ROUGH-TOOTHED DOLPHIN (*Steno bredanensis*): Northern Gulf of Mexico Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Rough-toothed dolphins (*Steno bredanensis*) are distributed worldwide in the Atlantic, Pacific, and Indian Oceans, generally in warm temperate, subtropical, or tropical waters. They are commonly reported in a wide range of water depths, from shallow, nearshore waters to oceanic waters (West *et al.* 2011). In the northern Gulf of Mexico (i.e., U.S. Gulf of Mexico), rough-toothed dolphins occur in oceanic and to a lesser extent continental shelf waters (Figure 1; Fulling *et al.* 2003, Mullin and Fulling 2004, Maze-Foley and Mullin 2006, Garrison and Aichinger Dias 2020). They have been observed in all seasons during NMFS visual surveys in the Gulf of Mexico (Hansen *et al.* 1996, Mullin and Hoggard 2000) but are not seen every survey year attesting to their low density in this region.

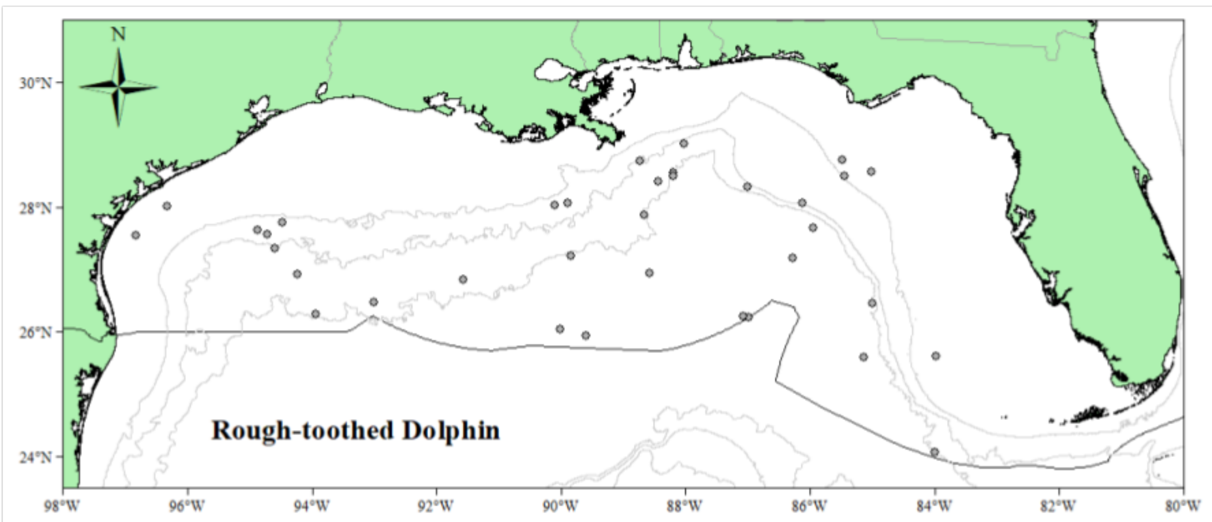

Figure 1. Distribution of rough-toothed dolphin on-effort sightings from SEFSC vessel surveys during spring 1996–2001, summer 2003, spring 2004, summer 2009, summer 2017, and summer/fall 2018. Isobaths are the 200-m, 1,000-m, and 2,000-m depth contours. The darker line indicates the U.S. EEZ.

All the cetacean species found in the oceanic 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. Nevertheless, there are records for most oceanic species in the southern Gulf (e.g., Jefferson and Schiro 1997; Ortega Ortiz 2002; Ortega-Argueta *et al.* 2005; Jefferson *et al.* 2008; Vázquez Castán *et al.* 2009; Whitt *et al.* 2011). This is therefore likely a transboundary stock with Cuba and/or Mexico. Because U.S. waters only comprise about 40% of the entire Gulf of Mexico and 35% of the oceanic (i.e., >200 m) Gulf of Mexico (Mullin and Fulling 2004), abundance and stock boundaries of oceanic species are poorly known.

Rough-toothed dolphins in the northern Gulf of Mexico are managed separately from those in the western North Atlantic. Several lines of evidence support this distinction. Four dolphins from a mass stranding of 62 animals in the Florida Panhandle in December 1997 were rehabilitated and released in 1998, and satellite-linked transmitters on three of these were tracked for up to 112 days. A report after five months indicated that the animals returned to, and remained in, northeastern Gulf waters (Wells *et al.* 2008), providing evidence for fidelity to the Gulf. In addition, analyses of worldwide genetic differentiation in Steno indicate animals in the western Atlantic Ocean are strongly differentiated from those in the Pacific and Indian Oceans (Albertson 2014, da Silva *et al.* 2015). Albertson (2014) illustrated that this species may exhibit fine-scale population structure and da Silva *et al.* (2015) provided evidence for multiple populations in the western South Atlantic. Finally, the separation of Atlantic and Gulf of Mexico stocks is consistent with the fact that the two areas belong to distinct marine ecoregions (Spalding *et al.* 2007, Moore and Merrick 2011).

There are insufficient data to determine whether the northern Gulf of Mexico stock comprises multiple demographically independent populations. Additional morphological, acoustic, genetic, and/or behavioral data are needed to further delineate population structure within the Gulf of Mexico and across the broader geographic area.

POPULATION SIZE

The best abundance estimate (Nest) for the northern Gulf of Mexico rough-toothed dolphin is unknown (Table 1) since no sightings of this species were made during the summer 2017 or summer/fall 2018 oceanic surveys covering waters from the 200-m isobath to the seaward extent of the U.S. EEZ (Garrison *et al.* 2020).

Earlier Abundance Estimates

Estimates of rough-toothed dolphin abundance have been made based on data from surveys during: 2003 (June−August), 2004 (April−June), 2009 (July−August), 2017 (July−August), and 2018 (August−October). Each of these surveys had a similar design and was conducted using the same vessel or a vessel with a similar observation platform. Surveys in 2003, 2004, and 2009 employed a single survey team while the 2017 and 2018 surveys employed two survey teams. In addition, the 2017 and 2018 surveys were conducted in "passing" mode rather than “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. Comparisons of the survey results over the years 2003 through 2009 required adjustments for these differences, including apportioning unidentified species among identified taxa to address the first issue, applying the model for detection probability on the trackline from the summer 2017 survey to the abundance estimates from the 2003, 2004, and 2009 surveys, and examining relationships between sighting distance and estimated group size (Garrison *et al.* 2020). This resulted in revised abundance estimates of: 2003, N=9,253 (CV=0.78); 2004, N=0 (CV=NA); and 2009, N=3,509 (CV=0.67).

Recent Surveys and Abundance Estimates

Two vessel surveys were conducted in the northern Gulf of Mexico from the continental shelf edge (~200-m isobath) to the seaward extent of the U.S. EEZ (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). 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. No sightings of rough-toothed dolphins were made during these two vessel surveys; therefore, the abundance estimate for rough-toothed dolphins is unknown.

Table 1. Summary of recent abundance estimates for rough-toothed dolphins in the northern Gulf of Mexico oceanic waters (200 m to the offshore extent of the EEZ) by month, year, and area covered during each abundance survey and the resulting abundance estimate (Nest) and coefficient of variation (CV).

Years	Area	Nest	CV
2017, 2018	Gulf of Mexico	Unknown	-

Minimum Population Estimate

The minimum population estimate (Nmin) 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 and minimum estimates of abundance for rough-toothed dolphins are unknown.

Current Population Trend

Using revised abundance estimates for surveys conducted in 2003 (June−August), 2004 (April−June), and 2009 (July−August; see above), pairwise comparisons of the non-zero log-transformed means were conducted, and significant differences were assessed at alpha=0.10. There were no significant differences between survey years (Garrison *et al.* 2020).

However, 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). In addition, because these surveys are restricted to U.S. waters, it is not possible to distinguish between changes in population size and Gulf-wide shifts in spatial distribution.

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 life history (Barlow *et al.* 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is currently undetermined. 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 is unknown. The maximum productivity rate is 0.04, the default value for cetaceans. The recovery factor is 0.40 because the CV of the average mortality estimate is greater than 0.8 (Wade and Angliss 1997; Table 2).

Table 2. Best and minimum abundance estimates for the northern Gulf of Mexico rough-toothed dolphin stock with Maximum Productivity Rate (R_{max}), Recovery Factor (F_r) and PBR.

N_{est}	CV	N_{min}	F_r	R_{max}	PBR
Unknown	-	Unknown	0.40	0.04	Undetermined

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

The estimated mean annual fishery-related mortality and serious injury for this stock during 2014–2018 was 0.8 rough-toothed dolphins (CV=1.00) due to interactions with the large pelagics longline fishery and 0.2 rough-toothed dolphins due to an interaction with the hook and line fishery (see Fisheries Information sections below; Tables 3–4). Mean annual mortality and serious injury during 2014–2018 due to other human-caused actions (the *Deepwater Horizon* oil spill) was predicted to be 38. The minimum total mean annual human-caused mortality and serious injury for this stock during 2014–2018 was, therefore, 39 (Table 5).

Table 3. Total annual estimated fishery-related mortality and serious injury for the northern Gulf of Mexico rough-toothed dolphin stock.

Years	Source	Annual Avg.	CV
2014–2018	U.S. fisheries using observer data	1.0	1.00

Fisheries Information

There are three commercial fisheries that interact, or that potentially could interact, with this stock in the Gulf of Mexico. These include two Category I fisheries, the Atlantic Highly Migratory Species (high seas) longline fishery, and the Atlantic Ocean, Caribbean, Gulf of Mexico large pelagics longline fishery, and one Category III fishery, the Atlantic Ocean, Gulf of Mexico, Caribbean commercial passenger fishing vessel (hook and line) fishery (Appendix III).

Longline

There is very little effort within the Gulf of Mexico by the Atlantic Highly Migratory Species (high seas) longline fishery, and no takes of rough-toothed dolphins within high seas waters of the Gulf of Mexico have been observed or reported thus far. Pelagic swordfish, tunas and billfish are the targets of the large pelagics longline fishery operating in the northern Gulf of Mexico. For the five-year period 2014–2018, the estimated annual combined serious injury and mortality attributable to the large pelagics longline fishery in the northern Gulf of Mexico was 0.8 (CV=1.00) rough-toothed dolphins (Table 4; Garrison and Stokes 2016, 2017, 2019, 2020a, 2020b). During the second quarter of 2014, one serious injury was observed (Garrison and Stokes 2016). Percent observer coverage (percentage of sets observed) for the two longline fisheries for each year during 2014–2018 was 18, 19, 23, 13 and 20, respectively. During the first and second quarters of 2014–2018, observer coverage in the Gulf of Mexico large pelagics longline fishery was greatly enhanced to collect more robust information on the interactions between pelagic longline vessels and spawning bluefin tuna. Therefore, the high annual observer coverage rates during 2014–2018 (Table 4) primarily reflect high coverage rates during the first and second quarters of each year. During these quarters, this elevated coverage results in an increased probability that relatively rare interactions will be detected. Species within the oceanic Gulf of Mexico are presumed to be resident year-round; however, it is unknown if the bycatch rates observed during the first and second quarters are representative of that which occurs throughout the year.

Table 4. Summary of the incidental mortality and serious injury of rough-toothed dolphins by the pelagic longline commercial fishery including the years sampled (Years), the type of data used (Data Type), the annual observer coverage (Observer Coverage), the annual observed serious injury and mortality recorded by on-board observers, the annual estimated serious injury and mortality, the combined annual estimates of serious injury and mortality (Est. Combined Mortality), the estimated CV of the combined annual mortality estimates (Est. CVs), the mean of the combined annual mortality estimates, and the CV of the mean combined annual mortality estimate (CV of Mean).

Fishery	Years	Data Type[a]	Observer Coverage[b]	Observed Serious Injury[c]	Observed Mortality	Estimated Serious Injury[c]	Est. Mort.	Est. Combined Mortality	Est. CVs	Mean Combined Annual Mortality	CV of Mean
Pelagic Longline	2014	Obs. Data, Trip Logbook	0.18	1	0	4.2	0	4.2	1	0.8	1.00
	2015		0.19	0	0	0	0	0	-		
	2016		0.23	0	0	0	0	0	-		
	2017		0.13	0	0	0	0	0	-		
	2018		0.20	0	0	0	0	0	-		
Total										**0.8**	**1.00**

[a] Number of vessels in the fishery is based on vessels reporting effort to the pelagic longline logbook.

[b] Observer data (Obs. Data) are used to measure bycatch rates, and the data are collected within the Northeast Fisheries Observer Program. Mandatory logbook data were used to measure total effort for the longline fishery. These data are collected at the Southeast Fisheries Science Center (SEFSC). Observer coverage in the GOM is dominated by very high coverage rates during April–June associated with efforts to improve estimates of bluefin tuna bycatch.

[c] Proportion of sets observed.

Other Mortality

Hook and Line (Rod and Reel)

During 2014–2018, stranding data included one mortality and one serious injury for which hook and line gear entanglement or ingestion were documented. For the mortality, the stranding data suggested the hook and line gear interaction was not a contributing factor to cause of death. Therefore, only the serious injury (Maze-Foley and Garrison 2020) was included in the annual human-caused mortality and serious injury total for this stock (Table 5). Both cases occurred in 2018 and were included in the stranding database and are included in the stranding totals presented in Table 6 (Southeast Regional Marine Mammal Stranding Network; NOAA National Marine Mammal Health and Stranding Response Database unpublished data, accessed 21 May 2019).

It should be noted that, in general, it cannot be determined if rod and reel hook and line gear originated from a commercial (i.e., commercial fisherman, charter boat, or headboat) or recreational angler because the gear type used by both sources is typically the same. Also, it is not possible to estimate the total number of interactions with hook and line gear because there is no systematic observer program. The documented interactions in this gear represent a minimum known count of interactions in the last five years.

Table 5. Summary of the incidental mortality and serious injury of rough-toothed dolphins during 2014–2018 from all sources, including observed commercial fisheries, unobserved commercial fisheries, and other sources.

Mean Annual Mortality due to the observed commercial large pelagics longline fishery (2014–2018) (Table 4)	0.8
Mean Annual Mortality due to the unobserved hook and line fishery (2014–2018)	0.2
Mean Annual Mortality due to Other Human-Caused Sources (DWH oil spill) (2014–2018)	38
Minimum Total Mean Annual Human-Caused Mortality and Serious Injury (2014–2018)	**39**

Other Mortality

There were six stranded rough-toothed dolphins in the northern Gulf of Mexico during 2014–2018 (Table 6; NOAA National Marine Mammal Health and Stranding Response Database unpublished data, accessed 21 May 2019). Evidence of human interaction was detected for two of the stranded animals, both of which were classified as fishery interactions. No evidence of human interaction was detected for one stranded animal, and for the remaining three, it could not be determined if there was evidence of human interaction. Stranding data probably 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). In particular, oceanic stocks in the Gulf of Mexico are less likely to strand than nearshore coastal stocks or shelf stocks (Williams *et al.* 2011). 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.

An Unusual Mortality Event (UME), involving primarily bottlenose dolphins, was declared for cetaceans in the northern Gulf of Mexico beginning 1 March 2010 and ending 31 July 2014 (Litz *et al.* 2014; http://www.nmfs.noaa.gov/pr/health/mmume/cetacean_gulfofmexico.htm, accessed 1 June 2016). It included cetaceans that stranded prior to the *Deepwater Horizon* (DWH) oil spill (see “Habitat Issues” 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). One stranding of a rough-toothed dolphin in 2013 was considered to be part of this UME.

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 this stock experienced a 17% maximum reduction in population size due to the oil spill (DWH MMIQT 2015). The mortality projected for the years 2010–2013 due to the spill has not been reported previously. Based on the population model, it was projected that 362 rough-toothed dolphins died during 2010–2013 (four year annual average of 91) due to elevated mortality associated with oil exposure (see Appendix VI). For the 2014–2018 reporting period of this SAR, the population model estimated 188 rough-toothed dolphins died due to elevated mortality associated with oil exposure. The population model used to predict rough-toothed 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 rough-toothed 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.

Table 6. Rough-toothed dolphin strandings along the northern Gulf of Mexico coast, 2014–2018. Data are from the NOAA National Marine Mammal Health and Stranding Response Database unpublished data, accessed 21 May 2019. There were no strandings of rough-toothed dolphins in Alabama or Texas.

State	2014	2015	2016	2017	2018	Total
Florida	0	3	0	1	0	4
Louisiana	0	0	0	0	1[a]	0

Mississippi	0	0	0	0	1[a]	0
Total	**0**	**3**	**0**	**1**	**0**	**4**

a. Both 2018 animals were classified as fishery interactions.

HABITAT ISSUES

The 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 ~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 41% (95%CI: 16–100) of rough-toothed dolphins in the Gulf were exposed to oil, that 19% (95%CI: 9–26) of females suffered from reproductive failure, and 15% (95%CI: 6–23) of rough-toothed dolphins suffered adverse health effects (DWH MMIQT 2015). A population model estimated the stock experienced a maximum 17% reduction in population size (see Other Mortality section above).

Anthropogenic sound in the world's oceans has been shown to affect marine mammals, with vessel traffic, seismic surveys, and active naval sonars being the main anthropogenic contributors to low- and mid-frequency noise in oceanic waters (e.g., Nowacek *et al.* 2015; Gomez *et al.* 2016; NMFS 2018). The long-term and population consequences of these impacts are less well-documented and likely vary by species and other factors. Impacts on marine mammal prey from sound are also possible (Carroll *et al.* 2017), but the duration and severity of any such prey effects on marine mammals are unknown.

STATUS OF STOCK

Rough-toothed dolphins are not listed as threatened or endangered under the Endangered Species Act. The most recent abundance surveys (2017–2018) observed no rough-toothed dolphins, rendering PBR undetermined. The northern Gulf of Mexico stock is therefore not considered strategic under the MMPA. However, the mean modeled annual human-caused mortality and serious injury due to the DWH oil spill (38 animals) greatly exceeds the previous, but expired, estimate of PBR for this stock (2.5) based on 2009 surveys. Total fishery-related mortality and serious injury for this stock was 0.8, which is not less than 10% of the previously calculated PBR, and therefore it is likely that fishery-related mortality and serious injury cannot be considered to be insignificant and approaching zero mortality and serious injury rate. The status of rough-toothed dolphins in the northern Gulf of Mexico, relative to OSP, is unknown. There was no statistically significant trend in population size for this stock.

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