RICE’S WHALE (*Balaenoptera ricei*):
Northern Gulf of Mexico Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Rice’s whales are medium-sized baleen whales closely related to Bryde’s whales and sei whales (Rosel and Wilcox 2014; Rosel *et al.* 2021). Rice’s whales were identified as a unique evolutionary lineage and given species status in 2021 (Rosel *et al.* 2021). The species has a relatively restricted range within the northern Gulf of Mexico, although further research is ongoing to evaluate other potentially suitable habitat in the western and southern Gulf of Mexico. Sighting records and acoustic detections of Rice’s whales in the northern Gulf of Mexico (i.e., U.S. Gulf of Mexico) occur primarily in the northeastern Gulf in the De Soto Canyon area, along the continental shelf break between 100 m and 400 m depth, with a single sighting at 408 m (Figure 1; Hansen *et al.* 1996; Mullin and Hoggard 2000; Mullin and Fulling 2004; Maze-Foley and Mullin 2006; Rice *et al.* 2014; Rosel and Wilcox 2014; Širović *et al.* 2014; Rosel *et al*. 2016; Soldevilla *et al.* 2017). Rice’s whales have been sighted in all seasons within the De Soto Canyon area (Mullin and Hoggard 2000; Maze-Foley and Mullin 2006; Mullin 2007; DWH MMIQT 2015). Two strandings from the southeastern U.S. Atlantic coast share the same genetic characteristics with those from the northern Gulf of Mexico (Rosel and Wilcox 2014), but it is unclear whether these are extralimital strays (Mead 1977) or whether they indicate the population extends from the northeastern Gulf of Mexico to the Atlantic coast of the southern U.S. (Rosel and Wilcox 2014). There have been no confirmed sightings of Rice’s whales along the U.S. east coast during NMFS cetacean surveys (Rosel *et al*. 2016; Rosel *et al.* 2021).

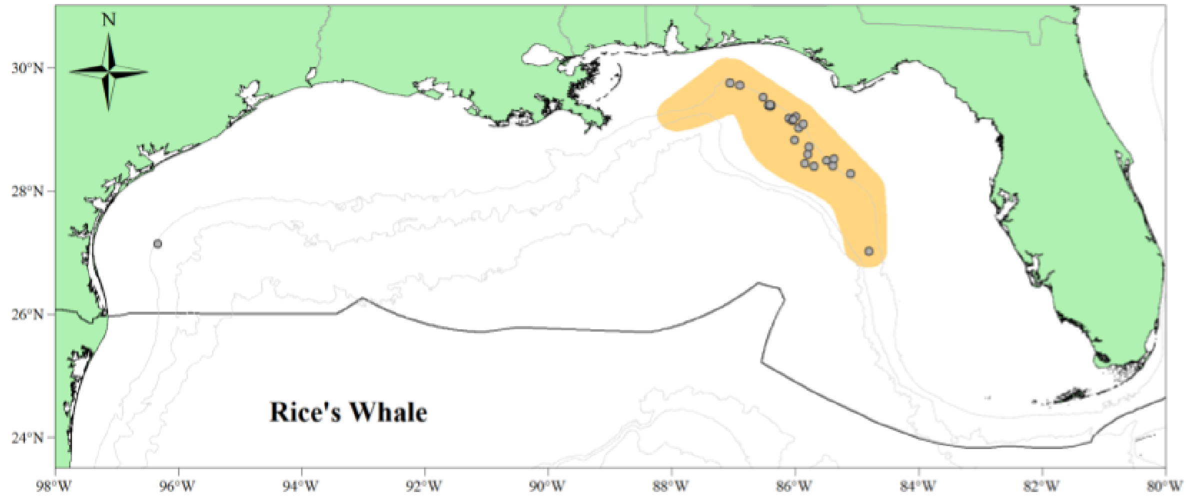

Figure 1. Distribution of all Rice’s whale sightings from SEFSC vessel surveys during spring 1996–2001, summer 2003, spring 2004, summer 2009, summer 2017, and summer/fall 2018. Isobaths are the 200-m, 1,000-m, and 2,000-m depth contours. The darker line indicates the U.S. EEZ. The shaded area indicates the core habitat.

Historical whaling records from the 1800s suggest that Rice’s whales may have been more common in the U.S. waters of the north central Gulf of Mexico and in the southern Gulf of Mexico in the Bay of Campeche (Reeves *et al.* 2011). Limited information exists on how regularly they currently use U.S. waters of the western Gulf of Mexico. There has been only one genetically confirmed sighting of a Rice’s whale in this region, a whale observed during a 2017 NMFS vessel survey off Texas (Garrison *et al.* 2020; Rosel et al. 2021), despite substantial NMFS survey effort in the north central and western Gulf dating back to the early 1990s (e.g., Hansen et al. 1996; Mullin and Hoggard 2000; Mullin and Fulling 2004; Maze-Foley and Mullin 2006). Rice’s whale calls were present on up to 16% of days per site during one year of acoustic recordings at three sites along the north-central and northwestern Gulf shelf break, indicating some whales persistently occur in waters beyond the core habitat (Soldevilla *et al.* 2022a). Whether these whales represent a separate population from those in the northeastern Gulf, or are animals that utilize a broader range than just the northeastern Gulf, bears further study. A compilation of available records of cetacean sightings, strandings, and captures in Mexican waters of the southern Gulf of Mexico identified no Rice's whales (Ortega-Ortiz 2002). Additional work to evaluate the presence and abundance of this species in the western and southern Gulf of Mexico will further understanding of their distribution and the plausibility of additional demographically independent populations.

POPULATION SIZE

The best abundance estimate available for Rice's whales in the northern Gulf of Mexico is 51 (CV=0.50; 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 Rice's whale 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=0 (CV=NA); 2004, N=64 (CV=0.88); and 2009, N=100 (CV=1.03).

Recent surveys and abundance estimates

An abundance estimate for Rice's whales 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 (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. 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. Both surveys used a double-platform data-collection procedure to allow estimation of the detection probability on the trackline using the independent observer approach assuming point independence (Laake and Borchers 2004). Due to the restricted habitat range of Rice's whales, survey effort was re-stratified to include only effort within their core habitat area (Figure 1; https://www.fisheries.noaa.gov/resource/map/gulf-mexico-brydes-whale-core-distribution-area-map-gis-data) including 941 km of effort in 2017 and 848 km of effort in 2018. In addition, there was an insufficient number of Rice's whale sightings during these surveys to develop an appropriate detection probability function. Therefore, a detection function was derived based on 91 sightings of Rice's whale groups observed during SEFSC large-vessel surveys between 2003 and 2019. The abundance estimates include unidentified large whales and baleen whales observed within the Rice's whale habitat. However, the estimate does not include the sighting of a confirmed Rice's whale in the western Gulf of Mexico in 2017. It is not possible to extrapolate estimated density beyond the core area since little is known about habitat use and distribution outside of this area. Estimates of abundance were derived using MCDS distance sampling methods that account for the effects of covariates (e.g., sea state, glare) on detection probability within the surveyed strip (Thomas *et al.* 2010) implemented in package mrds (version 2.21, Laake *et al.* 2020) in the R statistical programming language. The 2017 and 2018 estimates were N=84 (CV=0.92) and N=40 (CV=0.55), respectively. The inverse variance weighted mean calculation resulted in a best abundance estimate for Rice's whales in oceanic waters during 2017 and 2018 of 51 (CV=0.50;

Table 1; Garrison *et al.* 2020). This estimate was not corrected for the probability of detection on the trackline because there was only one resighting and few sightings overall of Rice's whales during the two-team surveys.

Table 1. Best abundance estimate (Nest) and coefficient of variation (CV) of Rice's whales in northern Gulf of Mexico 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	Nest	CV Nest
2017, 2018	Gulf of Mexico	51	0.50

Minimum Population Estimate

The minimum population estimate (Nmin) is the lower limit of the two-tailed 60% confidence interval of the log-normally distributed best 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 Rice's whales is 51 (CV=0.50). The minimum population estimate for the northern Gulf of Mexico Rice's whale is 34 (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 non-zero 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 no significant differences in between survey years when whales were observed (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.

All verified Rice's whale sightings, with one exception, have occurred in a very restricted area of the northeastern Gulf (Figure 1) during surveys that uniformly sampled the entire oceanic northern Gulf. Because the population size is small, in order to effectively monitor trends in Rice's whale abundance in the future, other methods need to be used.

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 likely do not grow at rates much greater than 4% given the constraints of their reproductive life history (Barlow *et al.* 1995). Between 1988 and 2018, there have been two documented strandings of calves (total length <700 cm) in the northern Gulf of Mexico (SEUS Historical Stranding Database unpublished data; NOAA National Marine Mammal Health and Stranding Response Database unpublished data).

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; Wade 1998). The minimum population size is 34. The maximum productivity rate is 0.04, the default value for cetaceans. The recovery factor is 0.1 because the stock is listed as endangered. PBR for the northern Gulf of Mexico Rice's whale stock is 0.07 (Table 2; value is 0.068 before rounding (NMFS 2016)).

Table 2. Best and minimum abundance estimates for northern Gulf of Mexico Rice's whales with Maximum Productivity Rate (Rmax), Recovery Factor (Fr) and PBR.

Nest	CV Nest	Nmin	Fr	Rmax	PBR
51	0.50	34	0.1	0.04	0.07

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

The total annual estimated fishery-related mortality and serious injury for the northern Gulf of Mexico Rice's whale stock during 2016–2020 is unknown. There was no documented fishery-caused mortality or serious injury for this stock during 2016–2020 (Table 3). Mean annual mortality and serious injury during 2016–2020 due to other human-caused actions (the *Deepwater Horizon* oil spill, ingested plastic) was predicted to be 0.5 (Appendix VI). The minimum total mean annual human-caused mortality and serious injury for this stock during 2016–2020 was, therefore, 0.5. This is considered a minimum mortality estimate as some fisheries with which the stock could interact have limited observer coverage. In addition, the likelihood is low that a whale killed at sea due to a fishery interaction or vessel-strike will be recovered (Williams *et al.* 2011).

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

Years	Source	Annual Avg.	CV
2016–2020	U.S. fisheries using observer data	Unknown	-

Fisheries Information

There are three commercial fisheries that overlap geographically and potentially could interact with this stock in the Gulf of Mexico. These include the Category I Atlantic Ocean, Caribbean, Gulf of Mexico large pelagics longline fishery, and two Category III fisheries, the Southeastern U.S. Atlantic, Gulf of Mexico shark bottom longline/hook-and-line fishery and the Southeastern U.S. Atlantic, Gulf of Mexico, and Caribbean snapper-grouper and other reef fish bottom longline/hook-and-line fishery. See Appendix III for detailed fishery information. All three of these fisheries have observer programs, however observer coverage is limited for the two Category III fisheries.

Pelagic swordfish, tunas, and billfish are the targets of the large pelagics longline fishery operating in the northern Gulf of Mexico. During 2016–2020 there were no observed mortalities or serious injuries to Rice's whales by this fishery (Garrison and Stokes 2019; 2020a; 2020b; 2021; 2023). Percent observer coverage (percentage of sets observed) for this longline fishery for each year during 2016–2020 was 23, 13, 20, 13, and 6.3, respectively. For the two category III bottom longline/hook-and-line fisheries, the target species are large and small coastal sharks and reef fishes such as snapper, grouper, and tilefish. There has been no reported fishery-related mortality or serious injury of a Rice's whale by either of these fisheries (e.g., Scott-Denton *et al.* 2011; Gulak *et al.* 2013; 2014; Enzenauer *et al.* 2015; 2016; Mathers *et al.* 2017; 2018; 2020a,b). Within the Gulf of Mexico, observer coverage for the snapper-grouper and other reef fish bottom longline fishery is ~1% or less annually, and for the shark bottom longline fishery coverage is 1–2% annually. Usually bottom longline gear is thought to pose less of a risk for cetaceans to become entangled than pelagic longline gear. However, if cetaceans forage along the seafloor, as is suspected for the Rice's whale (Soldevilla *et al.* 2017), then there is an opportunity for these whales to become entangled in the mainline as well as in the vertical buoy lines (Rosel *et al.* 2016).

Two other commercial fisheries that overlap to a small degree with the primary Rice's whale habitat in the northeastern Gulf of Mexico are the Category III Gulf of Mexico butterfish trawl fishery and Category II Southeastern U.S. Atlantic, Gulf of Mexico shrimp trawl fishery (Rosel *et al.* 2016). No interactions with Rice's whales have been documented for either of these fisheries. There is no observer coverage for the butterfish trawl fishery. The shrimp trawl fishery has ~2% observer coverage annually.

Other Mortality

There was one reported stranding of a Rice's whale in the Gulf of Mexico during 2016–2020 (Henry et al. 2022; NOAA National Marine Mammal Health and Stranding Response Database unpublished data, accessed 15 June 2021). One whale stranded in 2019, and there was evidence of human interaction in the form of a hard, sharp piece of ingested plastic. The plastic ingestion was believed to contribute to the stranding and ultimate death of the animal (Rosel *et al.* 2021).

Stranding data underestimate the extent of human and fishery-related mortality and serious injury because not all of the whales 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). 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) 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). Two Rice's whale strandings in 2012 were 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). Based on the population model, it was projected that 1.4 Rice's whales died during 2016–2020 (see Appendix VI) due to elevated mortality associated with oil exposure and that the stock experienced a 22% maximum reduction in population size due to the oil spill (DWH MMIQT 2015). The DWH Marine Mammal Injury Quantification Team cautioned that the capability of Rice's whales to recover from the DWH oil spill is unknown because the population models do not account for stochastic processes and genetic effects (DWH MMIQT 2015), to which small populations are highly susceptible (Shaffer 1981; Rosel and Reeves 2000). The population model used to predict Rice's whale 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 Rice's whales 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.

It should be noted that vessel strikes also pose a threat to this stock (Soldevilla *et al.* 2017), although none were observed or documented during the 2016–2020 time period covered by this report. In 2009, a Rice's whale was found floating in the Port of Tampa, Tampa Bay, Florida. The whale had evidence of pre-mortem and post-mortem blunt trauma, and was determined to have been struck by a vessel, draped across the bow, and carried into port. In addition, Rosel et al. (2021) reported a 2019 sighting of a free-swimming Rice's whale with a spinal deformation consistent with a vessel strike at some point in the past.

All mortalities and serious injuries during 2016–2020 from known sources for Rice's whales are summarized in Table 4.

Table 4. Summary of the incidental mortality and serious injury of Rice's whales during 2016–2020 from all sources.

Mean Annual Mortality due to commercial fisheries (2016–2020, Table 3)	Unknown
Mean Annual Mortality due to the DWH oil spill (2016–2020, Appendix VI)	0.3
Mean Annual Mortality due to Other Human-Caused Sources (ingested plastic) (2016–2020)	0.2
Minimum Total Mean Annual Human-Caused Mortality and Serious Injury (2016–2020)	**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 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 48% of Rice's whales in the Gulf were exposed to oil, that 22% (95% CI: 10–31) of females suffered from reproductive failure, and 18% (95% CI: 7–28) of the population suffered adverse health effects (DWH MMIQT 2015). A population model estimated the stock experienced a maximum 22% 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. Anecdotal evidence indicated Rice's whales temporarily stopped calling when approached by a research vessel (Soldevilla *et al.* 2022b), and this suggests disturbance from vessel noise and activity may be a management concern for this small stock.

New industries including aquaculture and wind energy development are actively being pursued in the Gulf of Mexico, which may have complex and adverse interactions with Rice's whales if development occurs within or near their habitat. The Gulf of Mexico has been chosen as one of the first areas for aquaculture development under the U.S. Presidential Executive Order 13921 (May 7, 2020) calling for the expansion of sustainable seafood production in the U.S. Potential impacts can occur at all stages of aquaculture development, operation, and decommissioning and can include attraction to farms or displacement from important habitats, resulting in changes to distribution, behaviors, or social structures (Clement 2013; Price *et al.* 2017; Heinrich *et al.* 2019). Physical interactions with gear (entanglement) or vessels can also result in injuries or mortalities (Price *et al.* 2017; Callier *et al.* 2018). For example, two Bryde's whale mortalities occurred in New Zealand due to entanglement in mussel farm spat lines (Baker *et al.* 2010). Possible indirect effects include noise or light pollution, habitat degradation, harmful algal blooms, or disease outbreaks (Clement 2013; Heinrich *et al.* 2019). Wind energy development has the potential to affect Rice's whales and/or their prey during pre-construction, construction, operation, and decommissioning through increased underwater sound and vibrations, vessel strikes, habitat alteration, chemical pollution, and entanglement (Rolland *et al.* 2012; Bailey *et al.* 2014; Taormina *et al.* 2018; Farr *et al.* 2021; Popper *et al.* 2022).

STATUS OF STOCK

The Rice's whale is listed as endangered under the Endangered Species Act, and therefore the northern Gulf of Mexico stock is considered strategic under the MMPA. The stock is very small and exhibits very low genetic diversity (Rosel and Wilcox 2014; Rosel *et al.* 2021), which places the stock at great risk of demographic stochasticity. The stock's restricted range also places it at risk of environmental stochasticity. In addition, the mean annual human-caused mortality and serious injury exceeds PBR for this stock. The status of Rice's whales in the northern Gulf of Mexico, relative to optimum sustainable population, is unknown. There was no statistically significant trend in population size for this stock.

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