Review of the Rice's Whale Proposed Critical Habitat and Related Scientific Literature

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1 Background and Introduction

This report reviews the scientific information presented by NMFS in the proposed critical habitat rule for Rice's whale, *Balaenoptera ricei* (88 FR 47453, 24 July 2023), as well as other best available scientific information, and examines whether the proposed critical habitat is supported by the best available science. NMFS has taken into account several recent studies to inform the proposed critical habitat including Rosel et al. (2021), Soldevilla et al. (2021a,b), Kiszka et al. (2023), and updated habitat-based density modeling (Rappucci et al. 2023; Garrison et al. 2023). Nonetheless, there are many data gaps related to the occurrence, distribution, and life history of the Rice's whale.

In 2015, LaBrecque et al. (2015) defined a Biologically Important Area (BIA) in the waters of the northeastern Gulf of Mexico (GOMx) between the 100–300 m isobath from south of Pensacola Florida to west of Fort Meyers, Florida (Figure 1), on the basis that this area is biologically important to the Bryde's whale, *Balaenoptera edeni*. In 2016, after receiving a petition to list the Bryde's whale in the GOMx as an "endangered species" under the Endangered Species Act (ESA), NMFS conducted a status review of the "GoMx Bryde's whale" in which the BIA was taken into account when defining the habitat of the population (Rosel et al. 2016; Figure 1). In 2019, the GOMx Bryde's whale was listed as an "endangered species" under the ESA as the GOMx subspecies of the Bryde's whale (84 FR 15446, April 15, 2019). In 2021, a final rule was published that revised the listing of the GOMx Bryde's whale to reflect the change in taxonomy (Rosel et al. 2021) to Rice's whale, *B. ricei* (86 FR 47022, 23 August 2021). In the final listing rule, NMFS noted that critical habitat was not determinable at the time of the listing because of insufficient data on the areas occupied by Rice's whale. However, the final rule defined the "core habitat" as an area categorized by a convex hull polygon of all GOMx baleen whale sightings clipped at the 410-m isobath (NMFS 2021; Figure 1). On July 23, 2023, NMFS proposed to designate critical habitat for Rice's whale in the GOMx, consisting of approximately 28,270 square miles of continental shelf and slope-associated waters between the 100-m to 400-m isobaths. NMFS is currently requesting comments regarding the proposed rule (88 FR 47453, 24 July 2023).

2 Rice's Whale Life History

2.1 Reproduction and Growth

There is limited information on the life history of the Rice's whale, specifically regarding the reproduction and growth of the species; thus, information about the closely related Bryde's whale is provided, when appropriate. The Rice's whale is a rorqual whale most well-defined by three distinct ridges in front of its blowhole (NOAA 2023a). Its body is sleek and uniformly dark gray on top with a pale/pink colored belly (NOAA 2023a). The dorsal fin is pointed and strongly hook-shaped, located about two-thirds of the way back on its body (NOAA 2023a). The Rice's whale is commonly observed traveling in pairs but may travel alone or in larger groups while feeding (Maze-Foley and Mullin 2006). The estimated length of time between Bryde's whale generations is 18.4 years based on a maximum age of 58 years (Best 1977) and an age at first reproduction/sexual maturity of 9 years (Lockyer 1984; IWC 1997). Bryde's whales are believed to be pregnant for 10–12 months followed by up to 12 months of nursing (NOAA 2023a). Taylor et al. (2007) estimate that the Bryde's whale reproduces every 2–3 years (single calf). Based on the available life history of Bryde's whale, it has been inferred that Rice's whale has a low reproductive rate, consistent with other baleen whale species; however, we are unable to locate studies that document the Rice's whale reproductive cycle. It is also important to note that the life history traits of

Rice's whale are based on what is known about Bryde's whale within the North Pacific Ocean and off South Africa, which may not be directly applicable to the Rice's whale in the GOMx.

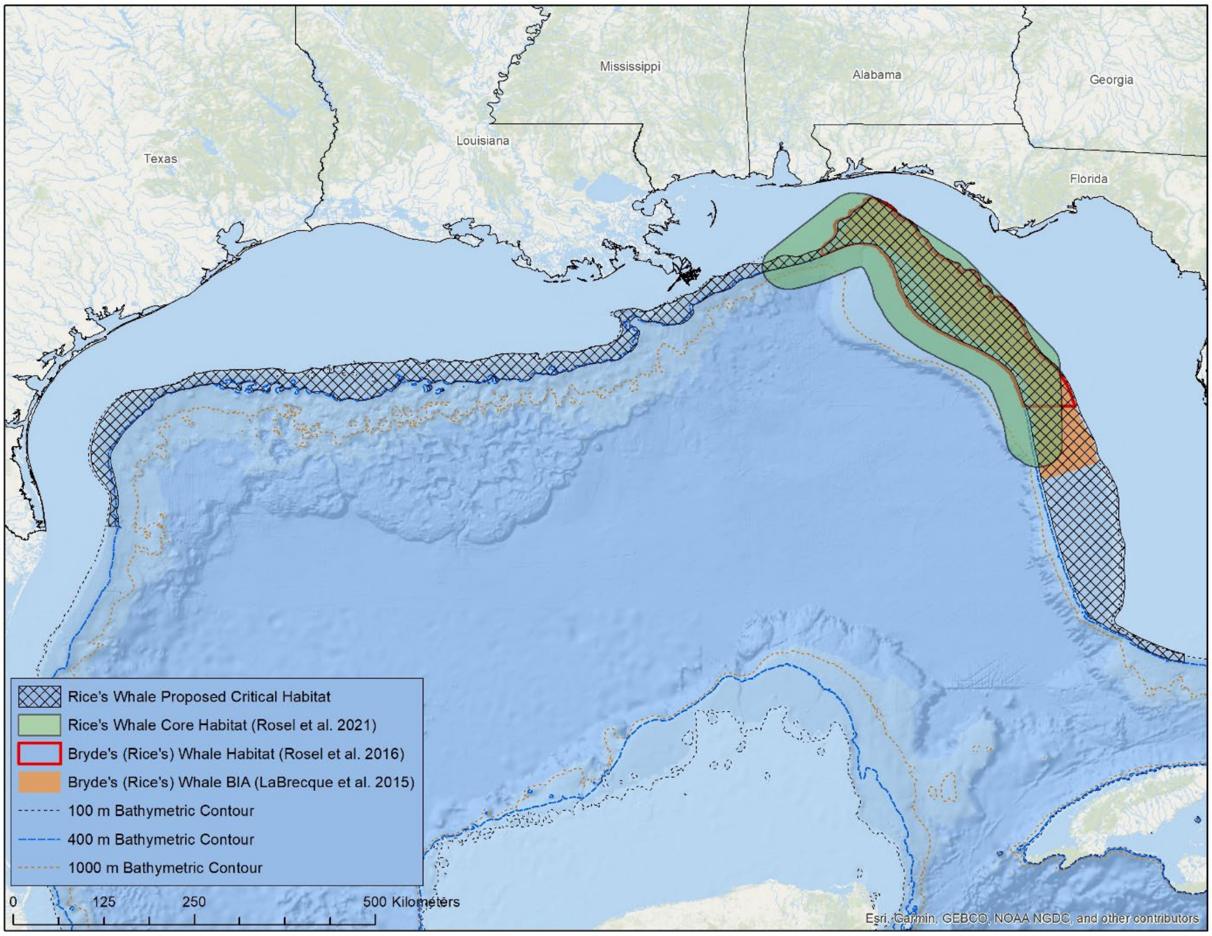

Figure 1. Rice's whale habitat designations from 2015–2021. BIA (orange shading) by LaBrecque et al. (2015), Bryde's (Rice's) whale habitat (red outline) defined in species status review by Rosel et al. (2016), "core habitat" (green shading) defined in Rice's whale taxonomy revision (Rosel et al. 2021) and proposed critical habitat (checkered area).

Stranding and biopsy data indicate both sexes of Rice's whale occur in portions of the GOMx (Rosel et al. 2021). The stranding records also include smaller Rice's whales, most likely calves, suggesting the species may engage in reproductive activity within portions of the GOMx (Rosel et al. 2021). The largest stranded individual was a 12.65 meters (m) lactating female reported in 2014 (Rosel and Wilcox 2014). Two Bryde's whale calves have been recorded stranded off the coast of Florida – one in the Florida Panhandle in 2006 (470 cm), and a juvenile north of Tampa, Florida, in 1988 (693 centimeter [cm]) (NOAA 2021; Edds et al. 1993). Current and maximum net productivity rates are unknown for this species due to limited data availability (Hayes et al. 2021). The most recent mean abundance estimate is 51 individuals (CV 0.50; Garrison et al. 2020) based on the summer 2017 and summer/fall 2018 line-transect surveys covering waters from the 200-m isobath to the seaward extent of the U.S. exclusive economic zone (EEZ).

2.2 Vocalizations

Balaenopterid whales are known to produce a variety of low-frequency tonal and broadband calls, ranging from 1–60 seconds, frequencies between 10–1,000 hertz (Hz), and high source levels from around 145 to over 190 dB re 1 µPa at 1 m (Richardson et al. 1995; Miller et al. 2021). Bryde's-like whale calls are easy to differentiate from those produced by other low-frequency cetaceans within the GOMx (e.g., fin and sei whales) (e.g., Baumgartner et al. 2008; Delarue et al. 2009; Castellote et al. 2012). Distinct low-frequency (60–950 Hz) pulses, tonals, and moans have been reported in free-ranging Bryde's whale adults and calves in the Eastern Tropical Pacific, Gulf of California, southern Caribbean, and North Pacific (Cummings et al. 1986; Oleson et al. 2003; Heimlich et al. 2005; McDonald 2006; Kerosky et al. 2012).

The call repertoire of the Rice's whale is not well known; however, several call types have been determined to be produced by Rice's whales in certain areas of the GOMx including three verified calls and a number of proposed high- and low-frequency downsweep call types (Rice et al. 2014; Širović et al. 2014; Soldevilla et al. 2022a,b). The first verified call type is characterized by a sequence of two or more short-duration downsweep pulses (mean: 8 downsweeps, range 2–27) ranging in frequency from 110 ± 4 to 78 ± 7 Hz (mean ± standard error [SE]) with a mean duration of 0.4 ± 0.01 seconds, an inter-pulse interval of 1.3 ± 0.01 seconds, and source level of 155 ± 14 dB re 1 µPa at 1 m (Rice et al. 2014; Širović et al. 2014). This pulsed downsweep sequence was recorded during concurrent visual and passive acoustic monitoring (PAM) surveys using directional sonobuoys deployed in the surrounding waters of the De Soto Canyon within the northeastern GOMx (Širović et al. 2014).

A second call type of the Rice's whale was recorded during the deployment of four bottom-mounted archival marine autonomous recording units (MARUs) within the northeastern GOMx (Rice et al. 2014). This long-moan call type starts with a short duration (2–3 seconds) constant tone at ~150 Hz, followed by a frequency-modulated downsweep, and ending with a long (10–20 second) duration tonal tail at ~100 Hz (Rice et al. 2014). During a long-term PAM study conducted by Soldevilla et al. (2022b), the loan-moan call type was recorded on a maximum of 90–100% of study days within the northeastern GOMx, suggesting consistent presence of the Rice's whale near the De Soto Canyon (Soldevilla et al. 2022b).

The third verified call starts with the long-moan call but is then followed by a tonal sequence of 1–6 narrow-band nearly constant-frequency tones in a sequence, with the tonals centered at ~103 Hz and an average duration of 3.6 seconds per tone (Rice et al. 2014). Other than the three verified call types, similar low-frequency downsweep stereotyped calls, recorded primarily outside of the core habitat in the northeastern GOMx, have been proposed as potential Rice's whale calls (Soldevilla et al. 2022b).

Soldevilla et al. (2022b) conducted a single-year deployment of autonomous PAM recorders at five sites along the northern GOMx shelf to determine where the Rice's whale occurs seasonally (Figure 2). Calls recorded at a 6th long-term site located within the known core habitat of the Rice's whale in the northeastern GOMx were used for comparison. Six new stereotyped variants calls were detected at the northwestern GOMx recording sites. These western sub-type calls had many similar features to the northeastern GOMx long-moan call including a brief 2–3 second start, a downsweep transition, and long 10–20 second tonal tail to the call (at ~100 Hz) (Soldevilla et al. 2022b). These similarities with the long-moan call also make it likely that these calls are from Rice's whales, as these same features are what distinguish the Rice's whale long-moan from other whale species. However, visual confirmation of the species making the western sub-type calls has not occurred, leaving some uncertainty. It is also theoretically possible that the western sub-type calls are from whales that do not regularly occur in the northeastern GOMx.

The six western sub-type calls are distinguished from one another, as well as from the long-moan eastern call, by the start of the call. Specifically, the transition zone is distinctly different between each western sub-type call and is followed by a sharp frequency drop (Soldevilla et al. 2022b). Western variant calls were rarely recorded within the known Rice's whale core habitat (150 out of 66,583 total calls recorded [<0.25%] on 21 recording days [6.4%]). At each of the five sites where western variant calls were detected, the calls showed temporal clustering with long periods of time (often multiple weeks) without any calls (Soldevilla et al. 2022b; Figure 6).

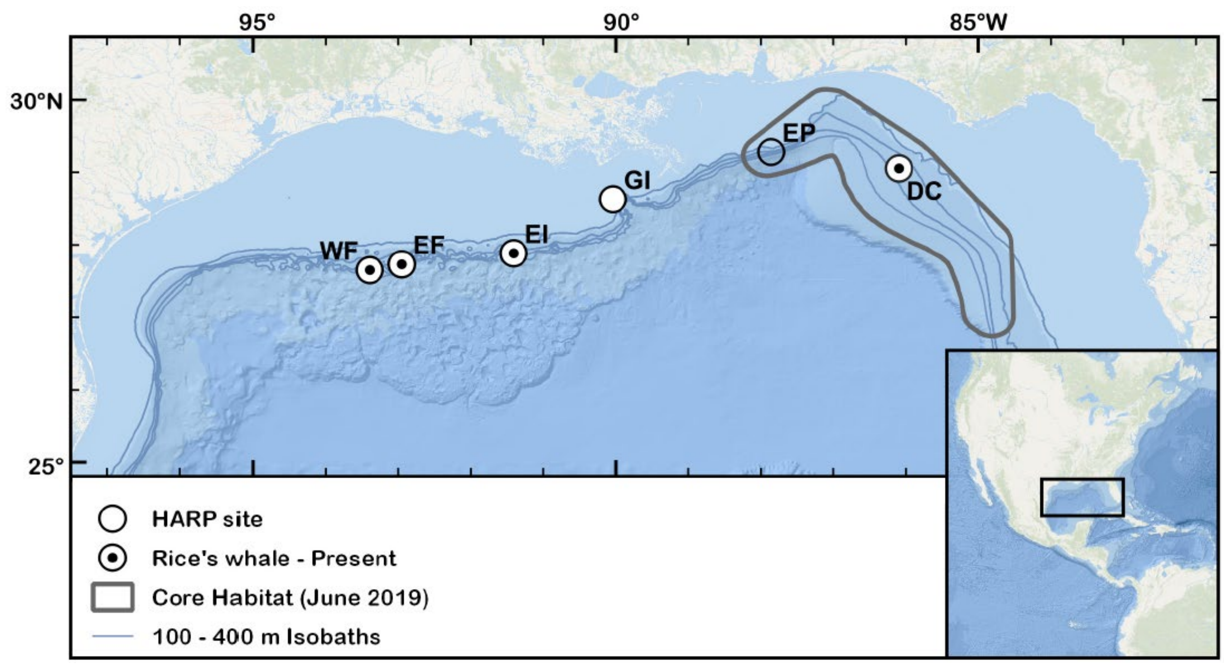

Figure 2. [*Reproduced from Soldevilla et al. 2022b*] Location of acoustic recording devices deployed at sites in potential Rice's whale habitat from July 2016 to August 2017 and a long-term acoustic recording site in the core habitat area. White-filled circles indicate successful data collection; black dots indicate Rice's whale call presence.

2.3 Feeding Ecology

Members of the Bryde's whale complex have been observed feeding using a variety of foraging techniques at the sea surface on a variety of prey species, largely in the order *Clupeiformes* (sardines, herring, menhaden, and anchovies) (Best 2001; Konishi et al. 2009; Murase et al. 2007; Siciliano et al. 2004; Tershy 1992; Watanabe et al. 2012). The specific diet of the Rice's whale is poorly characterized as few studies have observed Rice's whale foraging habits (NMFS 2023b). Kiszka et al. (2023) deployed mid-water fish trawls in the summer of 2019 at stations during daylight hours in Rice's whale core habitat in the northeastern GOMx to investigate prey selection in relation to prey availability and energy density.

Measurement of carbon isotopes, energy content, percent lipid, and percent protein were estimated from samples of each species collected within the trawls (e.g., *Ariomma bondi, Doryteuthis pealeii, Diaphus dumerilii, Marolicus weitzaman*) and compared to stable isotopes in biopsy samples from Rice's whales also collected in the northeastern GOMx (Kiszka et al. 2023). Results indicated that Rice's whales are selective predators consuming schooling prey with the highest energy content, specifically *A. bondi*. This species had the lowest abundance, but the highest biomass of potential prey in trawls sampled within the northeastern GOMx. Kiszka et al. (2023) deployed trawls only within the currently known Rice's whale core habitat in the northeastern GOMx; thus, the study does not provide evidence for the presence of this prey species, or use of it by Rice's whale, elsewhere in the GOMx. If *A. bondi* or other suitable prey are present elsewhere in the GOMx, further research is required to determine whether Rice's whales move out of the core habitat area for feeding purposes.

Both echosounder and trawl data collected in the Rice's whale core habitat within the northeastern GOMx showed that small schooling fish and invertebrates concentrate near the seafloor during the daytime, with occasional high-density aggregations, and move upward closer to the surface at night (Kiszka et al. 2023; NOAA 2023b). Although the echosounder and trawl survey data show the daily patterns of possible prey within the Rice's whale core habitat, it is unknown how Rice's whales locate their prey. One attribute of the proposed critical habitat suggests that the Rice's whale may use sound to locate prey at depth, but there is no evidence to support this theory (see additional discussion in Section 4.2.1). Additionally, it is unknown whether the small, schooling fish Rice's whales feed on that are found in the core habitat are present in sufficient numbers year-round in order to meet the daily energetic demands of Rice's whales (Kiszka et al. 2023).

Limited information is available regarding the foraging behaviors of Rice's whales in the GOMx. It has been inferred that Rice's whales spend the daytime diving near the seafloor and spend the majority of their time at night closer to the surface based on the tagging of a single Bryde's whale (Soldevilla et al. 2017). Using a kinematic tag attached to a Rice's whale for 3 days in the core habitat, dive patterns showed a slow descent to the seafloor (271 m) where the whale was then observed making a circular lunge pattern which was associated with foraging behavior (Soldevilla et al. 2017). Foraging lunges were characterized by concurrent changes in pitch, roll, and depth associated with short increases in broadband flow noise (Soldevilla et al. 2017). During the night, the whale was observed making shallow dives with occasional deeper dives between 30–150 m (Soldevilla et al. 2017).

3 Rice's Whale Occurrence and Distribution

The location of confirmed and suspected Rice's whale sightings and strandings was summarized by Rosel et al. (2021) and a map showing those locations is reproduced in Figure 3. The core habitat for the Rice's whale identified in Rosel et al. (2021) was defined using a convex hull polygon of all GOMx baleen whale sightings clipped at the 410 m isobath (because the deepest sighting of a rice's whale occurred in water 408 m deep) (NMFS 2021; Rosel et al. 2021). This area was based on 119 recorded sightings of GOMx baleen whales (Rice's whale, Rice's/sei, and Rice's/sei/fin) visually observed between 1989–2018 (Figure 3), telemetry locations (n = 52) from a single female Rice's whale tagged in 2010, and focal-follow sighting locations (n = 41) of a whale tagged with an Acousonde tag in 2015 (Rosel et al. 2021; Soldevilla et al. 2017). The convex hull polygon was then buffered by 30 km to account for the 10 km strip width of surveys as well as an additional 20 km to account for the median daily range of movements from satellite-tagged animals (Rosel et al. 2021). The addition of the full 20 km median daily range of movement to the buffer is illogical because assuming a total of 20 km of movement in a day means that a whale could only move 10 km beyond the maximum extent of known sightings and return those 10 km to get back within a single day. A 10–15 km buffer around the convex hull polygon is better supported by the movement data and potential error associated with sighting locations.

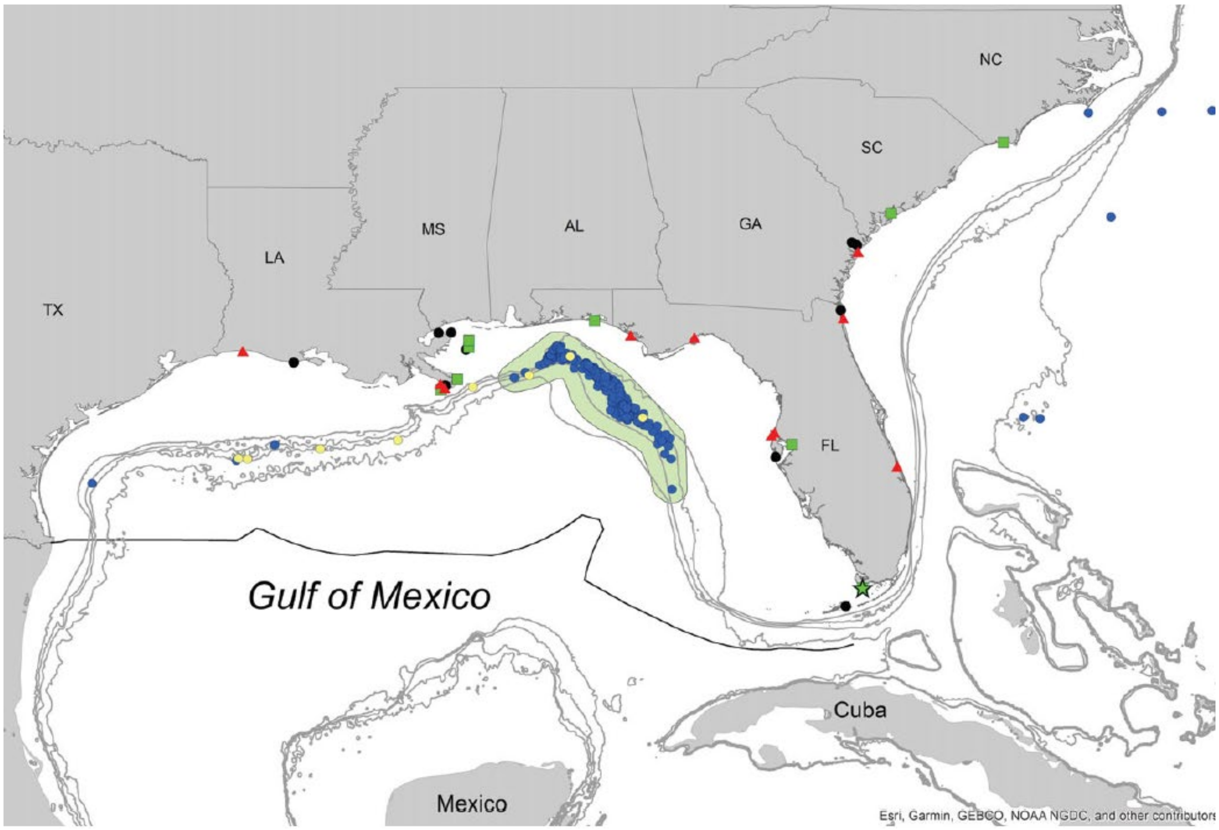

Figure 3. [R*eproduced from Rosel et al. 2021*]. Distribution of all sightings and strandings of Bryde's-like whales in the Gulf of Mexico and Atlantic U.S. EEZ. All visual survey sightings (blue circles) recorded as "Bryde's," "Bryde's/sei," and "Balaenoptera sp.". whales during NMFS vessel and aerial surveys from 1992 to 2019, including all sightings listed as "Bryde's/sei whales" or "Balaenoptera sp." in the western North Atlantic and sightings recorded by protected species observers (PSO) on seismic vessels (yellow circles) that could potentially have been a baleen whale. All strandings recorded as "Bryde's whales" (red triangle; presence of rostral ridges confirmed in stranding record or photos) or unconfirmed Bryde's-like whale (black circle; could not confirm presence of rostral ridges in stranding record), and genetically confirmed Gulf of Mexico Bryde's-like whale (green square) through May 2019, including the extralimital strandings in the western North Atlantic. Green polygon represents the core habitat for the whales in the northeastern Gulf of Mexico. The 100 m, 200 m, 400 m, and 1,000 m isobaths and the U. S. EEZ are shown.

The latest habitat-based marine mammal density models predict that the Rice's whale occurs within the core habitat, but also throughout the central and northwestern GOMx within the 100–400 m isobath (Rappucci et al. 2023; Garrison et al. 2023; Figure 4). This is based on the selection of a statistical model that identified a set of habitat characteristics (water depths 100–400 m, seafloor water temperatures 10–19 °C and intermediate Chlorophyll-*a* concentrations) most often associated with locations where confirmed Rice's whale sightings have been recorded (almost exclusively in the core habitat area, Figure

5). That set of habitat characteristics was then used to predict the presence of Rice's whales throughout the GOMx.

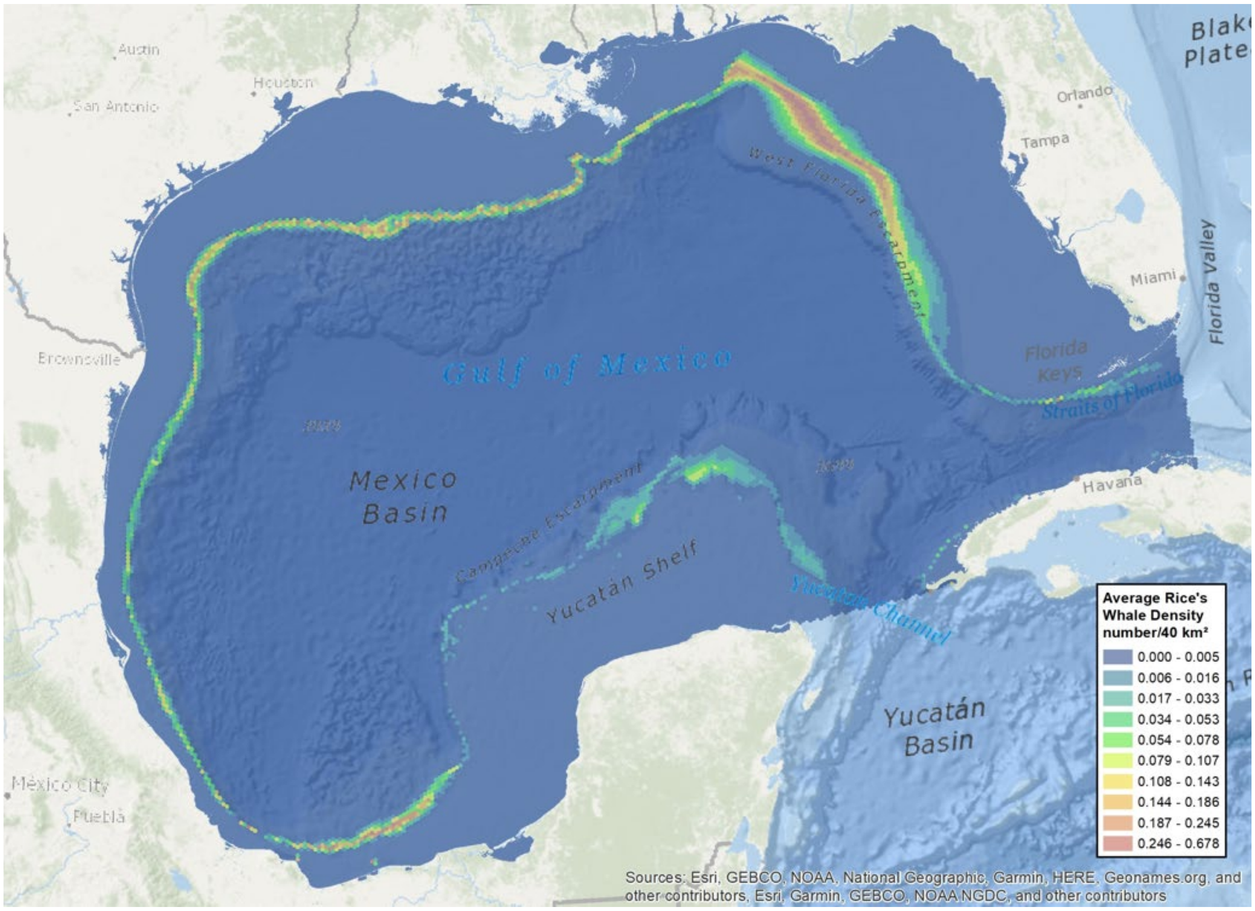

Figure 4. Annual average predicted density of Rice's whales in the GOMx calculated from monthly habitat based density predictions (Garrison et al. 2023).

While this overall modeling approach is generally accepted for marine mammals, there are significant limitations to the ability of these types of models to predict the presence of species outside of where survey effort or observations were made. The prediction of species presence outside of areas where detections were made assumes that species-habitat relationships are consistent throughout the GOMx and, as noted by the authors, this may not be the case (Garrison et al. 2023; Rappucci et al. 2023). The physical characteristics and resulting model-predicted higher density of Rice's whales occur primarily in the northeastern core habitat. It cannot be assumed that the simple presence of similar physical features elsewhere in the GOMx means that Rice's whales will be present there as well. In fact, Garrison et al. (2023) note such limitations and caution against the over-interpretation of their model predictions for species in the southern GOMx. This same level of caution should be applied to model predictions in areas where survey effort occurred, but only a single sighting was recorded (Figure 5).

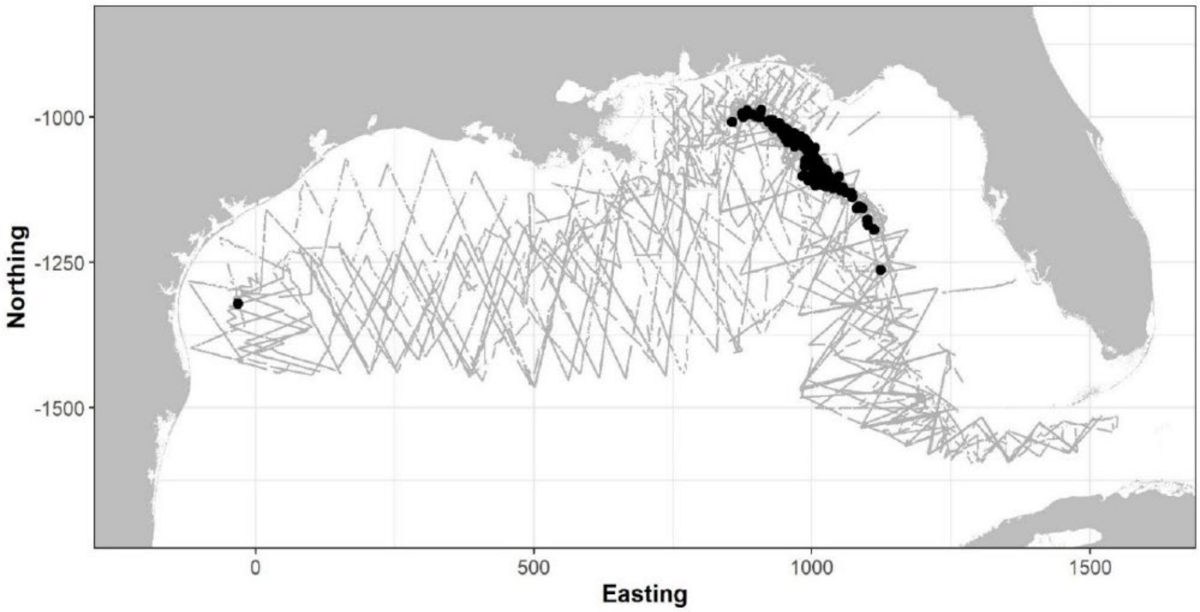

Figure 5. [*Reproduced from Garrison et al. 2023*] Survey effort and Rice's whale sightings used to develop the Rice's whale habitat-based density models (Garrison et al. 2023).

Overprediction is a common issue in Species Distribution Models (SDMs) and can have significant effects when used in conservation planning (Mendes et al. 2020; Velazco et al. 2020). Overprediction is common because SDMs rarely account for biotic interactions (e.g., competition, predation) or dispersal constraints (e.g., philopatry), and rely on coarse environmental datasets – of which each tend to result in coarser/broader predictions than actual populations exhibit (Mendes et al. 2020). Without accounting for potential overprediction of SDMs this "can lead to a misallocation of limited economic resources towards low-effective regions and misdirect conservation policies" (Velazco et al. 2020). As such, it is considered important to "…emphasize that predictions from SDMs, especially when used to inform conservation decisions, should be treated as hypotheses to be tested with independent data rather than as stand-ins for the population parameters we seek to know" (Lee-Yaw et al. 2021). In the case of the Rice's whale SDM that was used in defining Critical Habitat, it is difficult to ascertain exactly what environmental variables were included in the initial analyses. It appears that the center of abundance is in the Desoto Canyon region and eastward, along the edge of the West Florida Shelf. This Desoto Canyon region is somewhat unique within the Gulf of Mexico and there are a variety of biological discontinuities that occur here. Phylogeographic breaks in this region occur for species with diverse life and evolutionary histories, including octocorals, crustaceans, and squid (Quattrini et al. 2014, Drumm & Kreiser 2012, Herke & Foltz 2002), demographic breaks exist here for several fish species (Johnson et al. 2009), and the region has the greatest decapod species richness in the Gulf of Mexico (Wicksten & Packard 2005).

Whether Garrison et al. (2023) included variables that could, in part, account for features that might be unique to this area (e.g., distance to the west wall of the Desoto Canyon, predictions of prey occurrence, the acoustic soundscape), is unclear. However, the variables included in the model that were ultimately used to predict Rice's whale density would not specifically account for the physical and biogeographic uniqueness of this region. It is interesting to note that the SDM of Garrison et al. (2023) predicts abundances in the U.S. Gulf of Mexico ranging from 82–280 individuals by month (low =

October, high = January) whereas Roberts et al. (2015) predict 44 individuals. In concern that their models might be overpredicting Rice's whale, Roberts et al. (2015) state "The habitat predicted by our model might be too expansive–for example, Bryde's whales may not occur near the Florida Keys or west of the Mississippi River Delta, even though the model predicts them in these locations. …In any case, in the northeastern area where all of the sightings occurred in the 1994–2009 period, our model predicts density to be an order of magnitude or more higher than these more questionable areas."

As noted above, the model predicted presence of Rice's whale in the western GOMx is not well supported by visual detections which are limited to the single genetically verified Rice's whale sighting off Corpus Christie, Texas in 2017 (included in the modeling), two medium-size balaenopterid whale sightings off Louisiana, and two Bryde's-like whale strandings in western Louisiana none of which were confirmed to be Bryde's or Rice's whales (Rosel et al. 2016, 2021). PAM data collected in the central and northwestern GOMx provides support for the infrequent presence of Rice's whales west of the core habitat area in the northeastern GOMx. Rice's whale western sub-type long-moan variant calls were present on a maximum of 16% of study days within the northwestern GOMx compared to the original long-moan call being present on 90–100% of days at the northeastern GOMx site (Soldevilla et al. 2022b). The temporal pattern of vocalizations detected within the northwestern GOMx (Figure 6) does not suggest the types of behavior(s) the whales are engaging in while present in the area (e.g., breeding or feeding). For example, if this area were used for breeding on a seasonal basis, one might expect a period of persistent presence at the site followed by a longer period of absence the rest of the year. Instead, calls were only detected for a day to a week at a time, followed by an absence of calls for several weeks to more than a month.

Considering the very low number or absence of detections at the PAM deployment sites in the northcentral GOMx (Soldevilla et al. 2022b), it remains unknown whether the whales occasionally detected in the northwestern GOMx near the Flower Garden Banks National Marine Sanctuary (FGBNMS) are from the same population or social group that is regularly present within the core habitat area in the northeastern GOMx. There is a lack of data on the possible occurrence of Rice's whales outside the U.S. GOMx. NMFS (2023b) assumes that there are no Rice's whales outside the U.S. GOMx, and that there are no Rice's whales moving into the GOMx from outside of the Gulf despite two strandings on the U.S. Atlantic coast (in South Carolina and North Carolina, Figure 3; Rosel et al. 2021). The low number or lack of detections at the northcentral GOMx sites (Soldevilla et al. 2022b) could have several explanations including that few or no Rice's whales use that area, that Rice's whales did not or rarely vocalized when present in the area when the recorders were deployed, or that the ambient sound conditions were too loud to detect Rice's whale calls very far from the recorders. All of these alternative explanations should be thoroughly considered and evaluated when using the acoustic data as a part of defining the distribution and habitat of Rice's whale.

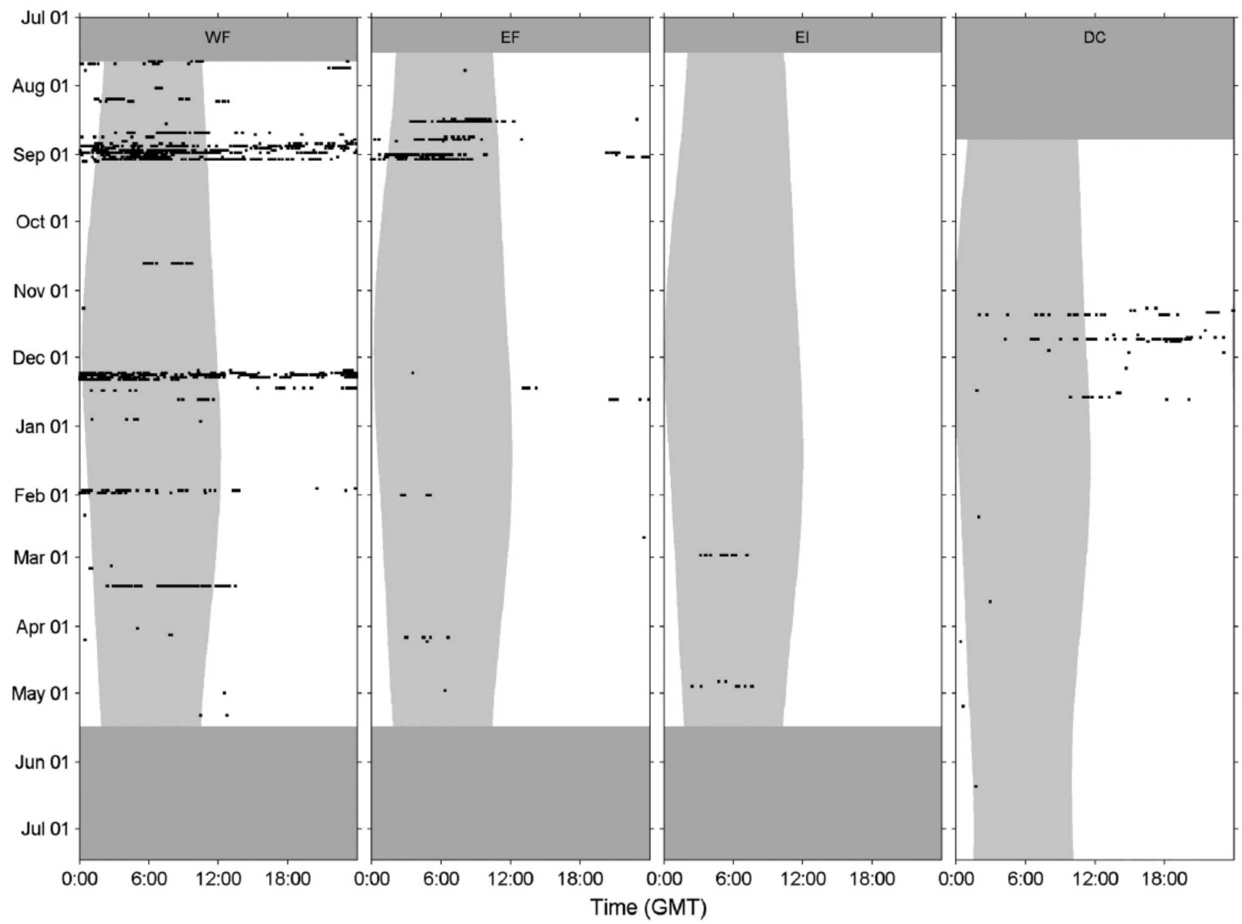

Figure 6. [*Reproduced from Soldevilla et al. 2022b*] Temporal occurrence of Rice's whale calls from long-term spectral average analyses at the WF (western Flower Garden Banks), EF (eastern Flower Garden Banks), EI (south of Eugene Isle), and DC (De Soto Canyon) from 2016–2017. Gray hourglass shading represents nighttime, while darker gray shading indicates periods of no effort. The black markers represent western long-moan variant calls; eastern long-moans detected at site DC are not plotted.

4 Proposed Critical Habitat

Critical habitat is defined in Section 3 of the ESA (16 U.S.C. 1532(3)), as "(1) Specific areas within the geographical area occupied by a species, at the time it is listed in accordance with the ESA, on which are found those physical or biological features (a) essential to the conservation of the species and (b) that may require special management considerations or protection; and (2) specific areas outside the geographical area occupied by the species if the agency determines that the area itself is essential for conservation." The proposed critical habitat for Rice's whale in the GOMx (88 FR 47453, 24 July 2023) appears to be primarily based on the habitat-based density model by Garrison et al. (2023). The model predicts the whales' presence throughout the GOMx in the 100-400 m water depth range.

4.1 Occupied Habitat

Here we refer to occupied habitat (or geographical areas occupied by the species), as outlined in the statutory definition of critical habitat (16 U.S.C. 1532(5)(A)(i)). By regulations, it is defined as "an area that may generally be delineated around species' occurrences, as determined by the Secretary (i.e., range). Such areas may include those areas used throughout all or part of the species' life cycle, even if not used on a regular basis (e.g., migratory corridors, seasonal habitats, and habitats used periodically, but not solely by vagrant individuals)" (50 CFR 424.02).

NMFS (2023b) states "we have determined that at the time of listing Rice's whales occupied the Gulf of Mexico" (pg. 47460). This statement is only true to the extent that Rice's whales are only known to occur within the GOMx (aside from the two strandings along the southeastern U.S. Atlantic coast (Figure 3; Rosel et al. 221). It is incorrect to state that Rice's whales actually occupy the entire GOMx. At present, there are no data to suggest that all portions of the GOMx are actually occupied by the Rice's whale.

There are no available data to support that Rice's whales occur in shallower or deeper waters of the GOMx away from the continental shelf break. There have been no reported sightings in waters <100 m or >408 m deep (Rosel et al. 2021). Based on sightings and acoustic detections (Rosel et al. 2021; Soldevilla et al. 2022a,b), the only habitat in which Rice's whales are known to consistently and regularly occur in the GOMx is the core habitat in the northeastern GOMx (Figure 1). As reviewed in Section 3, evidence of Rice's whale occurrence in the northwestern GOMx is based on infrequent and irregular acoustic detections (Soldevilla et al. 2022a,b) and a single confirmed sighting (NMFS 2018a). There is no evidence of persistent presence or a regular pattern of occurrence in the acoustic data (Soldevilla et al. 2022b) that would provide insight into how the whales use this area, such as for migration, seasonal foraging, or breeding.

4.2 Physical and Biological Features

ESA regulations define physical and biological features as "those that occur in specific areas and that are essential to support the life-history needs of the species, including but not limited to, water characteristics, soil type, geological features, sites, prey, vegetation, symbiotic species, or other features." (50 CFR 424.02). NMFS (2023b) has identified one "catch-all" feature as essential to the conservation of the Rice's whale: "GOMx continental shelf and slope associated waters between the 100 and 400 m isobaths that support individual growth, reproduction, and development, social behavior, and overall population growth." However, very little is known about the life history of Rice's whales (see Section 3), and much of the information has been gleaned from Bryde's whales (NMFS 2023b). Thus, there is very little scientific evidence upon which to precisely define the physical and biological features that support the largely unknown life-history needs of the Rice's whale.

NMFS (2023b) assumes that "Rice's whales rely entirely on the GOMx continental shelf and slope waters between the 100 and 400 m isobaths to support all of their life history stages", although the evidence to support this is largely limited to the location of all visual sightings. It is inferred that Rice's whales, particularly in the core habitat, use the area for reproduction and feeding.

Indirect evidence of feeding within the core habitat is provided by Soldevilla et al. (2017) and Kiszka et al. (2023). However, it is still somewhat uncertain what Rice's whales actually prey on. According to NMFS (2023b), "Diet is poorly characterized for Rice's whales" and, in fact, very few studies have examined the feeding ecology of Rice's whales. There have been no studies that examined stomach contents or fecal samples and no surface feeding events have been reported (NMFS 2023b). Soldevilla et al. (2017, 2022a) did report dives in the core habitat to depths near the seafloor with lunging and the lunging behavior is commonly associated with foraging in baleen whales. As summarized in Section 2.3, Kiszka et al. (2023) examined the feeding ecology of Rice's whales in the northeastern GOMx via stable isotopes, prey availability, and energy density, and suggested that Rice's whales are selective predators consuming schooling prey with the highest energy content, specifically *A. bondi*. However, there is no direct evidence to show what specific prey species Rice's whales are actually feeding on within or outside the core habitat (NMFS 2023b).

Although NMFS (2023b) noted that there is evidence of breeding in the GOMx, this statement appears to be based on records of smaller Bryde's-like whales in the GOMx, but no confirmed records of living Rice's whale calves. As no mating or births have been reported in the GOMx, there is no direct evidence to indicate that breeding or calving actually occurs in the GOMx. Nonetheless, indirect evidence was offered by Rosel et al. (2021) in that two Bryde's whale calves have been recorded stranded off the coast of Florida – one in the Florida Panhandle in 2006 (470 cm), and a juvenile north of Tampa, Florida, in 1988 (693 centimeter [cm]) (NOAA 2021; Edds et al. 1993). This suggests that calving likely does take place in the eastern GOMx.

Additionally, it is unknown how much of the GOMx continental shelf and slope-associated waters between the 100 and 400 m isobaths actually support the life history needs of the Rice's whale. Based on the regular occurrence (both sightings and acoustic detections) in the core habitat (Rosel et al. 2021; Soldevilla et al. 2022b), it is likely that this region has more of the essential features needed for Rice's whale than the rest of the shelf/slope region in the GOMx. In particular, the De Soto Canyon region (the area where the core habitat is located) appears to have unique oceanographic characteristics that are not known to occur in the same combination anywhere else in the GOMx. Because of the De Soto Canyon's physical structure and location relative to water masses, upwelling appears to drive the circulation patterns in this area, which in turn leads to recurring cold-water masses that are atypical for its latitude (Schroeder and Woods 2000). Farmer et al. (2022) noted that in addition to water masses such as the Loop Current, wind also plays a factor in the persistent upwelling in this region. The Mississippi River and the Loop Current and associated eddies interact in this area leading to mixing (Kendall and Schroeder 2000), which can in turn lead to elevated productivity. The variation in bottom features of the Canyon itself likely has a significant effect on the biological processes in the area (Schroeder and Woods 2000). Despite the uniqueness of the De Soto Canyon area, it is largely unknown why Rice's whales congregate in this area. Areas of seasonal upwelling are also known to occur along the slope of the western and central GOMx (Zavala-Hidalgo et al. 2006); it is uncertain whether other areas of upwelling may be important to Rice's whales.

A more thorough evaluation of existing data describing the physical and biological oceanography in the De Soto Canyon and core habitat area should have been performed to determine what characteristics make this area unique and result in it being the only location where Rice's whales are consistently present. The oceanographic features most associated with Rice's whale sightings in this area (water depths 100–400 m, seafloor water temperatures 10–19 °C and intermediate Chlorophyll-*a* concentrations, as determined by the habitat-based density model selection process (Garrison et al. 2023)) are not necessarily what make this area unique. That combination of oceanographic features are present along the shelf break throughout much of the GOMx. Therefore, the habitat-based density model predicts Rice's whales are present in all of those other areas, even though what makes the De Soto Canyon and core habitat area uniquely suitable to the Rice's whale may not actually be present in those locations.

4.2.1 Attributes

NMFS (2023b) noted the following "attributes" of the single broad biological and physical feature used to define critical habitat: "(1) Sufficient density, quality, abundance, and accessibility of small demersal and vertically migrating prey species, including scombriformes, stomiiformes, myctophiformes, and myopsida; (2) Marine water with (i) elevated productivity, (ii) bottom temperatures of 10–19 degrees Celsius, and (iii) levels of pollutants that do not preclude or inhibit any demographic function; and (3) Sufficiently quiet conditions for normal use and occupancy, including intraspecific communication, navigation, and detection of prey, predators, and other threats." NMFS (2023b) notes that these attributes "support Rice's whales' ability to forage, develop, communicate, reproduce, rear calves, and migrate throughout the GOMx continental shelf and slope waters and influence the value of the feature to the conservation of the species".

The first attribute identifies likely prey species of Rice's Whale. Having sufficient prey available to sustain life history functions is certainly an essential part of potential critical habitat. However, it does not appear that an effort was made to identify where else in the GOMx, outside of the core habitat where the Kiszka et al. (2023) study occurred, these species may occur and whether that information could be used to better define where critical habitat is or may be located. Additional information regarding the distribution of the *A. bondi* species in the GOMx outside of the core habitat area can be found within the fishery-independent survey system (FINSS) (NMFS 2018b). A brief review of data from "fish" and "high opening" trawls from 1985–2006 and shrimp trawls from 1982–2022 in the FINSS for the presence of *A. bondi* in the GOMx shows that *A. bondi* primarily occurs near the shelf edge (Figure 7), but also in water depths <100 m where no Rice's whales have been observed (NMFS 2018b). Using a catch-per-unit-effort (CPUE) metric, *A. bondi* is not uniformly distributed within shelf and slope waters of the GOMx, but tends to occur in high densities in a few locations (Figure 8). The FINSS data and other fisheries information were available when assessing Rice's whale habitat requirements and should have been thoroughly evaluated and used to define specific biological and physical oceanographic features necessary for Rice's whale prey species.

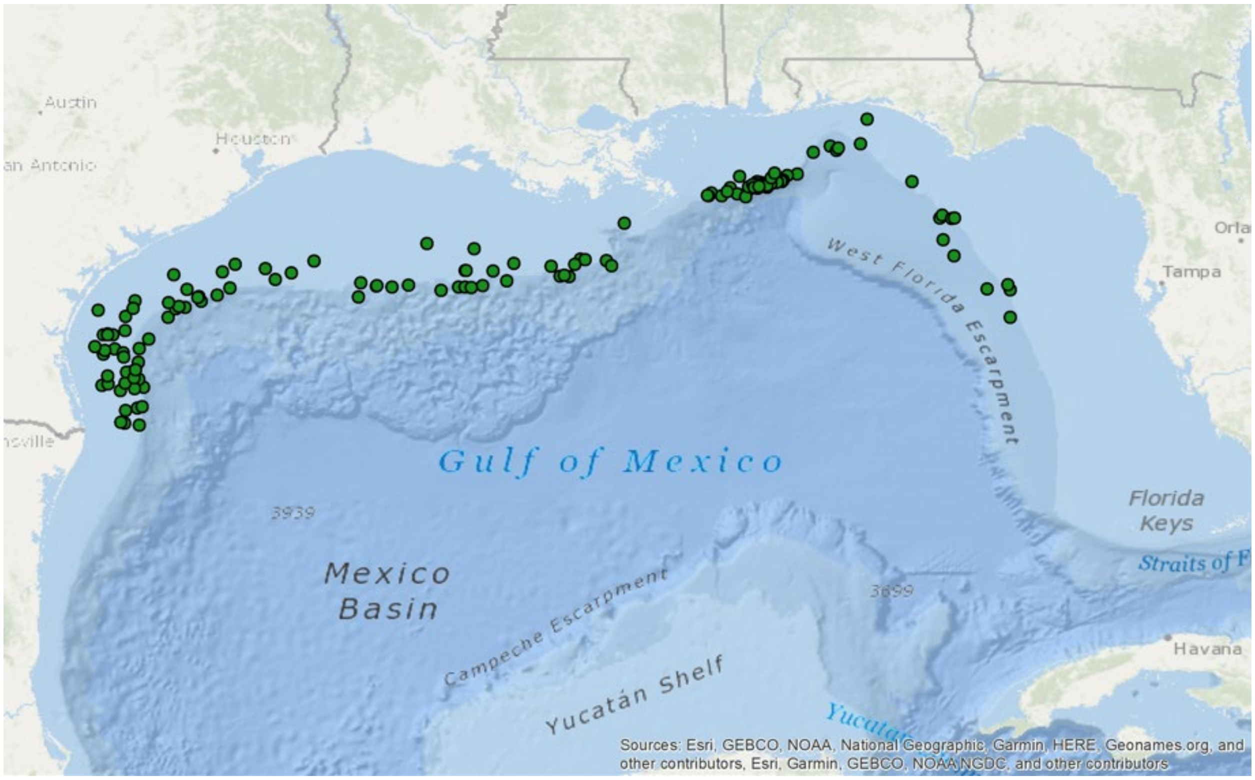

Figure 7. Map showing the location of all "fish", "high opening" and shrimp trawl samples in which *A. bondi* were present in the fishery-independent survey system database.

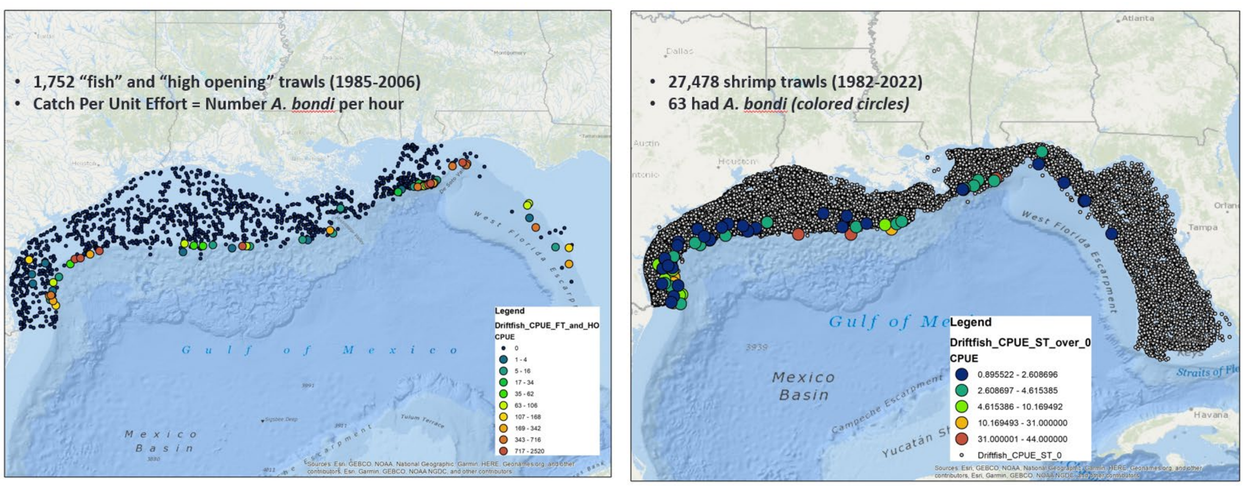

Figure 8. Map showing the catch per unit effort (number of *A. bondi* per hour) from fishery-independent survey "fish" and "high opening" trawls (left panel) and shrimp trawls (right panel).

The second attribute identifies marine waters with a specific range of seafloor water temperatures and elevated productivity that have low levels of pollutants. The reasoning behind the identification of these specific parameters is not explained in NMFS (2023b). We assume that these parameters are somehow related to where Rice's whale prey species occur or what those species require, but a rationale or evidence for this is not clearly presented in NMFS (2023b). According to NMFS (2023b) and Farmer et al. (2022), habitat-based density modeling identified surface chlorophyll-a concentration, water depth, and bottom temperature as the primary factors that predict Rice's whale habitat. Farmer et al. (2022) references Garrison (2021) regarding oceanographic characteristics of the core habitat, but that document does not appear to be publicly available. The modeling results presented in Garrison et al. (2023) and Rappucci et al. (2023) do show that Rice's whale detections are most associated with waters 100–400 m deep with bottom temperatures of 10-19°C and intermediate surface chlorophyll-a concentrations. Farmer et al. (2022) also noted that the core habitat area is characterized by (1) seasonal advection of low salinity, high productivity surface waters, leading to persistent upwelling driven by wind and intrusion of the Loop current, and (2) mixing of coastal and deep oceanic waters. These additional features noted by Farmer et al. (2022) were not present in the final habitat-based density model selected by Garrison et al. (2023). Therefore, the predictions of that model are limited to the few oceanographic variables that are not very unique to the De Soto Canyon and core habitat areas. Thus, the habitat-based density model may not represent the unique oceanographic characteristics of Rice's whale habitat area and therefore over-predict the occurrence of Rice's whales outside of the core habitat.

The third attribute relates to sufficiently quiet conditions for normal use and occupancy. However, no definition is provided for what is considered 'sufficiently quiet conditions' for Rice's whale or what is meant by 'normal use and occupancy'. NMFS (2023b) notes that Rice's whales rely on their ability to produce and receive sound within their environment to navigate, communicate, and detect prey and predators"; however, no sound threshold levels specific to Rice's whales are available to examine what levels may interfere with communication, navigation, or detection of prey or threats. NMFS (2023b) also noted that Rice's whale foraging strategy "is adapted to the waters near the continental shelf and slope of the Gulf of Mexico", and that Rice's whale may use acoustic cues to find prey near the seafloor where light levels are diminished; however, there have been no directed studies to test the hypothesis that baleen whales use acoustic cues to find prey. Thus, there is no evidence to support that sound plays a role in foraging for Rice's whales.

4.2.2 Specific Areas as Critical Habitat

NMFS is required to "determine the specific areas within the geographical area occupied by the species that contain the physical or biological features essential to the conservation of the species." 50 CFR 424.12(b)(1)(iii). According to NMFS (2023b), the geographical area occupied by Rice's whale is the GOMx and the specific area is the shelf/slope between the 100-m and 400-m isobaths. However, the entire GOMx is not occupied by Rice's whale. Based on the available data, the shelf/slope area between the 100-400 m isobaths shows high occurrence in some areas (e.g., the core area) and little or no occurrence in other areas (see Section 5.1 above). There have been no records of Rice's whales in the northcentral GOMx (shelf/slope waters between the core habitat and east of 91°W) or in the shelf/slope area south of approximately 26.9°N to the edge of the U.S. EEZ (Figure 3). Although there have been detections in the shelf/slope region west of 91°W, it is unknown whether this area has the physical or biological features essential to the conservation of Rice's whale.

The physical and biological features identified by NMFS (2023b) should allow for specific portions of the actual occupied habitat to be delineated. However, the one PBF (100–400 m water depths that support Rice's whales) is so broadly defined that it is indistinguishable from any potentially occupied habitat. The attributes associated with the PBF are similarly broad or undefined. There is no measure of productivity given to define areas of "elevated" productivity or levels of pollutants that could be harmful and no sound level is provided to assess what is considered quiet enough for "normal use and occupancy".

The only part of an attribute for which a quantitative value is given, bottom water temperature 10–19 °C, is highly correlated with the 100–400 m water depth PBF definition, providing little further information about specific areas that are critical. As a result, the PBF and attribute definitions do not allow for specific areas to be identified and the only remaining option is to identify where Rice's whales are most often observed, which is in the core habitat in the northeastern GOMx.

5 Summary

The proposed critical habitat has been deemed, by NMFS, to have the essential physical and biological features needed for the Rice's whale to feed, breed, and reproduce. However, direct evidence for what oceanographic features within the 100-400 m isobath band identified by NMFS are required to sustain the Rice's whale is lacking, and the extent of those truly important features elsewhere in the GOMx is uncertain and may not reach into the central or northwestern GOMx as predicted by the habitat-based density model (Garrison et al. 2023). Even though there is evidence to support the possible occurrence of Rice's whale near the FGBNMS in the northwestern GOMx, there are no data that show this area is being used to support important life history functions such as breeding, feeding, or migrating. Additionally, the sightings and acoustic detections that have been recorded there are much less frequent than those recorded for Rice's whale in the core habitat in the northeastern GOMx. Based on the limited data available on the use and occurrence of Rice's whale in the central and northwestern GOMx (one acoustic study (Soldevilla et al. 2022b), one confirmed sighting (NMFS 2018a) and a few unconfirmed sightings (Rosel et al. 2021)), there is insufficient scientific evidence to determine that essential features for Rice's whale conservation are indeed present in the central and northwestern GOMx. In fact, data on the life-history requirements of Rice's whale even in the core habitat are still lacking and need further investigation.

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EDUCATION

2004	Master of Science (***Fish and Wildlife Management***), Montana State University, Bozeman, MT
2000	Bachelor of Arts (***Biology***), Colby College, Waterville, ME

PROFESSIONAL EXPERIENCE

Senior Wildlife Biologist, VP – LGL **2005 – Present**

Project manager for permitting and monitoring projects related to Marine Mammal Protection Act (MMPA), National Environmental Protection Act (NEPA), and Endangered Species Act (ESA) compliance during offshore activities in Alaska, Gulf of Mexico, and Atlantic regions.

- Authored or co-authored more than 60 MMPA take authorization applications and supporting NEPA and ESA documents, including the calculation of marine mammal densities and the use of sound propagation and sound exposure modeling outputs for estimating potential take related to various activities such as high-resolution geophysical surveys, pile driving related to offshore wind foundations, 2D and 3D seismic surveys, geotechnical investigations, exploration drilling programs, as well as development projects.
- Developed and managed the implementation of multi-disciplinary monitoring plans to record and estimate potential impacts from industrial operations around permitted activities including the use of vessel-based observers, aerial surveys, unmanned aerial systems, static and towed passive acoustic recorders, and infrared camera systems.
- Worked closely with client management and planning teams to develop operational plans and monitoring programs to reduce and document potential impacts to marine mammals, subsistence users and other stakeholders.
- Directed Protected Species Observer (PSO) field operations including vessel and aerial survey programs involving over 60 observers simultaneous deployed across 20 vessels and aircraft as well as acoustic monitoring activities.
- Supervised and conducted daily reporting from monitoring programs to clients and regulatory agencies to meet multiple levels of reporting requirements with different notification timelines.
- Directed and conducted end-of-season data analysis and report writing to meet client's MMPA authorization requirements (90-day, annual, and comprehensive reports).
- Presented significant results at numerous scientific conferences.

Team lead for various technology development efforts associated with projects including the evaluation of fixed-wing unmanned aircraft for marine mammal surveys, automated software for the detection of marine mammals in aerial digital imagery, evaluation of infrared camera systems for the detection of marine mammals, and the development of observer data entry software to streamline collection, QA/QC and reporting procedures.

Graduate Research Assistant **2002 – 2004**

Developed methods for estimating the mass of adult female and pup Weddell seals in Antarctica from digital photographs. Tagged adult and pup Weddell seals as part of an ongoing population study. Assisted in the collection of blood and blubber samples and the application of time-depth recorders. Wrote annual progress reports and coordinated efforts in the field with other research teams studying Weddell seals.

**** Department of Ecology, Montana State University, Bozeman, Montana***

Graduate Teaching Assistant **Fall 2004**

Taught three laboratory sections of Introductory Biology to undergraduate students. Prepared brief lectures and introductory materials for weekly lab assignments and assisted students with the development of critical thinking skills integral to the scientific method, as well as experimental design, data collection and analysis, presentation, and report writing skills.

**** Department of Ecology, Montana State University, Bozeman, Montana***

Biological Science Technician **1999 – 2002**

Assisted with and supervised data collection including hair samples for DNA analysis using barbed wire hair snares, identification and measurement of bear tracks, aerial and ground radio telemetry of radio-collared animals, scat collection, and annual surveys of food abundance.

Assisted and supervised the locating, trapping, and handling of grizzly and black bears in and around Yellowstone N.P. Conducted roadside crowd control and removed carcasses along roadsides. Analyzed data and created maps for the Fish and Wildlife Service during ESA consultations concerning effects of road building on grizzly bear habitat. Wrote a grant proposal and procured funding for a study of fire effects on grizzly bear vegetal foods. Designed, conducted, and wrote a biological assessment on the presence of Canada lynx along roads scheduled for re-construction.

**** Bear Management Office, Yellowstone National Park, Wyoming***

Field Technician **2000 – 2001**

Located mountain lions and wolves using radio telemetry from the ground as well as in small aircraft across the northern range of Yellowstone. Tracked mountain lions to study behavior and locate kills as well as interactions with wolves and elk. Investigated, performed necropsies, and collected samples from wolf and cougar kills which included elk, mule deer, and bighorn sheep. Conducted track surveys looking for other forest predators. Assisted with the capture and handling of kitten and adult mountain lions. Supervised and instructed co-workers on use of radio-telemetry equipment, winter backcountry survival and first aid.

**** Hornocker Wildlife Institute/Wildlife Conservation Society, Gardiner, Montana***

PUBLICATIONS

Rickard, M.E., K.S. Lomac-MacNair, **D.S. Ireland**, S.M. Leiter, M.D. Poster, A.M. Zoidis. 2022. Evidence of Large Whale Socio-Sexual Behavior in the New York Bight. Aquatic Mammals: 48(5) pg 401-417. DOI 10.1578/AM.48.5.2022.401.

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Ireland, D. W.R. Koski, T.A. Thomas, M. Jankowski, D.W. Funk, A.M. Macrander and C. Rea. 2008. Distribution and Relative abundance of cetaceans in the eastern Chukchi Sea in 2006 and 2007. Paper SC/60/BRG27 presented to the International Whaling Commission Scientific Committee, 2008. 11 pp.

Koksi, W.R., D.W. Funk, **D.S. Ireland**, C. Lyons, A.M. Macrander, and I. Voparil. 2008. Feeding by bowhead whales near an offshore seismic survey in the Beaufort Sea. Paper SC/60/E14 presented to the International Whaling Commission Scientific Committee, 2008. 14 pp.

Buck, G.B., **D. Ireland**, W.R. Koski, D.J. Sliwa, T. Allen, and C. Rushing. 2007. Strategies to improve UAS performance for marine mammal detection. Paper SC/59/E2 presented to the International Whaling Commission Scientific Committee, Anchorage, AK, May 2007. 15 pp.

Ireland, D., R. A. Garrott, J. Rotella, J. Banfield. 2006. Development and application of a mass-estimation method for Weddell seals. *Marine Mammal Science*. 22(2): 361-378.

Ireland, D. 2004. Mass estimation of Weddell seals through photogrammetry. M.S. Thesis. Montana State University. Bozeman, MT.

CONFERENCE PRESENTATIONS & POSTERS

Zoidis, A.M., K. Lomac-MacNair, **D. Ireland**, M. Rickard. 2020. Large whale distribution and density in the New York Bight from monthly aerial surveys (2017-2020). (Poster) Society for Marine Mammalogy Biennial Conference. December 2021, Palm Beach, Florida.

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Brandon, J.R., T. Thomas, S. Blackwell, W.R. Koski, **D.S. Ireland**, C. Reiser, M. Bourdon, D.W. Funk, A.M. Macrander. 2012. Ice, seismic activity and the 2010 fall migration of bowheads through Harrison Bay in the central Beaufort Sea. (Poster) Alaska Marine Science Symposium, Jan. 2012. Anchorage, Alaska.

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Christie, K., C. Lyons, W.R. Koski, **D.S. Ireland**, and D.W. Funk. Patterns of bowhead whale occurrence and distribution during marine seismic operations in the Alaskan Beaufort Seas. (Poster) Society for Marine Mammalogy Biennial Conference, Oct. 2009. Quebec City, Canada.

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Ireland, D.S., L. Bisson, S.B. Blackwell, M. Austin, D.E. Hannay, K. Bröker, A.M. Macrander (eds.). 2016. Comprehensive Report of Marine Mammal Monitoring and Mitigation in the Chukchi and Beaufort Seas, 2006–2015. LGL Alaska Report P1363-E. Report from LGL Alaska Research Associates, Inc., Greeneridge Sciences, Inc., and JASCO Applied Sciences Ltd., for Shell Gulf of Mexico, Inc. and National Marine Fisheries Service, U.S. Fish and Wildlife Service. 558 p. plus Appendices.

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LGL Alaska Research Associates, Inc., Anchorage, AK, LGL Ltd., environmental research associates, King City, Ont., JASCO Research, Ltd., Victoria, BC, and Greeneridge Sciences, Inc., Santa Barbara, CA, for Shell Offshore, Inc., Anchorage, AK, ConocoPhillips Alaska, Inc., Anchorage, AK, and the National Marine Fisheries Service, Silver Springs, MD, and the U.S. Fish and Wildlife Service, Anchorage, AK. 485 p. plus Appendices.

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Ireland, D., D. Hannay, R. Rodrigues, H. Patterson, B. Haley, A. Hunter, M. Jankowski, and D. W. Funk. 2007. Marine mammal monitoring and mitigation during open water seismic exploration by GX Technology in the Chukchi Sea, October—November 2006: 90-day report. LGL Draft Rep. P891-1. Rep. from LGL Alaska Research Associates Inc., Anchorage, AK, LGL Ltd., King City, Ont., and JASCO Research, Ltd., Victoria, B.S., Can. for GX Technology, Houston, TX, and Nat. Mar. Fish. Serv., Silver Spring, MD. 118 p.

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