A petition to list the Gulf of Mexico Bryde's whale (*Balaenoptera edeni*) as endangered under the Endangered Species Act

Photo credit: NOAA's Southeast Fisheries Science Center

September 18, 2014

Acknowledgments

Michael Jasny, Sylvia Fallon, and Giulia Good Stefani (all of NRDC), and Brendan Hurley (Department of Geography and Geoinformation Science, George Mason University) and Andrew J. Wright (Department of Environmental Science and Policy, George Mason University) contributed to the drafting of portions of this petition. Rebecca Riley and Andrew Wetzler provided valuable consultation and review.

The cover photo appears courtesy of NOAA's Southeast Fisheries Science Center.

Notice of Petition

The Natural Resources Defense Council ("NRDC") hereby petitions the Secretary of Commerce, through the National Marine Fisheries Service ("NMFS"), to list the Gulf of Mexico population of Bryde's whales (*Balaenoptera edeni*) as an endangered species and designate critical habitat to ensure its recovery pursuant to Section 4(b) of the Endangered Species Act ("ESA"), 16 U.S.C. § 1533(b), section 553(3) of the Administrative Procedure Act, 5 U.S.C. § 533(e), and 50 C.F.R. § 424.14(a).

NRDC is a national not-for-profit conservation organization with approximately 1.4 million members and activists. One of NRDC's organizational goals is to further the ESA's purpose by preserving our national biodiversity. NRDC's members have a direct interest in ensuring the survival and recovery of Gulf of Mexico Bryde's whales and in conserving the natural communities on which they rely and which they benefit.

NMFS has jurisdiction over this Petition. This Petition sets in motion a specific process, requiring NMFS to make an initial finding as to whether the Petition "presents substantial scientific or commercial information indicating that the petitioned action may be warranted." 16 U.S.C. § 1533 (b)(3)(A). NMFS must make this initial finding "(t)o the maximum extent practicable, within 90 days after receiving the petition." *Id*. A petitioner need not demonstrate that listing is warranted, but rather present information demonstrating that such a listing *may* be warranted. While NRDC believes that the best available science demonstrates that listing the Gulf of Mexico Bryde's whales as endangered is in fact warranted, the available information clearly indicates that listing the species may be warranted. As such, NMFS must promptly make a positive finding on the Petition and commence a status review as required by 16 U.S.C. § 1533 (b)(3)(B).

Respectfully submitted this 18th day of September, 2014.

Sylvia Fallon, Ph.D.
Director, Wildlife Conservation
Natural Resources Defense Council
1152 Fifteenth Street, N.W.
Washington, DC 20005
Tel: 202 289-6868
Fax: 202 289-1060
sfallon@nrdc.org

Michael Jasny
Director, Marine Mammal Protection
Natural Resources Defense Council
1314 Second Street
Santa Monica, CA 90401
Tel: 310-434-2300
Fax: 310-434-2399
mjasny@nrdc.org

Executive Summary

The Bryde's whale (*Balaenoptera edeni*), a marine mammal found in warm waters of the Atlantic, Pacific, and Indian Oceans, exists in the Gulf of Mexico as a small, resident population. It is the only baleen whale known to be resident to the Gulf. Recent abundance estimates put the population's size at fewer than 50 animals, and they are severely restricted in range, being found only in the northeastern Gulf, more specifically in the waters of the DeSoto Canyon.

A recent study from NMFS' Southeast Fisheries Science Center (Rosel and Wilcox, 2014) evaluated genetic diversity and phylogenetic distinctiveness of this population to determine how unique it is in comparison to other Bryde's whales worldwide. The study found that the Gulf of Mexico Bryde's whale population has little genetic diversity, suggesting a small population size and a history of isolation; and that the population is evolutionarily distinct from all other Bryde's whales examined to date. The scientists conclude that the level of divergence suggests a unique evolutionary lineage for this population that is equivalent to currently recognized subspecies and species within the Bryde's complex, and among species and subspecies of certain other baleen whales. The small population in the Gulf of Mexico, which is also morphologically and behaviorally distinct from others in the complex, constitutes the only known members of this unique lineage.

Unfortunately, the population faces a suite of potential threats in the Gulf's industrialized waters. These include mortality and serious injury from vessel collision, acoustic impacts from intensive oil and gas exploration and commercial shipping, bioaccumulation of persistent organic pollutants, and the long-term effects of the *Deepwater Horizon* spill. These threats—which are already profound—may intensify further with increased shipping traffic and new oil and gas leasing in the northern Gulf. The population's extremely small abundance, its low genetic diversity, its apparently limited range, and its exposure to numerous anthropogenic threats leave it highly vulnerable to extinction.

The Gulf of Mexico Bryde's whale qualifies as a distinct population segment and, given its vulnerability, must be listed as an endangered species under the Endangered Species Act.

Table of Contents

I. Systematics and natural history of the Gulf of Mexico Bryde's whale (*Balaenoptera edeni*)

A. Species description

Bryde's whales (*Balaenoptera edeni*) are a baleen whale, more specifically a rorqual, belonging to the same group as blue whales and humpback whales. They are distributed around the tropical waters of the world between 40°N and 40°S, or in waters warmer than 16.3°C (Kato, 2002). Bryde's whales are represented by two subspecies, *B. e. edeni* and *B. e. brydei*. The generally larger form, *B. e. brydei* or "ordinary Bryde's whale," is found in temperate and tropical waters within the Atlantic, Pacific, and Indian Oceans, with a somewhat smaller inshore group found in coastal South Africa; the smaller form, *B. e. edeni*, has been found only in the Western Pacific, in waters off Asia and possibly Australia. Two other species, the sei whale (*Balaenoptera borealis*) and the Omura's whale (*B. omurai*) are closely related to Bryde's whales and often considered part of the Bryde's whale "complex" (Wada et al., 2003; Sasaki et al., 2006). Here we use the term Bryde's whales to refer to *B. edeni* and its subspecies.

Bryde's whales are generally found in a range of habitats and water depths; in the Gulf of Mexico, however, their distribution appears highly limited to a relatively small area off the Florida Panhandle. More specifically, they are found right along the shelf edge in DeSoto Canyon at depths between 100 and 1,000m (e.g., Mullin and Fulling, 2004; Širović et al., 2014).

B. Identifying characteristics

Like other rorquals, Bryde's whales have twin blowholes behind a protruding ridge and have two rows of baleen plates instead of teeth. Possibly the best descriptions of Bryde's whales can be found in Olsen (1913) and Best (1977). Although both descriptions are specifically for the animals around South Africa, Best (1977) noted that similar observations had been made for Bryde's whales elsewhere. These reports noted that Bryde's whales are dark smoky gray dorsally and usually white ventrally. They are also quite elongated, with a small, curved dorsal fin and slender and pointed flippers. These flippers are bluish-black dorsally, grey ventrally and can reach approximately 10% of the total length of the animal. The throat area is dark bluish-grey, with 42-54 ventral grooves or furrows that extend back at least as far as the umbilicus. They have around 280 relatively stiff baleen plates (ranging from 255 to 365) of up to 0.5 m in length on each side of the mouth. Each plate has very coarse bristles forming a "bush" at the top. A median groove extending from the umbilicus to the genital aperture is also typically present.

In general, the smaller form of Bryde's whale (*B. e. edeni*) rarely exceeds 11.5 m in body length, while the larger form (*B. e. brydei*) can reach 14-15 m in length (Rice, 1998). According to Best (1977), the "inshore" ecotype found off South Africa, at 13 and 14 m in length for males and females, respectively, are slightly smaller than others in the larger *brydei* form, including those found further offshore South Africa.

One additional difference, noted by Rice (1998), is the coloration of the baleen plates: grey in the larger form, and two-tone in the smaller. Finally, the Northeastern Pacific "pygmy Bryde's whale" (determined to be *B. omurai* by Wada et al., 2003) is reported to be distinguishable from *B.e. edeni* / *B.e. brydei*, as it has fewer (around 200) baleen plates, a process of maxilla that broadens towards its posterior end, and a larger number of grooves (estimated at 80-90) that extend behind the umbilicus (Wada et al., 2003).

Bryde's whales produce low-frequency tonal and swept calls that are similar to the calls of other balaenopterid species. Oleson et al. (2003) noted that the calls of Bryde's whales, like those of other mysticetes, may be useful in studying population structure as variations often appear geographically. The majority of calls from Bryde's whales have a fundamental frequency below 60 Hz, and all persist for 0.25 to several seconds and are produced in extended sequences (Oleson et al., 2003; Heimlich et al., 2005; McDonald, 2006). None of the calls reported from the Eastern Tropical Pacific or the southern Caribbean were produced by cow-calf pairs, or by lone juveniles. In contrast, Edds et al. (1993) reported a 'growl-like' pulsed moan produced by a 1-2 year-old juvenile taken into rehabilitation at SeaWorld following stranding in Florida, with energy in the 200-900 Hz range. However, it is unknown if these sounds are limited to younger animals, the result of influences of captivity (such as mimicry), or some other factor. Additionally, recent acoustic studies suggest that the Gulf of Mexico population may produce some more distinct sounds (Širović et al., 2014; Rice et al., 2014; see more details below).

C. Taxonomic classification

The Bryde's whales are in the Order Cetacea, Suborder Mysticeti, and Family Balaenopteridae. The Society for Marine Mammalogy's Committee on Taxonomy, recognizes two species within the Bryde's whale 'complex,' *B. edeni* and *B. omurai*, with two subspecies *in B. edeni:* the smaller form, *B. e. edeni*, and the larger form, *B. e. brydei* (Committee on Taxonomy, 2011; followed by Kershaw et al., 2013, and Rosel and Wilcox, 2014). Although not recognized by the Committee, the Sei whale groups closely with *B. edeni* and *B. omurai* and could also be considered part of this complex (Sasaki et al., 2006; Agnarson and May-Collado, 2008; McGowen and Gatesy, 2009).

Since the advent of stock assessment reports in 1995, NMFS has treated the Gulf of Mexico (GOMx) Bryde's population as a separate stock for management purposes (NMFS, 2012) based on various expert opinions (e.g., Mead, 1977; Schmidly, 1981; Leatherwood and Reeves 1983). New genetic information, discussed below, has allowed NMFS biologists to differentiate this population from other Atlantic Bryde's whales and indeed from all other known species and populations in the complex (Rosel and Wilcox, 2014). This differentiation suggests that GOMx Bryde's whales are as distinct as the currently recognized subspecies of Bryde's whales.

D. Life history

Relatively little is known of the life history of Bryde's whales. In both the inshore and offshore South African ecotypes, as reported by Best (1977), both males and females become sexually mature at around 12 m in length, which is between to 8 to 13 years of age for females. Bryde’s whales may mate year round, although the offshore South African form displays a slight autumnal peak. Pregnancy is assumed to last 12 months, in line with other balaenopterid species, and lactation is thought to be similar to that of the sei whale at six months to a year. Mothers typically give birth to a single calf of around 3.5 m in length and weighing around 1,000 kilograms. Successful breeding may only occur in alternate years, although a new conception may occur relatively quickly following the loss of a calf. The South African inshore Bryde's whale has a slower overall rate of growth and reaches a smaller maximum size than offshore whales, which may mean a lower rate of population growth (Best, 1977).

Bryde’s whales in the Gulf of California have typically been observed alone when travelling, but often gathered in small groups of fewer than ten animals when feeding (Tershy, 1992). Social behavior is not clear as observations during surface feeding in the Central Gulf of California suggest that individuals react independently to prey species (Tershy et al., 1993), while one double tag deployment off Madeira Island revealed synchronous diving (Alves et al., 2010).

E. Habitat

Animals from the Bryde’s whale complex are found around the world’s warmer waters between about 40°N and 40°S, or in waters warmer than 16.3°C (Kato, 2002), with winter migration towards the equator, as reported in the southeast Atlantic (Best, 1996) and the northwest Pacific (Kishiro, 1996) populations. Although they can be found in pelagic habitats (e.g., Wade and Gerrodette, 1993; and as indicated from whaling data: IWC, 2006), several sheltered and enclosed waters harbor regular if not resident populations, such as in the northern Gulf of California (Urbán-Ramirez and Flores, 1996) but not in the Mediterranean (Reeves and Notabartolo di Sciara, 2006). They are also commonly found, at least at certain times of the year, in some coastal areas, such as the coasts of Peru and Ecuador (Valdivia et al., 1981), Chile (in an area of upwelling: Gallardo et al., 1983) and the western coast of southern Africa (Best, 2001).

In the North Atlantic, Bryde’s whales are known to occur in the Gulf of Mexico (Mullin and Fulling, 2004) and throughout the wider Caribbean (Ward et al., 2001). On the U.S. Atlantic coast, they have been seen northwards to Cape Hatteras (see Rice, 1998), with one stranding reported as far north as the Chesapeake (Mead, 1977). They are also seen in the eastern North Atlantic, such as around Madeira Island (Alves et al., 2010).

With regard to the northern Gulf of Mexico, several records of strandings exist (e.g., Mead, 1977; Jefferson and Schiro, 1997), complementing the various sightings data provided by NMFS surveys (Mullin and Fulling, 2004; NMFS, 2012). These data sets are complimentary, highlighting a relatively small habitat range offshore in the area off the Florida Panhandle, with sightings only along the shelf edge near DeSoto Canyon at depths between 100 and 1,000m. The Canyon is an erosional valley that cuts through the broad continental shelf and creates an upwelling of deep nutrient-rich water that leads to more consistently high primary productivity. Recent acoustic data support the consistent presence of Bryde's whales in this area and their residency in the Gulf (Širović et al., 2014).

F. Prey

Bryde's whales around the world have been observed feeding at the surface, typically taking schooling fish such as sardines (clupeid: e.g., in Brazil, Siciliano et al., 2004). Alves et al. (2010) tagged two Bryde's whales off Madeira Island and found that they were lunge-feeding at depth while diving synchronously to depths up to nearly 300 m, with increasingly shallow dives around dusk and increasingly deep dives from around midnight to dawn (and with a period of shallow dives in between). A similar dawn and dusk feeding pattern was observed visually in the Gulf of California (Tershy, 1992). Alves et al. (2010) suggested that this was not unlike other *Balaenoptera* species, and that the whales were likely to be consuming zooplankton and following the deep scattering layer's diel migration.

While Bryde's whales in the Gulf of California primarily consume fish (mainly sardines) at the surface, they were observed also consuming krill and some crustaceans (Tershy, 1992; Tershy et al., 1993). Similarly, DNA from fecal samples of Bryde's whales in the Hauraki Gulf, New Zealand (Jarman et al., 2006), also indicate consumption of zooplankton, in this case, specifically krill and amphipods). In the Hauraki Gulf, however, ray-finned fish, not sardines, were also observed (Jarman et al., 2006). Best (1977) reported both sardines and ray-finned fish (in this case, anchovies) taken by Bryde's whales off South Africa. Finally, some individuals may exhibit preferences for one type of prey (e.g., fish over zooplankton), while others may be more flexible in response to changing food availability (see Niño-Torres et al., 2013).

II. The Gulf of Mexico Bryde's whale qualifies as a listable entity under the ESA

The ESA provides for the listing of all species that warrant the protections afforded by the Act. The term "species" is defined broadly under the act to include "any subspecies of fish or wildlife or plants and any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature." 16 U.S.C. § 1532(16).

NMFS and the U.S. Fish and Wildlife Service ("FWS") have published a policy to define a "distinct population segment" for the purposes of listing, delisting, and reclassifying species under the ESA. 61 FR 4722 (February 7, 1996). Under this policy, a population segment must be found to be both "discrete" and "significant" before it can be considered for listing under the Act. *Id.* The Gulf of Mexico Bryde's whale meets both of these criteria and thus is a distinct population segment under the ESA.

A. Discreteness

Under the joint NMFS/FWS policy, a population segment of a vertebrate species is considered discrete if it satisfies either of the following conditions:

1. It is markedly separated from other populations of the same taxon as a consequence of physical, physiological, ecological, or behavioral factors.

2. It is delimited by international governmental boundaries within which difference in control of exploitation, management of habitat, conservation status, or regulatory mechanisms exist that are significant in light of section 4(a)(1)(D) of the Act.

The Gulf of Mexico Bryde's whale satisfies the first criteria: it is markedly separated from other Bryde's whales by a number of distinct factors.

1. The Gulf of Mexico Bryde's whale is genetically distinct from other Bryde's whales

Recent genetic data indicates that Gulf of Mexico (GOMx) Bryde's whales are genetically distinct and demographically independent from other Bryde's whales (Rosel and Wilcox, 2014). Scientists from the National Marine Fisheries Service recently examined 21 DNA samples from Bryde's whales collected in the Gulf of Mexico and 2 from the western North Atlantic. Their findings, which looked at 3 mitochondrial DNA genes, 9 nuclear genes, and 42 microsatellite loci, revealed low genetic diversity at all of the molecular markers. This low level of genetic diversity suggests that the population of whales has been genetically and demographically isolated for a long period of time.

Furthermore, when Rosel and Wilcox (2014) compared the mitochondrial sequences to all other available published Bryde's whale sequences they found that Bryde's whales in the Gulf of Mexico are evolutionarily distinct from all other members of the Bryde's whale complex examined to date. Specifically, the authors report 9.6 and 13% corrected sequence divergence between GOMx Bryde's whales and *B. e. edeni* and *B. e. brydei* samples, respectively. These values are on the order of the estimated difference of 9.9% between the two recognized subspecies (Rosel and Wilcox, 2014). In fact, Penry (2010) report 1.9-2.3% (uncorrected) sequence divergence between *B. e. brydei* from South Africa and *B. e. edeni* from Japan and Singapore, underscoring just how divergent the GOMx Bryde's whales are compared to some measurements between the other two recognized subspecies. Additionally, GOMx Bryde's whales are more differentiated from *B. e. edeni* and *B. e. brydei* than the Sei whale is at 9.3% and 7.8%, respectively (Rosel and Wilcox, 2014, Table 2). Furthermore, Rosel and Wilcox (2014) report that the level of divergence seen between GOMx Bryde's whales and other Bryde's whales far exceeds the level of divergence described between subspecies and species of right and fin whales (Rosel and Wilcox, 2014 and references therein).

GOMx Bryde's whales are clearly genetically distinct from other Bryde's whales. In fact, GOMx Bryde's whales are as evolutionarily distinct as currently recognized subspecies and species within the Bryde's whale complex. As a result, Rosel and Wilcox (2014) conclude that GOMx Bryde's whales "may warrant species or subspecies status" (p. 32).

2. The Gulf of Mexico Bryde's whale is morphologically, behaviorally and otherwise unique from other Bryde's whales

Rosel and Wilcox (2014) also report that GOMx Bryde's whales appear to demonstrate a unique size to other Bryde's whales. *B. e. edeni* is the smaller form that rarely exceeds 11.5 m in body length, while *B. e. brydei* reaches sexual maturity at body lengths of 11.2-11.7 m, with some individuals attaining 14-15 m in length. Of the GOMx Bryde's whales that have been measured, Rosel and Wilcox report several within the range of 11.2-11.6 m with the largest whale measuring 12.65 m, suggesting that GOMx Bryde's whales may be intermediate in size to the other subspecies (Rosel and Wilcox, 2014).

Additionally, recent evidence indicates acoustic behavior that appears unique to the Gulf of Mexico population. In general, Bryde's whales produce a range of low-frequency calls, including a call type labeled by Oleson et al. (2003) as Be6. This call is slightly higher in frequency than most others, being a roughly 0.5 second downsweep from 208 Hz to 76 Hz; it is typically produced in a series of 3 or 4 sweeps, which is then repeated after an interval of 18 seconds. Two recent studies, however, have reported a variant of this Be6 downsweep, termed Be9 by Širović et al. (2014), that appears unique to Bryde's whales from the Gulf of Mexico. These Be9 calls begin at frequencies of 110-143 Hz and drop down to 51-85 over 0.3 to 0.7 seconds (Širović et al., 2014; Rice et al., 2014). The calls are typically repeated 8-9 times, but can be produced in chains of "pulses" of any number from 2 to 27, and occasionally only a single pulse was recorded (Širović et al., 2014; Rice et al., 2014).

Furthermore, Rice et al. (2014) also reported tonal signals in the Gulf of Mexico that had not been previously described for Bryde's whales. This 'long moan' is also a variant of a downsweep, but over a much longer (approximately 22-second) period. After a sharp frequency rise, it falls from a maximum frequency of about 150 Hz to a frequency of about 103 Hz, and can then be followed by a series of shorter (around 5-second) tonals at the 103 Hz level.

Confirmation through associated visual observations make it extremely likely that the Be9 call type is indeed produced by Bryde's whales (Širović et al., 2014). The 'long moan' documented by Rice et al. (2014) is attributed to Bryde's whales based on proximity to the Gulf of Mexico population, the prevalence of the call type in the record, and the fact that the Bryde's whale is the only resident mysticete in the Gulf of Mexico. These calls are indicative of an acoustic culture unique to the Gulf of Mexico Bryde's whale.

3. The Gulf of Mexico Bryde's whale is resident to the Gulf of Mexico and appears geographically isolated from other Bryde's whales

Based on information from stranded animals, Mead (1977) suggested that "B. edeni may be resident in [the Gulf of Mexico and the Caribbean] and the strandings of this species along the Atlantic coast may represent strays." Other scientists have also come to the conclusion that the northern Gulf of Mexico population represents a distinct resident population (e.g., Schmidly 1981; Leatherwood and Reeves, 1983), leading NMFS to provisionally treat them as such for management purposes (NMFS, 2012) pending additional information such as that presented here.

Virtually all reported sightings of Bryde's whales, made during several series of springtime abundance surveys in the northern Gulf, have occurred within the northern part of the DeSoto Canyon, suggesting a highly limited range (Mullin and Fulling, 2004; Maze-Foley and Mullin, 2006; NMFS, 2012). Similarly, passive acoustic surveys using towed hydrophone arrays and fixed High-frequency Acoustic Recording Packages detected beaked whales only within the DeSoto Canyon, despite commensurate effort in other locations in the Central and Eastern Gulf (Širović et al., 2014). With the closest other Bryde's whale population observed outside the Gulf, in the Caribbean (e.g., Mead, 1977; Notarbartolo di Sciara, 1983), this population appears to be geographically isolated.

Recent genetic data confirms the isolation of the GOMx Bryde's whales. Rosel and Wilcox (2014) report that, "based on whales sampled in the South Atlantic off Africa (Pendry 2010) and whales examined from Brazil (de Moura & Siciliano 2012), Curacao (Soot-Ryen 1961) and Aruba (Lukesenburg 2012) we can say that [the geographic distribution of the GOMx Bryde's whale population] likely does not reach that far" (p. 32). The two individuals that stranded on the Atlantic coast were genetically related to the GOMx Bryde's whales, which could indicate a distribution beyond the GOMx; however, the low levels of genetic diversity for this population suggest a small, isolated population rather than a broad, wide-ranging one. Therefore, it is likely that these two samples represent individuals that strayed from the GOMx, as hypothesized by Mead (1977).

Additionally, although sampling may be incomplete, all other Bryde's whales in the Atlantic that have been genetically typed belong to the *B. e. brydei* subspecies (Rosel and Wilcox, 2014). Yet GOMx Bryde's whales appear more closely related to *B. e. edeni*, suggesting that the geographically nearest Bryde's whales are not even the closest relatives of the GOMx Bryde's whales (see Fig. 4, pg.30).

4. The Gulf of Mexico Bryde's whale constitutes a stock under the Marine Mammal Protection Act

The Gulf of Mexico Bryde's whales are provisionally classified as a "stock" in the latest Stock Assessment Reports that NMFS has prepared pursuant to the Marine Mammal Protection Act, 16 U.S.C. § 1386. In classifying stocks, NMFS generally follows the phylogeographic approach of Dizon et al. (1992), which involves a four-part analysis of (1) distributional data, (2) population response data, (3) phenotypic data, and (4) genotypic data. While stock determinations under the Marine Mammal Protection Act differ from distinct population segment ("DPS") analysis under the NMFS/USFWS policy, the classification of Gulf of Mexico Bryde's whales as a stock supports the finding that the population is a distinct population segment under the ESA.

B. Significance

According to the listing policy, once a population is established as discrete, its biological and ecological significance are considered. This consideration may include, but is not limited to, the following:

1. Persistence of the discrete population segment in an ecological setting unusual or unique to this taxon;
2. Evidence that loss of the discrete population would result in a significant gap in the range of a taxon;
3. Evidence that the discrete population segment represents the only surviving natural occurrence of a taxon that may be more abundant elsewhere as an introduced population outside its historical range; and
4. Evidence that the discrete population segment differs markedly from other populations of the species in its genetic characteristics.

The Gulf of Mexico Bryde's whale meets at least one of the expressed significance criteria, as well as other criteria that highlight the significance of the population.

1. The Gulf of Mexico Bryde's whale differs markedly from other populations of the species in its genetic characteristics

As discussed above, a recent genetic study found that the Gulf of Mexico Bryde's whale is uniquely identifiable by its mitochondrial haplotypes from other Bryde's whales sampled throughout the rest of the world (Rosel and Wilcox, 2014). Rosel and Wilcox (2014) compared portions of the mitochondrial DNA of Bryde's whales in the GOMx to every other published sequence of Bryde's whales (*B. e. edeni* and *B. e. brydei*) as well as Sei whales (*B. borealis*), Omura's whale (*B. omurai*) and other baleen species of whale. Phylogenetic analysis revealed that GOMx Bryde's whales form a distinct evolutionary clade. They were most closely related to *B. e. edeni* whales, but differed from them by 9.6% sequence divergence. The level of differentiation between GOMx Bryde's whales and other whales was equal to or greater than other recognized subspecies of whales.

The GOMx Bryde's whales are on such a distinct evolutionary trajectory that Rosel and Wilcox (2014) argue they "may also warrant species or subspecies status" (pg. 32). In addition to being significantly differentiated from the two other subspecies of Bryde's whales, Rosel and Wilcox (2014) point out that GOMx Bryde's whales are more differentiated than are other recognized subspecies of fin whales and recognized species of right whales. If they were to be recognized as their own species or subspecies GOMx Bryde's whales would become "one of the most endangered of the baleen whales" (Rosel and Wilcox, 2014, pg. 32).

The level of differentiation shown by GOMx Bryde's whales makes clear that not only do they differ markedly from other populations of Bryde's whales, but they do so in a way that is evolutionarily significant.

2. The Gulf of Mexico Bryde's whale is behaviorally and morphologically different from other Bryde's whale populations

As discussed above, recordings of calls unique to the Bryde's whales in the Gulf of Mexico have recently been reported (Širović et al., 2014; Rice et al., 2014). These include a low-frequency downsweep, labeled Be9, that differs markedly in frequency and repetitive structure from variants heard in other Bryde's whale populations (Širović et al., 2014; Rice et al., 2014), and also, potentially, a "long moan" that involves a sharp rise and gradual downsweep, sometimes followed by a series of tonal calls (Rice et al., 2014). These divergences from the vocal behavior of other whales in the Bryde's complex suggest the presence, in the Gulf population, of a unique acoustic culture. Additionally, measured body lengths of GOMx Bryde's whales appear to fall between those of the smaller *edeni* and larger *brydei* forms, suggesting that the Gulf population may be intermediate in size to the two subspecies (Rosel and Wilcox, 2014).

3. The Gulf of Mexico Bryde's whale is the region's only resident baleen whale population

Rorqual whales (*Balaenoptera spp*.) are generally uncommon in the Gulf, as are mysticetes in general (see Schmidly, 1981; Jefferson and Schiro, 1997; Maze-Foley and Mullin, 2006). Despite their very small population size, the Bryde's whales are the most commonly detected mysticete in the Gulf of Mexico, and they are thought to be the only resident baleen whale species (see Schmidly, 1981; Jefferson and Schiro, 1997; Maze-Foley and Mullin, 2006), as discussed above. Accordingly, this species fills a unique ecological niche in the region. This point was further emphasized recently by Rosel and Wilcox 2014, who concluded that "Bryde's whales are the only known resident baleen whale species in the northern GOMx, and hence they are a unique component of the biodiversity in this ecosystem" (pg. 31).

III. Abundance and population trends in the Gulf of Mexico Bryde's whale

NMFS (2012) estimates the abundance of the Gulf of Mexico Bryde's whales to be 33 (CV = 1.07) based on a 2009 survey (with a maximum best estimate from 1996-2001 of 40 animals; CV = 0.61). The small population size and general lack of data (with associated large confidence intervals) precludes the establishment of a trend in abundance for the Gulf of Mexico Bryde's whale (see NMFS, 2012). However, and as discussed further below, restricted ranges and small population sizes together with a high degree of habitat specialization have been linked to increased vulnerability to extinction from stochastic, demographic and environmental processes (see Lande et al., 2003). The IUCN acknowledges this, stating that a "population size estimated to number fewer than 50 mature individuals" is alone enough to justify designation in the IUCN Red List as critically endangered (IUCN, 2012).

Although historical abundance measures are not available for GOMx Bryde's whales, there is some indication that they previously had a wider geographic range than they currently do, suggesting that they have undergone a range contraction. Specifically, Reeves et al. (2011) reviewed historical whaling logbooks from the Gulf of Mexico and found multiple records of "finbacks," or *Balaenoptera*. Reeves et al. (2011) report, "The consensus among scientists working in the Gulf of Mexico (as well as the Caribbean Sea) is that Bryde's whales are the most common *Balaenoptera* whales in the region…. Reports of finbacks in the logbooks examined for this study suggest a much broader distribution, at least historically, encompassing much of the north-central and southern Gulf" (pg. 51). Rosel and Wilcox (2014) examined these findings and further reported, "the most notable difference in distribution lies in shelf waters south and west of the Mississippi River Delta, of which logbooks contain numerous records" (pg. 31). While precise species identification of the "finbacks" identified in these logbooks is not possible, multiple experts have concluded that historical data suggest the GOMx Bryde's whales once had a much larger distribution in the region.

IV. The Gulf of Mexico Bryde's whale qualifies as endangered under ESA

The Endangered Species Act, 16 U.S.C. § 1531-1534, allows for the protection of any species of fish, wildlife, or plant. In the case of vertebrates, the Act also allows for the protection of distinct population segments. The Gulf of Mexico Bryde's whale meets the criteria of a distinct population segment and therefore qualifies as a "species" under the ESA. *See* 16 U.S.C. § 1531. Petitioners seek protection for the species throughout its range.

Under the ESA, a species must be listed if it is in danger of extinction or threatened by possible extinction in all or a significant portion of its range. 16 U.S.C. § 1533(a)(1). In making this determination, the agency must rely "solely on the best scientific and commercial data available" and analyze the species' status in light of five statutory listing factors:

1. the present or threatened destruction, modification, or curtailment of its habitat or range;
2. overutilization for commercial, recreational, scientific or educational purposes;
3. disease and predation;
4. the inadequacy of existing regulatory mechanisms; and
5. other natural or manmade factors affecting its continued existence.

16 U.S.C. §§ 1533(a)(1)(A)-(E); 50C.F.R. §§ 424.11(c)(1)-(5).

The Gulf of Mexico Bryde's whale is endangered by at least three of the five listing factors: present modification of its habitat, the inadequacy of existing regulatory mechanisms, and other natural or manmade factors.

A. Modification of habitat

1. Mortality and serious injury via ship strike

Ship strike remains one of the most troubling threats facing most marine mammals, including baleen whales. In response to ship strikes of the North Atlantic right whale, which are considered responsible for a roughly 2 percent annual loss in right whale recovery, NMFS issued in 2008, and recently renewed, a set of speed restriction regulations for the North Atlantic. 73 Fed. Reg. 60173; 78 Fed. Reg. 73726. With certain exceptions, vessels greater than 65ft in length were restricted to speeds of ten knots or less in strategic areas, i.e., areas where right whales and ships were likely to interact. These areas fall entirely outside the Gulf of Mexico and do not include any known habitat of the Bryde's whale population under consideration here.

In 2009, a Bryde's whale was struck by a ship near Tampa, Florida (Waring et al., 2013). (Eight additional Bryde's whales are known to have stranded along the U.S. coast of the Gulf of Mexico between 1975 and 1996, from unknown causes (Laist, 2001).) Given the likely abundance (Waring et al., 2013), the serious injury or mortality of a single animal would unquestionably be detrimental to the population's survival and recovery. For point of comparison, NMFS has stated that the loss of an individual North Atlantic right whale—with a population numbering in the low hundreds of animals—could contribute to species extinction, and proceeded to promulgate a vessel-speed regulation for the right whale on that basis. 69 Fed. Reg. 30,857, 30,858 (June 1, 2004); *see also* 73 Fed. Reg. 60,173, 60,173 (Oct. 10, 2008); 72 Fed. Reg. 34,632, 34,632 (June 25, 2007); 66 Fed. Reg. 50,390, 50,392 (Oct. 3, 2001).

Ship-strike risk may increase in the near future as, in 2015, construction on a third lane of the Panama Canal is projected to be completed. It is estimated that containerized tonnage moving through the Canal will increase at an average annual rate of approximately 5.6%, from 98 million Panama Canal net tons (PCUMS) in 2005 to nearly 296 million in 2025 (Panama Canal Authority, 2006), with an associated increase in the possibility of ship strike for all species of cetaceans. Rising traffic will also increase levels of operational substance (oil and other chemicals) leakage from vessels (see discussions of oil and contaminants below).

2. Presence of oil and dispersant from the *Deepwater Horizon* spill

The *Deepwater Horizon* drilling platform exploded and sank in April 2010, and precipitating the largest oil spill in U.S. history. An estimated 4.9 million barrels of oil gushed out of the wellhead and into the Gulf of Mexico (U.S. Coast Guard, 2011). The response to the spill included extensive use of surface and benthic dispersants, in-situ burning of oil, skimming, and containment booms. Oil itself can interfere with the filtering abilities of baleen whales (Engelhardt, 1983), and while there is limited literature on the effects of oil on marine mammals, Garaci (1990) notes that external exposure of marine mammals to oil can cause skin irritation and chemical burns. Aerial surveys assessing the oil spill were flown, with NOAA researchers noting four marine mammal species swimming in the oil slick (NOAA, 2010). Peterson et al. (2003) noted long-term persistence of oil in the environment following the Exxon Valdez spill, which suggests that the spill zone in the Gulf of Mexico may be contaminated for decades.

During the cleanup, approximately 2,900,000 liters of dispersants were deployed in order to break up large oil slicks. Two dispersants were used more than others in the cleanup: Corexit 9527, for surface slicks, and Corexit 9500A, for both the wellhead and surface (Kujawinski, 2011). The benthic dispersant, Corexit 9500A, was found more than 300km from the wellhead after 64 days, at a depth of approximately 1100m (Kujawinski, 2011). Ladner and Hagstrom (1975) found that, for dispersant Corexit 7664, concentrations of between 950 and 10,000 milligram/liter could be toxic for fish, bivalves, and crustaceans when exposure times reach 96 hours. 75% of sampled toxicity thresholds for fish, mollusks, and crustaceans were above 1000ppm, though Wells (1984) notes that a suite of physiochemical factors influence toxicity in dispersants.

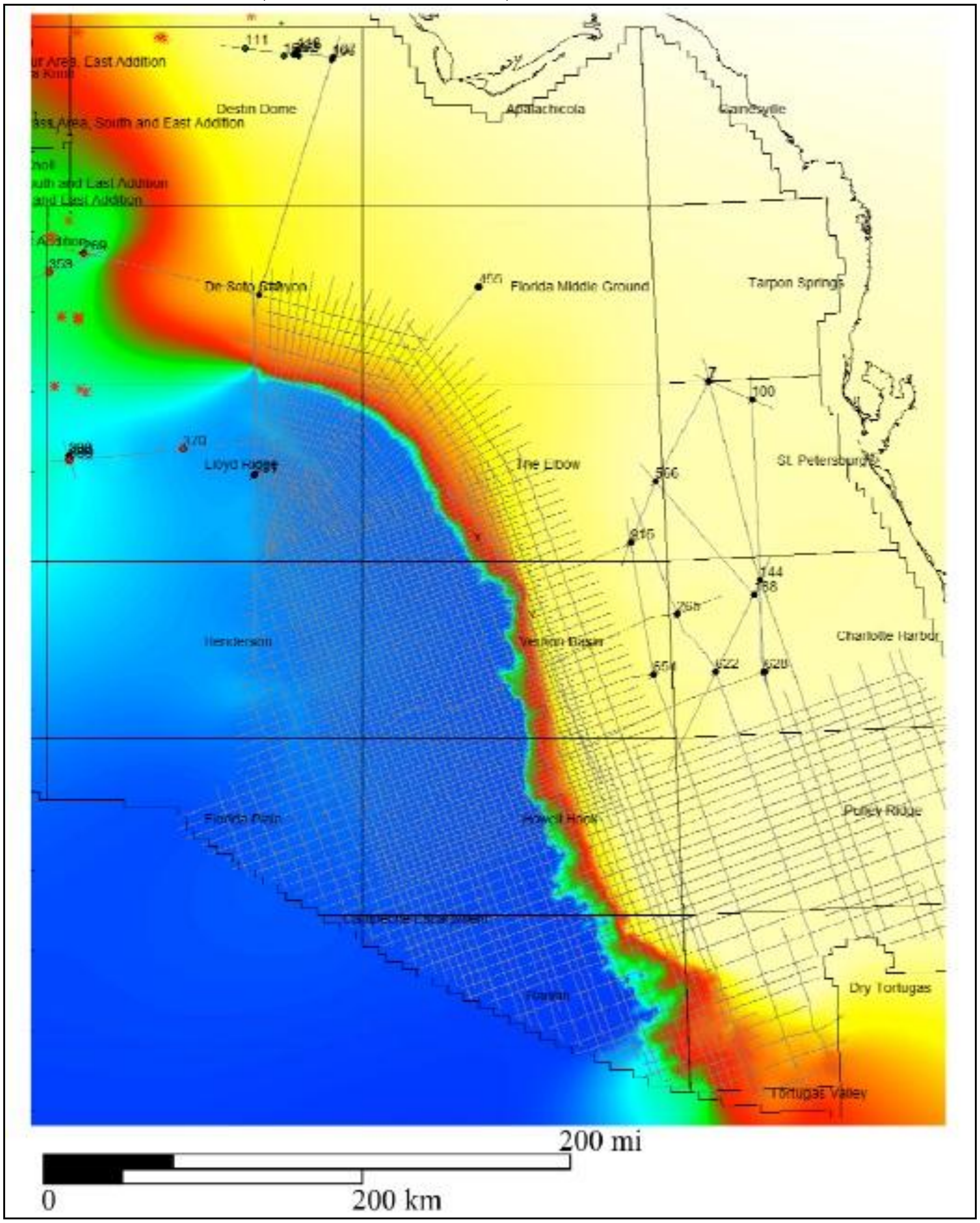
Additionally, Schwacke et al. (2013) sampled dolphins in Barataria Bay, an area that was inundated with oil from the *Deepwater Horizon* spill, and in Sarasota Bay, an area that was not. The dolphins sampled in Barataria Bay showed signs consistent with adrenal toxicity, and were 5 times more likely than the control sample in Sarasota to have moderate to severe lung disease.

DeSoto Canyon lies roughly adjacent to the Mississippi Canyon, where the blow-out occurred, and falls well within the radius of the spill (NOAA et al., 2014). Given their apparent fidelity to the DeSoto Canyon, including in the year following the blow-out (Širović et al., 2014), Bryde's whales are highly likely to have been exposed. Indeed, the one Bryde's whale sampled during a post-spill biopsy study showed levels of nickel and chromium—two genotoxic metals found in Macondo oil—consistent with those seen in Gulf sperm whales, some of which were sampled closer to the spill site; these levels were two to five times higher than the global mean for sperm whales (Wise et al. 2014). Bioaccumulation is an obvious concern. As noted below in the discussion of persistent organic pollutants, baleen whale calves appear particularly vulnerable to contaminant effects given efficient transplacental and lactational transfer from their mothers (Metcalfe et al., 2004).

3. Risk of injury and contamination from future oil spills

The Bureau of Ocean Energy Management estimates that the Eastern Gulf of Mexico has a possible yield of 3.88 billion barrels of oil (BBO) and 21.51 trillion cubic feet of gas (Humphries et al. 2010). To date, 64 oil wells have been drilled in the Eastern Gulf (Fig. 1), resulting in 7 commercial discoveries, all between 2010 and 2011, and BOEM intends to lease block 225 in 2014, and block 226 in 2016. It is expected that oil and gas exploration and extraction in the Eastern Gulf and elsewhere in the region will increase in coming years (BOEM 2014). The risks of exposure to spills from such activities, as (for example) discussed above, will rise accordingly.

Fig. 1: Seismic acquisition (grid lines) and drilling activity (points) in the Eastern Gulf of Mexico in June 2012 (from Bowman 2012).



4. Potential for increased levels of other toxic chemicals

Persistent Organic Pollutants ("POPs") are a family of organic molecules that have been present in the environment, both marine and terrestrial, for decades. POPs have been shown in several studies to have immunosuppressive effects (Houde et al., 2005; Jenssen, 2006; Schecter et al., 2012). Kucklick et al. (2011) found the presence of POPs in the blubber of bottlenose dolphins at every sampling location in the Gulf of Mexico. One

POP, Perfluorooctane sulfonate ("PFOS") is a perfluorinated molecule used in a wide variety of industrial and commercial products such as pesticides, packaging, semi-conductors, metal plating, fire extinguisher foams, and various cleaning products (EPA, 2012). PFOS is extremely persistent in the environment and can be transported long distances in air, and, as a result, has been discovered to affect marine mammals on a global level (Kannan et al., 2001). Kannan et al. (2001) additionally found PFOS in a majority of marine mammal samples (n=247) taken from various regions, including the Gulf of Mexico. Contaminant levels in the Gulf can be expected to be high given the heavy influx following Hurricane Rita and other recent major storms, as well as the *Deepwater Horizon* spill discussed above.

Bryde's whales are long-lived predators, making bioaccumulation of POPs and other pollutants a serious concern. While baleen whales have generally exhibited lower concentrations of persistent organic pollutants (POPs) than other cetaceans, contaminant loads in some baleen whale populations—particularly in areas with comparatively heavy industrial pollution, such as the Gulf of Maine—exceed levels known to cause immunosuppression and other dysfunction in other marine mammal species (Elfes et al., 2010; see also Aguilar et al., 2002; Metcalfe et al., 2004). Baleen whale calves are burdened with similar contaminant levels as adult females, indicating that bioaccumulation occurs through transplacental and lactational transfer, leaving the young vulnerable (Metcalfe et al., 2004).

5. Acoustic impacts

Commercial and industrial ocean noise has been shown to have a range of negative effects on marine mammals, including hearing loss, masking of biologically significant sounds, and disruption in foraging and other vital behaviors (e.g., NRC, 2003; Weilgart, 2007; CBD, 2012). The Northern Gulf of Mexico, with its intensive shipping and oil and gas development activity, has average annual ambient noise levels that easily approach or exceed NMFS' present "take" thresholds for continuous noise under the Marine Mammal Protection Act (see NOAA, 2014a).

Commercial shipping is a major contributor to noise in the world's oceans and in the Gulf of Mexico, with the Ports of South Louisiana (New Orleans) and the Port of Houston among the ten busiest ports in the world, as measured by cargo volume (American Association of Port Authorities, 2012), and several other ports among the nation's busiest. Azzara et al. (2013) found that Gulf shipping traffic may be disrupting sperm whale behavior and possibly communication and foraging patterns. The calls of Bryde's whale fall well within the range of commercial shipping noise (5 to 500 Hz; see Hildebrand, 2009). The high average levels of ambient noise in Gulf is likely to severely constrain their communication range (e.g., Hatch et al., 2012) and may potentially induce a chronic stress response (e.g., Rolland et al., 2012), as has been suggested for other mysticetes.

Seismic exploration is another major contributor to ocean noise and the northern Gulf of Mexico is the most heavily prospected body of water in the world. Airguns produce their peak noise output in the 5-300 Hz range (Hildebrand, 2009), which also overlaps the range of Bryde's whale's calls. Since airgun pulses spread, with distance, across the interpulse interval and contribute to ambient noise levels (e.g., Nieukirk et al., 2004, 2012), the Gulf's extensive airgun exploration would, like shipping, degrade Bryde's whale communication. These loud impulsive sources may also disrupt the behavior of the whales as well, as has been reported in other baleen whale species (e.g., Clark and Gagnon, 2006; Gailey et al., 2007; Di Iorio and Clark, 2010; Castellote et al., 2012; Blackwell et al., 2013; Cerchio et al., 2014). Other oil and gas development activities, including transport, vessel stabilizers, offshore construction, drilling, and platform removal, add to the industrial noise profile of the Gulf.

While the impact of these activities on GOMx Bryde's whales has not been directly measured, scientists have relied on indirect evidence to hypothesize their effects. For example, in exploring the range contraction of GOMx Bryde's whales historically, Rosel and Wilcox (2014) write, "It may be worth noting that energy exploration and production in the GOMx peaks in the shelf and slope waters west of the Mississippi River Delta. This habitat disruption, along with associated noise, seismic activity, and vessel traffic, could have resulted in the abandonment of the northwestern GOMx by Bryde's whales" (pg. 31).

Finally, mid-frequency active sonar has been identified as another source of impact on marine mammals. While the U.S. Navy conducts only limited training in the Gulf of Mexico, compared to other regions, its Panama City and Pensicola Opeations Areas and its Naval Surface Warfare Center-Panama City Testing Range all overlap with DeSoto Canyon (Navy, 2013). A number of studies raise concerns about the impact of mid-frequency acoustic sources on mysticetes (e.g., Nowacek et al., 2004; Goldbogen et al., 2013). The whales' limited distribution may render them less able to avoid high-level noise exposure. Additionally, the Navy—and the Air Force, which operates out of Eglin Air Force Base close to Panama City—routinely conduct explosives training, gunnery exercises, and other potentially harmful activities in offshore waters (Navy 2013; 78 Fed. Reg. 33357; 79 Fed. Reg. 13568).

Regardless of the source, any disruption in foraging, communication, or breeding in such a small population is a concern. Acute exposures may act cumulatively with more chronic effects and potentially lead to a range of fitness-related problems (see Wright et al., 2007).

6. Ocean acidification

Ocean acidification is well documented (Orr et al., 2005; Doney et al., 2009; Guinotte et al. 2008) and is changing oceanic carbonate chemistry. Its presence in the Gulf of Mexico may affect some of the main prey species of the Bryde's whale, krill, copepods, and crustaceans, by compromising the ability of these lower trophic level marine organisms to form calcareous structures (Doney, 2009; Fabry et al., 2008; Guinotte et al,. 2008). Doney et al. (2007) found that up to 50% more CO2 driven acidification will occur in coastal regions, due to atmospheric and oceanic processes, and that the total impacts could be more severe, as these regions are vulnerable to other human impacts, including nutrient runoff and overfishing. Cai et al. (2011) found runoff of particular concern, as it will add to acidification through eutrophication. The extent to which this will impact the Gulf of Mexico Bryde's whale is unknown.

7. Entanglement in fishing gear

The Gulf of Mexico pelagic tuna and swordfish longline fisheries are the most likely fisheries to have entanglement interactions with large whales (Waring et al 2013). While no confirmed cases of Bryde's whale entanglement were reported from 1998 to 2010 (Garrison, 2009; Waring et al., 2013), NOAA's observer corps in the region covers only about 8% of fishing vessels (NOAA, 2014b). The DeSoto Canyon is presently closed to longline fishing (50 C.F.R. § 635.21); however, as discussed below, NMFS has recently proposed modifying the closure in ways that would substantially reduce its restrictions (78 Fed. Reg. 75327).

8. Overfishing and prey reductions

Overfishing on a global scale has been well documented for decades (Jackson et al., 2001; Daskalov, 2002; Smith et al., 1993). Bryde's whales feed on a wide range of species, from krill to anchovies and sardines. While no fisheries are extensively targeting these species in the Gulf at present, overall commercial fisheries catch in the region has declined in from 2.6 billion pounds in 1984 to only 1.3 billion pounds in 2010 due in part to overfishing (Hesselgrave, 2012), likely impacting the trophic system and wider ecosystem in a variety of ways. Thus, the heavy use of the Gulf by fisheries may suggest other impacts on the Bryde's whale, including reduction in prey due to bycatch, that are not known. Additional pressures may come from recreational anglers, who are themselves in competition with commercial fisheries for many species (NOAA Fisheries, 2013).

B. Inadequacy of existing regulatory mechanisms

1. State law

As discussed above, all the reported sightings of Bryde's whales in the 2012 Bryde's Whale Northern Gulf of Mexico Stock Report were in the DeSoto Canyon of the northern Gulf of Mexico. The DeSoto Canyon is an erosional valley that lies almost entirely in pelagic waters off the coast of the Florida Panhandle. A small section (the southwest portion) of the DeSoto Canyon lies in pelagic waters off the coast of Alabama. As of the 2009 NMFS vessel surveys, all sightings of Bryde's whales have occurred off Florida.

a. Florida

The State of Florida maintains several statutes and regulations that nominally extend to marine mammals, but their applicability is limited in this case and none has proven effective in conserving Bryde's whales. The Florida Endangered and Threatened Species Act of 1977 provides for research and management to conserve and protect threatened and endangered species as a natural resource and declares that it is unlawful for a person to intentionally kill or wound any species of fish or wildlife listed as endangered, threatened, or of special concern. Fla. Stat. §§ 379.2291-379.231. In addition, Wildlife Rule 68A-27.003 of the Florida Administrative Code states that no person shall pursue, molest, harm, harass, capture, possess, or sell any endangered species or parts thereof or their nests or eggs except as authorized by specific permit. Fla. Admin. Code R. 68A-27.003. However, since neither state nor federal law currently lists the Northern Gulf of Mexico Bryde's whale as endangered, threatened, or (in the case of Florida) of special concern, the population does not receive any of the special protections that state law affords listed species.

Furthermore, Bryde's whale sightings from vessel surveys, as reported in the latest stock assessment report prepared by NMFS, have been concentrated offshore between the 100m and 1,000m isobaths. These sightings suggest that Bryde's whale habitat is well beyond 3nm from shore, putting the whales outside Florida's coastal waters and beyond the management of Florida's Department of Environmental Protection and state law.

b. Alabama

The State of Alabama maintains several statutes and regulations that nominally extend to marine mammals, but their applicability is limited in this case and none has proven effective in conserving Byrde's whales. Some species do receive protection through the Alabama Regulations on Game Fish and Fur Bearing Animals published annually by the Alabama Department of Conservation and Natural Resources. In particular, Nongame Species Regulation 220-2-.92 provides a list of state protected species; however, Bryde's whales are not listed as protected.

The Alabama Department of Environmental Management's coastal area management program establishes rules and procedures to administer the permitting, regulatory, and enforcement functions of the Alabama Coastal Area Management Program (ACAMP). The ACAMP oversees development and activity in coastal waters, including construction of marinas, piers, and canals. Alabama also has the Alabama Marine Mammal Protection Act of 1976, § 9-11-390 *et seq.,* which prohibits taking of marine mammals or marine mammal products. Both ACAMP and the Alabama Marine Mammal Protection Act, however, are limited to Alabama coastal waters. As noted above, Bryde's whale habitat occurs well beyond 3nm from shore, putting the whales outside Alabama's coastal waters and beyond the management of ACAMP or the Alabama Marine Mammal Protection Act.

2. Federal law

a. MMPA

The Marine Mammal Protection Act, 16 U.S.C. §§ 1361-1423, was enacted in 1972 to ameliorate the consequences of human impacts on marine mammals. Accordingly, the law contains specific provisions to reduce marine mammal bycatch from commercial fishing and requires that proponents of various other activities obtain prior authorization from the Secretary of Commerce before incidentally taking marine mammals. 16 U.S.C. §§ 1371(a)(5), 1374, 1387. The measures afforded by the MMPA are inadequate, however, to protect the Northern Gulf of Mexico Bryde's whales from the significant threats described above and below.

The MMPA has not adequately protected the population from the risk of ship-strike. While NMFS has exercised its authority under the MMPA to issue, and recently renewed, a set of speed restriction regulations for the North Atlantic along the Eastern Seaboard (78 Fed. Reg. 73726; 73 Fed. Reg. 60173), no such restrictions have been put in place to protect Bryde's whales in the Gulf of Mexico. As discussed above, Bryde's whales have suffered from an alarming and likely unsustainable rate of ship strikes with eight whales struck in the Gulf of Mexico from 1975 to 1996 (Laist, 2001). Without any restrictions on vessel traffic speed in the Gulf of Mexico, the MMPA does not protect Northern Gulf of Mexico Bryde's whales from ship strikes.

NMFS does presently recognize the Gulf of Mexico Bryde's whale population as a "strategic stock;" however, the Bryde's whale has seen little benefit from this designation because the MMPA requires that NMFS first allocate funds for fisheries observers to species listed as endangered or threatened under the ESA, with strategic stocks a lower priority. 16 U.S.C. § 1387(d)(4)(B). Currently the NOAA Pelagic Observer Program (POP) only maintains observer coverage of 8 percent.

The MMPA has also proved inadequate to protect Bryde's whales from acoustic impacts. To search for oil and gas, each year industry conducts dozens of seismic exploration surveys in the northern Gulf, one of the most highly prospected bodies of water on the planet. These surveys typically employ arrays of high-volume airguns that release intense blasts of compressed air into the water approximately every 10 to 12 seconds, for weeks or months at a time. Such surveys have received little oversight under the MMPA, notwithstanding the Act's prohibition against marine mammal take; and, although they are ongoing, NMFS has not issued any authorizations or conducted any public review of these activities pursuant to the MMPA's incidental take authorization provisions. While a Settlement Agreement concerning airgun exploration was adopted last year in the case of *NRDC v. Jewell*, No. 10-cv-01882 (E.D. La. June 18, 2013), the Agreement provides only limited benefits to Bryde's whales. The Agreement's benefits are temporally limited as it compels mitigation only in the short term (for thirty months from June 24, 2013); its chief temporary benefit for Bryde's whales, the exclusion of the DeSoto Canyon from airgun surveys, does not extend to that portion of the canyon lying in Bureau of Ocean Energy Management's Central Gulf of Mexico Planning Area or to waters falling within present lease sales; the agreement does not address masking effects, which come from far-reaching ambient noise unaffected by the agreement (see Hatch et al., 2012); and, the agreement does not alter the U.S. Department of the Interior's plans to open more of the eastern Gulf to leasing under the current 5-year leasing program.

As discussed above, commercial and recreational shipping is a major source of sound in the Northern Gulf of Mexico. However, these acoustic impacts presently go unregulated by the MMPA.

Unlike commercial shipping, underwater detonations related to U.S. Navy training and testing activities are regulated under the MMPA. However, although the Navy has committed to avoid planning major exercises in the DeSoto Canyon "when feasible" (50 C.F.R. § 218.84(a)(3)(iv)(A)), explosives activities are not banned within the canyon, and so the effectiveness of the MMPA's oversight is dependent on the monitoring effectiveness of ship-based observers. The Navy has received NMFS authorization to detonate its explosives and engage in related training and testing activities at all hours, day or night, and during any weather conditions; at night, human ship-based observers are highly ineffectual, and during stormy or rough waters their efficacy is also dramatically reduced (e.g., Barlow, 2013; Barlow and Gisiner, 2006). Observers alone do not adequately protect Bryde's whales from underwater explosives and associated acoustic impacts. Due to the small number of remaining whales in this population, the death or serious injury of even a single animal could be catastrophic for the population.

Finally, neither the MMPA's general authorization provisions, nor its bycatch provisions, are presently used to regulate other threats to the Bryde's whale, including overfishing of its principal prey species, toxic contamination, ocean acidification, and future oil spills.

For all these reasons, the MMPA has not adequately protected the Northern Gulf of Mexico population.

b. Magnuson-Stevens Fishery Conservation and Management Act

Enacted in 1976, the Magnuson-Stevens Fishery Conservation and Management Act, 16 U.S.C. §§ 1801-1884, is the leading federal statute governing marine fisheries in U.S. waters and the Exclusive Economic Zone. The law establishes various Regional Fishery Management Councils throughout the country that promulgate management plans for each federally managed fishery, with the review and approval of the Secretary of Commerce. 16 U.S.C. §§ 1852(a)(1), 1854. While the law provides some authority to protect marine mammal species,[1] it does not mandate the use of regulatory mechanisms adequate to conserve the Gulf of Mexico Bryde's whale.

First, although NMFS made changes to the longline fisheries that are managed under Magnuson-Stevens in the Gulf of Mexico by way of the 2006 Consolidated Atlantic Highly Migratory Species Fishery Management Plan, there is a current proposal to undue many of those changes. Currently, DeSoto Canyon is designated as a closed area to pelagic longline fisheries (50 C.F.R. § 635.21); however, a recent proposed amendment (78 Fed. Reg. 75327) would revise and greatly reduce the restrictions related to that designation. The proposed measure would allow vessels with an Atlantic Tunas Longline

---

[1] The Magnuson-Stevens Act charges Regional Fishery Management Councils with promulgating measures that "prevent overfishing and rebuild overfished stocks, and to protect, restore, and promote the long-term health and stability of the fishery" while achieving "optimum yield" from each fishery 16 U.S.C. § 1853(a)(1),2); The law also specifies that optimum yield is to be calculated by taking into account "social, economic, and ecological factors" including impacts on marine mammals. 50 C.F.R. § 600.310. However, these regulations, and the Act's optimum yield mandates, are so general that they have proved to have little impact on the consideration of ecological factors by Fishery management Councils when setting catch limits.

permit, Swordfish Incidental or Directed Limited Access permit, and/or a Shark Limited Access permit fishing with bottom or pelagic longline gear to transit areas that are closed or restricted to such gear, including DeSoto Canyon, if they remove and stow parts of that gear. The proposed measure would also allow year-round access to the DeSoto Canyon closed area pursuant to certain limitations. The trips would be observed, but they would be numerous. NMFS estimates that the maximum number of trips into the pelagic longline closed areas would be 80 trips into the DeSoto Canyon per quarter. These proposed changes are inadequate to prevent the hooking or entanglement of Gulf of Mexico Bryde's whales.

Second, the Magnuson-Stevens Act has not been successful in preventing the depletion of fisheries (Baum et al., 2003, 2005, Sibert et al., 2006; Hesselgrave, 2012). As discussed above, overall commercial fisheries catch in the Gulf of Mexico region has declined dramatically in the last three decades, impacting the trophic system and wider ecosystem in a variety of ways, and likely impacting the Bryde's whale by, e.g., reducing prey due to bycatch.

The regulatory mechanisms put in place by the Magnuson-Stevens Act are thus inadequate to conserve Gulf of Mexico Bryde's whales.

c. Coastal Zone Management Act

The Coastal Zone Management Act (CZMA) was enacted on October 27, 1972, to encourage coastal states to develop comprehensive programs to manage and balance competing uses of and impacts to coastal resources. Section 307 of the CZMA (16 USC § 1456), is a powerful tool that coastal states can use to manage coastal uses and resources and to facilitate cooperation and coordination with federal agencies. In particular, where states develop coastal management programs, federal license or permit activities and federal financial assistance activities that have reasonably foreseeable coastal effects are required to be fully consistent with the program's policies.

The CZMA's consistency determination provision, however, has been limited to federal activities that affect a state's coastal zone or coastal resources. Coastal effects are broadly defined under the Act to include activities that occur outside the coastal zone but for which it is reasonably foreseeable that their impacts will affect uses and resources of the coastal zone. Coastal resources include biological resources that are found within a state's coastal zone on a regular or cyclical basis. Since Bryde's whale habitat in the Gulf of Mexico lies entirely outside state coastal waters, activities with effects on Bryde's whales are not covered by the CZMA.

d. Outer Continental Shelf Lands Act

The Outer Continental Shelf Lands Act (OCSLA), adopted on August 7, 1953, governs the mineral exploration and development of all submerged lands under U.S. jurisdiction lying seaward of state coastal waters. Under the OCSLA, the Secretary of the Interior is responsible for regulating and granting leases for exploration and development of oil and gas on the continental shelf. It is the stated objective of the OCSLA "to prevent or minimize the likelihood of blowouts, loss of well control, fires, spillages . . . or other occurrences which may cause damage to the environment or to property, or endanger life or health." 43 U.S.C. § 1332(6). The OCSLA further requires the study of the environmental impacts of oil and gas leases on the continental shelf, including an assessment of effects on marine biota. 43 U.S.C. § 1346. However, the OCSLA has, in practice, provided only limited protection for Bryde's whales from oil spills.

Neither the OCSLA regulations nor environmental review provisions foresaw or prevented the *Deepwater Horizon* disaster, the ramifications of which continue to present a threat to Bryde's whales. In the wake of the blowout, as a result of the Energy Policy Act of 2005 (Pub. L. 109–58), new regulations have been adopted under OCSLA to reduce drilling risk and improve containment and control of spilled oil. 76 Fed. Reg. 64431. Despite these amendments, small spills and at least one blowout have since occurred (BSEE, 2013a, b).

Impacts from airgun-related oil and gas exploration in continental shelf waters are partially covered by the settlement agreement recently adopted in *NRDC v. Jewell*, No. 10-cv-01882 (E.D. La. June 18, 2013). As discussed in the context of acoustic impacts, the settlement agreement's benefits are limited. The agreement only affects activities in the short term, does not completely exclude Bryde's whale habitat from airgun surveys, does not address masking effects, and does not alter the U.S. Department of the Interior's plans to open more of the eastern Gulf to oil and gas leases under the current 5-year leasing program. For all these reasons, Bryde's whales are not adequately protected from the risk of present oil and dispersant from the *Deepwater Horizon* spill, future oil spills, or oil and gas acoustic impacts by the OCSLA. The OCSLA does not regulate other threats to the Bryde's whale, including overfishing of its principal prey species, toxic contamination, ship strikes, entanglement, or ocean acidification.

3. Foreign and international law

The Gulf of Mexico Bryde's whale occurs entirely within the territorial sea and Exclusive Economic Zone of the United States. No other nation has jurisdiction over the population or over any part of its range, nor has any other nation adopted laws to conserve or prevent its decline.

Furthermore, no international conventions or agreements exist that substantively address existing threats to the population. Because the Northern Gulf of Mexico stock does not predictably and cyclically cross U.S. jurisdiction (¶ 1(a)), it does not fall within the competence of the Convention on Migratory Species, 19 I.L.M. 15 (1980) and, accordingly, is not listed in the convention's appendices of covered wildlife (Convention on Migratory Species 2009). Bryde's whales do fall generically within the competence of the International Convention for the Regulation of Whaling, 161 U.N.T.S. 74 (1946), but whaling does not constitute an existing threat to the Northern Gulf of Mexico population. Likewise, while Bryde's whales are listed, along with the majority of other cetaceans, under Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora, 12 I.L.M. 1088 (1973), international trade in Bryde's whales and whale parts does not represent an existing threat to the Northern Gulf of Mexico stock.

C. Other factors

1. Risks inherent to small populations

Purvis et al. (2000) describe the four most important risk factors for extinction as (1) high trophic level, (2) low population density, (3) slow life history, and (4) small geographic range size. The Gulf of Mexico Bryde's whale meets each of these risk factors. This stock feeds at a medium trophic level (consuming primarily small fishes, krill, and crustaceans (see above) and has a low population density estimated at roughly 33 animals throughout its limited range (Waring et al., 2013). The species is slow to mature and reproduce, with an estimated calving interval of 2 years (see above). Its range is limited to a very small part of the Northern Gulf of Mexico (see above; Waring et al., 2013).

Small populations are particularly vulnerable to extinction due to demographic and environmental stochasticity, the risks of local catastrophes, slower rates of adaptation, deleterious effects of inbreeding, and "mutational meltdown" (see Lande et al., 2003) Demographic stochasticity is chance variation in demographic parameters such as reproductive rate, a feature inherent to small populations, while environmental stochasticity refers to variability in environmental or ecological conditions such as oceanographic productivity or disease outbreaks. Small populations are also at risk of deleterious genetic effects on population health due to the loss of genetic variability over time (inbreeding) and the potential for "mutational meltdown" that arises from the expression of harmful alleles, also known as genetic load. Franklin (1980) posited that small populations have a reduced capacity for genetic adaptation due to these effects.

Of particular concern for low-density animals with low reproductive rates such as cetaceans is the effect of small population sizes on the ability of individuals to find mates (the Allee effect). The Allee effect, also known as depensation, can cause a decline in per capita reproduction at low population densities. This effect is thought to be a potential factor in limiting recovery in several depleted cetacean species including Antarctic blue whales (*Balaenoptera musculus*) (Whitehead et al., 2000).

2. Synergistic and cumulative effects

The anthropogenic threats to Gulf of Mexico Bryde's whales outlined above do not act in isolation, and their potential cumulative and synergistic impacts on the population must be considered. While some of these threats, such as contamination with persistent organochlorine pollutants, may themselves have significant sublethal effects, they may also contribute cumulatively towards reduced survival and reproductive rates in Bryde's whales. A decline in reproductive rate from toxic contamination, when combined with, for example, the Allee effect, could have a significant impact on long-term population abundance. Likewise, direct mortality from ship strike, which on its own may not be sustainable (see above), could combine with these other stressors to further depress the survival rate.

Synergistic effects arise when the effects of multiple stressors are greater than the sum of the stressors considered in isolation. Such effects have been documented in the case of particular combinations of contaminants, but may also be observed across stressor types. For example, a reduction in prey can cause the animals to be on a lower nutritional plane and result in metabolism of stored fat. If contaminant levels are high, metabolizing fat can quickly mobilize high levels of toxins into the bloodstream causing acute health problems (e.g., Colborn and Smolen, 1996).

V. Conclusion

The Gulf of Mexico Bryde's, the region's only resident baleen whale, is small, discrete, and as evolutionarily distinct as other recognized subspecies within its complex. It qualifies as a distinct population segment under the Endangered Species Act. The population faces numerous threats to its survival including mortality and serious injury from vessel collision, acoustic impacts from intensive oil and gas exploration and commercial shipping, bioaccumulation of persistent organic pollutants, and the long-term effects of the *Deepwater Horizon* spill. According to NMFS' best population estimate, fewer than 50 individual animals remain. Given the risks inherent to small populations and the potential cumulative effects of the above threats, the Gulf of Mexico Bryde's whale must be listed as an endangered species under the ESA.

References

Aguilar, A., A. Borrell, and P.J.H. Reijnders. 2002. Geographical and temporal variation in levels of organochlorine contaminants in marine mammals. Marine Environmental Research 53: 425-452.

Alves, F., A. Dinis, I. Cascão, and L. Freitas. 2010. Bryde’s whale (*Balaenoptera brydei*) stable associations and dive profiles: New insights into foraging behavior. Marine Mammal Science 26: 202–212. DOI: 10.1111/j.1748-7692.2009.00333.x

American Association of Port Authorities. 2012. World Port Rankings 2011. Available at: http://aapa.files.cms-plus.com/PDFs/WORLD%20PORT%20RANKINGS%202011.pdf.

Andersen, M. and C.C. Kinze. 2005. Re-identification of a Skeleton of the Bryde's Whale (*Balaenoptera edeni*) from the Northern Coast of Borneo. Natural History Bulletin of the Siam Society 53: 133-144.

Anderson, J. 1879. Anatomical and zoological researches comprising an account of the zoological results of the two expeditions to Western Yunnan in 1868 and 1875; and a monograph of the two cetacean genera, *Platanista* and *Orcaella*. London, B. Quaritch: 551–564.

Andrews, R.C. 1918. A note on the skeleton of *Balaenoptera edeni*, Anderson, in the Indian Museum, Calcutta. Records of the Indian Museum 15: 105–107.

Azzara, A.J., W.M. von Zharen, and J.J. Newcomb. 2013. Mixed-methods analytic approach for determining potential impacts of vessel noise on sperm whale click behavior. Journal of the Acoustical Society of America 134: 4566.

Barlow, J. 2013. Inferring trackline detection probabilities from differences in apparent densities of beaked whales and dwarf and pygmy sperm whales in different survey conditions. NOAA Tech. Memo. NMFS-SWFSC-508. 33 pp.

Barlow, J., and R. Gisiner. 2006. Mitigating, monitoring and assessing the effects of anthropogenic sound on beaked whales. Journal of Cetacean Research and Management 7(3): 239-249.

Baum, J.K., R.A. Myers, D.G. Kehler, B. Worm, J. Harley, and P.A. Doherty. 2003. Collapse and conservation of shark populations in the northwest Atlantic. Science 299: 389-392.

Baum, J.K., R.A. Kehler, and R.A. Myers. 2005. Robust estimates of decline for pelagic shark populations in the northwest Atlantic and Gulf of Mexico. Fisheries 30: 27-30.

Best, P.B. 1977. Two allopatric forms of Bryde’s whale off South Africa. Reports of the International Whaling Commission Special Issue 1: 10-38.

Best, P.B., D. S. Butterworth and L. H. Rickett. 1984. An assessment cruise for the South African inshore stock of Bryde’s Whales (*Balaenoptera edeni*). Report of the International Whaling Commission 34: 403–423.

Best, P.B. 1996. Evidence of migration by Bryde's whales from the offshore population in the southeast Atlantic. Reports of the International Whaling Commission 46: 315-331.

Best, P.B. 2001. Distribution and population separation of Bryde's whale *Balaenoptera edeni* off southern Africa. Marine Ecology Progress Series 220: 277-289

Bettridge, S., and G. Silber. 2009. Update on the United States’ Actions to Reduce the Threat of Ship Collisions with Large Whales. International whaling Commission meeting agenda item 4.

Blackwell, S.B., C.S. Nations, T.L. McDonald, C.R. Greene, Jr., A.M. Thode, M. Guerra, and M. Macrander. 2013. Effects of airgun sounds on bowhead whale calling rates in the Alaskan Beaufort Sea. Marine Mammal Science 29(4): E342-E365.

Bowman, S.A. 2012. Exploration targets of offshore western Florida. Gulf Coast Association of Geological Societies Transactions 62: 13-26.

Bureau of Ocean Energy Management. 2014. 2012 - 2017 Lease Sale Schedule. Available at: http://www.boem.gov/Oil-and-Gas-Energy-Program/Leasing/Five-Year-Program/Lease-Sale-Schedule/2012---2017-Lease-Sale-Schedule.aspx.

Bureau of Safety and Environmental Enforcement. 2013a. BSEE and Coast Guard respond to well control event in Gulf of Mexico, 55 miles offshore Louisiana [Press Release]. Accessed April 28, 2014, at www.bsee.gov/BSEE-Newsroom/Press-Releases/2013/Press07242013.

Bureau of Safety and Environmental Enforcement. 2013b. Coast Guard, BSEE respond to loss of well control in the Gulf of Mexico [Press Release]. Accessed April 28, 2014, at www.bsee.gov/BSEE-Newsroom/Press-Releases/2013/Press07092013.

Cai, W., X. Hu, W. Huang, M.C. Murrell, J.C. Lehrter, S.E. Lohrenz, W. Chou, W. Zhai, J.T. Hollibaugh, Y. Wang, P. Zhao, X. Gou, K. Gundersen, M. Dai, and G. Gong. 2011. Acidification of subsurface coastal waters enhanced by eutrophication. Nature Geoscience 4: 766–770.

Castellote, M., C.W. Clark, and M.O. Lammers. 2012. Acoustic and behavioural changes by fin whales (*Balaenoptera physalus*) in response to shipping and airgun noise. Biological Conservation 147: 115-122.

Cerchio, S., S. Strindberg, T. Collins, C. Bennett, and H. Rosenbaum. 2014. Seismic surveys negatively affect humpback whale singing activity off Northern Angola. PLoS ONE 9(3): e86464. DOI:10.1371/journal.pone.0086464.

Clark, C.W., and G.C. Gagnon. 2006. Considering the temporal and spatial scales of noise exposures from seismic surveys on baleen whales. IWC Doc. SC/58/E9. 9 pp.

Colborn, T., and M.J. Smolen. 1996. Epidemiological analysis of persistent organochlorine contaminants in cetaceans. Reviews of Environmental Contamination and Toxicology 146: 91-172.

Convention on Biological Diversity. 2012. Scientific synthesis on the impacts of underwater noise on marine and coastal biodiversity and habitats. UN Doc. UNEP/CBD/SBSTTA/16/INF/12. 93 pp.

Convention on Migratory Species. 2009. Appendices I and II of the Convention on the Conservation of Migratory Species of Wild Animals (CMS). Effective Mar. 5, 2009. 10 pp.

Daskalov, G.M. 2002. Overfishing drives a trophic cascade in the Black Sea. Marine Ecology Progress Series 225: 53-63.

Di Iorio, L., and C.W. Clark. 2010. Exposure to seismic survey alters blue whale communication. Biology Letters 6: 51-54.

Dizon, A.E., C. Lockyer, W.F. Perrin, D.P. Demaster, and J. Sisson. 1992. Rethinking the stock concept: a phylogenetic approach. Conservation Biology 6: 24-36.

Doney, S.C., N. Mahowald, I. Lima, R.A. Feely, F.T. Mackenzie, J. Lamarque, and P.J. Rasch. 2007. Impact of anthropogenic atmospheric nitrogen and sulfur deposition on ocean acidification and the inorganic carbon system. Proceedings of the National Academy of Sciences 104: 14580–14585.

Doney, S.C., V.J. Fabry, R.A. Feely, and J.A. Kleypas. 2009. Ocean acidification: The other CO2 problem. Annual Review of Marine Science 1: 169–92.

Edds, P. L., D. K. Odell, and B. R. Tershy. 1993. Vocalization of a captive juvenile and freeranging adult-calf pairs of Bryde's whales, *Balaenoptera edeni*. Marine Mammal Science 9: 269–284.

Ekdale, E.G., A. Berta, and T.A. Deméré. 2011. The comparative osteology of the petrotympanic complex (ear region) of extant baleen whales (Cetacea: Mysticeti). PLoS ONE 6: e21311. doi:10.1371/journal.pone.0021311.

Elfes, C.T., G.R. Vanblaricom, D. Boyd, J. Calambokidis, P.J. Clapham, R.W. Pearce, J. Robbins, J.C. Salinas, J.M. Straley, P.R. Wade, and M.M. Krahn. 2010. Geographic variation of persistent organic pollutant levels in humpback whale (*Megaptera novaeangliae*) feeding areas of the North Pacific and North Atlantic. Environmental Toxicology and Chemistry 29: 824-834.

Engelhardt, F.R. 1983. Petroleum effects on marine mammals. Aquatic Toxicology 4: 199-217.

Environmental Protection Agency. 2012. Emerging Contaminants Fact Sheet– PFOS and PFOA. Available at: http://www.epa.gov/fedfac/pdf/emerging_contaminants_pfos_pfoa.pdf.

European Food Safety Authority (EFSA). 2008. Perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA) and their salts. The European Food Safety Authority Journal 6: 1-131.

Fabry, V.J., B.A. Seibel, R.A. Feely, and J.C. Orr. 2008. Impacts of ocean acidification on marine fauna and ecosystem processes. ICES Journal of Marine Science 65: 414–432.

Franklin, I.R. 1980. Evolutionary change in small populations. Pp.135-150 in: M.E. Soule and B. Wilcox, eds. Conservation Biology: An Evolutionary–Ecological Perspective. Sunderland, Mass.: Sinauer.

Gailey, G., B. Würsig, and T.L. McDonald. 2007. Abundance, behavior, and movement patterns of western gray whales in relation to a 3-D seismic survey, Northeast Sakhalin Island, Russia. Environmental Monitoring and Assessment 134: 75-91. DOI: 10.1007/s10661-007-9812-1.

Gallardo V.A., D. Arcos, M. Salamanca, and L. Pastene. 1983. On the occurrence of Bryde’s whales (*Balaenoptera edeni* Anderson 1878) in an upwelling area off central Chile. Reports of the International Whaling Commission 33: 481-488.

Garrison, L.P., L. Stokes, and C. Fairfield. 2009. Estimated bycatch of marine mammals and turtles in the U.S. Atlantic pelagic longline fleet during 2008. NOAA Tech. Memo. NMFS-SEFSC-591. 63 pp.

Geraci, J.R. 1990. Physiologic and toxic effects on cetaceans. Pp. 167-197 in: J.R. Geraci and D. J. St. Aubin, eds. Sea Mammals and Oil: Confronting the Risks. New York: Academic Press. 259 pp.

Goldbogen, J.A., B.L. Southall, S.L. DeRuiter, J. Calambokidis, A.S. Friedlaender, E.L. Hazen, E.A. Falcone, G.S. Schorr, A. Douglas, D.J. Moretti, C. Kyburg, M.F. McKenna, M.F., and P.L. Tyack. 2013. Blue whales respond to simulated mid-frequency sonar. Proceedings of the Royal Society Part B: Biological Sciences 280: 20130657. http://dx.doi.org/10.1098/rspb.2013.0657.

Guinotte, J.M., and V.J. Fabry. 2008. Ocean acidification and its potential effects on marine ecosystems. Annals of the New York Academy of Sciences 1134(1): 320-342.

Hatch, L.T., C.W. Clark, S.M. Van Parijs, A. Frankel, and D.W. Ponirakis. 2012. Quantifying loss of acoustic communication space for right whales in and around a US national marine sanctuary. Conservation Biology 26: 983-994. DOI : 10.1111/j.1523-1739.2012.01908

Heimlich, S.L., D.K. Mellinger, S.L. Nieukirk, and C.G. Fox. 2005. Types, distribution, and seasonal occurrence of sounds attributed to Bryde's whales (*Balaenoptera edeni*) recorded in the eastern tropical Pacific, 1999–2001. Journal of the Acoustical Society of America 118: 1830–1837.

Hesselgrave, T. 2012. Economic Costs of Historic Overfishing on Recreational Fisheries: South Atlantic and Gulf of Mexico Regions. Report to The Pew Charitable Trusts. 47 pp.

Hildebrand, J.A. 2009. Anthropogenic and natural sources of ambient noise in the ocean. Marine Ecology Progress Series 395: 5-20.

Houde, M., R.S. Wells, P.A. Fair, G.D. Boassart, A.A. Hohn, T.K. Rowles, J.C. Sweeney, K.R.Solomon, and D.C.G. Muir. 2005. Polyfluoroalkyl compounds in free-ranging bottlenose dolphins (*Tursiops truncatus*) from the Gulf of Mexico and the Atlantic Ocean. Environmental Science and Technology 39: 6591-6598.

Humphries, M., R. Pirog, and G. Whitney. 2010. U.S. Offshore oil and gas resources: Prospects and processes. Congressional Research Service Publication 7-5700. Washington, D.C. 29 pp.

International Whaling Commission. 2006. Report of the workshop on the pre-implementation assessment of western North Pacific Bryde's whales. Journal of Cetacean Research and Management 8: 337-355.

International Union for Conservation of Nature (IUCN). 2012. International Union for Conservation of Nature Red List Categories and Criteria: Version 3.1. Second edition. Gland, Switzerland and Cambridge, UK: IUCN. iv + 32pp.

Jackson, B.C., M.X. Kirby, W.H. Berger, K.A. Bjorndal, L.W. Botsford, B.J. Bourque, R.H. Bradbury, R. Cooke, J. Erlandson, J.A. Estes, T.P. Hughes, S. Kidwell, C.B. Lange, H.S. Lenihan, J.M. Pandolfi, C.H. Peterson, R.S. Steneck, M.J. Tegner, R.R. Warner. 2001. Historical overfishing and the recent collapse of coastal ecosystems. Science 293: 629-637.

Jarman, S.N., N. Wiseman, C.S. Baker and N.J. Gales. 2006. Incidence of prey DNA types in Bryde's whale scats. Information paper SC/58/E29 to the Scientific Committee of the International Whaling Commission.

Jefferson, T.A., and A.J. Schiro. 1997. Distribution of cetaceans in the offshore Gulf of Mexico. Mammal Review 27: 27-50.

Jenssen, B.M. 2006. Endocrine-disrupting chemicals and climate change: A worst-case combination for Arctic marine mammals and seabirds? Environ Health Perspectives 114 (Supp. 1): 76–80.

Junge, G.C.A. 1950. On a specimen of the rare fin whale, *Balaenoptera edeni* Anderson, stranded on Pulu Sugi near Singapore. Zoologische Verhandelingen 9: 1–26.

Kannan, K., J. Koistinen, K. Beckman, T. Evans, J.F. Gorzelany, K.J. Hansen, P.D. Jones, E. Helle, M. Nyman, and J.P. Giesy. 2001. Accumulation of perfluorooctane sulfonate in marine mammals. Environmental Science and Technology 35: 1593-1598.

Kato, H. 2002. Bryde’s Whales. Pp. 171-177 in: W.F., Perrin, B., Würsig, and J.G.M. Thewissen, eds. Encyclopedia of Marine Mammals. Academic Press: New York.

Kershaw, F., M.S. Leslie, T. Collins, R.M. Mansur, B.D. Smith, G. Minton, R. Baldwin, R.G. Leduc, R.C. Anderson, R.L. Brownell, Jr., and Rosenbaum, H.C. 2013. Population differentiation of two forms of Bryde’s whales in the Indian and Pacific Oceans. Journal of Heredity 104: 755-764. DOI: 10.1093/jhered/est057.

Kishiro, T. 1996. Movements of marked Bryde's whales in the western North Pacific. Reports of the International Whaling Commission 46: 421-428.

Kucklick, J., L. Schwacke, R. Wells, A. Hohn, A. Guichard, J. Yordy, L. Hansen, E. Zolman, R. Wilson, J. Litz, D. Nowacek, T. Rowles, R. Pugh, B. Balmer, C. Sinclair, and P. Rosel. 2011. Bottlenose dolphins as indicators of persistent organic pollutants in the Western North Atlantic Ocean and Northern Gulf of Mexico. Environmental Science & Technology 45: 4270-4277.

Kujawinski, E.B., M.C. Kido Soule, D. L. Valentine, A.K. Boysen, K. Longnecker, and M.C. Redmond. 2011. Fate of dispersants associated with the Deepwater Horizon oil spill. Environmental Science & Technology 45: 1298–1306.

Ladner, L., and A. Hagstrom. 1975. Oil spill protection in the Baltic Sea. Journal of the Water Pollution Control Federation 47: 796-809.

Laist, D.W., A.R. Knowlton, J.G. Mead, A.S. Collet, and M. Podesta. 2001. Collisions between ships and whales. Marine Mammal Science 17:35–75.

Lande, R., S. Engen, and E. Saether. 2003. Stochastic population dynamics in ecology and conservation. Oxford Series in Ecology and Evolution. Oxford, UK: Oxford University Press.

Leatherwood, S., and R.R. Reeves. 1983. The Sierra Club Handbook of Whales and Dolphins. San Francisco: Sierra Club Books. 302 pp.

Maze-Foley, K., and K.D. Mullin. 2006. Cetaceans of the oceanic northern Gulf of Mexico: Distributions, group sizes and interspecific associations. Journal of Cetacean Research and Management 8: 203–213.

McDonald, M.A. 2006. An acoustic survey of baleen whales off Great Barrier Island, New Zealand. New Zealand Journal of Marine and Freshwater Research 40: 519-529.

Mead, J.G. 1977. Records of Sei and Bryde's Whales from the Atlantic coast of the United States, the Gulf of Mexico, and the Caribbean. Information paper SC/SP74/Doc 36 to the Scientific Committee of the International Whaling Commission. Report of the International Whaling Commission (Special Issue 1): 113-116.

Metcalfe, C., B. Koenig, T. Metcalfe, G. Paterson, and R. Sears. 2004. Intra- and inter-species differences in persistent organic contaminants in the blubber of blue whales and humpback whales from the Gulf of St. Lawrence, Canada. Marine Environmental Research 57: 245-260.

Mullin, K.D., and G.L. Fulling. 2004. Abundance of cetaceans in the oceanic northern Gulf of Mexico. Marine Mammal Science 20: 787-807.

National Research Council. 1989. Using Oil Spill Dispersants on the Sea. Washington, D.C.: The National Academies Press.

National Oceanic and Atmospheric Administration (NOAA). 2010. Effects of oil on marine mammals and sea turtles. Available at: http://sero.nmfs.noaa.gov/deepwater_horizon/documents/pdfs/fact_sheets/marine_mammal_intervention_and_rescue.pdf.

National Oceanic and Atmospheric Administration (NOAA). 2013. Framing the Red Snapper Issue in the Gulf of Mexico. Available at: http://sero.nmfs.noaa.gov/sustainable_fisheries/Gulf_fisheries/red_snapper/article/index.html

National Oceanic and Atmospheric Administration (NOAA). 2014a. Average annual ambient noise methodology: Seismic airgun arrays in the Gulf of Mexico. Prepared under the NOAA Cetacean and Sound Mapping Program. Available at: http://cetsound.noaa.gov/sound_data.html.

National Oceanic and Atmospheric Administration (NOAA). 2014b. Pelagic Observer Program Information. Available at: http://www.sefsc.noaa.gov/fisheries/observers/pelagic.htm

National Research Council (NRC). 2003. Ocean Noise and Marine Mammals. Washington: National Academy Press. 204 pp.

Navy. 2013. Atlantic Fleet Training and Testing Environmental Impact Statement/ Overseas Environmental Impact Statement. Norfolk, Va.: NAVFAC Atlantic. 2890 pp.

Nieukirk, S.L., K.M. Stafford, D.K. Mellinger, R.P. Dziak, and C.G. Fox. 2004. Low-frequency whale and seismic airgun sounds recorded in the mid-Atlantic Ocean. Journal of the Acoustical Society of America 115(4): 1832-1843.

Nieukirk, S.L., D.K. Mellinger, S.E. Moore, K. Klinck, R.P. Dziak, and J. Goslin. 2012. Sounds from airguns and fin whales recorded in the mid-Atlantic Ocean, 1999-2009. Journal of the Acoustical Society of America 131:1102- 1112.

Niño-Torres, C.A., R.J. Urbán, and T. Olavarrieta. 2013. Dietary preferences of Bryde's whales (*Balaenoptera edeni*) from the Gulf of California: A $\delta^{13}C$, $\delta^{15}N$ analysis. Marine Mammal Science DOI: 10.1111/mms.12081.

NOAA, EPA, Department of the Interior, Department of Homeland Security, and University of New Hampshire. 2014. Environmental Response Management Application (ERMA) Deepwater Gulf Response. Accessed July 8, 2014, at response.restoration.noaa.gov/erma.

Notarbartolo di Sciara, G.N. 1983. Bryde's whales (*Balaenoptera edeni* Anderson 1878) off eastern Venezuela (Cetacea, Balaenopteridae). Technical Report 83-153 of the Hubbs-SeaWorld Research Institute. San Diego, Calif. 27 pp.

Nowacek, D.P., M.P. Johnson, and P.L. Tyack. 2004. Right whales ignore ships but respond to alarm stimuli. Proceedings of the Royal Society of London, Pt. B: Biological Sciences 271: 227-231.

Oleson, E.M., J. Barlow, J. Gordon, S. Rankin, and J.A. Hildebrand. 2003. Low frequency calls of Bryde's whales. Marine Mammal Science 19: 406–419.

Orr, J.C., V.J. Fabry, O. Aumont, L. Bopp, S.C. Doney, R.A. Feely, A. Gnanadesikan, N. Gruber, A. Ishida, F. Joos, R.M. Kay, K. Linsay, E. Maier-Reimer, R. Matear, P. Monfray, A. Muchet, R.G. Najjar, G.Plattner, K.B. Rodgers, C.L. Sabine, J.L. Sarmiento, R. Schlitzer, R.D. Slater, I.J. Totterdell, M. Weirig, Y. Yamanaka, and A. Yool. 2005. Anthropogenic ocean acidification over the twenty-first century and its impact on calcifying organisms. Nature 437: 681-686.

Panama Canal Authority. 2006. Proposal for the Expansion of the Panama Canal: Third Set of Locks Project. Available at: www.pancanal.com/eng/plan/documentos/propuesta/acp-expansion-proposal.pdf. 92 pp.

Perrin, W.E., M.L. Dolar, and E. Ortega. 1996. Osteological comparison of Bryde's whales from the Philippines with specimens from other regions. Report of the International Whaling Commission 46: 409-413.

Peterson, C.H., S.D. Rice, J.W. Short, D. Esler, J.L. Bodkin, B.E. Ballachey, and D.B. Irons. 2003. Long-term ecosystem response to the Exxon Valdez oil spill. Science 302: 2082-2086.

Purvis, A., J.L. Gittleman, G. Cowlishaw, and G.M. Mace. 2000. Predicting extinction risk in declining species. Proceedings of the Royal Society of London B 267: 1947-1952.

Reeves, R.R., B.D. Smith, E.A. Crespo and G.N. di Sciara, comp. 2003. Dolphins, Whales and Porpoises: 2002-2010 Conservation Action Plan for the World's Cetaceans. IUCN/SSC Cetacean Specialist Group. Gland, Switzerland and Cambridge, U.K.: IUCN. 147 pp.

Reeves, R.R., and G.N. Di Sciara. 2006. The Status and Distribution of Cetaceans in the Black Sea and Mediterranean Sea. Malaga, Spain: IUCN Centre for Mediterranean Cooperation. 137 pp.

Rice, A.N., K.J. Palmer, J.T. Tielens, C.A. Muirhead, and C.W. Clark. 2014. Potential Bryde’s whale calls (*Balaenoptera edeni*) recorded in the Northern Gulf of Mexico. Journal of the Acoustical Society of America 135: 3066-3076.

Rice, D.W. 1998. Marine Mammals of the World: Systematics and Distribution. Special Publication Number 4. Lawrence, Ks.: Society for Marine Mammalogy. 234 pp.

Rolland, R.M., S.E. Parks, K.E., Hunt, M. Castellote, P.J. Corkeron, D.P. Nowacek, S.K. Wasser, and S.D. Kraus. 2012. Evidence that ship noise increases stress in right whales. Proceedings of the Royal Society B 279: 2363-2368.

Rosel, P.E., and Wilcox, L.A. 2014. Genetic evidence reveals a unique lineage of Bryde’s whales in the northern Gulf of Mexico. Endangered Species Research 25: 19-34.

Sasaki, T., M. Nikaido, S. Wada, T.K. Yamada, Y. Cao, M. Hasegawa, and N. Okada. 2006. *Balaenoptera omurai* is a newly discovered baleen whale that represents an ancient evolutionary lineage. Molecular Phylogenetics and Evolution 41: 40-52.

Schecter, A., N. Malik-Bass, A.M. Calafat, K. Kato, J.A. Colacino, T.L, Gent, L.S. Hynan, T.R. Harris, S. Malla, and L. Bimbaum. 2012. Polyfluoroalkyl compounds in Texas children from birth through twelve years of age. Environmental Health Perspectives 120: 590–594.

Schmidly, D.J. 1981. Marine Mammals of the Southeastern United States and the Gulf of Mexico. U.S. Fish and Wildlife Service Report No. FWS/OBS-80/41. Washington, D.C.: U.S. Fish and Wildlife Service, Office of Biological Services. 165 pp.

Schwacke, L., T. Rowles, and E. Zolman. 2011. Assessing potential sublethal and chronic health impacts from the Mississippi Canyon 252 oil spill on coastal and estuarine bottlenose dolphins. Natural Resource Damage Assessment. Available at: http://www.Gulfspillrestoration.noaa.gov/wp-content/uploads/2011/05/Assessing-Potential-SublethalChronic-Health-Impacts-on-CoastalEstuarine-Dolphins4-1-2011.redacted.pdf.

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

Sibert, J., J. Hampton, P. Kleiber, and M. Maunder. 2006. Biomass, size and trophic status of top predators in the Pacific Ocean. Science 314:1773-1776.

Siciliano, S., M.C. de O. Santos, A.F. Vicente, F. Alvarenga, E. Zampirolli, J. Lailson-Brito, A. Azevedo, and J.L. Pizzorno. 2004. Strandings and feeding records of Bryde's whales (*Balaenoptera edeni*) in South-Eastern Brazil. Journal of the Marine Biological Association of the UK 84: 857–859.

Širović, A., H.R. Bassett, S.C. Johnson, S.M. Wiggins, and J.A. Hildebrand. 2014. Bryde's whale calls recorded in the Gulf of Mexico. Marine Mammal Science 30: 399-409.

Silber G.K., N.W. Newcomer, and M. Perez-Cortes. 1990. Killer whales (*Orcinus orca*) attack and kill a Bryde's whale (*Balaenoptera edeni*). Canadian Journal of Zoology 68: 1603-1606.

Smith, S.J., J. Hunt, and D. Rivard. 1993. Risk Evaluation and Biological Reference Points for Fisheries Management. Canadian Special Publication of Fisheries and Aquatic Science (120). 442 pp.

Tershy, B., A. Acevedo-Gutierrez, D. Breese, and C. Strong. 1993. Diet and feeding behavior of fin and Bryde's whales in the Central Gulf of California, Mexico. Revista de Investigacion Cientifica de la Universidad Autonoma de Baja California Sur. Serie Ciencias del Mar (No. Esp. SOMEMMA) 1: 31–37.

Tershy, B.R. 1992. Body size, diet, habitat use, and social behavior of *Balaenoptera* whales in the Gulf of California. Journal of Mammalogy 73: 477-486.

U.S. Coast Guard. 2011. On Scene Coordinator Report Deep Water Horizon Oil Spill: Submitted to the National Response Team. Available at: http://www.uscg.mil/foia/docs/dwh/fosc_dwh_report.pdf.

Urbán, R.J., and R.S. Flores. 1996. A note on Bryde's whales (*Balaenoptera edeni*) in the Gulf of California, Mexico. Reports of the International Whaling Commission 46: 453-458.

Valdivia, J., F. Franco, and P. Ramirez. 1981. The exploitation of Bryde’s whales in the Peruvian Sea. Reports of the International Whaling Commission 31: 441-448.

Wada, S., M. Oishi, and T. Yamada. 2003. A newly discovered species of living baleen whale. Nature 426: 278-281.

Wade, P.R., and T. Gerrodette. 1993. Estimates of cetacean abundance and distribution in the eastern tropical Pacific. Reports of the International Whaling Commission 43: 477-493.

Ward, N., A. Moscrop, and C. Carlson. 2001. Elements for the development of a Marine Mammal Action Plan for the wider Caribbean: A review of marine mammal distribution. UN Doc. UNEP(DEC)/CAR IG.20/INF.3. 83 pp.

Waring, G.T., E. Josephson, K. Maze-Foley, and P.E. Rosel. 2013. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments—2012, Volume 1. 425 pp.

Weilgart, L. 2007. The impacts of anthropogenic ocean noise on cetaceans and implications for management. Canadian Journal of Zoology 85: 1091-1116.

Wells, P.G. 1984. Conservation and Protection. Dartmouth, Nova Scotia: Environment Canada.

Whitehead, H.A., R.R. Reeves, and P.L. Tyack. 2000. Science and the conservation, protection and management of wild cetaceans. Pp. 308-332 in: J. Mann, R.C. Connor, P.L. Tyack, and H. Whitehead, eds. Cetacean Societies: Field Studies of Dolphins and Whales. Chicago: University of Chicago Press. 433 pp.

Wise, J.P., Jr., J.T.F. Wise, C.F. Wise, S.S. Wise, C. Gianios,, Jr., H. Xie, W.D. Thompson, C. Perkins, C. Falank, and J.P. Wise, Sr. 2014. Concentrations of the genotoxic metals, chromium and nickel, in whales, tar balls, oil slicks, and released oil from the Gulf of Mexico in the immediate aftermath of the Deepwater Horizon oil crisis: Is genotoxic metal exposure part of the Deepwater Horizon legacy? Environmental Science and Technology 48: 2997-3006.

Wright, A.J., N. Aguilar Soto, A.L. Baldwin, M. Bateson, C. Beale, C. Clark, T. Deak, E.F. Edwards, A. Fernández, A. Godinho, L. Hatch, A. Kakuschke, D. Lusseau, D. Martineau, L.M. Romero, L. Weilgart, B. Wintle, G. Notarbartolo di Sciara, and V. Martin. 2007. Do marine mammals experience stress related to anthropogenic noise? International Journal of Comparative Psychology 20: 274-316.

Würsig, B., T. Jefferson, and D. Schmidly. 2000. The Marine Mammals of the Gulf of Mexico. College Station, Texas: Texas A&M University Press. 256 pp.