RISSO'S DOLPHIN (*Grampus griseus*): Northern Gulf of Mexico Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Risso's dolphins are distributed worldwide in tropical to warm temperate waters (Leatherwood and Reeves 1983, Jefferson *et al.* 2014). Risso's dolphins in the northern Gulf of Mexico (i.e., U.S. Gulf of Mexico) occur throughout oceanic waters but are concentrated in continental slope waters (Figure 1; Baumgartner 1997, Maze-Foley and Mullin 2006, Garrison and Aichinger Dias 2020). This species has been observed in all seasons in the northern Gulf of Mexico (Hansen *et al.* 1996, Mullin and Hoggard 2000).

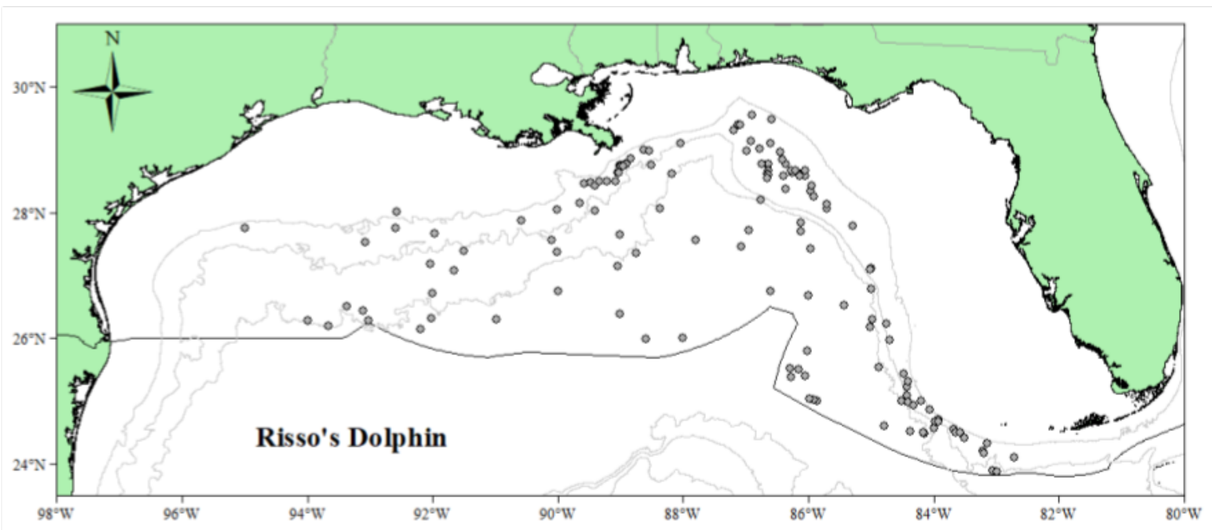

Figure 1. Distribution of Risso's dolphin on-effort sightings from SEFSC vessel surveys during spring 1996–2001, summer 2003, spring 2004, summer 2009, summer 2017, and summer/fall 2018. Isobaths are the 200-m, 1,000-m, and 2,000-m depth contours. The darker line indicates the U.S. EEZ.

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. Risso's dolphins in the northern Gulf of Mexico are managed separately from those in the western North Atlantic. Although there have been no directed studies of the degree of demographic independence between the two areas, this management structure is consistent with acoustic evidence. The frequency values of spectral peaks in Risso's dolphin echolocation clicks differ between the western North Atlantic and Gulf of Mexico stocks (Soldevilla *et al.* 2017). In addition, these two stocks occupy distinct marine ecoregions (Spalding *et al.* 2007, Moore and Merrick 2011) and biogeographic endemism has been identified for Risso's dolphins in the North Pacific (Chen *et al.* 2018). However, a stranded, rehabilitated Risso's dolphin that was released and tagged with a satellite-linked transmitter moved from the Gulf release site near Tampa, Florida, into the Atlantic Ocean and north to just off of Delaware over a 23 day period (Wells *et al.* 2009), suggesting the possibility of connectivity between the two basins. As Wells *et al.* (2009) note, it is difficult to determine the effects of stranding and rehabilitation on post-release behavior, so it is unknown whether these movements were representative of Risso's dolphin ranging patterns in either the Gulf of Mexico or Atlantic Ocean. 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 Risso's dolphin is 1,974 (CV=0.46; Table 1). This estimate is from summer 2017 and 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

Five point estimates of Risso's 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=4,471 (CV=0.47); 2004, N=4,641 (CV=0.86); and 2009, N=7,788 (CV=0.67).

Recent Surveys and Abundance Estimates

An abundance estimate for Risso's 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. The abundance estimate for this stock included sightings of unidentified small whales that were apportioned among identified species based on their relative density within the survey strata (Garrison *et al.* 2020). The 2017 and 2018 estimates were N=2,998 (CV=0.52) and N=632 (CV=0.60), respectively. The inverse variance weighted mean abundance estimate for Risso's dolphins in oceanic waters during 2017 and 2018 was 1,974 (CV=0.46; Table 1; Garrison *et al.* 2020). Unlike previous abundance estimates, this estimate was corrected for the probability of detection on the trackline.

Table 1. Most recent abundance estimate (N_{est}) and coefficient of variation (CV) of northern Gulf of Mexico Risso's dolphins in oceanic waters (200 m to the offshore extent of the EEZ) based on the inverse variance weighted mean from summer 2017 and summer/fall 2018 vessel surveys.

Years	Area	N_{est}	CV
2017, 2018	Gulf of Mexico	1,974	0.46

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 estimate of abundance for Risso's dolphins is 1,974 (CV=0.46). The minimum population estimate for the northern Gulf of Mexico Risso's dolphin is 1,368 (Table 2).

Current Population Trend

Using revised abundance estimates for surveys conducted in 2003 (June−August), 2004 (April−June), and 2009 (July−August; see above), and the 2017 (July−August) and 2018 (August−October) estimates, pairwise comparisons of the log-transformed means were conducted between years, and significant differences were assessed at alpha=0.10. P-values were adjusted for multiple comparisons. There were significant differences between the 2003 and 2018 estimates (p.adjusted=0.026) and the 2009 and 2018 estimates (p.adjusted=0.011; 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 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 1,368. The maximum productivity rate is 0.04, the default value for cetaceans. The recovery factor is 0.5 because the stock is of unknown status. PBR for the northern Gulf of Mexico Risso's dolphin is 14 (Table 2).

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

N_{est}	CV	N_{min}	F_r	R_{max}	PBR
1,974	0.46	1,368	0.5	0.04	14

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Total annual estimated fishery-related mortality and serious injury to this stock during 2014–2018 was presumed to be zero, as there were no reports of mortalities or serious injuries to Risso's dolphins in the Gulf of Mexico (Table 3). Mean annual mortality and serious injury during 2014–2018 due to other human-caused actions (the *Deepwater Horizon* oil spill) was predicted to be 5.3. The minimum total mean annual human-caused mortality and serious injury for this stock during 2014–2018 was, therefore, 5.3.

Table 3. Total annual estimated fishery-related mortality and serious injury for northern Gulf of Mexico Risso's dolphins.

Years	Source	Annual Avg.	CV
2014–2018	U.S. fisheries using observer data	0	-

Fisheries Information

There are two commercial fisheries that interact, or that could potentially interact, with this stock in the Gulf of Mexico. These are the Category I Atlantic Highly Migratory Species (high seas) longline fishery and the Category I Atlantic Ocean, Caribbean, Gulf of Mexico large pelagics longline fishery (Appendix III). Percent observer coverage (percentage of sets observed) for these longline fisheries for each year during 2014–2018 was 18, 19, 23, 13 and 20, respectively. There is very little effort within the Gulf of Mexico by the high seas longline fishery, and no takes of Risso's 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. During 2014–2018 there were no observed mortalities or serious injuries to Risso's dolphins by this fishery (Garrison and Stokes 2016, 2017, 2019, 2020a, 2020b).

Other Mortality

There were five reported strandings of Risso's dolphins in the Gulf of Mexico during 2014–2018 (Table 4; NOAA National Marine Mammal Health and Stranding Response Database unpublished data, accessed 21 May 2019). No evidence of human interaction was detected for one of the stranded animals, and it could not be determined if there was evidence of human interaction for the remaining four stranded animals. 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.

Since 1990, there have been 13 common bottlenose dolphin or cetacean die-offs or Unusual Mortality Events (UMEs) in the northern Gulf of Mexico, and two of these included a Risso's dolphin. Between August 1999 and May 2000, 150 common bottlenose dolphins died coincident with K. brevis blooms and fish kills in the Florida Panhandle (additional strandings included three Atlantic spotted dolphins, *Stenella frontalis*, one Risso's dolphin, 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). A 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 *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 Risso's dolphin stranding from 2012 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 3% 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 52 Risso's dolphins died during 2010–2013 (four year annual average of 13) due to elevated mortality associated with oil exposure (see Appendix VI). For the 2014–2018 reporting period of this SAR, the population model estimated 27 Risso's dolphins died due to elevated mortality associated with oil exposure. The population model used to predict Risso's 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 Risso's 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 4. Risso's 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 Risso's dolphins in Alabama, Mississippi, or Texas.

State	2014	2015	2016	2017	2018	Total
Florida	0	1	3	0	0	4
Louisiana	0	0	0	1	0	1
Total	**0**	**1**	**3**	**1**	**0**	**5**

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 8% (95%CI: 5–13) of Risso's dolphins in the Gulf were exposed to oil, that 3% (95%CI: 2–5) of females suffered from reproductive failure, and 3% (95%CI: 1–4) of Risso's dolphins suffered adverse health effects (DWH MMIQT 2015). A population model estimated the stock experienced a maximum 3% 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

Risso's 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. No fishery-related mortality or serious injury has been observed in recent years; therefore, total fishery-related mortality and serious injury can be considered to be insignificant and approaching zero mortality and serious injury rate. The status of Risso's dolphins in the northern Gulf of Mexico, relative to OSP, is unknown. The population trend for this stock is also unknown.

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