ATLANTIC SPOTTED DOLPHIN (*Stenella frontalis*): Northern Gulf of Mexico Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

There are two species of spotted dolphins in the Atlantic Ocean, the Atlantic spotted dolphin (*Stenella frontalis*) and the pantropical spotted dolphin (*S. attenuate*; Perrin *et al.* 1987). The Atlantic spotted dolphin occurs in two forms which may be distinct subspecies (Perrin *et al*. 1987, 1994; Rice 1998; Viricel and Rosel 2014): the large, heavily spotted form which inhabits the continental shelf and is usually found inside or near the 200-m isobath; and the smaller, less spotted island and offshore form which occurs in the Atlantic Ocean but is not known to occur in the Gulf of Mexico (Fulling *et al.* 2003; Mullin and Fulling 2003; Mullin and Fulling 2004; Viricel and Rosel 2014). Where they co-occur, the offshore form of the Atlantic spotted dolphin and the pantropical spotted dolphin can be difficult to differentiate at sea.

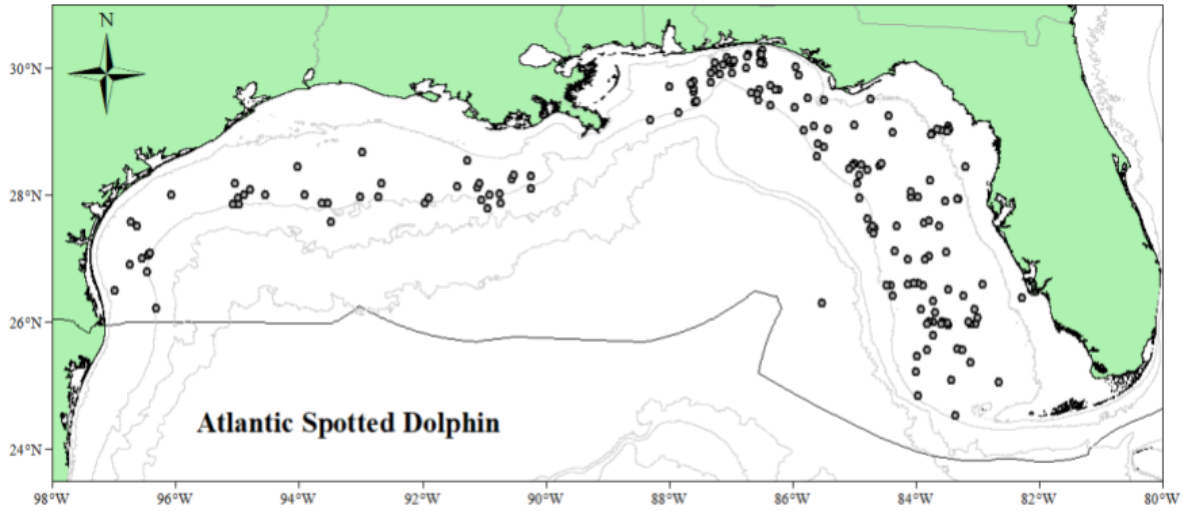

Figure 1. Distribution of Atlantic spotted dolphin on-effort sightings from SEFSC spring and fall vessel surveys during 1996–2001, vessel surveys during summer 2003, spring 2004, summer 2009, summer 2017, and summer/fall 2018, and aerial surveys during spring 2011, summer 2011, fall 2011, winter 2012, summer 2017, winter 2018, and fall 2018. Isobaths are the 20-m, 200-m, 1,000-m, and 2,000-m depth contours. The darker line indicates the U.S. EEZ.

The Atlantic spotted dolphin is endemic to the Atlantic Ocean in temperate to tropical waters (Perrin *et al.* 1987, 1994). In the Gulf of Mexico, Atlantic spotted dolphins occur primarily from continental shelf waters 10−200 m deep to slope waters <500 m deep (Figure 1; Fulling *et al.* 2003; Mullin and Fulling 2004; Maze-Foley and Mullin 2006; Garrison and Aichinger Dias 2020). Atlantic spotted dolphins were seen in all seasons during aerial and vessel surveys of the northern Gulf of Mexico (i.e., U.S. Gulf of Mexico; Hansen *et al.* 1996; Mullin and Hoggard 2000; Fulling *et al.* 2003; Mullin and Fulling 2004; Maze-Foley and Mullin 2006; Garrison and Aichinger Dias 2020). It has been suggested that this species may move inshore seasonally during spring, but data supporting this hypothesis are limited (Caldwell and Caldwell 1966; Fritts *et al.* 1983).

All the cetacean species found in the northern Gulf of Mexico almost certainly occur in similar habitat beyond U.S. boundaries in the southern Gulf. There are fewer cetacean sighting and stranding records in the southern Gulf due to more limited effort. Because there are confirmed records from the southern Gulf of Mexico beyond U.S.

boundaries (e.g., Jefferson and Schiro 1997; Ortega Ortiz 2002), this is likely a transboundary stock with Mexico.

Genetic analysis of Atlantic spotted dolphins in the Gulf of Mexico and western North Atlantic revealed significant differentiation for both nuclear and mitochondrial DNA markers (Adams and Rosel 2005; Viricel and Rosel 2014). Estimates of immigration rates between the western North Atlantic shelf population and the Gulf of Mexico were less than 1% per year (Viricel and Rosel 2014), which is well below the 10% per year threshold for demographic independence (Hastings 1993), thereby supporting separate stocks for Gulf of Mexico and western North Atlantic shelf populations. Viricel and Rosel (2014) also found support for two demographically independent populations within the northern Gulf of Mexico. One population primarily occupied shelf waters from the Texas-Mexico border eastward to Cape San Blas, Florida, while the second population was concentrated over the Florida shelf in the eastern Gulf of Mexico and stretched westward to the Florida panhandle. Thus, the two populations appear to overlap slightly in shelf waters between approximately Mobile Bay and Cape San Blas. Additional work is necessary to identify a boundary between them.

POPULATION SIZE

The current population size for the Atlantic spotted dolphin in the northern Gulf of Mexico is 21,506 (CV=0.26; Table 1). This estimate combines an estimate from an aerial survey during summer 2017 covering waters over the continental shelf (Garrison *et al*. 2021) and an estimate from summer 2017/2018 that covers oceanic waters (Garrison *et al.* 2020).

Earlier Abundance Estimates

Please see Appendix IV for a summary of abundance estimates, including earlier estimates and survey descriptions.

Recent Surveys and Abundance Estimates

An abundance estimate for Atlantic spotted dolphins was generated from vessel surveys conducted in the northern Gulf of Mexico from the continental shelf edge (~200-m isobath) to the seaward extent of the U.S. EEZ (Table 1; Garrison *et al.* 2020). One survey was conducted from 2 July to 25 August 2017 and consisted of 7,302 km of on-effort trackline, and the second survey was conducted from 11 August to 6 October 2018 and consisted of 6,473 km of on-effort trackline within the surveyed strata. Both surveys used a double-platform data-collection procedure, which allowed estimation of the detection probability on the trackline using the independent observer approach assuming point independence (Laake and Borchers 2004). Abundance was calculated using mark-recapture distance sampling implemented in package mrds (version 2.21; Laake *et al.* 2020) in the R statistical programming language. This approach accounted for the effects of covariates (e.g., sea state, glare) on detection probability within the surveyed strip. The surveys were conducted in "passing mode" (e.g., Schwarz *et al.* 2010) while all prior surveys in the Gulf of Mexico have been conducted in "closing mode." Passing mode eliminates the problems of fragmented tracklines associated with using closing mode in areas with high densities of animals. When using the closing mode with the two-team method, both teams must be allowed the opportunity to see a mammal group and allow it to pass behind the ship before turning to close on it, making it difficult to reacquire the group and resulting in long periods spent chasing the group, with the increased potential for off-effort sightings. For passive acoustics, in closing mode the vessel often turns before the acoustic team is able to achieve a good localization. This is especially important for deep-diving species where visual surveys are less optimal for abundance estimates. However, passing mode can result in increased numbers of unidentified sightings and may have affected group size estimation for distant groups of dolphins and small whales. The abundance estimate for this stock included sightings of unidentified dolphins that were apportioned among identified species based on their relative density within the survey strata (Garrison *et al.* 2020). The inverse variance weighted mean abundance estimate for Atlantic spotted dolphins in oceanic waters during 2017 and 2018 was 5,577 (CV=0.41; Garrison *et al.* 2020). Unlike previous abundance estimates, this estimate was corrected for the probability of detection on the trackline.

The Southeast Fisheries Science Center conducted aerial surveys of continental shelf waters (shoreline to 200 m depth) along the U.S. Gulf of Mexico coast from the Florida Keys to the Texas/Mexico border during summer (June–August) 2017 and fall (October–November) 2018 (Garrison *et al.* 2021). The stock was only partially surveyed during a winter 2018 aerial survey, and therefore this survey was not included in the current abundance estimates (Garrison *et al.* 2021). The surveys were conducted along tracklines oriented perpendicular to the shoreline and spaced 20 km apart. The total survey effort varied during each survey due to weather conditions, and was 10,781 km (fall) and 14,590 km (summer). Each of these surveys was conducted using a two-team approach to develop estimates of

visibility bias using the independent observer approach with Distance analysis (Laake and Borchers 2004). Abundance was calculated using mark-recapture distance sampling implemented in package mrds (version 2.21; Laake *et al.* 2020) in the R statistical programming language. This approach estimates both the probability of detection on the trackline and within the surveyed strip accounting for the effects of sighting conditions (e.g., sea state, glare, turbidity, and cloud cover). A different detection probability model was used for each seasonal survey (Garrison *et al.* 2021). The survey data were post-stratified into spatial boundaries corresponding to the defined boundaries of common bottlenose dolphin stocks within the surveyed area. The abundance estimates for the Continental Shelf Stock of common bottlenose dolphins were based upon tracklines and sightings in waters from the 20-m to the 200-m isobaths and between the Texas-Mexico border and the Florida Keys. The seasonal abundance estimates for this stock were: summer – 15,929 (CV=0.32) and fall – 2,529 (CV=0.71). Because the aerial survey estimate needs to be combined with vessel based estimates from surveys conducted during summer months, the summer 2017 aerial survey was used.

The best abundance estimate for Atlantic spotted dolphins is the sum of the estimates from continental shelf and oceanic waters during summer 2017–2018 surveys, and is 21,506 (CV=0.26; Table 1).

Table 1. Most recent abundance estimate (N_{est}) and coefficient of variation (CV) of northern Gulf of Mexico Atlantic spotted dolphins in continental shelf waters (coastline to 200-m isobath) and oceanic waters (200 m to the offshore extent of the EEZ) based on 2017 and 2018 aerial and vessel surveys.

Season/Year	Area	N_{est}	CV N_{est}
Summers 2017 and 2018	Oceanic	5,577	0.41
Summer 2017	Continental Shelf	15,929	0.32
Summers 2017 and 2018	Oceanic and Continental Shelf	21,506	0.26

Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed 60% confidence interval of the log-normal distributed abundance estimate. This is equivalent to the 20th percentile of the log-normal distributed abundance estimate as specified by Wade and Angliss (1997). The best estimate of abundance for Atlantic spotted dolphins is 21,506 (CV=0.26). The minimum population estimate for Atlantic spotted dolphins is 17,339 (Table 2).

Current Population Trend

The statistical power to detect a trend in abundance for this stock is poor due to the relatively imprecise abundance estimates and long intervals between surveys. For example, the power to detect a precipitous decline in abundance (i.e., 50% decrease in 15 years) with estimates of low precision (e.g., CV>0.30) remains below 80% (alpha=0.30) unless surveys are conducted on an annual basis (Taylor *et al.* 2007). Estimates of the portion of this stock over the continental shelf are available from aerial surveys conducted in 2011–2012 that can be compared to estimates from the 2017–2018 surveys. However, there is no corresponding vessel survey for the summer of 2011 that would allow an assessment of potential trend in the abundance of this stock. Therefore, no trend analysis can be conducted for the entire stock of Atlantic spotted dolphins.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. For purposes of this assessment, the maximum net productivity rate was assumed to be 0.04. This value is based on theoretical modeling showing that cetacean populations may not grow at rates much greater than 4% given the constraints of their reproductive history (Barlow *et al.* 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of the minimum population size, one half the maximum net productivity rate and a recovery factor (MMPA Sec. 3.16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size of this stock is 17,339. The maximum productivity rate is 0.04, the default value for cetaceans. The recovery factor is 0.48 because the CV of the shrimp trawl mortality estimate is greater than 0.3 (Wade and Angliss 1997). PBR for the northern Gulf of Mexico Atlantic spotted dolphin is 166 (Table 2).

Table 2. Best and minimum abundance estimates for northern Gulf of Mexico Atlantic spotted dolphins with Maximum Productivity Rate (R_{max}), Recovery Factor (F_r) and PBR.

Nest	Nest CV	Nmin	Fr	Rmax	PBR
21,506	0.26	17,339	0.48	0.04	166

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Total annual estimated fishery-related mortality and serious injury for this stock during 2015–2019 was 36 (CV=0.47) Atlantic spotted dolphins based on observer data for the commercial shrimp trawl fishery (Table 3; see Fisheries Information section below). The mean annual mortality and serious injury during 2015–2019 due to the *Deepwater Horizon* (DWH) oil spill was projected to be 231 continental shelf dolphins, which includes both Atlantic spotted dolphins and the Continental Shelf Stock of common bottlenose dolphins. Therefore, the mean annual mortality and serious injury during 2015–2019 due to other human-caused actions (DWH oil spill) is unknown for this stock. The minimum total mean annual human-caused mortality and serious injury for this stock during 2015–2019 was, therefore, 36. This is considered a minimum because 1) not all fisheries that could interact with this stock are observed and/or observer coverage is very low, and 2) the population model used to estimate population decline for the northern Gulf of Mexico stocks impacted by the DWH oil spill includes both Atlantic spotted dolphins and common bottlenose dolphins inhabiting the continental shelf and does not estimate mortality and serious injury to the Atlantic spotted dolphin stock alone. Therefore no estimate for injury has been included for the Atlantic spotted dolphin stock due to the DWH oil spill.

Table 3. Total annual estimated fishery-related mortality and serious injury for northern Gulf of Mexico Atlantic spotted dolphins.

Years	Source	Annual Avg.	CV
2015–2019	U.S. fisheries using observer data	36	0.47

Fisheries Information

There are two commercial fisheries that interact, or that potentially could interact, with this stock in the Gulf of Mexico. These are the Category I Atlantic Ocean, Caribbean, Gulf of Mexico large pelagics longline fishery and the Category II Southeastern U.S. Atlantic, Gulf of Mexico shrimp trawl fishery. Detailed fishery information is presented in Appendix III.

Longline Fishery

Pelagic swordfish, tunas and billfish are the targets of the large pelagics longline fishery operating in the northern Gulf of Mexico. Percent observer coverage (percentage of sets observed) for this fishery for each year during 2015–2019 was 19, 23, 13, 20 and 13, respectively. There were no observed mortalities or serious injuries to Atlantic spotted dolphins by this fishery during 2015–2019 (Garrison and Stokes 2017, 2019, 2020a, 2020b, 2021).

Shrimp Trawl

Between 1997 and 2019, 13 common bottlenose dolphins and nine unidentified dolphins, which could have been either common bottlenose dolphins or Atlantic spotted dolphins, became entangled in the lazy line, turtle excluder device or tickler chain gear in observed trips of the commercial shrimp trawl fishery in the Gulf of Mexico (Soldevilla *et al.* 2021). All dolphin bycatch interactions resulted in mortalities except for one unidentified dolphin that was released alive in 2009 (Maze-Foley and Garrison 2016). Soldevilla *et al.* (2015, 2016, 2021) provided mortality estimates calculated from analysis of shrimp fishery effort data and NMFS's Observer Program bycatch data. Annual mortality estimates were calculated for the years 2015–2019 from stratified annual fishery effort and bycatch rates, and the five-year unweighted mean mortality estimate was calculated for Gulf of Mexico dolphin stocks (Soldevilla *et al.* 2021). The 4-area (TX, LA, MS/AL, FL) stratification method was chosen because it best approximates how fisheries operate (Soldevilla *et al.* 2021). The mean annual mortality estimate for the Atlantic spotted dolphin stock is 36 (CV=0.47). Limitations and biases of annual bycatch mortality estimates are described in detail in Soldevilla *et al.* (2021).

Other Mortality

A population model was developed to estimate the injury and time to recovery for stocks affected by the DWH oil spill, taking into account long-term effects resulting from mortality, reproductive failure, reduced survival rates, and the proportion of the stock exposed to DWH oil (DWH MMIQT 2015). Overall, the model estimated that continental shelf dolphins, including Atlantic spotted dolphins and the continental shelf stock of common bottlenose dolphins, experienced a 3% maximum reduction in population size due to the oil spill (DWH MMIQT 2015). The mortality projected for the years 2010–2014 due to the spill has not been reported previously. Based on the population model, it was projected that 3,384 continental shelf dolphins died during 2010–2014 (five year annual average of 677) due to elevated mortality associated with oil exposure (see Appendix VI). For the 2015–2019 reporting period of this SAR, the population model estimated 1,153 continental shelf dolphins died due to elevated mortality associated with oil exposure. The population model used to predict shelf dolphin mortality due to the DWH event has a number of sources of uncertainty. Model parameters (e.g., survival rates, reproductive rates, and life-history parameters) were derived from literature sources for common bottlenose dolphins occupying waters outside of the Gulf of Mexico. In addition, proxy values for the effects of DWH oil exposure on both survival rates and reproductive success were applied based upon estimated values for common bottlenose dolphins in Barataria Bay. Finally, there was no estimation of uncertainty in model parameters or outputs.

Although outside the time period of this report, it should be noted that there was an entanglement in seismic survey nodal line during 2014 that resulted in one mortality of an Atlantic spotted dolphin.

Strandings

Three Atlantic spotted dolphins were reported stranded in the Gulf of Mexico during 2015–2019 (NOAA National Marine Mammal Health and Stranding Response Database unpublished data, accessed 25 August 2020). One animal stranded in Alabama in 2017, one in Alabama in 2018, and one in Florida in 2019. For all three strandings, it could not be determined if there was evidence of human interaction.

There are a number of difficulties associated with the interpretation of stranding data. Stranding data underestimate the extent of human and fishery-related mortality and serious injury because not all of the dolphins that die or are seriously injured in human interactions wash ashore, or, if they do, they are not all recovered (Peltier *et al*. 2012; Wells *et al*. 2015; Carretta *et al.* 2016). Additionally, not all carcasses will show evidence of human interaction, entanglement or other fishery-related interaction due to decomposition, scavenger damage, etc. (Byrd *et al*. 2014). Finally, the level of technical expertise among stranding network personnel varies widely as does the ability to recognize signs of human interaction.

Since 1990, there have been 15 common bottlenose dolphin die-offs or Unusual Mortality Events (UMEs) in the northern Gulf of Mexico, and three of these included Atlantic spotted dolphins. 1) Between August 1999 and May 2000, 150 common bottlenose dolphins died coincident with *Karenia brevis* blooms and fish kills in the Florida Panhandle. Additional strandings included three Atlantic spotted dolphins, one Risso's dolphin, *Grampus griseus*, two Blainville's beaked whales, *Mesoplodon densirostris*, and four unidentified dolphins. Brevetoxin was determined to be the cause of this event (Twiner *et al.* 2012; Litz *et al.* 2014). 2) In 2005, a particularly destructive red tide (*K. brevis*) bloom occurred off of central west Florida. Manatee, sea turtle, bird and fish mortalities were reported in the area in early 2005 and a manatee UME had been declared. Common bottlenose dolphin mortalities began to rise above the historical averages by late July 2005, continued to increase through October 2005, and were then declared to be part of a multi-species UME. The multi-species UME extended into 2006, and ended in November 2006. A total of 190 dolphins were involved, primarily common bottlenose dolphins plus strandings of one Atlantic spotted dolphin and 23 unidentified dolphins. The evidence suggests the effects of a red tide bloom contributed to the cause of this event (Litz *et al.* 2014). 3) An Unusual Mortality Event (UME) was declared for cetaceans in the northern Gulf of Mexico beginning 1 March 2010 and ending 31 July 2014 (Litz *et al.* 2014; https://www.fisheries.noaa.gov/national/marine-life-distress/2010-2014-cetacean-unusual-mortality-event-northern-gulf-mexico). It included cetaceans that stranded prior to the DWH oil spill (see Habitat Issues section below), during the spill, and after. Exposure to the DWH oil spill was determined to be the primary underlying cause of the elevated stranding numbers in the northern Gulf of Mexico after the spill (e.g., Schwacke *et al.* 2014; Venn-Watson *et al.* 2015; Colegrove *et al.* 2016; DWH NRDAT 2016; see Habitat Issues section). Fourteen strandings of Atlantic spotted dolphins during 2010–2014 were considered to be part of this UME.

HABITAT ISSUES

The *Deepwater Horizon* (DWH) MC252 drilling platform, located approximately 80 km southeast of the

Mississippi River Delta in waters about 1,500 m deep, exploded on 20 April 2010. The rig sank, and over 87 days up to ~3.2 million barrels of oil were discharged from the wellhead until it was capped on 15 July 2010 (DWH NRDAT 2016). Shortly after the oil spill, the Natural Resource Damage Assessment (NRDA) process was initiated under the Oil Pollution Act of 1990. A variety of NRDA research studies were conducted to determine potential impacts of the spill on marine mammals. These studies estimated that 13% (95%CI: 9–19) of continental shelf dolphins, including Atlantic spotted dolphins and the continental shelf stock of common bottlenose dolphins, in the Gulf were exposed to oil, that 6% (95%CI: 3–8) of females suffered from reproductive failure, and 5% (95%CI: 2–7) of continental shelf dolphins suffered adverse health effects (DWH MMIQT 2015). A population model estimated that the stock experienced a 3% maximum reduction in population size (see Other Mortality section above).

STATUS OF STOCK

Atlantic spotted dolphins are not listed as threatened or endangered under the Endangered Species Act, and the northern Gulf of Mexico stock is not considered strategic under the MMPA. The total human-caused mortality and serious injury for this stock is unknown but at a minimum is greater than 10% of the calculated PBR and, therefore, cannot be considered to be insignificant and approaching zero mortality and serious injury rate. The status of Atlantic spotted dolphins in the northern Gulf of Mexico, relative to optimum sustainable population, is unknown. There are insufficient data to determine the population trends for this stock.

REFERENCES CITED

Adams, L. and P. E. Rosel. 2005. Population differentiation of the Atlantic spotted dolphin *Stenella frontalis* in the Western North Atlantic, including the Gulf of Mexico. Mar. Biol. 148(3):671–681.

Barlow, J., S.L. Swartz, T.C. Eagle and P.R. Wade. 1995. U.S. Marine mammal stock assessments: Guidelines for preparation, background, and a summary of the 1995 assessments. NOAA Tech. Memo. NMFS-OPR-6, 73pp.

Byrd, B.L., A.A. Hohn, G.N. Lovewell, K.M. Altman, S.G. Barco, A. Friedlaender, C.A. Harms, W.A. McLellan, K.T. Moore, P.E. Rosel and V.G. Thayer. 2014. Strandings illustrate marine mammal biodiversity and human impacts off the coast of North Carolina, USA. Fish. Bull. 112:1–23.

Caldwell, D. K. and M. C. Caldwell. 1966. Observations on the distribution, coloration, behavior and audible sound production of the spotted dolphin, *Stenella plagiodon* (Cope). Los Angeles County Museum Contribution to Science, 104:1–28.

Carretta, J.V., K. Danil, S.J. Chivers, D.W. Weller, D.S. Janiger, M. Berman-Kowalewski, K.M. Hernandez, J.T. Harvey, R.C. Dunkin, D.R. Casper, S. Stoudt, M. Flannery, K. Wilkinson, J. Huggins and D.M. Lambourn. 2016. Recovery rates of bottlenose dolphin (*Tursiops truncatus*) carcasses estimated from stranding and survival rate data. Mar. Mamm. Sci. 32(1):349–362.

Colegrove, K.M., S. Venn-Watson, J. Litz, M.J. Kinsel, K.A. Terio, E. Fougeres, R. Ewing, D.A. Pabst, W.A. McLellan, S. Raverty, J. Saliki, S. Fire, G. Rappucci, S. Bowen-Stevens, L. Noble, A. Costidis, M. Barbieri, C. Field, S. Smith, R.H. Carmichael, C. Chevis, W. Hatchett, D. Shannon, M. Tumlin, G. Lovewell, W. McFee and T.K. Rowles. 2016. Fetal distress and *in utero* pneumonia in perinatal dolphins during the Northern Gulf of Mexico unusual mortality event. Dis. Aquat. Org. 119(1):1–16.

DWH MMIQT [*Deepwater Horizon* Marine Mammal Injury Quantification Team]. 2015. Models and analyses for the quantification of injury to Gulf of Mexico cetaceans from the *Deepwater Horizon* Oil Spill, MM_TR.01_Schwacke_Quantification.of.Injury.to.GOM.Cetaceans. Southeast Fisheries Science Center, Protected Resources and Biodiversity Division, 75 Virginia Beach Dr., Miami, Florida 33140. PRBD Contribution #: PRBD-2020-02.

DWH NRDAT [*Deepwater Horizon* Natural Resource Damage Assessment Trustees]. 2016. *Deepwater Horizon* oil spill: Final programmatic damage assessment and restoration plan and final programmatic environmental impact statement. http://www.gulfspillrestoration.noaa.gov/restoration-planning/gulf-plan

Fritts, T.H., A.B. Irvine, R.D. Jennings, L.A. Collum, W. Hoffman and M.A. McGehee. 1983. Turtles, birds, and mammals in the northern Gulf of Mexico and nearby Atlantic waters. U.S. Fish and Wildlife Service, Division of Biological Services, Washington, D.C., FWS/OBS-82/65. 455pp.

Fulling, G.L., K.D. Mullin and C.W. Hubard. 2003. Abundance and distribution of cetaceans in outer continental shelf waters of the U.S. Gulf of Mexico. Fish. Bull. 101:923–932.

Garrison, L.P. and L. Aichinger Dias. 2020. Distribution and abundance of cetaceans in the northern Gulf of Mexico. NOAA Tech. Memo. NMFS-SEFSC-747. 40pp. https://repository.library.noaa.gov/view/noaa/25568

Garrison, L.P. and L. Stokes. 2017. Estimated bycatch of marine mammals and sea turtles in the U.S. Atlantic pelagic longline fleet during 2015. NOAA Tech. Memo. NMFS-SEFSC-709. 61pp.

Garrison, L.P. and L. Stokes. 2019. Estimated bycatch of marine mammals and sea turtles in the U.S. Atlantic pelagic longline fleet during 2016. Southeast Fisheries Science Center, Protected Resources and Biodiversity Division, 75 Virginia Beach Dr., Miami, Florida 33140. PRBD Contribution # PRBD-2019-01. 62pp.

Garrison, L.P. and L. Stokes. 2020a. Estimated bycatch of marine mammals and sea turtles in the U.S. Atlantic pelagic longline fleet during 2017. Southeast Fisheries Science Center, Protected Resources and Biodiversity Division, 75 Virginia Beach Dr., Miami, Florida 33140. PRD Contribution # PRD-2020-05. 61pp.

Garrison, L.P. and L. Stokes. 2020b. Estimated bycatch of marine mammals and sea turtles in the U.S. Atlantic pelagic longline fleet during 2018. Southeast Fisheries Science Center, Protected Resources and Biodiversity Division, 75 Virginia Beach Dr., Miami, Florida 33140. PRD Contribution # PRD-2020-08. 56pp.

Garrison, L.P. and L. Stokes. 2021. Estimated bycatch of marine mammals and sea turtles in the U.S. Atlantic pelagic longline fleet during 2019. NOAA Tech. Memo. NMFS-SEFSC-750. 59pp.

Garrison, L.P., J. Ortega-Ortiz and G. Rappucci. 2020. Abundance of marine mammals in the waters of the U.S. Gulf of Mexico in the summer of 2017 and 2018. Southeast Fisheries Science Center, Protected Resources and Biodiversity Division, 75 Virginia Beach Dr., Miami, Florida 33140. PRBD Contribution # PRBD-2020-07. 55pp. https://repository.library.noaa.gov/view/noaa/26505

Garrison, L.P., J. Ortega-Ortiz and G. Rappucci. 2021. Abundance of coastal and continental shelf stocks of common bottlenose and Atlantic spotted dolphins in the northern Gulf of Mexico: 2017–2018. Southeast Fisheries Science Center, Protected Resources and Biodiversity Division, 75 Virginia Beach Dr., Miami, Florida 33140. PRD-2021-01. 25pp.

Hansen, L.J., K.D. Mullin, T.A. Jefferson and G.P. Scott. 1996. Visual surveys aboard ships and aircraft. Pages 55–132 *in:* R.W. Davis and G.S. Fargion (eds). Distribution and abundance of marine mammals in the north-central and western Gulf of Mexico: Final report. Volume II: Technical report. OCS Study MMS 96-0027. Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA.

Hastings, H. 1993. Complex interactions between dispersal and dynamics: Lessons from coupled logistic equations. Ecology 74:1362–1372.

Jefferson, T.A. and A.J. Schiro. 1997. Distribution of cetaceans in the offshore Gulf of Mexico. Mammal Rev. 27(1): 27–50.

Laake, J.L. and D.L. Borchers. 2004. Methods for incomplete detection at distance zero. Pages 108–109 *in*: Advanced distance sampling. S.T. Buckland, D.R. Andersen, K.P. Burnham, J.L. Laake and L. Thomas (eds). Oxford University Press, New York.

Laake, J., D. Borchers, L. Thomas, D. Miller and J. Bishop. 2020. Package 'mrds': Mark-recapture distance sampling. Version 2.2.3. http://github.com/DistanceDevelopment/mrds/

Litz, J.A., M.A. Baran, S.R. Bowen-Stevens, R.H. Carmichael, K.M. Colegrove, L.P. Garrison, S.E. Fire, E.M. Fougeres, R. Hardy, S. Holmes, W. Jones, B.E. Mase-Guthrie, D.K. Odell, P.E. Rosel, J.T. Saliki, D.K. Shannon, S.F. Shippee, S.M. Smith, E.M. Stratton, M.C. Tumlin, H.R. Whitehead, G.A.J. Worthy and T.K. Rowles. 2014. Review of historical unusual mortality events (UMEs) in the Gulf of Mexico (1990–2009): Providing context for the complex and long-lasting northern Gulf of Mexico cetacean UME. Dis. Aquat. Organ. 112:161–175.

Maze-Foley, K. and K.D. Mullin. 2006. Cetaceans of the oceanic northern Gulf of Mexico: Distributions, group sizes and interspecific associations. J. Cetacean Res. Manage. 8(2):203–213.

Mullin, K.D. and G. L. Fulling. 2003. Abundance and distribution of cetaceans in the southern U.S. Atlantic Ocean during summer 1998. Fish. Bull. 101:603–613.

Mullin, K.D. and G. L. Fulling. 2004. Abundance of cetaceans in the oceanic northern Gulf of Mexico. Mar. Mamm. Sci. 20(4):787–807.

Mullin, K.D. and W. Hoggard. 2000. Visual surveys of cetaceans and sea turtles from aircraft and ships. Pages 111–172 *in:* R.W. Davis, W.E. Evans and B. Würsig (eds). Cetaceans, sea turtles and seabirds in the northern Gulf of Mexico: Distribution, abundance and habitat associations. Volume II: Technical report. OCS Study MMS 2000-003. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA.

Ortega Ortiz, J.G. 2002. Multiscale analysis of cetacean distribution in the Gulf of Mexico. Ph.D. dissertation. Texas A&M University, College Station. 170pp.

Peltier, H., W. Dabin, P. Daniel, O. Van Canneyt, G. Dorémus, M. Huon and V. Ridoux. 2012. The significance of stranding data as indicators of cetacean populations at sea: Modelling the drift of cetacean carcasses. Ecol. Indicators 18:278–290.

Perrin, W.F., E.D. Mitchell, J.G. Mead, D.K. Caldwell, M.C. Caldwell, P.J.H. van Bree and W.H. Dawbin. 1987. Revision of the spotted dolphins, *Stenella* spp. Mar. Mamm. Sci. 3(2):99–170.

Perrin, W.F., D.K. Caldwell and M.C. Caldwell. 1994. Atlantic spotted dolphin *Stenella frontalis* (G. Cuvier, 1829). Pages 173–190 i*n:* S.H. Ridgway and R. Harrison (eds). Handbook of marine mammals, Vol. 5: The first book of dolphins. Academic Press, London. 416pp.

Rice, D.W. 1998. Marine mammals of the world, systematics and distribution. Spec. Publ. No. 4. The Society for Marine Mammalogy, Lawrence, KS. 231pp.

Schwacke, L.H., C.R. Smith, F.I. Townsend, R.S. Wells, L.B. Hart, B.C. Balmer, T.K. Collier, S. De Guise, M.M. Fry, L.J. Guillette, S.V. Lamb, S.M. Lane, W.E. McFee, N.J. Place, M.C. Tumlin, G.M. Ylitalo, E.S. Zolman and T.K. Rowles. 2014. Health of bottlenose dolphins (*Tursiops truncatus*) in Barataria Bay, Louisiana following the *Deepwater Horizon* oil spill. Environ. Sci. Technol. 48(1):93–103.

Schwarz, L.K., T. Gerrodette and F.I. Archer. 2010. Comparison of closing and passing mode from a line-transect survey of delphinids in the eastern Tropical Pacific Ocean. J. Cetacean Res. Manage. 11(3):253–265.

Soldevilla, M.S., L.P. Garrison, E. Scott-Denton and J.M. Nance. 2015. Estimation of marine mammal bycatch mortality in the Gulf of Mexico shrimp otter trawl fishery. NOAA Tech. Memo. NMFS-SEFSC-672, 70pp.

Soldevilla, M.S., L.P. Garrison, E. Scott-Denton and R.A. Hart. 2016. Estimated bycatch mortality of marine mammals in the Gulf of Mexico shrimp otter trawl fishery during 2012 to 2014. NOAA Tech. Memo. NMFS-SEFSC-697. 47pp.

Soldevilla, M.S., L.P. Garrison, E. Scott-Denton and J. Primrose. 2021. Estimated bycatch mortality of marine mammals in the Gulf of Mexico shrimp otter trawl fishery during 2015 to 2019. NOAA Tech. Memo. NMFS-SEFSC-749. 78pp.

Taylor, B.L., M. Martinez, T. Gerrodette, J. Barlow and Y.N. Hrovat. 2007. Lessons from monitoring trends in abundance in marine mammals. Mar. Mamm. Sci. 23(1):157–175.

Twiner, M.J., L.J. Flewelling, S.E. Fire, S.R. Bowen-Stevens, J.K. Gaydos, C.K. Johnson, J.H. Landsberg, T.A. Leighfield, B. Mase-Guthrie, L. Schwacke, F.M. Van Dolah, Z. Wang and T.K. Rowles. 2012. Comparative analysis of three brevetoxin-associated bottlenose dolphin (*Tursiops truncatus*) mortality events in the Florida panhandle region (USA). PLOS ONE 7(8). 19 pp.

Venn-Watson, S., K.M. Colegrove, J. Litz, M. Kinsel, K. Terio, J. Saliki, S. Fire, R. Carmichael, C. Chevis, W. Hatchett, J. Pitchford, M. Tumlin, C. Field, S. Smith, R. Ewing, D. Fauquier, G. Lovewell, H. Whitehead, D. Rotstein, W. McFee, E. Fougeres and T. Rowles. 2015. Adrenal gland and lung lesions in Gulf of Mexico common bottlenose dolphins (*Tursiops truncatus*) found dead following the *Deepwater Horizon* Oil Spill. PLoS ONE 10(5):e0126538.

Viricel, A. and P.E. Rosel. 2014. Hierarchical population structure and habitat differences in a highly mobile marine species: The Atlantic spotted dolphin. Mol. Ecol. 23:5018–5035.

Wade, P.R. and R.P. Angliss. 1997. Guidelines for assessing marine mammal stocks: Report of the GAMMS Workshop April 3–5, 1996, Seattle, WA. NOAA Tech. Memo. NMFS-OPR-12. 93pp.

Wells, R.S., J.B. Allen, G. Lovewell, J. Gorzelany, R.E. Delynn, D.A. Fauquier and N.B. Barros. 2015. Carcass-recovery rates for resident bottlenose dolphins in Sarasota Bay, Florida. Mar. Mamm. Sci. 31(1): 355–368.