Estimated Bycatch of Marine Mammals and Sea Turtles in the U.S. Atlantic Pelagic Longline Fleet During 2018

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Abstract

The U.S. Atlantic Pelagic Longline fleet operates throughout the western North Atlantic Ocean, including along the U.S. coast from the Gulf of Mexico to New England, the waters of the Caribbean, and in international waters of the North Atlantic Ocean. The Atlantic longline fleet is defined as a Category I fishery under the Marine Mammal Protection Act, and it is also the subject of management under the Endangered Species Act due to interactions with leatherback (*Dermochelys coriacea*) and loggerhead (*Caretta caretta*) turtles. Total bycatch of marine mammals and turtles in the longline fishery was estimated for 2017 using data from the pelagic longline fishery observer program and a mandatory fishery logbook reporting program. We applied a delta-lognormal approach to estimate region specific and total annual interactions with protected species in the fishery. During 2018, there were an estimated 120.0 (69.8 – 206.2 [95% CI]) interactions with leatherback turtles and 61.0 (32.3 – 115.3 [95% CI]) interactions with loggerhead turtles. The primary marine mammals interacting with this fishery were pilot whales (*Globicephala* sp.) in western North Atlantic waters. Interactions were apportioned between short-finned and long-finned pilot whales based upon location and environmental parameters. The majority of interactions were with short-finned pilot whales with an estimated 102.2 (48.9 – 13.81 [95% CI]) interactions resulting in serious injury. Potential sources of bias and uncertainty in these bycatch estimates are discussed.

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Introduction

Pelagic longline fisheries operate throughout the world's oceans targeting large pelagic fish including swordfish, tunas, and sharks. The U.S. Atlantic Pelagic Longline fleet operates throughout the western North Atlantic Ocean, along the U.S. coast from the Gulf of Mexico to New England, the waters of the Caribbean, and in international waters of the North Atlantic Ocean (Figure 1). The Atlantic longline fleet is defined as a Category I fishery under the Marine Mammal Protection Act (50 CFR Part 229, Federal Register Vol. 69, No. 135, 15 July 2003) due to frequently documented interactions with marine mammals.

The fishery is also the subject of management under the Endangered Species Act (ESA) due to frequent interactions with marine turtles including leatherback (*Dermochelys coriacea*) and loggerhead sea turtles (*Caretta caretta*). In June 2004, a Biological Opinion was issued by the National Marine Fisheries Service, Southeast Regional Office, finding that the U.S. Pelagic Longline Fleet posed a jeopardy to leatherback turtles in the Atlantic Ocean as defined under the ESA. To allow continued operation of the fishery, the Biological Opinion mandated increased reporting of bycatch, required education and outreach programs to train fishers in careful handling and release of turtles, and instituted large-scale changes in fishing gear. Most notably, the fishery was required to exclusively use "circle" hooks (size 16/0 or greater) and to adopt safe handling and release practices for sea turtles after August 2004. These mandates were based upon expected reductions in bycatch rate due to hook shape and size demonstrated by experimental studies conducted in the Northeast Distant Water (NED) fishing area and

an expected reduction in post-release mortality by using the handling and release protocols (Watson *et al.*, 2005).

In addition, several time-area closures were introduced into the fishery in 2000 and 2001 due to concerns over both finfish and protected species bycatch (NMFS 2003, 50 CFR Part 635). These include year-round closures near the De Soto Canyon in the Gulf of Mexico after 1 November 2000 (Figure 1, Label A) and in waters off the Atlantic coast of Florida after 1 March 2001 (Figure 1, Label B). Seasonal closures are in effect in the Charleston Bump region between 1 February and 30 April (Figure 1, Label C) and in a bluefin tuna area off the New Jersey coast between 1 June and 30 June (Figure 1, Label D). The NED area was closed to non-experimental longline fishing from 2001 to 2004 in response to high turtle bycatch. However, with the implementation of gear changes, it was reopened to fishing in June 2004.

In late 2009, regulations were implemented in the fishery to reduce the serious injury and mortality of pilot whales and Risso's dolphins in the Mid-Atlantic Bight region. The Pelagic Longline Take Reduction Plan (PLTRP) was developed based upon consensus recommendations of a team of scientists, managers, and commercial fisheries organizations per the Take Reduction Team process under the MMPA. Regulations were effective on 18 June, 2009 and include restriction of mainline lengths to less than 20 nautical miles in the Mid-Atlantic Bight area and mandatory reporting requirements for fishermen operating in waters offshore of Cape Hatteras, North Carolina (50 CFR Part 229, Federal Register Vol. 74, No. 95, 18 May 2009).

The pelagic longline fishery has had a fishery observer program (Pelagic Observer Program, POP) in place since 1992 to document finfish bycatch, characterize

fishery behavior, and quantify the interactions with protected species (Beerkircher *et al.*, 2004). In addition, a mandatory fishery logbook system (FLS) has been in place since 1992 requiring vessel captains to report fishing effort, gear characteristics, and commercial catch. These data have been used to generate annual estimates of marine mammal and turtle bycatch (Johnson *et al.*, 1999; Yeung, 1999a; Yeung 1999b; Yeung, 2001; Garrison 2003; Garrison and Richards, 2004; Garrison 2005; Fairfield-Walsh and Garrison, 2006, 2007, 2008; Garrison, Stokes, and Fairfield 2009; Garrison and Stokes, 2010, 2012a, 2012b, 2013, 2014, 2016, 2017, 2019, 2020).

In this report, marine mammal and marine turtle bycatch estimates are calculated for pelagic longline fishery effort during 2018. Bycatch rates (catch per 1000 hooks) are quantified based upon observer data by fishing area and quarter. The estimated bycatch rate is then multiplied by the total fishing effort (number of hooks) reported to the FLS program to obtain estimates of total interactions for each species of marine mammal and turtle.

Methodology

Geographic Stratification

Fishery observer effort is currently allocated among 11 large geographic areas and calendar quarter based upon the historical fishing range of the fleet (Figure 1). The target annual coverage is 8% of the total reported hooks, and observer effort is allocated randomly based upon reported fishing effort during the previous calendar year in each quarter/fishing area stratum (Beerkircher *et al.*, 2004).

Bycatch rates for quarter-area strata with more than 10 reported longline fishery sets that had no corresponding observer coverage in 2018 were replaced with previously

observed mean bycatch rates from 2013-2017. There were both marine mammal and sea turtle interactions observed in these "missing" cells in prior years.

The Magnuson-Stevens Fishery Conservation and Management Act places restrictions on reporting fishery information including that collected by observers. NMFS rules therefore restrict the reporting of business information within temporal or spatial strata including fewer than 3 vessels. Business information includes information on the fishing gear or level of effort. As such, the number of sets and hooks cannot be reported in some quarter-area strata in reported effort data, observer data, or both. In cases where by simple calculation one could derive the level of effort in such cells, we have not reported sufficient information to make those calculations. Quarter-area strata where the level of reporting is limited by confidentiality concerns are noted in the appropriate tables.

Delta Lognormal Estimator

Sets in which a portion of the longline broke away, and therefore had multiple recorded haul times, were combined into single sets. This is consistent with the approach of prior estimates (Garrison, 2003; Garrison and Richards, 2004; Garrison, 2005; Fairfield-Walsh and Garrison, 2006; Fairfield-Walsh and Garrison, 2007; Fairfield and Garrison, 2008 Garrison, Stokes, and Fairfield 2009; Garrison and Stokes, 2010, 2012a, 2012b, 2013, 2014, 2016, 2017, 2019, 2020). The mean and variance of catch rates for marine mammals and turtles observed in longline sets were calculated using a delta lognormal estimator (Pennington, 1983). The delta estimator is more appropriate than the simple mean because catch rates are generally log-normally distributed and bycatch

events (i.e., positive sets) are rare. The unit of effort in this analysis is the number of hooks, consistent with methods used to estimate total catch and bycatch of finfish and previous analyses of protected resource interactions (Johnson *et al.*, 1999). The mean bycatch rate for each analytical stratum, t, is calculated as:

$$(1) \quad C_t = \frac{m_t}{n_t} e^{L_t} G\left(s_{L_t}^2/2\right),$$

where:

m_t is the number of sets with observed bycatch,

n_t is the total number of observed sets,

L_t is the mean of the log-transformed number of animals taken per 1000 hooks when bycatch occurred,

s_L^2 is the observed sample variance of the log transformed bycatch rate, and G is the cumulative probability function from the Poisson distribution given as:

$$(2) \quad G\left(s_L^2/2\right) = 1 + \frac{m_t - 1}{m_t}\left(s_L^2/2\right) + \sum_{j=2}^{\infty} \frac{\left(m_t - 1\right)^{2j-1}}{m_t^j \left(m_t + 1\right)\left(m_t + 3\right)....\left(m_t + 2j - 3\right)} \times \frac{\left(s_L^2/2\right)^j}{j!}.$$

The series was computed numerically over j terms until meeting a convergence criterion of a change in the function value of < 0.0001 with additional terms (j). Convergence was generally achieved with <10 terms. The variance of the delta estimator is:

$$(3) \quad \mathrm{var}(C_t) = \frac{m_t}{n_t}\left(e^{2L_t}\right)\left[\frac{m_t}{n_t} G^2\left(s_L^2/2\right) - \left(\frac{m_t - 1}{n_t - 1}\right) G\left(\frac{m-2}{m-1} s_L^2\right)\right].$$

When m_t is equal to 1, the mean bycatch rate reduces to the simple mean rate where

$$(4) \quad C_t = \frac{\exp(L_t)}{n_t},$$

and

$$(5)\ \ \mathrm{var}(C_t) = \left(\frac{\exp(L_t)}{n_t} \right)^2 .$$

The C_t calculated above gives the mean number of animals caught per 1000 hooks in the observed trips. To estimate total interactions, *N*, these rates are multiplied by the total number of hooks reported to the FLS database for each analytical stratum. The stratified estimates and associated variances were summed to provide annual estimates for each species. Approximate 95% confidence intervals (95% CI) were calculated assuming log-normal distribution of total mortality as *N/C* and *N·C* for the lower and upper confidence bounds respectively where:

$$(6) \qquad \mathrm{C} = \exp\left[\ z_{\alpha} \sqrt{\mathrm{var}(\ln \mathrm{N})} \ \right] ,$$

and

$$(7)\ \mathrm{var}(\ln \mathrm{N}) = \ln\left[1 + \mathrm{var}(\mathrm{N}) / \mathrm{N}^2 \ \right] ,$$

where z_{α} is 1.96, the z score for $\alpha = 0.05$.

Sea Turtle Life History Form

Detailed information on the characteristics of longline interactions with sea turtles was recorded by the fisheries observers during 2018. These data include detailed descriptions of the type of interaction, the extent of entanglement, the location of any hook attached to the animal or swallowed, and other data (Appendix A). Detailed information on entanglement, hooked animals, and the location of hooks are shown in Appendix B.

Marine Mammal Serious Injury Determination

The Marine Mammal Protection Act (MMPA) requires that mortality and serious injury of marine mammals incidental to commercial fishing operations be reduced to a level approaching a zero mortality rate. "Serious injury" has been defined as an injury more likely than not to result in mortality (NOAA Fisheries 50 CFR 229.2, Angliss and DeMaster, 1998). In prior annual reports, serious injury determinations were based upon criteria developed during a workshop of NOAA Fisheries and external experts convened in 1997 (Angliss and DeMaster, 1998). These guidelines were reviewed at a workshop conducted during 2007, and a proposed revision of the criteria for serious injuries in pinnipeds, large whales, and small cetaceans was developed (Andersen et al. 2008). This proposal was reviewed and evaluated by NMFS, and a policy for determining serious vs. non-serious injury in marine mammals with associated criteria was established in 2012 (NMFS 2012a, NMFS 2012b). Observer comments for all takes of marine mammals from 2018 (Appendix B) were reviewed, and serious injury determinations were made on a case by case basis based upon observer comments and photographs (when available) consistent with the 2012 guidelines.

Some observed interactions were scored as "Could Not Be Determined" (CBD) based upon the serious injury criteria. These include two types of cases. First, are those cases where the observer was unable to record sufficient information to allow a definitive determination. These include cases where the animal was involved with the gear in some way, but the observer recorded that it was "unknown if hooked or entangled." Second, are those cases where the animal was released from the gear; however, the duration of

time it was involved in the gear or behavioral indicators (e.g., slow swimming, tail slaps, etc.) indicate the possibility that the animal was in distress. Details for each case and the associated score are noted in Appendix B. For observations where the determination was CBD, these cases were apportioned between serious and non-serious injury based upon the proportion of observed cases for that species since 2011 (the year the serious injury guidelines were revised) that were scored as serious injuries. These apportioned cases were therefore split between "serious injury" and "released alive" in the estimation of total bycatch based on past data.

Apportioning Pilot Whale Takes Between Species

Two species of pilot whales, short-finned and long-finned, occur within the MAB and NEC regions and are difficult to reliably identify at sea based upon visual observations. Therefore, nearly all of the observations of pilot whale interactions by observers have been assigned to "Unidentified Pilot Whales" (*Globicephala sp.*). The region of overlap between the two species is thought to occur between 38-40ºN latitude along the shelf break during warm months of the year. In the past decade, there have been very few interactions observed north of 38.5ºN. Available data from studies directed at understanding the relative distribution of the two species based upon genetic and photo-identification data demonstrated that long-finned pilot whales did not occur this far south, and therefore all pilot whale takes were presumed to be from short-finned pilot whales. However, during 2018, there were several interactions in the northern part of the MAB where overlap between the species is possible, and therefore it was unclear

whether or not these takes could be reliably assigned to short-finned vs. long-finned pilot whales.

There have been 542 biopsy skin samples collected from pilot whales in the MAB and NEC regions between 1989-2014 from both directed field studies and fisheries bycatch. This included 10 genetic identifications of samples collected from the pelagic longline fishery from 2009-2014. These samples have been analyzed genetically and identified to species. All of the samples collected from the pelagic longline fishery have to date been identified as short-finned pilot whales. A logistic regression model was used to estimate the probability that an observed pilot whale was a short-finned vs. long-finned pilot whale based upon the location and sea surface temperature at the time of the sample collection. The model used samples that were collected during May-November, as these were most representative of the period when pilot whale bycatch in the pelagic longline fishery is observed. The resulting model indicated that at water temperatures above 22ºC and latitudes south of 39ºN, the probability of a sample coming from a short-finned pilot whale exceeds 80% (see Garrison and Rosel, 2016 for additional detail).

Of the 10 observed pilot whale interactions during 2018, all had a greater than 95% probability of being from short-finned pilot whales. For all observed unidentified pilot whales, the predicted probability of it being short-finned vs. long-finned was used to apportion the estimated bycatch between the two species. Due to the very low probability of the observed takes being from long-finned pilot whales, the estimated bycatch of this species was very low compared to that for short-finned pilot whales.

Results and Discussion

Reported Fishing Effort and Observer Coverage

The total reported pelagic longline fishing effort included 4.0 million hooks during 2018 (Table 1A, Figure 2). The reported fishery effort included 5,634 sets during 2018, 731 of which were observed by the POP program (Tables 1B and 2B, Figure 2). The overall percent coverage during regular fishing was 13.3% expressed as a proportion of reported hooks and 13.0% as a proportion of reported sets (Table 3). The relatively high annual rate reflects the high coverage of the fishery during the first and second quarter in the MAB. Observer coverage for other area-quarter strata is shown in Table 3.

Areas with no observer coverage during 2018 with more than 10 sets of reported fishing effort include the CAR during quarter 2 and the Tuna North (TUN) during Quarters 1-3 (Table 3).

Observed Protected Species Interactions

There were 19 observed interactions with leatherback turtles, 9 with loggerhead turtles, and 1 green turtle (Table 4, Figure 3) in 2018. The greatest number of observed leatherback takes occurred in the NED during Quarter 3 and the GOM during Quarter 1 and 3 (Table 4A, Figure 3). Loggerhead takes were observed in the greatest numbers in the FEC during Quarter 2, NED during Quarter 3, and SAB Quarter 4 (Table 4B, Figure 3).

The vast majority of the turtles were characterized as being released alive and injured (i.e., most had been hooked) based upon recorded information on the sea turtle life history form (Table 5). Leatherback turtles were most typically hooked externally,

while loggerhead turtles were hooked in the mouth or beak or had swallowed the hook (Table 5). All gear was removed before release from 13 of the 29 turtles captured (Table 6). A total of 3 leatherbacks were released either entangled or with the hook and line remaining that was > ½ the carapace length (Table 6).

There were 16 interactions observed with marine mammals (Table 7, Figure 4). This included 10 interactions with pilot whales, and none of these were sampled to allow direct identification to species (Table 8). Ten of the observed marine mammal interactions were categorized as serious injuries including 6 pilot whales (Table 9). Three of the serious injuries were due to animals being hooked in the mouth/head, and 7 case involved being released with gear likely to further entangle the animal (Table 9). There were 3 cases where a determination could not be made, and the interaction was therefore pro-rated based on historical serious injury rates. Observer comments used in serious injury determinations are summarized in Appendix B.

Stratum estimates of total interactions for sea turtles are shown in Table 10. High numbers of leatherback interactions occurred particularly in the SAR during Quarter 1 (13.1), NED during Quarter 3 (23.1), in the MAB in Quarter 2 (15.4) and Quarter 4 (18.4), and the GOM in Quarter 3 (14.1, Table 10). For loggerhead turtles, the estimated interactions were highest in the SAB in Quarter 4 (17.0) and SAR in Quarter 1 (12.4, Table 10).

The quarter-area strata estimates for observed marine mammal mortality, serious injury, and live releases are presented in Table 11. The highest level of serious injuries occurred for short-finned pilot whales in the MAB during Quarters 3 and 4.

Estimated Interactions in Unobserved Areas with Fishing Effort

The average bycatch rates and estimated catches in strata that were not observed during 2018 are summarized in Table 12. There were notable estimated sea turtle takes in prior years in several areas during Quarter 4 in the NEC for both leatherback turtles (Table 12).

Total Estimated Bycatch

There were an estimated total of 120.0 (69.8 – 206.2 [95% CI]) interactions with leatherback turtles during 2018 (Table 13). For loggerhead turtles, the estimated total number of interactions was 61.0 turtles (32.3 – 115.3 [95% CI], Table 13), and the estimate total interactions with green turtles was 16.3 (0.8 - 20.6 [95% CI], Table 13).

Annual estimates of marine mammal bycatch are shown in Table 14 with catch estimates separated among three large regions: Atlantic (FEC, SAB, MAB, and NEC), Gulf of Mexico (GOM), and Offshore (CAR, NED, SAR, and NCA). The Offshore region corresponds to regions outside of the U.S. EEZ, while Gulf and Atlantic correspond to boundaries between western North Atlantic and Gulf of Mexico stocks of the affected species. The highest number of interactions and serious injuries were with Atlantic short-finned pilot whales with a total of 51.8 (CV = 0.54) animals released alive, and 102.2 (CV = 0.39) animals seriously injured (Table 14a).

Trends in Bycatch Estimates

The leatherback take estimate reached a historical high in 2004, and prior to that had increased sharply since 1998 (Figure 5A). A significant decrease in the leatherback

bycatch rate and the annual estimated number of interactions with leatherback turtles occurred beginning in 2005 after the implementation of regulations in August 2004. The estimated take of leatherback turtles remained low and generally trended downward during 2007-2011, and then sharply increased in 2012 associated with an increase in reported fishing effort. The estimates have returned to a downward trend in recent years. Overall the total annual bycatch has been consistent since 2005.

Loggerhead turtle interactions since 2000 have been below the historical highs that occurred in the mid-1990's (Figure 5B). Following the implementation of regulations, the bycatch dropped in 2005, but rebounded to be similar to the pre-regulation period. There appears to be a cyclic pattern in loggerhead bycatch rate occurring at 4 year intervals since 1996 with a generally increasing trend over a four year period, followed by a sharp decline. This cycle continued during the 2010-2015 period. The 2014-2017 estimates remain relatively low and seem to be consistent with an overall downward trend since the late 1990's. There has been a consistent downward trend in loggerhead turtle takes since 2012.

For pilot whales (unspecified and short-finned pilot whales combined), the 2018 estimate of total catch was consistent with that from recent years, but has remained relatively constant since 2011 (Figure 6) with no apparent trend. The bycatch estimate for Risso's dolphins was very low, consistent with that since 2013 (Figure 6).

Sources of Bias and Uncertainty

The fishery logbook system is a mandatory reporting program, and thus it is expected that reporting rates are generally high. Due to the intense management focus on

the longline fishery, there has been close monitoring of reporting rates, and observed trips can be directly linked to reported effort. In general, the gear characteristics and amount of observed effort is consistent with the reported effort. However, reporting errors are possible in this fishery that would result in a bias in bycatch estimates.

Observer coverage in the pelagic longline fishery is generally high, particularly in comparison to that of other commercial fisheries. The sampling level is sufficient to provide reasonably precise estimates of interactions with protected species. The observed coefficients of variation for annual estimates of loggerhead and leatherback turtles are near or below the 30% benchmark established by guidelines for precision set by NOAA Fisheries.

The delta estimator was applied to calculate bycatch rates primarily to maintain consistency with previous estimates for this fishery (Johnson *et al.*, 1999; Yeung, 1999a; Yeung, 1999b; Yeung, 2001; Garrison, 2003; Garrison and Richards, 2004; Garrison, 2005; Fairfield-Walsh and Garrison, 2006, 2007, 2008; Garrison, Stokes, and Fairfield 2009; Garrison and Stokes, 2010, 2012a, 2012b, 2013, 2014, 2016, 2019, 2020). This approach assumes that: 1) catch rates (animals per hook) are log-normally distributed, and 2) the number of hooks is an appropriate unit of effort. The first assumption was critically examined for sea turtles in Johnson *et al.* (1999); however, it is difficult to verify for marine mammals given the generally low rate of these interactions. The delta estimator is sensitive to the assumption of log-normality, and violations of this assumption may result in biased (positive or negative) estimates of catch rate and associated variances. The second assumption has not been examined critically in previous analyses. The current approach assumes that total bycatch is linearly related to

the total number of hooks fished. If this assumption is not correct, for example if there are saturation effects resulting in a non-linear relationship between the number of hooks and total catch, then there is potentially a bias, of unknown direction and magnitude, in the estimate of total bycatch.

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categories defined in the Small Cetacean Serious Injury Guidelines (NMFS, 2012a,b). CBD indicates that the serious injury status could not be determined from available information. These observed interactions were prorated based on past observed serious injury rates.

Table 10. Estimated interactions with sea turtles in the pelagic longline fishery during 2018 by fishing area and quarter. NR indicates strata where effort cannot be reported due to confidentiality considerations.

Table 11. Estimated A) Serious Injury and B) Released Alive marine mammals in the pelagic longline fishery during 2018 by fishing area and quarter. NR indicates strata where effort cannot be reported due to confidentiality considerations. Long-finned and short-finned pilot whale estimates reflect the apportioning of observed unidentified pilot whale takes by species based upon location and environmental conditions. Interactions where serious injury status could not be determined were prorated based on past observed serious injury rates.

Table 12. Bycatch rates for sea turtles in area-quarter strata with reported effort that were not observed in 2018. NR indicates strata where effort cannot be reported for 2018 due to confidentiality restrictions.

Table 13. Total estimated interactions for A) Leatherback, B) Loggerhead and C) Green turtles in the pelagic longline fishery during 2018 by fishing area. This includes estimates for strata that were not observed during 2018.

Table 14. Total estimated interactions with marine mammals in the pelagic longline fishery during 2018.

Figure 1. Pelagic longline fishing areas in the North Atlantic Ocean: CAR = Caribbean, GOM = Gulf of Mexico, FEC = Florida East Coast, SAB = South Atlantic Bight, SAR = Sargasso Sea, MAB = Mid-Atlantic Bight, NEC = Northeast Coastal, NED = Northeast Distant, NCA = North Central Atlantic, TUN = Tuna North. Year-round closed areas in the DeSoto Canyon (A) and the Florida East Coast (B) are indicated along with seasonal closures in the Charleston Bump (C) and in the Mid-Atlantic (D).

Figure 2. Observed and reported pelagic longline fishing effort during 2018.

Figure 3. Observed pelagic longline fishing effort and sea turtle takes during 2018.

Figure 4. Observed pelagic longline fishing effort and marine mammal takes during 2018.

Figure 5. Historical trends in fishery effort and estimated marine turtle takes in the pelagic longline fishery between 1992 and 2018 for A) Leatherback Turtles, and B) Loggerhead Turtles. Errors bars represent 95% confidence intervals.

Figure 6. Historic trends in fishery effort and estimated marine mammal takes in the pelagic longline fishery from 1992 to 2018 for A) Pilot Whales and B) Risso's Dolphins. Errors bars represent 95% confidence intervals. For pilot whales, all takes are most likely of short-finned pilot whales.

Table 1. Total amount of fishing effort reported to the pelagic longline logbook program during 2018 by quarter and fishing area. Fishing effort is reported as A) Number of hooks (thousands) and B) Number of sets. NR indicates strata where effort cannot be reported due to confidentiality considerations.

A. Number of Hooks (thousands)

Quarter	CAR	FEC	GOM	MAB	NCA	NEC	NED	SAB	SAR	TUN	TUS	Total
1	NR	191.6	203.0	50.4	NR	0.0	0.0	106.0	99.8	NR	0.0	678.5
2	NR	33.2	289.6	222.0	NR	NR	NR	576.7	0.0	NR	0.0	1182.4
3	NR	40.6	415.9	462.3	0.0	49.9	91.9	125.8	0.0	NR	0.0	1249.6
4	NR	87.2	242.4	405.2	0.0	NR	11.6	121.0	NR	NR	NR	919.9
Total	57.3	352.6	1150.8	1139.9	3.0	54.1	112.5	929.5	106.9	122.0	NR	4030.4

B. Number of Sets

Quarter	CAR	FEC	GOM	MAB	NCA	NEC	NED	SAB	SAR	TUN	TUS	Total
1	NR	262	253	94	NR	0	0	147	108	NR	0	887
2	NR	51	397	374	NR	NR	NR	692	0	NR	0	1564
3	NR	67	631	725	0	55	98	216	0	NR	0	1851
4	NR	143	303	663	0	NR	13	167	NR	NR	NR	1332
Total	67	523	1584	1856	3	60	120	1222	116	82	NR	5634

Table 2. Total amount of fishing effort observed during 2018 by quarter and fishing area. Fishing effort is reported as A) Number of hooks (thousands) and B) Number of sets. Dashes indicate cells where no fishery effort was reported. NR indicates strata where effort cannot be reported due to confidentiality considerations.

A. Number of Hooks (thousands)

Quarter	CAR	FEC	GOM	MAB	NCA	NEC	NED	SAB	SAR	TUN	TUS	Total
1	0.0	33.5	90.7	1.1	0.0	-	-	8.6	7.4	0.0	-	141.3
2	0.0	1.4	66.9	22.0	0.0	NR	0.0	43.6	-	0.0	-	135.5
3	NR	6.8	53.6	35.6	-	0.0	31.0	17.5	-	0.0	-	150.4
4	NR	5.1	40.2	21.8	-	0.0	NR	16.5	0.0	NR	0.0	108.7
Total	12.7	46.7	251.4	80.5	0.0	NR	NR	86.2	7.4	NR	0.0	535.9

B. Number of Sets

Quarter	CAR	FEC	GOM	MAB	NCA	NEC	NED	SAB	SAR	TUN	TUS	Total
1	0	44	109	2	0	-	-	13	9	0	-	177
2	0	3	83	40	0	NR	0	74	-	0	-	202
3	NR	12	69	52	-	0	36	30	-	0	-	206
4	NR	8	49	46	-	0	NR	20	0	NR	0	146
Total	16	67	310	140	0	NR	NR	137	9	NR	0	731

Table 3. Percentage of reported fishing effort observed during 2018 by quarter and fishing area by A) Number of hooks and B) Number of sets. Dashes indicate no reported fishing effort. Cells in which >10 longline sets were reported with no observer coverage are indicated in bold. Totals indicate overall percentage coverage by area and quarter.

A. Number of Hooks

Quarter	CAR	FEC	GOM	MAB	NCA	NEC	NED	SAB	SAR	TUN	TUS	Total
1	0.0	17.5	44.7	2.2	0.0	-	-	8.1	7.4	**0.0**	-	20.8
2	**0.0**	4.2	23.1	9.9	0.0	48.4	0.0	7.6	-	**0.0**	-	11.5
3	17.4	16.8	12.9	7.7	-	0.0	33.7	13.9	-	**0.0**	-	12.0
4	88.4	5.8	16.6	5.4	-	0.0	39.1	13.7	0.0	39.1	0.0	11.8
Total	22.1	13.2	21.8	7.1	0.0	3.1	31.6	9.3	6.9	11.4	0.0	13.3

B. Number of Sets

Quarter	CAR	FEC	GOM	MAB	NCA	NEC	NED	SAB	SAR	TUN	TUS	Total
1	0.0	16.8	43.1	2.1	0.0	-	-	8.8	8.3	**0.0**	-	20.0
2	**0.0**	5.9	20.9	10.7	0.0	50.0	0.0	10.7	-	**0.0**	-	12.9
3	17.9	17.9	10.9	7.2	-	0.0	36.7	13.9	-	**0.0**	-	11.1
4	90.0	5.6	16.2	6.9	-	0.0	38.5	12.0	0.0	39.1	0.0	11.0
Total	23.9	12.8	19.6	7.5	0.0	7.8	11.0	3.3	34.2	11.2	0.0	13.0

Table 4. Total number of observed interactions with A) Leatherback turtles, B) Loggerhead turtles, and C) All sea turtles in the pelagic longline fishery during 2018 by quarter and fishing area. Dashes indicate areas where there was no observed fishing effort, and an X indicates an area where no effort was reported. *One green turtle interaction was observed in FEC, Quarter 1.

A. Leatherback Turtles

Quarter	CAR	FEC	GOM	MAB	NCA	NEC	NED	SAB	SAR	TUN	TUS	Total
1	-	1	3	0	-	X	X	1	1	-	X	6
2	-	0	0	1	-	0	-	0	X	-	X	1
3	0	0	2	0	X	-	8	0	X	-	X	10
4	0	0	0	1	X	-	0	1	-	0	0	2
Total	0	1	5	2	0	0	8	2	1	0	0	19

B. Loggerhead Turtles

Quarter	CAR	FEC	GOM	MAB	NCA	NEC	NED	SAB	SAR	TUN	TUS	Total
1	-	2	0	0	-	X	X	0	1	-	X	3
2	-	0	1	0	-	0	-	0	X	-	X	1
3	0	0	0	0	X	-	2	0	X	-	X	2
4	0	0	1	0	X	-	0	2	-	0	0	3
Total	0	2	2	0	0	0	2	2	1	0	0	9

C. All Turtles

Quarter	CAR	FEC	GOM	MAB	NCA	NEC	NED	SAB	SAR	TUN	TUS	Total
1	-	4*	3	0	-	X	X	1	2	-	X	10
2	-	0	1	1	-	0	-	0	X	-	X	2
3	0	0	2	0	X	-	10	0	X	-	X	12
4	0	0	1	1	X	-	0	3	-	0	0	5
Total	0	4	7	2	0	0	10	4	2	0	0	29

Table 5. Summary of A) Release condition, B) Hook location in hooked animals, and C) Animals with all gear removed, by hook location for sea turtles observed in the pelagic longline fishery during 2018. Hook location information is recorded on the sea turtle life history form (Appendix A) by the observer.

A. Capture condition

Species	Alive, Uninjured	Alive, Unknown	Alive, injured	Total
Leatherback	2	2	15	19
Loggerhead	0	0	9	9
Green	0	0	1	1
Total	**2**	**2**	**25**	**29**

B. Hook Location in hooked animals

				Internal			External	
Species	**Not Hooked**	**Unknown if Hooked**	**Hooked, Location Unknown**	**Unknown Internal**	**Swallowed**	**Beak or Mouth**		**Total**
Leatherback	2	2	1	0	0	2	12	19
Loggerhead	0	0	0	0	3	6	0	9
Green	0	0	0	0	0	1	0	1
Total	**2**	**2**	**1**	**0**	**3**	**9**	**12**	**29**

C. Animals with all gear removed, by hook location

				Internal			External	
Species	**Not Hooked**	**Unknown if Hooked**	**Hooked, Location Unknown**	**Unknown Internal**	**Swallowed**	**Beak or Mouth**		**Total**
Leatherback	2	0	0	0	0	0	5	7
Loggerhead	0	0	0	0	0	5	0	5
Green	0	0	0	0	0	1	0	1
Total	**2**	**0**	**0**	**0**	**0**	**6**	**5**	**13**

Table 6. Release status and gear removal for sea turtles captured and released alive in the U.S. Atlantic Pelagic Longline Fishery during 2018. Condition columns refer to post-release mortality categories in Table 1 of SEFSC 2012.

Release Status	Leatherback	Loggerheads	Green
Released entangled (Condition Column A)	2	0	0
Released with hook and line ≥ ½ carapace length (Condition Column B)	1	0	0
Released with hook and line < ½ carapace length (Condition Column C)	9	4	0
Released with all gear removed (Condition Column D)	7	5	1

Table 7. Total number of marine mammals observed in interactions with the pelagic longline fishery during 2018 by quarter and fishing area. Dashes indicate areas where there was no observed fishing effort, and an X indicates an area where no effort was reported.

Quarter	CAR	FEC	GOM	MAB	NCA	NEC	NED	SAB	SAR	TUN	TUS	Total
1	-	0	0	0	-	X	X	1	0	-	X	1
2	-	0	0	1	-	0	-	2	X	-	X	3
3	0	0	0	4	X	-	1	1	X	-	X	6
4	0	0	0	6	X	-	0	0	-	0	0	6
Total	0	0	0	11	0	0	1	4	0	0	0	16

Table 8. Marine mammal interactions with the pelagic longline fishery during 2018 by species, quarter, and fishing area. CBD indicates that the serious injury status could not be determined from available information. These observed interactions were prorated based on past observed serious injury rates.

Species	Quarter	Fishing Area	Serious Injuries	CBD	Released Alive	Total
Bottlenose Dolphin	2	SAB	1	0	0	1
Bottlenose Dolphin	3	MAB	0	1	0	1
Common Dolphin	3	NED	0	1	0	1
Unidentified Marine Mammal	3	SAB	1	0	0	1
Unidentified Marine Mammal	4	MAB	2	0	0	2
Pilot Whales	1	SAB	1	0	0	1
Pilot Whales	2	MAB	1	0	0	1
Pilot Whales	2	SAB	1	0	0	1
Pilot Whales	3	MAB	1	0	2	3
Pilot Whales	4	MAB	2	1	1	4
Total			**10**	**3**	**3**	**16**

Table 9. Summary of release condition and serious injury types for marine mammals observed in the pelagic longline fishery during 2018. Serious injury determinations were based upon written observer comments (Appendix B). Codes indicate table injury categories defined in the Small Cetacean Serious Injury Guidelines (NMFS, 2012a,b). CBD indicates that the serious injury status could not be determined from available information. These observed interactions were prorated based on past observed serious injury rates.

Species	Alive	CBD	Dead	Serious Injury Type			Serious Injury Total	Total
				Hooked in Head/Mouth (S5a)	Gear Attached Likely to Entangle (S6)	Freed After Entanglement (S7b)		
Bottlenose dolphin	0	1	0	1	0	0	1	2
Common dolphin	0	1	0	0	0	0	0	1
Unid. Marine Mammal	0	0	0	1	2	0	3	3
Pilot Whale	3	1	0	1	5	0	6	10
Total	**3**	**3**	**0**	3	7	0	**10**	**16**

Table 10. Estimated interactions with sea turtles in the pelagic longline fishery during 2018 by fishing area and quarter. NR indicates strata where effort cannot be reported due to confidentiality considerations.

A. Leatherback

Area	Quarter	# Positive Sets	# Observed Sets	Mean CPUE	CV	Hooks Reported (x1000)	Estimated Catch
FEC	1	1	44	0.027	1.000	191.6	5.2
GOM	1	3	109	0.031	0.581	203.0	6.3
GOM	3	2	69	0.034	0.702	415.9	14.1
MAB	2	1	40	0.069	1.000	222.0	15.4
MAB	4	1	46	0.045	1.000	405.2	18.4
NED	3	5	36	0.252	0.471	91.9	23.1
SAB	1	1	13	0.092	1.000	106.0	9.7
SAB	4	1	20	0.052	1.000	121.0	6.3
SAR	1	1	9	0.131	1.000	99.8	13.1

Table 10 – Continued

B. Loggerheads

Area	Quarter	# Positive Sets	# Observed Sets	Mean CPUE	CV	Hooks Reported (x1000)	Estimated Catch
FEC	1	2	44	0.046	0.702	191.6	8.9
GOM	2	1	83	0.014	1.000	289.6	4.0
GOM	4	1	49	0.026	1.000	242.4	6.3
NED	3	2	36	0.062	0.697	91.9	5.7
SAB	4	2	20	0.141	0.713	121.0	17.0
SAR	1	1	9	0.124	1.000	99.8	12.4

C. Green

Area	Quarter	# Positive Sets	# Observed Sets	Mean CPUE	CV	Hooks Reported (x1000)	Estimated Catch
FEC	1	1	44	0.021	1.000	191.6	4.0

Table 11. Estimated A) Serious Injury and B) Released Alive marine mammals in the pelagic longline fishery during 2018 by fishing area and quarter. NR indicates strata where effort cannot be reported due to confidentiality considerations. Long-finned and short-finned pilot whale estimates reflect the apportioning of observed unidentified pilot whale takes by species based upon location and environmental conditions. Interactions where serious injury status could not be determined were prorated based on past observed serious injury rates.

A. Serious Injury

Species	Area	Quarter	# Positive Sets	# Observed Sets	Mean CPUE	CV CPUE	# Hooks Reported (x1000)	Estimated Catch
Bottlenose dolphin	SAB	2	1	74	0.019	1.00	576.7	10.82
Bottlenose dolphin	MAB	3	1	52	0.014	1.00	462.3	6.55
Common dolphin	NED	3	1	36	0.016	1.00	91.9	1.44
Unid. Marine Mammal	SAB	3	1	30	0.042	1.00	125.8	5.34
Unid. Marine Mammal	MAB	4	2	46	0.088	0.72	405.2	35.53
Long-finned Pilot Whale	MAB	2	1	40	0.002	1.00	222.0	0.36
Short-finned Pilot Whale	SAB	1	1	13	0.100	1.00	106.0	10.59
Short-finned Pilot Whale	MAB	2	1	40	0.036	1.00	222.0	7.90
Short-finned Pilot Whale	SAB	2	1	74	0.022	1.00	576.7	12.92
Short-finned Pilot Whale	MAB	3	1	52	0.027	1.00	462.3	12.28

Table 11 cont.

B. Alive

Species	Area	Quarter	# Positive Sets	# Observed Sets	Mean CPUE	CV CPUE	# Hooks Reported (x1000)	Estimated Catch
Bottlenose dolphin	MAB	3	1	52	0.013	1.00	462.3	6.19
Common dolphin	NED	3	1	36	0.015	1.00	91.9	1.36
Short-finned pilot whale	MAB	3	2	52	0.046	0.70	462.3	21.36
Short-finned pilot whale	MAB	4	2	46	0.075	0.77	405.2	30.41

Table 12. Bycatch rates for sea turtles and marine mammals in area-quarter strata that were not observed in 2018. NR indicates strata where effort cannot be reported for 2018 due to confidentiality restrictions.

A. Sea Turtles

Status	Species	Area	Quarter	# Positive Sets	#Observed Sets	Mean CPUE	CV CPUE	# Hooks Reported (X1000) 2018	Estimated Catch 2018
Alive	Leatherback	NEC	3	18	226	0.105	0.252	49.9	5.2
Alive	Leatherback	NEC	4	10	77	0.266	0.345	NR	0.2
Alive	Leatherback	SAR	4	3	108	0.029	0.579	NR	0.2
Alive	Leatherback	TUN	1	1	31	0.025	1.000	NR	0.6
Alive	Leatherback	TUN	2	1	25	0.033	1.000	NR	1.2
Alive	Leatherback	TUN	3	1	36	0.036	1.000	NR	1.0
Alive	Loggerhead	NEC	3	18	226	0.119	0.249	49.9	5.9
Alive	Loggerhead	NEC	4	3	77	0.043	0.581	NR	0.0
Alive	Loggerhead	SAR	4	3	108	0.028	0.578	NR	0.2
Alive	Loggerhead	TUN	1	1	31	0.025	1.000	NR	0.6

Table 12 cont.

B. Marine Mammals

Injury Type	Species	Area	Quarter	# Positive Sets	#Observed Sets	Mean CPUE	CV CPUE	# Hooks Reported (X1000) 2018	Estimated Catch 2018
Serious Injury	Risso's dolphin	NEC	3	1	226	0.004	1.00	49.9	0.22
Serious Injury	Risso's dolphin	NEC	4	1	77	0.018	1.00	NR	0.01
Serious Injury	Long-finned pilot whale	NEC	3	1	226	0.000	1.00	49.9	0.02
Serious Injury	Long-finned pilot whale	NEC	4	6	77	0.005	0.42	NR	0.00
Serious Injury	Short-finned pilot whale	NEC	3	3	226	0.015	0.58	49.9	0.75
Serious Injury	Short-finned pilot whale	NEC	4	6	77	0.099	0.42	NR	0.08
Alive	Bottlenose dolphin	NEC	4	1	77	0.018	1.00	NR	0.01
Alive	Risso's dolphin	NEC	3	1	226	0.004	1.00	49.9	0.22
Alive	Unid. Marine Mammal	NEC	4	1	77	0.018	1.00	NR	0.01
Alive	Long-finned pilot whale	NEC	4	2	77	0.001	0.79	NR	0.00
Alive	Short-finned pilot whale	NEC	4	2	77	0.018	0.76	NR	0.01

Table 13. Total estimated interactions and experimental takes for A) Leatherback, B) Loggerhead, and C) Green turtles in the pelagic longline fishery during 2018 by fishing area. This includes estimates for strata that were not observed during 2018.

A. Leatherbacks

Area	Alive	Alive CV	Total 95% Confidence Interval
CAR	0	-	-
FEC	5.2	1.00	1.0 - 26.5
GOM	20.4	0.52	7.9 – 53.0
MAB	33.8	0.71	9.7 - 118.1
NCA	0	-	-
NEC	5.4	0.24	3.4 - 8.7
NED	23.1	0.47	9.6 - 55.6
SAB	16.0	0.72	4.5 - 57.1
SAR	13.3	0.98	2.6 - 66.6
TUN	2.8	0.60	0.9 - 8.2
TUS	0	-	-
Total	**120.0**	**0.28**	**69.8 – 206.2**

B. Loggerheads

Area	Alive	Alive CV	Total 95% Confidence Interval
CAR	0	-	-
FEC	8.9	0.70	2.6 - 30.8
GOM	10.3	0.72	2.9 - 36.9
MAB	0	-	-
NCA	0	-	-
NEC	6.0	0.25	3.7 - 9.6
NED	5.7	0.70	1.7 - 19.6
SAB	17.0	0.71	4.8 - 59.8
SAR	12.6	0.98	2.5 - 63.1
TUN	0.6	1.00	0.1 - 2.9
TUS	0	-	-
Total	**61.0**	**0.33**	**32.3 – 115.3**

C. Green

Area	Alive	Alive CV	Total 95% Confidence Interval
FEC	16.3	1.00	0.8 – 20.6

Table 14. Total estimated interactions with marine mammals in the pelagic longline fishery during 2018.

A. Atlantic

Species	Estimated Alive	CV Alive	95% CI Alive	Estimated Serious Injury	CV Serious Injury	95% CI Serious Injury
Risso's Dolphin	0.22	1.000	0.04 – 1.14	0.23	1.000	0.04 - 1.11
Long-finned Pilot whale	0	-	-	0.39	0.929	0.08 – 1.82
Short-finned pilot whale	51.78	0.536	19.34 – 138.7	102.2	0.390	48.9 – 213.8
Bottlenose Dolphin	6.21	0.998	1.22 – 31.62	17.37	0.728	4.84 – 62.39
Unidentified marine mammal	0.01	1.000	0.00 – 0.07	40.87	0.639	12.98 – 128.74

B. Offshore

Species	Estimated Alive	CV Alive	95% CI Alive	Estimated Serious Injury	CV Serious Injury	95% CI Serious Injury
Common Dolphin	1.36	1.000	0.27 – 6.97	1.44	1.000	0.282 – 7.377

Figure 1. Pelagic longline fishing areas in the North Atlantic Ocean: CAR = Caribbean, GOM = Gulf of Mexico, FEC = Florida East Coast, SAB = South Atlantic Bight, SAR = Sargasso Sea, MAB = Mid-Atlantic Bight, NEC = Northeast Coastal, NED = Northeast Distant, NCA = North Central Atlantic, TUN = Tuna North, TUS = Tuna South. Year-round closed areas in the De Soto Canyon (A) and the Florida East Coast (B) are indicated along with seasonal closures in the Charleston Bump (C) and in the Mid-Atlantic (D).

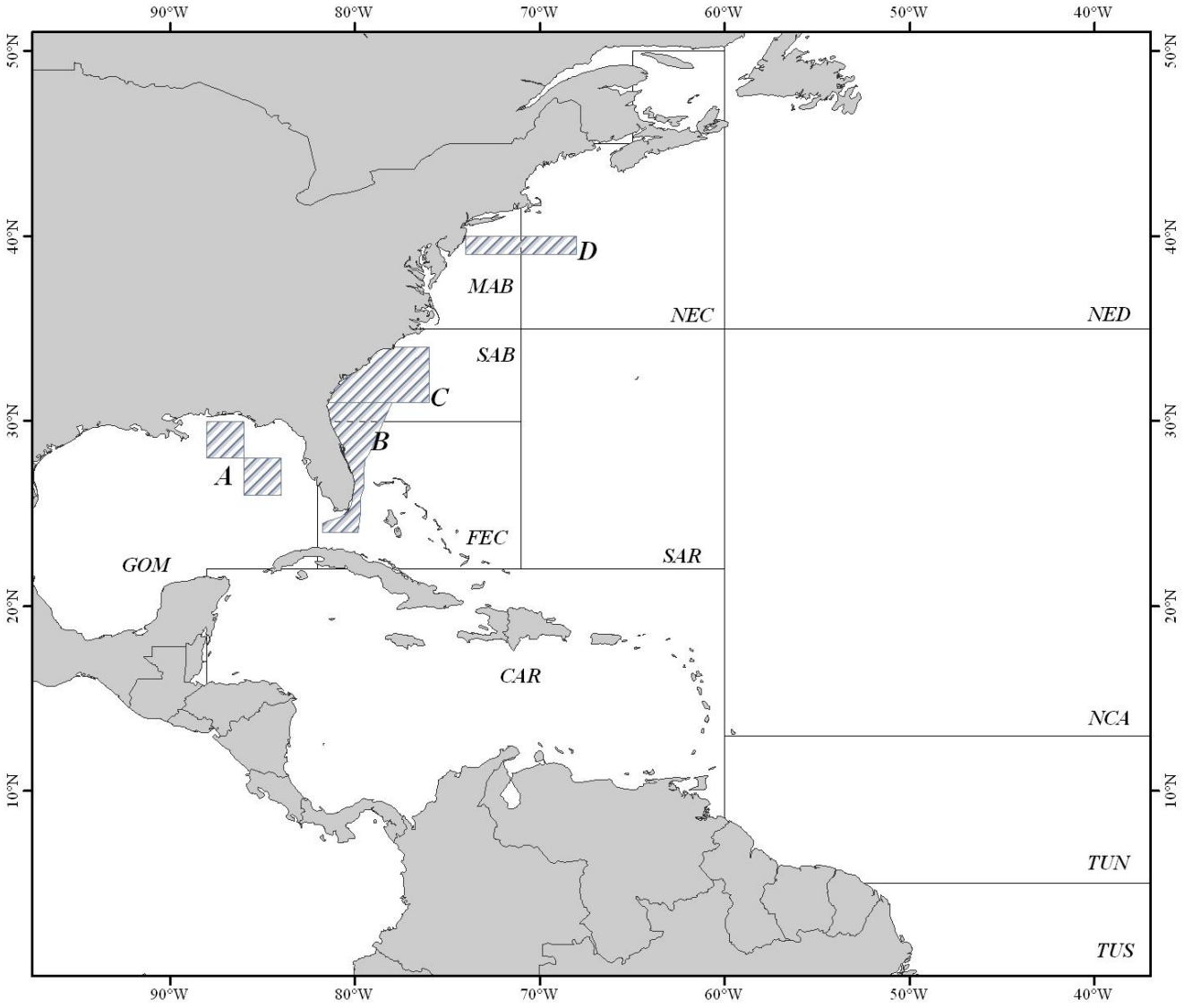


Figure 2. Observed (gray circles) and reported (black circles) pelagic longline fishing effort during 2018.

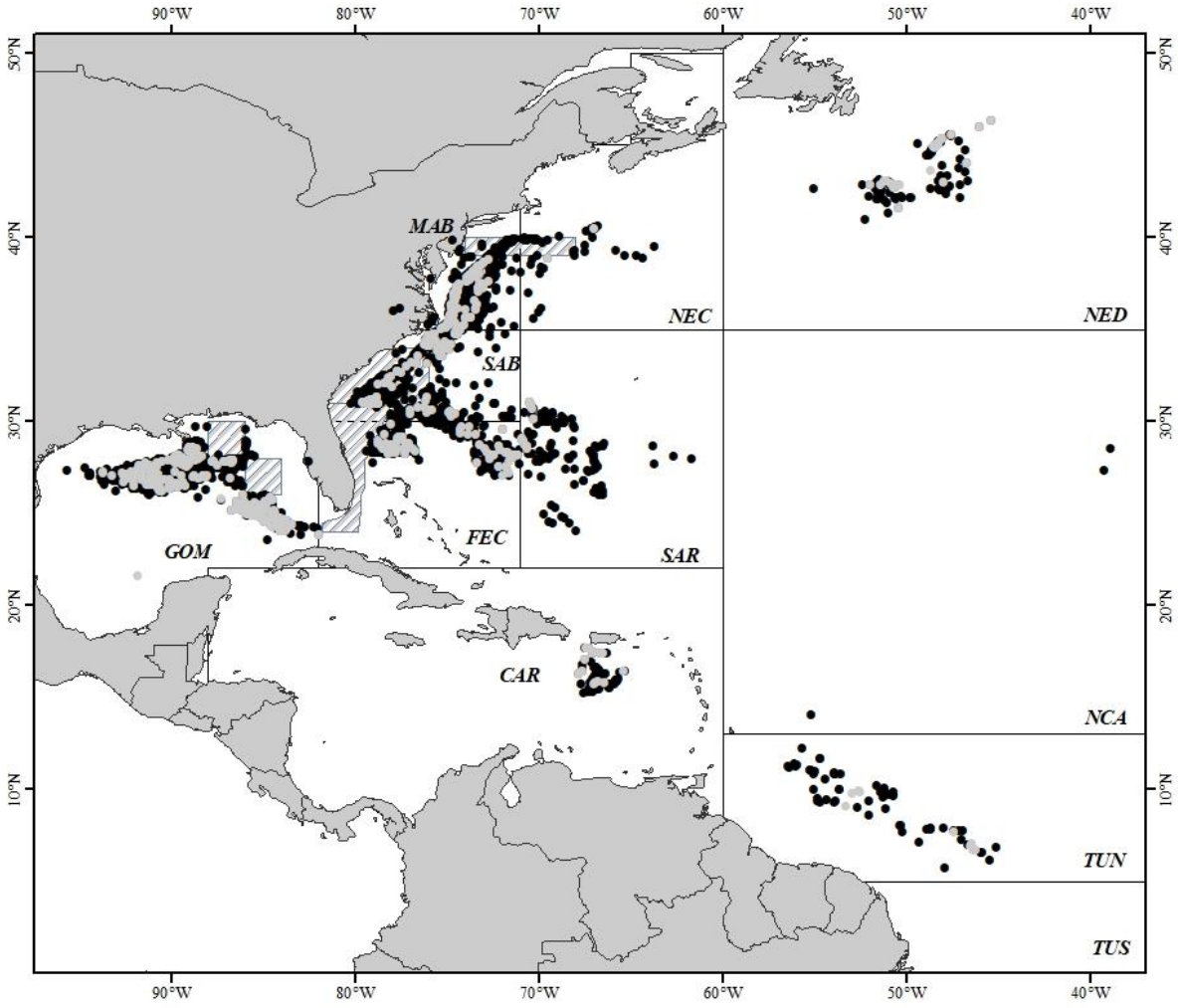


Figure 3. Observed pelagic longline fishing effort and sea turtle interactions during 2018.

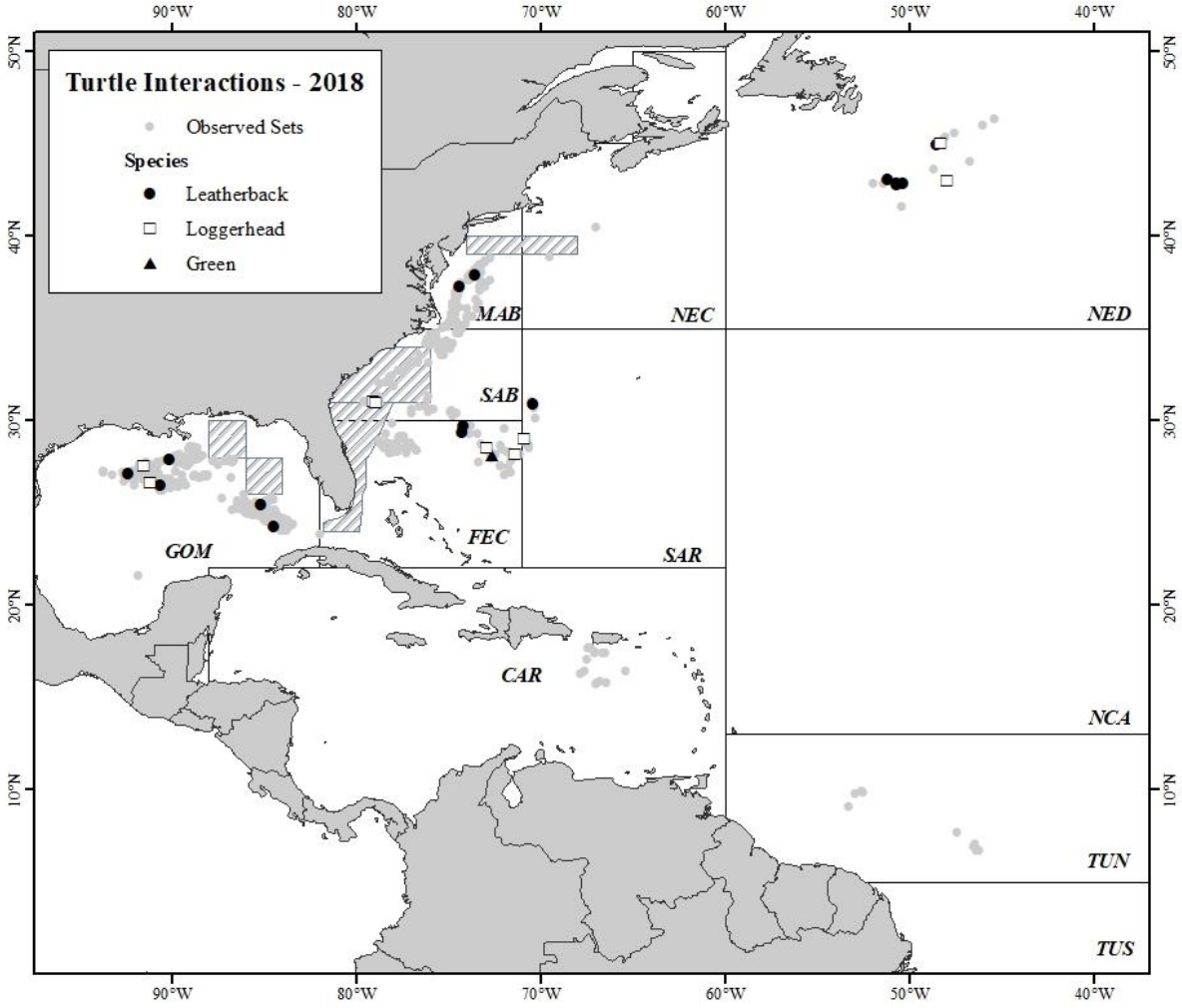


Figure 4. Observed pelagic longline fishing effort and marine mammal takes during 2018.

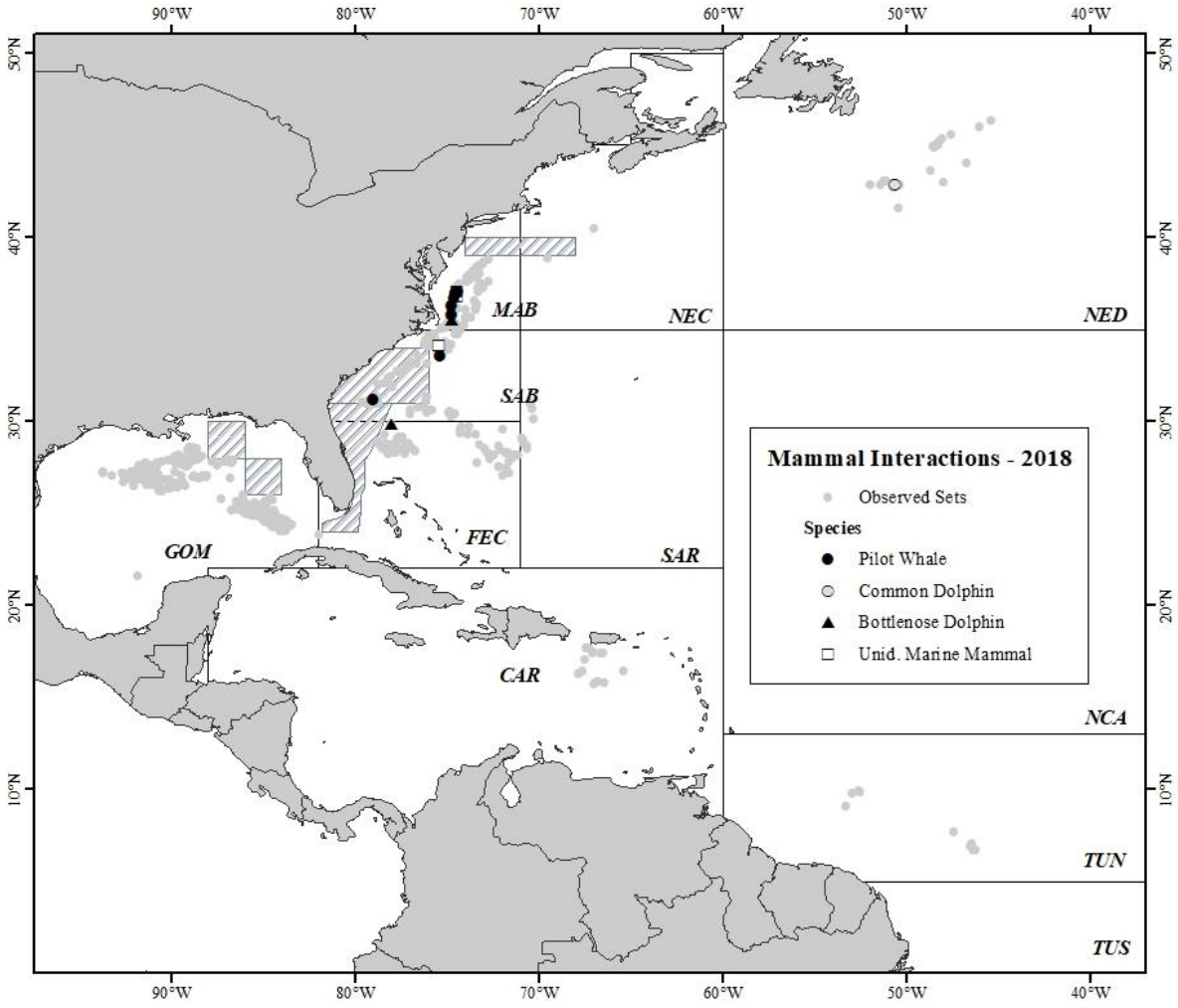
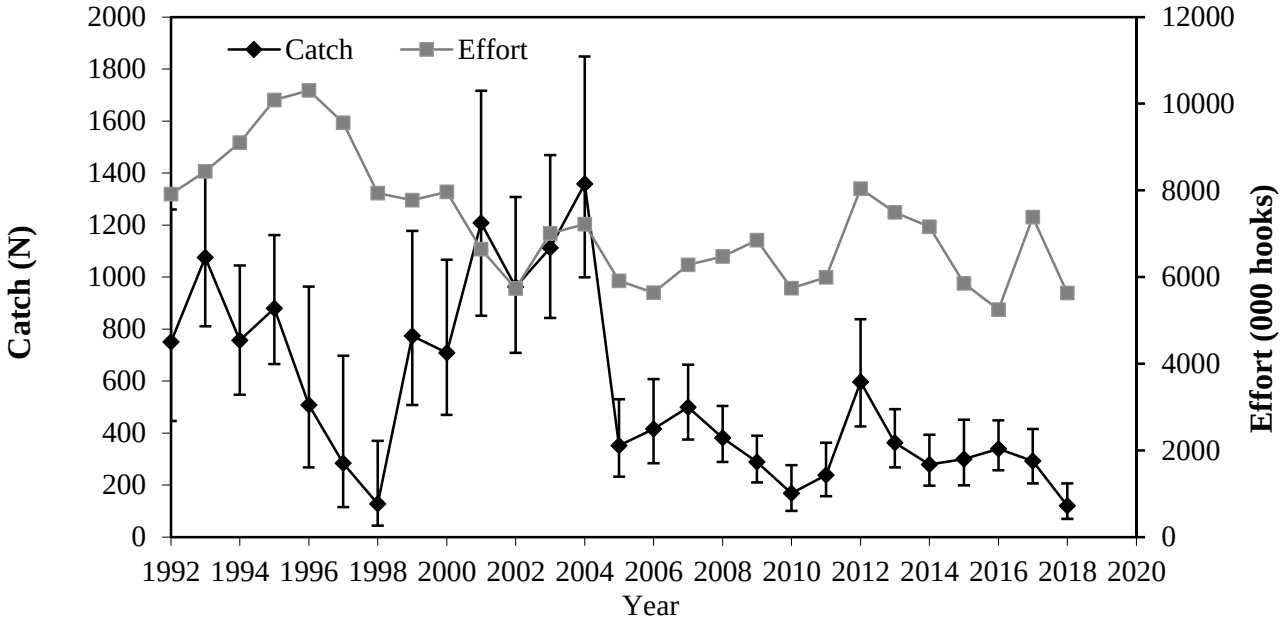


Figure 5. Historical trends in fishery effort and estimated marine turtle takes in the pelagic longline fishery from 1992 to 2018 for A) Leatherback Turtles, and B) Loggerhead Turtles. Errors bars represent 95% confidence intervals.

A. Leatherback Turtles



B. Loggerhead Turtles

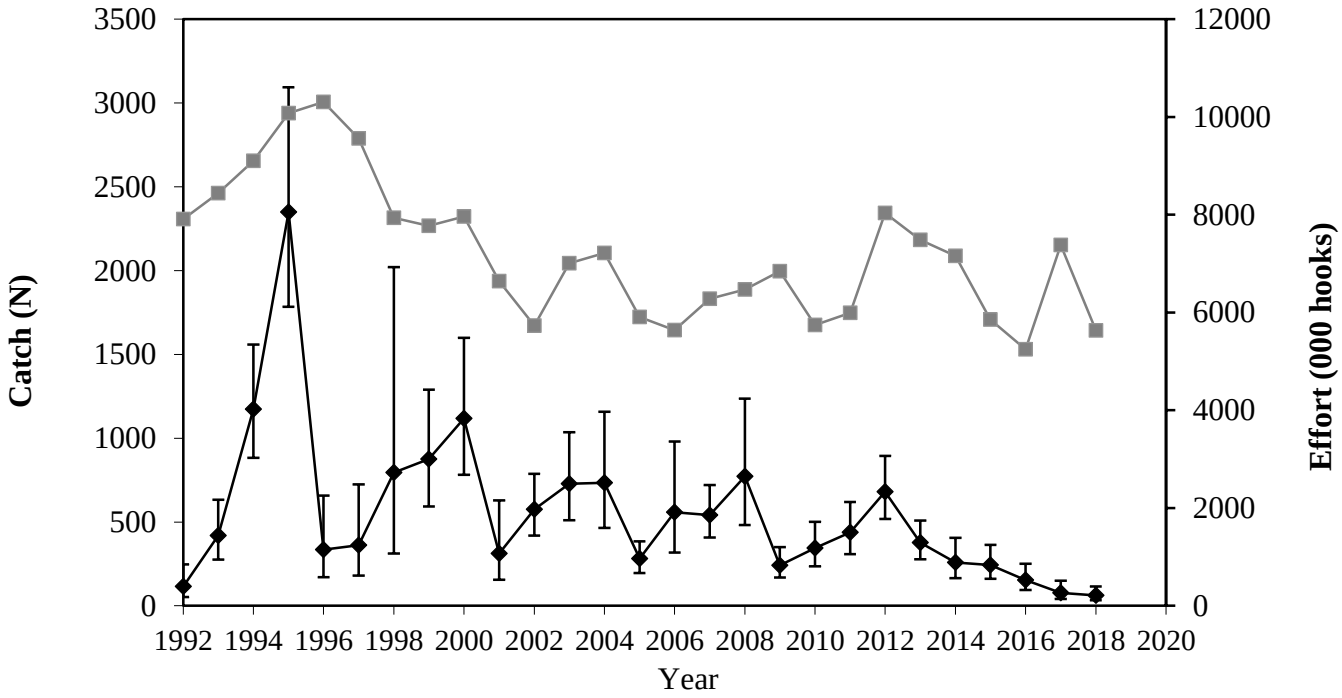
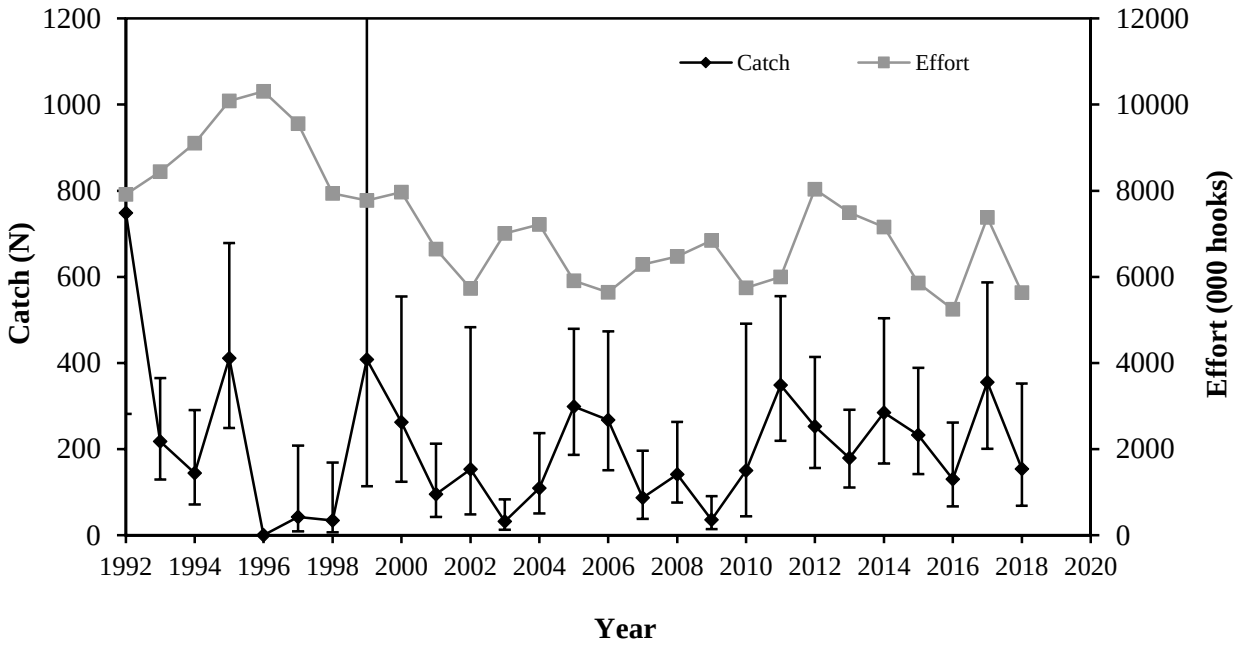
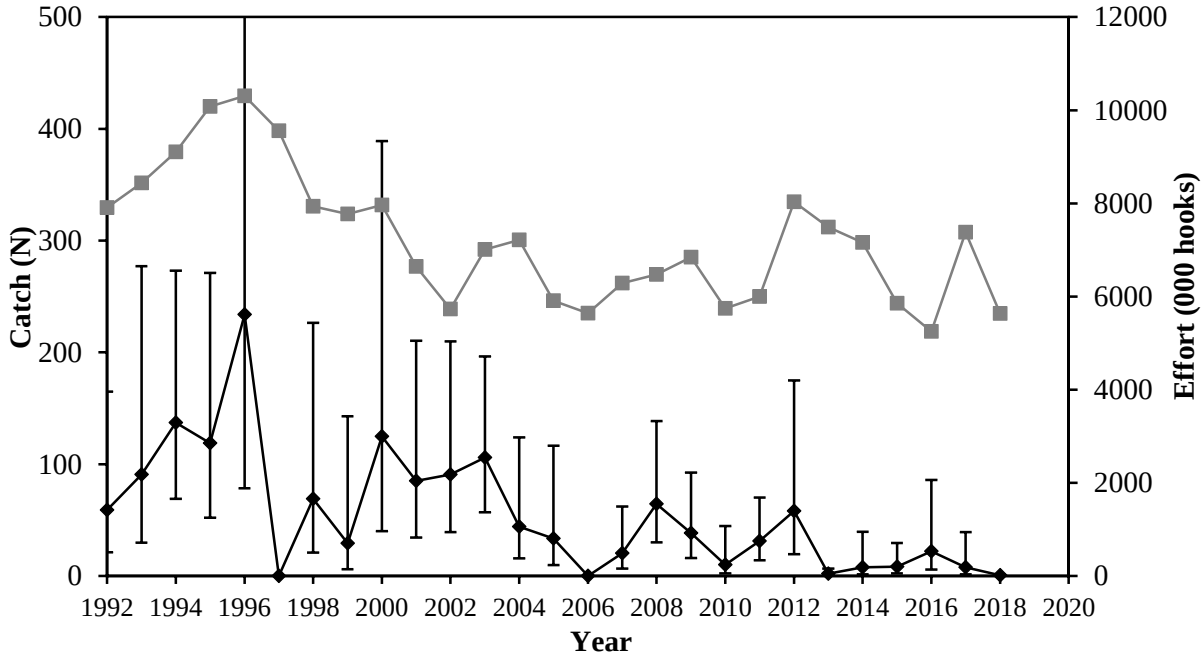


Figure 6. Historic trends in fishery effort and estimated marine mammal takes in the pelagic longline fishery from 1992 to 2018 for A) Pilot Whales and B) Risso's Dolphins in Western North Atlantic waters. Errors bars represent 95% confidence intervals. For pilot whales, all takes are most likely of short-finned pilot whales.

A. Pilot Whales



B. Risso's Dolphins



Appendix A. Sea Turtle Life History Form

SEA TURTLE LIFE HISTORY FORM

02/2012

CAPTURE INFORMATION

TRIP ☐☐☐☐☐☐ YEAR 20☐☐ MONTH☐☐ DAY☐☐

SET/HAUL/TOW ☐☐☐ SPECIMEN NUMBER BY TRIP ☐☐☐ EXPERIMENTAL Y / N? (if Y, note project name in comments)

GEAR TYPE: ☐Longline ☐Gill Net _____ ☐Trawl_____ (note time in comments)
GEAR DEPTH: ☐Surface ☐Midwater ☐Bottom ☐Other _____

TARGET CATCH: _____ TIME (24 hr) ☐☐☐☐ WATER TEMP (°F) ☐☐.☐

LATITUDE☐☐deg☐☐.☐min N / S LONGITUDE☐☐☐deg☐☐.☐min E / W

Did turtle slide out/escape from gear? Y / N Was turtle brought on board? Y / N

IDENTIFICATION (see back) Number of Photos Taken? ☐☐

SPECIES: ☐Leatherback ☐Loggerhead ☐Kemp's ridley ☐Green ☐Hawksbill ☐Olive ridley ☐Unidentified Hardshell ☐Unknown

---

CONDITION OF TURTLE AT CAPTURE ☐ Injured ☐ Uninjured ☐ Unknown

(Please check injury status above as well as condition below; complete condition evaluation on p. 2 for any not coded "alive")

☐Previously dead ☐Fresh dead/comatose/unresponsive Attempted resuscitation? Y / N
☐Alive ☐Unknown (describe) ☐Other (describe)

IF GEAR IS A FORM OF HOOK AND LINE, COMPLETE THIS SECTION, AS APPLICABLE:

HOOK TYPE ☐ "J" ☐ Circle ☐other (describe) _____ SIZE ☐☐/0
MANUFACTURER/STYLE NO. _____ DEGREE OFFSET ☐☐°
BAIT ☐Squid ☐Mackerel ☐Sardine ☐Unknown ☐Other (describe)_____SIZE_____
Caught on hook timer? Y / N If yes, fill in time elapsed ☐☐ ☐☐
Was light stick on hook? Y / N / U / Not Applicable If No, number of gangions to next light stick ☐☐
Light stick type (circle) : Chemical / LED
Light stick color (circle)? White, Pink, Blue, Green, Black, Red, Yellow, Purple, Other, Unknown
Number of gangions to next float ☐☐

HOOK LOCATION (See Appendix in manual for descriptive figures)
(circle specific location; check box if specifics are not known; annotate drawing on reverse to indicate location as needed):

☐ Not Hooked ☐ Not Known if Hooked ☐Hooked, but location totally Unknown ☐Holding bait/hook

Internal: ☐ Unknown, internal
☐ Swallowed (Esophagus) Hook visible? Visible to insertion point / Partial hook / Not visible
☐ Beak/ Mouth (Circle one) Jaw Location (Check one) ☐upper ☐lower ☐side (mouth only)
Check one for mouth: ☐ tongue ☐ glottis ☐ roof of mouth ☐ jaw joint ☐other (describe)

External: ☐Unknown, external ☐Beak/Head/Neck ☐Carapace/Plastron
☐Front Flipper/Shoulder/Armpit ☐Rear Flipper/Groin/Tail

Was hook recovered from this animal? Y / N / Unknown / Not Applicable

---

Was animal entangled in gear? At capture? Y / N / Unknown At Release? Y / N / Unknown
How much gear (linear feet) was left on turtle when released? ☐☐☐.☐ ft. (estimated/measured)

Appendix A. Sea Turtle Life History Form (cont.)

BIOLOGICAL INFORMATION

Estimated carapace length (notch-to-tip straight line): ☐☐.☐ ft (needed only if turtle is not boated & measured)

DIMENSIONS (cm)	Curved (measuring tape) Standard Measurements	Straight Line (calipers) Standard Measurements	Straight Line (calipers)
Carapace Length	☐☐☐.☐ notch-to-tip	☐☐☐.☐ notch-to-tip	☐☐☐.☐ notch-to-notch
Carapace Width	☐☐☐.☐	☐☐☐.☐	

TAGS (identify address on each tag in the comments section)

Flipper Tag Number	Metal (1) or Plastic (2)	Position (Flipper) LF, RF, LR, RR	Already Present (1) or Applied by Observer (2)	Were Tags Removed?
☐☐☐☐☐☐	☐	☐☐	☐	Y / N
☐☐☐☐☐☐	☐	☐☐	☐	Y / N
☐☐☐☐☐☐	☐	☐☐	☐	Y / N
☐☐☐☐☐☐	☐	☐☐	☐	Y / N

PIT Tag ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ Position (Flipper) ☐☐ ☐ Scanned? Y / N

Living Tag (describe)_____ Other Tags (describe) _____

(Put PIT tag label here) If you have the option of Decimal or Hexidecimal sequence, choose DECIMAL

BIOPSY SAMPLES TAKEN? Y (itemize below) / N / Unsuccessful

RELEASE INFORMATION

LATITUDE ☐☐deg☐☐.☐min N / S LONGITUDE ☐☐☐deg☐☐.☐min E / W

TIME (24 hr) ☐☐☐☐ WATER TEMP (°F) ☐☐.☐

DATE, if different from capture: YEAR 20☐☐ MONTH☐☐ DAY☐☐

FINAL DISPOSITION

☐ Discarded Dead/Comatose/Unresponsive Carcass Marked? Y / N

☐ Salvaged Carcass/Parts ☐ Released Alive ☐ Taken to Holding Facility ☐ Unknown (explain)

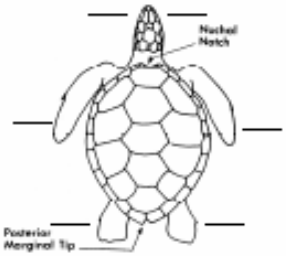
ADDITIONAL COMMENTS (list all biological samples collected; describe/sketch anomalies):

_____

_____

_____

_____



IDENTIFICATION CRITERIA

Number of:				
Left Lateral Scutes	☐	Overlapping Scutes?	Y / N / U	
Right Lateral Scutes	☐	Inframarginal Pores?	Y / N / U	
Vertebral Scutes	☐	1 Pair Prefrontal Scales?	Y / N / U	
L. Inframarginal Scutes	☐	Lacks Bony Shell?	Y / N	
R. Inframarginal Scutes	☐	Does Nuchal Scute Touch 1st Lateral Scute?	Y / N / U	

CONDITION EVALUATION FOR TURTLES NOT CODED "ALIVE"

Mark each line on diagram above with a 'Y' to indicate positive reflex/response, and 'N' for no response.

Rigor Mortis	Y / N / U
Rotting Flesh	Y / N / U
Foul Smell	Y / N / U

Dorsal Coloration ☐ Black ☐ Orange/Red-Brown ☐ Brown ☐ Gray-Green ☐ Other_____

Appendix B. Details of Sea Turtle and Marine Mammal Interactions

Table B1. Gear types and hooking locations based upon observed comments and the sea turtle life history form for each A) Leatherback, B) Loggerhead, and C) Green turtles observed during 2018. These data are summarized in Tables 5 and 6. Q indicates calendar quarter, "CL Est." indicates an estimated carapace length in feet, "CCL" indicates a measured curved carapace length in cm, and "N-N" indicates a straight line measurement of the turtle carapace from notch to notch (see Appendix A). "Injury Cat. Row" and "Release Cond. Col." refer to rows and columns, respectively, for post-release mortality assignments in SEFSC 2012.

A. Leatherback Turtles

#	Area	Q	Hook Type	Offset (degrees)	Bait	Bait Size (g)	Capture Condition	Final Disposition	Hook Location	Hook Removed?	Entangled Capture?	Entangled Release?	Injury Cat. Row	Release Cond. Col	Line Left (ft)	CL Est. (ft)	CCL (cm)	N-N (cm)
1	FEC	1	C-16/0	0	Squid or Mackerel	585 or 405	Alive uninjured	Released alive	Not hooked	N/A	Yes	No	5	D	0.0	5.0		
2	GOM	1	C-16/0	0	Mackerel	293	Alive injured	Released alive	Armpit	Yes	No	No	1	D	0.0	3.5		
3	GOM	1	C-16/0	0	Mackerel	369	Alive injured	Released alive	Shoulder	No	No	No	1	C	0.5	5.0		
4	GOM	1	C-16/0	0	Squid or Pacific saury	113 or 59	Alive injured	Released alive	Beak (internal), upper jaw	No	No	No	1	C	1.0	5.0		
5	SAB	1	C-16/0	0	Squid or Mackerel	585 or 405	Alive unknown	Released alive	Not known if hooked	Unknown	Unknown	Unknown	4	A	Unknown	6.0		
6	SAB	1	C-16/0	0	Squid or Mackerel	270 or 405	Alive injured	Released alive	Mouth, unknown	No	Yes	No	4	C	1.5	4.0		
7	MAB	2	C-16/0	0	Squid	198	Alive injured	Released alive	Shoulder	No	No	No	1	C	1.0	3.0		
8	GOM	3	C-16/0	0	Pacific saury	104	Alive injured	Released alive	Front flipper	No	No	No	1	C	1.5	4.0		
9	GOM	3	C-16/0	0	Pacific saury	90	Alive unknown	Released alive	Not known if hooked	No	Yes	Yes	4	A	3.0	4.0		
10	NED	3	C-18/0	10	Mackerel	266	Alive injured	Released alive	Unknown location	No	No	No	4	B	2.0	3.5		
11	NED	3	C-18/0	10	Mackerel	315	Alive injured	Released alive	Armpit	Yes	No	No	1	D	0.0	7.0		

Appendix B, Table B1, A. Leatherback Turtles cont.

#	Area	Q	Hook Type	Offset (deg)	Bait	Bait Size (g)	Capture Condition	Final Disposition	Hook Location	Hook Removed?	Entangled Capture?	Entangled Release?	Injury Cat. Row	Release Cond. Col.	Line Left (ft)	CL Est. (ft)	CCL (cm)	N-N (cm)
12	NED	3	C-18/0	10	Mackerel	315	Alive injured	Released alive	Unknown external	No	No	No	1	C	0.0	7.0		
13	NED	3	C-18/0	10	Mackerel	315	Alive injured	Released alive	Armpit	Yes	No	No	1	D	0.0	6.0		
14	NED	3	C-18/0	10	Mackerel	315	Alive injured	Released alive	Armpit	No	No	No	1	C	0.5	6.0		
15	NED	3	C-18/0	10	Mackerel	315	Alive uninjured	Released alive	Not hooked	N/A	Yes	No	5	D	0.0	6.0		
16	NED	3	C-18/0	10	Mackerel	315	Alive injured	Released alive	Armpit	Yes	No	No	1	D	0.0	5.0		
17	NED	3	C-18/0	0	Mackerel	207	Alive injured	Released alive	Front flipper	No	No	No	1	C	0.0	4.0		
18	MAB	4	C-16/0	0	Squid or Ballyhoo	252 or 90	Alive injured	Released alive	Shoulder	No	Yes	No	1	C	1.0	5.0		
19	SAB	4	C-16/0	0	Mackerel	216	Alive injured	Released alive	Front flipper	Yes	No	No	1	D	0.0	6.0		

Appendix B, Table B1, B. Loggerhead Turtles

#	Area	Q	Hook Type	Offset (deg)	Bait	Bait Size (g)	Capture Condition	Final Disposition	Hook Location	Hook Removed?	Entangled Capture?	Entangled Release?	Injury Cat. Row	Release Cond. Col.	Line Left (ft)	CL Est. (ft)	CCL (cm)	N-N (cm)
1	FEC	1	C-16/0	0	Squid or Mackerel	585 or 405	Alive injured	Released alive	Mouth, lower jaw, other	Yes	No	No	2	D	0.0	3.0		
2	FEC	1	C-18/0	10	Squid or Mackerel	234 or 531	Alive injured	Released alive	Mouth, side, other	No	No	No	2	C	0.0	3.0		
3	SAR	1	C-18/0	10	Squid	234	Alive injured	Released alive	Swallowed, hook not visible	No	No	No	4	C	0.3	3.0		
4	GOM	2	C-16/0	0	Squid or Pacific saury	113 or 59	Alive injured	Released alive	Swallowed, hook not visible	No	No	No	4	C	0.1	2.5		
5	NED	3	C-18/0	10	Mackerel	167	Alive injured	Released alive	Beak (internal), lower jaw	Yes	No	No	1	D	0.0		69.0	
6	NED	3	C-18/0	0	Mackerel	207	Alive injured	Released alive	Beak (internal)/mouth, upper jaw	Yes	No	No	3	D	0.0		58.0	52.0
7	GOM	4	C-16/0	0	Squid	113	Alive injured	Released alive	Beak (internal)/mouth, lower jaw	Yes	No	No	3	D	0.0	4.0		
8	SAB	4	C-16/0	0	Mackerel	216	Alive injured	Released alive	Tongue	Yes	No	No	3	D	0.0		65.0	61.0
9	SAB	4	C-16/0	0	Mackerel	297	Alive injured	Released alive	Swallowed, hook not visible	No	No	No	4	C	0.0	3.0		

Appendix B, Table B1, C. Green Turtles

#	Area	Q	Hook Type	Offset (degrees)	Bait	Bait Size (g)	Capture Condition	Final Disposition	Hook Location	Hook Removed?	Entangled Capture?	Entangled Release?	Injury Cat. Row	Release Cond. Col.	Line Left (ft)	CL Est. (ft)	CCL (cm)	N-N (cm)
1	FEC	1	C-16/0	0	Squid or Mackerel	585 or 405	Alive injured	Released alive	Mouth, lower jaw, other	Yes	No	No	2	D	0.0		30.0	

Appendix B cont.

Table B2: 2018 observer comments and serious injury codes for marine mammals are presented. Lengths (cm) are estimated visually by the observer. Interaction type categories are based on NMFS Serious Injury determination policy.

	Species	Length (cm)	Release Condition	Interaction Type	Observer Comments
1	Pilot whale	300	1	S6 - Gear attached to free-swimming animal with potential to be ingested or entangle	[Unknown if hooked. Entangled in dropline, float, and gangion around flukes. No wraps cut, released with 13ft. of gear] Gear appeared to be wrapped several times around its tail. The whale was pulled close enough to the boat for me to tray and get a biopsy. Line was then cut with whale next to the boat. Animal appeared to be lively. Swam away strong and dove right away. [10 minute interaction duration]
2	Bottlenose dolphin	150	1	S5a - Hook in head, S6 - Gear attached to free-swimming animal with potential to be ingested or entangle	[Hooked, noted that line appeared to originate from the beak area. Line cut released with 20ft. of trailing gear] Multiple attempts to draw the animal closer were made, however the animal would repeatedly go into dives which the crew proved incapable of pulling against. After a few minutes they retrieved the long-handled line cutter and cut the line at the extent of its reach which left about 20ft trailing. The animal repeatedly dove to try and escape, breaching the surface in a porpoising type maneuver approx. every 10 second during the encounter. Upon release it dove strongly and was not seen again. [Interaction duration 2 minutes]
3	Pilot whale	180	1	S5a - Hook in head	[Hooked, internal, hook not visible. Line cut with 3 ft. remaining. Not entangled] Pulled MPW to boat until MPW pulled back, cut line with line cutter. MPW very docile [tired?] when close to boat started to pull, line cut.
4	Pilot whale	240	1	S6 - Gear attached to free-swimming animal with potential to be ingested or entangle	[Hooked external, drawing indicates in area of pec flipper. Line not cut intentionally, 55 ft remaining. Not entangled] Crew put vessel in neutral and attempted to handline whale to the vessel to remove hook/mono but the whale broke gangion and swam away strongly. Whale resisted being handlined to the vessel, swimming away from the vessel diving below the vessel, swam away strongly, when gangion broke. [15 minute interaction time]
5	Pilot whale	180	0	S7b - Entangled before being freed without gear attached	[Not hooked. Entangled in mainline around flukes. Gear removed] Used a combination of long handled line cutter and monofilament line cutters to cut away all the entangled pieces around the fluke at boatside. Mammal swam away near surface as soon as detangled. Animal swam straight away from boat right away near the surface, doing dives. [3 minute interaction time]
6	Pilot whale	150	0	S7b - Entangled before being freed without gear attached	[Not hooked. Entangled in mainline and dropline around head and mouth. All gear removed.] Tied off mainline from opposite side of mammal to boat then used long handled line cutters to cut mammal free at boat side, mammal swam away normally and with no gear remaining attached. Animal swam away immediately on being released, went slightly down and directly away from the boat. [4 minutes interaction time]

Appendix B, Table B2 (cont.)

Animal #	Species	Length (cm)	Release Condition	Interaction Type	Observer Comments
7	Unid. Marine Mammal	150	Serious Injury	S5a - Hook in head, S6 - Gear attached to free-swimming animal with potential to be ingested or entangle	[Hooked in head/mouth, hook visible, noted in side of jaw. Line cut released with 5ft remaining. Not entangled.] They saw it was a mammal and immediately yelled out to cut the line. Mammal went to other side of the vessel. Was moving fine, took a couple breaths before submerging. [10 second interaction time]
8	Bottlenose Dolphin	210	CBD	S7b - Entangled before being freed without gear attached	[Not hooked. Entangled around head, flukes, body in mainline. Gear removed with wraps cut.] Cut with cutter. Animal was very wrapped up one or two times on body, twice on dorsal fin, badly around right front flipper. Tangled all over. Was fighting strong, breathing heavy. Swam away immediately once cut. Line cut deep the front right flipper - could see the pink and red flesh. [3 minute interaction time]
9	Common Dolphin	150	CBD	S7b - Entangled before being freed without gear attached	[Not hooked. Entangled around head and mouth in mainline. Gear removed.] Crew handled MAM01 to the boat and crew was able to untangle lines without cutting any wraps. Rested at surface for 20-30 seconds then slowly swam away.
10	Pilot Whale	300	Serious Injury	S6 - Gear attached to free-swimming animal with potential to be ingested or entangle	[Not hooked. Entangled around flukes in mainline and dropline. Partial removal of gear, 40 ft of line remaining] Whale was handlined to the vessel, mainline was removed from keel of fluke, whale pulled free still trailing part of a dropline, whale swam away strongly. Whale swam away strongly then dove. [5 minute interaction time\]
11	Pilot Whale	180	Released Alive	S7b - Entangled before being freed without gear attached	[Not hooked. Entangled around flukes, head, mouth in mainline, gangion, and dropline. Gear removed and cut.] Used gaff and line handle cutters to cut line from whales tail and remove wrapped line from the head/mouth. Swam away fast. [6 minute interaction time]
12	Pilot Whale	210	Serious Injury	S6 - Gear attached to free-swimming animal with potential to be ingested or entangle	[Unknown if hooked. Unknown if entangled. Line cut with 48 ft remaining] Spent 26 minutes trying to get whale close enough to the boat for release, Capt. instructed crew to cut line. Swam away quickly. [30 minute interaction time]
13	Unid. Marine Mammal	180	Serious Injury	S6 - Gear attached to free-swimming animal with potential to be ingested or entangle	[Unknown if hooked. Unknown if entangled. Line cut with 48 ft of line remaining] After 25 minutes of trying to bring animal to surface, captain deemed to dangerous and line was cut at the snap. Active, live marine mammal. Line was cut at the snap, did not see whale surface again. Saw animal briefly breech surface, did not see any (too far away) distinctive entanglement or hooking, but saw gangion jerk up when jump. [25 minute interaction time]

Appendix B, Table B2 (cont.)

Animal #	Species	Length (cm)	Release Condition	Interaction Type	Observer Comments
14	Unid. Marine Mammal	180	Serious Injury	S6 - Gear attached to free-swimming animal with potential to be ingested or entangle	[Unknown if hooked. Unknown if entangled. Line cut with 48 ft remaining] Spent 20 minutes trying to bring mammal close enough to boat when Captain decided to cut line. Active, live marine mammal. Too dark and far away to see. [30 minute interaction time]
15	Pilot Whale	210	Serious Injury	S6 - Gear attached to free-swimming animal with potential to be ingested or entangle	[Had hooked tuna in mouth. Crew indicated animal was not hooked. Line cut, with 48 ft remaining, presumably attached to Tuna] Line was cut at snap. MPW surfaced near vessel with hooked tuna in its mouth, Capt. cut leader. Observer didn't see tuna, only MPW swim away with line coming from mouth, presumptively from tuna. The animal swam away normally, it seems to have been eating a tuna that was hooked and cut off from gear. [30 second interaction time]
16	Pilot Whale	300	CBD	S7b - Entangled before being freed without gear attached	[Not hooked. Entangled around flukes in mainline. Partial gear, perhaps all, removed.] Pilot whale was handlined to the boat where a crewmember used a pair of monofilament cutters to remove mainline wrapped around the whale's tail. Some or possibly all mainline and monofilament was removed. Whale swam away from vessel strongly and then dove, after pausing to rest for approx. 5 seconds. [2 minute interaction time]