500	794	4.1
0.2	16100	1669	10.4
0.2	14000	1643	11.7
0.2	12000	1612	13.4
0.3	16500	788	4.8
0.3	14000	781	5.6
0.3	11900	774	6.5