Estimated Takes of Sea Turtles in the Bottom Longline Portion of the Gulf of Mexico
Reef Fish Fishery July 2006 through December 2008 Based on Observer Data.

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Background

This report estimates total captures of sea turtles in the bottom longline portion of the U.S. Gulf of Mexico (GOM) reef fish fishery for the second half of 2006 through the end of 2008. Fishers engaged in the GOM reef fish fishery use bottom longlines, vertical lines, and fish traps to target a variety of species, including some snappers, groupers, tilefish, jacks, and other assorted species[1]. The SEFSC started placing observers on GOM 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 GOM reef fish fishery. In 2008 a voluntary electronic monitoring special project, hereafter the "reef fish electronic monitoring" (RFEM), observed 7 trips of 6 bottom longline vessels (Pria et al. 2008). Although the RFEM was in part administered by the RFOP, it was not part of the normal operation of a mandatory observer program and used different methods, and therefore was considered separately in the extrapolated estimates provided in this report.

For the purposes of this report, takes of sea turtles (hereafter "takes") refers to sea turtles that were incidentally captured during fishing operations. Between them, all three programs observed a total of 21 sea turtle captures (Table 1) and no marine mammals in their samples of bottom longline gear.

This report estimates total sea turtle takes, and stratified takes, based on catch per hook derived from assumed representative samples from the RFOP and the SBLOP of commercial vessels using bottom longline gear, extrapolated to total reported hook effort, plus takes from the RFEM. Total reported effort was collected from permitted fishers by the Fisheries Logbook System (FLS) database, at the Southeast Fisheries Science Center (SEFSC). Estimation of the total fishery effort for extrapolation from the observed takes to total estimated takes was constrained by the information consistently and reliably reported in common between the FLS data and the two sources of mandatory observation data, the SBLOP and the RFOP. For this analysis we used two measures of effort, set and number of hooks in a set. The use of sets and hooks as effort variables was due in part to the use of these effort parameters and analysis types in similar fisheries, the commercial directed shark bottom longline (Richards 2006, SEFSC 2007) and the pelagic longline (e.g. Johnson et al. 1999, Walsh and Garrison 2006). The use of these effort variables was also constrained by what was considered to be reliably reported to the FLS coastal logbook. Other effort variables such as soak time, or other gear characteristics are not considered reliable, in part because of temporal changes in reporting requests (e.g. time fished per set vs. per trip[1]), or because some characteristics are set based rather than trip based (e.g. depth fished per set in observer data vs. average depth fished per trip in reported effort).

[1] Biological Opinion on the continued authorization of reef fish fishing under the Gulf of Mexico (GOM) Reef Fish Fishery Management Plan (RFFMP) and proposed Amendment 23.

All stratified analyses approximately followed the observer program designs. For the purposes of this report, season 1 was defined as Jan 1 thru June 31, and season 2 as July 1 thru December 31, and GOM was spatially divided into east and west strata at 88 degrees W longitude.

A similar report was prepared to provide estimates of bycatch in the GOM bottom longline fishery for July 206-2007 (SEFSC 2008). Those estimates have been revised herein, based on updates to both the FLS and observer databases.

Fishery Effort: FLS data

Extrapolated estimates of total takes in this report were based upon self reported effort from SEFSC FLS. All federally permitted commercial fishers report their activities by individual trip to the FLS without reference to a target fishery. To determine participation in the GOM reef fish fishery from the trip based coastal logbook program, we 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.

The total bottom longline effort within the coastal logbook was allocated to either the shark directed ("shark") or "other" catch (e.g. reef fish, tilefish, incidentally captured sharks, etc.); effort of those with shark permits whose trips could not be allocated to either shark directed or "other" catch was identified as "mixed". Allocation of effort to the directed portion of either the directed shark fishery or the reef fish fishery by those vessels with directed shark permits was based upon the Southeast Regional Office's (SERO) permit database (to determine which vessels had the permits), and expert opinion about what comprises a shark trip (that 2/3 of landings by weight were sharks) or a non-shark trip ("other", which we assume belongs to the GOM reef fish fishery). The 2/3 by weight landings rule was based on our approximation of what comprises a directed shark trip (see SEFSC 2007). This rule was intended to balance the allocation of trip level effort to the commercial directed shark bottom longline fishery and the GOM reef fish fishery. All vessels reporting effort but not holding directed shark permits were allocated to the "other" catch category. Thus, allocation to directed GOM reef fish fishery was the sum of effort of those without directed shark permits and those with directed shark permits whose catch was greater than 2/3 by weight of species other than sharks. All other effort was either shark directed or unallocated, that is, those with directed shark permits, but did not either catch at least 2/3 by weight sharks or 2/3 by weight species other than sharks. We also removed questionable data trips: those trips with less than 30 hooks per set and trips with sets greater than 25 miles in length (both were in the lower or upper 0.25% of the data). This removal introduces a further negative bias in addition to that introduced by underreporting.

Total fishery effort that was used for extrapolation is summarized in Table 2. In our attempt to allocate all bottom longline effort within the coastal logbook to either directed shark or other catch, we found that the effort we could not allocate to either category was

relatively small, between 2.2% and 2.6% (trip, set, or hook) of all bottom longline effort for 2006 and even less (0.3% to 0.5%) in 2007, (Figure 1). We did not do similar calculations for 2008 because there were no takes of sea turtles in the regularly observed (RFOP and SBLOP) portions of the fishery; therefore allocation of total effort has no effect on our current estimates. Nonetheless, this potentially indicates a small underestimate of the total reef fish or directed shark effort (Figure 1; see Appendix A for unallocated data). Total fishery effort from FLS data is also subject to changes over time due to quality control and editing of the database, removal of duplicates, etc., and additional logbook forms being submitted to the SEFSC. For example, between this report and the prior report (SEFSC 2008), the total allocated FLS reported effort for the eastern GOM in 2007, season 1, increased by 5 trips (0.8% increase) and in season 2 increased by 77 trips (15.8% increase) (see Table 2, and Table 2 from SEFSC 2008). This temporal effect was presumably due to late logbook submissions to the SEFSC and appears to diminish rapidly with time (e.g. within 1 to 2 years). Overall there is some level of under reporting (logbooks forms that are never submitted to the SEFSC), which we assumed was small, but resulted in a negative bias to our estimates of total takes.

Observed Effort:

Three different programs or projects deployed observers on commercial bottom longline vessels that targeted reef fish from July 2006 through 2008, the SBLOP, the RFOP, and the RFEM. The SBLOP and the RFOP used random sampling in their attempt to achieve a representative sample of the fishery. The RFEM was based on a solicitation for volunteers. Six suitable vessels agreed to take video monitoring equipment and an observer; 245 sets and at least 207,575 (hook counts were not available for 2 sets) were observed over 7 trips (Pria et al. 2008). Although sampling frames are different between the SBLOP and the RFOP, we consider them independent random samples of their respective portions of the GOM reef fish fishery. The RFEM was not a random sample and although they attempted to use vessels that were representative of the fishery, we did not consider the RFEM sample representative, in part because 5 of the 6 vessels came from a single port (the 6th hailed from a nearby port) and all observations occurred in mid-March through early May (Pria et al. 2008). The SBLOP attempts to randomly sample those with directed shark permits (which may or may not also hold reef fish permits), temporally stratified by three open Large Coastal Shark Complex Seasons in the GOM from 2006 (Season 1- January 1 through April 15, Season 2 - July 6 through July 31, and Season 3 - September 1 through November 7 [Hale and Carlson, 2007, Hale et. al. 2007]). In 2007 the GOM open season dates were: Season 1 - January 1 through January 15, Season 2 - September 1 through September 22; in 2008 the season was open July 24 through December 31. In the Gulf of Mexico, sampling was spatially divided into two strata at 88 degrees W longitude by home port of the permit holder in statistical areas 1-10 (east), and statistical areas 11-21 (west) (statistical areas are defined in logbook forms at: http://www.sefsc.noaa.gov/PDFdocs/2009_COASTAL_FISHERIES.pdf). The RFOP attempts to randomly sample all vessels with reef fish permits stratified by gear type (hand, bandit, longline), season (January – March, April-June, July-September, October – December) and region (east and west GOM). For the RFOP, GOM strata were divided at 86 degrees W longitude by effort in statistical areas 1-8 (east) and 9-21 (west)

(http://www.sefsc.noaa.gov/PDFdocs/2009_COASTAL_FISHERIES.pdf). For the sampling of the GOM reef fish fishery, the RFOP essentially randomly samples vessels from the total effort we allocated to the directed fishery (both trips reported by vessels with directed shark permits but with "other" catch and by those vessels without directed shark permits), while the SBLOP randomly samples vessels from the total effort we allocated only to "other with directed shark permit" (Figure 1). The SBLOP records target species group (a few types of sharks, grouper/reef fish, and tilefish) by set; the RFOP did not record target. Neither program samples proportional to fishing effort, so extrapolation to the entire fishery requires the assumption that the sample was representative of fishing effort either because the random sample of vessels was sufficiently large to capture the variability in reported effort by vessel or that vessels operate in a sufficiently similar way (e.g. similar number of trips per year and sets and hooks per set, per trip).

There were a total of 18 observed takes of loggerhead turtles (*Caretta caretta*) and 3 observed takes of unknown hardshell sea turtles (Table 1, and Figure 2) from bottom longline gear targeting reef fish within the GOM (combined SBLOP, RFOP, and RFEM). Of these there were 16 observed takes of loggerhead turtles (*Caretta caretta*) and 2 observed takes of unknown hardshell sea turtles (Table 1, and Figure 2) from our assumed representative samples of bottom longline gear targeting reef fish within the GOM (RFOP and SBLOP). The representative sample is what was used for estimation of take rates and extrapolation to the total fishery effort. Of all the observed representative samples, approximately 17.6% of trips and 1.9% of sets captured turtles. Of all takes reported here (from the RFOP, SBLOP, and RFEM) approximately 19.1% of trips and 1.7% of sets captured sea turtles.

Observed bottom longline effort by observer program is shown in Table 3 for trips, sets, and hooks. Percent observed of bottom longline effort varied between 0.12% and 3.64% depending upon strata, effort unit, and observer program (Table 4). The overall percent observed effort for July 2006-2008 was between 1.3% and 1.6% depending upon effort type.

Take rate estimation methods

A delta lognormal approach (Pennington 1983) was used to estimate the mean and variance of takes per hook per set per observed strata. This method combines a binomial model for the total observations by set with a lognormal model for the non-zero catch per unit effort (CPUE) data, which are assumed to be lognormally distributed. Extrapolated takes by the fishery were the multiplication of catch per hook by the total number of hooks extracted and allocated using our 2/3 by weight landings rule (see "Fishery Effort: FLS coastal logbook data" above) from the coastal logbook. The delta approach in this case does not really affect point estimates for most strata, as they are very similar to standard ratio estimators, due to the small number of non-zero samples, but it is intended to provide a more realistic estimate of the CV and confidence intervals. Although, if assumptions of the method are violated the resulting confidence intervals may be unrealistically narrow. Sparse data are not likely to fit a critical assumption of the delta

lognormal model (Pennington 1983) that the non-zero CPUE's are drawn from a lognormal distribution. One could argue that the sample could have been drawn from a larger population of captures within the fishery, and that this larger population was lognormally distributed. Although vessel was the unit of random selection by the observer programs and sets are not independent of trip, we assumed that sets were independent of trip, and proceeded as if sets were the randomly selected observation unit. In any case, the extrapolated estimates based upon sparse data sets should not be assumed to be reasonable without potentially invoking large assumptions regarding unobserved events. Although pooling the data across stratifications of season and region might be justified to reduce the sparseness of the data, such pooling may not be appropriate because it would ignore the non-random distribution of the sea turtles incidentally captured, and the potential differential operation of the fishery between areas or seasons.

Extrapolated takes

Extrapolated estimated sea turtle takes are presented in Tables 5, and 6. Table 5 gives the estimated takes of only positively identified loggerheads in the GOM, while Table 6 gives the estimated takes including "unknown hardshells". "Unknown hardshells" was used by the observers because they did not get a chance to identify the turtle, except a glimpse to identify them as hardshell. While this does not indicate the species (except to exclude leatherback), it does indicate that they were unidentifiable, but not because it was a rare species that the observer was not familiar with. All information needed to reproduce these estimates is provided in Tables 1, 2, and 3: takes by set and trip, total effort, and observed effort, respectively. Sums of the extrapolated estimates and their associated CV's and 95% confidence intervals by observer program are also provided and were estimated as the addition of the estimates and their associated variances over all temporal strata. Lognormal confidence intervals and CV's were then recalculated using the summed variance. Weighted sums for the RFOP or the SBLOP are also provided. Weightings were determined as the proportion of total allocated effort in sets by strata. For example, let the relative weighting for RFOP be 1.0, then the relative weight for the SBLOP in the eastern GOM in season 2 of 2006 was 3730/(3730+8270)=0.31 from Table 2b. From this, one can estimate the total takes for the eastern GOM in season 2 of 2006 as (836.6 * 0.31 + 142.4)/ (1+0.31) = 307.0 from the RFOP and SBLOP specific values by strata in Table 6. The sum over all strata are provided in Tables 5 and 6.

For the period of July 2006-2008 we estimated the total number of interactions of the Gulf of Mexico reef fish fishery with hardshell turtles as 861.3 (95% CI 383.5 – 1934.3, Table 6). If we assume the death rate is constant over time and base our estimates of that rate on the Final Disposition field in Appendix B, we estimate 410 turtles were released alive, 246 were released dead or unresponsive, and the status at release was unknown for 205. Future research will address this assumption of the constant death rate.

Potential bias and unquantified uncertainty in the extrapolated takes

Unallocated effort (effort that could not be clearly allocated to either the directed shark or the reef fish fisheries, Figure 1) creates a small underestimate in total takes in either this fishery or the commercial directed shark bottom longline fishery on the order of 2.6% for 2006, and 0.5% for 2007, depending upon how this effort is allocated. Unquantified uncertainty exists in the allocation itself, that is, the application of our 2/3 landings by weight rule. If the rule were changed it could affect the estimate in this report by a large amount, but whatever that percent increase or decrease in total effort allocation, it would be represented as a decrease or increase in the commercial shark bottom longline fishery, and these potential changes are not necessarily linear. The relatively small number of total observed takes in the reef fish fishery (18 from the SBLOP and RFOP, Table 1), and the lack of observed takes in some strata, are another cause for concern about the accuracy of the estimates. We could not determine the direction of potential bias due to unobserved strata or sparse data associated with relatively low sampling effort for the two fisheries (reef fish fishery and directed shark fishery). Relatively low observer coverage (Table 4) coupled with the small magnitude of coverage, such as a single trip observed in season 1 of 2008 by the RFOP in a strata with relatively large effort is problematic. Increased observer effort at any level would improve our confidence in the estimates. To obtain observer effort at an expected take level of 5 sea turtles or more per strata, based on observed rates in this report, might require an increase in observer effort of at least 3 to 5 times 2007 effort, or about a 3% to 5% observer coverage. Ideally, expansion factors such as the unit effort used in analysis (hooks in this case) or some proxy for this effort (such as set) should be also used for the randomized selection procedure. However, both the RFOP and SBLOP programs used vessel as the selection unit (see Hale and Carlson 2007, for similar methods for the shark directed portion of the SBLOP). This is very different than randomized selection based on effort as is used in other longline observer programs (see Beerkircher et al 2004 for description of the SEFSC pelagic observer program) and subsequent extrapolation (see Walsh and Garrison 2006 for an example).

Overall, we are fairly confident that our estimated confidence intervals encompass the true take estimate for this fishery. The width of the confidence intervals was large (about 180% of the midpoint estimate) which shows little precision in our midpoint estimate and we recommend caution to users of this information. Take estimates for the same fishery can vary considerably due to observed annual variation in takes and to variation in the data itself. For example, in this report we estimate a total take of 861.3 hardshell turtles by this fishery for a two and a half year period (July 2006-2008), or roughly 344 turtles per year, but an earlier estimate for the first year and a half (July 2006-2007) was of a total take of 902.4 hardshell turtles, or 602 per year (SEFSC 2008). This estimate of number of takes per year (344 vs 602) changed due to changes to reported effort in the FLS logbook and observed effort in the RFOP, and the lack of observed takes in 2008 in the sampled portion of the fishery. The logbook effort changes result from a slight decrease in 2006 effort, presumably due to quality control and editing of the database, removal of duplicates, etc., and an increase in effort in 2007 presumably due to additional logbook forms being submitted to the SEFSC. The increase in observer effort for 2006 and 2007 from the prior report was due to additional trips being archived in the database.

The lack of observed takes in 2008 was based on a very low sample size. Compared to 2007, the RFOP had observer coverage reduced by about 50% and the SBLOP was reduced by about 20%. Low or non-existent coverage levels for some strata (e.g. western GOM) would likely contribute another negative bias to our estimates. If we treated the RFEM as a representative sample and included it with the RFOP data to extrapolate to the total fishery effort, then the overall estimated take for all hardshell sea turtles during the period from July 2006 – 2008 would be 967.1 (95% CI 463.1-2,019.9) and for loggerheads would be 782.0 (95% CI 344.7-1,774.3). Also the percent of the fishery observed in 2008 Season 1 for the eastern GOM would rise to 1.38% of trips. Post-stratification of the data, such as allocation to the deep water grouper or shallow water grouper complex as a target could also be done and would affect our estimates. This is likely to be small as long as the SBLOP and the RFOP samples were not biased to over represent either target complex.

To date this report represents the best methods and assumptions that optimize our confidence in the estimates. Users need to be aware that a number of assumptions inherent to the methods used are either untested or probably are violated. The primary point we emphasize is that the estimates provided here are statistical estimates with large uncertainty, and are subject to change depending upon revisions to the data and methods used.

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Table 1: Observed takes of loggerhead and unidentified hardshell sea turtles by bottom longline trip and set in the eastern Gulf of Mexico by fishers targeting reef fish. Season 1 is January to June and Season 2 is July to 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. See Appendix B for more information on each turtle.

Year	Season	Trip	Set Id.	Hooks	Species	Number	Program
2006	2	1	1	2077	Caretta caretta	1	SBLOP
2006	2	1	5	1815	Caretta caretta	1	SBLOP
2006	2	1	6	754	Caretta caretta	1	SBLOP
2006	2	1	11	1981	Caretta caretta	1	SBLOP
2006	2	1	17	1929	Caretta caretta	2	SBLOP
2006	2	1	21	1964	Caretta caretta	1	SBLOP
2006	2	2	5	1500	Caretta caretta	1	RFOP
2006	2	3	1	1400	Caretta caretta	1	RFOP
2006	2	3	1	1400	Unidentified Hardshell	1	RFOP
2007	1	4	1	2400	Caretta caretta	1	RFOP
2007	1	5	4	2500	Caretta caretta	1	RFOP
2007	1	5	5	2500	Caretta caretta	1	RFOP
2007	1	5	16	2500	Caretta caretta	1	RFOP
2007	2	6	8	1475	Caretta caretta	1	RFOP
2007	2	6	15	1475	Caretta caretta	1	RFOP
2007	2	7	7	650	Unidentified Hardshell	1	RFOP
2007	2	8	3	1100	Caretta caretta	1	SBLOP
2008	1	9	43	800	Caretta caretta	1	RFEM
2008	1	9	49	800	Caretta caretta	1	RFEM
2008	1	10	13	700	Unidentified Hardshell	1	RFEM

Table 2(a-c): Reported effort in trips, sets, and hooks from the Southeast Fisheries Science Center's Fisheries Logbook System for fishing vessels that reported using bottom longline gear, and either did not have a commercial directed shark permit or had a commercial directed shark permit and landed at least 2/3 by weight of species other than sharks. Season 1 was January through June and Season 2 was July through December. GOM is Gulf of Mexico, divided into east and west strata at 88 degrees W longitude. Effort from the reef fish electronic monitoring special project was removed. See Appendix A for uncombined effort categories and see text for more details.

2a. Reported trips

| Year – Season | GOM East | | GOM West | |
	Shark Permit	No Shark Permit	Shark Permit	No Shark Permit
2006-2	210	336	17	56
2007-1	289	363	11	55
2007-2	209	279	0	3
2008-1	244	335[1]	*	54
2008-2	153	270	0	6

2b. Reported sets

| Year - Season | GOM East | | GOM West | |
	Shark Permit	No Shark Permit	Shark Permit	No Shark Permit
2006-2	3,730	8,270	227	650
2007-1	5,504	7,544	342	1,391
2007-2	4,183	6,806	0	43
2008-1	4,585	7,666[1]	*	1,530
2008-2	2,698	6,417	0	148

2c. Reported hooks

| Year - Season | GOM East | | GOM West | |
	Shark Permit	No Shark Permit	Shark Permit	No Shark Permit
2006-2	5,160,988	8,499,235	340,500	771,400
2007-1	7,375,100	8,415,700	513,000	1,545,700
2007-2	5,706,590	7,993,728	0	21,500
2008-1	5,851,500	8,562,503[1]	*	1,666,850
2008-2	3,131,320	6,719,800	0	123,100

* less than 3 vessels
[1] Effort from RFEM was removed, 7 trips, 245 sets, and at least 207,575 (hook counts were not available for 2 sets).

Table 3(a-c): Observed reef fish bottom longline effort for the Gulf of Mexico (GOM) in trips, sets, and hooks from the Panama City Laboratory shark bottom longline observer program (SBLOP) and Galveston Laboratory reef fish observer program (RFOP) by year and season. The Gulf of Mexico is divided into east and west strata at 88 degrees W longitude. Observed mixed trips (shark targeted sets and grouper or tilefish targeted sets) were shown as a proportion of non-shark target sets. Season 1 was January through June, and Season 2 was July through December.

3a: Trips

		Eastern GOM		Western GOM	
Year	Season	SBLOP	RFOP	SBLOP	RFOP
2006	2	1.57	12	0	0
2007	1	5	5	0	0
2007	2	3.91	6	0	0
2008	1	4.52	1	0.48	2
2008	2	1	2	1	0

3b: Sets

		Eastern GOM		Western GOM	
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

3c: Hooks

		Eastern GOM		Western GOM	
Year	Season	SBLOP	RFOP	SBLOP	RFOP
2006	2	40,606	204,000	0	0
2007	1	113,311	112,925	0	0
2007	2	85,793	127,075	0	0
2008	1	11,7960	18,000	6,754	42,456
2008	2	22,348	34,600	19,800	0

Table 4(a-c): Percent observed of total reef fish bottom longline effort for Gulf of Mexico (GOM) in trips, sets, and hooks from the Panama City Laboratory's shark bottom longline observer program (SBLOP) and Galveston Laboratory's reef fish observer program (RFOP) by year and season. The Gulf of Mexico is divided into east and west strata at 88 degrees W longitude. Percents calculated for the RFOP from observed effort (Table 3) divided by sum of "shark permit" and "no shark permit" reported effort (Table 2) and SBLOP from observed effort (Table 3) divided by "shark permit" reported effort (Table 2), by respective strata and multiplied by 100. Season 1 was January through June, and Season 2 was July through December. The reef fish electronic monitoring special project is not included in these estimates.

4a: Percent Observed Trips

		Eastern GOM		Western GOM	
Year	Season	SBLOP	RFOP	SBLOP	RFOP
2006	2	0.75	2.20	0.0	0.0
2007	1	1.73	0.77	0.0	0.0
2007	2	1.87	1.23	-[2]	0.0
2008	1	1.85	0.17	*	3.64
2008	2	0.65	0.47	-[3,*]	0.0

4b: Percent Observed Sets

		Eastern GOM		Western GOM	
Year	Season	SBLOP	RFOP	SBLOP	RFOP
2006	2	0.72	1.68	0.0	0.0
2007	1	1.80	0.42	0.0	0.0
2007	2	1.89	1.26	-[2]	0.0
2008	1	2.09	0.12	*	3.15
2008	2	0.70	0.50	-[3,*]	0.0

4c: Percent Observed Hooks

		Eastern GOM		Western GOM	
Year	Season	SBLOP	RFOP	SBLOP	RFOP
2006	2	0.79	1.49	0.0	0.0
2007	1	1.54	0.72	0.0	0.0
2007	2	1.50	0.93	-[2]	0.0
2008	1	2.02	0.12	*	2.50
2008	2	0.71	0.35	-[3,*]	0.0

* Less than 3 vessels, but percent observed was > 0.
[2] No reported effort for this strata (see Table 2).
[3] No reported effort for this strata (see Table 2), one trip was observed (see Table 3).

Table 5. Estimated total takes of loggerhead sea turtles in the Gulf of Mexico (GOM) by year and season in the bottom longline portion of the reef fish fishery by the Panama City Laboratory shark bottom longline observer program (SBLOP), Galveston Laboratory reef fish observer program (RFOP), and reef fish electronic monitoring (RFEM). The Gulf of Mexico is divided into east and west strata at 88 degrees W longitude. Weightings determined by proportion sets allocated to the respective portions of the total effort that were sampled by an observer program (see text, and Table 2). Catch per 1000 hooks (CPUE) are provided for reference, they are total takes divided by the appropriate effort from Table 2. Season 1 was January to June, and Season 2 was July to December.

		Eastern GOM			Western GOM		
Year	Season	Takes (CPUE)	95% CI	CV	Takes	95% CI	CV
SBLOP							
2006	2	836.6 (0.162)	391.3 - 1,789.0	0.40	-	-	-
2007	1	0.0	-	-	-	-	-
2007	2	65.6 (0.012)	12.8 – 335.8	1.00	0.0	-	-
2008	1	0.0	-	-	0.0	-	-
2008	2	0.0	-	-	0.0	-	-
Sum SBLOP stratified		902.3	437.8 - 1,859.6	0.38	0.0	-	-
RFOP							
2006	2	94.9 (0.007)	27.0 – 326.3	0.71	-	-	-
2007	1	464.2 (0.030)	188.2 – 1144.5	0.49	-	-	-
2007	2	133.6 (0.010)	38.5 – 463.8	0.70	-	-	-
2008	1	0.0	-	-	0.0	-	-
2008	2	0.0	-	-	-	-	-
Sum RFOP stratified		597.8	301.5 – 1,185.5	0.36	0.0	-	-
Weighted sum of stratified estimates		712.7	296.1 – 1,715.7	0.47	0.0	-	-
RFEM							
2008	1	2	**-**	**-**	-	-	-
2.5 year sum		**714.7[4]**	**296.9 – 1,720.5**	**0.47**	0.0	-	-

[4] Also total GOM estimate because 714.7 + 0 = 714.7

Table 6. Estimated total takes of all hardshell sea turtles (loggerhead and unknown hardshell) in the Gulf of Mexico (GOM) by year and season in the bottom longline portion of the reef fish fishery by the Panama City Laboratory shark bottom longline observer program (SBLOP), Galveston Laboratory reef fish observer program (RFOP), and reef fish electronic monitoring (RFEM). The Gulf of Mexico is divided into east and west strata at 88 degrees W longitude. Weightings determined by proportion sets allocated to the respective portions of the total effort that were sampled by an observer program (see text, and Table 2). Catch per 1000 hooks (CPUE) are provided for reference, they are total takes divided by the appropriate effort from Table 2. Season 1 is January to June and Season 2 is July to December.

		Eastern GOM			Western GOM		
Year	Season	Takes (CPUE)	95% CI	CV	Takes	95% CI	CV
SBLOP							
2006	2	836.6 (0.162)	391.3 - 1,789.0	0.40	-	-	-
2007	1	0.0	-	-	-	-	-
2007	2	65.6 (0.012)	12.8 – 335.8	1.00	0.0	-	-
2008	1	0.0	-	-	0.0	-	-
2008	2	0.0	-	-	0.0	-	-
Sum SBLOP stratified		902.3	437.8 - 1,859.6	0.38	0.0	-	-
RFOP							
2006	2	142.4 (0.010)	38.4 – 528.1	0.75	-	-	-
2007	1	464.2 (0.029)	188.2 – 1,144.5	0.49	-	-	-
2007	2	283.5 (0.021)	93.7 – 857.7	0.61	-	-	-
2008	1	0.0	-	-	0.0	-	-
2008	2	0.0	-	-	-	-	-
Sum RFOP stratified		747.6	390.1 – 1,432.7	0.34	0.0	-	-
Weighted sum of stratified estimates		858.3	382.1 – 1,927.6	0.43	0.0	-	-
RFEM							
2008	1	3	-	-	0.0	-	-
2.5 year sum		**861.3[5]**	**383.5 – 1,934.3**	**0.43**	0.0		

[5] Also total GOM estimate because 861.3 + 0 = 861.3

Figure 1: Allocation of bottom longline trips based on the 2/3 landings by weight rule to "shark directed", "mixed", "other with directed shark permit", and "other". Both "other" categories comprise what we assume is the reef fish fishery.

1a: 2006 bottom longline trips

"shark directed with shark permit" (26.4%)

"other" (45.9%)

"mixed with shark permit" 2.2%

"other with shark permit" (25.5%)
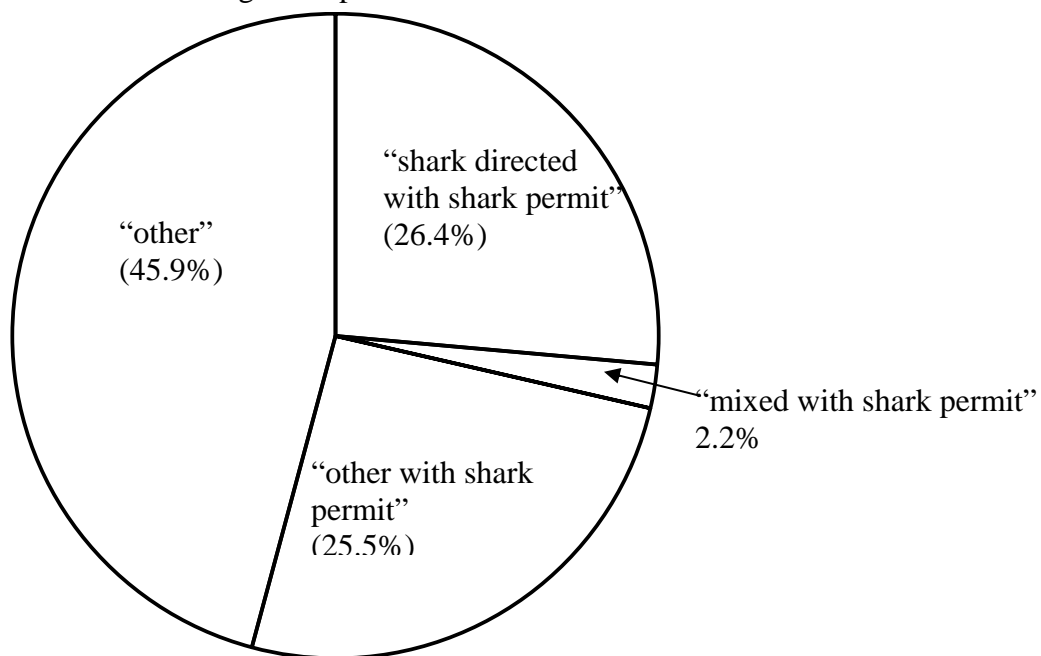
1b: 2007 bottom longline trips.

"shark directed with shark permit" 11.2%

"mixed with shark permit" (0.5%)

"other" 51.4%

"other with shark permit" 37.0%

Figure 2: Sea turtle take locations by year in the Gulf of Mexico observed in bottom longline reef fish sets. Depth contours shown in meters; 20 fathoms is 36.6 m and would lie between the 30 m and 40 m c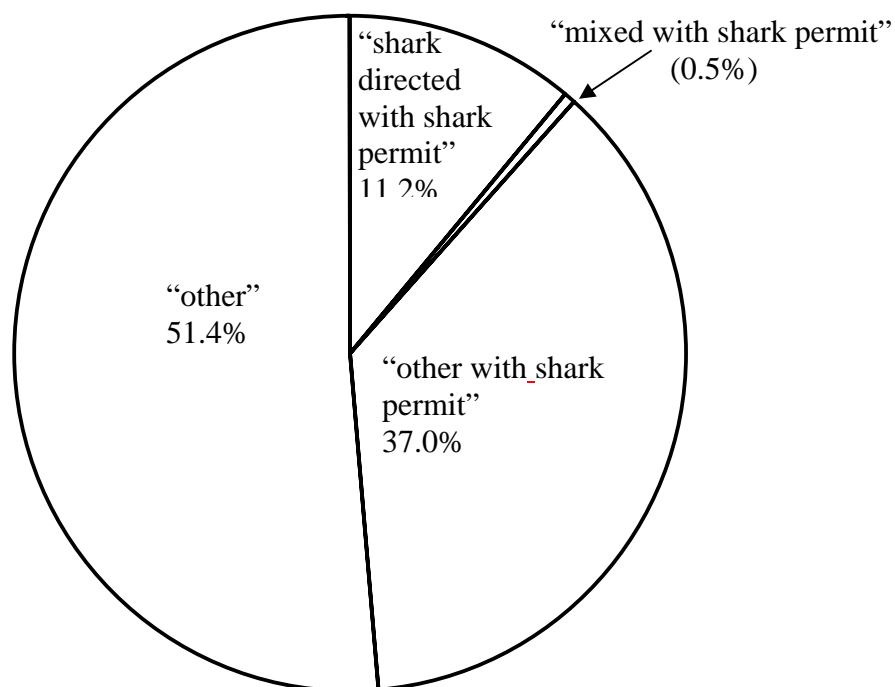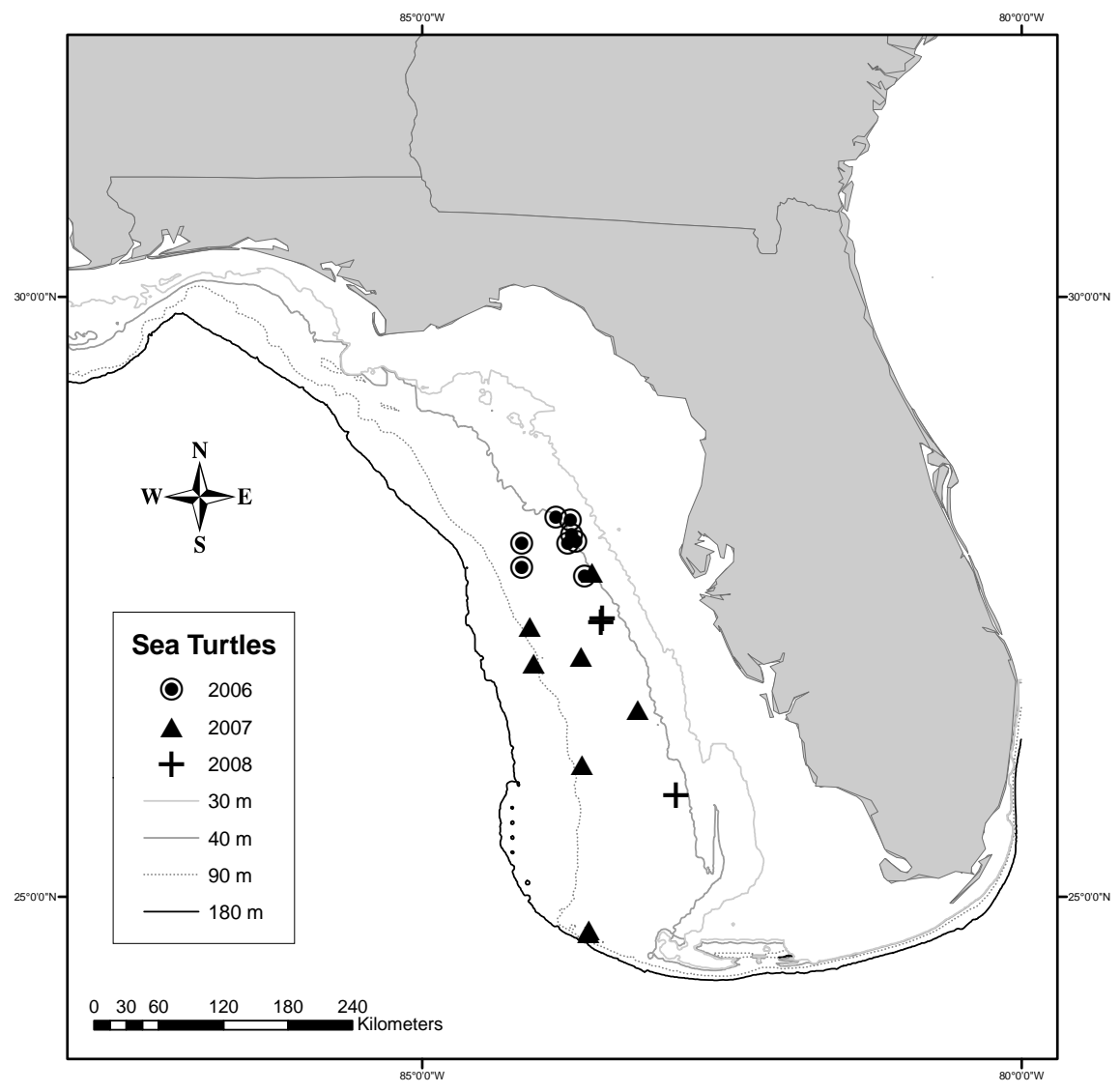ontour lines, 50 fathoms is 91.4 m, and 100 fathoms is 182.9 m. Figure includes the three sea turtle takes from the reef fish electronic monitoring special project in 2008.

Appendix A: Bottom longline effort from the SEFSC coastal logbook, categorized to target by 2/3 landings rule (see text). Reef fish electronic monitoring special project effort was removed[1].

Year	subregion	target	permit	season	shark season	trips	sets	hooks
2006	east	other	0	1	Closed	209	4,795	4,901,830
2006	east	other	0	1	open1	272	4,872	5,077,053
2006	east	shark	0	1	open1	8	9	11,800
2006	east	mixed	1	1	Closed	3	6	4,100
2006	east	mixed	1	1	open1	12	175	205,300
2006	east	other	1	1	Closed	132	2,552	3,229,590
2006	east	other	1	1	open1	156*	2,356*	3,061,696*
2006	east	shark	1	1	Closed			
2006	east	shark	1	1	open1	167*	484*	331,110*
2006	east	mixed	0	2	Closed			
2006	east	other	0	2	Closed	166	4,313	4,329,155
2006	east	other	0	2	open2	48	1,264	1,211,380
2006	east	other	0	2	open3	115	2,666	2,939,170
2006	east	shark	0	2	open2	4*	11*	10,180*
2006	east	shark	0	2	open3	*	*	*
2006	east	mixed	1	2	Closed			
2006	east	mixed	1	2	open2	8	156	178,000
2006	east	mixed	1	2	open3	20	350	482,700
2006	east	other	1	2	Closed	130	2,239	2,964,100
2006	east	other	1	2	open2	20	362	542,450
2006	east	other	1	2	open3	60	1,129	1,654,438
2006	east	shark	1	2	Closed	4	19	7,400
2006	east	shark	1	2	open2	114	310	256,906
2006	east	shark	1	2	open3	117	376	280,890
2006	west	other	0	1	Closed	44	918	1,129,000
2006	west	other	0	1	open1	53	868	1,076,300
2006	west	other	1	1	Closed	15	416	579,000
2006	west	other	1	1	open1	18	381	556,900
2006	west	shark	1	1	Closed	3	11	8,400
2006	west	shark	1	1	open1	64	112	90,200
2006	west	other	0	2	Closed	32	346	446,000
2006	west	other	0	2	open2	12	167	215,900
2006	west	other	0	2	open3	12*	137*	109,500*
2006	west	mixed	1	2	Closed	*	*	*
2006	west	mixed	1	2	open2			
2006	west	other	1	2	Closed	5*	75*	112,500*
2006	west	other	1	2	open2			
2006	west	other	1	2	open3	11*	137*	205,500*
2006	west	shark	1	2	Closed			
2006	west	shark	1	2	open2	35	109	84,300
2006	west	shark	1	2	open3	60*	154*	109,500*
2007	east	mixed	0	1	open1			
2007	east	other	0	1	Closed	330	6,926	7,733,910
2007	east	other	0	1	open1	32	610	680,830

* less than 3 vessels

Appendix A continued:

year	subregion	target	permit	season	shark season	trips	sets	hooks
2007	east	mixed	1	1	Closed	*	*	*
2007	east	mixed	1	1	open1	*	*	*
2007	east	other	1	1	Closed	274	5,255	7,019,700
2007	east	other	1	1	open1	15	249	355,400
2007	east	shark	1	1	open1	35*	74*	51,180*
2007	east	mixed	0	2	open2			
2007	east	other	0	2	Closed	235	5,812	6,810,428
2007	east	other	0	2	open2	43*	992*	1,179,900*
2007	east	mixed	1	2	Closed			
2007	east	mixed	1	2	open2	3	73	105,040
2007	east	other	1	2	Closed	193	3,788	5,135,090
2007	east	other	1	2	open2	16	395	571,500
2007	east	shark	1	2	Closed	15	42	29,090
2007	east	shark	1	2	open2	66	219	171,190
2007	west	other	0	1	Closed	53*	1,296*	1,424,200*
2007	west	other	0	1	open1			
2007	west	other	1	1	Closed	11*	342*	513,000*
2007	west	shark	1	1	Closed			
2007	west	shark	1	1	open1	9	16	8,700
2007	west	other	0	2	Closed	3*	43*	21,500*
2007	west	shark	1	2	Closed			
2007	west	shark	1	2	open2	21	39	24,300
2008	east	other	0	1	Closed	335[1]	7,666[1]	8,562,503[1]
2008	east	other	1	1	Closed	244	4,585	5,851,500
2008	east	other	0	2	Closed	38	1,110	1,246,000
2008	east	other	0	2	open1	232	5,307	5,473,800
2008	east	mixed	1	2	open1	4	61	28,920
2008	east	other	1	2	Closed	21	468	608,650
2008	east	other	1	2	open1	132	2,230	2,522,670
2008	east	shark	1	2	open1	58	123	55,670
2008	west	other	0	1	Closed	54*	1,530*	1,666,850*
2008	west	other	1	1	Closed			
2008	west	other	0	2	open1	6	148	123,100
2008	west	shark	1	2	open1	60	63	23,500

* less than 3 vessels
[1] Effort from RFEM was removed, 7 trips, 245 sets, and at least 207,575 (hook counts were not available for 2 sets).

Appendix B: Supplementary Gulf of Mexico non-directed shark bottom longline sea turtle captures from 2006 and 2007, information from the Sea Turtle Life History HMS Database. The table is split and rows are identified by record number. Reef fish electronic monitoring special project captures are record numbers 19-21

Record Number	year	Season	Species	Capture Condition	Hook Type	Offset (degrees)	Bait	Bait Size (g)
1	2006	2	Caretta caretta	comatose, not successfully resuscitated	13/0 Circle	0	Squid	Unknown
2	2006	2	Caretta caretta	fresh dead	13/0 Circle	0	Squid	Unknown
3	2006	2	Caretta caretta	comatose, not successfully resuscitated	13/0 Circle	0	Squid	Unknown
4	2006	2	Caretta caretta	comatose, successfully resuscitated	13/0 Circle	0	Squid	Unknown
5	2006	2	Caretta caretta	comatose, unknown	13/0 Circle	0	Squid	Unknown
6	2006	2	Caretta caretta	comatose, not successfully resuscitated	13/0 Circle	0	Squid	Unknown
7	2006	2	Caretta caretta	unknown	13/0 Circle	0	Squid	Unknown
8	2006	2	Caretta caretta	alive, injured	13/0 Circle	0	Unknown	Unknown
9	2006	2	Caretta caretta	alive, injured	14/0 Circle	Unknown	Unknown	Unknown
10	2006	2	Unidentified Hardshell	alive, injured	14/0 Circle	Unknown	Unknown	Unknown
11	2007	1	Caretta caretta	alive, injured	14/0 Circle	0	Mackerel	Unknown
12	2007	1	Caretta caretta	unknown	14/0 Circle	10	Unknown	Unknown
13	2007	1	Caretta caretta	comatose, not successfully resuscitated	14/0 Circle	10	Unknown	Unknown
14	2007	1	Caretta caretta	alive, injured	14/0 Circle	10	Unknown	Unknown
15	2007	2	Caretta caretta	alive, injured	14/0 Circle	Unknown	Skate	Unknown
16	2007	2	Caretta caretta	comatose, not successfully resuscitated	14/0 Circle	Unknown	Unknown	Unknown
17	2007	2	Unidentified Hardshell	unknown	13/0 Circle	0	Unknown	Unknown
18	2007	2	Caretta caretta	alive, injured	14/0 Circle	0	Shark	100
19	2008	1	Caretta caretta	alive, injured	14/0 Circle	unknown	Bonefish/ squid/shad	Unknown
20	2008	1	Caretta caretta	alive, injured	14/0 Circle	unknown	Bonefish/ squid	Unknown
21	2008	1	Unidentified hardshell	unknown, injured	6/0 Circle	5	unknown	Unknown

Appendix B continued:

Record Number	Final Disposition	Hook Location	Hook Removed?	Entangled Capture?	Entangled Release?	Line Left (ft)	CL Est. (ft)	CCL (cm)	SCL N-N (cm)
1	discarded marked dead/unresponsive carcass	roof of mouth	Yes	No	No	0.00		61	
2	discarded unmarked dead/unresponsive carcass	side jaw joint	No	No	No	1.00			
3	discarded marked dead/unresponsive carcass	beak (internal)/mouth, unknown	No	No	No	0.20		80.5	
4	released alive	side jaw joint	No	No	No	0.50		74	
5	unknown	roof of mouth	No	No	No	0.50		73	
6	discarded marked dead/unresponsive carcass	side jaw joint	No	No	No	0.50			
7	Unknown	side jaw joint	No	No	No	2.00	4.00		
8	released alive	beak (internal)/mouth, unknown AND front flipper	No (mouth)/ Yes (flipper)	Unknown	Unknown	0.00			
9	released alive	beak (internal)/mouth, unknown	No	No	No	0.00			
10	released alive	beak (internal)/mouth, unknown	No	Unknown	No	0.50			
11	released alive	beak external, upper	No	No	No	0.50	3.50		
12	unknown	unknown location	No	No	No	2.00	4.00		
13	discarded unmarked dead/unresponsive carcass	beak internal, lower jaw	Yes	No	No	0.00	4.00		
14	released alive	unknown location	No	No	No	4.00	4.00		
15	released alive	side jaw joint	Unknown	No	No	0.00		93.4	
16	discarded marked dead/unresponsive carcass	roof of mouth	Yes	No	No	0.00		77	
17	unknown	not known if hooked	Unknown	Unknown	Unknown	1.00	3.00		
18	released alive	front flipper	Yes	No	No	0.00	5.00		
19	released alive	front flipper	yes	no	no	0	3.5		
20	released alive	mouth, side	yes	no	no	0			
21	unknown	unknown	no	unknown	unknown	3			