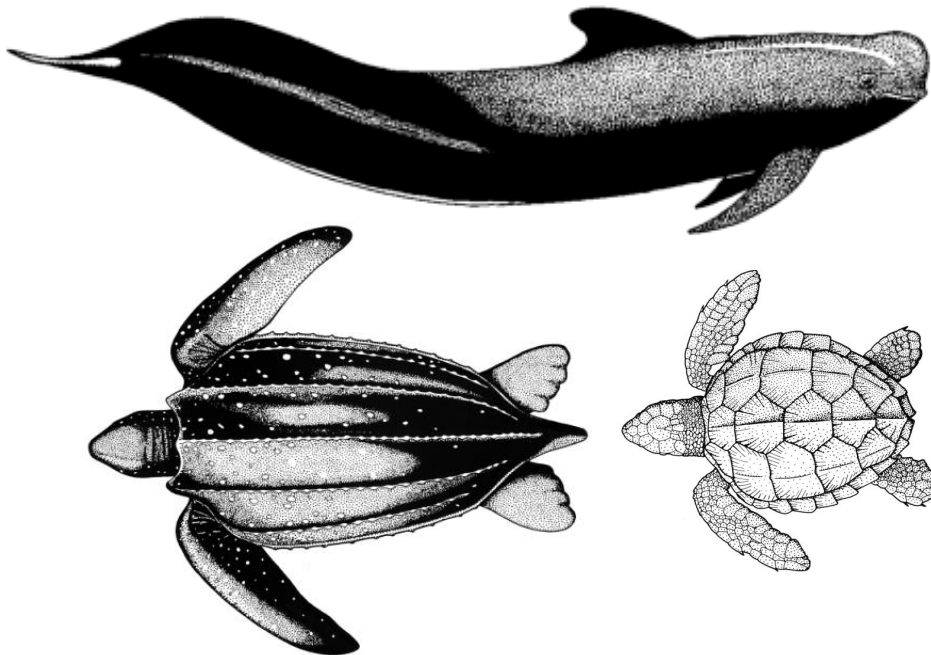




**Estimated Bycatch of Marine Mammals and Sea Turtles in the U.S. Atlantic Pelagic
Longline Fleet During 2019**

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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 2019 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 2019, there were an estimated 90.8 (48.4 – 166.4 [95% CI]) interactions with leatherback turtles and 67.4 (33.2– 136.7 [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 131.2 (64.8 – 265.6 [95% CI]) interactions resulting in serious injury. Potential sources of bias and uncertainty in these bycatch estimates are discussed.

TABLE OF CONTENTS

Introduction.....	1
Methodology	3
Geographic Stratification.....	3
Delta Lognormal Estimator	4
Sea Turtle Life History Form.....	6
Marine Mammal Serious Injury Determination.....	7
Apportioning Pilot Whale Takes Between Species	8
Results and Discussion.....	10
Reported Fishing Effort and Observer Coverage	10
Observed Protected Species Interactions	10
Estimated Interactions in Unobserved Areas with Fishing Effort	12
Total Estimated Bycatch	12
Trends in Bycatch Estimates.....	12
Sources of Bias and Uncertainty.....	13
Literature Cited	16
List of Tables and Figures.....	19
Appendix A. Sea Turtle Life History Form.....	44
Appendix B. Details of Sea Turtle and Marine Mammal Interactions.....	46

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 *et al.*, 2009; Garrison and Stokes, 2010, 2012a, 2012b, 2013, 2014, 2016, 2017, 2019, 2020a, 2020b).

In this report, marine mammal and marine turtle bycatch estimates are calculated for pelagic longline fishery effort during 2019. 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 2019 were replaced with previously

observed mean bycatch rates from 2014-2018. 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 three 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, *et al.*, 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:

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

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:

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

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:

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

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

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

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 $N \cdot C$ for the lower and upper confidence bounds respectively where:

$$(6) \quad C = \exp [z_\alpha \sqrt{\text{var}(\ln N)}] ,$$

and

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

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 2019. 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 2019 (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 identify reliably 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 38-40°N latitude along the shelf break during warm months of the year. In the past decade, there have been very few interactions observed north of 38.5°N. 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 2019, 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 to date have 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 22°C and latitudes south of 39°N, the probability of a sample coming from a short-finned pilot whale exceeds 80% (see Garrison and Rosel, 2016 for additional detail).

Of the 15 observed pilot whale interactions during 2019, 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 3.7 million hooks during 2019 (Table 1A, Figure 2). The reported fishery effort included 4,823 sets during 2019, 502 of which were observed by the POP program (Tables 1B and 2B, Figure 2). The overall percent coverage during regular fishing was 10.2% expressed as a proportion of reported hooks and 10.4% as a proportion of reported sets (Table 3). The relatively high annual rate reflects the high coverage of the fishery during the second quarter in the GOM and the fourth quarter in the NED. Observer coverage for other area-quarter strata is shown in Table 3.

Areas with no observer coverage during 2019 with more than 10 sets of reported fishing effort include the CAR during Quarters 1, 2, and 4; NED during Quarter 3; and the Tuna North (TUN) during Quarters 1-3 (Table 3).

Observed Protected Species Interactions

There were 13 observed interactions with leatherback turtles, 7 with loggerhead turtles, and 2 unidentified turtles (Table 4, Figure 3) in 2019. The greatest number of observed leatherback takes occurred in the NED during Quarter 4 and the GOM during Quarter 2 (Table 4A, Figure 3). Loggerhead takes were observed in the greatest numbers in the FEC during Quarter 2 and NED during 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 8 of the 22 turtles captured (Table 6). A total of 2 leatherbacks were released either entangled or with the hook and line remaining that was $> \frac{1}{2}$ the carapace length (Table 6).

There were 16 interactions observed with marine mammals (Table 7, Figure 4). This included 15 interactions with pilot whales (Table 8), and none of these were sampled to allow direct identification to species. Ten of the observed marine mammal interactions were categorized as serious injuries including 9 pilot whales (Table 9). Six of the serious injuries were due to animals being hooked in the mouth/head, and 4 cases involved being released with gear likely to entangle the animal further (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 MAB during Quarter 4 (29.6), in the SAB in Quarter 1 (10.4) and 2 (11.4), and the GOM in Quarter 1 (12.6, Table 10). For loggerhead turtles, the estimated interactions were highest in the FEC in Quarter 1 (11.5) and Quarter 2 (21.3) and SAB in Quarter 2 (13.7, 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 Quarter 4.

Estimated Interactions in Unobserved Areas with Fishing Effort

The average bycatch rates and estimated catches in strata that were not observed during 2019 are summarized in Table 12. There were notable estimated sea turtle takes in prior years during Quarter 3 in the NED for leatherback turtles (Table 12).

Total Estimated Bycatch

There were an estimated total of 90.8 (48.4 – 166.4 [95% CI]) interactions with leatherback turtles during 2019 (Table 13). For loggerhead turtles, the estimated total number of interactions was 67.4 turtles (33.2 – 136.7 [95% CI], Table 13), and the estimate total interactions with unidentified hardshell turtles was 7.6 (2.1 – 27.1 [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 52.4 (18.0 – 152.6 [95% CI]) animals released alive, and 131.2 (64.8 – 265.6 [95% CI]) 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 2015-2019 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 2019 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 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 *et al.*, 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.

Literature Cited

- Andersen, M.S., K.A. Forney, T.V.N. Cole, T. Eagle, R. Angliss, K. Long, L. Barre, L. Van Atta, D. Borggaard, T. Rowles, B. Norberg, J. Whaley, and L. Engleby. 2008. Differentiating Serious and Non-Serious Injury of Marine Mammals: Report of the Serious Injury Technical Workshop, 10-13 September 2008, Seattle, Washington. NOAA Technical Memorandum NMFS-OPR-39. 94 p.
- Angliss, R.P. and D.P. DeMaster. 1998. Differentiating serious and non-serious injury of marine mammals taken incidental to commercial fishing operations. NOAA Technical Memorandum NMFS-OPR-13: 48 p.
- Beerkircher, L.R., C.J. Brown, D.L. Abercrombie and D.W. Lee. 2004. SEFSC Pelagic Longline Observer Program data summary for 1992-2002, NOAA Technical Memorandum NMFS-SEFSC-522: 25 p.
- Fairfield-Walsh, C. and L.P. Garrison. 2006. Estimated Bycatch of Marine Mammals and Turtles in the U.S. Atlantic Pelagic Longline Fleet During 2005. NOAA Technical Memorandum NOAA NMFS-SEFSC-539: 52 p.
- Fairfield-Walsh, C. and L.P. Garrison. 2007. Estimated Bycatch of Marine Mammals and Turtles in the U.S. Atlantic Pelagic Longline Fleet During 2006. NOAA Technical Memorandum NOAA NMFS-SEFSC-560: 54 p.
- Fairfield, C. and L.P. Garrison. 2008. Estimated Bycatch of Marine Mammals and Sea Turtles in the U.S. Atlantic Pelagic Longline Fleet During 2007. NOAA Technical Memorandum NOAA NMFS-SEFSC-572: 62p.
- Garrison, L.P. 2003. Estimated Bycatch of Marine Mammals and Turtles in the U.S. Atlantic Pelagic Longline Fleet During 2001-2002. NOAA Technical Memorandum NOAA NMFS-SEFSC-515: 52 p.
- Garrison, L.P. 2005. Estimated Bycatch of Marine Mammals and Turtles in the U.S. Atlantic Pelagic Longline Fleet During 2004. NOAA Technical Memorandum NMFS-SEFSC-531: 52 p.
- Garrison, L.P. and P.M. Richards. 2004. Estimated Bycatch of Marine Mammals and Turtles in the U.S. Atlantic Pelagic Longline Fleet During 2003. NOAA Technical Memorandum NMFS-SEFSC-527: 57 p.
- Garrison, L.P. and P.E. Rosel. 2016. Spatial distribution of short-finned and long-finned pilot whales along the U.S. east coast and partitioning abundance and bycatch estimates. Southeast Fisheries Science Center, Protected Resources and Biodiversity Division Report #PRBD-2016-17.

- Garrison, L.P., L. Stokes, and C. Fairfield. 2009. Estimated Bycatch of Marine Mammals and Sea Turtles in the U.S. Atlantic Pelagic Longline Fleet During 2008. NOAA Technical Memorandum NOAA NMFS-SEFSC-591: 63p.
- Garrison, L.P. and L. Stokes. 2010. Estimated Bycatch of Marine Mammals and Sea Turtles in the U.S. Atlantic Pelagic Longline Fleet During 2009. NOAA Technical Memorandum NOAA NMFS-SEFSC-607: 63p.
- Garrison, L.P. and L. Stokes. 2012a. Estimated Bycatch of Marine Mammals and Sea Turtles in the U.S. Atlantic Pelagic Longline Fleet During 2010. NOAA Technical Memorandum NOAA NMFS-SEFSC-624: 59p.
- Garrison, L.P. and L. Stokes. 2012b. Estimated Bycatch of Marine Mammals and Sea Turtles in the U.S. Atlantic Pelagic Longline Fleet During 2011. NOAA Technical Memorandum NOAA NMFS-SEFSC-632: 61p.
- Garrison, L.P. and L. Stokes. 2013. Estimated Bycatch of Marine Mammals and Sea Turtles in the U.S. Atlantic Pelagic Longline Fleet During 2012. NOAA Technical Memorandum NOAA NMFS-SEFSC-655: 62p.
- Garrison, L.P. and L. Stokes. 2014. Estimated Bycatch of Marine Mammals and Sea Turtles in the U.S. Atlantic Pelagic Longline Fleet During 2013. NOAA Technical Memorandum NOAA NMFS-SEFSC-667: 61p.
- Garrison, L.P. and L. Stokes. 2016. Estimated Bycatch of Marine Mammals and Sea Turtles in the U.S. Atlantic Pelagic Longline Fleet During 2014. NOAA Technical Memorandum NOAA NMFS-SEFSC-696: 61p.
- Garrison, L.P. and L. Stokes. 2017. Estimated Bycatch of Marine Mammals and Sea Turtles in the U.S. Atlantic Pelagic Longline Fleet During 2015. NOAA Technical Memorandum NOAA NMFS-SEFSC-709: 61p.
- Garrison, L.P. and L. Stokes. 2019. Estimated Bycatch of Marine Mammals and Sea Turtles in the U.S. Atlantic Pelagic Longline Fleet During 2016. Southeast Fisheries Science Center, Protected Resources and Biodiversity Division Report, PRD-2019-01, 61p.
- Garrison, L.P. and L. Stokes. 2020. Estimated Bycatch of Marine Mammals and Sea Turtles in the U.S. Atlantic Pelagic Longline Fleet During 2017. Southeast Fisheries Science Center, Protected Resources and Biodiversity Division Report, PRD-2020-05, 58p.
- Garrison, L.P. and L. Stokes. 2020. Estimated Bycatch of Marine Mammals and Sea Turtles in the U.S. Atlantic Pelagic Longline Fleet During 2018. Southeast Fisheries Science Center, Protected Resources and Biodiversity Division Report, PRD-2020-08, 56p.

- Johnson, D.R., C. Yeung, and C.A. Brown. 1999. Estimates of marine mammal and marine turtle bycatch by the U.S. Atlantic pelagic longline fleet in 1992-1997. NOAA Technical Memorandum NMFS-SEFSC-418: 70 p.
- NMFS. 2003. Guide for complying with the regulations for Atlantic tunas, swordfish, sharks, and billfish. September 2003.
http://www.nmfs.noaa.gov/sfa/hms/2003_ComplianceGuide.pdf
- NMFS 2012a. Process for distinguishing serious from non-serious injury of marine mammals. National Marine Fisheries Service Policy Directive PD 02-038. January 2012. <http://www.nmfs.noaa.gov/directives>.
- NMFS 2012b. Process for distinguishing serious from non-serious injury of marine mammals: Process for injury determinations. National Marine Fisheries Service Policy Directive PD 02-038-01. January 2012.
<http://www.nmfs.noaa.gov/directives>.
- Pennington, M. 1983. Efficient estimators of abundance for fish and plankton surveys. Biometrics 39: 281-286.
- Southeast Fisheries Science Center. 2012. Protocols for categorizing sea turtles for post-release mortality estimates. NMFS Southeast Fisheries Science Center Contribution PRD-2011-07, August 17, 2011, revised February 2012, 8p. Available from: Southeast Fisheries Science Center, 75 Virginia Beach Dr., Miami, FL 33149;
http://www.sefsc.noaa.gov/turtledocs/UPR_SEFSC_PHMortality_2012.pdf
- Watson, J.W., S.P. Epperly, A.K. Shah and D.G. Foster. 2005. Fishing methods to reduce sea turtle mortality associated with pelagic longlines. Canadian Journal of Fisheries and Aquatic Science 62: 965-981.
- Yeung, C. 1999a. Revised mortality estimates of marine mammal bycatch by the U.S. Atlantic pelagic longline fleet in 1992-1997 based on serious injury guidelines. NOAA Technical Memorandum NMFS-SEFSC-429: 23 p.
- Yeung, C. 1999b. Estimates of marine mammal and marine turtle bycatch by the U.S. Atlantic pelagic longline fleet in 1998. NOAA Technical Memorandum NMFS-SEFSC-430: 26 p.
- Yeung, C. 2001. Estimates of marine mammal and marine turtle bycatch by the U.S. Atlantic pelagic longline fleet in 1999-2000. NOAA Technical Memorandum NMFS-SEFSC-467: 43 p.

List of Tables and Figures

Table 1. Total amount of fishing effort reported to the pelagic longline logbook program during 2019 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.

Table 2. Total amount of fishing effort observed during 2019 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.

Table 3. Percentage of reported fishing effort observed during 2019 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.

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 2019 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. * Unidentified hardshell turtle interactions were observed in FEC, Quarter 3 and GOM Quarter 2.

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 2019. Hook location information is recorded on the sea turtle life history form (Appendix A) by the observer.

Table 6. Release status and gear removal for sea turtles captured and released alive in the U.S. Atlantic Pelagic Longline Fishery during 2019. Condition columns refer to post-release mortality categories in Table 1 of SEFSC (2012).

Table 7. Total number of marine mammals observed in interactions with the pelagic longline fishery during 2019 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.

Table 8. Marine mammal interactions with the pelagic longline fishery during 2019 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.

Table 9. Summary of release condition and serious injury types for marine mammals observed in the pelagic longline fishery during 2019. 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.

Table 10. Estimated interactions with sea turtles in the pelagic longline fishery during 2019 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 2019 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 2019. NR indicates strata where effort cannot be reported for 2019 due to confidentiality restrictions.

Table 13. Total estimated interactions for A) Leatherback, B) Loggerhead and C) Unidentified hardshell turtles in the pelagic longline fishery during 2019 by fishing area. This includes estimates for strata that were not observed during 2019.

Table 14. Total estimated interactions with marine mammals in the pelagic longline fishery during 2019.

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 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 (gray circles) and reported (black circles) pelagic longline fishing effort during 2019.

Figure 3. Observed pelagic longline fishing effort and sea turtle takes during 2019.

Figure 4. Observed pelagic longline fishing effort and marine mammal takes during 2019.

Figure 5. Historical trends in fishery effort and estimated marine turtle takes in the pelagic longline fishery between 1992 and 2019 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 2019 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.

Table 1. Total amount of fishing effort reported to the pelagic longline logbook program during 2019 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	19.3	154.6	155.9	56.0	0.7	0.0	0.0	190.9	45.0	37.7	0.0	660.2
2	29.4	116.4	124.1	213.4	0.0	0.0	0.0	496.3	1.6	21.4	0.0	1002.7
3	39.9	83.1	194.5	338.6	0.8	290.6	50.7	72.7	0.0	26.1	0.0	1096.9
4	59.5	56.1	255.1	345.0	1.6	55.1	32.0	96.8	1.0	10.8	0.0	913.0
Total	148.2	410.2	729.7	953.1	3.1	345.7	82.7	856.6	47.5	96.0	0.0	3672.7

B. Number of Sets

Quarter	CAR	FEC	GOM	MAB	NCA	NEC	NED	SAB	SAR	TUN	TUS	Total
1	23	213	198	94	1	0	0	246	47	27	0	849
2	36	165	159	322	0	0	0	590	2	18	0	1292
3	40	115	274	493	1	341	45	121	0	22	0	1452
4	52	74	347	524	2	58	33	133	1	6	0	1230
Total	151	567	978	1433	4	399	78	1090	50	73	0	4823

Table 2. Total amount of fishing effort observed during 2019 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	12.6	14.9	1.5	0.0	0.0	0.0	32.3	3.6	0.0	0.0	65.0
2	0.0	9.4	51.6	19.7	0.0	0.0	0.0	42.3	0.0	0.0	0.0	122.9
3	3.5	18.0	15.8	18.1	0.0	34.0	0.0	11.6	0.0	0.0	0.0	101.0
4	0.0	3.7	19.5	25.7	0.0	3.3	14.8	5.6	0.0	10.8	0.0	83.5
Total	3.5	43.8	101.8	65.1	0.0	37.3	14.8	91.8	3.6	10.8	0.0	372.4

B. Number of Sets

Quarter	CAR	FEC	GOM	MAB	NCA	NEC	NED	SAB	SAR	TUN	TUS	Total
1	0	16	19	2	0	0	0	46	4	0	0	87
2	0	16	61	42	0	0	0	58	0	0	0	177
3	5	22	20	31	0	41	0	18	0	0	0	137
4	0	3	25	42	0	3	15	7	0	6	0	101
Total	5	57	125	117	0	44	15	129	4	6	0	502

Table 3. Percentage of reported fishing effort observed during 2019 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	8.2	9.5	2.7	0.0	-	-	16.9	8.0	0.0	-	9.8
2	0.0	8.1	41.6	9.2	-	-	-	8.5	0.0	0.0	-	12.3
3	8.8	21.7	8.1	5.4	0.0	11.7	0.0	16.0	-	0.0	-	9.2
4	0.0	6.6	7.6	7.5	0.0	6.0	46.2	5.8	0.0	100.0	-	9.1
Total	2.4	10.7	14.0	6.8	0.0	10.8	17.9	10.7	7.5	11.3	-	10.1

B. Number of Sets

Quarter	CAR	FEC	GOM	MAB	NCA	NEC	NED	SAB	SAR	TUN	TUS	Total
1	0.0	7.5	9.6	2.1	0.0	-	-	18.7	8.5	0.0	-	10.2
2	0.0	9.7	38.4	13.0	-	-	-	9.8	0.0	0.0	-	13.7
3	12.5	19.1	7.3	6.3	0.0	12.0	0.0	14.9	-	0.0	-	9.4
4	0.0	4.1	7.2	8.0	0.0	5.2	45.5	5.3	0.0	100.0	-	8.2
Total	3.3	10.1	12.8	8.2	0.0	11.0	19.2	11.8	8.0	8.2	-	10.4

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 2019 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. *Unidentified hardshell turtle interactions were observed in FEC Quarter 3 and GOM Quarter 2.

A. Leatherback Turtles

Quarter	CAR	FEC	GOM	MAB	NCA	NEC	NED	SAB	SAR	TUN	TUS	Total
1	-	0	1	0	-	X	X	2	0	-	X	3
2	-	0	3	0	X	X	X	1	-	-	X	4
3	0	0	0	0	-	0	-	0	X	-	X	0
4	-	0	0	2	-	0	3	0	0	1	X	6
Total	0	0	4	2	-	0	3	3	-	1	-	13

B. Loggerhead Turtles

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

C. All Turtles

Quarter	CAR	FEC	GOM	MAB	NCA	NEC	NED	SAB	SAR	TUN	TUS	Total
1	-	1	1	0	-	X	X	2	0	-	X	4
2	-	2	4*	1	X	X	X	2	-	-	X	9
3	0	1*	0	0	-	0	-	0	X	-	X	1
4	-	0	0	2	-	0	5	0	0	1	X	8
Total	0	4	5	3	-	0	5	4	-	1	-	22

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 2019. Hook location information is recorded on the sea turtle life history form (Appendix A) by the observer.

A. Release condition

Species	Alive, Uninjured	Alive, Unknown	Alive, injured	Total
Leatherback	2	1	10	13
Loggerhead	0	0	7	7
Hardshell	0	1	1	2
Total	2	2	18	22

B. Hook location in hooked animals

				Internal			External	Total
Species	Not Hooked	Unknown if Hooked	Hooked, Location Unknown	Unknown Internal	Swallowed	Beak or Mouth		
Leatherback	3	1	0	1	0	1	7	13
Loggerhead	0	0	0	0	2	4	1	7
Hardshell	0	1	0	0	0	1	0	2
Total	3	2	0	1	2	6	8	22

C. Animals with all gear removed, by hook location

				Internal			External	Total
Species	Not Hooked	Unknown if Hooked	Hooked, Location Unknown	Unknown Internal	Swallowed	Beak or Mouth		
Leatherback	3	0	0	0	0	0	1	4
Loggerhead	0	0	0	0	0	3	0	3
Hardshell	0	0	0	0	0	1	0	1
Total	3	0	0	0	0	4	1	8

Table 6. Release status and gear removal for sea turtles captured and released alive in the U.S. Atlantic Pelagic Longline Fishery during 2019. Condition columns refer to post-release mortality categories in Table 1 of SEFSC (2012).

Release Status	Leatherbacks	Loggerheads	Hardshell
Released entangled (Condition Column A)	1	0	1
Released with hook and line $\geq \frac{1}{2}$ carapace length (Condition Column B)	1	1	0
Released with hook and line $< \frac{1}{2}$ carapace length (Condition Column C)	7	3	0
Released with all gear removed (Condition Column D)	4	3	1

Table 7. Total number of marine mammals observed in interactions with the pelagic longline fishery during 2019 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	0	0	-	X	0
2	-	0	0	1	X	X	X	0	-	-	X	1
3	0	0	1	1	-	-	-	0	X	-	X	2
4	-	0	0	13	-	-	0	0	0	0	X	13
Total	0	0	1	15	-	0	0	0	-	0	-	16

Table 8. Marine mammal interactions with the pelagic longline fishery during 2019 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.

<i>Species</i>	<i>Quarter</i>	<i>Fishing Area</i>	<i>Serious Injuries</i>	<i>CBD</i>	<i>Released Alive</i>	<i>Total</i>
Pantropical Spotted Dolphins	3	GOM	1	0	0	1
Pilot Whales	2	MAB	1	0	0	1
Pilot Whales	3	MAB	0	1	0	1
Pilot Whales	4	MAB	8	2	3	13
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 2019. 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)		
Pantropical Spotted Dolphin	0	0	0	0	1	0	1	1
Pilot Whale	3	3	0	6	3	0	9	15
Total	3	3	0	6	4	0	10	16

Table 10. Estimated interactions with sea turtles in the pelagic longline fishery during 2019 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
GOM	1	1	19	0.081	1.000	155.9	12.6
GOM	2	2	61	0.064	0.740	124.1	7.9
MAB	4	2	42	0.086	0.704	345.0	29.6
NED	4	2	15	0.200	0.725	32.0	6.4
SAB	1	2	46	0.054	0.706	190.9	10.4
SAB	2	1	58	0.023	1.000	496.3	11.4
TUN	4	1	6	0.147	NA	10.8	1*

*100% of the sets reported in TUN in Quarter 4 were observed

Table 10 – Continued

B. Loggerheads

Area	Quarter	# Positive Sets	# Observed Sets	Mean CPUE	CV	Hooks Reported (x1000)	Estimated Catch
FEC	1	1	16	0.074	1.000	154.6	11.5
FEC	2	2	16	0.183	0.686	116.4	21.3
MAB	2	1	42	0.041	1.000	213.4	8.8
NED	4	2	15	0.133	0.681	32.0	4.3
SAB	2	1	58	0.028	1.000	496.3	13.7

C. Unidentified Hardshell

Area	Quarter	# Positive Sets	# Observed Sets	Mean CPUE	CV	Hooks Reported (x1000)	Estimated Catch
FEC	3	1	22	0.060	1.000	83.1	5.0
GOM	2	1	61	0.019	1.000	124.1	2.3

Table 11. Estimated A) Serious Injury and B) Released Alive marine mammals in the pelagic longline fishery during 2019 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
Pantropical Spotted Dolphin	GOM	3	1	20	0.066	1.000	194.5	12.9
Long-finned Pilot Whale	MAB	2	1	42	0.002	1.000	213.4	0.4
Short-finned Pilot Whale	MAB	2	1	42	0.041	1.000	213.4	8.8
Short-finned Pilot Whale	MAB	3	1	31	0.028	1.000	338.6	9.3
Short-finned Pilot Whale	MAB	4	6	42	0.328	0.416	345.0	113.1

B. Alive

Species	Area	Quarter	# Positive Sets	# Observed Sets	Mean CPUE	CV CPUE	# Hooks Reported (x1000)	Estimated Catch
Short-finned Pilot Whale	MAB	3	1	31	0.011	1.000	338.6	3.7
Short-finned Pilot Whale	MAB	4	4	42	0.141	0.629	345.0	48.7

Table 12. Bycatch rates for sea turtles and marine mammals in area-quarter strata that were not observed in 2019. NR indicates strata where effort cannot be reported for 2019 due to confidentiality restrictions.

A. Sea Turtles

Status	Species	Area	Quarter	# Positive Sets	#Observed Sets	Mean CPUE	CV CPUE	# Hooks Reported (X1000) 2019	Estimated Catch 2019
Alive	Leatherback	NED	3	18	158	0.165	0.242	50.7	8.4
Alive	Leatherback	SAR	4	3	78	0.040	0.577	1.0	0.0
Alive	Leatherback	TUN	1	1	31	0.025	1.000	37.7	1.0
Alive	Leatherback	TUN	2	1	19	0.043	1.000	21.4	0.9
Alive	Leatherback	TUN	3	1	29	0.044	1.000	26.1	1.2
Alive	Loggerhead	CAR	4	2	27	0.083	0.695	59.5	4.9
Alive	Loggerhead	NED	3	5	158	0.038	0.459	50.7	1.9
Alive	Loggerhead	SAR	4	2	78	0.026	0.713	1.0	0.0
Alive	Loggerhead	TUN	1	1	31	0.025	1.000	37.7	0.9
Alive	Unid. Hardshell	NED	3	1	158	0.006	1.000	50.7	0.3

Table 12 cont.

B. Marine Mammals

Injury Type	Species	Area	Quarter	# Positive Sets	#Observed Sets	Mean CPUE	CV CPUE	# Hooks Reported (X1000) 2019	Estimated Catch 2019
Serious Injury	Common Dolphin	NED	3	1	158	0.005	1.000	50.7	0.2
Serious Injury	Beaked Whale	NED	3	1	158	0.007	1.000	50.7	0.3
Dead	Unid. Whales	NED	3	1	158	0.005	1.000	50.7	0.2

Table 13. Total estimated interactions for A) Leatherback, B) Loggerhead, and C) Unidentified hardshell turtles in the pelagic longline fishery during 2019 by fishing area. This includes estimates for strata that were not observed during 2019.

A. Leatherbacks

Area	Alive	Alive CV	Total 95% Confidence Interval
CAR	0	-	-
FEC	0	-	-
GOM	20.5	0.677	6.1-68.4
MAB	29.6	0.704	8.5-102.7
NCA	0	-	-
NEC	0	-	-
NED	14.8	0.343	7.7-28.4
SAB	21.8	0.622	7.1-66.9
SAR	0.0	0.577	0-0.1
TUN	4.0	0.580	1.1-8.7
TUS	0	-	-
Total	90.8	0.323	48.4 – 166.4

B. Loggerheads

Area	Alive	Alive CV	Total 95% Confidence Interval
CAR	4.9	0.695	1.4-16.8
FEC	32.8	0.567	11.6-92.2
GOM	0	-	-
MAB	8.8	1.000	1.7-45.2
NCA	0	-	-
NEC	0	-	-
NED	6.2	0.490	2.5-15.4
SAB	13.7	1.000	2.7-70
SAR	0.0	0.713	0-0.1
TUN	0.9	1.000	0.2-4.8
TUS	0	-	-
Total	67.4	0.373	33.2 – 136.7

C. Unidentified Hardshell

Area	Alive	Alive CV	Total 95% Confidence Interval
FEC	5.0	1.000	1-25.4
GOM	2.3	1.000	0.5-11.9
NED	0.3	1.000	0.1-1.4
Total	7.6	0.725	2.1 – 27.1

Table 14. Total estimated interactions with marine mammals in the pelagic longline fishery during 2019.

A. Atlantic

Species	Estimated Alive	CV Alive	95% CI Alive	Estimated Serious Injury	CV Serious Injury	95% CI Serious Injury
Long-finned Pilot whale	0	-	-	0.39	1.000	0.08 – 2.0
Short-finned pilot whale	52.4	0.589	18.0 – 152.6	131.2	0.372	64.8 - 265.6

B. Gulf of Mexico

Species	Estimated Alive	CV Alive	95% CI Alive	Estimated Serious Injury	CV Serious Injury	95% CI Serious Injury
Pantropical Spotted Dolphin	0	-	-	12.9	1.000	2.5 – 65.9

C. Offshore

Species	Estimated Alive	CV Alive	95% CI Alive	Estimated Serious Injury	CV Serious Injury	95% CI Serious Injury
Common Dolphin	0	-	-	0.2	1.000	0.1 – 1.3
Beaked Whales	0	-	-	0.3	1.000	0.1 – 1.8
Unidentified Whales*	0	-	-	0.2*	1.000	0.1 – 1.2*

* For unidentified whales values are reported for mortalities rather than serious injuries.

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).

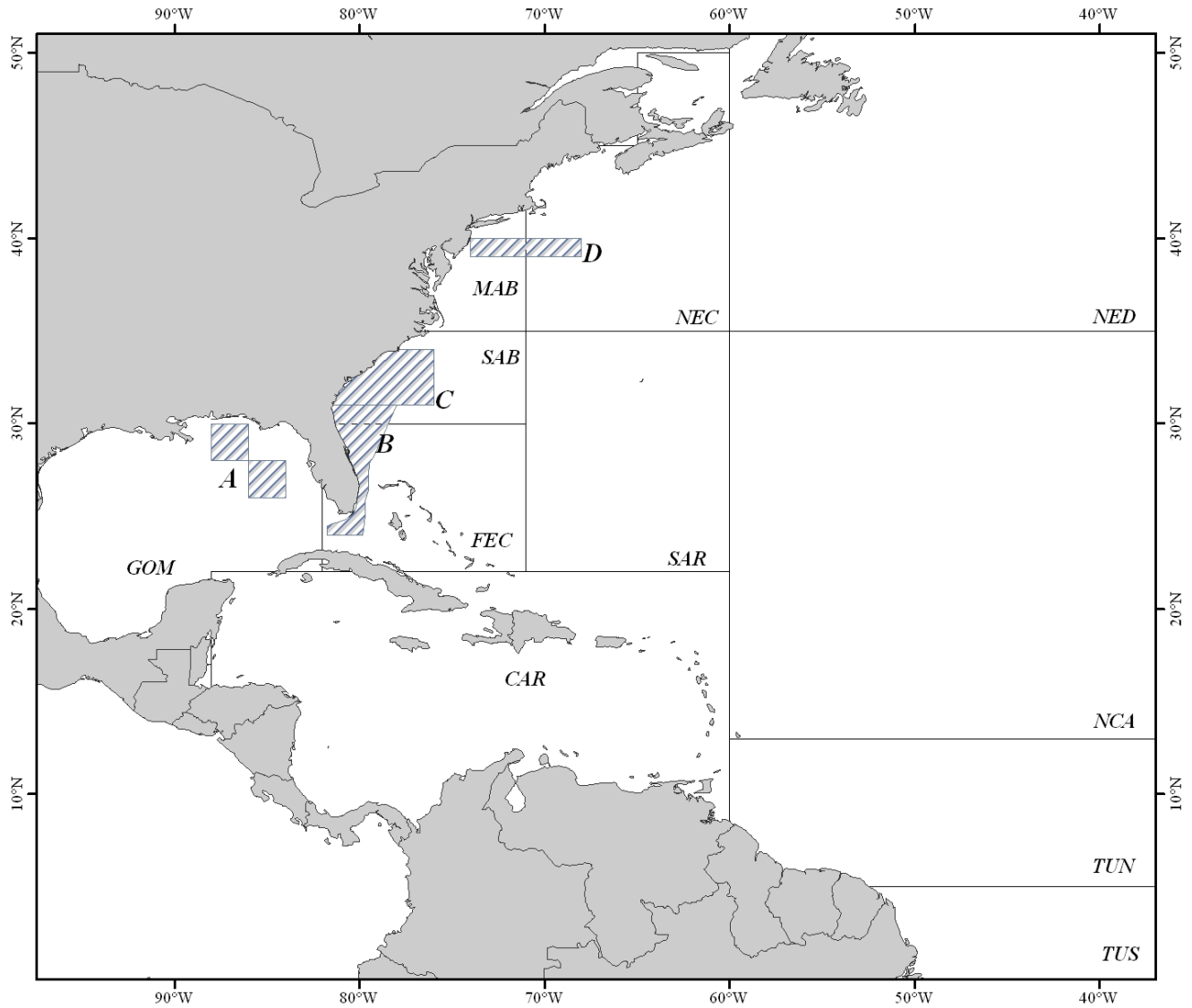


Figure 2. Observed (gray circles) and reported (black circles) pelagic longline fishing effort during 2019.

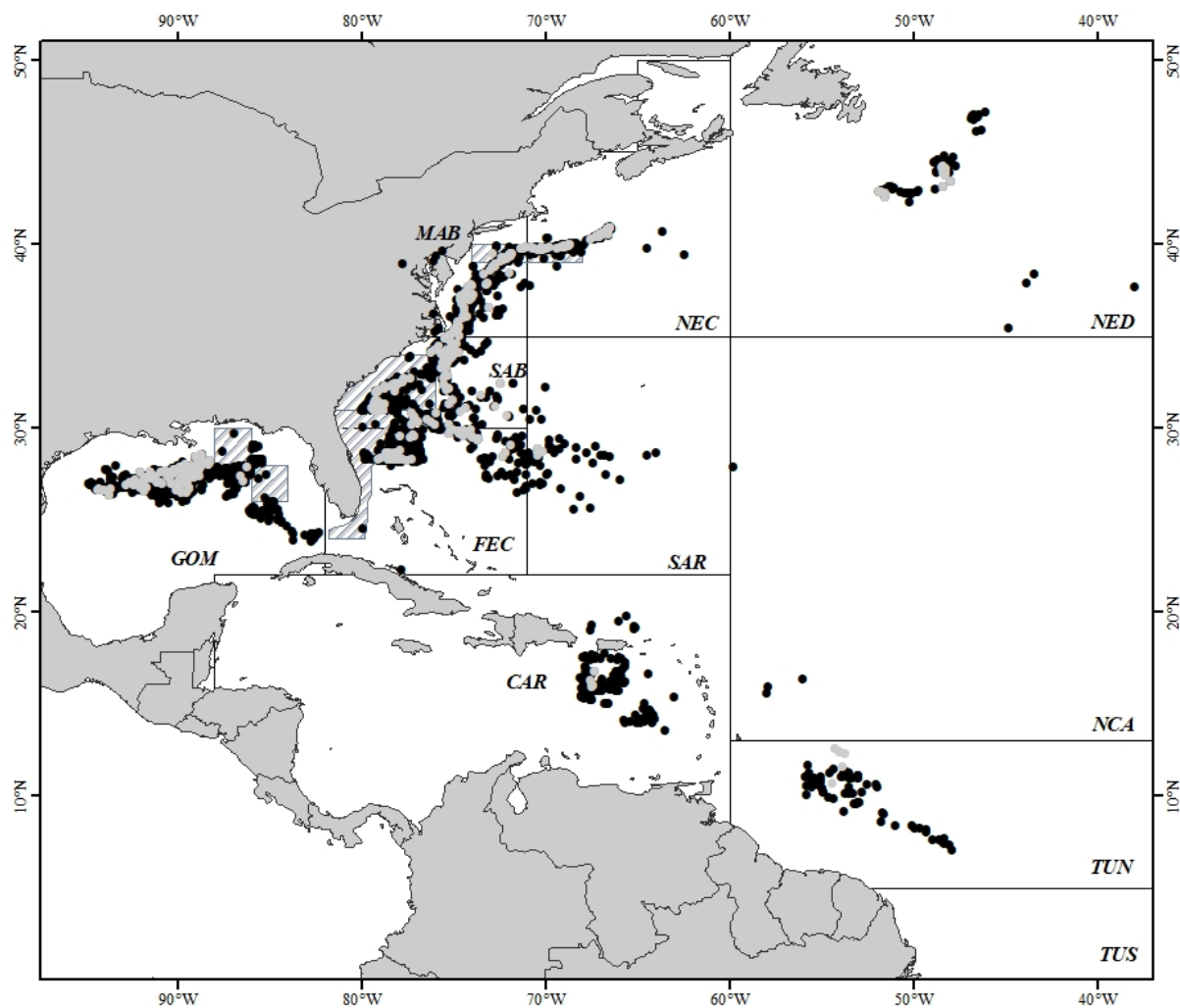


Figure 3. Observed pelagic longline fishing effort and sea turtle interactions during 2019.

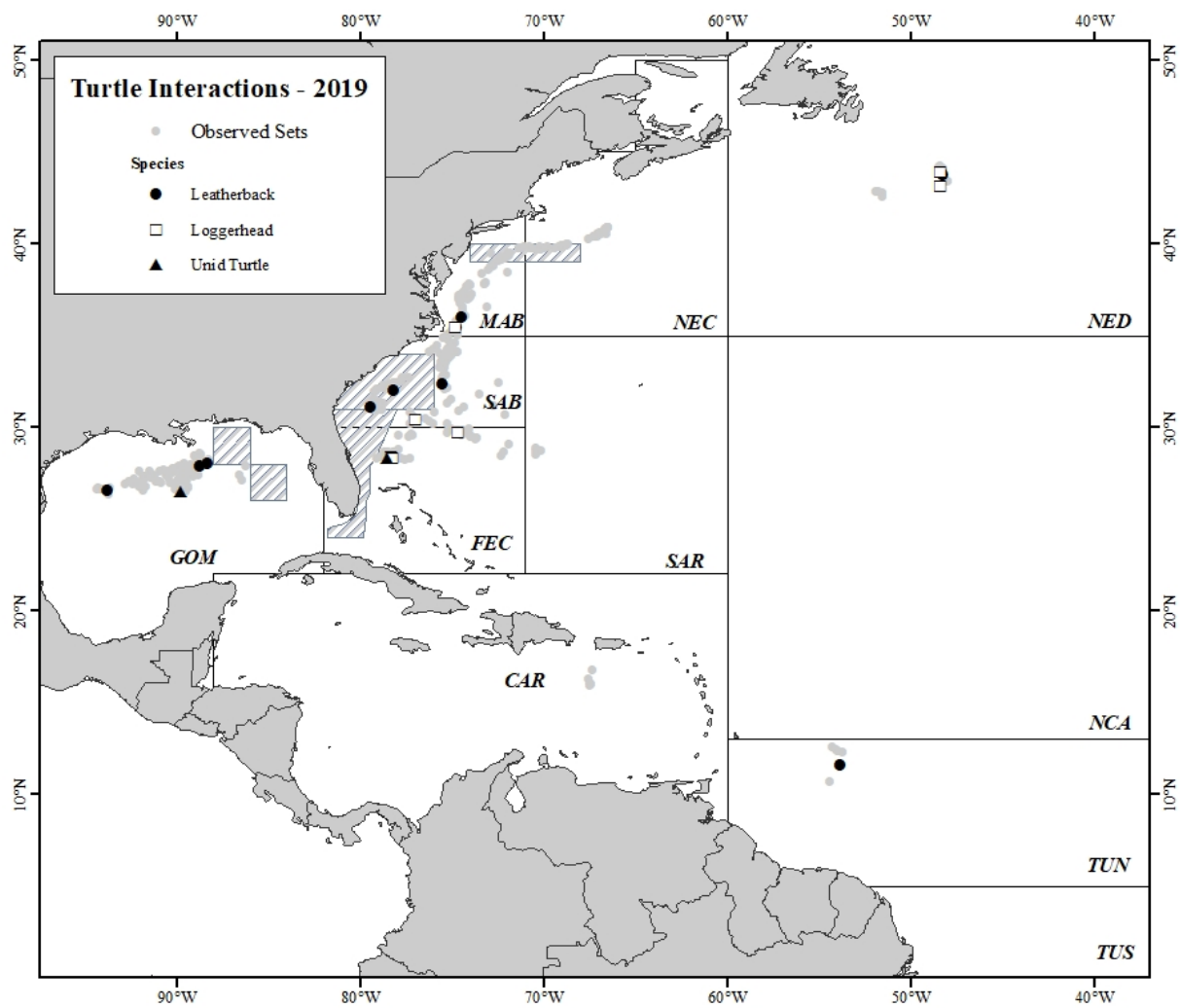


Figure 4. Observed pelagic longline fishing effort and marine mammal takes during 2019.

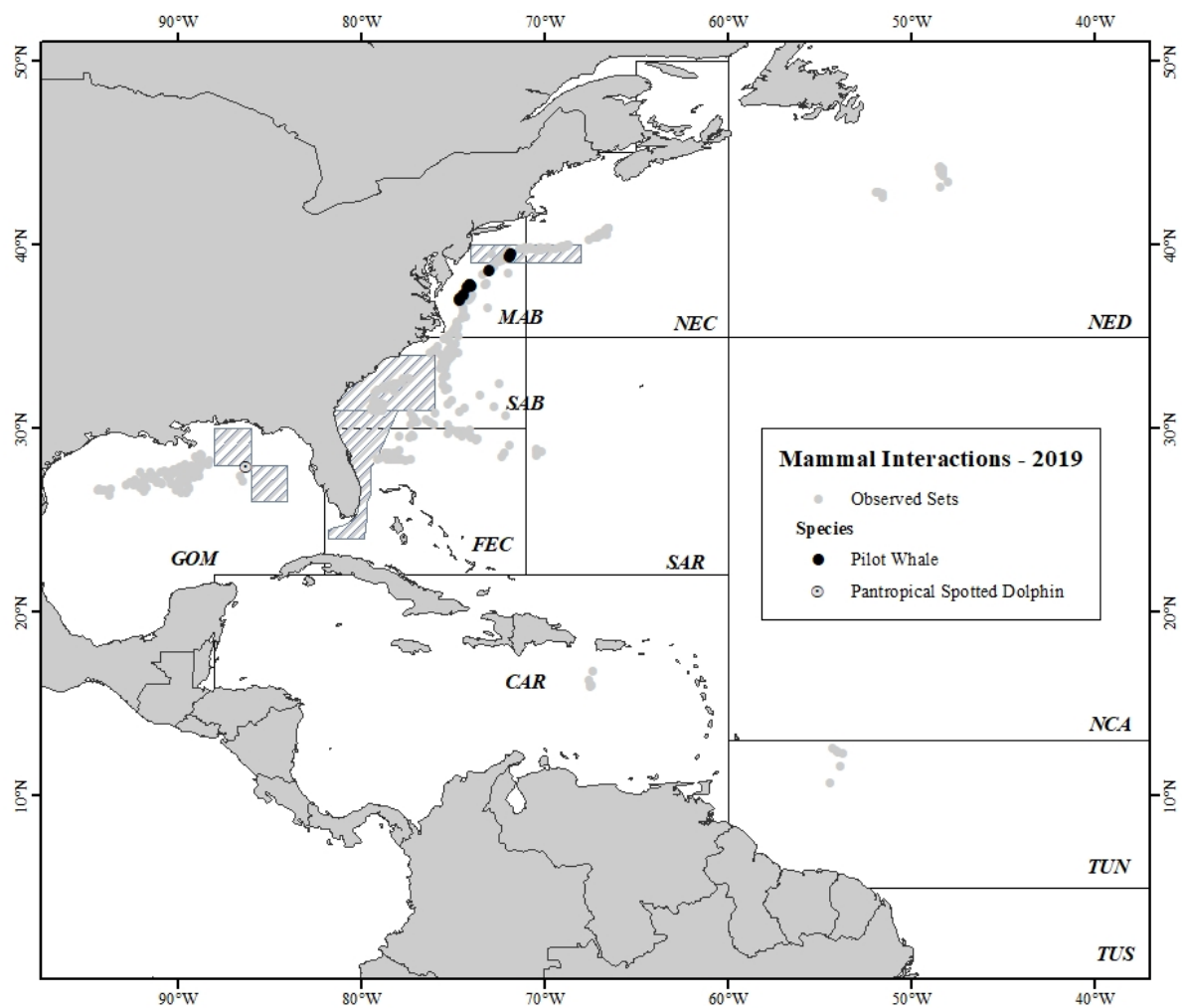
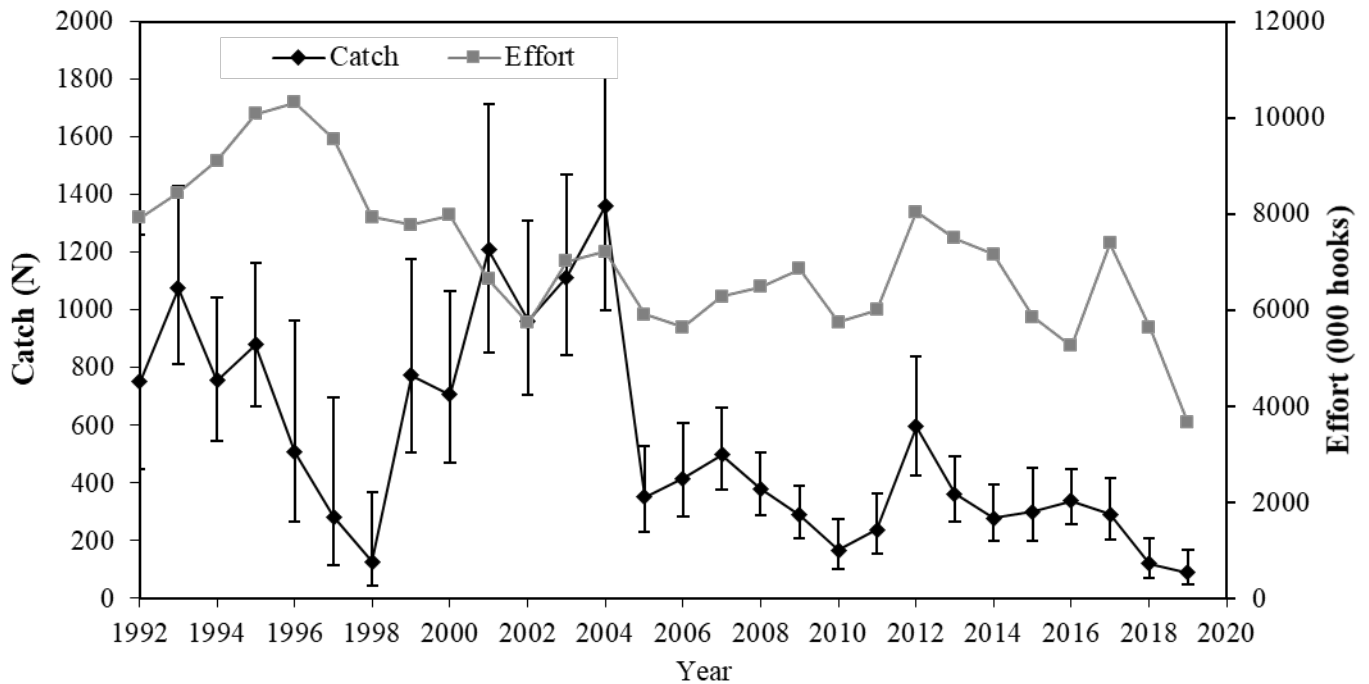


Figure 5. Historical trends in fishery effort and estimated marine turtle takes in the pelagic longline fishery from 1992 to 2019 for A) Leatherback Turtles, and B) Loggerhead Turtles. Errors bars represent 95% confidence intervals.

A. Leatherback Turtles



B. Loggerhead Turtles

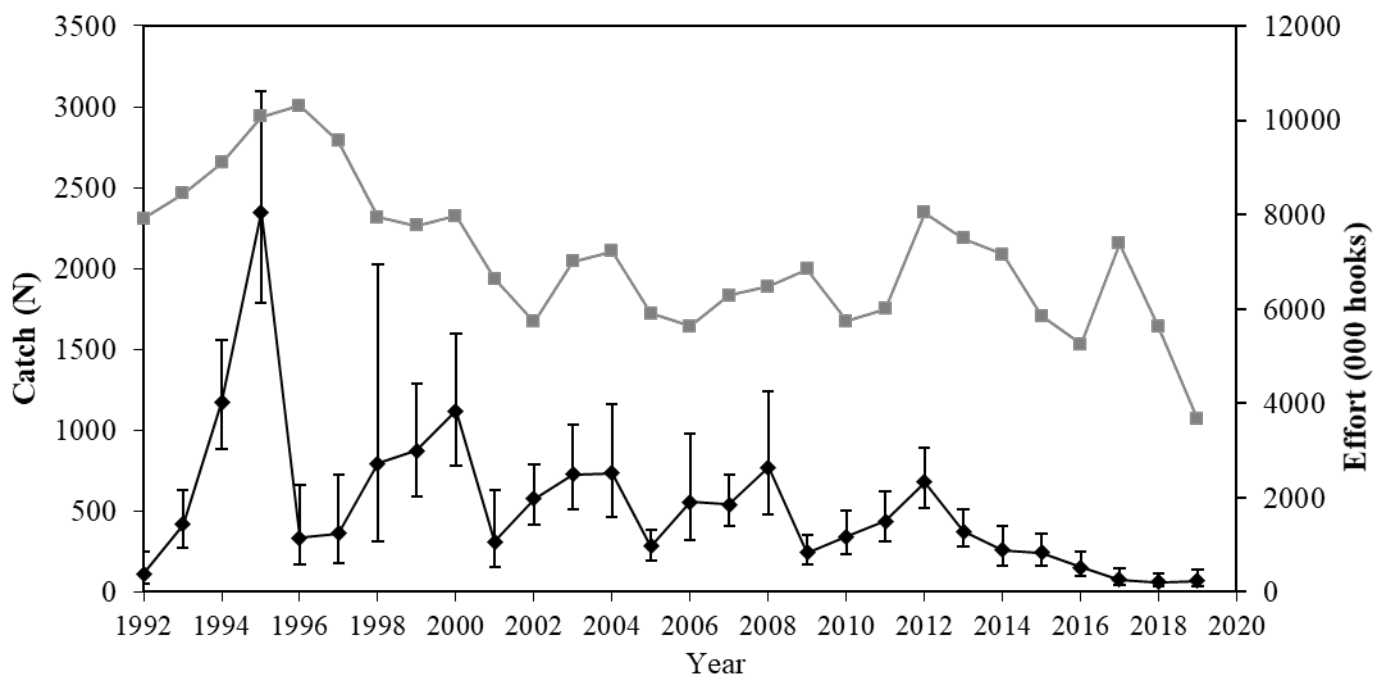
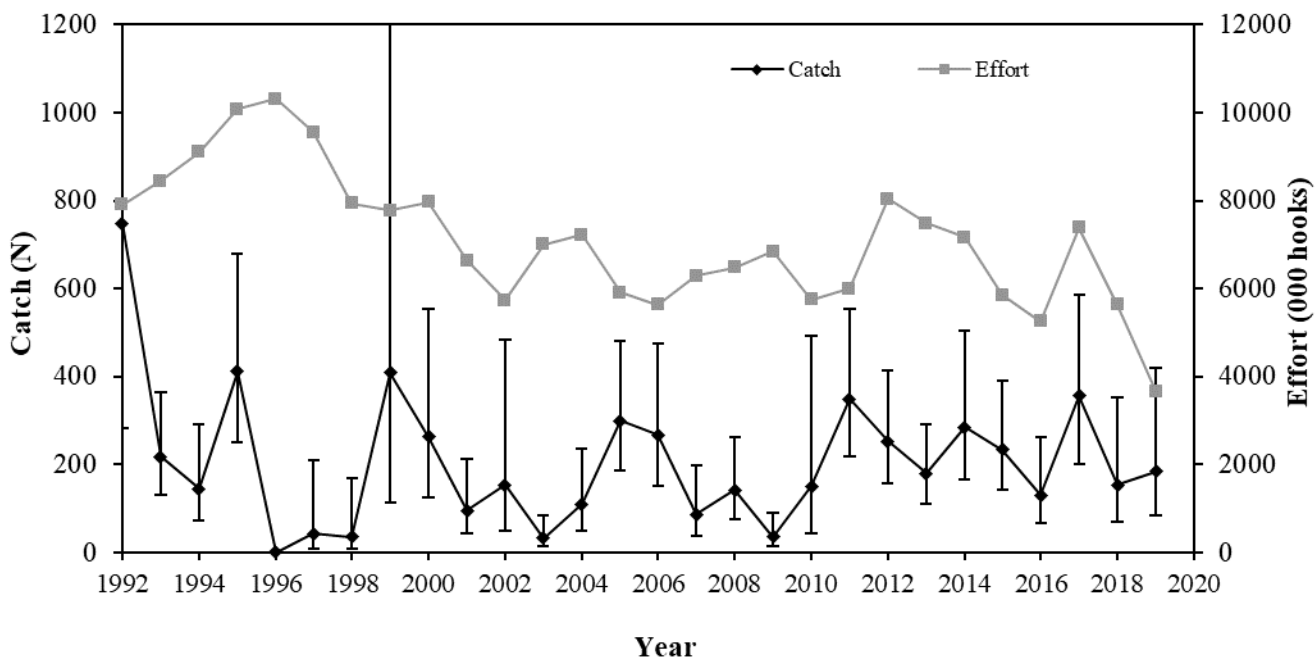
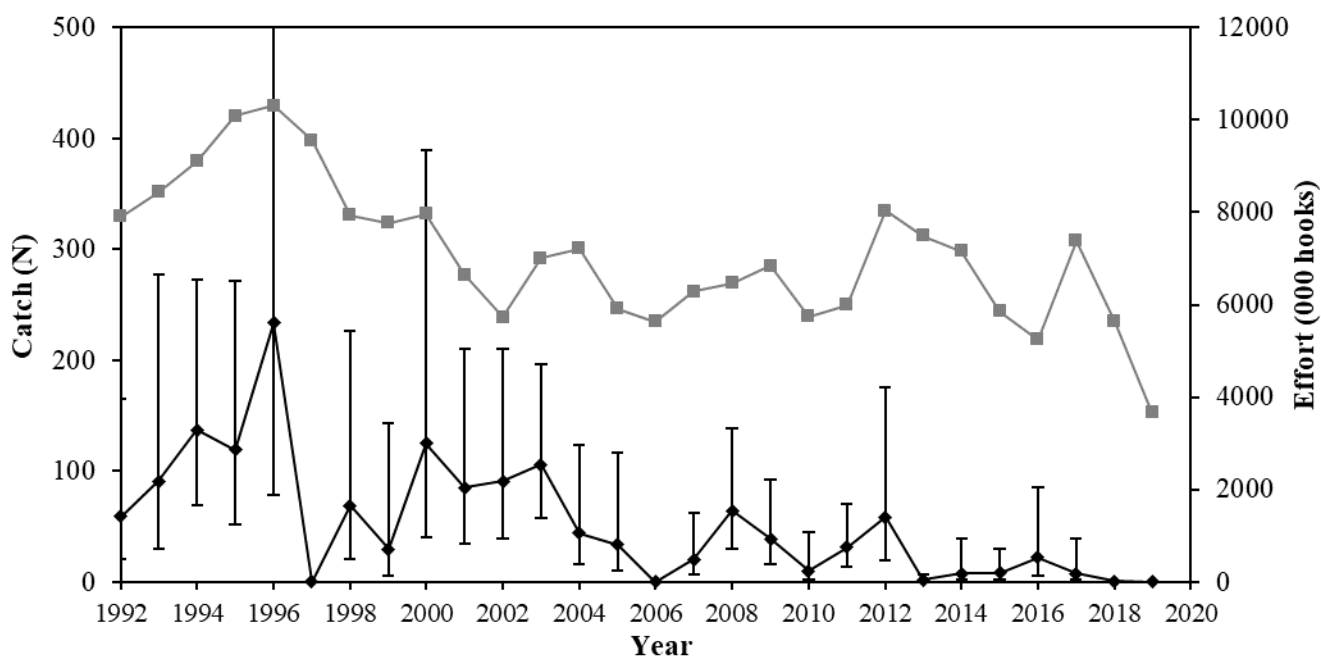


Figure 6. Historic trends in fishery effort and estimated marine mammal takes in the pelagic longline fishery from 1992 to 2019 for A) Pilot Whales and B) Risso's Dolphins in western North Atlantic waters. Errors bars represent 95% confidence intervals. For pilot whales, all takes are most likely of 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)

<u>DIMENSIONS (cm)</u>	Curved (measuring tape) Standard Measurements	Straight Line (calipers) Standard Measurements	Straight Line (calipers) Standard Measurements
Carapace Length	<input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> notch-to-tip	<input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> notch-to-tip	<input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> notch-to-notch
Carapace Width	<input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>	<input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>	<input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>

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?
<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/>	Y / N
<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/>	Y / N
<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/>	Y / N
<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/>	Y / N

[illegible]

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)

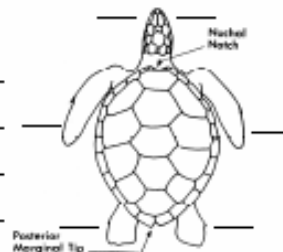
DATE, if different from capture: YEAR 20 MONTH DAY

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	<input type="checkbox"/>	Overlapping Scutes?	Y / N / U
Right Lateral Scutes	<input type="checkbox"/>	Inframarginal Pores?	Y / N / U
Vertebral Scutes	<input type="checkbox"/>	1 Pair Prefrontal Scales?	Y / N / U
L. Inframarginal Scutes	<input type="checkbox"/>	Lacks Bony Shell?	Y / N
R. Inframarginal Scutes	<input type="checkbox"/>	Does Nuchal Scute Touch 1 st Lateral Scute?	Y / N / U

Dorsal Coloration ☐ Black ☐ Orange/Red-Brown ☐ Brown ☐ Gray-Green ☐ Other _____

**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

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) Unidentified hardshell turtle observed during 2019. 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

#	Q	Area	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	1	SAB	C-16/0	0	Squid	270	Alive injured	Released alive	Armpit	No	No	No	1	C	1.0	5.0		
2	1	GOM	C-16/0	0	Squid	189	Alive unknown	Released alive	Not known if hooked	Unknown	Yes	No	4	C	0.0	5.0		
3	1	SAB	C-16/0	0	Mackerel	207	Alive injured	Released alive	Armpit	No	No	No	1	C	0.5	6.0		
4	2	SAB	C-16/0	0	Mackerel, squid or Pacific saury	158/158 /68	Alive uninjured	Released alive	Not hooked	N/A	Yes	No	5	D	0.0	5.0		
5	2	GOM	C-16/0	0	Pacific saury	99	Alive injured	Released alive	Unknown internal	No	No	No	4	C	2.0	5.0		
6	2	GOM	C-16/0	0	Pacific saury	99	Alive injured	Released alive	Shoulder	No	No	No	1	C	1.0	6.0		
7	2	GOM	C-16/0	0	Squid	126	Alive injured	Released alive	Shoulder	No	No	No	1	C	1.0	6.0		
8	4	MAB	C-16/0	0	Squid	198	Alive injured	Released alive	Armpit	No	Yes	No	1	B	3.0	6.0		
9	4	NED	C-18/0	10	Mackerel	324	Alive injured	Released alive	Shoulder	Yes	No	No	1	D	0.0	5.0		

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

#	Q	Area	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)
10	4	NED	C-18/0	10	Mackerel	320	Alive injured	Released alive	Not hooked	N/A	Yes	No	5	D	0.0	4.0		
11	4	NED	C-18/0	10	Squid	320	Alive injured	Released alive	Shoulder	No	No	No	1	C	0.0	4.0		
12	4	MAB	C-16/0	0	Squid	188	Alive uninjured	Released alive	Not hooked	N/A	Yes	No	5	D	0.0	6.0		
13	4	CAR	C-16/0	0	Squid	171	Alive injured	Released alive	Mouth side other	No	Yes	Yes	2	A	100.0	6.0		

Appendix B, Table B1, B. Loggerhead Turtles

#	Q	Area	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	1	FEC	C-16/0	0	Mackerel	207	Alive injured	Released alive	Swallowed hook not visible	No	No	No	4	B	1.5	2.0		
2	2	SAB	C-16/0	0	Squid	230	Alive injured	Released alive	Front flipper	No	No	No	1	C	0.5	3.0		
3	2	FEC	C-16/0	0	Squid	225	Alive injured	Released alive	Swallowed hook not visible	No	No	No	4	C	0.5	4.5		
4	2	FEC	C-16/0	0	Squid	230	Alive injured	Released alive	Beak (internal/ mouth unknown)	No	No	No	3	C	0.5	3.0		
5	2	MAB	C-16/0	0	Squid	167	Alive injured	Released alive	Tongue	Yes	No	No	3	D	0.0	3.0		
6	4	NED	C-18/0	10	Mackerel	324	Alive injured	Released alive	Mouth lower jaw other	Yes	No	No	2	D	0.0	2.0		
7	4	NED	C-18/0	10	Mackerel	320	Alive injured	Released alive	Beak (internal) lower jaw	Yes	No	No	1	D	0.0	2.0		

Appendix B, Table B1, C. Unidentified Hardshells

#	Q	Area	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	2	GOM	C-16/0	0	Squid or Pacific saury	171 or 108	Alive unknown	Released alive	Not known if hooked	No	Unknown	Unknown	4	A	90.0	2.5		
2	3	FEC	C-16/0	0	Squid	194	Alive injured	Released alive	Mouth lower jaw other	Yes	No	No	2	D	0.0	2.0		

Appendix B cont.

Table B2: 2019 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.

Animal #	Species	Length (cm)	Release Condition	Interaction Type	Observer Comments
1	Pantropical Spotted Dolphin	120	Serious Injury	S6 - Gear attached to free-swimming animal with potential to be ingested or entangle	[Not hooked. Entangled around flukes in gangion/leader. Partial gear removed with 5 wraps remaining]. Animal was brought to bow where captain and crew made attempts to unwrap mono from tail. As the animal grew more distressed, captain decided to cut the line leaving about 3 feet trailing and approximately 5 wraps around the tail. Swam away, popped up for air a few times.
2	Pilot Whale	450	Serious Injury	S6 - Gear attached to free-swimming animal with potential to be ingested or entangle	[Unknown if hooked, unknown if entangled. Line cut leaving 60 feet trailing line, not removed]. Crew pulled MPW as close to the vessel as they could with gripable line available. Once gangion was within scissor distance, crew cut line. During the interaction the animal repeatedly surfaced for breath followed by trying to dive away, remaining out of sight until surfacing for another breath. This continued until the line was cut and the animal dove and dove away rapidly.
3	Pilot Whale	270	CBD	S7b - Entangled before being freed without gear attached	[Unknown if hooked, line cut with 10 feet remaining, unknown if entangled] The crew handlined the whale as close to the boat as possible (whale was swimming vigorously away) and then used a long handled monofilament cutter to cut the leader that was holding the whale. Whale was swimming away from the vessel during the interaction, when released it swam away strongly and dove.
4	Pilot Whale	300	Serious Injury	S6 - Gear attached to free-swimming animal with potential to be ingested or entangle	[Hooked in mouth, line going into mouth, hook not visible. Line cut, 8 feet remaining. Not entangled]/ Whale was handlined to the rail of the vessel, long handled line cutter was used to cut leader when the crew was able to reach. Whale swam away strongly and dove when released.
5	Pilot Whale	270	Serious Injury	S5a - Hook in head	[Hooked in mouth, hook visible to insertion point. Line cut with 5 feet remaining, not entangled.] Capt. Hand-lined whale to vessel and cut leader with hand clippers when approximately 5 feet of mono was remaining. Whale vigorously resisted being pulled to vessel, was circling, breaching, and swam away strongly and dove when released.
6	Pilot Whale	300	Released Alive	S7b - Entangled before being freed without gear attached	[Not hooked. Entangled in mainline around head/neck. Gear removed and wraps cut] Entangled in one loop of mainline. Capt. Cut mainline loop w hand clippers and the free end of the mainline loop slipped off. Swam away strongly when freed from mainline.

Appendix B, Table B2 (cont.)

Animal #	Species	Length (cm)	Release Condition	Interaction Type	Observer Comments
7	Pilot Whale	300	Released Alive	S7b - Entangled before being freed without gear attached	[Not hooked. Entangled in mainline around tail stock. Gear removed]. Capt. Held mainline steady at the tuna door while another crew member cut the line away from the wrapped tail. No gear remained. Crew used hand held line cutters to cut wraps. Happily swam off.
8	Pilot Whale	240	Released Alive	S5d – Hooked externally	[Hooked external in flipper. Line cut, 3 feet remaining and hook. Not entangled] Animal was thrashing so line was cut intentionally. Line was cut using hand held line cutter. Quick and frantic, dove under and swam instantly.
9	Pilot Whale	300	Serious Injury	S6 - Gear attached to free-swimming animal with potential to be ingested or entangle	[Not hooked. Entangled in mainline around tail/flukes. Partial wraps cut, 4 feet remaining with animal] Crew did their best to remove all gear, but the gangion broke leaving some mainline wrapped around its tail. Tired at first and listing at the surface to catch its breath, then swam away with its friend. Friend looked like it was waiting.
10	Pilot Whale	180	Serious Injury	S5a - Hook in head	[Hooked in side of mouth with hook partially visible. Line cut with 3 feet trailing. Not entangled.] Crew pulled animal as close to the boat as they could together and cut line with handheld clippers. Seemed tired but did swim away.
11	Pilot Whale	300	Serious Injury	S6 - Gear attached to free-swimming animal with potential to be ingested or entangle	[Not hooked. Entangled in mainline around tail/flukes. Partial wraps cut, 7 feet remaining] Crew had animal at edge of boat to remove the wraps but the animal jerked away from the tuna door. Wraps remain embedded in tail with approx 3 ft trailing line, plus wrap. Loose wraps were pulled free. Frantic and instant escape on release.
12	Pilot Whale	300	CBD	S7b - Entangled before being freed without gear attached	[Not hooked. Entangled in mainline around tail/flukes. Line cut, but wraps not removed.] Animal was too strong to cut wraps. Crew used long handled line cutter to sever trailing line less than 1 ft from the tail but wraps remain. Actively swam away, albeit w/line wrapped around the base of its tail.
13	Pilot Whale	180	Serious Injury	S5a - Hook in head	[Hooked with line coming out of mouth. Hook not visible. Line cut within 4 feet remaining] Mammal was slowly pulled toward boat and line was cut by extended (12 ft) line cutter. 4 feet of line left on mammal. Mammal stayed on surface for approximately 2 minutes and then dove down.

Appendix B, Table B2 (cont.)

Animal #	Species	Length (cm)	Release Condition	Interaction Type	Observer Comments
14	Pilot Whale	180	Serious Injury	S5a - Hook in head, S6 - Gear attached to free-swimming animal with potential to be ingested or entangle	[Hooked in mouth, could not see hook location. Line cut, 42 feet remaining.] Gangion was cut at mainline, 42 feet of line left with animal. Mammal came to surface for a breath, dove down and then the line was cut. Did not see mammal come back up again. Seemed unharmed.
15	Pilot Whale	180	CBD	S7b - Entangled before being freed without gear attached	[Not hooked. Entangled in dropline around flukes. Partial gear removed. Amount remaining not specified.] Gear was cut using hand line cutter. Not sure if line fell off or not. Whale swam away unharmed, normal behavior.
16	Pilot Whale	240	Serious Injury	S5a - Hook in head	[Hooked in upper mouth, visible to insertion point. Unknown if removed. Entangled around body in mainline and gangion. Entangling gear removed.] Crewmember got on his belly and began to cut line away from face. The whale rolled over and untangled itself, took a breath and dove down normally. Whale took a breath and dove down, seemed unharmed.

