NOAA Technical Memorandum NMFS-SEFSC-749

ESTIMATED BYCATCH MORTALITY OF MARINE MAMMALS IN THE GULF OF MEXICO SHRIMP OTTER TRAWL FISHERY DURING 2015 TO 2019

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Cover photograph: Common bottlenose dolphin in South Carolina, June 2005. Photo was edited to remove vessel name for privacy protection.
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ABSTRACT

The Gulf of Mexico shrimp otter trawl fishery operates throughout the U.S waters of the Gulf of Mexico, including coastal and continental shelf waters and bays, sounds, and estuaries. The Atlantic and Gulf of Mexico shrimp fisheries are defined as a Category II fishery under the Marine Mammal Protection Act. The Gulf of Mexico otter trawl fishery can impact the Gulf of Mexico common bottlenose dolphin (*Tursiops truncatus*), and Atlantic spotted dolphin (*Stenella frontalis*) stocks, which include one spotted dolphin stock, one bottlenose dolphin continental shelf stock, three bottlenose dolphin coastal stocks, and 31 bottlenose dolphin bay, sound, and estuary (BSE) stocks. Total annual bycatch mortalities of marine mammals in the shrimp otter trawl fishery from 2015 to 2019 are estimated using data from NMFS's shrimp fishery Observer Program and stratified shrimp fishery effort models. Bycatch rates are calculated under two stratification scenarios and two species identification assumptions. Annual mortality estimates for each year from 2015 to 2019 are calculated using the ratio estimator with stratified annual fishery effort data for 2015 to 2019 and aggregate bycatch rates for 2000 to 2019. For each of the five years, 5-year unweighted mean mortality estimates are calculated for Gulf of Mexico dolphin stocks. BSE stock mortality estimates are aggregated at the state level.

Resulting bycatch mortality estimates over the five years indicate that under both stratification scenarios and both species identification scenarios, bycatch mortality estimates exceed 10% of Potential Biological Removal (PBR) for the Western Coastal bottlenose dolphin stock while bycatch mortality estimates for the Northern Coastal bottlenose dolphin stock have decreased since the first 2011 estimates and were at or below 10% of PBR in 2015 to 2019. Bycatch mortality estimates for the Eastern Coastal bottlenose dolphin stock have increased since the 2012 to 2014 estimates, approaching but remaining below 10% of PBR in 2015 to 2019. Other stocks which may have shrimp otter trawl bycatch mortalities above 10% of PBR include the Continental Shelf bottlenose dolphin stock and the Atlantic spotted dolphin stock, depending on the species identification scenario modeled. It remains possible that bycatch estimates have exceeded 50% of PBR for the Louisiana BSE bottlenose dolphin stock group in all years from 2015 to 2019, with some years potentially exceeding the PBR threshold, and that the PBR threshold may have been exceeded for the Alabama/Mississippi BSE stock group depending on the model used (all models have estimates above 10% of PBR). It is possible that bycatch mortalities for the Texas BSE stock group may be above 10% or 50% of PBR depending on the model used. Further data on both abundance and bycatch rates in inshore waters are required to determine whether this has occurred for the four inshore BSE stock groups. Potential sources of bias and uncertainty in these bycatch mortality estimates are discussed.

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INTRODUCTION

The commercial Gulf of Mexico shrimp trawl fishery is one of the largest and most economically important fisheries in the southeastern U.S. With a fleet of more than 4,000 vessels, of which approximately 1,400 are federally permitted[1], the fishery operates year-round in the Gulf of Mexico, with the highest effort during May through December (Nance 1993). The fishery targets primarily three species of penaeids [brown shrimp (*Farfantepenaeus aztecus*), pink shrimp (*F. duorarum*), and white shrimp (*Litopenaeus setiferus*)], and to a lesser extent, rock shrimp (*Sicyonia* spp.), Trachypenaeus shrimp (*Trachypenaeus* spp.), seabobs (*Xiphopenaeus kroyeri*), and royal red shrimp (*Pleoticus robustus*) (NOAA 2002, Scott-Denton et al. 2012). Main fishery activity extends throughout estuarine waters and coastal waters of less than 10 m depth and extends out over continental shelf waters to 120 m depth, with some effort for royal red shrimp in deeper waters (Nance et al. 2010, Caillouet Jr et al. 2011). Otter trawls are the primary gear type used by the fishery throughout the Gulf of Mexico, and skimmer trawls are additionally used in the bays, sounds, and estuaries of Louisiana, Alabama, and Mississippi (Hein & Meier 1995, Epperly et al. 2002, Scott-Denton et al. 2006, Price & Gearhart 2011, Scott-Denton et al. 2012).

The National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS) manages the shrimp trawl fishery Observer Program, which was established to monitor significant bycatch of finfish species and protected species, including sea turtles (Pellegrin Jr. 1982, Henwood & Stunz 1987, Nichols et al. 1987, Alverson et al. 1994, NMFS 1995, NMFS 1998, Epperly et al. 2002, NOAA 2012, Scott-Denton et al. 2012, Waring et al. 2012). Since 1991, management organizations have evaluated and subsequently required bycatch reduction devices (BRDs) and turtle excluder devices (TEDs) to reduce the bycatch of red snapper and sea turtles, respectively (Epperly et al. 2002, Epperly & Teas 2002, Scott-Denton 2007, Scott-Denton et al. 2012). Additionally, under the authorization of the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) and the Endangered Species Act (ESA), NMFS and the Gulf and South Atlantic Fisheries Foundation (Foundation)

[1] Federal permits are required for all commercial shrimp vessels that fish in Federal waters of the Gulf of Mexico. Federal waters range from 9 to 200 nautical miles off the coast of Florida and Texas and from 3 to 200 nautical miles off Alabama, Mississippi, and Louisiana.

implemented voluntary observer programs in 1992 and enacted a mandatory NMFS Observer Program in July 2007 to characterize shrimp trawl bycatch of finfish and protected species, characterize fishery behavior, and evaluate gear types for bycatch reduction (Scott-Denton et al. 2012, Federal Register 71:56039–56047, 26 September 2006).

The Southeastern U.S. Atlantic, Gulf of Mexico Shrimp Trawl Fishery has been defined as a Category II fishery under the Marine Mammal Protection Act since 2010 (75FR 68468, November 8, 2010) due to documented interactions with marine mammals. These interactions include 11 marine mammal interactions with the shrimp fishery that lead to mortality or serious injury[2] (MSI) [7 unidentified dolphins, 4 common bottlenose dolphins (*Tursiops truncatus*)] observed in the Gulf of Mexico by the shrimp trawl Observer Program during 1993 to 2010, and an additional 13 dolphin mortalities [1 Atlantic spotted dolphin (*Stenella frontalis*), 12 common bottlenose dolphins] in Southeast U.S. research trawl operations or sea turtle relocation trawls prior to 2010 (Wade & Angliss 1997, Waring et al. 2012). While the shrimp trawl fishery includes southeastern U.S. Atlantic and Gulf of Mexico waters, more than 90% of Observer Program effort and all Observer Program marine mammal takes have occurred in the Gulf of Mexico. Skimmer trawls, which account for an average of 55% of annual landings in Louisiana, Alabama, and Mississippi inshore waters, have had limited Observer Program coverage and no observed marine mammal takes (Scott-Denton et al. 2006, Pulver et al. 2012). Annual bycatch mortality of Gulf of Mexico common bottlenose dolphin and Atlantic spotted dolphin stocks[3] in the Gulf of Mexico otter trawl portion of the shrimp fishery have recently been estimated to document the fishery's impact for future management and conservation of these stocks (Soldevilla et al. 2015, Soldevilla et al. 2016).

Only two delphinid species, common bottlenose dolphins and Atlantic spotted dolphins, are commonly found in waters where the shrimp trawl fishery operates (Scott 1990, Mullin & Hansen 1999); the unidentified takes described above may belong to either of these species. NOAA-NMFS currently manages common bottlenose dolphins (hereafter referred to as

[2] Any injury that will likely result in mortality (50 CFR 216.3). Throughout this report, the term bycatch mortality is used to indicate MSI bycatch interactions.

[3] As defined by the MMPA, the term "stock" means a group of marine mammals of the same species or smaller taxa in a common spatial arrangement, that interbreed when mature.

bottlenose dolphins) as 36 distinct stocks within the Gulf of Mexico. These include one oceanic, one continental shelf, three coastal (Western Coastal, Northern Coastal, and Eastern Coastal), and 31 bay, sound, and estuary stocks (Hayes et al. 2020). The Northern Gulf of Mexico Oceanic stock is found in waters deeper than 200 m, outside of shrimp trawl fishing areas, and is unlikely to interact with the fishery. The Gulf of Mexico Continental Shelf stock's management boundaries are the 20-m and 200-m isobaths, and the three coastal stocks are bound by the shore, barrier islands, or bays, and the 20-m isobath. Climatic and oceanographic boundaries delineate the three coastal stocks such that the Gulf of Mexico Eastern Coastal stock ranges from 84°W to Key West, FL, the Gulf of Mexico Northern Coastal stock ranges from 84°W to the Mississippi River Delta, and the Gulf of Mexico Western Coastal stock ranges from the Mississippi River Delta to the Texas/Mexico border (Figure 1). The ranges of the Western Coastal and Continental Shelf stocks may continue into Mexican waters. Gulf of Mexico Bay, Sound, and Estuary (BSE) stocks were delineated in each of 31 areas of nearly contiguous, enclosed, or semi-enclosed water bodies adjacent to the U.S. Gulf of Mexico. Knowledge of stocks' seasonal movements is limited (e.g. Irvine et al. 1981, Fazioli et al. 2006). Spatial overlap may occur between BSE and coastal stocks where their distributions meet. Likewise, the Continental Shelf stock may overlap with coastal and Oceanic stocks where their distributions meet; for these stocks, crossing of "stock boundaries" is likely to occur. Most of the BSE stocks' abundance estimates are uncertain, as survey data are older than eight years (Table 1, Appendix A). Although no confirmed Atlantic spotted dolphin takes have been reported by the Observer Program, this species has been documented foraging around shrimp trawls in the Gulf of Mexico (Caldwell 1955, Delgado Estrella 1997, Fertl & Leatherwood 1997) and confirmed as bycatch in the Gulf of Mexico on several occasions in the 1980s (Ford 1991 pers. comm. in Fertl & Leatherwood 1997). Additionally, two Atlantic spotted dolphin (hereafter referred to as spotted dolphin) bycatch mortalities were documented in research shrimp trawls, one in the Atlantic and one in the Gulf of Mexico. Their range, across the northern Gulf of Mexico shelf between the 10-m and 200-m isobaths, almost completely overlaps with that of the Continental Shelf stock of bottlenose dolphins.

Dolphin entanglements in shrimp fishery gear mainly occurred in the lazy line or main body of the trawl net and also occurred in the TED, tickler chain, and other lines (Soldevilla et al. 2015, Soldevilla et al. 2016). Otter trawl gear includes two outriggers, each equipped with

one or two relatively fine-meshed otter trawl nets of approximately 30-50 ft. headrope length and variable net design, wooden doors at the net edges, a tickler chain, lead ropes, and headrope floats (Appendix B; Jenkins 2012, Scott-Denton et al. 2012). The net tapers from the mouth to the back to form a funnel ending in a codend, to which a lazy line is attached for bringing the net onboard for emptying (Maril 1983, 1995, Maiolo 2004). A variety of TED and BRD designs are approved for use in the Gulf of Mexico shrimp trawls and are integrated into the main body of the otter trawl net, ahead of the codend, enabling the escape of larger animals while retaining shrimp catch (Jenkins 2012, Scott-Denton et al. 2012).

In this report, estimates of annual marine mammal stock bycatch mortality are calculated for otter trawl gear in the commercial Gulf of Mexico shrimp trawl fishery for each of the years from 2015 to 2019. Additionally, unweighted five-year mean estimates are provided for the 2011-2015, 2012-2016, 2013-2017, 2014-2018, and 2015-2019 periods. Annually-aggregated bycatch rates (catch per hour fished) for otter trawl gear are quantified based upon observer data from 2000 to 2019, stratified by fishing area, depth, and season. The estimated bycatch rate is then multiplied by the total annual fishing effort (hours fished) estimated from landings and port interviews for each stratum for 2015 to 2019. Stratified bycatch mortality estimates are summed within dolphin stock distributional ranges to obtain estimates of total annual mortalities from otter trawl gear for the bottlenose dolphin and spotted dolphin stocks expected to be interacting with the fishery. Best-case and worst-case bycatch mortality estimates are developed for the stocks to account for uncertainty in species identification of some documented marine mammal takes. Sources of bias and variability in bycatch mortality estimates are discussed.

METHODS

Data Sources

Fishery Effort Data

Total effort data for the commercial Gulf of Mexico shrimp trawl fishery are obtained from modeled effort parameters derived by Nance et al. (2008). Stratified effort estimates (for both otter and skimmer trawls) are modeled from landings data collected by seafood dealers and port agent interviews with fishermen (Nance 1992, Nance 2004, Nance et al. 2008). Seafood dealer reports provide monthly data on total pounds of catch per species in 21 statistical subareas

(Figure 1) and 9 depth zones (Patella 1975). Shrimp catch per unit effort (CPUE) in each stratum has been obtained from port agent interviews with fishermen at the termination of their trips and by electronic logbooks (ELB) since 2006. While data are collected in fine resolution strata (12 months, 21 subareas, 9 depth zones), the models are built for coarser resolution strata to account for uncertainty in combining dealer reports and port agent interviews. The 36 coarse spatio-temporal strata used in the effort models are: a) four state-area groupings of the 21 statistical subareas [Florida (FL): subareas 1-9; Alabama/Mississippi (AL/MS[4]): subarea 10-12; Louisiana (LA[4]): subareas 13-17; Texas (TX): subareas 18-21]; b) three groupings of the 9 depth zones (inshore, nearshore, and offshore waters); and three seasonal strata or trimesters (Jan-Apr, May-Aug, and Sept-Dec). Inshore waters are those of the bays, sounds, and estuaries, defined as internal to the International Regulations for Preventing Collisions at Sea 1972 (COLREGS) line. Nearshore waters are those extending from the COLREGS line to the 10-fm (18-m) isobath. Offshore waters are those beyond the 10-fm (18-m) isobath. Total fishery effort per stratum, in nominal days fished (i.e., total trawl bottom time divided by 24 hours), is modeled as the total shrimp catch divided by CPUE (see Nance 1992, Nance 2004, Nance et al. 2008 for full details). Shrimp fishery effort data include all three depth zones, while the Observer Program (next section) primarily covers nearshore and offshore waters.

In the inshore waters of the LA and AL/MS state areas, fishery effort estimates include effort from skimmer and otter trawls. The Observer Program primarily places observers on otter trawl vessels, but the skimmer trawl fishery does not have enough observer coverage to estimate marine mammal bycatch. Therefore, skimmer effort is removed to yield stratified fishery effort estimates for commercial harvest from otter trawls only. Available effort data include stratified total fishery effort and stratified catch by weight apportioned to otter and skimmer trawls. Shrimp CPUE data stratified for skimmer and otter trawl gear in the Gulf of Mexico are not available. Limited comparisons of otter and skimmer trawl CPUEs in North Carolina estuaries indicate high variability seasonally and by penaeid species caught (Coale et al. 1994), and CPUEs have been shown to vary spatially, temporally, and by species for both gear types in the Gulf of Mexico (Nance 1992, Coale et al. 1994, Nance 2004, Warner et al. 2004, Scott-Denton et

[4] The AL/MS state area includes Louisiana state waters east of the Mississippi River Delta while the LA state area only includes waters west of the Mississippi River Delta.

al. 2006, Pulver et al. 2012). Since there was no systematic difference between CPUEs for the two gear types (Coale et al. 1994), we assumed equal CPUE for skimmer and otter trawls, and removed skimmer effort by multiplying the stratified total effort by the stratified proportion of catch by weight from otter trawls only to total catch (Table 2). Effort estimates in inshore LA and AL/MS strata may be biased if this assumption is invalid; implications of this assumption are considered further in the Discussion. In this report, we provide otter trawl effort estimates for 2011 to 2019 with updated values for years 2011 to 2014; data included in previous reports (Soldevilla et al. 2015, Soldevilla et al. 2016) had errors in the landings data (catch by weight) used to partition the effort by gear types due to an incorrect table join in the NMFS shrimp effort databases.

Additional effort data for Louisiana state waters, which have some of the highest levels of shrimp fishery effort, were obtained from the Louisiana Department of Wildlife and Fisheries (LDWF) Trip Ticket Program to improve our understanding of inshore effort distribution by water body and the validity of our CPUE assumptions for partitioning fishery effort by gear type. For 2011 to 2018, LDWF provided data on the total number of trips reporting shrimp catch by each of the otter trawl and skimmer trawl gear types stratified by year, season, and water basins containing subarea groupings. Using maps provided by LDWF (Appendix C1), subareas were grouped into water basins corresponding to each of the Louisiana BSE stock area boundaries (Appendix C2). In cases where fewer than three fishers reported catch from trips in a given gear type, water basin, trimester, and year stratum, the data were confidential and could not be released by LDWF. Comparing the total number of trips per year per gear type with the stratified trips indicates this impacts less than 0.5% of trips each year. For each gear type, total trips per year were compared among inshore water basins in western Louisiana (west of the Mississippi River Delta; LA state area) and eastern Louisiana (east of the Mississippi River Delta; AL/MS state area). The proportional effort (percent of trips) was calculated for each year, gear type, and state area to understand inshore effort distribution with respect to BSE dolphin stocks.

Further, the annual proportion of total effort (percent of trips) per gear type was calculated for western and eastern Louisiana inshore areas to improve our understanding of the validity of proportioning effort by landings. This is not directly comparable to NMFS effort

results, which are provided as nominal days of active fishing effort rather than trips. We weight the proportions by gear type by the average total active fishing effort (hours fished) per trip obtained from NMFS Observer Program data (described below) to improve this comparison; however, weighting by average durations of fishing effort per trip does not account for variation in fishery effort, and this is only a useful approximation to improve our understanding of the assumptions that go into our dolphin bycatch estimates. Further analyses of a robust dataset of inshore skimmer CPUEs and otter trawl CPUEs are needed, as described further in the Discussion.

Observer Program Data

NMFS Gulf of Mexico Shrimp Trawl Observer Program data collection methods have been described in detail previously (Scott-Denton 2007, Scott-Denton et al. 2012, Scott-Denton et al. 2020). Briefly, in the Gulf of Mexico, NMFS-approved observers were placed on randomly selected shrimp vessels based on lists of federally permitted vessels which were active in the previous year. Random selection was based on the previous year of effort stratified by state area, depth zone, and season. The list of active vessels was derived from a cross-reference of NMFS shrimp landings files and U.S. Coast Guard documentation records. Under the MSFCMA (MSFCMA; 16 USC1801), ESA, and MMPA, federal fishery permit holders are required to carry an observer if selected (MSFCMA § 303(b)(8)). Mandatory observer coverage compliance in the Gulf of Mexico shrimp trawl fishery has increased since 2007 as safety compliance by shrimp vessels has improved. For federally-selected vessels, a minimum sea-day requirement of 18 days within a seasonal selection period was established to prevent potential early trip termination as a result of having an observer on board. A vessel may carry an observer for multiple trips to meet this minimum-sea-day requirement.

The NMFS Gulf of Mexico Shrimp Trawl Observer Program primarily observes nearshore and offshore fishery operations, but occasionally, federally-permitted vessels operate in state nearshore and inshore waters when observers are on board and these inshore waters are an area of particular concern for protected species bycatch estimation (Soldevilla et al. 2015, Soldevilla et al. 2016). Beginning in 2015, funds were obtained from the NMFS Marine Fisheries Initiative (MARFIN) program to expand the shrimp fishery Observer Program coverage (by approximately 100 sea days per year) into inshore waters of the northern Gulf of

Mexico to improve assessment of protected species bycatch from both otter and skimmer trawl vessels. NMFS-approved observers were placed on randomly selected skimmer and otter trawl vessels fishing in inshore waters based on lists of federally and state permitted vessels which were active in the previous year. Random selection was based on the previous year of effort stratified by state area (Louisiana, Mississippi, and Alabama) and season (trimesters). The list of active vessels was obtained from the NMFS Gulf Shrimp System (GSS) database and state license files for each Gulf state were obtained from the Southeast Regional Office under the purview of the MMPA program. Under the ESA and MMPA, both federal fishery permit holders and state fishery permit holders are required to carry an observer if selected. In 2015, vessel compliance in the skimmer trawl observer component decreased significantly from previous years. As a result, efforts to increase vessel compliance have been enhanced through communications with NOAA's Office of General Counsel and Office of Law Enforcement. For selected vessels operating in inshore waters, a minimum sea-day requirement of 5 days within a seasonal selection period was established to prevent potential early trip termination as a result of having an observer on board. A vessel may carry an observer for multiple trips to meet this minimum-sea-day requirement. In this report, overall Observer Program coverage levels and statistics on inshore fishing effort by gear type and state area are presented; inshore coverage is not yet sufficiently robust to estimate bycatch rates for BSE stocks.

For each trip, a variety of vessel and gear characteristics are recorded, and for each tow, a variety of fishery-specific data are collected (See the observer manual, NMFS 2010, NMFS 2020, and Scott-Denton et al. 2012 for further details). The trip-level data used in bycatch analyses include number of observed tows and number of unobserved tows (unobserved tow data only were consistently available from 2007 onward). The tow-level data used in bycatch analyses include trip, date, time, location, depth, tow duration, number of nets towed, and number of mammals caught. Marine mammal bycatch documentation included information on the trip and tow in which bycatch occurred, number of animals, species identification, date, time, latitude, longitude, depth, gear entanglement location (e.g. TED net, lazy line), final disposition (e.g. dead/unresponsive, alive, unknown), and additional comments (Appendix D). Only data collected by the NMFS Observer Program for the Gulf of Mexico shrimp otter trawl fishery were used in these analyses. Data from the voluntary Foundation Observer Program (12.2% of tows),

Atlantic shrimp trawl fishery (8.2% of tows), and skimmer, butterfly, and roller trawls (6.1% of tows) were not analyzed.

Analyses

Annual bycatch mortality estimates were calculated for each year from 2015 to 2019 using the stratified ratio of means estimator method and associated assumptions described in detail for previous mortality estimates (Soldevilla et al. 2015, Soldevilla et al. 2016), and briefly described here. The estimates follow a stratified random sample single-stage design with observed trip as the sampling unit.

Data Preparation

All Gulf of Mexico shrimp otter trawl tows observed by the NMFS Observer Program from 1997 to 2019 (N = 52,086) were assigned to one of the 36 fishery effort strata based on date, sub-area and depth at the start of the tow. When possible, missing depth values at the start of tows (N = 1,300) were assigned a depth based on the depth at the end of the tow or the ETOP01 depth (Amante & Eakins 2009) for the location of the start or end of the tow. A total of 105 tows were discarded due to missing year or depth data. Due to the inclusion of additional inshore fishery coverage, tows were assigned to depth strata by mapping locations of tow starts overlaid with polygons of the inshore and nearshore shrimp fishery boundaries, using QGIS software (QGIS Development Team 2020). During this process, location errors were noted in historical observer data; refreshed data for the entire period (1997 to 2019) were downloaded from the database which had undergone significant QA/QC since the publishing of prior marine mammal bycatch analyses (Soldevilla et al. 2015, Soldevilla et al. 2016). This report includes revised bycatch rate and extrapolated bycatch estimates for the 2007-2014 period with minor changes from prior estimates due to this QA/QC process.

To analyze Observer Program effort and bycatch data at the trip level, tow data were aggregated by summing both observed hours fished and bycatch over all observed tows within a stratum for each trip. Effort was represented as total hours fished per trip; number of nets towed was not included because the total fishery effort did not account for number of nets towed and the stratified design accounts for bycatch rate differences in numbers of nets towed between inshore and offshore waters (Soldevilla et al. 2015, Soldevilla et al. 2016). In some instances,

trips were split if they occurred in multiple strata. Marine mammal bycatch is reported for all tows per trip, however, a small portion of tows (2.3%) were not observed with respect to the recording of fish bycatch and fishing effort. To correct the lower total documented effort per trip on trips with unobserved tows, data on the number of unobserved tows per trip were used to estimate corrected total effort per trip, $h_{corr,_l}$, as

$$h_{corr,_l} = (n_l + m_l)\,\frac{h_l}{n_l}$$

where $n_l$is the number of observed tows on the l^{th} trip, m_l is the number of unobserved tows on the l^{th} trip, and h_l is the total observed hours fished on the l^{th} trip.

Species Identification Scenarios and Final Disposition Status

During 1997 to 2019, of 22 observed marine mammal takes, the 13 identified to species were bottlenose dolphins; however, the remaining 9 takes were unidentified to species and may have been bottlenose dolphins or spotted dolphins. During the 1980s in the Gulf of Mexico, several spotted dolphins were documented as bycatch (Fertl & Leatherwood 1997), and spotted dolphin foraging in association with shrimp vessels has also been described (Delgado Estrella 1997, Fertl & Leatherwood 1997). Two spotted dolphin mortalities have occurred in research trawls, one in the southeastern U.S. Atlantic and one in the Gulf of Mexico. Additionally, during BRD gear studies, the shrimp trawl Observer Program documented spotted dolphins present and sometimes following gear during 10 tows from 2007 to 2019 (by comparison, bottlenose dolphins were identified around 33 tows). All unidentified takes occurred in ≥29 ft. (8.8 m) waters and therefore cannot be confidently assigned to either species based on bathymetric distribution boundaries. To account for this uncertainty, bycatch rates are estimated under best-case and worst-case scenarios for bottlenose dolphin stocks and spotted dolphin stocks in which all unidentified dolphin takes are assigned to one species or the other.

The final disposition of observed marine mammal interactions with the shrimp fishery were evaluated to determine if they met the criteria for mortality or serious injury, as defined by Angliss and DeMaster (1998). One marine mammal observed during 1997 to 2019 was released alive with no evidence of serious injury and was not included in bycatch mortality calculations. Three marine mammal takes identified as decomposed animals with no supporting description or

photographs were included in bycatch mortality estimates as it is impossible without a necropsy to determine whether the animals died in the net or were dead prior to interacting with the trawl. Each of these animals lacked species identification, so the best-case and worst-case scenarios still encompass the range of mortalities if any of the animals were captured in this state.

Stratified Bycatch Rate Estimation

The shrimp otter trawl fishery is such a large fishery (annual mean of 2.8 million hours actively fished for 2007 to 2019) that the Observer Program, with current resources, can only cover about 0.7% of total active fishing effort (including both state- and federally-permitted fishing in inshore, nearshore and offshore waters; primarily federally-permitted vessels in nearshore and offshore waters are observed). At this level of coverage, observed marine mammal bycatch is a relatively rare occurrence, with approximately one bycatch event observed per year. Due to the relatively low level of observer effort (Table 3) and the low number of observed takes (22 dolphins) from 1997 to 2019 (23 years), a fully stratified (24 strata) bycatch rate estimate per year is unreasonable, as most strata will have zero takes and may only sample a single fishing trip. Variability in bycatch rates is lowest across years compared with fishery strata and does not vary significantly between voluntary and mandatory periods of the NMFS Observer Program (Soldevilla et al. 2015). We estimate bycatch rates for 2015 to 2019 on area-season-depth stratified data aggregated across 20 years to improve precision given the low number of observed takes. Previous analyses used all observer data available at the time (15 and 18 years for the 2007-2011 and 2012-2014 analyses, respectively) for the bycatch rate estimates. The current estimates include 20 years of data in the bycatch rate analysis to balance the need to reduce the number of zeros in some strata that are likely due to limited observer effort rather than true absence of bycatch within these strata (e.g. Soldevilla et al. 2015) with the need to use the most current representative data.

To further reduce the impact of zeros given the high stratification and low percentage observer coverage and observed takes, in estimating dolphin stock annual bycatch mortality, two methods of bycatch rate stratification are compared to examine the trade-offs of accurately representing the sampling design (reduced bias) over pooling data (improved precision). The first method estimates semi-stratified (2 areas, 3 seasons, 2 depths) bycatch rates and applies them to fully stratified (4 areas, 3 seasons, 3 depths) effort data to obtain total annual bycatch

mortality per stock[5]. In this case, the four state areas are combined into two larger regions of western Gulf (TX, LA, AL/MS) and eastern Gulf (FL). These regions are appropriate as they represent two major provinces with differences in oceanographic circulation, freshwater input, and benthic habitat characteristics (Gallaway 1981) that lead to differences in fishery target catch with brown and white shrimp targeted in the western Gulf and pink and rock shrimp targeted in the eastern Gulf. The second method estimates fully-stratified (4 areas, 3 seasons, 2 depths) bycatch ratios and applies them to fully stratified (4 areas, 3 seasons, 3 depths) effort data to obtain total annual bycatch mortality per stock[5]. This method accurately reflects the study sampling design.

For each of the stratification methods and species identification scenarios, stratified bycatch rates are estimated using the ratio of means method (Cochran 1977). This method weights longer duration trips more heavily than shorter duration trips and was selected under the assumption that long duration trips more accurately estimate catch rates of rare events than short duration trips.

The stratified bycatch rate, r_{ijk}, for the i^{th} area, j^{th} trimester, and k^{th} depth zone is calculated as

$$r_{ijk} = \frac{\sum_{l=1}^{n_{ijk}} y_{ijkl}}{\sum_{l=1}^{n_{ijk}} h_{ijkl}}$$

where n_{ijk}, y_{ijkl}, and h_{ijkl} are the number of observed trips, the total trip bycatch, and the corrected total hours fished per trip, respectively, on the l^{th} trip in the i^{th} area, j^{th} trimester, and k^{th} depth zone.

[5] The shrimp trawl Observer Program generally does not cover inshore waters; bycatch rates for nearshore strata were applied to the corresponding inshore strata. This method assumes that otter trawl bycatch rates are the same in coastal and inshore waters. Under MARFIN funding during the period from 2015 to 2019, the Observer Program has been able to extend a limited amount of coverage into inshore waters. The accuracy of the assumption of similar coastal and inshore bycatch rates will remain unknown until Observer Program coverage in inshore waters reaches sufficient levels to incorporate data into the stratified analyses. At this time, the nearshore bycatch rate estimates aggregate data from inshore and nearshore observed tows.

Stock Bycatch Mortality Estimation

To estimate annual bycatch mortality per bottlenose dolphin stock, strata were assigned to bottlenose dolphin stocks as follows: a) strata from all areas and seasons in offshore waters were assigned to the Continental Shelf stock; b) TX and LA area strata from all seasons in nearshore waters were assigned to the Western Coastal stock; c) AL/MS area strata from all seasons in nearshore waters were assigned to the Northern Coastal stock; d) FL area strata from all seasons in nearshore waters were assigned to the Eastern Coastal stock; e) inshore strata were limited to state area resolution and seasonal strata were aggregated per state area and assigned to aggregated BSE stocks for each state (Table 4, Figure 1). For spotted dolphins, all offshore and nearshore strata were aggregated. Overall, the fishery strata boundaries match the dolphin stock boundaries well, with two exceptions: 1) the AL/MS to FL state boundary and the 84ºW boundary between the Eastern Coastal and Northern Coastal bottlenose dolphin stocks and 2) the AL/MS inshore area includes the eastern Louisiana BSE stocks and a portion of the Northern Coastal bottlenose dolphin stock range (Figure 1). In both cases, the Northern Coastal stock range is underestimated, and in the first case, the Eastern Coastal stock range is overestimated. Additionally, state area boundaries for all inshore waters do not provide the resolution needed to assign bycatch to individual BSE stocks.

To obtain annual bycatch mortality, we multiply the stratified bycatch rates by annual stratified effort estimates for each year from 2015 to 2019 to obtain stratified bycatch mortality estimates for the five years. We then combine these estimates over the appropriate strata to obtain annual bycatch mortality estimates per stock. The stratified estimator of the total annual bycatch mortality per stock is calculated as

$$\hat{\tau}_{stock} = \sum_{i}\sum_{j}\sum_{k} M_{ijk} r_{ijk}$$

where M_{ijk} is the total hours fished in the i^{th} area, j^{th} trimester, and k^{th} depth zone summed over areas and depth zones that fall within each stock's boundaries (Table 4).

Coefficients of Variation and Confidence Intervals

Bias corrected and accelerated (BCa) bootstrapping (Efron 1987) techniques were used to derive the confidence intervals (CIs) and standard bootstrapping (Efron & Tibshirani 1994) techniques were used to derive the coefficients of variation (CV) for the bycatch mortality estimates for each stock. As with bycatch rate estimation, the re-sampling unit used was an entire trip rather than an individual tow to ensure that any within-trip dependence was carried over into the estimated CV.

Five-year Mean Annual Bycatch Mortality Estimate

Following the Guidelines for Assessing Marine Mammal Stocks (GAMMS) (Wade & Angliss 1997), the unweighted 5-year mean annual bycatch mortality estimates for each year from 2015 to 2019 were calculated for the trailing five years (e.g. 2011 to 2015, 2012 to 2016, etc.) based on the 2011 to 2019 annual stock bycatch mortality estimates derived in this study.

Comparison with Potential Biological Removal

The estimated annual stock bycatch mortalities are compared against the allowable mortalities determined by Potential Biological Removal (PBR) from the most recent stock assessment report (SAR) in which a valid minimum abundance (N_{min}) and PBR was available (Table 1, Waring et al. 1999, Waring et al. 2009a, Waring et al. 2009b, Hayes et al. 2020, and Hayes et al. in review). Wade and Angliss (1997) recommend that N_{min} values older than 8 years not be used in the calculation of PBR values as they are unreliable. The PBR values of 20 Gulf of Mexico bottlenose dolphin BSE stocks are older than 8 years and are presented only to give a general scale of where bycatch mortality may fall with respect to stock abundance; updated N_{min} and PBR values are required to accurately represent any impact of the fishery on these stocks. The abundances of five BSE stocks with reported abundance estimates of 0 due to limited survey effort are likely higher than zero; therefore, calculated N_{min} and PBR values are underestimates. For BSE stocks, for which shrimp fishery effort is only available at the state area resolution, the available lowest, the highest, and the summed N_{min}s and PBRs of all BSE stocks within the state area are included. The minimum BSE PBR provides a conservative estimate in the event that all takes are from a single stock with low abundance, while the maximum BSE PBR provides an

estimate if all takes are from a single stock with the highest abundance, and the aggregate BSE PBR provides an estimate if all stocks are proportionally affected by bycatch mortalities.

RESULTS AND DISCUSSION

Reported NMFS Fishery Effort

From January 2015 through December 2019, annual effort in the Gulf of Mexico shrimp otter trawl fishery averaged 114,956 ± 8,679 nominal days fished (Table 2), similar to effort levels since 2006 (Soldevilla et al. 2015, Soldevilla et al. 2016). Geographically, the greatest effort during 2015 to 2019 occurred off LA (59%), followed by TX (21%; Table 2, Figure 2), and seasonally, the most effort occurs between May to August (44%) and September to December (41%; Table 2). By depth, most otter trawl effort took place in inshore waters (41%), followed by offshore waters (> 10 fathoms, 33%), and nearshore waters (26%, Table 2). Updated effort data, as otter trawl only and the percent of total effort for inshore LA and AL/MS areas, are presented for years 2011 to 2019 (Table 2; Appendix Tables D1, D2) due to the discovery of incorrect landings data used to partition skimmer and otter effort in prior years' analyses.

Reported LDWF Fishery Effort

From January 2011 through December 2018, LDWF data reveal that annual shrimp otter trawl fishery effort in western Louisiana inshore waters averaged 4,947 ± 822 trips, while annual shrimp otter trawl fishery effort in eastern Louisiana inshore waters averaged 1,633 ± 149 trips. Geographically, the percentage of otter trawl trips per western Louisiana water body from highest to lowest is Terrebonne and Timbalier bays (29%), Barataria Bay (27%), Calcasieu Lake (24%), Vermillion, West Cote Blanche, and Atchafalaya bays (11%), and Sabine Lake (<1%), with the remaining 8% of trips occurring in waters outside of BSE bottlenose stock boundaries. Geographically, the percentage of otter trawl trips per eastern Louisiana water body is 23% in Mississippi Sound, Lake Borgne, and Bay Boudreau waters and 22% in Mississippi River Delta waters, with the remaining 54% of trips occurring in waters outside of BSE bottlenose stock boundaries.

From January 2011 through December 2018, LDWF data reveal that annual shrimp skimmer fishery effort in western Louisiana inshore waters averaged 29,156 ± 4,303 trips, while annual shrimp skimmer fishery effort in eastern Louisiana inshore waters averaged 3,707 ± 1,120 trips. Geographically, the percentage of skimmer trips per western Louisiana water body from highest to lowest is Terrebonne and Timbalier bays (45%), Barataria Bay (44%), Vermillion, West Cote Blanche, and Atchafalaya bays (3%), Calcasieu Lake (2%), and Sabine Lake (<1%), with the remaining 6% of trips occurring in waters outside of BSE bottlenose stock boundaries. Geographically, the percentage of skimmer trips per eastern Louisiana water body is 10% in Mississippi Sound, Lake Borgne, and Bay Boudreau waters and 56% in Mississippi River Delta waters, with the remaining 34% of trips occurring in waters outside of BSE bottlenose stock boundaries.

In western Louisiana inshore waters, the annual percent of shrimp fishery effort per gear type, as number of LDWF reported trips weighted by average fishing effort per gear type from NMFS Observer Program data (see next section), varied little (1.7%) from year to year between 2011 and 2018 with an average of 16.8% of effort coming from otter trawl gear and 83.2% of effort from skimmer gear. In eastern Louisiana inshore waters, the annual percent of shrimp fishery effort per gear type, as number of LDWF reported trips weighted by average fishing effort per gear type from NMFS Observer Program data, varied moderately (6.1%) from year to year between 2011 and 2018 with an average of 35.4% of effort coming from otter trawl gear and 64.6% of effort from skimmer gear. By comparison, percent landings by gear type over this time period also varied little from year to year for western Louisiana inshore waters (2.8%) with an average of 30.2% of landings attributed to otter trawl gear and 69.8% of landings from skimmer gear. In eastern Louisiana inshore waters, percent landings varied moderately (9.6%), with 48.7% of landings from otter trawl gear and 51.3% of landings from skimmer gear. The differences in gear type percentages between LDWF effort and NMFS landings suggest that our otter trawl fishery effort data may be biased high. However, it is difficult to determine which data are most accurate for partitioning effort by gear type due to the associated assumptions: using NMFS landings to partition effort assumes equal CPUEs across gear types while using LDWF trips to partition effort assumes of equal mean hours fished per trip across basins and season. Additionally, the eastern Louisiana area lacks data on trip effort for AL and MS waters that are a part of this area. Further studies should evaluate CPUEs for otter trawls compared to

skimmer trawls in inshore waters and hours fished per trip by gear type, water basin and season. If the inshore otter trawl effort estimates used in this report are biased high, the dolphin bycatch estimates for LA and AL/MS BSE stocks would also be biased high.

Reported NMFS Observer Coverage

Between January 1997 and December 2019, a total of 1,495 trips and 561 unique vessels were observed by the NMFS Gulf of Mexico shrimp otter trawl fishery Observer Program, which includes periods of voluntary and mandatory coverage. During the 2015-2019 period, 456 trips and 264 unique vessels were observed, with a mean of 1.7 trips per vessel. Repeated observation of vessels during the mandatory coverage period is mainly due to multiple observed trips per vessel to reach the 18-day minimum requirement for observer placement. For fully stratified analyses of bycatch rate, the 1,495 trips yielded a total of 2,498 trip*strata observations, as trips frequently crossed strata (years, seasons, depths, state areas), covering, on average, 1.67 strata per trip. In total, 52,086 tows were observed for a total of 279,718 hours fished, of which 16,957 tows and 93,661 hours fished occurred during 2015 through 2019. Between 2000 and 2019, an additional 951 unobserved tows did not have tow duration data to inform active fishing effort; including estimated effort for these tows yields an estimated 283,167 hours fished for trips observed between 1997 and 2019. All unobserved tows from 2015 to 2019 include tow duration data. Mean annual fishery effort for 2015 to 2019 was 2,758,944 ± 208,302 hours fished, and mean annual observed effort was 18,732 ± 4,876 hours fished. The Observer Program coverage of the otter trawl fishery was 0.65%, 0.68%, 0.87%, 0.69%, and 0.46% in years 2015 through 2019, respectively. Coverage in 2019 was lower than typical due to a change in the observer provider contract for fisheries observers leading to a decreased level of coverage. A major limitation for marine mammal bycatch estimation is that the Observer Program rarely covers state-licensed vessels in inshore or nearshore state waters unless a vessel holds both a state and federal permit (with the exception of the recent limited data collection from the MARFIN-funded pilot study), where a substantial proportion of the fishery operates.

With the additional inshore observer coverage under the MARFIN pilot project, a total of 385 trips and 227 unique otter trawl vessels were observed by the NMFS Gulf of Mexico shrimp fishery Observer Program in inshore waters from 2001 to 2019 for a total of 10,909 h of observed fishing effort. A total of 2,641 otter trawl tows were observed with average tow

durations of 4.13 ± 2.12 hours. Observed inshore otter trawl trips averaged 6.9 ± 9.4 tows per trip (range 0-64) and 28.3 ± 46.3 hours of active fishing effort per trip (range 0 – 334.2 hours). The majority of observed inshore effort occurred in the AL/MS state area 2 (1,554 tows) followed by LA (490 tows), TX (410 tows), and FL (187) tows. A total of 175 trips and 86 unique skimmer vessels were observed by the NMFS Gulf of Mexico shrimp fishery Observer Program from 2010 to 2019 for a total of 4,167 h of observer skimmer fishing effort. A total of 4,113 skimmer tows were observed with average tow durations of 1.01 ± 0.46 hours. Observed skimmer trips averaged 23.5 ± 20.8 tows per trip (range 1-147) and 23.8 ± 20.8 hours of active fishing effort per trip (range 0.1 to 108 hours). The majority of observed skimmer effort occurred in LA state area waters (2,922 tows) followed by AL/MS waters (1,190 tows).

Observed Marine Mammal Interactions

From 2015 to 2019, eight marine mammal mortalities were observed in the Gulf of Mexico otter trawl fishery (Table 5). During these 5 years, a single mortality was observed in each year, except in 2018 when 4 mortalities were observed. These include 6 animals identified as bottlenose dolphins and two that remained unidentified to species. The two unidentified species mortalities each occurred in nearshore waters just inside the 10-m isobath, off western Louisiana and Texas, in late February and mid-April. Based on the proximity to the Atlantic spotted dolphin distribution boundary, the distance covered over the course of a trawl, the fact that Atlantic spotted dolphins may move inshore in spring, and the fact that dolphins are known to be attracted to shrimp vessels, SEFSC scientists determined it is possible these could be either bottlenose or spotted dolphins. Further, the two dolphins unidentified to species included notes indicating the potential that they were previously dead, with the 2015 animal described as having a foul odor, and the 2019 animal described as having extreme decomposition and rotten. The photos obtained for these two events were not sufficient to determine whether the carcasses died prior to or during the tow so these events are precautionarily included in the mortality estimates, as described above. Six of the mortalities occurred during the January to April season and two occurred during the September to December season. Five of the mortalities occurred in the TX state area while one occurred in each of the other three areas (LA, AL/MS, and FL). One observed dolphin mortality occurred in inshore waters, while three and four observed dolphin mortalities occurred in the nearshore (<10 fathom) and offshore ($\geq$10 fathom) waters,

respectively. The October 2017 morality in the inshore waters of the Mississippi River Delta stock, the first observed BSE mortality, occurred during a trip funded under the MARFIN pilot project. Four of the mortalities were due to entanglement in the lazy line, three were entangled in the trawl net (one with its fluke through the TED bars), and one was entangled in the try net. Including these eight mortalities, a total of 22 marine mammal interactions were observed by the NMFS Observer Program between 1997 and 2019 (Table 5, Figure 1).

Bycatch Rate and Bycatch Mortality Estimates

The 2015 to 2019 effort, bycatch rate, and annual bycatch mortality estimates for marine mammal stocks from each of the two stratification methods and two species scenarios are presented in Appendix E, annual bycatch rates and effort per stratum are presented in Figures 3 and 4, and the five-year unweighted mean annual total bycatch mortality estimates for 2015 through 2019 are presented for each bottlenose and spotted dolphin stock in Table 6. Additional data from the recalculations of the 2007 to 2011 and 2012 to 2014 analyses using the corrected effort and QA/QC'd Observer Program data are also included in these figures, tables and appendices. While we describe the changes over time, it is important to note that bycatch rates from the three analyses include observer data from three different time periods and therefore are not directly comparable.

For the Continental Shelf stock of bottlenose dolphins, median bycatch mortality estimates remain relatively constant over time with a slight increase until 2017 and then decreasing, with estimates above 10% of PBR in 2015 to 2018 under the species scenario in which unidentified dolphins are all assigned to bottlenose dolphins (Figure 5). Under the species scenario in which unidentified dolphins are all assigned to spotted dolphins, median bycatch mortality estimates increase through 2016 and then begin decreasing. Median estimates remain below 10% of PBR in all 5 years, though the 4-area 95% CIs extend above 10% of PBR in several years (Figure 5). The increasing then decreasing bycatch estimates are primarily influenced by changes in effort over time (Appendix E1, 2, Figures 3, 4, 5), as well as by increasing bycatch rates in some strata due to two observed takes between 2012 to 2014 and 4 observed takes between 2015 to 2019 occurring in offshore waters of this stock's range (Table 5, Appendix E3).

For the Western Coastal stock of bottlenose dolphins, across most models and years, median annual bycatch mortality estimates from 2015 to 2019 range between 10% and 50% of the stock's PBR, with the 95% CIs remaining below 50% PBR across most models over the 5 years (Figure 5, Appendix E3). In 2015 and 2019, median annual bycatch mortality estimates drop below 10% PBR for the 4-area model in which all unidentified dolphins were assigned to Atlantic spotted dolphins. The 5-year annual mean of bycatch mortality estimates are generally decreasing over time, which appears to be influenced by a decrease in fishery effort over time (Table 2, Appendix E3). For the Northern Coastal stock of bottlenose dolphins, across all models, median annual bycatch mortality estimates decreased over time with median estimates below 10% of the stocks PBR for most stocks from 2015 to 2019, and with 95% CIs remaining below 50% of the stock's PBR for all models over the five years (Figure 5, Appendix E3). In 2019, the median bycatch estimate was above 10% of PBR for the 4-area model in which all unidentified dolphins were assigned to bottlenose dolphins. The changes in estimated bycatch mortality appear to be primarily driven by changing effort in AL/MS state area nearshore waters (Figures 3, 4, 5). For the Eastern Coastal stock of bottlenose dolphins, median annual bycatch mortality estimates increased in 2015 to 2019 compared to previous years, but remained under 10% of the stocks PBR (with the 95% CIs remaining under 50% of the stock's PBR), under the species scenario in which unidentified dolphins are all assigned to bottlenose dolphins, for both area-stratification models (Figure 5, Appendix E3. The increase in estimated bycatch is primarily driven by increased fishery effort during these years (Figures 3, 4, 5). Under the species scenario in which unidentified dolphins are all assigned to spotted dolphins, bycatch mortality estimates for the Eastern Coastal bottlenose dolphin stock are zero as all observed takes in waters off FL are unidentified to species.

For the TX BSE bottlenose dolphin stocks 2-area stratification method, annual bycatch mortality estimates were similar to most previous years from 2015 to 2019 with the median estimates falling between 10 and 100% of the aggregate TX BSE stocks last known PBRs for both species scenarios, and 95% CIs remaining below 100% of the aggregate PBR (Figure 5, Appendix E3). Changes in bycatch estimates over time reflect changes in fishery effort over time; the spike seen in 2014 was not repeated during this five year period (Figures 3, 4, 5). Under the 4-area stratification method, 2015 to 2019 median annual bycatch mortality estimates for TX BSE bottlenose dolphin stocks remained below 10% of the aggregate PRB in all years

between 2015 to 2019 except 2016 for the species scenario in which unidentified dolphins are all assigned to bottlenose dolphins, while the median annual bycatch mortality estimates remain zero for species scenario in which unidentified dolphins are all assigned to bottlenose dolphins because no positively identified dolphin bycatch have been observed in this stratum. For the LA BSE bottlenose dolphin stocks, median annual bycatch mortality estimates were from 2015 to 2019 were similar to estimates from 2012 to 2014, and remained lower than they were from 2007 to 2011. The median annual bycatch mortality estimates were greater than 50% of the aggregate LA BSE stocks last known PBRs for all models for all five years, and were greater than the aggregate PRB in 2016 and 2017 for both models in the species scenario where all unidentified dolphins are assigned to bottlenose dolphins (Figure 5, Appendix E3). The decrease appears to be driven by a decrease in bycatch rates over time as observer effort increases over the 1997-2019 period; only one new observed mortality has occurred in these strata during this time period (Appendix E1, 2). For the AL/MS BSE bottlenose dolphin stocks, across the four models over the 2015-2019 period, median annual bycatch mortality estimates were highly variable with respect to the aggregate AL/MS BSE stocks last known PBRs (Figure 5, Appendix E3). The four-area Tursiops-only model had median annual bycatch mortality estimates above the aggregate PBR in all five years while the 4-area models with unidentified dolphins assigned to spotted dolphins had median estimates greater than the aggregate PBR in all years except 2015. For the two-area models, the Tursiops-only model median estimates were above 50% of the aggregate PBR in all years except 2015, while the median estimates for the scenario with unidentified dolphins assigned to spotted dolphins were greater than the 10% of the aggregate PBR in all five years and greater than 50% of the aggregate PBR in 2016 (Figure 5, Appendix E3). These estimates are higher than those for 2012 to 2014 due to a new observed bycatch mortality in season 3 which has high levels of effort each year (Appendix E1, 2, Figures 3, 4). The annual changes in median bycatch mortalities over these five years closely follow changes in annual effort (Figures 3, 4, 5). For the FL BSE bottlenose dolphin stocks, median annual bycatch mortality estimates from 2015 to 2019 were similar to those from 2012 to 2014, and lower than they were from 2009 to 2011, with the median and 95% CI estimates falling at or below 10% of the aggregate FL BSE bottlenose dolphin stocks last known PBRs for all models for all five years, except 2016 when 95% CIs rose above the 10% aggregate PBR (Figure 5, Appendix E3). This decrease is mainly due to low annual fishing effort in the FL state area

inshore waters during 2015 to 2019 (Figures 3, 4, 5). Under the species scenario in which unidentified dolphins are all assigned to spotted dolphins, bycatch mortality estimates for FL BSE bottlenose dolphin stocks are zero as all observed takes in waters off FL are unidentified to species.

The median annual bycatch mortality estimates for the Atlantic spotted dolphin stock were higher during 2015 to 2019 than during 2012 to 2014 for both area-stratification methods under the species scenario in which unidentified dolphins are all assigned to spotted dolphins (Figure 5, Appendix E3), with the median estimated annual bycatch estimates between 10% and 50% of PBR for this stock. The range of 95% CI estimates falls below 50% of PBR in most years for both models. The increase starting in 2015 is mainly influenced by an increase in bycatch rates with the addition of two unidentified dolphin takes observed during these five years (Table 5) while the changes among years from 2015 to 2019 are primarily driven by changes in annual fishery effort in strata overlapping the range of spotted dolphins (Figures 3, 4, 5). Under the species scenario in which unidentified dolphins are all assigned to bottlenose dolphins, bycatch mortality estimates for spotted dolphins are zero as no takes observed by the Observer Program have been positively identified as spotted dolphins.

The bycatch mortality estimate 5-year means were generally decreasing or decreasing then leveling out for several bottlenose dolphin stocks: Western Coastal, Northern Coastal, LA BSE, and FL BSE (Table 6, Figure 5). In the decreasing cases, the 5-year means tend to be higher than the median annual bycatch mortality estimates (Appendix E3) since the means represent the trailing 5 years. Conversely, the bycatch mortality estimate 5-year means were generally increasing or increasing then leveling out for the Continental Shelf and Eastern Coastal stocks of bottlenose dolphins, and 5-year means are lower than the median annual estimates. The 5-year mean AL/MS BSE bottlenose dolphin stocks and the Atlantic spotted dolphin stocks were decreasing in previous years and are now increasing, while the TX BSE mean estimates are highly influenced by the spike in 2014.

Sources of Bias and Uncertainty

The greatest sources of error and bias in bycatch mortality estimates come from inadequate knowledge of both the fishery and the stocks it impacts including: 1) distribution of

fishery effort in inshore waters, 2) bycatch rates of dolphins in inshore waters, 3) stock abundance, particularly in inshore waters, and 4) whether skimmer trawls and non-commercial fisherman catch dolphins. Brief descriptions of these and additional sources of bias and uncertainty follow; further details can be found in Soldevilla et al 2015.

Fishery Effort Biases and Uncertainty

Estimation of total fishery effort, and hence bycatch mortality estimates, may be biased by three factors.

First, the distribution of total fishery effort by strata may be biased in some areas. Modeled effort may be higher in western offshore waters and lower in western nearshore waters due to misallocation of effort based on landings data and port agent interviews (Nance 1992, Gallaway et al. 2003). This most likely would result in our bycatch mortality estimate for the Western Coastal stock of bottlenose dolphins being biased low, but this effort distribution bias has been reduced in recent years by incorporating effort location information from electronic logbook data into models of total effort (Nance et al. 2008). Additionally, the modeled fishery effort in inshore waters cannot be finely distributed at the BSE level, and therefore the fishery impact on individual BSE stocks cannot be estimated. Recent data obtained from LDWF sheds light on effort distribution by water body in Louisiana state waters for perspective. However, these data cannot be applied to proportion out LA BSE bycatch to individual stocks because effort is provided as trips rather than hours fished and it is unknown how hours fished per trip varies by season and water body. Continuing increased Observer Program coverage in inshore waters and expanding ELB use in inshore waters can help answer these questions.

Second, total inshore fishery effort from skimmer trawls has been removed from total fishery effort as it is unknown how often this commercial fishery gear type results in marine mammal bycatch mortalities. Total otter trawl effort and resulting bycatch estimates for inshore waters of LA, MS, and AL may be biased by the assumption that CPUEs are equal across gear types and therefore the proportion of landings can be used as a proxy for proportion of fishery effort. Based on comparisons of inshore Louisiana shrimp fishery effort by gear type in LDWF data, otter trawl effort appears to be lower when proportioning by trips instead of landings, which suggests otter trawls may have higher CPUEs than skimmer trawls in inshore waters. If

our inshore otter trawl effort estimates are biased high, the bycatch mortality estimates for LA and AL/MS BSEs will also be biased high. However, more information is needed on how active hours of fishing effort per trip varies by season and water basin for each gear type to know if the LDWF data can be used to accurately proportion effort, or data on CPUEs by gear type, season and water basin would help make better use of the landings data. Conversely, the removal of the high levels of skimmer trawl effort in the inshore waters of LA, MS, and AL may bias bycatch mortality estimates low if this gear type commonly results in mortalities. Since 2013, two bycatch interactions have been observed in a research skimmer trawl, one in which the animal was released alive and in good condition, and one resulting in mortality (Pers. comm. Keith Mullin, NOAA Fisheries, SEFSC), and in 2020, a shrimp fisher operating a skimmer vessel in Mississippi Sound, MS reported a lazy line entanglement of a live dolphin (later determined to be a serious injury) to the local stranding team. Increased Observer Program coverage on commercial skimmer trawls, as was conducted during the limited MARFIN-funded pilot study, should continue to obtain sufficient sample size for robust statistical analyses of skimmer bycatch rates.

Finally, total inshore effort, and possibly bycatch mortality estimates for BSE stocks, may be biased low as commercial shrimp fishery effort data do not include shrimp harvested by recreational fishermen, small-scale commercial fishermen that sell their catches along roadsides (Poffenberger 1991), or those caught for use as bait. It is unknown whether non-commercial fishery effort results in marine mammal bycatch mortalities.

Fishery Effort Biases and Uncertainty

Two factors associated with Observer Program coverage may bias estimation of bycatch rates.

First, a major data gap in Observer Program coverage in inshore waters led to our assumption that bycatch rates in inshore waters are similar to those in nearshore waters of the corresponding state area and seasonal strata. While the direction and degree of the resulting bias in bycatch mortality estimates for inshore waters remains unknown, the 2017 observed bycatch mortality in Mississippi River Delta stock waters indicates this approach is more reasonable than assuming no bycatch mortality in the inshore waters with high fishing effort, and preliminary

indications from the MARFIN-funded pilot project placing observers on inshore vessels suggest the assumption of similar rates is not unreasonable. During the 2001 – 2019 period, one bycaught marine mammal was observed over the 10,909 hours of observed inshore Gulf of Mexico otter trawl fishing effort; Soldevilla et al. (2015) noted that one bycaught marine mammal is observed for every 12,500 hours of otter trawl fishing for nearshore and offshore effort over the 1997 – 2011 period. Additionally, in 2016, a shrimp fisher operating in Mobile Bay, AL self-reported a dolphin mortality due to lazy line entanglement. Continued Observer Program effort in inshore waters is needed to reach a sufficient sample size for robust statistical analyses of inshore bycatch rates.

Second, bycatch rates in nearshore and inshore waters may be biased if rates differ between observed federally-permitted vessels and state-permitted vessels. If smaller vessels that tow fewer nets for shorter durations have lower mammal bycatch rates, as has been suggested for turtles (Epperly et al. 2002), bycatch mortality estimates might be biased high in inshore waters. The effect of vessel size, speed, and number of nets towed on mammal bycatch rates is completely unknown; continued inshore Observer Program effort will be helpful to obtain sufficient data to address this data gap.

Species and Stock Biases and Uncertainty

Lastly, four factors associated with quantifying species and stock information may bias estimation of bycatch rates.

First, uncertainty in the species of unidentified marine mammal takes was addressed by estimating best-case and worst-case scenarios for each species. Given the lack of spotted dolphins in identified takes, the worst-case scenario bottlenose dolphin estimates (all unidentified delphinids are assigned to bottlenose dolphin) are probably more accurate, particularly in western waters where spotted dolphin abundance is lower.

Second, errors may have occurred in the assignment of takes to Gulf of Mexico bottlenose dolphin stocks where stock boundaries and shrimp trawl fishery strata boundaries do not align. Four notable deviations include: 1) the discrepancy between the Northern Coastal/Eastern Coastal stock boundaries and the FL vs AL/MS state area boundary which may bias mortalities estimates low for the Northern Coastal stock and high for the Eastern Coastal

stock, 2) the discrepancy between the Northern Coastal stock and AL/MS BSE stock boundaries and the inshore/ nearshore boundaries in this area which may bias mortalities estimates low for the Northern Coastal stock and high for the AL/MS BSE stocks 3) the grouping of all BSE stocks within a state due to lack of finer resolution effort data and 4) limited knowledge of population boundaries and seasonal movements.

Third, there is a high degree of uncertainty in the status of the 20 stocks with abundance and PBR estimates older than 8 years (Hayes et al. in review) and in what levels of shrimp fishery bycatch mortality they can sustain. New stock abundances and PBRs have recently been estimated for six stocks that had outdated estimates (St. Andrew Bay, FL; Barataria Bay, LA; Terrebonne/Timbalier bays, LA; Sabine Lake, LA; Galveston/East/Trinity bays, TX; and West Bay, TX stocks), yielding a total of 11 BSE stocks with up-to-date abundance estimates. New photo-identification mark-recapture surveys are being conducted to update abundance estimates for the Mobile Bay/ Bonsecour Bay, AL and Perdido Bay, AL stocks of bottlenose dolphins.

Finally, bycatch mortality estimates may be biased low for the Continental Shelf bottlenose dolphin and Atlantic spotted dolphin stocks if the one animal observed to be released alive was in fact a serious injury. Observer comments indicated that the animal was entangled in the lazy line, the line was cut, the animal was released alive and appeared in good condition with no noticeable injuries but additional entanglement details were not available to determine the likelihood of capture myopathy, unobservable internal injuries, or separation from its social group that may have led to subsequent mortality (Angliss & DeMaster 1998, Andersen et al. 2008, NMFS 2012).

Variance

Sources of variance uncertainty in these bycatch mortality estimates that could not be accounted for include: 1) estimates of uncertainty from fishery effort models (Nance 1992, Nance 2004); 2) within-vessel variance among trips due to the two-stage vessels then trips sampling design; 3) variation in the number of nets towed, particularly in nearshore and inshore waters; and 4) errors in assigning effort to strata from unobserved tows which could affect both bycatch rate and effort variance. These effects are probably random and non-directional in nature and unlikely to bias bycatch mortality estimates and variances. Finally, variance calculations

may be biased due to the inclusion of voluntary Observer Program data from 1997 to 2006 (representing 28% of observed tows from 1997 to 2019); however, this bias is expected to be small compared to the improvements in estimation realized by including more years of data for a dataset with such a high quantity of zeros.

SUMMARY

This report presents estimates of total annual bycatch mortality of marine mammals in the Gulf of Mexico shrimp otter trawl fishery for 2015 to 2019. Two stratification methods were considered along with two scenarios to account for unidentified marine mammal species catch. In all cases, bycatch mortality estimates exceed 10% of PBR for the Western Coastal bottlenose dolphin stock while bycatch mortality estimates for the Northern Coastal bottlenose dolphin stock have decreased since the first 2011 estimates and were at or below 10% of PBR in 2015 to 2019. Bycatch mortality estimates for the Eastern Coastal bottlenose dolphin stock have increased since the 2012 to 2014 estimates, approaching but remaining below 10% of PBR in 2015 to 2019. Other stocks which may have shrimp otter trawl bycatch mortalities above 10% of PBR include the Continental Shelf bottlenose dolphin stock and the Atlantic spotted dolphin stock, depending on the species identification scenario modeled. It remains possible that bycatch estimates have exceeded 50% of PBR for LA BSE bottlenose dolphin stock group in all years from 2015 to 2019, with some years potentially exceeding the PBR threshold, and that the PBR threshold may have been exceeded for the AL/MS BSE stock group depending on the model used (all models have estimates above 10% of PBR). It is possible that bycatch mortalities for the TX BSE stock group may be above 10% or 50% of PBR depending on the model used. Further data on both abundance and bycatch rates in inshore waters are required to determine whether this has occurred for the four inshore BSE stock groups. The greatest sources of error and bias in bycatch mortality estimates come from inadequate knowledge of both the fishery and the stocks it impacts including: 1) distribution of fishery effort in inshore waters, 2) bycatch rates of dolphins in inshore waters, 3) stock abundance, particularly in inshore waters, and 4) whether skimmer trawls and non-commercial fisherman catch dolphins. Updated abundance estimates from recent stock assessment surveys have been calculated for all coastal and shelf dolphin stocks and for 11 of the 31 BSE stocks of bottlenose dolphins, but abundance estimates are

outdated for the remaining inshore stocks. New surveys for the remaining inshore stocks would reduce uncertainty in PBR for these stocks.

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Table 1. Summary of 2021 stock assessment information for Gulf of Mexico bottlenose dolphin (Tt) and Atlantic spotted dolphin (Sf) stocks. Estimates in red are NOT VALID as they combine data from stocks with current abundance estimates and those with abundance estimates older than 8 years. They are included only for a sense of scale when comparing to bycatch mortality estimates. Updated abundance (N_{best} and N_{min}) and Potential Biological Removal (PBR) estimates MUST be completed before bycatch impacts on stocks can be accurately assessed. There are 31 Bay, Sound and Estuary (BSE) stocks managed by NOAA NMFS, however bycatch can only be estimated at the state area level resolution (TX, LA, AL/MS, and FL) for these waters. For BSE stocks, N_{best}, N_{min}, and PBR represent the combined total for all BSE stocks found within state area waters (Note eastern LA BSE stocks are included in AL/MS waters). The minimum PBR and maximum PBR for all individual BSE stocks in a given state's waters are included in parentheses, and represent the range of scenarios if bycatch is limited to a single stock within that state. Ideally, it would be best to use the PBR of the affected stock if all of a state's BSE bycatch is limited to a single stock; however, geographic resolution of the shrimp fishery effort is limited to the state area level and this cannot be determined.

Dolphin Stock	Stocks	N_{best}	CV	N_{min} (min; max)	F_R	R_{max}	PBR (min; max)	Last Survey
Tt Shelf	1	63,280	0.11	57,917	0.48	0.04	556	2017-2018
Tt Western Coastal	1	20,759	0.13	18,585	0.45	0.04	167	2017-2018
Tt Northern Coastal	1	11,543	0.19	9,881	0.45	0.04	89	2017-2018
Tt Eastern Coastal	1	16,407	0.17	14,199	0.40	0.04	114	2017-2018
Tt TX BSE stocks *	6	1,133	Varies	961 (30; 787)	0.40	0.04	7.7 (0.2; 6.3)	Varies
Tt LA BSE stocks *	5	6,063	Varies	5,501 (0; 3,426)	0.45	0.04	49 (0.0; 31)	Varies
Tt AL/MS BSE stocks *	4	2,833	Varies	2,277 (0; 1,238)	0.40	0.04	18 (0.0; 9.9)	Varies
Tt FL BSE stocks *	16	3,746	Varies	3,068 (0; 766)	0.40	0.04	24 (0.0; 6.1)	Varies
Sf Northern GoM	1	21,506	0.26	17,339	0.48	0.04	166	2017-2018

* BSE stocks included in each state area are as follows:
1) TX [Laguna Madre; Nueces Bay, Corpus Christi Bay; Copano Bay, Aransas Bay, San Antonio Bay, Redfish Bay, Espiritu Santo Bay; Matagorda Bay, Tres Palacios Bay, Lavaca Bay; West Bay; Galveston Bay, East Bay, Trinity Bay]. Two of the six stocks (West Bay; Galveston Bay East Bay, Trinity Bay) have recent abundance and PBR estimates;
2) LA [Sabine Lake; Calcasieu Lake; Vermilion Bay, West Cote Blanche Bay, Atchafalaya Bay; Terrebonne Bay, Timbalier Bay; Barataria Bay]. Three of the five stocks (Sabine Lake; Terrebonne Bay, Timbalier Bay; Barataria Bay) have recent abundance and PBR estimates;
3) AL/MS [Mississippi River Delta; Mississippi Sound, Lake Borgne, Bay Boudreau; Mobile Bay, Bonsecour Bay; Perdido Bay]. Two of the four stocks (Mississippi River Delta; Mississippi Sound, Lake Borgne, Bay Boudreau) have recent abundance and PBR estimates; and
4) FL [Pensacola Bay, East Bay; Choctawhatchee Bay; St. Andrew Bay; St. Joseph Bay; St. Vincent Sound, Apalachicola Bay, St. George Sound; Apalachee Bay; Waccasassa Bay, Withlacoochee Bay, Crystal Bay; St. Joseph Sound, Clearwater Harbor; Tampa Bay; Sarasota Bay, Little Sarasota Bay; Lemon Bay, Pine Island Sound, Charlotte Harbor, Gasparilla Sound; Caloosahatchee River; Estero Bay; Chokoloskee Bay, Ten Thousand Islands, Gullivan Bay; Whitewater Bay; Florida Keys (Bahia Honda to Key West)]. Four of the 16 stocks (Choctawhatchee Bay; St. Andrew Bay; St. Joseph Bay; Sarasota Bay, Little Sarasota Bay) have recent abundance and PBR estimates.

Table 2. Annual Gulf of Mexico shrimp trawl fishery effort by strata (stat area, depth zone and season) as corrected for otter trawls only in hours fished. Percentage of total effort (i.e., including skimmer effort) is presented for depth zone 0 in Stat Areas 2 and 3. Stat Areas: 1 = FL, 2 = AL/MS, 3 = LA, 4= TX. Depth Zones: 0 = Inshore, 1 = 0 – 10 fathom (0-18 m); 2 = 10+ fathom (18+ m). Seasons: 1 = Jan – Apr, 2 = May – Aug, 3 = Sept – Dec. Data are included for 2011 to 2014 in addition to the current years as landings data used to partition inshore otter and skimmer effort in previous reports were erroneous.

			Otter Trawl Fishery Effort in Hours Fished (% of Total Effort)			
Year	Stat Area	Depth Zone	Season 1	Season 2	Season 3	Annual Total
2011	1	0	12,009.6	50,296.8	22,118.4	84,424.8
2011	1	1	4,165.7	10,189.7	3,693.6	18,049.0
2011	1	2	42,652.6	50,071.4	28,929.1	121,653.1
2011	2	0	21,768.9 (55.4)	62,360.0 (57.2)	50,132.8 (39.5)	134,261.7
2011	2	1	11,040.2	42,691.0	12,503.3	66,234.5
2011	2	2	16,039.7	37,166.6	18,305.8	71,512.1
2011	3	0	100,475.6 (64.1)	130,267.1 (32.9)	94,474.0 (24.9)	325,216.7
2011	3	1	72,076.8	243,356.2	148,879.2	464,312.2
2011	3	2	59,122.3	186,704.9	98,292.2	344,119.4
2011	4	0	1,507.2	17,208.0	9,960.0	28,675.2
2011	4	1	14,726.9	33,317.5	49,134.2	97,178.6
2011	4	2	78,025.4	121,558.8	220,015.7	419,599.9
2012	1	0	973.7	1,093.7	2,378.4	4,445.8
2012	1	1	2,803.2	5,636.6	1,727.5	10,167.4
2012	1	2	51,389.8	15,818.9	37,198.3	104,407.0
2012	2	0	3,954.4 (65.9)	57,140.6 (61.7)	32,822.2 (23.6)	93,917.2
2012	2	1	8,300.4	52,277.8	29,514.0	90,092.2
2012	2	2	4,025.0	42,269.8	39,739.4	86,034.2
2012	3	0	40,213.5 (65.5)	115,577.1 (30.4)	85,567.6 (21.7)	241,358.2
2012	3	1	86,462.2	338,176.8	215,582.2	640,221.1
2012	3	2	73,821.6	123,547.9	112,324.1	309,693.6
2012	4	0	5,841.8	27,507.1	6,102.2	39,451.2
2012	4	1	32,360.4	60,774.2	54,880.3	148,015.0
2012	4	2	30,789.1	90,550.6	182,149.9	303,489.6
2013	1	0	4,914.2	63,687.8	7,615.9	76,218.0
2013	1	1	3,097.2	9,881.0	1,806.5	14,784.7
2013	1	2	72,643.9	35,030.9	4,868.4	112,543.2
2013	2	0	1,174.7 (60.9)	38,770.2 (53.2)	53,978.1 (50.2)	93,923.0
2013	2	1	1,855.7	41,367.6	22,379.0	65,602.3
2013	2	2	13,159.7	62,743.4	32,859.1	108,762.2
2013	3	0	20,603.1 (66.2)	132,593.1 (30.8)	77,416.0 (27.7)	230,612.2
2013	3	1	30,778.1	278,980.3	144,671.5	454,429.9
2013	3	2	63,735.1	167,721.1	84,287.0	315,743.3
2013	4	0	492.2	18,606.2	12,710.2	31,808.6
2013	4	1	17,423.5	54,809.3	50,101.4	122,334.2
2013	4	2	38,703.1	104,396.9	217,041.4	360,141.4
2014	1	0	5,209.0	8,590.3	126.2	13,925.5
2014	1	1	4,750.8	8,536.3	38.6	13,325.8
2014	1	2	39,362.4	29,857.9	3,674.9	72,895.2
2014	2	0	2,202.5 (86.4)	13,532.1 (40.0)	5,767.1 (24.0)	21,501.8
2014	2	1	3,859.9	35,011.4	26,692.3	65,563.7
2014	2	2	17,569.0	29,887.0	44,775.1	92,231.0
2014	3	0	84,922.2 (78.7)	64,955.2 (22.3)	51,263.7 (23.4)	201,141.1
2014	3	1	111,816.5	281,687.8	221,981.0	615,485.3
2014	3	2	49,339.2	165,082.6	84,285.8	298,707.6

			Otter Trawl Fishery Effort in Hours Fished (% of Total Effort)			
Year	Stat Area	Depth Zone	Season 1	Season 2	Season 3	Annual Total
2014	4	0	72,587.3	37,861.7	52,647.8	163,096.8
2014	4	1	74,426.9	36,102.0	57,643.0	168,171.8
2014	4	2	28,482.0	139,583.5	273,937.0	442,002.5
2015	1	0	413.8	550.6	1,322.2	2,286.5
2015	1	1	22,833.4	23,265.6	48,718.1	94,817.0
2015	1	2	17,416.1	15,561.8	8,917.0	41,894.9
2015	2	0	1,010.6 (65.2)	58,342.2 (62.1)	46,044.1 (60.0)	105,396.8
2015	2	1	2,445.1	27,749.0	13,106.2	43,300.3
2015	2	2	19,245.8	49,114.6	26,654.9	95,015.3
2015	3	0	28,070.0 (75.4)	155,860.8 (32.9)	70,608.8 (19.8)	254,539.6
2015	3	1	22,303.7	264,114.0	154,780.6	441,198.2
2015	3	2	110,336.6	179,078.2	100,735.9	390,150.7
2015	4	0	2,341.0	18,113.0	10,728.0	31,182.0
2015	4	1	12,654.2	43,449.4	28,832.9	84,936.5
2015	4	2	35,346.0	104,765.3	272,961.1	413,072.4
2016	1	0	9,627.6	10,967.3	9,588.2	30,183.1
2016	1	1	45,063.1	40,608.0	28,988.9	114,660.0
2016	1	2	12,554.9	12,132.7	12,859.4	37,547.0
2016	2	0	8,791.6 (80.8)	53,086.7 (60.9)	60,002.0 (37.2)	121,880.3
2016	2	1	5,346.0	8,071.9	18,146.6	31,564.6
2016	2	2	26,488.3	40,990.6	35,984.6	103,463.5
2016	3	0	53,736.1 (75.4)	112,082.0 (31.5)	111,579.5 (21.4)	277,397.5
2016	3	1	79,778.9	197,795.8	160,771.2	438,345.8
2016	3	2	75,558.7	208,151.8	99,721.9	383,432.4
2016	4	0	8,979.6	19,003.7	26,629.2	54,612.5
2016	4	1	66,440.6	43,265.5	59,028.5	168,734.6
2016	4	2	64,724.4	118,851.6	281,295.4	464,871.4
2017	1	0	5,087.0	6,832.3	1,592.4	13,511.8
2017	1	1	54,678.7	39,658.6	28,194.2	122,531.5
2017	1	2	28,615.4	14,506.1	16,516.8	59,638.3
2017	2	0	12,865.6 (79.8)	72,425.0 (60.8)	48,497.7 (57.0)	133,788.3
2017	2	1	4,581.8	15,134.2	12,774.0	32,490.0
2017	2	2	18,785.0	39,023.8	26,806.3	84,615.1
2017	3	0	79,470.7 (64.2)	106,690.5 (34.3)	80,019.3 (22.6)	266,180.4
2017	3	1	91,977.1	202,165.4	136,409.0	430,551.6
2017	3	2	121,502.6	194,233.2	90,848.6	406,584.5
2017	4	0	4,570.6	9,296.4	24,263.5	38,130.5
2017	4	1	42,346.6	52,129.0	70,609.9	165,085.4
2017	4	2	78,107.3	139,031.5	222,312.7	439,451.5
2018	1	0	1,181.8	5,447.8	2,579.8	9,209.3
2018	1	1	48,512.9	36,354.7	27,235.2	112,102.8
2018	1	2	47,320.3	18,796.3	10,733.0	76,849.7
2018	2	0	5,915.6 (86.0)	71,514.0 (61.5)	63,788.6 (50.7)	141,218.2
2018	2	1	3,096.2	18,227.0	16,104.5	37,427.8
2018	2	2	9,742.8	49,459.0	29,311.9	88,513.7
2018	3	0	52,281.0 (66.7)	130,226.6 (27.2)	81,323.2 (26.1)	263,830.8
2018	3	1	63,456.2	275,041.2	132,894.7	471,392.2
2018	3	2	63,971.5	140,818.6	83,201.8	287,991.8
2018	4	0	978.5	16,298.2	17,586.5	34,863.1
2018	4	1	26,094.7	60,146.2	57,284.4	143,525.3
2018	4	2	49,399.9	129,370.1	256,927.0	435,697.0
2019	1	0	2,929.2	5,077.7	4,617.1	12,624.0

			Otter Trawl Fishery Effort in Hours Fished (% of Total Effort)			
Year	Stat Area	Depth Zone	Season 1	Season 2	Season 3	Annual Total
2019	1	1	40,130.9	34,324.6	38,126.6	112,582.1
2019	1	2	20,670.0	13,028.4	17,776.6	51,475.0
2019	2	0	6,434.2 (85.0)	69,970.4 (48.7)	51,793.5 (45.7)	128,198.1
2019	2	1	7,633.9	40,771.7	24,366.5	72,772.1
2019	2	2	23,562.5	15,601.4	20,579.3	59,743.2
2019	3	0	36,127.4 (84.7)	115,094.7 (31.8)	87,535.3 (25.7)	238,757.5
2019	3	1	23,121.1	195,811.7	91,826.6	310,759.4
2019	3	2	104,226.5	159,307.7	88,167.4	351,701.5
2019	4	0	417.1	8,226.2	11,963.5	20,606.9
2019	4	1	29,578.8	51,428.9	64,275.4	145,283.0
2019	4	2	23,281.7	90,455.0	206,180.6	319,917.4

Table 3. Annual Gulf of Mexico shrimp trawl Observer Program effort and percentage of observed to total effort by strata (stat area, depth zone and season). Stat Areas: 1 = FL, 2 = AL/MS, 3 = LA, 4= TX. Depth Zones: 0 = Inshore, 1 = 0 – 10 fathom (0-18 m); 2 = 10+ fathom (18+ m). Seasons: 1 = Jan – Apr, 2 = May – Aug, 3 = Sept – Dec. The strata in which a marine mammal take was observed are indicated by bold text. Updated for years 2011 to 2014 are included in addition to the new 2015 to 2019 values due to minor QA/QC updates to the Observer Program data.

			Otter Trawl Fishery Observed Effort in Hours Fished				Otter Trawl Fishery Percent Observed Effort			
Year	Stat Area	Depth Zone	Season 1	Season 2	Season 3	Annual Total	Season 1	Season 2	Season 3	Annual Total
2011	1	0	56.2	0.0	0.0	56.2	0.47	0.00	0.00	0.07
2011	1	1	88.5	24.7	0.0	113.2	2.12	0.24	0.00	0.63
2011	1	2	704.5	588.6	0.0	1,293.1	1.65	1.18	0.00	1.06
2011	2	0	53.6	48.1	514.4	616.1	0.14	0.04	0.41	0.46
2011	2	1	125.1	87.6	126.1	338.8	1.13	0.21	1.01	0.51
2011	2	2	85.1	61.5	42.6	189.2	0.53	0.17	0.23	0.26
2011	3	0	263.1	8.9	53.3	325.3	0.17	0.00	0.01	0.10
2011	3	1	363.1	2,330.7	1,318.2	4,012.0	0.50	0.96	0.89	0.86
2011	3	2	885.6	1,290.3	1,469.3	3,645.2	1.50	0.69	1.49	1.06
2011	4	0	0.0	11.1	12.4	23.5	0.00	0.06	0.12	0.08
2011	4	1	141.0	506.9	379.5	1,027.4	0.96	1.52	0.77	1.06
2011	4	2	388.1	973.8	**1,593.3**	2,955.2	0.50	0.80	0.72	0.70
2012	1	0	54.1	0.0	0.0	54.1	5.56	0.00	0.00	1.22
2012	1	1	208.1	19.5	0.0	227.6	7.42	0.35	0.00	2.24
2012	1	2	564.2	347.7	409.0	1,320.9	1.10	2.20	1.10	1.27
2012	2	0	83.7	23.3	285.0	392.0	1.40	0.03	0.21	0.42
2012	2	1	67.1	42.3	81.5	190.9	0.81	0.08	0.28	0.21
2012	2	2	58.3	28.3	393.5	480.1	1.45	0.07	0.99	0.56
2012	3	0	8.4	4.7	9.3	22.4	0.01	0.00	0.00	0.01
2012	3	1	334.2	867.2	1,143.3	2,344.7	0.39	0.26	0.53	0.37
2012	3	2	1,606.7	417.4	1,136.4	3,160.5	2.18	0.34	1.01	1.02
2012	4	0	18.7	4.1	19.3	42.1	0.32	0.01	0.32	0.11
2012	4	1	179.8	98.9	359.5	638.2	0.56	0.16	0.66	0.43
2012	4	2	248.4	1,827.3	4,181.2	6,256.9	0.81	2.02	2.30	2.06
2013	1	0	0.0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
2013	1	1	27.4	4.9	0.0	32.3	0.88	0.05	0.00	0.22
2013	1	2	547.5	195.0	139.8	882.3	0.75	0.56	2.87	0.78
2013	2	0	0.0	122.4	43.5	165.9	0.00	0.17	0.04	0.18
2013	2	1	101.3	283.7	62.0	447.0	5.46	0.69	0.28	0.68
2013	2	2	385.8	678.9	85.1	1,149.8	2.93	1.08	0.26	1.06
2013	3	0	26.3	44.2	19.2	89.7	0.08	0.01	0.01	0.04
2013	3	1	548.1	3,042.4	723.9	4,314.4	1.78	1.09	0.50	0.95
2013	3	2	1,171.4	**2,697.8**	1,369.0	5,238.2	1.84	1.61	1.62	1.66
2013	4	0	0.0	6.8	0.0	6.8	0.00	0.04	0.00	0.02
2013	4	1	820.0	556.5	378.2	1,754.7	4.71	1.02	0.75	1.43
2013	4	2	372.3	1,189.6	2,900.1	4,462.0	0.96	1.14	1.34	1.24
2014	1	0	0.0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
2014	1	1	443.3	128.8	50.5	622.6	9.33	1.51	130.69	4.67
2014	1	2	769.0	910.3	52.2	1,731.5	1.95	3.05	1.42	2.38
2014	2	0	15.0	190.5	529.3	734.8	0.59	0.56	2.20	3.42
2014	2	1	5.1	442.9	458.7	906.7	0.13	1.27	1.72	1.38
2014	2	2	121.9	1,007.8	565.5	1,695.2	0.69	3.37	1.26	1.84
2014	3	0	28.9	192.7	90.3	311.9	0.03	0.07	0.04	0.16
2014	3	1	375.9	1,779.2	2,675.6	4,830.7	0.34	0.63	1.21	0.78

Year	Stat Area	Depth Zone	Otter Trawl Fishery Observed Effort in Hours Fished				Otter Trawl Fishery Percent Observed Effort			
			Season 1	Season 2	Season 3	Annual Total	Season 1	Season 2	Season 3	Annual Total
2014	3	2	1,513.5	824.3	523.8	2,861.6	3.07	0.50	0.62	0.96
2014	4	0	202.6	102.7	96.7	402.0	0.28	0.27	0.18	0.25
2014	4	1	1,299.2	284.6	272.4	1,856.2	1.75	0.79	0.47	1.10
2014	4	2	443.3	**851.5**	2,908.5	4,203.3	1.56	0.61	1.06	0.95
2015	1	0	5.1	0.0	0.0	5.1	1.23	0.00	0.00	0.22
2015	1	1	31.3	0.0	10.7	42.0	0.14	0.00	0.02	0.04
2015	1	2	447.9	588.5	766.6	1,803.0	2.57	3.78	8.60	4.30
2015	2	0	0.0	526.6	511.9	1,038.5	0.00	0.56	0.67	0.99
2015	2	1	13.4	306.0	395.2	714.6	0.55	1.10	3.02	1.65
2015	2	2	418.8	1,059.6	284.5	1,762.9	2.18	2.16	1.07	1.86
2015	3	0	10.0	127.9	40.4	178.3	0.03	0.03	0.01	0.07
2015	3	1	**666.0**	1,728.5	2,534.8	4,929.3	2.99	0.65	1.64	1.12
2015	3	2	1,783.1	863.1	747.0	3,393.2	1.62	0.48	0.74	0.87
2015	4	0	134.2	123.6	6.2	264.0	5.73	0.68	0.06	0.85
2015	4	1	447.5	76.6	12.0	536.1	3.54	0.18	0.04	0.63
2015	4	2	114.6	211.8	2,521.4	2,847.8	0.32	0.20	0.92	0.69
2016	1	0	41.0	10.9	0.0	51.9	0.43	0.10	0.00	0.17
2016	1	1	264.4	349.6	187.8	801.8	0.59	0.86	0.65	0.70
2016	1	2	1,204.7	558.0	438.8	2,201.5	9.60	4.60	3.41	5.86
2016	2	0	0.0	484.8	634.6	1,119.4	0.00	0.56	0.39	0.92
2016	2	1	201.8	214.8	22.0	438.6	3.77	2.66	0.12	1.39
2016	2	2	508.1	1,700.0	652.7	2,860.8	1.92	4.15	1.81	2.77
2016	3	0	0.0	82.3	41.9	124.2	0.00	0.02	0.01	0.04
2016	3	1	87.4	1,860.2	986.0	2,933.6	0.11	0.94	0.61	0.67
2016	3	2	1,823.9	1,894.9	1,105.2	4,824.0	2.41	0.91	1.11	1.26
2016	4	0	1.3	5.3	6.5	13.1	0.01	0.03	0.02	0.02
2016	4	1	276.7	434.0	301.7	1,012.4	0.42	1.00	0.51	0.60
2016	4	2	**1,399.9**	525.5	2,481.4	4,406.8	2.16	0.44	0.88	0.95
2017	1	0	0.0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
2017	1	1	431.7	91.2	206.9	729.8	0.79	0.23	0.73	0.60
2017	1	2	335.9	589.4	735.9	1,661.2	1.17	4.06	4.46	2.79
2017	2	0	0.0	349.8	**184.0**	533.8	0.00	0.29	0.22	0.40
2017	2	1	31.2	79.0	203.0	313.2	0.68	0.52	1.59	0.96
2017	2	2	758.0	3,187.1	577.2	4,522.3	4.04	8.17	2.15	5.34
2017	3	0	13.0	86.2	64.5	163.7	0.01	0.03	0.02	0.06
2017	3	1	3,384.4	2,301.8	1,203.3	6,889.5	3.68	1.14	0.88	1.60
2017	3	2	1,006.4	1,934.2	1,599.5	4,540.1	0.83	1.00	1.76	1.12
2017	4	0	78.8	5.5	33.9	118.2	1.72	0.06	0.14	0.31
2017	4	1	432.3	319.0	1,557.8	2,309.1	1.02	0.61	2.21	1.40
2017	4	2	1,180.7	499.2	1,050.8	2,730.7	1.51	0.36	0.47	0.62
2018	1	0	0.0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
2018	1	1	190.1	70.0	21.0	281.1	0.39	0.19	0.08	0.25
2018	1	2	**1,193.4**	117.6	266.4	1,577.4	2.52	0.63	2.48	2.05
2018	2	0	0.0	283.1	175.0	458.1	0.00	0.24	0.14	0.32
2018	2	1	23.3	281.5	704.5	1,009.3	0.75	1.54	4.37	2.70
2018	2	2	124.1	1,991.5	511.1	2,626.7	1.27	4.03	1.74	2.97
2018	3	0	38.3	6.7	98.9	143.9	0.05	0.00	0.03	0.05
2018	3	1	**688.8**	2,232.3	1,983.7	4,904.8	1.09	0.81	1.49	1.04
2018	3	2	1,157.6	1,330.5	787.9	3,276.0	1.81	0.94	0.95	1.14
2018	4	0	58.5	6.4	109.7	174.6	5.98	0.04	0.62	0.50
2018	4	1	960.2	158.4	612.4	1,731.0	3.68	0.26	1.07	1.21

Year	Stat Area	Depth Zone	Otter Trawl Fishery Observed Effort in Hours Fished				Otter Trawl Fishery Percent Observed Effort			
			Season 1	Season 2	Season 3	Annual Total	Season 1	Season 2	Season 3	Annual Total
2018	4	2	**1,867.4**	961.6	**540.3**	3,369.3	3.78	0.74	0.21	0.77
2019	1	0	0.0	59.2	0.0	59.2	0.00	1.17	0.00	0.47
2019	1	1	81.7	300.6	5.7	388.0	0.20	0.88	0.01	0.34
2019	1	2	60.6	495.2	447.9	1,003.7	0.29	3.80	2.52	1.95
2019	2	0	36.7	317.6	104.5	458.8	0.49	0.22	0.09	0.36
2019	2	1	245.7	1,199.1	162.1	1,606.9	3.22	2.94	0.67	2.21
2019	2	2	386.3	603.3	257.1	1,246.7	1.64	3.87	1.25	2.09
2019	3	0	9.0	44.4	0.0	53.4	0.02	0.01	0.00	0.02
2019	3	1	581.8	792.7	307.3	1,681.8	2.52	0.40	0.33	0.54
2019	3	2	1,554.4	504.5	217.4	2,276.3	1.49	0.32	0.25	0.65
2019	4	0	95.1	7.6	0.0	102.7	22.80	0.09	0.00	0.50
2019	4	1	**782.5**	356.6	74.7	1,213.8	2.65	0.69	0.12	0.84
2019	4	2	76.6	417.3	709.2	1,203.1	0.33	0.46	0.34	0.38

Table 4. Gulf of Mexico shrimp trawl fishery strata (by state areas and depth zones) associations with delphinid stocks. Upper panel refers to common bottlenose dolphin, (*T. truncatus*) stocks while lower panel refers to Atlantic spotted dolphin (*S. frontalis*) stock. Inshore depth zone encompasses waters inshore of the COLREGs demarcation lines, nearshore encompasses waters from the COLREGS lines out to 10 fathoms (18 m), and offshore waters are those greater than 10 fathoms (18 m) depth. All bay, sound, and estuary (BSE) bottlenose dolphin stocks within a state are grouped for this comparison since fishery effort is only available at the state area resolution level. There is a mismatch between the boundary of the FL and AL/MS state areas and the boundary of the Northern Coastal (N Coastal) and Eastern Coastal (E Coastal) bottlenose dolphin stocks, with the N Coastal stock boundary extending into FL waters along the panhandle. The LA BSEs includes only waters west of the Mississippi River Delta, while the AL/MS BSEs include Louisiana waters east of the Mississippi River Delta.

	TX	LA	AL/MS	FL
Inshore	TX BSEs	LA BSEs	AL/MS BSEs	FL BSEs
Nearshore	W Coastal	W Coastal	N Coastal	E Coastal
Offshore	Shelf	Shelf	Shelf	Shelf
Inshore	-	-	-	-
Nearshore	*S. frontalis*	*S. frontalis*	*S. frontalis*	*S. frontalis*
Offshore	*S. frontalis*	*S. frontalis*	*S. frontalis*	*S. frontalis*

Table 5. Marine mammal bycatch incidents from 1997 to 2019, as reported by the Gulf of Mexico shrimp trawl Observer Program on the Protected Species Capture Report (Appendix D) with information on number of nets towed from the Observer Program station data.

Date	Time	Latitude	Longitude	Nets	Water Depth (ft.)	Species ID	Entanglement Gear	Release Condition
7 Dec, 2001	0:30	30.1356	-88.1372	4	58	Marine Mammal	TED	Decomposed
26 Mar, 2002	19:12	25.9656	-82.3950	4	85.6	Marine Mammal	Net	Unknown
5 Mar, 2003	11:50	30.2378	-88.1431	4	23	Bottlenose Dolphin	Lazy Line	Fresh Dead
4 Sep, 2004	19:54	28.3461	-93.9992	4	172	Marine Mammal	Lazy Line	NG
9 Mar, 2006	18:20	28.1339	-91.7431	4	286	Marine Mammal	TED	Decomposed
27 Mar, 2007	7:10	26.7056	-82.4486	4	57	Marine Mammal	TED	NG
28 Dec, 2007	19:46	29.1717	-91.5792	4	23	Bottlenose Dolphin	Lazy Line	Fresh Dead
3 Feb, 2008	0:56	26.2244	-96.5528	4	180	Dolphin Carcass	Ticker Chain	Decomposed
2 Dec, 2008	7:35	26.8603	-97.1256	4	90	Bottlenose Dolphin	Lazy Line	Fresh Dead
13 May, 2009	15:56	27.4258	-97.1939	4	60	Dolphin	Lazy Line	Alive[o]
7 Feb, 2010	19:02	29.1228	-90.1167	2	25.4	Bottlenose Dolphin	Net	Fresh Dead
22 Nov, 2011	7:35	26.4844	-96.8731	4	n/a[*]	Bottlenose Dolphin	Lazy Line	Fresh Dead
31 Aug, 2013	15:15	28.1753	-91.9711	4	240	Bottlenose dolphin	Line from net to tickler chain	Dead
23 Aug, 2014	6:52	28.4906	-95.1039	4	100	Bottlenose dolphin	Lazy Line	Dead
10 Apr, 2015	21:55	29.4292	-92.4533	4	28.7	Unid. Marine Mammal	Try Net	Dead
21 Jan, 2016	7:59	26.6700	-96.8514	4	170.4	Bottlenose dolphin	Lazy Line	Dead
30 Oct, 2017	14:42	29.4428	-89.3242	2	16.3	Bottlenose dolphin	TED Net	Dead
11 Apr, 2018	22:04	28.8892	-95.1806	4	61	Bottlenose dolphin	Lazy Line	Dead
27 Apr, 2018	1:18	24.7394	-82.5739	4	87.6	Bottlenose dolphin	Trawl Net	Dead
2 Apr, 2018	13:54	29.6533	-93.9900	2	13	Bottlenose dolphin	Lazy Line	Dead
8 Sep, 2018	4:31	26.3078	-96.9772	4	93	Bottlenose dolphin	Lazy Line	Dead
26 Feb, 2019	12:58	28.2425	-96.5022	2	30	Unid. Marine Mammal	Trawl Net	Dead

* Based on trip and tow information from other observer forms and Lat/Long, this entanglement occurred in > 60 ft. (>10 fathom) waters.

[o] This animal was released alive with no apparent injury, and therefore was not included in bycatch mortality estimation. Comments indicated: "The dolphin was tangled in the lazy line; the line was cut. The dolphin appeared in good condition, alive, and with no noticeable injuries."

Table 6. Unweighted five-year mean of annual stock bycatch mortality estimates for each year from 2011 to 2019 by stratification method and species classification scenario for unidentified dolphins. Coefficients of variation (CV) of the standard error were estimated using standard bootstrap methods, and 95% confidence intervals (CI) were estimated using bias corrected and accelerated bootstrap methods. Annual bycatch mortality estimates for 2011 to 2019 are included in Appendix E. Species codes: Ud are unidentified dolphins, Tt are bottlenose dolphins (*T. truncatus*), and Sf are Atlantic spotted dolphins (*S. frontalis*). Stratification methods (2-areas, and 4-areas refer to stratification of bycatch rate estimation). The models thought to be the most appropriate for the stock assessment reports, as described in the text, are indicated with bold type. Updated bycatch estimates for years 2011 to 2014 are included in addition to the new 2015 to 2019 estimates due to errors in otter trawl effort estimates and minor QA/QC updates to the Observer Program data.

		2011			2012			2013		
		2007-2011 Mean	CV	95% CI	2008-2012 Mean	CV	95% CI	2009-2013 Mean	CV	95% CI
2-area										
Ud=Tt	Tt Shelf	48	0.43	15 - 99	47	0.42	16 - 93	49	0.40	17 - 95
	Tt W Coastal	74	0.53	17 - 176	68	0.54	15 - 167	60	0.62	13 - 167
	Tt N Coastal	10	0.66	2.5 - 34	9.5	0.74	2.4 - 36	7.8	0.90	1.6 - 37
	Tt E Coastal	2.3	1.20	0 - 11	1.8	1.34	0.0 - 12	1.7	1.39	0.0 - 13
	Tt TX BSE	3.8	0.76	0.9 - 15	3.0	0.76	0.7 - 13	2.7	0.85	0.6 - 13
	Tt LA BSE	101	0.56	22 - 253	97	0.60	20 - 254	87	0.70	14 - 260
	Tt AL/MS BSE	30	0.64	5.1 - 87	29	0.66	4.0 - 87	27	0.75	3.0 - 90
	Tt FL BSE	3.3	1.46	0 - 26	3.2	1.52	0 - 26	3.3	1.46	0 - 26
	Sf	0		0 - 0	0	-	0 - 0	0	-	0 - 0
Ud=Sf	Tt Shelf	19	0.73	0.0 - 59	20	0.68	0.0 - 55	22	0.65	0.0 - 60
	Tt W Coastal	56	0.61	0.0 - 147	51	0.62	0.0 - 140	45	0.71	5.0 - 145
	Tt N Coastal	7.7	0.71	1.1 - 26	6.9	0.79	1.0 - 27	5.8	0.96	0.6 - 29
	Tt E Coastal	0		0 - 0	0	-	0 - 0	0	-	0 - 0
	Tt TX BSE	2.3	0.84	0.3 - 10	1.9	0.79	0.3 - 7.8	1.7	0.91	0.1 - 8.2
	Tt LA BSE	77	0.65	0.0 - 219	74	0.70	5.9 - 222	65	0.82	4.0 - 233
	Tt AL/MS BSE	20	0.75	2.1 - 68	19	0.79	0.7 - 68	18	0.90	0.4 - 71
	Tt FL BSE	0		0 - 0	0	-	0 - 0	0	-	0 - 0
	Sf	52	0.51	13 - 124	48	0.52	12 - 113	45	0.52	13 - 112
4-area										
Ud=Tt	Tt Shelf	**56**	**0.46**	**17 - 119**	**54**	**0.45**	**17 - 115**	**57**	**0.43**	**19 - 116**
	Tt W Coastal	**68**	**0.82**	**0.0 - 235**	**62**	**0.82**	**0.0 - 217**	**55**	**0.91**	**0.0 - 232**
	Tt N Coastal	**21**	**0.81**	**0.0 - 84**	**19**	**0.87**	**0.0 - 89**	**16**	**0.98**	**0.0 - 90**
	Tt E Coastal	**2.3**	**1.20**	**0.0 - 12**	**1.8**	**1.33**	**0.0 - 13**	**1.7**	**1.38**	**0.0 - 13**
	Tt TX BSE	**0**	-	**0 - 0**	**0**	-	**0 - 0**	**0**	-	**0 - 0**
	Tt LA BSE	**131**	**0.88**	**0.0 - 504**	**126**	**0.93**	**0.0 - 521**	**111**	**1.05**	**0.0 - 573**
	Tt AL/MS BSE	**61**	**0.82**	**0.0 - 227**	**60**	**0.84**	**0.0 - 225**	**55**	**0.91**	**0.0 - 228**
	Tt FL BSE	**3.3**	**1.44**	**0.0 - 26**	**3.2**	**1.51**	**0.0 - 26**	**3.3**	**1.45**	**0.0 - 26**
	Sf	0		0 - 0	0	-	0 - 0	0	-	0 - 0
Ud=Sf	Tt Shelf	29	0.72	0.0 - 81	28	0.69	0.0 - 79	30	0.66	0.0 - 81
	Tt W Coastal	68	0.82	0.0 - 235	62	0.82	0.0 - 217	55	0.91	0.0 - 232
	Tt N Coastal	9.5	0.92	0.0 - 36	8.8	0.96	0.0 - 36	7.9	1.09	0.0 - 38
	Tt E Coastal	0	-	0 - 0	0	-	0 - 0	0	-	0 - 0
	Tt TX BSE	0	-	0 - 0	0	-	0 - 0	0	-	0 - 0
	Tt LA BSE	131	0.88	0.0 - 504	126	0.93	0.0 - 521	111	1.05	0.0 - 573
	Tt AL/MS BSE	19	1.08	0.0 - 100	18	1.15	0.0 - 101	17	1.28	0.0 - 103
	Tt FL BSE	0	-	0 - 0	0	-	0 - 0	0	-	0 - 0
	Sf	**41**	**0.48**	**11 - 92**	**38**	**0.52**	**11 - 92**	**36**	**0.53**	**11 - 93**

		2014			2015			2016		
		2010-2014 Mean	CV	95% CI	2011-2015 Mean	CV	95% CI	2012-2016 Mean	CV	95% CI
2-area										
Ud=Tt	Tt Shelf	50	0.39	18 - 97	52	0.37	20 - 95	54	0.35	21 - 95
	Tt W Coastal	56	0.58	13 - 144	48	0.65	13 - 146	47	0.61	13 - 134
	Tt N Coastal	5.1	0.70	1.0 - 17	3.8	0.73	0.9 - 14	3.1	0.62	0.8 - 9.4
	Tt E Coastal	1.3	1.44	0.0 - 13	1.5	1.55	0.0 - 17	2.9	1.74	0.0 - 38
	Tt TX BSE	6.3	1.48	1.4 - 63	5.6	1.69	1.7 - 71	6.1	1.52	1.6 - 65
	Tt LA BSE	73	0.76	18 - 269	58	0.80	18 - 259	48	0.55	11 - 120
	Tt AL/MS BSE	22	0.97	1.4 - 95	14	1.05	1.7 - 76	11	0.81	0.9 - 37
	Tt FL BSE	2.3	1.65	0 - 25	1.1	1.72	0 - 14	0.9	1.45	0 - 5.7
	Sf	0	-	0 - 0	0	-	0 - 0	0	-	0 - 0
Ud=Sf	Tt Shelf	25	0.61	0.0 - 64	30	0.55	0.0 - 67	34	0.48	7.5 - 73
	Tt W Coastal	42	0.68	4.6 - 124	36	0.77	5.8 - 128	33	0.74	6.0 - 120
	Tt N Coastal	3.8	0.86	0.4 - 15	2.7	0.92	0.4 - 13	2.0	0.74	0.3 - 7.4
	Tt E Coastal	0	-	0 - 0	0	-	0 - 0	0	-	0 - 0
	Tt TX BSE	5.0	1.72	0.9 - 63	4.6	1.88	1.1 - 69	5.0	1.73	1.2 - 65
	Tt LA BSE	54	0.89	6.8 - 230	41	0.94	9.3 - 226	31	0.66	3.4 - 89
	Tt AL/MS BSE	14	1.13	0.4 - 74	9.1	1.26	0.7 - 66	6.3	0.97	0.3 - 28
	Tt FL BSE	0	-	0 - 0	0	-	0 - 0	0	-	0 - 0
	Sf	41	0.52	11 - 101	37	0.50	11 - 87	37	0.48	11 - 82
4-area										
Ud=Tt	Tt Shelf	**57**	**0.42**	**20 - 116**	**58**	**0.40**	**22 - 116**	**60**	**0.38**	**23 - 114**
	Tt W Coastal	**51**	**0.88**	**0.0 - 199**	**43**	**0.99**	**0.0 - 216**	**39**	**0.88**	**0.0 - 167**
	Tt N Coastal	**11**	**0.77**	**0.0 - 37**	**8.5**	**0.80**	**0.0 - 32**	**7.5**	**0.78**	**0.0 - 28**
	Tt E Coastal	**1.3**	**1.39**	**0.0 - 13**	**1.5**	**1.59**	**0.0 - 19**	**2.9**	**1.74**	**0.0 - 37**
	Tt TX BSE	**0**	-	**0 - 0**	**0**	**3.06**	**0.0 - 1.8**	**0.3**	**2.40**	**0.0 - 5.7**
	Tt LA BSE	**91**	**1.11**	**0.0 - 553**	**67**	**1.18**	**9.1 - 530**	**47**	**0.79**	**0.0 - 159**
	Tt AL/MS BSE	**45**	**1.10**	**0.0 - 247**	**31**	**1.12**	**0.0 - 181**	**26**	**1.00**	**0.0 - 114**
	Tt FL BSE	**2.3**	**1.59**	**0.0 - 25**	**1.1**	**1.68**	**0.0 - 13**	**0.9**	**1.44**	**0.0 - 5.7**
	Sf	0	-	0 - 0	0	-	0 - 0	0	-	0 - 0
Ud=Sf	Tt Shelf	33	0.63	0.0 - 87	38	0.56	5.1 - 92	42	0.51	9.4 - 96
	Tt W Coastal	51	0.88	0.0 - 199	42	1.02	0.0 - 214	34	0.99	0.0 - 177
	Tt N Coastal	5.5	1.12	0.0 - 28	4.1	1.13	0.0 - 24	3.3	0.96	0.0 - 15
	Tt E Coastal	0	-	0 - 0	0	-	0 - 0	0	-	0 - 0
	Tt TX BSE	0	-	0 - 0	0	-	0 - 0	0	-	0 - 0
	Tt LA BSE	91	1.11	0.0 - 553	66	1.20	5.2 - 530	44	0.83	0.0 - 162
	Tt AL/MS BSE	14	1.52	0.0 - 118	10	1.64	0.0 - 102	8.6	1.65	0.0 - 97
	Tt FL BSE	0	-	0 - 0	0	-	0 - 0	0	-	0 - 0
	Sf	**31**	**0.52**	**10 - 77**	**27**	**0.48**	**8.7 - 64**	**29**	**0.50**	**10 - 73**

		2017			2018			2019		
		2013-2017 Mean	CV	95% CI	2014-2018 Mean	CV	95% CI	2015-2019 Mean	CV	95% CI
2-area										
Ud=Tt	Tt Shelf	56	0.33	24 - 98	57	0.32	25 - 97	56	0.32	26 - 96
	Tt W Coastal	47	0.58	13 - 129	50	0.53	15 - 129	42	0.50	15 - 101
	Tt N Coastal	2.7	0.54	0.8 - 7.1	2.6	0.52	0.9 - 7.0	2.8	0.50	1.0 - 7.2
	Tt E Coastal	4.8	1.48	0.0 - 42	6.4	1.24	0.0 - 32	7.6	1.06	0.0 - 29
	Tt TX BSE	6.4	1.43	1.9 - 65	6.5	1.40	2.1 - 65	2.6	0.70	0.8 - 8.6
	Tt LA BSE	50	0.52	11 - 117	53	0.47	15 - 117	53	0.46	17 - 118
	Tt AL/MS BSE	10	0.75	0.7 - 32	10	0.71	1.4 - 32	12	0.56	2.7 - 32
	Tt FL BSE	1.0	1.27	0.0 - 5.2	0.8	1.46	0.0 - 5.8	0.7	1.59	0.0 - 7.2
	Sf	0	-	0 - 0	0	-	0 - 0	0	-	0 - 0
Ud=Sf	Tt Shelf	38	0.44	8.1 - 74	39	0.40	12 - 74	40	0.38	15 - 75
	Tt W Coastal	32	0.72	6.7 - 118	34	0.68	8.6 - 118	26	0.57	7.0 - 71
	Tt N Coastal	1.7	0.64	0.3 - 5.0	1.6	0.61	0.4 - 4.9	1.8	0.59	0.5 - 5.0
	Tt E Coastal	0	-	0 - 0	0	-	0 - 0	0	-	0 - 0
	Tt TX BSE	5.1	1.69	1.3 - 65	5.2	1.65	1.5 - 65	1.6	0.77	0.4 - 6.1
	Tt LA BSE	33	0.62	3.6 - 87	35	0.56	7.1 - 88	34	0.56	6.6 - 85
	Tt AL/MS BSE	6.2	0.88	0.3 - 26	6.8	0.82	0.4 - 25	8.1	0.67	0.8 - 25
	Tt FL BSE	0	-	0 - 0	0	-	0 - 0	0	-	0 - 0
	Sf	40	0.47	12 - 86	41	0.45	13 - 87	40	0.43	15 - 86
4-area										
Ud=Tt	Tt Shelf	**64**	**0.36**	**25 - 116**	**65**	**0.34**	**27 - 116**	**64**	**0.34**	**28 - 114**
	Tt W Coastal	**38**	**0.81**	**1.5 - 151**	**40**	**0.75**	**6.7 - 151**	**32**	**0.66**	**7.6 - 96**
	Tt N Coastal	**6.2**	**0.72**	**0.0 - 21**	**6.2**	**0.67**	**0.0 - 20**	**6.5**	**0.64**	**1.4 - 20**
	Tt E Coastal	**4.8**	**1.49**	**0.0 - 41**	**6.4**	**1.24**	**0.0 - 32**	**7.6**	**1.06**	**0.0 - 29**
	Tt TX BSE	**0.4**	**1.81**	**0.0 - 4.7**	**0.4**	**1.68**	**0.0 - 4.7**	**0.4**	**1.62**	**0.0 - 4.7**
	Tt LA BSE	**48**	**0.73**	**0.0 - 150**	**50**	**0.68**	**4.1 - 150**	**45**	**0.65**	**7.9 - 132**
	Tt AL/MS BSE	**25**	**0.92**	**0.0 - 108**	**28**	**0.85**	**0.0 - 105**	**33**	**0.70**	**0.9 - 104**
	Tt FL BSE	**1.0**	**1.26**	**0.0 - 5.2**	**0.8**	**1.46**	**0.0 - 5.8**	**0.7**	**1.58**	**0.0 - 7.0**
	Sf	0	-	0 - 0	0	-	0 - 0	0	-	0 - 0
Ud=Sf	Tt Shelf	47	0.46	11 - 97	50	0.41	15 - 98	49	0.41	17 - 97
	Tt W Coastal	30	0.98	0.0 - 168	30	0.98	4.7 - 172	21	0.75	2.5 - 70
	Tt N Coastal	3.0	0.87	0.0 - 12	3.5	0.75	0.0 - 11	4.4	0.76	0.0 - 16
	Tt E Coastal	0	-	0 - 0	0	-	0 - 0	0	-	0 - 0
	Tt TX BSE	0	-	0 - 0	0	-	0 - 0	0	-	0 - 0
	Tt LA BSE	43	0.79	0.0 - 147	43	0.77	0.0 - 147	37	0.72	3.4 - 115
	Tt AL/MS BSE	12	1.33	0.0 - 86	15	1.07	0.0 - 71	18	0.87	0.0 - 67
	Tt FL BSE	0	-	0 - 0	0	-	0 - 0	0	-	0 - 0
	Sf	**33**	**0.53**	**11 - 85**	**34**	**0.51**	**12 - 84**	**36**	**0.47**	**13 - 83**

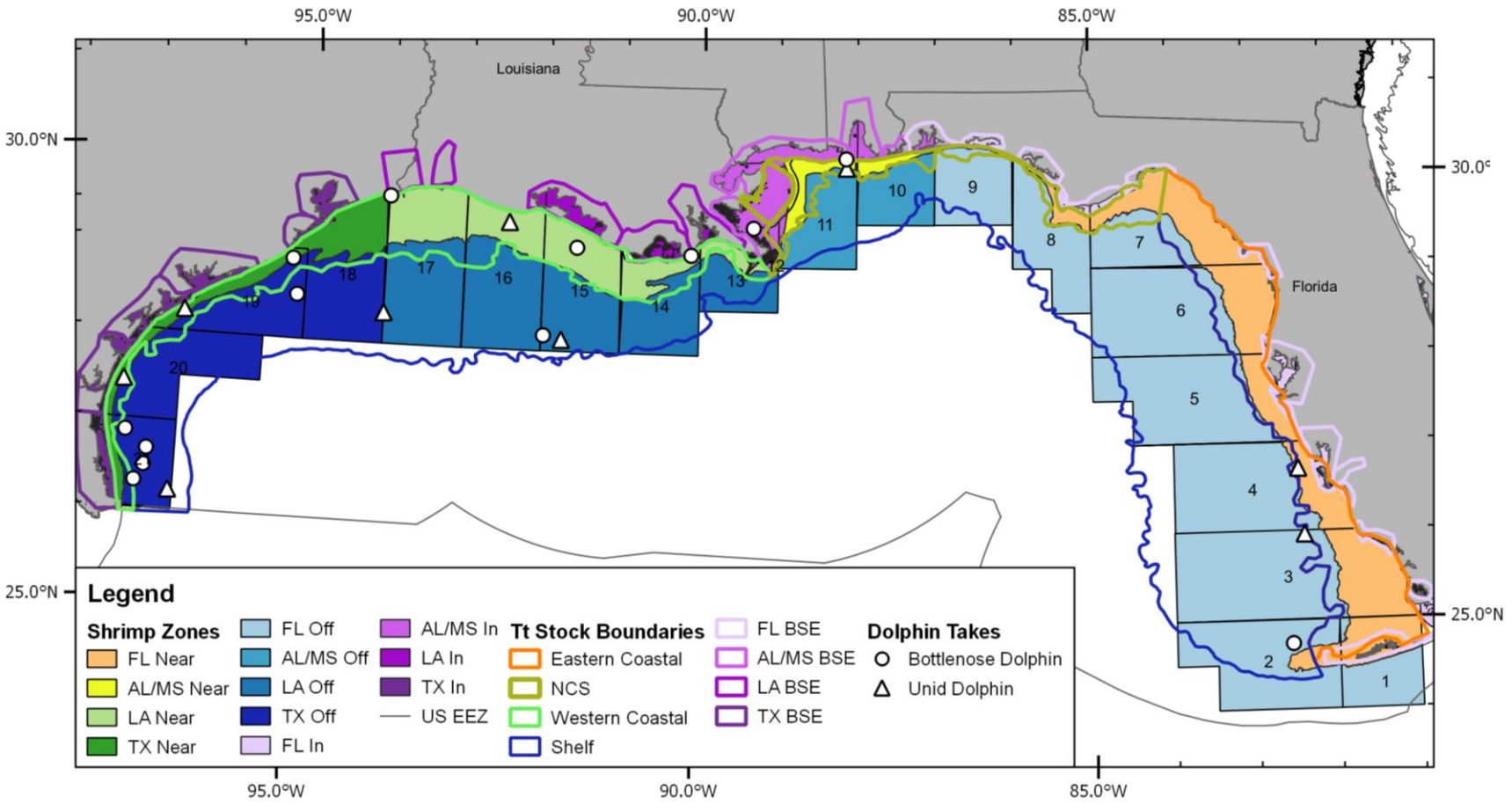

Figure 1. Gulf of Mexico shrimp trawl fishery statistical zones, state area and depth boundaries, shelf and coastal bottlenose dolphin stock boundaries, and observed dolphin take locations. Shrimp fishery statistical zones described by Patella (1975) include 21 statistical areas and 9 depth zones based on isobaths in 10 fathom intervals. Statistical areas are grouped into coarser resolution state areas, and nearshore and offshore (>10 Fm) depth zones, as indicated by color groupings. Coastal and shelf bottlenose dolphin stock boundaries are indicated by colored out lines. Locations of marine mammal entanglements observed by the NMFS Gulf of Mexico shrimp otter trawl fishery Observer Program from 1997 to 2014 are overlaid. Bycaught dolphins were identified as bottlenose dolphin (*T. truncatus*) or remained unidentified and may be bottlenose dolphins or Atlantic spotted dolphins (*S. frontalis*). Bathymetry is indicated by 10 and 100 Fm (18.3 and 182.9 m) isobaths.

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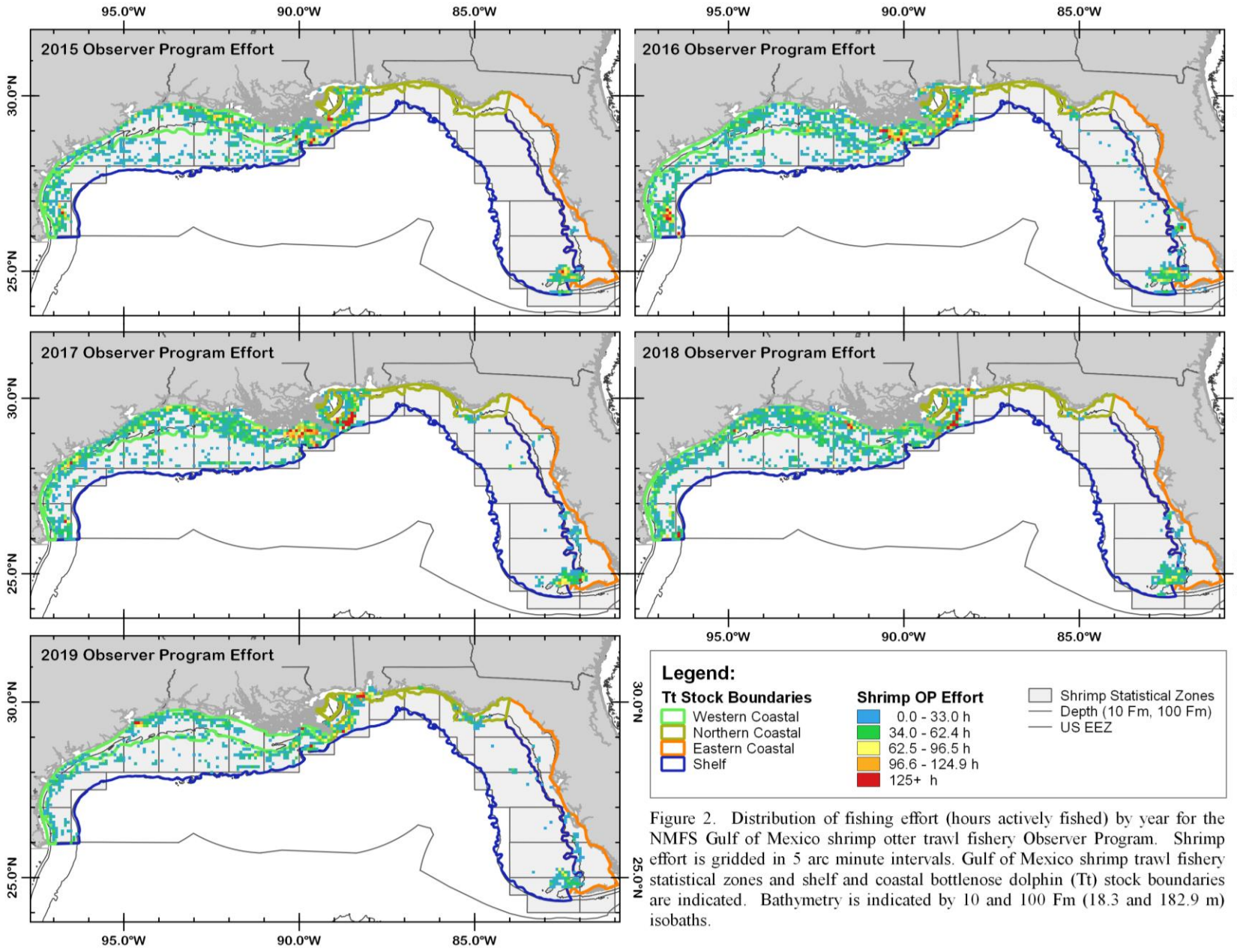


Figure 2. Distribution of fishing effort (hours actively fished) by year for the NMFS Gulf of Mexico shrimp otter trawl fishery Observer Program. Shrimp effort is gridded in 5 arc minute intervals. Gulf of Mexico shrimp trawl fishery statistical zones and shelf and coastal bottlenose dolphin (Tt) stock boundaries are indicated. Bathymetry is indicated by 10 and 100 Fm (18.3 and 182.9 m) isobaths.

Figure 3. Annual bycatch per unit effort (BPUE) and annual fishery effort for each depth zone, season, and stat area stratum for best case scenario for bottlenose dolphins (Tt), worst case scenario for spotted dolphins (Ud=Sf), and worst-case scenario for bottlenose dolphins (Tt + Ud=Tt) for the 2-area models.

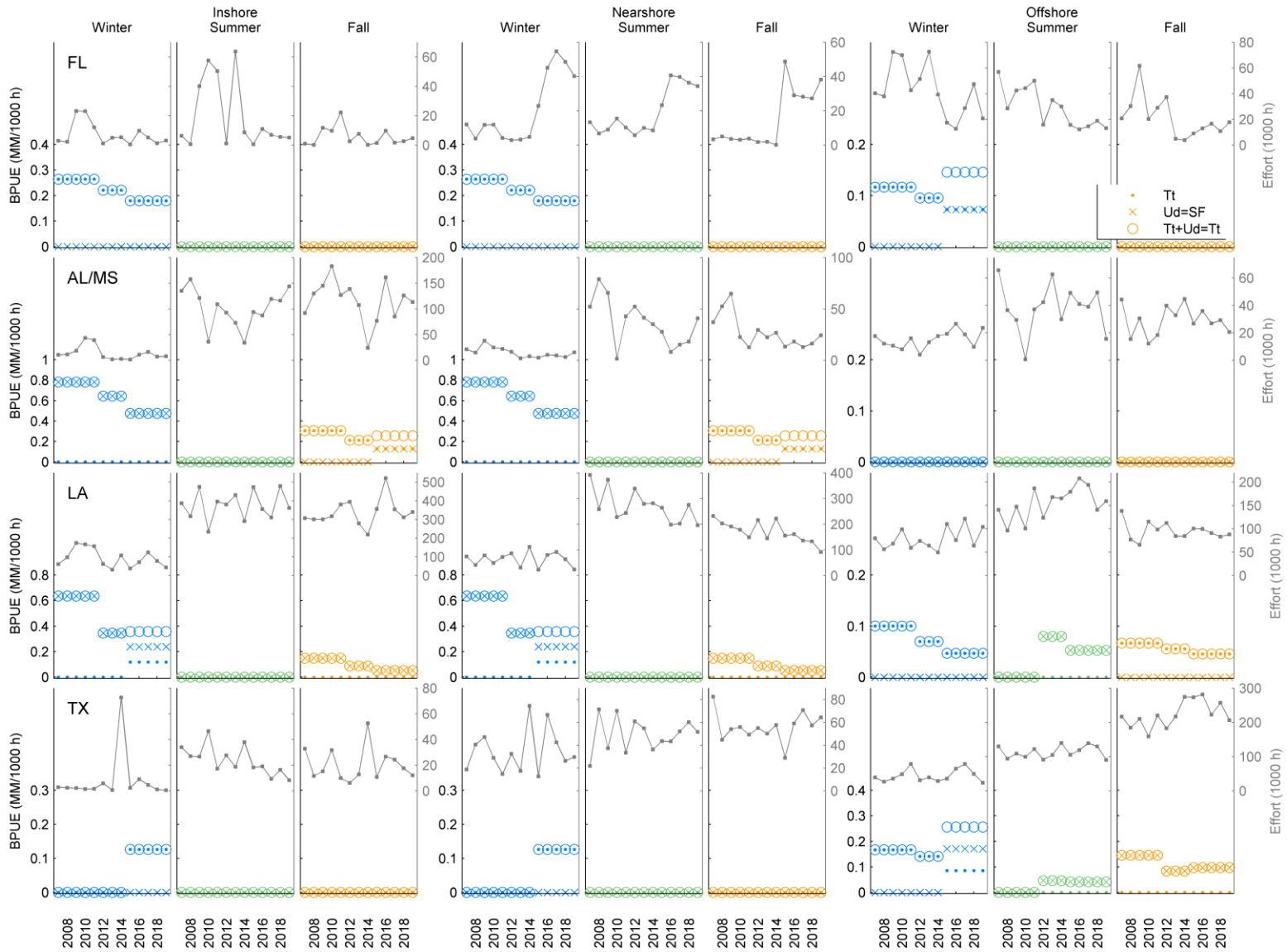


Figure 4. Annual bycatch per unit effort (BPUE) and annual fisher effort for each depth zone, season, and stat area stratum for best case scenario for bottlenose dolphins (Tt), worst case scenario for spotted dolphins (Ud=Sf), and worst-case scenario for bottlenose dolphins (Tt + Ud=Tt) for the 4-area models.

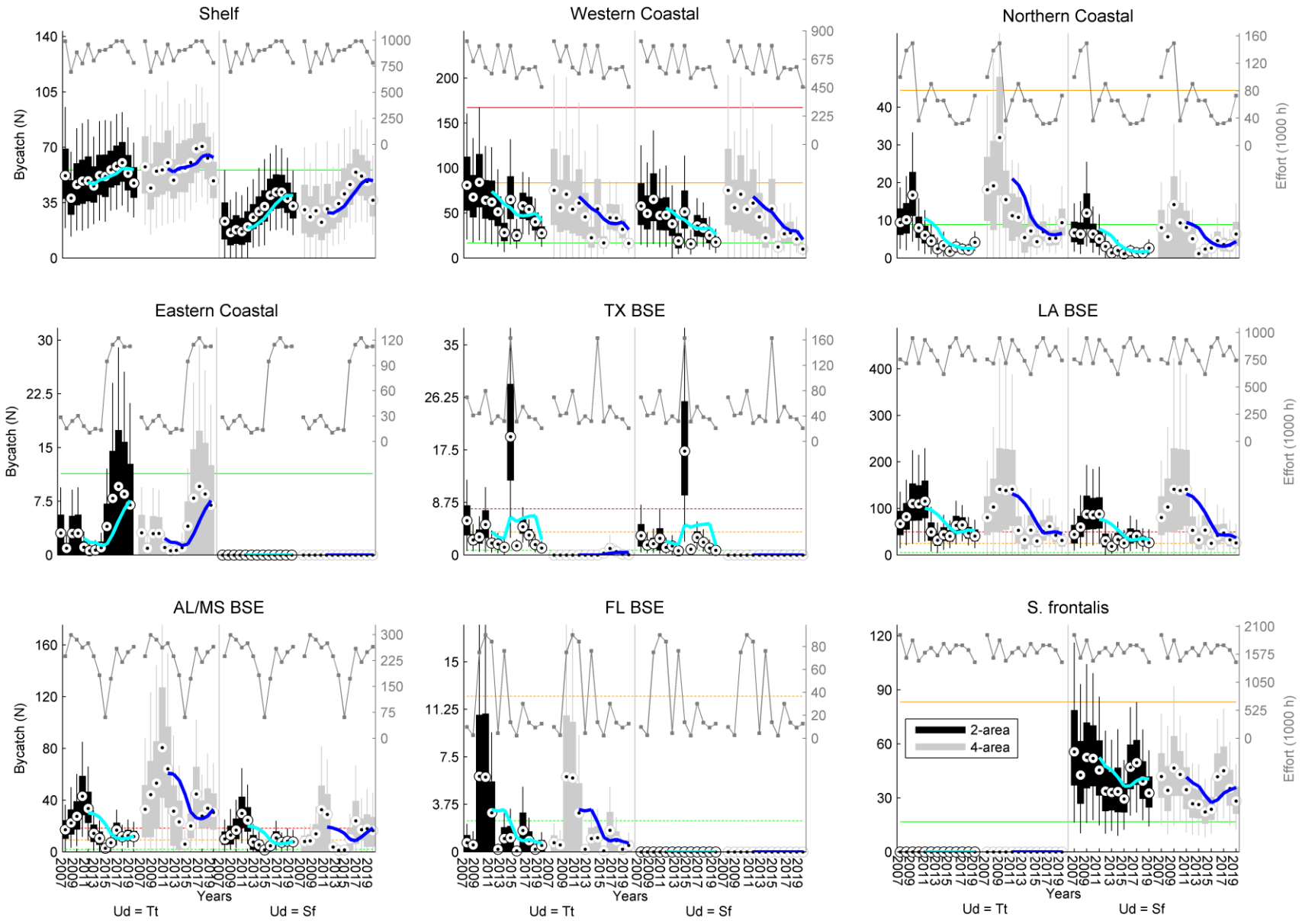

Shelf
Western Coastal
Northern Coastal
Eastern Coastal
TX BSE
LA BSE
AL/MS BSE
FL BSE
S. frontalis
Bycatch (N)
Effort (1000 h)
2-area
4-area
Years
Ud = Tt
Ud = Sf

Figure 5. Trends in estimated bycatch mortality for each stock by stratification method (2-area and 4-area) and under two species identification scenarios from 2007 to 2019. Estimates are presented for 8 stock groups of bottlenose dolphins (Shelf (S), Western Coastal (WC), Northern Coastal (NC), Eastern Coastal (EC), TX BSE (TX), LA BSE (LA), AL/MS BSE (AL/MS), and FL BSE (FL)) and for one stock of Atlantic spotted dolphins (Sf). The two species identification scenarios represent best and worst case scenarios for each species, in which all unidentified takes are assigned to either species. Bycatch mortality for each method is represented by box and whisker plots which indicate the median (circle), 25 – 75% quartiles (box), and 95% CIs (whiskers). The 5-year average estimates for 2011 to 2019 are overlaid in cyan and blue for the 2-area and 4-area methods, respectively. Best available data on Potential Biological Removal (PBR) is shown for reference (green = 10% PBR, orange = 50% PBR, red = PBR), but estimates for some bottlenose dolphin Bay, Sound and Estuary (BSE) stocks are uncertain due to the age (>8 years) of the last abundance estimates. PBR values for BSE stocks represent the aggregate PBR for all stocks within each state area. Total annual fishery effort aggregated over strata that match stock ranges are plotted as thousands of hours fished for each method.

APPENDICES

APPENDIX A. Northern Gulf of Mexico common bottlenose dolphin Bay, Sound, and Estuary (BSE) stocks abundance table and map reproduced from Hayes et al. in review.

Table 1. Most recent common bottlenose dolphin abundance estimate (Nbest), coefficient of variation (CV), minimum population estimate (Nmin), Potential Biological Removal (PBR), year of the most recent abundance estimate and associated publication (Year), and minimum counts of annual human-caused mortality and serious injury (HCMSI) in northern Gulf of Mexico bay, sound and estuary stocks. When estimates are based on data collected more than eight years ago, they are considered unknown or undetermined for management purposes. Blocks refer to aerial survey blocks illustrated in Figure 1. UNK – unknown; UND – undetermined. For each stock denoted with a † symbol, please refer to the stand-alone report for this stock.

Blocks	Gulf of Mexico Estuary	Nbest	CV	Nmin	PBR	Year (Reference)	Minimum Annual HCMSI, 2015–2019
B51	Laguna Madre	80	1.57	UNK	UND	1992 (A)	0.8
B52	Nueces Bay/Corpus Christi Bay	58	0.61	UNK	UND	1992 (A)	0.2
B50	Copano Bay/Aransas Bay/San Antonio Bay/Redfish Bay/Espiritu Santo Bay	55	0.82	UNK	UND	1992 (A)	0.6
B54	Matagorda Bay/Tres Palacios Bay/Lavaca Bay	61	0.45	UNK	UND	1992 (A)	0.4
B55	West Bay†						
B56	Galveston Bay/East Bay/Trinity Bay†						
B57	Sabine Lake	122[a]	0.19	104	0.9	2017	0
B58	Calcasieu Lake	0[b]	-	-	UND	1992 (A)	0.2
B59	Vermilion Bay/West Cote Blanche Bay/Atchafalaya Bay	0[b]	-	-	UND	1992 (A)	0
B60	Terrebonne-Timbalier Bay Estuarine System†						
B61	Barataria Bay Estuarine System†						
B30	Mississippi River Delta	1,446[c]	0.19	1,238	11	2017–18 (C)	9.2
B02–05, 29, 31	Mississippi Sound/Lake Borgne/Bay Boudreau†						
B06	Mobile Bay/Bonsecour Bay	122	0.34	UNK	UND	1993 (A)	15.6
B07	Perdido Bay	0[b]	-		UND	1993 (A)	0.6
B08	Pensacola Bay/East Bay	33	0.80	UNK	UND	1993 (A)	0.4
B09	Choctawhatchee Bay†						
B10	St. Andrew Bay†						
B11	St. Joseph Bay†						
B12–13	St. Vincent Sound/Apalachicola Bay/St. George Sound	439	0.14	UNK	UND	2007 (D)	0.2
B14–15	Apalachee Bay	491	0.39	UNK	UND	1993 (A)	0
B16	Waccasassa Bay/Withlacoochee Bay/Crystal Bay	UNK	-	UNK	UND	-	0.4
B17	St. Joseph Sound/Clearwater Harbor	UNK	-	UNK	UND	-	0.6
B32–34	Tampa Bay	UNK	-	UNK	UND	-	3.0
B20, 35	Sarasota Bay/Little Sarasota Bay	158	0.27	126	1.0	2015 (E)	0.2
B21–23	Pine Island Sound/Charlotte Harbor/Gasparilla Sound/Lemon Bay	826	0.09	UNK	UND	2006 (F)	1.0
B36	Caloosahatchee River	0[b]	-	-	UND	1985 (G)	0.2
B24	Estero Bay	UNK	-	UNK	UND	-	0.2
B25	Chokoloskee Bay/Ten Thousand Islands/Gullivan Bay	UNK	-	UNK	UND	-	0.2
B27	Whitewater Bay	UNK	-	UNK	UND	-	0

B28	Florida Keys (southwest Marathon Key to Marquesas Keys)	UNK	-	UNK	UND	-		0

References: A – Blaylock and Hoggard 1994; B – Ronje *et al.* 2020; C – Garrison *et al.* in review; D – Tyson *et al.* 2011; E – Tyson and Wells 2016; F – Bassos-Hull *et al.* 2013; G – Scott *et al.* 1989

Notes:

a Winter seasonal estimate, Selective dataset.

b During earlier surveys (Scott *et al.* 1989), the range of seasonal abundances was as follows: Calcasieu Lake, 0–6 (0.34); Vermilion Bay/West Cote Blanche Bay/Atchafalaya Bay, 0–0; Perdido Bay, 0–0; Lemon Bay, 0–15 (0.43); and Caloosahatchee River, 0–0.

c Abundance estimate utilizes density estimate from adjacent waters. See Garrison *et al.* (in review) for details.

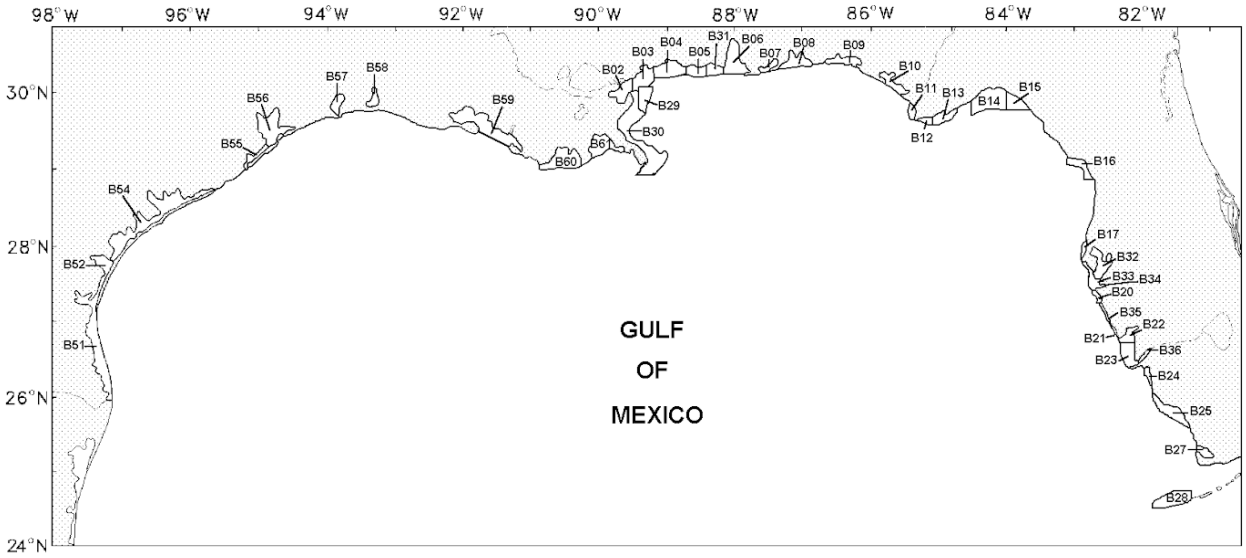


Figure 1. Northern Gulf of Mexico bays, sounds, and estuaries. Each of the alpha-numerically designated blocks corresponds to one of the NMFS Southeast Fisheries Science Center logistical aerial survey areas listed in Table 1. The common bottlenose dolphins inhabiting each bay, sound, or estuary are considered to comprise a unique stock for purposes of this assessment. Eight stocks have their own stock assessment report (see Table 1). (Reproduced from Hayes et al., in review)

APPENDIX B. Trawl gear configuration reproduced from Scott-Denton et al. (2012)

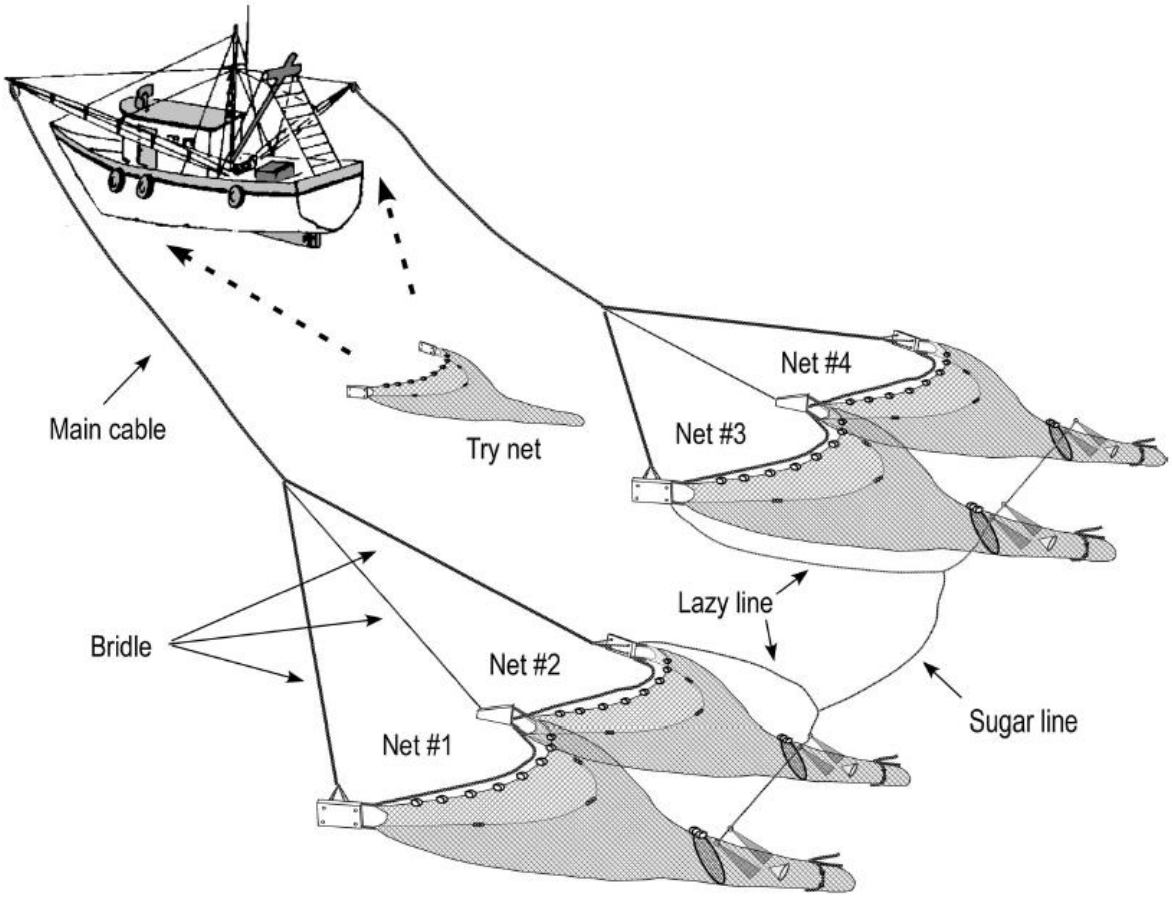


Figure 2.—Typical gear configuration for U.S. southeastern shrimp vessels equipped with four nets.

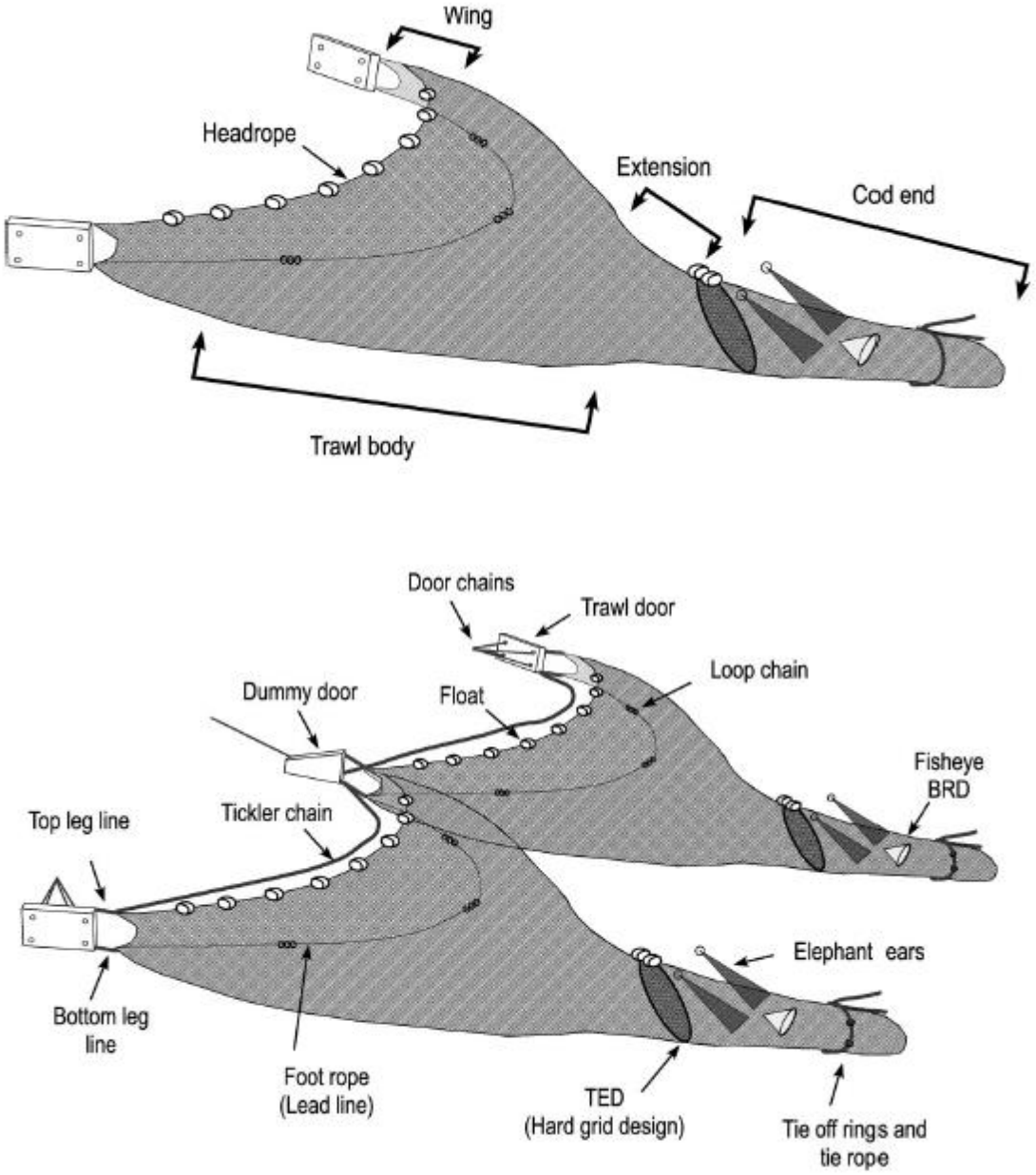
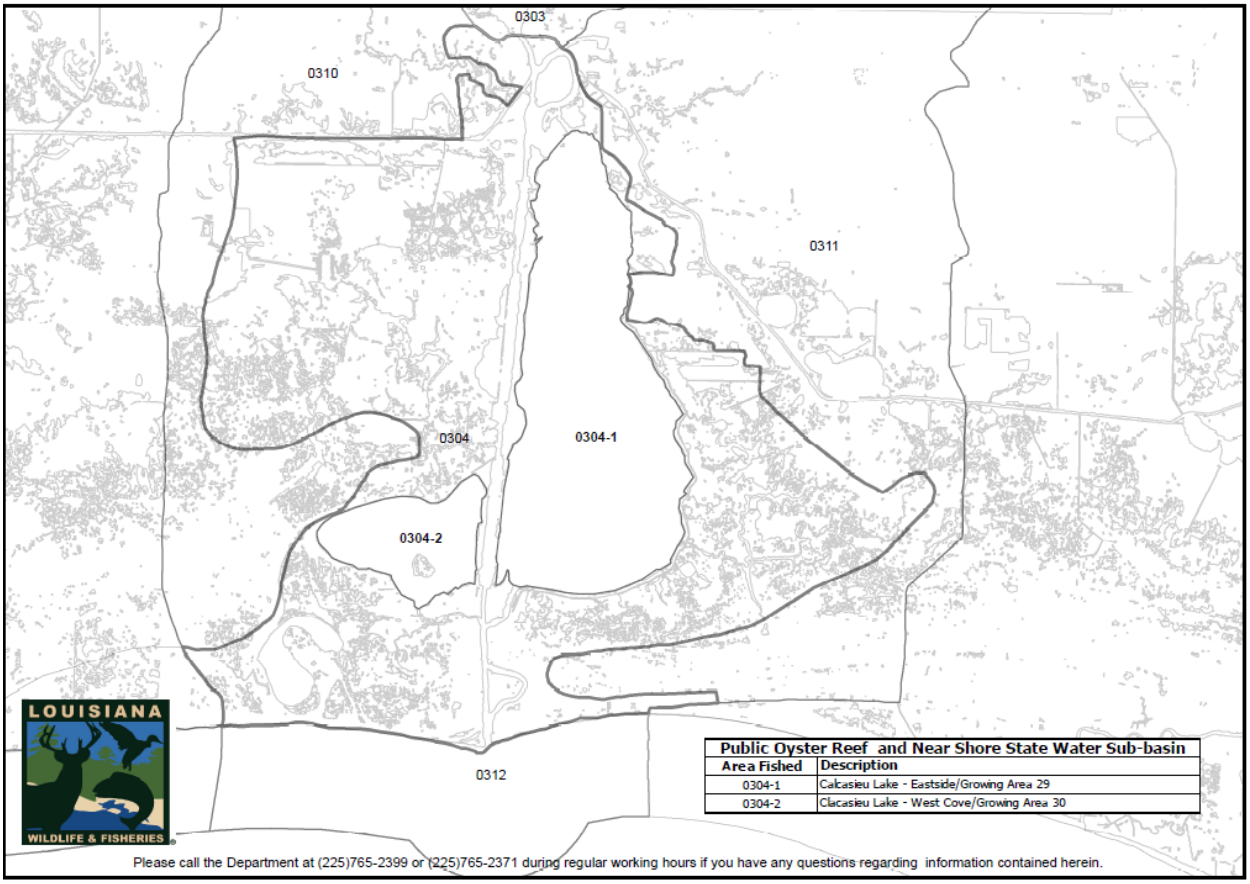


Figure 3.—Typical gear components for U.S. southeastern shrimp vessels.

APPENDIX C. Louisiana state water basins and sub-basins from the Louisiana Department of Wildlife and Fisheries (LDWF) and their overlap with Gulf of Mexico common bottlenose dolphin Bay Sound and Estuary stock boundaries.

1. Maps of Louisiana water basins and sub-basins

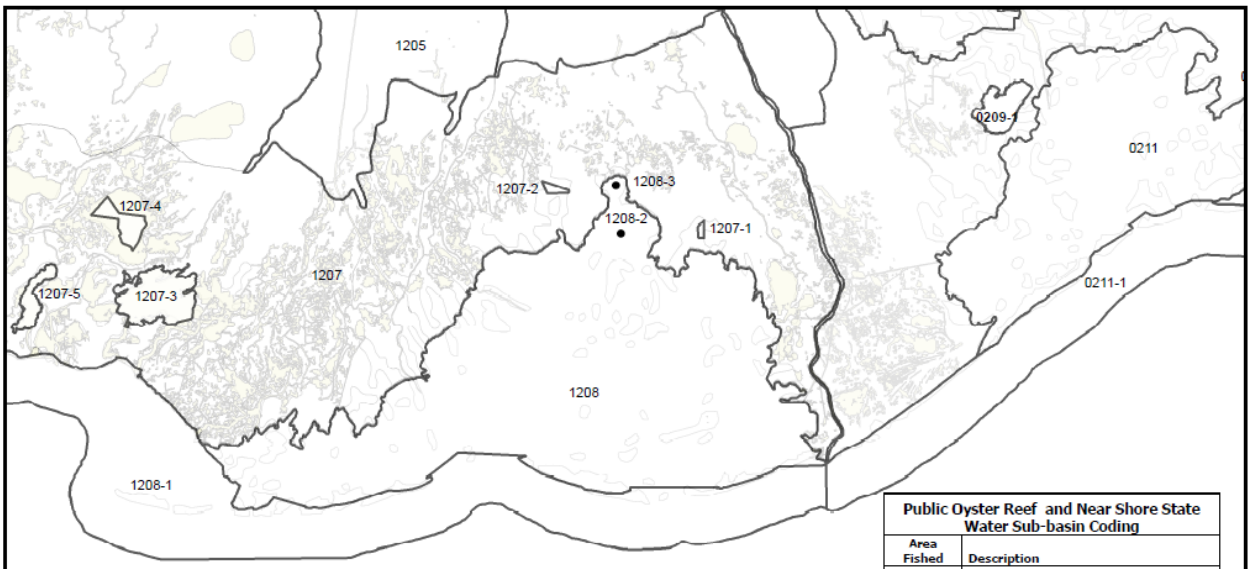
Public Oyster Reef Coding for Calcasieu Lake



Public Oyster Reef and Near Shore State Water Sub-basin	
Area Fished	**Description**
0304-1	Calcasieu Lake - Eastside/Growing Area 29
0304-2	Clacasieu Lake - West Cove/Growing Area 30

Please call the Department at (225)765-2399 or (225)765-2371 during regular working hours if you have any questions regarding information contained herein.

Public Oyster Reef and Near Shore State Water Coding West of the Mississippi



Public Oyster Reef and Near Shore State Water Sub-basin Coding	
Area Fished	**Description**
0420-1	Lake Borgne Public Oyster Seed Ground
0420-2	Mississippi Sound Public Oyster Seed Ground
0422-1	Public Oyster Seed Grounds North of MRGO
0422-2	Public Oyster Seed Grounds South of MRGO
0209-1	Hackberry Bay Public Oyster Seed Reservation
0209-2	Little Lake Public Oyster Seed Ground
0211-1	State waters (0-3 miles) off Barataria Basin
1208-1	State waters (0-3 miles) off Terrebonne Basin
1208-2	Lake Felicity Public Oyster Seed Ground
1208-3	Lake Chien Public Oyster Seed Ground
1207-1	Deep Lake Public Oyster Seed Ground
1207-2	Lake Tambour Public Oyster Seed Ground
1207-3	Sister Lake Public Oyster Seed Reservation
1207-4	Lake Mechant Public Oyster Seed Ground
1207-5	Bay Junop Public Oyster Seed Reservation

LOUISIANA WILDLIFE & FISHERIES

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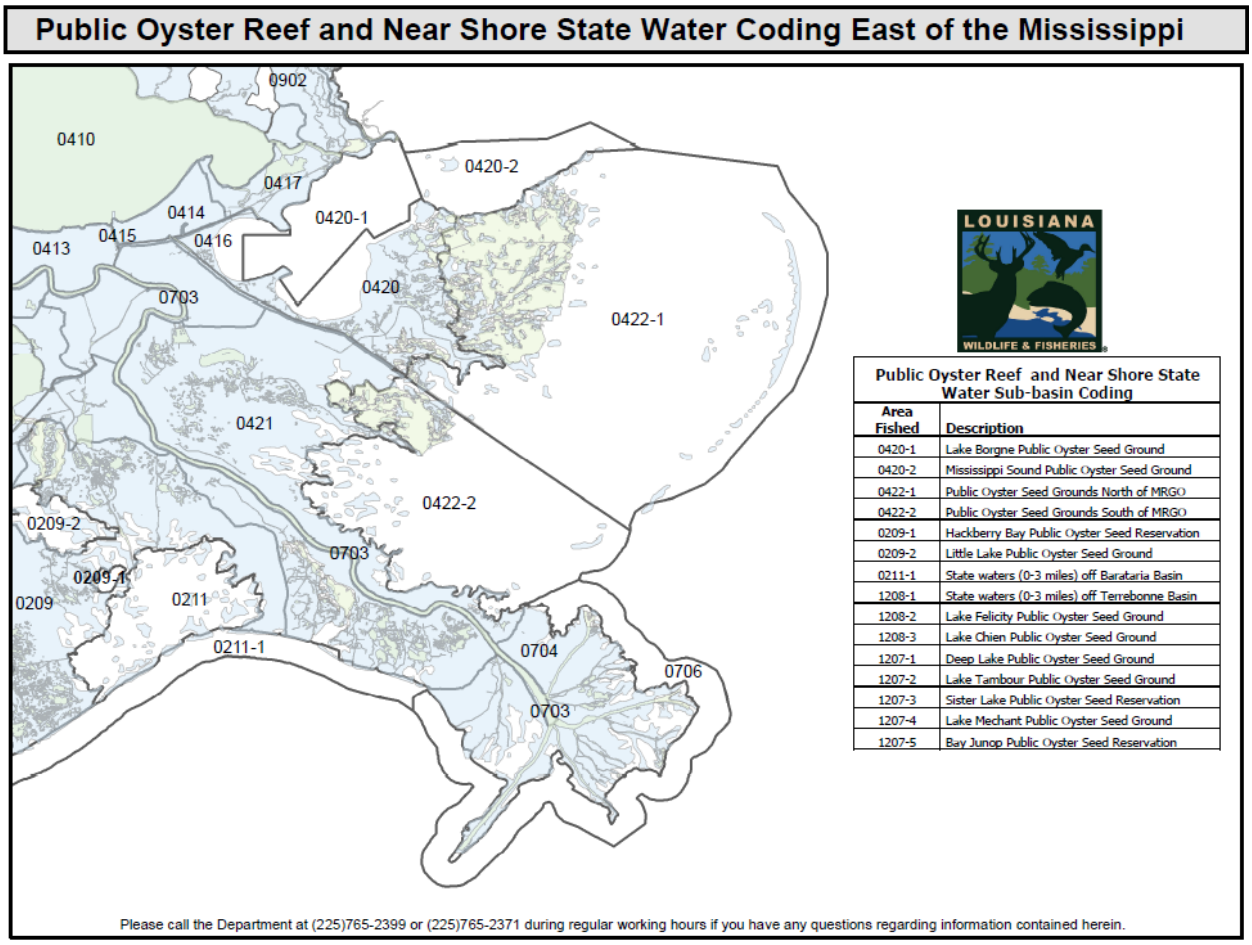


2. Grouping assignments of Louisiana sub-basin into dolphin stock water body groups.

Bottlenose Dolphin Stock	**Sub-basins included in stock water body grouping**
Sabine Lake stock	1103
Calcasieu Lake stock	0304, 0303
Vermillion, West Cote Blanche, Atchafalaya Bay stock	0611, 0610, 0106, 0108, 0109
Terrebonne Bay/ Timbalier Bay stock	1207, 1208 (not 1208-1)
Barataria Bay stock	0204, 0209, 0210, 2011 (not 0211-1)
Mississippi River Delta stock	0704, 0422-2, 0421
Mississippi Sound, Lake Borgne, Bay Boudreau stock	0420
Western Coastal stock/cont shelf	1107; 0312; 0509; 0612; 1208-1; 0211-1; Areas 13-17
Northern Coastal stock/ cont shelf	0422; 0706
Remaining inshore eastern LA basins	Any remaining sub-basins from Pearl River, Mississippi River and Lake Pontchartrain Basins
Remaining inshore western LA basins	Remaining sub-basins west of the Mississippi River

APPENDIX D. Observer Program bycatch forms. The Sawfish, Sturgeon, Marine Mammals, and Birds form was used from 1997 to 2010, and the Marine Mammal Life history form was used from 2011 to 2019.

SAWFISH, STURGEON, MARINE MAMMALS, BIRDS

PROTECTED RESOURCES CAPTURE REPORT

REPORT WITH IN 24 HOURS OF CAPTURE 1_10

Trip Number ☐☐☐☐☐☐ MO DY YR ___/___/___ Set/Tow ☐☐☐ ☐ Station ☐ Non-Station ☐ Captured ☐ Sighted Specimen # By Trip ☐☐☐

Check type of specimen captured and reference species (if known) in space provided:

☐ Sawfish ☐ Sturgeon _____ ☐ Marine Mammal ☐ Birds _____

Vessel ☐☐☐ Observer ☐☐☐ State ☐☐ Time (24 hr) ☐☐:☐☐ Water Depth (ft.) ☐☐☐.☐ Photos Y/N ☐ Number ☐☐

LATITUDE ☐☐ deg ☐☐ min ☐☐ sec LONGITUDE ☐☐ deg ☐☐ min ☐☐ sec

Gear Type: ☐ Longline ☐ Gill Net ☐ Trawl ☐ Bandit Reel ☐ Handline ☐ Jug ☐ Fish Trap ☐ Spear Fishing

Gear Depth: ☐ Surface ☐ Midwater ☐ Bottom ☐ Other _____

Net Position ☐ Net Type Animal Captured In: ☐ Try Net ☐ Standard Net Net Modifications: ☐ TED ☐ TED/BRD ☐ BRD ☐ None ☐ Unknown

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) _____

Was hook removed 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 the animal when released? ☐☐☐.☐ ft. (estimated/measured)

TARGET SPECIES: List all targeted species for this set using genus species format.

_____ _____ _____ _____

DIMENSIONS (cm):

Estimated total length: ☐☐.☐ ft. Estimated length of saw: ☐☐.☐ ft.

Total Length: ☐☐☐.☐ cm (if boated)

TAG ID NUMBERS:

_____ _____ _____ _____

RELEASE INFORMATION: TIME (24hr) ☐☐:☐☐ DATE ___/___/___ MO DY YR

LATITUDE ☐☐ deg ☐☐ min ☐☐ sec LONGITUDE ☐☐ deg ☐☐ min ☐☐ sec

FINAL DISPOSITION: ☐ Discarded Dead/Unresponsive Carcass ☐ Released Alive ☐ Unknown (explain)

ADDITIONAL COMMENTS: (list all biological samples collected):

MARINE MAMMAL LIFE HISTORY FORM
CAPTURE INFORMATION

6_11

Trip Number ____ MO/ DY/ YR ____ Set/Tow ____ ☐ Station ☐ Non-Station ☐ Capture ☐ Sighted Specimen # by Trip ____ Time (24 hr) ____ Water Depth (ft.) ____

GEAR TYPE: ☐ Longline ☐ Gillnet ☐ Trawl ☐ Hook and Line

GEAR DEPTH: ☐ Surface (pelagic) ☐ Midwater ☐ Bottom ☐ Other ____

LATITUDE ☐☐ deg ☐☐ min ☐☐ sec LONGITUDE ☐☐ deg ☐☐ min ☐☐ sec

SPECIES IDENTIFICATION: Photos Taken? Y / N Number of photo taken ____

☐ Pilot whale ☐ Bottlenose dolphin ☐ Pantropical spotted dolphin ☐ Risso's dolphin ☐ Common dolphin

☐ Striped dolphin ☐ Atlantic spotted dolphin ☐ Unid. Marine mammal ☐ Other ____

Diagnostic features: ____

Confidence Level of Species ID: ☐ Good ☐ Fair ☐ Poor

IF HOOK AND LINE GEAR USED, COMPLETE AS APPLICABLE: Hook Type: ☐ "J" ☐ Circle ☐ Other (describe) ____

Hook Size ____/0 Manufacturer/Style No. ____ Degree Offset ____°

BAIT: ☐ Squid ☐ Mackerel ☐ Sardine ☐ Unknown Other (describe) ____

HOOKING OF MARINE MAMMAL: Was animal hooked? ☐ Yes ☐ No ☐ Unknown (If no, skip to next section)

Hook Location **Internal:** ☐ In Mouth? ☐ Yes ☐ No Mouth Location? ☐ Upper ☐ Lower ☐ Side Swallowed? ☐ Yes ☐ No Hook Visable? ☐ Visible to insertion point ☐ Partial hook ☐ Not visible

External: ☐ ☐ Front Flipper ☐ Dorsal fin ☐ Body ☐ Head/Neck ☐ Tail ☐ Other ____

Was hook removed from animal? ☐ Yes ☐ No ☐ Unknown

If No, was line cut? ☐ Yes ☐ No

If Yes, how much line was left trailing? ____ feet

ENTANGLEMENT OF MARINE MAMMAL: Was animal entangled? ☐ Yes ☐ No ☐ Unknown

Entanglement Location (check all that apply) ☐ Front Flipper ☐ Head/Neck ☐ Tail ☐ Body ☐ Mouth ☐ Other ____

Gear involved: ☐ Hook ☐ Mainline ☐ Gangion ☐ Dropline/Floatline ☐ Float

Was gear removed from animal? ☐ Yes ☐ No ☐ Partial ☐ Unknown

Amount of gear left on animal ____ feet Were loops cut? ☐ Yes ☐ No ☐ Unknown

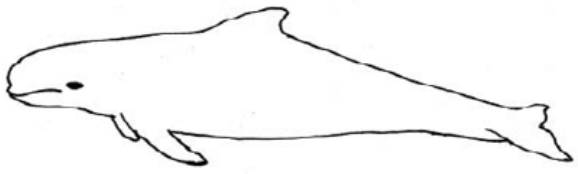
DESCRIPTION OF RELEASE PROCEDURE ____

CONDITION OF MARINE MAMMAL UPON RELEASE

☐ Alive, swam away normally ☐ Alive, swam abnormally ☐ Dead

Description of animal's behavior upon release ____

SKETCH OF ANIMAL SHOWING WHERE GEAR WAS HOOKED OR ENTANGLED ON BODY



PRESENCE OF OTHER MARINE MAMMALS AT TIME OF CAPTURE:

Were other marine mammals present at time of capture? ☐ Yes ☐ Didn't look ☐ Looked but did not see

Number of other marine mammals present (record all three) ____ MIN ____ MAX ____ BEST GUESS

Same species as animal captured? ☐ Yes ☐ No Species ID if different ____

Approximate distance from vessel (in yards) ____

Were actions taken by vessel to deter or avoid marine mammals? ☐ Yes ☐ No ☐ Unknown

Describe actions taken ____

Biopsy Sample Taken? ☐ Yes ☐ No ☐ Unsuccessful If yes, itemize samples: ____

TAGS Tagged before release? ☐ Yes ☐ No Tag number: ____ Tag Type: ____ Metal (1) / Plastic (2)

Position of tag: ☐ Left flipper ☐ Right flipper ☐ Dorsal fin ☐ Tail

APPENDIX E

1. Gulf of Mexico shrimp otter trawl fishery effort, Observer Program effort, marine mammal takes, and marine mammal bycatch rates for the 2-area stratified method of bycatch rate estimation for 2011 to 2019. Species codes: Ud are unidentified dolphins, Tt are bottlenose dolphins (*T. truncatus*), and Sf are Atlantic spotted dolphins (*S. frontalis*). State areas are Florida (FL), Alabama/Mississippi (AL/MS), Louisiana (LA), and Texas (TX). Fishery effort is presented for the estimation year only, while OP effort, marine mammal takes, and marine mammal bycatch rates represent the aggregate over the 15, 18, or 20-year period indicated for the 2011, 2012 to 2014, and 2015 to 2019 analyses, respectively. Updated values for years 2011 to 2014 are included in addition to the new 2015 to 2019 values due to errors in otter trawl effort estimates and minor QA/QC updates to the Observer Program data.

Area	Season	Depth Zone	Fishery Effort Hours Fished	Fishery Effort Est. Trips	OP Effort Hours Fished	OP Effort Trips	Marine Mammal Takes Sf Ud=Sf	Marine Mammal Takes Tt Ud=Sf	Marine Mammal Takes Tt Ud=Tt	Marine Mammal Bycatch Rate (Takes per 1000 Hours) Sf Ud=Sf	Marine Mammal Bycatch Rate (Takes per 1000 Hours) Tt Ud=Sf	Marine Mammal Bycatch Rate (Takes per 1000 Hours) Tt Ud=Tt
2011 Fishery Effort and 1997-2011 Bycatch Rates												
Eastern	1	In	12,010	232	3,787	73	1	0	1	0.264	0	0.264
Eastern	1	Near	4,166	80	3,787	73	1	0	1	0.264	0	0.264
Eastern	1	Off	42,653	398	8,583	80	1	0	1	0.117	0	0.117
Eastern	2	In	50,297	1,876	831	31	0	0	0	0	0	0
Eastern	2	Near	10,190	380	831	31	0	0	0	0	0	0
Eastern	2	Off	50,071	684	2,487	34	0	0	0	0	0	0
Eastern	3	In	22,118	1,909	185	16	0	0	0	0	0	0
Eastern	3	Near	3,694	319	185	16	0	0	0	0	0	0
Eastern	3	Off	28,929	263	2,754	25	0	0	0	0	0	0
Western	1	In	197,462	3,222	4,964	81	0	2	2	0	0.403	0.403
Western	1	Near	97,844	1,597	4,964	81	0	2	2	0	0.403	0.403
Western	1	Off	153,187	847	19,723	109	2	0	2	0.101	0	0.101
Western	2	In	521,856	7,712	14,480	214	0	0	0	0	0	0
Western	2	Near	319,365	4,720	14,480	214	0	0	0	0	0	0
Western	2	Off	345,430	2,401	32,223	224	0	0	0	0	0.000	0.000
Western	3	In	516,922	6,299	13,458	164	1	1	2	0.074	0.074	0.149
Western	3	Near	210,517	2,565	13,458	164	1	1	2	0.074	0.074	0.149
Western	3	Off	336,614	2,129	33,681	213	1	2	3	0.030	0.059	0.089
2012 Fishery Effort and 1997-2014 Bycatch Rates												
Eastern	1	In	974	20	4,520	93	1	0	1	0.221	0	0.221
Eastern	1	Near	2,803	58	4,520	93	1	0	1	0.221	0	0.221
Eastern	1	Off	51,390	476	10,463	97	1	0	1	0.096	0	0.096
Eastern	2	In	1,094	41	984	37	0	0	0	0	0	0
Eastern	2	Near	5,637	212	984	37	0	0	0	0	0	0
Eastern	2	Off	15,819	177	3,940	44	0	0	0	0	0	0
Eastern	3	In	2,378	192	236	19	0	0	0	0	0	0
Eastern	3	Near	1,728	139	236	19	0	0	0	0	0	0
Eastern	3	Off	37,198	377	3,355	34	0	0	0	0	0	0
Western	1	In	73,212	1,016	9,078	126	0	2	2	0	0.220	0.220
Western	1	Near	127,123	1,764	9,078	126	0	2	2	0	0.220	0.220
Western	1	Off	108,636	602	25,645	142	2	0	2	0.078	0	0.078
Western	2	In	500,783	6,656	22,572	300	0	0	0	0	0	0
Western	2	Near	451,229	5,997	22,572	300	0	0	0	0	0	0
Western	2	Off	256,368	1,793	41,746	292	0	2	2	0	0.048	0.048
Western	3	In	539,473	6,121	20,712	235	1	1	2	0.048	0.048	0.097
Western	3	Near	299,976	3,404	20,712	235	1	1	2	0.048	0.048	0.097
Western	3	Off	334,213	2,023	47,751	289	1	2	3	0.021	0.042	0.063
2013 Fishery Effort and 1997-2014 Bycatch Rates												
Eastern	1	In	4,914	101	4,520	93	1	0	1	0.221	0	0.221
Eastern	1	Near	3,097	64	4,520	93	1	0	1	0.221	0	0.221
Eastern	1	Off	72,644	673	10,463	97	1	0	1	0.096	0	0.096

Area	Season	Depth Zone	Fishery Effort: Hours Fished	Fishery Effort: Est. Trips	OP Effort: Hours Fished	OP Effort: Trips	Marine Mammal Takes: Sf Ud=Sf	Marine Mammal Takes: Tt Ud=Sf	Marine Mammal Takes: Tt Ud=Tt	Marine Mammal Bycatch Rate (Takes per 1000 Hours): Sf Ud=Sf	Marine Mammal Bycatch Rate (Takes per 1000 Hours): Tt Ud=Sf	Marine Mammal Bycatch Rate (Takes per 1000 Hours): Tt Ud=Tt
Eastern	2	In	63,688	2,394	984	37	0	0	0	0	0	0
Eastern	2	Near	9,881	371	984	37	0	0	0	0	0	0
Eastern	2	Off	35,031	391	3,940	44	0	0	0	0	0	0
Eastern	3	In	7,616	614	236	19	0	0	0	0	0	0
Eastern	3	Near	1,806	146	236	19	0	0	0	0	0	0
Eastern	3	Off	4,868	49	3,355	34	0	0	0	0	0	0
Western	1	In	33,541	466	9,078	126	0	2	2	0	0.220	0.220
Western	1	Near	50,057	695	9,078	126	0	2	2	0	0.220	0.220
Western	1	Off	115,598	640	25,645	142	2	0	2	0.078	0	0.078
Western	2	In	522,222	6,941	22,572	300	0	0	0	0	0	0
Western	2	Near	375,157	4,986	22,572	300	0	0	0	0	0	0
Western	2	Off	334,861	2,342	41,746	292	0	2	2	0	0.048	0.048
Western	3	In	399,199	4,529	20,712	235	1	1	2	0.048	0.048	0.097
Western	3	Near	217,152	2,464	20,712	235	1	1	2	0.048	0.048	0.097
Western	3	Off	334,188	2,023	47,751	289	1	2	3	0.021	0.042	0.063
2014 Fishery Effort and 1997-2014 Bycatch Rates												
Eastern	1	In	5,209	107	4,520	93	1	0	1	0.221	0	0.221
Eastern	1	Near	4,751	98	4,520	93	1	0	1	0.221	0	0.221
Eastern	1	Off	39,362	365	10,463	97	1	0	1	0.096	0	0.096
Eastern	2	In	8,590	323	984	37	0	0	0	0	0	0
Eastern	2	Near	8,536	321	984	37	0	0	0	0	0	0
Eastern	2	Off	29,858	333	3,940	44	0	0	0	0	0	0
Eastern	3	In	126	10	236	19	0	0	0	0	0	0
Eastern	3	Near	39	3	236	19	0	0	0	0	0	0
Eastern	3	Off	3,675	37	3,355	34	0	0	0	0	0	0
Western	1	In	183,056	2,541	9,078	126	0	2	2	0	0.220	0.220
Western	1	Near	190,103	2,638	9,078	126	0	2	2	0	0.220	0.220
Western	1	Off	95,390	528	25,645	142	2	0	2	0.078	0	0.078
Western	2	In	362,693	4,821	22,572	300	0	0	0	0	0	0
Western	2	Near	352,801	4,689	22,572	300	0	0	0	0	0	0
Western	2	Off	334,553	2,340	41,746	292	0	2	2	0	0.048	0.048
Western	3	In	295,551	3,353	20,712	235	1	1	2	0.048	0.048	0.097
Western	3	Near	306,316	3,475	20,712	235	1	1	2	0.048	0.048	0.097
Western	3	Off	402,998	2,439	47,751	289	1	2	3	0.021	0.042	0.063
2015 Fishery Effort and 2000-2019 Bycatch Rates												
Eastern	1	In	414	9	5,565	119	1	0	1	0.180	0	0.180
Eastern	1	Near	22,833	488	5,565	119	1	0	1	0.180	0	0.180
Eastern	1	Off	17,416	156	13,706	123	1	1	2	0.073	0	0.146
Eastern	2	In	551	18	1,866	61	0	0	0	0	0	0
Eastern	2	Near	23,266	761	1,866	61	0	0	0	0	0	0
Eastern	2	Off	15,562	166	6,289	67	0	0	0	0	0	0
Eastern	3	In	1,322	55	668	28	0	0	0	0	0	0
Eastern	3	Near	48,718	2,042	668	28	0	0	0	0	0	0
Eastern	3	Off	8,917	82	6,011	55	0	0	0	0	0	0
Western	1	In	41,127	492	18,392	220	2	3	5	0	0.163	0.272
Western	1	Near	37,403	447	18,392	220	2	3	5	0	0.163	0.272
Western	1	Off	164,928	915	39,473	219	2	2	4	0.051	0	0.101
Western	2	In	585,268	7,218	37,380	461	0	0	0	0	0	0
Western	2	Near	335,312	4,135	37,380	461	0	0	0	0	0	0
Western	2	Off	332,958	2,306	59,053	409	0	2	2	0	0.034	0.034
Western	3	In	443,221	4,718	33,818	360	1	2	3	0.030	0.059	0.089
Western	3	Near	196,720	2,094	33,818	360	1	2	3	0.030	0.059	0.089
Western	3	Off	400,352	2,470	60,948	376	1	3	4	0.016	0.049	0.066
2016 Fishery Effort and 2000-2019 Bycatch Rates												
Eastern	1	In	9,628	206	5,565	119	1	0	1	0.180	0	0.180
Eastern	1	Near	45,063	964	5,565	119	1	0	1	0.180	0	0.180

Area	Season	Depth Zone	Fishery Effort: Hours Fished	Fishery Effort: Est. Trips	OP Effort: Hours Fished	OP Effort: Trips	Marine Mammal Takes: Sf Ud=Sf	Marine Mammal Takes: Tt Ud=Sf	Marine Mammal Takes: Tt Ud=Tt	Marine Mammal Bycatch Rate (Takes per 1000 Hours): Sf Ud=Sf	Marine Mammal Bycatch Rate (Takes per 1000 Hours): Tt Ud=Sf	Marine Mammal Bycatch Rate (Takes per 1000 Hours): Tt Ud=Tt
Eastern	1	Off	12,555	113	13,706	123	1	1	2	0.073	0	0.146
Eastern	2	In	10,967	359	1,866	61	0	0	0	0	0	0
Eastern	2	Near	40,608	1,328	1,866	61	0	0	0	0	0	0
Eastern	2	Off	12,133	129	6,289	67	0	0	0	0	0	0
Eastern	3	In	9,588	402	668	28	0	0	0	0	0	0
Eastern	3	Near	28,989	1,215	668	28	0	0	0	0	0	0
Eastern	3	Off	12,859	118	6,011	55	0	0	0	0	0	0
Western	1	In	91,132	1,090	18,392	220	2	3	5	0	0.163	0.272
Western	1	Near	151,566	1,813	18,392	220	2	3	5	0	0.163	0.272
Western	1	Off	166,771	925	39,473	219	2	2	4	0.051	0	0.101
Western	2	In	461,691	5,694	37,380	461	0	0	0	0	0	0
Western	2	Near	249,133	3,073	37,380	461	0	0	0	0	0	0
Western	2	Off	367,994	2,549	59,053	409	0	2	2	0	0.034	0.034
Western	3	In	709,410	7,552	33,818	360	1	2	3	0.030	0.059	0.089
Western	3	Near	237,946	2,533	33,818	360	1	2	3	0.030	0.059	0.089
Western	3	Off	417,002	2,573	60,948	376	1	3	4	0.016	0.049	0.066
2017 Fishery Effort and 2000-2019 Bycatch Rates												
Eastern	1	In	5,087	109	5,565	119	1	0	1	0.180	0	0.180
Eastern	1	Near	54,679	1,169	5,565	119	1	0	1	0.180	0	0.180
Eastern	1	Off	28,615	257	13,706	123	1	1	2	0.073	0	0.146
Eastern	2	In	6,832	223	1,866	61	0	0	0	0	0	0
Eastern	2	Near	39,659	1,297	1,866	61	0	0	0	0	0	0
Eastern	2	Off	14,506	155	6,289	67	0	0	0	0	0	0
Eastern	3	In	1,592	67	668	28	0	0	0	0	0	0
Eastern	3	Near	28,194	1,182	668	28	0	0	0	0	0	0
Eastern	3	Off	16,517	151	6,011	55	0	0	0	0	0	0
Western	1	In	144,395	1,727	18,392	220	2	3	5	0	0.163	0.272
Western	1	Near	138,906	1,662	18,392	220	2	3	5	0	0.163	0.272
Western	1	Off	218,395	1,212	39,473	219	2	2	4	0.051	0	0.101
Western	2	In	439,420	5,419	37,380	461	0	0	0	0	0	0
Western	2	Near	269,429	3,323	37,380	461	0	0	0	0	0	0
Western	2	Off	372,288	2,578	59,053	409	0	2	2	0	0.034	0.034
Western	3	In	463,862	4,938	33,818	360	1	2	3	0.030	0.059	0.089
Western	3	Near	219,793	2,340	33,818	360	1	2	3	0.030	0.059	0.089
Western	3	Off	339,968	2,097	60,948	376	1	3	4	0.016	0.049	0.066
2018 Fishery Effort and 2000-2019 Bycatch Rates												
Eastern	1	In	1,182	25	5,565	119	1	0	1	0.180	0	0.180
Eastern	1	Near	48,513	1,037	5,565	119	1	0	1	0.180	0	0.180
Eastern	1	Off	47,320	425	13,706	123	1	1	2	0.073	0	0.146
Eastern	2	In	5,448	178	1,866	61	0	0	0	0	0	0
Eastern	2	Near	36,355	1,189	1,866	61	0	0	0	0	0	0
Eastern	2	Off	18,796	200	6,289	67	0	0	0	0	0	0
Eastern	3	In	2,580	108	668	28	0	0	0	0	0	0
Eastern	3	Near	27,235	1,142	668	28	0	0	0	0	0	0
Eastern	3	Off	10,733	98	6,011	55	0	0	0	0	0	0
Western	1	In	86,236	1,032	18,392	220	2	3	5	0	0.163	0.272
Western	1	Near	92,647	1,108	18,392	220	2	3	5	0	0.163	0.272
Western	1	Off	123,114	683	39,473	219	2	2	4	0.051	0	0.101
Western	2	In	611,171	7,537	37,380	461	0	0	0	0	0	0
Western	2	Near	353,414	4,359	37,380	461	0	0	0	0	0	0
Western	2	Off	319,648	2,214	59,053	409	0	2	2	0	0.034	0.034
Western	3	In	454,604	4,839	33,818	360	1	2	3	0.030	0.059	0.089
Western	3	Near	206,284	2,196	33,818	360	1	2	3	0.030	0.059	0.089
Western	3	Off	369,441	2,279	60,948	376	1	3	4	0.016	0.049	0.066
2019 Fishery Effort and 2000-2019 Bycatch Rates												
Eastern	1	In	2,929	63	5,565	119	1	0	1	0.180	0	0.180

Area	Season	Depth Zone	Fishery Effort: Hours Fished	Fishery Effort: Est. Trips	OP Effort: Hours Fished	OP Effort: Trips	Marine Mammal Takes: Sf Ud=Sf	Marine Mammal Takes: Tt Ud=Sf	Marine Mammal Takes: Tt Ud=Tt	Marine Mammal Bycatch Rate (Takes per 1000 Hours): Sf Ud=Sf	Marine Mammal Bycatch Rate (Takes per 1000 Hours): Tt Ud=Sf	Marine Mammal Bycatch Rate (Takes per 1000 Hours): Tt Ud=Tt
Eastern	1	Near	40,131	858	5,565	119	1	0	1	0.180	0	0.180
Eastern	1	Off	20,670	185	13,706	123	1	1	2	0.073	0	0.146
Eastern	2	In	5,078	166	1,866	61	0	0	0	0	0	0
Eastern	2	Near	34,325	1,122	1,866	61	0	0	0	0	0	0
Eastern	2	Off	13,028	139	6,289	67	0	0	0	0	0	0
Eastern	3	In	4,617	194	668	28	0	0	0	0	0	0
Eastern	3	Near	38,127	1,598	668	28	0	0	0	0	0	0
Eastern	3	Off	17,777	163	6,011	55	0	0	0	0	0	0
Western	1	In	50,647	606	18,392	220	2	3	5	0	0.163	0.272
Western	1	Near	60,334	722	18,392	220	2	3	5	0	0.163	0.272
Western	1	Off	151,071	838	39,473	219	2	2	4	0.051	0	0.101
Western	2	In	513,520	6,333	37,380	461	0	0	0	0	0	0
Western	2	Near	288,012	3,552	37,380	461	0	0	0	0	0	0
Western	2	Off	265,364	1,838	59,053	409	0	2	2	0	0.034	0.034
Western	3	In	465,474	4,955	33,818	360	1	2	3	0.030	0.059	0.089
Western	3	Near	180,468	1,921	33,818	360	1	2	3	0.030	0.059	0.089
Western	3	Off	314,927	1,943	60,948	376	1	3	4	0.016	0.049	0.066

2. Gulf of Mexico shrimp fishery effort, Observer Program effort, marine mammal takes, and marine mammal bycatch rates for the 4-area stratified method of bycatch rate estimation for 2011 to 2019. Species codes: Ud are unidentified dolphins, Tt are bottlenose dolphins (*T. truncatus*), and Sf are Atlantic spotted dolphins (*S. frontalis*). State areas are Florida (FL), Alabama/Mississippi (AL/MS), Louisiana (LA), and Texas (TX). Fishery effort is presented for the estimation year only, while OP effort, marine mammal takes, and marine mammal bycatch rates represent the aggregate over the 15, 18, or 20 year period indicated for the 2011, 2012 to 2014, and 2015 to 2019 analyses, respectively. Updated values for years 2011 to 2014 are included in addition to the new 2015 to 2019 values due to errors in otter trawl effort estimates and minor QA/QC updates to the Observer Program data.

			Fishery Effort		OP Effort		Marine Mammal Takes			Marine Mammal Bycatch Rate (Takes per 1000 Hours)		
Area	Season	Depth Zone	Hours Fished	Est. Trips	Hours Fished	Trips	Sf Ud=Sf	Tt Ud=Sf	Tt Ud=Tt	Sf Ud=Sf	Tt Ud=Sf	Tt Ud=Tt
2011 Fishery Effort and 1997-2011 Bycatch Rates												
FL	1	In	12,010	232	3,787	73	1	0	1	0.264	0	0.264
FL	1	Near	4,166	80	3,787	73	1	0	1	0.264	0	0.264
FL	1	Off	42,653	398	8,583	80	1	0	1	0.117	0	0.117
FL	2	In	50,297	1,876	831	31	0	0	0	0	0	0
FL	2	Near	10,190	380	831	31	0	0	0	0	0	0
FL	2	Off	50,071	684	2,487	34	0	0	0	0	0	0
FL	3	In	22,118	1,909	185	16	0	0	0	0	0	0
FL	3	Near	3,694	319	185	16	0	0	0	0	0	0
FL	3	Off	28,929	263	2,754	25	0	0	0	0	0	0
AL/MS	1	In	39,283	1,014	1,279	33	0	1	1	0	0.782	0.782
AL/MS	1	Near	11,040	285	1,279	33	0	1	1	0	0.782	0.782
AL/MS	1	Off	16,040	154	3,739	36	0	0	0	0	0	0
AL/MS	2	In	109,042	2,739	2,628	66	0	0	0	0	0	0
AL/MS	2	Near	42,691	1,072	2,628	66	0	0	0	0	0	0
AL/MS	2	Off	37,167	420	6,102	69	0	0	0	0	0	0
AL/MS	3	In	126,830	2,760	3,263	71	1	0	1	0.306	0	0.306
AL/MS	3	Near	12,503	272	3,263	71	1	0	1	0.306	0	0.306
AL/MS	3	Off	18,306	255	4,958	69	0	0	0	0	0	0
LA	1	In	156,672	3,490	1,571	35	0	1	1	0	0.636	0.636
LA	1	Near	72,077	1,605	1,571	35	0	1	1	0	0.636	0.636
LA	1	Off	59,122	349	9,989	59	1	0	1	0.100	0	0.100
LA	2	In	395,606	3,540	8,828	79	0	0	0	0	0	0
LA	2	Near	243,356	2,178	8,828	79	0	0	0	0	0	0
LA	2	Off	186,705	2,068	8,578	95	0	0	0	0	0	0
LA	3	In	380,131	4,761	6,707	84	0	1	1	0	0.149	0.149
LA	3	Near	148,879	1,865	6,707	84	0	1	1	0	0.149	0.149
LA	3	Off	98,292	827	14,978	126	1	0	1	0.067	0	0.067
TX	1	In	1,507	14	2,114	19	0	0	0	0	0	0
TX	1	Near	14,727	132	2,114	19	0	0	0	0	0	0
TX	1	Off	78,025	677	5,996	52	1	0	1	0.167	0	0.167
TX	2	In	17,208	518	3,024	91	0	0	0	0	0	0
TX	2	Near	33,318	1,003	3,024	91	0	0	0	0	0	0
TX	2	Off	121,559	935	17,560	135	0	0	0	0	0	0
TX	3	In	9,960	116	3,512	41	0	0	0	0	0	0
TX	3	Near	49,134	574	3,512	41	0	0	0	0	0	0
TX	3	Off	220,016	1,761	13,745	110	0	2	2	0	0.146	0.146
2012 Fishery Effort and 1997-2014 Bycatch Rates												
FL	1	In	974	20	4,520	93	1	0	1	0.221	0	0.221
FL	1	Near	2,803	58	4,520	93	1	0	1	0.221	0	0.221
FL	1	Off	51,390	476	10,463	97	1	0	1	0.096	0	0.096
FL	2	In	1,094	41	984	37	0	0	0	0	0	0
FL	2	Near	5,637	212	984	37	0	0	0	0	0	0
FL	2	Off	15,819	177	3,940	44	0	0	0	0	0	0
FL	3	In	2,378	192	236	19	0	0	0	0	0	0

Area	Season	Depth Zone	Fishery Effort: Hours Fished	Fishery Effort: Est. Trips	OP Effort: Hours Fished	OP Effort: Trips	Marine Mammal Takes: Sf Ud=Sf	Marine Mammal Takes: Tt Ud=Sf	Marine Mammal Takes: Tt Ud=Tt	Marine Mammal Bycatch Rate (Takes per 1000 Hours): Sf Ud=Sf	Marine Mammal Bycatch Rate (Takes per 1000 Hours): Tt Ud=Sf	Marine Mammal Bycatch Rate (Takes per 1000 Hours): Tt Ud=Tt
FL	3	Near	1,728	139	236	19	0	0	0	0	0	0
FL	3	Off	37,198	377	3,355	34	0	0	0	0	0	0
AL/MS	1	In	5,997	159	1,551	41	0	1	1	0	0.645	0.645
AL/MS	1	Near	8,300	219	1,551	41	0	1	1	0	0.645	0.645
AL/MS	1	Off	4,025	41	4,305	44	0	0	0	0	0	0
AL/MS	2	In	92,661	2,308	3,733	93	0	0	0	0	0	0
AL/MS	2	Near	52,278	1,302	3,733	93	0	0	0	0	0	0
AL/MS	2	Off	42,270	487	7,817	90	0	0	0	0	0	0
AL/MS	3	In	138,847	2,675	4,723	91	1	0	1	0.212	0	0.212
AL/MS	3	Near	29,514	569	4,723	91	1	0	1	0.212	0	0.212
AL/MS	3	Off	39,739	563	6,002	85	0	0	0	0	0	0
LA	1	In	61,373	1,315	2,893	62	0	1	1	0	0.346	0.346
LA	1	Near	86,462	1,853	2,893	62	0	1	1	0	0.346	0.346
LA	1	Off	73,822	419	14,281	81	1	0	1	0.070	0	0.070
LA	2	In	380,614	3,301	14,758	128	0	0	0	0	0	0
LA	2	Near	338,177	2,933	14,758	128	0	0	0	0	0	0
LA	2	Off	123,548	1,254	12,517	127	0	1	1	0	0	0
LA	3	In	394,524	4,336	11,374	125	0	1	1	0	0.088	0.088
LA	3	Near	215,582	2,369	11,374	125	0	1	1	0	0.088	0.088
LA	3	Off	112,324	979	18,013	157	1	0	1	0.056	0	0.056
TX	1	In	5,842	49	4,634	39	0	0	0	0	0	0
TX	1	Near	32,360	272	4,634	39	0	0	0	0	0	0
TX	1	Off	30,789	279	7,060	64	1	0	1	0.142	0	0.142
TX	2	In	27,507	782	4,080	116	0	0	0	0	0	0
TX	2	Near	60,774	1,728	4,080	116	0	0	0	0	0	0
TX	2	Off	90,551	693	21,429	164	0	1	1	0	0	0
TX	3	In	6,102	89	4,638	68	0	0	0	0	0	0
TX	3	Near	54,880	805	4,638	68	0	0	0	0	0	0
TX	3	Off	182,150	1,220	23,735	159	0	2	2	0	0.084	0.084
2013 Fishery Effort and 1997-2014 Bycatch Rates												
FL	1	In	4,914	101	4,520	93	1	0	1	0.221	0	0.221
FL	1	Near	3,097	64	4,520	93	1	0	1	0.221	0	0.221
FL	1	Off	72,644	673	10,463	97	1	0	1	0.096	0	0.096
FL	2	In	63,688	2,394	984	37	0	0	0	0	0	0
FL	2	Near	9,881	371	984	37	0	0	0	0	0	0
FL	2	Off	35,031	391	3,940	44	0	0	0	0	0	0
FL	3	In	7,616	614	236	19	0	0	0	0	0	0
FL	3	Near	1,806	146	236	19	0	0	0	0	0	0
FL	3	Off	4,868	49	3,355	34	0	0	0	0	0	0
AL/MS	1	In	1,929	51	1,551	41	0	1	1	0	0.645	0.645
AL/MS	1	Near	1,856	49	1,551	41	0	1	1	0	0.645	0.645
AL/MS	1	Off	13,160	135	4,305	44	0	0	0	0	0	0
AL/MS	2	In	72,928	1,817	3,733	93	0	0	0	0	0	0
AL/MS	2	Near	41,368	1,031	3,733	93	0	0	0	0	0	0
AL/MS	2	Off	62,743	722	7,817	90	0	0	0	0	0	0
AL/MS	3	In	107,429	2,070	4,723	91	1	0	1	0.212	0	0.212
AL/MS	3	Near	22,379	431	4,723	91	1	0	1	0.212	0	0.212
AL/MS	3	Off	32,859	465	6,002	85	0	0	0	0	0	0
LA	1	In	31,120	667	2,893	62	0	1	1	0	0.346	0.346
LA	1	Near	30,778	660	2,893	62	0	1	1	0	0.346	0.346
LA	1	Off	63,735	361	14,281	81	1	0	1	0.070	0	0.070
LA	2	In	430,688	3,735	14,758	128	0	0	0	0	0	0
LA	2	Near	278,980	2,420	14,758	128	0	0	0	0	0	0
LA	2	Off	167,721	1,702	12,517	127	0	1	1	0	0	0
LA	3	In	279,060	3,067	11,374	125	0	1	1	0	0.088	0.088
LA	3	Near	144,672	1,590	11,374	125	0	1	1	0	0.088	0.088
LA	3	Off	84,287	735	18,013	157	1	0	1	0.056	0	0.056

Area	Season	Depth Zone	Fishery Effort: Hours Fished	Fishery Effort: Est. Trips	OP Effort: Hours Fished	OP Effort: Trips	Marine Mammal Takes: Sf Ud=Sf	Marine Mammal Takes: Tt Ud=Sf	Marine Mammal Takes: Tt Ud=Tt	Marine Mammal Bycatch Rate (Takes per 1000 Hours): Sf Ud=Sf	Marine Mammal Bycatch Rate (Takes per 1000 Hours): Tt Ud=Sf	Marine Mammal Bycatch Rate (Takes per 1000 Hours): Tt Ud=Tt
TX	1	In	492	4	4,634	39	0	0	0	0	0	0
TX	1	Near	17,424	147	4,634	39	0	0	0	0	0	0
TX	1	Off	38,703	351	7,060	64	1	0	1	0.142	0	0.142
TX	2	In	18,606	529	4,080	116	0	0	0	0	0	0
TX	2	Near	54,809	1,558	4,080	116	0	0	0	0	0	0
TX	2	Off	104,397	799	21,429	164	0	1	1	0	0	0
TX	3	In	12,710	186	4,638	68	0	0	0	0	0	0
TX	3	Near	50,101	735	4,638	68	0	0	0	0	0	0
TX	3	Off	217,041	1,454	23,735	159	0	2	2	0	0.084	0.084
2014 Fishery Effort and 1997-2014 Bycatch Rates												
FL	1	In	5,209	107	4,520	93	1	0	1	0.221	0	0.221
FL	1	Near	4,751	98	4,520	93	1	0	1	0.221	0	0.221
FL	1	Off	39,362	365	10,463	97	1	0	1	0.096	0	0.096
FL	2	In	8,590	323	984	37	0	0	0	0	0	0
FL	2	Near	8,536	321	984	37	0	0	0	0	0	0
FL	2	Off	29,858	333	3,940	44	0	0	0	0	0	0
FL	3	In	126	10	236	19	0	0	0	0	0	0
FL	3	Near	39	3	236	19	0	0	0	0	0	0
FL	3	Off	3,675	37	3,355	34	0	0	0	0	0	0
AL/MS	1	In	2,548	67	1,551	41	0	1	1	0	0.645	0.645
AL/MS	1	Near	3,860	102	1,551	41	0	1	1	0	0.645	0.645
AL/MS	1	Off	17,569	180	4,305	44	0	0	0	0	0	0
AL/MS	2	In	33,798	842	3,733	93	0	0	0	0	0	0
AL/MS	2	Near	35,011	872	3,733	93	0	0	0	0	0	0
AL/MS	2	Off	29,887	344	7,817	90	0	0	0	0	0	0
AL/MS	3	In	24,060	464	4,723	91	1	0	1	0.212	0	0.212
AL/MS	3	Near	26,692	514	4,723	91	1	0	1	0.212	0	0.212
AL/MS	3	Off	44,775	634	6,002	85	0	0	0	0	0	0
LA	1	In	107,921	2,313	2,893	62	0	1	1	0	0.346	0.346
LA	1	Near	111,816	2,396	2,893	62	0	1	1	0	0.346	0.346
LA	1	Off	49,339	280	14,281	81	1	0	1	0.070	0	0.070
LA	2	In	291,033	2,524	14,758	128	0	0	0	0	0	0
LA	2	Near	281,688	2,443	14,758	128	0	0	0	0	0	0
LA	2	Off	165,083	1,675	12,517	127	0	1	1	0	0	0
LA	3	In	218,843	2,405	11,374	125	0	1	1	0	0.088	0.088
LA	3	Near	221,981	2,439	11,374	125	0	1	1	0	0.088	0.088
LA	3	Off	84,286	735	18,013	157	1	0	1	0.056	0	0.056
TX	1	In	72,587	611	4,634	39	0	0	0	0	0	0
TX	1	Near	74,427	626	4,634	39	0	0	0	0	0	0
TX	1	Off	28,482	258	7,060	64	1	0	1	0.142	0	0.142
TX	2	In	37,862	1,077	4,080	116	0	0	0	0	0	0
TX	2	Near	36,102	1,027	4,080	116	0	0	0	0	0	0
TX	2	Off	139,584	1,068	21,429	164	0	1	1	0	0	0
TX	3	In	52,648	772	4,638	68	0	0	0	0	0	0
TX	3	Near	57,643	845	4,638	68	0	0	0	0	0	0
TX	3	Off	273,937	1,835	23,735	159	0	2	2	0	0.084	0.084
2015 Fishery Effort and 2000-2019 Bycatch Rates												
FL	1	In	414	9	5,565	119	1	0	1	0.180	0	0.180
FL	1	Near	22,833	488	5,565	119	1	0	1	0.180	0	0.180
FL	1	Off	17,416	156	13,706	123	1	1	2	0.073	0	0.146
FL	2	In	551	18	1,866	61	0	0	0	0	0	0
FL	2	Near	23,266	761	1,866	61	0	0	0	0	0	0
FL	2	Off	15,562	166	6,289	67	0	0	0	0	0	0
FL	3	In	1,322	55	668	28	0	0	0	0	0	0
FL	3	Near	48,718	2,042	668	28	0	0	0	0	0	0
FL	3	Off	8,917	82	6,011	55	0	0	0	0	0	0

Area	Season	Depth Zone	Fishery Effort: Hours Fished	Fishery Effort: Est. Trips	OP Effort: Hours Fished	OP Effort: Trips	Marine Mammal Takes: Sf Ud=Sf	Marine Mammal Takes: Tt Ud=Sf	Marine Mammal Takes: Tt Ud=Tt	Marine Mammal Bycatch Rate (Takes per 1000 Hours): Sf Ud=Sf	Marine Mammal Bycatch Rate (Takes per 1000 Hours): Tt Ud=Sf	Marine Mammal Bycatch Rate (Takes per 1000 Hours): Tt Ud=Tt
AL/MS	1	In	1,549	43	2,103	58	0	1	1	0	0.476	0.476
AL/MS	1	Near	2,445	67	2,103	58	0	1	1	0	0.476	0.476
AL/MS	1	Off	19,246	195	6,500	66	0	0	0	0	0	0
AL/MS	2	In	93,890	2,005	7,775	166	0	0	0	0	0	0
AL/MS	2	Near	27,749	592	7,775	166	0	0	0	0	0	0
AL/MS	2	Off	49,115	484	16,341	161	0	0	0	0	0	0
AL/MS	3	In	76,705	1,354	7,820	138	1	1	2	0.128	0	0.256
AL/MS	3	Near	13,106	231	7,820	138	1	1	2	0.128	0	0.256
AL/MS	3	Off	26,655	372	8,178	114	0	0	0	0	0	0
LA	1	In	37,237	529	8,379	119	1	2	3	0	0.239	0.358
LA	1	Near	22,304	317	8,379	119	1	2	3	0	0.239	0.358
LA	1	Off	110,337	653	21,286	126	1	0	1	0.047	0	0.047
LA	2	In	473,264	4,352	24,031	221	0	0	0	0	0	0
LA	2	Near	264,114	2,429	24,031	221	0	0	0	0	0	0
LA	2	Off	179,078	1,738	18,858	183	0	1	1	0	0	0
LA	3	In	355,788	3,870	18,663	203	0	1	1	0	0.054	0.054
LA	3	Near	154,781	1,684	18,663	203	0	1	1	0	0.054	0.054
LA	3	Off	100,736	918	21,950	200	1	0	1	0.046	0	0.046
TX	1	In	2,341	24	7,910	81	1	0	1	0	0	0
TX	1	Near	12,654	130	7,910	81	1	0	1	0	0	0
TX	1	Off	35,346	290	11,687	96	1	2	3	0.086	0	0.257
TX	2	In	18,113	439	5,573	135	0	0	0	0	0	0
TX	2	Near	43,449	1,053	5,573	135	0	0	0	0	0	0
TX	2	Off	104,765	821	23,870	187	0	1	1	0	0	0
TX	3	In	10,728	147	7,358	101	0	0	0	0	0	0
TX	3	Near	28,833	396	7,358	101	0	0	0	0	0	0
TX	3	Off	272,961	1,780	30,819	201	0	3	3	0	0.097	0.097
2016 Fishery Effort and 2000-2019 Bycatch Rates												
FL	1	In	9,628	206	5,565	119	1	0	1	0.180	0	0.180
FL	1	Near	45,063	964	5,565	119	1	0	1	0.180	0	0.180
FL	1	Off	12,555	113	13,706	123	1	1	2	0.073	0	0.146
FL	2	In	10,967	359	1,866	61	0	0	0	0	0	0
FL	2	Near	40,608	1,328	1,866	61	0	0	0	0	0	0
FL	2	Off	12,133	129	6,289	67	0	0	0	0	0	0
FL	3	In	9,588	402	668	28	0	0	0	0	0	0
FL	3	Near	28,989	1,215	668	28	0	0	0	0	0	0
FL	3	Off	12,859	118	6,011	55	0	0	0	0	0	0
AL/MS	1	In	10,877	300	2,103	58	0	1	1	0	0.476	0.476
AL/MS	1	Near	5,346	147	2,103	58	0	1	1	0	0.476	0.476
AL/MS	1	Off	26,488	269	6,500	66	0	0	0	0	0	0
AL/MS	2	In	87,101	1,860	7,775	166	0	0	0	0	0	0
AL/MS	2	Near	8,072	172	7,775	166	0	0	0	0	0	0
AL/MS	2	Off	40,991	404	16,341	161	0	0	0	0	0	0
AL/MS	3	In	161,360	2,848	7,820	138	1	1	2	0.128	0	0.256
AL/MS	3	Near	18,147	320	7,820	138	1	1	2	0.128	0	0.256
AL/MS	3	Off	35,985	502	8,178	114	0	0	0	0	0	0
LA	1	In	71,275	1,012	8,379	119	1	2	3	0	0.239	0.358
LA	1	Near	79,779	1,133	8,379	119	1	2	3	0	0.239	0.358
LA	1	Off	75,559	447	21,286	126	1	0	1	0.047	0	0.047
LA	2	In	355,587	3,270	24,031	221	0	0	0	0	0	0
LA	2	Near	197,796	1,819	24,031	221	0	0	0	0	0	0
LA	2	Off	208,152	2,020	18,858	183	0	1	1	0	0	0
LA	3	In	521,421	5,672	18,663	203	0	1	1	0	0.054	0.054
LA	3	Near	160,771	1,749	18,663	203	0	1	1	0	0.054	0.054
LA	3	Off	99,722	909	21,950	200	1	0	1	0.046	0	0.046
TX	1	In	8,980	92	7,910	81	1	0	1	0	0	0
TX	1	Near	66,441	680	7,910	81	1	0	1	0	0	0

Area	Season	Depth Zone	Fishery Effort: Hours Fished	Fishery Effort: Est. Trips	OP Effort: Hours Fished	OP Effort: Trips	Marine Mammal Takes: Sf Ud=Sf	Marine Mammal Takes: Tt Ud=Sf	Marine Mammal Takes: Tt Ud=Tt	Marine Mammal Bycatch Rate (Takes per 1000 Hours): Sf Ud=Sf	Marine Mammal Bycatch Rate (Takes per 1000 Hours): Tt Ud=Sf	Marine Mammal Bycatch Rate (Takes per 1000 Hours): Tt Ud=Tt
TX	1	Off	64,724	532	11,687	96	1	2	3	0.086	0	0.257
TX	2	In	19,004	460	5,573	135	0	0	0	0	0	0
TX	2	Near	43,266	1,048	5,573	135	0	0	0	0	0	0
TX	2	Off	118,852	931	23,870	187	0	1	1	0	0	0
TX	3	In	26,629	366	7,358	101	0	0	0	0	0	0
TX	3	Near	59,028	810	7,358	101	0	0	0	0	0	0
TX	3	Off	281,295	1,835	30,819	201	0	3	3	0	0.097	0.097
2017 Fishery Effort and 2000-2019 Bycatch Rates												
FL	1	In	5,087	109	5,565	119	1	0	1	0.180	0	0.180
FL	1	Near	54,679	1,169	5,565	119	1	0	1	0.180	0	0.180
FL	1	Off	28,615	257	13,706	123	1	1	2	0.073	0	0.146
FL	2	In	6,832	223	1,866	61	0	0	0	0	0	0
FL	2	Near	39,659	1,297	1,866	61	0	0	0	0	0	0
FL	2	Off	14,506	155	6,289	67	0	0	0	0	0	0
FL	3	In	1,592	67	668	28	0	0	0	0	0	0
FL	3	Near	28,194	1,182	668	28	0	0	0	0	0	0
FL	3	Off	16,517	151	6,011	55	0	0	0	0	0	0
AL/MS	1	In	16,132	445	2,103	58	0	1	1	0	0.476	0.476
AL/MS	1	Near	4,582	126	2,103	58	0	1	1	0	0.476	0.476
AL/MS	1	Off	18,785	191	6,500	66	0	0	0	0	0	0
AL/MS	2	In	119,212	2,545	7,775	166	0	0	0	0	0	0
AL/MS	2	Near	15,134	323	7,775	166	0	0	0	0	0	0
AL/MS	2	Off	39,024	384	16,341	161	0	0	0	0	0	0
AL/MS	3	In	85,096	1,502	7,820	138	1	1	2	0.128	0	0.256
AL/MS	3	Near	12,774	225	7,820	138	1	1	2	0.128	0	0.256
AL/MS	3	Off	26,806	374	8,178	114	0	0	0	0	0	0
LA	1	In	123,692	1,757	8,379	119	1	2	3	0	0.239	0.358
LA	1	Near	91,977	1,306	8,379	119	1	2	3	0	0.239	0.358
LA	1	Off	121,503	719	21,286	126	1	0	1	0.047	0	0.047
LA	2	In	310,912	2,859	24,031	221	0	0	0	0	0	0
LA	2	Near	202,165	1,859	24,031	221	0	0	0	0	0	0
LA	2	Off	194,233	1,885	18,858	183	0	1	1	0	0	0
LA	3	In	354,503	3,856	18,663	203	0	1	1	0	0.054	0.054
LA	3	Near	136,409	1,484	18,663	203	0	1	1	0	0.054	0.054
LA	3	Off	90,849	828	21,950	200	1	0	1	0.046	0	0.046
TX	1	In	4,571	47	7,910	81	1	0	1	0	0	0
TX	1	Near	42,347	434	7,910	81	1	0	1	0	0	0
TX	1	Off	78,107	642	11,687	96	1	2	3	0.086	0	0.257
TX	2	In	9,296	225	5,573	135	0	0	0	0	0	0
TX	2	Near	52,129	1,263	5,573	135	0	0	0	0	0	0
TX	2	Off	139,032	1,089	23,870	187	0	1	1	0	0	0
TX	3	In	24,264	333	7,358	101	0	0	0	0	0	0
TX	3	Near	70,610	969	7,358	101	0	0	0	0	0	0
TX	3	Off	222,313	1,450	30,819	201	0	3	3	0	0.097	0.097
2018 Fishery Effort and 2000-2019 Bycatch Rates												
FL	1	In	1,182	25	5,565	119	1	0	1	0.180	0	0.180
FL	1	Near	48,513	1,037	5,565	119	1	0	1	0.180	0	0.180
FL	1	Off	47,320	425	13,706	123	1	1	2	0.073	0	0.146
FL	2	In	5,448	178	1,866	61	0	0	0	0	0	0
FL	2	Near	36,355	1,189	1,866	61	0	0	0	0	0	0
FL	2	Off	18,796	200	6,289	67	0	0	0	0	0	0
FL	3	In	2,580	108	668	28	0	0	0	0	0	0
FL	3	Near	27,235	1,142	668	28	0	0	0	0	0	0
FL	3	Off	10,733	98	6,011	55	0	0	0	0	0	0
AL/MS	1	In	6,882	190	2,103	58	0	1	1	0	0.476	0.476
AL/MS	1	Near	3,096	85	2,103	58	0	1	1	0	0.476	0.476

Area	Season	Depth Zone	Fishery Effort: Hours Fished	Fishery Effort: Est. Trips	OP Effort: Hours Fished	OP Effort: Trips	Marine Mammal Takes: Sf Ud=Sf	Marine Mammal Takes: Tt Ud=Sf	Marine Mammal Takes: Tt Ud=Tt	Marine Mammal Bycatch Rate (Takes per 1000 Hours): Sf Ud=Sf	Marine Mammal Bycatch Rate (Takes per 1000 Hours): Tt Ud=Sf	Marine Mammal Bycatch Rate (Takes per 1000 Hours): Tt Ud=Tt
AL/MS	1	Off	9,743	99	6,500	66	0	0	0	0	0	0
AL/MS	2	In	116,261	2,482	7,775	166	0	0	0	0	0	0
AL/MS	2	Near	18,227	389	7,775	166	0	0	0	0	0	0
AL/MS	2	Off	49,459	487	16,341	161	0	0	0	0	0	0
AL/MS	3	In	125,913	2,222	7,820	138	1	1	2	0.128	0	0.256
AL/MS	3	Near	16,104	284	7,820	138	1	1	2	0.128	0	0.256
AL/MS	3	Off	29,312	409	8,178	114	0	0	0	0	0	0
LA	1	In	78,376	1,113	8,379	119	1	2	3	0	0.239	0.358
LA	1	Near	63,456	901	8,379	119	1	2	3	0	0.239	0.358
LA	1	Off	63,972	379	21,286	126	1	0	1	0.047	0	0.047
LA	2	In	478,612	4,402	24,031	221	0	0	0	0	0	0
LA	2	Near	275,041	2,529	24,031	221	0	0	0	0	0	0
LA	2	Off	140,819	1,367	18,858	183	0	1	1	0	0	0
LA	3	In	311,104	3,384	18,663	203	0	1	1	0	0.054	0.054
LA	3	Near	132,895	1,446	18,663	203	0	1	1	0	0.054	0.054
LA	3	Off	83,202	758	21,950	200	1	0	1	0.046	0	0.046
TX	1	In	978	10	7,910	81	1	0	1	0	0	0
TX	1	Near	26,095	267	7,910	81	1	0	1	0	0	0
TX	1	Off	49,400	406	11,687	96	1	2	3	0.086	0	0.257
TX	2	In	16,298	395	5,573	135	0	0	0	0	0	0
TX	2	Near	60,146	1,457	5,573	135	0	0	0	0	0	0
TX	2	Off	129,370	1,013	23,870	187	0	1	1	0	0	0
TX	3	In	17,586	241	7,358	101	0	0	0	0	0	0
TX	3	Near	57,284	786	7,358	101	0	0	0	0	0	0
TX	3	Off	256,927	1,676	30,819	201	0	3	3	0	0.097	0.097
2019 Fishery Effort and 2000-2019 Bycatch Rates												
FL	1	In	2,929	63	5,565	119	1	0	1	0.180	0	0.180
FL	1	Near	40,131	858	5,565	119	1	0	1	0.180	0	0.180
FL	1	Off	20,670	185	13,706	123	1	1	2	0.073	0	0.146
FL	2	In	5,078	166	1,866	61	0	0	0	0	0	0
FL	2	Near	34,325	1,122	1,866	61	0	0	0	0	0	0
FL	2	Off	13,028	139	6,289	67	0	0	0	0	0	0
FL	3	In	4,617	194	668	28	0	0	0	0	0	0
FL	3	Near	38,127	1,598	668	28	0	0	0	0	0	0
FL	3	Off	17,777	163	6,011	55	0	0	0	0	0	0
AL/MS	1	In	7,566	209	2,103	58	0	1	1	0	0.476	0.476
AL/MS	1	Near	7,634	211	2,103	58	0	1	1	0	0.476	0.476
AL/MS	1	Off	23,562	239	6,500	66	0	0	0	0	0	0
AL/MS	2	In	143,742	3,069	7,775	166	0	0	0	0	0	0
AL/MS	2	Near	40,772	870	7,775	166	0	0	0	0	0	0
AL/MS	2	Off	15,601	154	16,341	161	0	0	0	0	0	0
AL/MS	3	In	113,250	1,999	7,820	138	1	1	2	0.128	0	0.256
AL/MS	3	Near	24,366	430	7,820	138	1	1	2	0.128	0	0.256
AL/MS	3	Off	20,579	287	8,178	114	0	0	0	0	0	0
LA	1	In	42,664	606	8,379	119	1	2	3	0	0.239	0.358
LA	1	Near	23,121	328	8,379	119	1	2	3	0	0.239	0.358
LA	1	Off	104,226	617	21,286	126	1	0	1	0.047	0	0.047
LA	2	In	361,552	3,325	24,031	221	0	0	0	0	0	0
LA	2	Near	195,812	1,801	24,031	221	0	0	0	0	0	0
LA	2	Off	159,308	1,546	18,858	183	0	1	1	0	0	0
LA	3	In	340,261	3,701	18,663	203	0	1	1	0	0.054	0.054
LA	3	Near	91,827	999	18,663	203	0	1	1	0	0.054	0.054
LA	3	Off	88,167	803	21,950	200	1	0	1	0.046	0	0.046
TX	1	In	417	4	7,910	81	1	0	1	0	0	0
TX	1	Near	29,579	303	7,910	81	1	0	1	0	0	0
TX	1	Off	23,282	191	11,687	96	1	2	3	0.086	0	0.257
TX	2	In	8,226	199	5,573	135	0	0	0	0	0	0

Area	Season	Depth Zone	Fishery Effort		OP Effort		Marine Mammal Takes			Marine Mammal Bycatch Rate (Takes per 1000 Hours)		
			Hours Fished	Est. Trips	Hours Fished	Trips	Sf Ud=Sf	Tt Ud=Sf	Tt Ud=Tt	Sf Ud=Sf	Tt Ud=Sf	Tt Ud=Tt
TX	2	Near	51,429	1,246	5,573	135	0	0	0	0	0	0
TX	2	Off	90,455	709	23,870	187	0	1	1	0	0	0
TX	3	In	11,964	164	7,358	101	0	0	0	0	0	0
TX	3	Near	64,275	882	7,358	101	0	0	0	0	0	0
TX	3	Off	206,181	1,345	30,819	201	0	3	3	0	0.097	0.097

3. Total annual bycatch mortalities and CV of standard error of bottlenose dolphin (Tt) and Atlantic spotted dolphin (Sf) stocks for the 2-area and 4-area stratified methods of bycatch rate estimation. The top panels for each stratification scenario present results for the species scenario in which all unidentified dolphins are assigned to bottlenose dolphins (Ud=Tt), while the lower panel presents results for the species scenario in which all unidentified dolphins are assigned to spotted dolphins (Ud=Sf). The models thought to be the most appropriate for the stock assessment reports, as described in the text, are indicated with bold type. Updated bycatch estimates for years 2011 to 2014 are included in addition to the new 2015 to 2019 estimates due to errors in otter trawl effort estimates and minor QA/QC updates to the Observer Program data.

		Tt Shelf		Tt W Coastal		Tt N Coastal		Tt E Coastal		Tt TX BSE		Tt LA BSE		Tt AL/MS BSE		Tt FL BSE		Sf	
		Bycatch	CV	Bycatch	CV	Bycatch	CV	Bycatch	CV	Bycatch	CV	Bycatch	CV	Bycatch	CV	Bycatch	CV	Bycatch	CV
2 -area																			
Ud=Tt	2011	50	0.42	64	0.51	6.3	0.55	1.1	1.02	2.1	0.54	120	0.51	35	0.51	3.2	1.02	0	-
	2012	47	0.36	52	0.50	4.7	0.52	0.6	1.00	1.9	0.54	52	0.56	15	0.65	0.2	1.00	0	-
	2013	53	0.35	29	0.52	2.6	0.60	0.7	1.02	1.3	0.65	34	0.58	11	0.68	1.1	1.02	0	-
	2014	53	0.38	68	0.52	3.4	0.57	1.1	0.99	21	0.57	45	0.51	2.9	0.59	1.2	0.99	0	-
	2015	57	0.31	26	0.39	1.8	0.39	4.1	0.97	1.6	0.38	42	0.44	7.2	0.53	0.1	0.97	0	-
	2016	59	0.32	59	0.36	3.1	0.38	8.1	1.01	4.8	0.37	66	0.43	17	0.49	1.7	1.01	0	-
	2017	61	0.30	55	0.36	2.4	0.36	9.8	0.99	3.4	0.40	65	0.36	12	0.40	0.9	0.99	0	-
	2018	54	0.30	41	0.35	2.3	0.40	8.7	0.99	1.8	0.51	49	0.38	13	0.51	0.2	0.99	0	-
	2019	48	0.30	28	0.37	4.2	0.37	7.2	1.00	1.2	0.53	42	0.44	12	0.50	0.5	1.00	0	-
Ud=Sf	2011	20	0.71	50	0.58	5.4	0.62	0	-	1.3	0.63	91	0.58	25	0.58	0	-	47	0.47
	2012	26	0.50	39	0.59	3.3	0.61	0	-	1.6	0.61	33	0.67	8.0	0.86	0	-	35	0.50
	2013	30	0.50	20	0.59	1.5	0.73	0	-	0.7	0.83	20	0.69	5.6	0.90	0	-	34	0.46
	2014	33	0.50	55	0.59	2.1	0.68	0	-	19	0.63	34	0.58	1.7	0.73	0	-	35	0.51
	2015	41	0.37	17	0.49	1.2	0.49	0	-	1.0	0.48	27	0.55	4.8	0.66	0	-	30	0.39
	2016	42	0.38	37	0.46	1.9	0.47	0	-	3.0	0.47	42	0.54	11	0.61	0	-	48	0.38
	2017	42	0.36	34	0.45	1.5	0.46	0	-	2.2	0.51	41	0.46	7.7	0.51	0	-	50	0.37
	2018	39	0.36	26	0.45	1.5	0.50	0	-	1.2	0.62	31	0.48	8.6	0.62	0	-	41	0.38
	2019	34	0.36	18	0.47	2.7	0.47	0	-	0.8	0.65	27	0.55	7.9	0.61	0	-	33	0.38

		Tt Shelf		Tt W Coastal		Tt N Coastal		Tt E Coastal		Tt TX BSE		Tt LA BSE		Tt AL/MS BSE		Tt FL BSE		Sf	
		Bycatch	CV	Bycatch	CV	Bycatch	CV	Bycatch	CV	Bycatch	CV	Bycatch	CV	Bycatch	CV	Bycatch	CV	Bycatch	CV
4 -area																			
Ud=Tt	2011	**62**	**0.45**	**68**	**0.82**	**12**	**0.65**	**1.1**	**0.98**	**0**	**-**	**156**	**0.80**	**70**	**0.67**	**3.2**	**0.98**	0	-
	2012	**50**	**0.37**	**49**	**0.76**	**12**	**0.67**	**0.6**	**0.97**	**0**	**-**	**56**	**0.75**	**33**	**0.89**	**0.2**	**0.97**	0	-
	2013	**58**	**0.39**	**23**	**0.74**	**5.9**	**0.83**	**0.7**	**1.02**	**0**	**-**	**35**	**0.78**	**24**	**0.96**	**1.1**	**1.02**	0	-
	2014	**59**	**0.41**	**58**	**0.80**	**8.1**	**0.74**	**1.1**	**1.00**	**0**	**-**	**57**	**0.80**	**6.7**	**0.79**	**1.2**	**1.00**	0	-
	2015	**62**	**0.34**	**18**	**0.55**	**4.5**	**0.57**	**4.1**	**1.00**	**0.3**	**1.01**	**32**	**0.64**	**20**	**0.67**	**0.1**	**1.00**	0	-
	2016	**70**	**0.33**	**46**	**0.47**	**7.2**	**0.56**	**8.1**	**1.00**	**1.1**	**1.00**	**53**	**0.63**	**46**	**0.63**	**1.7**	**1.00**	0	-
	2017	**72**	**0.30**	**46**	**0.48**	**5.4**	**0.55**	**9.8**	**1.00**	**0.6**	**1.00**	**63**	**0.52**	**29**	**0.57**	**0.9**	**1.00**	0	-
	2018	**64**	**0.30**	**33**	**0.47**	**5.6**	**0.55**	**8.7**	**0.98**	**0.1**	**0.99**	**45**	**0.53**	**35**	**0.62**	**0.2**	**0.98**	0	-
	2019	**50**	**0.33**	**17**	**0.47**	**9.9**	**0.55**	**7.2**	**0.98**	**0.1**	**1.02**	**34**	**0.61**	**33**	**0.63**	**0.5**	**0.98**	0	-
Ud=Sf	2011	32	0.70	68	0.82	8.6	0.82	0	-	0	-	156	0.80	31	0.82	0	-	**35**	**0.48**
	2012	29	0.52	49	0.76	5.4	0.85	0	-	0	-	56	0.75	3.9	0.85	0	-	**28**	**0.44**
	2013	37	0.54	23	0.74	1.2	0.86	0	-	0	-	35	0.78	1.2	0.86	0	-	**27**	**0.44**
	2014	43	0.52	58	0.80	2.5	0.87	0	-	0	-	57	0.80	1.6	0.87	0	-	**23**	**0.44**
	2015	48	0.41	14	0.68	2.8	0.70	0	-	0	-	28	0.73	11	0.93	0	-	**24**	**0.39**
	2016	55	0.39	28	0.62	4.9	0.67	0	-	0	-	45	0.72	26	0.83	0	-	**43**	**0.41**
	2017	53	0.36	29	0.61	3.8	0.66	0	-	0	-	49	0.59	19	0.69	0	-	**46**	**0.40**
	2018	50	0.37	22	0.59	3.5	0.67	0	-	0	-	35	0.60	19	0.81	0	-	**36**	**0.40**
	2019	38	0.40	10	0.62	6.7	0.66	0	-	0	-	28	0.71	18	0.81	0	-	**29**	**0.38**