PETITION TO LIST THE GULF OF MEXICO CUVIER'S BEAKED WHALE (*ZIPHIUS CAVIROSTRIS*) AS ENDANGERED OR THREATENED UNDER THE ENDANGERED SPECIES ACT

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Submitted to the U.S. Secretary of Commerce acting through the National Oceanic and Atmospheric Administration and the National Marine Fisheries Service

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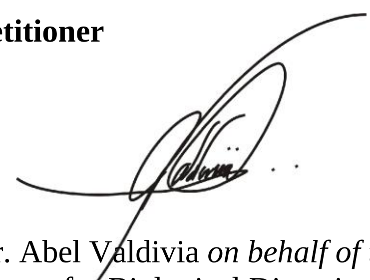

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The Center for Biological Diversity ("petitioner") hereby petitions the Secretary of Commerce and the National Oceanic and Atmospheric Administration ("NOAA"), through the National Marine Fisheries Service ("NMFS"), to list the Gulf of Mexico distinct population segment of Cuvier's beaked whales (*Ziphius cavirostris*) as an endangered or threatened 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(e) of the Administrative Procedure Act, 5 U.S.C. § 533(e), and 50 C.F.R. § 424.14(a). In the alternative, petitioner requests that the Secretary lists the Cuvier's beaked whale as threatened or endangered in a significant portion of its range.

The Center for Biological Diversity ("the Center') is a national, nonprofit conservation organization dedicated to the protection of endangered species and wild places through science, policy, and environmental law. Among the Center goals is to use the ESA as a powerful tool to preserve imperiled species throughout the United States and abroad and thus conserve and restore biodiversity. The Center has more than 1.5 million members and online activists with a direct interest in ensuring the survival and recovery of Gulf of Mexico Cuvier's beaked whale and in conserving the fragile and heavily impacted habitat and Gulf ecosystems on which this species depends for foraging, growth, and reproduction.

NMFS has jurisdiction over this petition because the Gulf of Mexico Cuvier's beaked whale is a marine species. This petition sets in motion a specific legal 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*. The petitioner does not need to demonstrate that listing is warranted, rather, the petitioner must only present information demonstrating that such a listing may be warranted. While the petitioner believes that the best available science demonstrates that listing the Gulf of Mexico Cuvier's beaked whales as endangered is in fact warranted, there can be no reasonable dispute that the available information indicates that listing this species as either threatened or endangered may be warranted. Thus, NMFS should promptly make a positive finding on the Petition and commence a status review as required by the ESA. 16 U.S.C. § 1533 (b)(3)(B).

The Center respectfully submitted this Petition this 11th day of October 2017.

Suggested citation:

Valdivia, A (2017) Petition to list the Gulf of Mexico Cuvier's beaked whale (*Ziphius cavirostris*) as endangered under the Endangered Species Act. *Center for Biological Diversity*, 57 pp.

Executive Summary

The Gulf of Mexico has only 74 Cuvier's beaked whales (*Ziphius cavirostris*) remaining. This small population is vulnerable to extinction in the near future. Cuvier's beaked whales are extremely sensitive to noise and depend on a healthy acoustic environment for echolocation and other essential life behaviors. In the Gulf of Mexico, Cuvier's beaked whales face significant ongoing threats to their continued existence. Accordingly, the Center for Biological Diversity petitions the Secretary to list the Gulf of Mexico distinct population segment of Cuvier's beaked whales as threatened or endangered under the Endangered Species Act.

Cuvier's beaked whales in the Gulf of Mexico are eligible for listing as a distinct population segment because of their strong site fidelity. Genetic studies show high degree of isolation among ocean basins and seas which has been corroborated by mark and recapture studies showing long-term high site-fidelity. Although the species is found in most oceans, the small population of Cuvier's beaked whales of the Northern Gulf of Mexico is a resident of the region and is isolated from other populations of the Western Atlantic.

The Cuvier's beaked whale population faces several threats across the Northern Gulf of Mexico's heavily industrialized waters. These threats include habitat degradation by oil spills, potential prey reduction due to fisheries, entanglement in fishing gear, vessel strikes, noise pollution, water pollution, and climate change. Existing regulatory mechanisms are inadequate to protect and promote population recovery and to efficiently address current threats. Moreover, these threats are increasing with industrialization of the Gulf of Mexico, including increases in commercial shipping and oil and gas activities. Importantly, small marine mammal populations have a heightened risk of extinction because they could be devastated by stochastic events.

Cuvier's beaked whales in the Gulf of Mexico warrant protections from extinction. These small cetaceans dive deeper than any other marine mammal on the planet, reaching 3,000 meters depth looking for they preferred food, squids. Protection under the Endangered Species Act may be the most powerful regulatory mechanism to protect the unique Cuvier's beaked whale from extinction in the Gulf. Therefore, NMFS must list the Gulf of Mexico Cuvier's beaked whale as an endangered or threatened species under the Endangered Species Act.

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1. Governing Provisions of the Endangered Species Act

The ESA was enacted in 1973 "to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, and to provide a program for the conservation of such endangered species and threatened species." 16 U.S.C. § 1531(b). Protection under the ESA only applies to species that have been listed as endangered or threatened according to the provisions of the statute. Thus listing species that need ESA protection is vital to their conservation.

Specifically, once listed as an "endangered" species, the ESA prohibits the "take" or the killing, capture, or harassment of individual animals, as well as the sale, export, or import of such species. *Id.* §§ 1538(a); 1532(19) (defining "take"). Alternatively, if a species is listed as "threatened", NMFS "shall issue such regulations as [it] deems necessary and advisable for the conservation of" the species including potentially the same bans applicable to endangered species. Additionally, whenever a U.S. federal agency takes any action that "may affect" a threatened or endangered species, that agency "shall" consult with NMFS or the Fish and Wildlife Service (FWS) regarding those impacts, and the consulting agencies may establish mitigation measures for the project. *Id.* § 1536(a).

1.1 Species Definition under the ESA

The term "species" is broadly defined under the ESA 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). The ESA provides for the listing of all species that warrant the protections afforded by the Act. 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 F.R. 4722 (February 7, 1996). Under this policy, a population that is both "discrete" and "significant" can be eligible for listing under the Act.

1.2 Significant Portion of the Species' Range

The ESA defines an "endangered species" as any species that is "in danger of extinction throughout all or a significant portion of its range," 16 U.S.C. § 1532(6), and a "threatened species" as one that "is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range." 16 U.S.C. § 1532(20). The ESA does not define the phrase "significant portion of its range" (SPR). In 2014, FWS and NMFS ("the Services") published a policy interpretation of SPR (79 FR 37577). The Services determined that "a portion of the range of a species is 'significant' if the species is not currently endangered or threatened throughout all of its range, but the portion's contribution to the viability of the species is so important that, without the members in that portion, the species would be in danger of extinction, or likely to become so in the foreseeable future, throughout all of its range" (79 FR 37577, p. 37580). However, this interpretation has been vacated in court (see *Center for Biological Diversity et al. v. Jewel 2017, CV-14-02506-TUC-RM*) and should not be followed.

NMFS should not interpret the phrase significant portion of the species range following the 2014 policy. Instead, NMFS should interpret the phrase "significant portion if its range" as a portion of a species range that face high extinction risk (threatened or endangered) and that is biologically significant based on the principles of conservation biology using the concepts of redundancy, resilience, and representation (the three Rs) (Shaffer & Stein 2000). Such concepts can also be expressed in terms of the four population viability characteristics commonly used by NMFS: abundance, spatial distribution, productivity, and diversity of the species.

1.3 Listing Factors under Section 4(A)(1) of the ESA

Under the ESA, NMFS must make a determination whether a species is endangered or threatened based on the best readily available scientific or commercial information on the following five listing factors, 16 U.S.C. §1533(a)(1):

A. The present or threatened destruction, modification, or curtailment of its habitat or range;
B. Overutilization for commercial, recreational, scientific, or education purposes;
C. Disease or predation;
D. The inadequacy of exiting regulatory mechanism; and
E. Other natural or manmade factors affecting its continue existence.

For a species to be listed under the ESA it needs to only face a substantial threat under one of the above mentioned factors. In addition, any combination of threats that can be considered cumulatively under multiple factors would also support ESA listing. The Gulf of Mexico Cuvier's beaked whale faces threats from several of the ESA listing factors.

1.4 90-Day and 12-Month Findings

NMFS is required to determine "to the maximum extent practicable … whether [a] petition presents substantial scientific or commercial information indication that the petitioned action may be warranted" within 90 days of receiving a petition to list a species. *Id.* § 1533(b)(3)(A). This is also known as the "90-day finding". A "negative" 90-day finding will end the listing process. *Id.* § 1533(b)(3)(C)(ii). A "positive" 90-day finding will lead to a more comprehensive "status review" and to a "12-month finding" that determines, based on the best available scientific and commercial information, whether listing the species as endangered or threatened is warranted, not warranted, or warranted but precluded by other pending listing proposals for higher priority species. *Id.* § 1533(b)(3)(B). A 90-day finding, a not warranted finding, or a warranted but precluded 12-month finding are subject to judicial review. *Id.* § 1533(b)(3)(C)(ii).

For the purposes of the 90-day finding, "substantial information" is defined as "the amount of information that would lead a reasonable person to believe that the measure proposed in the petition may be warranted" 50 C.F.R. § 424.14(b)(1). Under NMFS's regulations a petition presents "substantial information" if it:

i. Clearly indicates the administrative measure recommended and gives the scientific and any common name of the species involved;

ii. Contains detailed narrative justification for the recommended measure; describing, based on available information, past and present numbers and distribution of the species involved and any threats faced by the species;
iii. Provides information regarding the status of the species over all or a significant portion of its range; and
iv. Is accompanied by appropriate supporting documentation in the form of bibliographic references, reprints of pertinent publications, copies of reports or letters from authorities, and maps.

50 C.F.R. §§ 424.14(b)(2)(i)–(iv).

This petition presents substantial information that would lead a reasonable person to believe that listing the Gulf of Mexico Cuvier's beaked whaled under the ESA may be warranted.

1.5 Reasonable Person Standards

During the initial petition review to make a 90-day finding the ESA does not require "conclusive evidence of a high probability of species extinction" to support a positive outcome. 50 C.F.R. § 424.14(b)(1). Instead, during the initial 90-day review process, NMFS must consider whether a reasonable person could determine that the petition contains substantial information that may warrant a more in-depth status review of the petitioned species. Thus this initial review should be characterized as a "threshold determination." Accordingly, a petition does not need to demonstrate a high likelihood that a species is endangered or threatened during the 90-day finding process, but it need only warrant further review.

1.6 Best Available Scientific and Commercial Data

NMFS is required to make an ESA listing determination for the Gulf of Mexico Cuvier's beaked whale considering the five listing factors based on the best available scientific and commercial data. 16 U.S.C § 1533(b)(1)(A). NMFS cannot deny a listing for which little information is available if the best available information indicates that the species is endangered or threatened throughout all, or a significant portion of its range.

2. Natural history of the Gulf of Mexico Cuvier's beaked whale

2.1 Taxonomic classification and etymology

The Gulf of Mexico Cuvier's beaked whale is also known as goose-beaked whale, goosebeak whale, and ballena-picuda de Cuvier. In this petition, the taxonomy of the Gulf of Mexico Cuvier's beaked whales was based on the Integrated Taxonomic Information System ("ITIS"),[1] and is as follows:

[1] Integrated Taxonomic Information System: *Ziphius cavirostris* G. Cuvier, 1823. Taxonomic Serial No.: 180498 https://www.itis.gov/servlet/SingleRpt/SingleRpt?search_topic=TSN&search_value=180498#null

Kingdom: Animalia
Phylum: Chordata
Class: Mammalia, Linnaeus 1758
Order: Cetacea, Brisson 1762
Suborder: Odontoceti, Flower 1867 – (toothed whales)
Family: Hyperoodontidae, Gray 1846 – (beaked whales)
Genus: *Ziphius*, G. Cuvier 1823 – (goose-beaked whales)
Species: *Ziphius cavirostris* G. Cuvier 1823

Note, that the family of the species changed from Ziphiidae to Hyperoodontidae. The genus name *Ziphius* is derived from the Greek word *"xiphos"* meaning sword, because beaked whales are also considered the "sword-nose" whales. The species name "*cavirostris*" means concave-face.

2.2 Species description and identifying characteristics

Cuvier's beaked whales are medium-size odontocetes with an indistinct beak, a round and robust dark gray to reddish brown body, and a triangular falcate (curved) dorsal fin at the far down area of the animal's back (Jefferson et al. 1994 p. 82; NMFS 2017). The darker coloration on the dorsal side fades away to a paler counter-shaded underside. The species is known to occur in shades of rusty-brown, dark gray, or reddish-brown with a dark brown or black underside. The reddish-brown coloration is caused by microscopic diatoms and algae that live on the skin (Baird 2016; NMFS 2017). Older individuals are often paler than younger ones. In general, a whitish coloration is present on the face with dark colored patches around the eyes (Fig. 1). Thus, the head of the individual is often more lightly colored than the body (Fig. 1). Adult males often have more extensive white coloration than females but they can show similar patterns (Fig. 1). Females often have some dark pigmentation pattern on the head, and coloration is generally more variable amongst females (Baird 2016 p. 187). Young Cuvier's beaked whales are more darkly colored than adults, with coloration lightening as the individual ages (Baird 2016 p. 186).

Cuvier's beaked whales are relative medium-size delphinoid species. The species can reach lengths of ~ 15-23 feet and weigh between 4,000 and 6,800 lbs. The head does not have an obvious "melon" as other odontocetes, rather a goose-like profile or sloping concave-shape head, which the species name (*cavi-rostris* = concave-face) accurately describes. The dorsal blowhole forms a large slit. As with other odontocetes, the jaw-line is slightly upturned, which give these animals the smiling and charismatic appearance (Jefferson et al. 1994 p. 82; NMFS 2017).

Figure 1 Cuvier's beaked whale (*Ziphius cavirostris*) adult male (top) and adult female (middle), and calf (bottom). The linear scarring and erupted teeth can be used to discern between adult males and adult females. *Illustration by Uko Gorter with permission.*

There is not significant sexual dimorphism in body shape and both females and males are similar in body size. Like other beaked whales, Cuvier beaked males have two small but distinct cone-shaped teeth on the front region of the bottom jaw erupting upwards (Jefferson et al. 1994 p. 82; NMFS 2017) (Fig. 1). These teeth are often used for fighting with other males (Baird 2016 p. 186) leaving behind well-defined scars and scratches (Fig. 2). Adult males also have a more densely ossified rostrum than females, possibly to reinforce the skull in combat or for convection of sound (Heyning & Mead 2003). The body is often covered with oval-shaped scars that are thought to be originated from cookie cutter sharks (Fig. 3). As they grow older, a more distinguishable indentation is developed on the top of the head and males (less extent females) accumulate more scares from years of fighting (Baird 2016 p. 186).

Fossils of beaked whales are dated from the middle of the Miocene (Mead 1975; Lambert et al. 2010). Since then, beaked whales may have fed on deep-water squids, like their extant descendants. Due to their suction capacity, teeth lost their role in processing food, and thus convergent tooth loss is seen in several related beaked whale species (Fordyce & Barnes 1994 p. 447).

Figure 2 Dorsal side of a Cuvier's beaked whale showing linear scars from fighting and brownish coloration due to diatoms and algae growth. *Photo © M. Rosso – CIMA Foundation with permission.*

Figure 3 Female Cuvier's beaked whale from Hawaiian waters with round scars (~2 inches in diameter) and a fresh wound of parasitic Cookie Cutter sharks. *Photo © Robin Baird/ Cascadia Research Collective with permission.*

2.3 Life history

Cuvier's beaked whales usually reach sexual maturity at 7-11 years of age when body size is approximately 20 feet (6.1 m) long for females and 18-20 feet (5.5-6.1 m) long for males. Breeding and calving often occurs during the spring, but can also occur year round. The gestation period is about a year-long and females give birth to a single calf every 2-3 years. The newborn calves are usually dark blue or black in coloration, ~ 6.5-9 feet (2-2.7 m) long, and weigh 550-660 lbs (250-300 kg). The estimated lifespan for Cuvier's beaked whale is up to 60 years (NMFS 2017).

2.4 Diet and feeding ecology

Cuvier's beaked whales mostly feed on cephalopods (squids and octopus) that are hunted opportunistically in deep waters (Santos et al. 2001; MacLeod et al. 2003; West et al. 2017). This species also feed rarely on fish and crustaceans when their preferred food is not found (Santos et al. 2001; MacLeod et al. 2003; West et al. 2017). Previously published literature found the average diet of a Cuvier's beaked whale was comprised of 30% small squid, 30% large squid, 15% mesopelagic species, 15% miscellaneous fishes, and 10% benthic invertebrates (Pauly et al. 1998 p. 470). The most prevalent squid families in the diets of Cuvier's beaked whales include Brachioteuthidae, Chiroteuthidae (whip-lash squid), Cranchiidae (glass squid), Gonatidae (armhook squid), Histioteuthidae (cock-eyed squid), Octopoteuthidae, Onychoteuthidae (hooked squid), Ommastrephidae, and Pholidoteuthidae (Allen et al. 2012 p. 2). The stomach contents of a Cuvier's beaked whale found in southern Texas within the Gulf of Mexico included the remains of the species *Loligo pealei*, an ecologically and commercially important cephalopod (Fertl et al. 1997 p. 92).

Cuvier's beaked whales search for prey using active echolocation, producing high-frequency clicks during deep dives (Johnson et al. 2004 p. S383). A pair of ventral groves on the throat allows them to create a vacuum within their mouths, through which they suck their prey (Heyning & Mead 2003). Forage seems to occur during day and night (Schorr et al. 2014 p. 5).

2.5 Distribution

The best available scientific and commercial information indicates that the Gulf of Mexico Cuvier's beaked whale is resident of the Gulf where strandings have occurred throughout the years (Read 2000; NMFS 2012a p. 137; Würsig 2017 p. 1497). Cuvier's beaked whales have been detected in all seasons during the Gulf Cetacean (GulfCet) aerial surveys mostly across the Northern Gulf of Mexico in U.S. waters (Fig. 4) (Hansen et al. 1996 p. 2; Mullin & Hoggard 2000). Identification of Cuvier's beaked whales from aerial surveys is difficult because relatively low detectability as they tend to spend significantly amount of time foraging in deep waters (Davis et al. 2002 p. 123; NMFS 2012a p. 138; Schorr et al. 2014 p. 5). Beaked whale sightings from vessel surveys during spring and summer throughout the Gulf of Mexico are mostly distributed in deep waters > 500 m, confirming deep water distribution from aerial surveys (Maze-Foley & Mullin 2007 p. 206). Deep water distribution for beaked whales has also been predicted from habitat-based modelling (Roberts et al. 2016 p. 7). Most sightings have been recorded from waters within U.S. jurisdiction (Hansen et al. 1996 p. 2; Jefferson & Schiro 1997

p. 36; Davis et al. 2002 p. 123). However, it is likely that these whales also use deep habitats along the continental platform of Mexico and the insular platform of Cuba (Jefferson et al. 1994 p. 83).

Cuvier's beaked whales are also distributed throughout most of the world's oceans and seas, from cold Antarctic waters, deep subarctic waters to subtropical and tropical regions (Mitchell 1968; Leatherwood & Reeves 1983; Heyning & Mead 2003; Baird 2016). Most of known distributions of Cuvier's beaked whales around the world are based on stranding records. Studies have shown that Cuvier's beaked whales generally remain in their ocean basins and exhibit high long-term site fidelity (McSweeney et al. 2007a p. 679; Schorr et al. 2011; Baird et al. 2016 p. 6). Discrete populations are known in boreal, temperate, subtropical and tropical waters of the Northern Hemisphere including the Aleutian Islands, Bahamas, Bay of Biscay, British Columbia, Canada, Cape Hatteras, Caribbean Sea, Galapagos, Gulf of California, Gulf of Mexico, Massachusetts, Mediterranean Sea, and the Shetlands. Discrete populations are also found in the Southern Hemisphere around New Zealand, South Africa, and Tierra del Fuego (NMFS 2017). Migration patterns among these regions are not known.

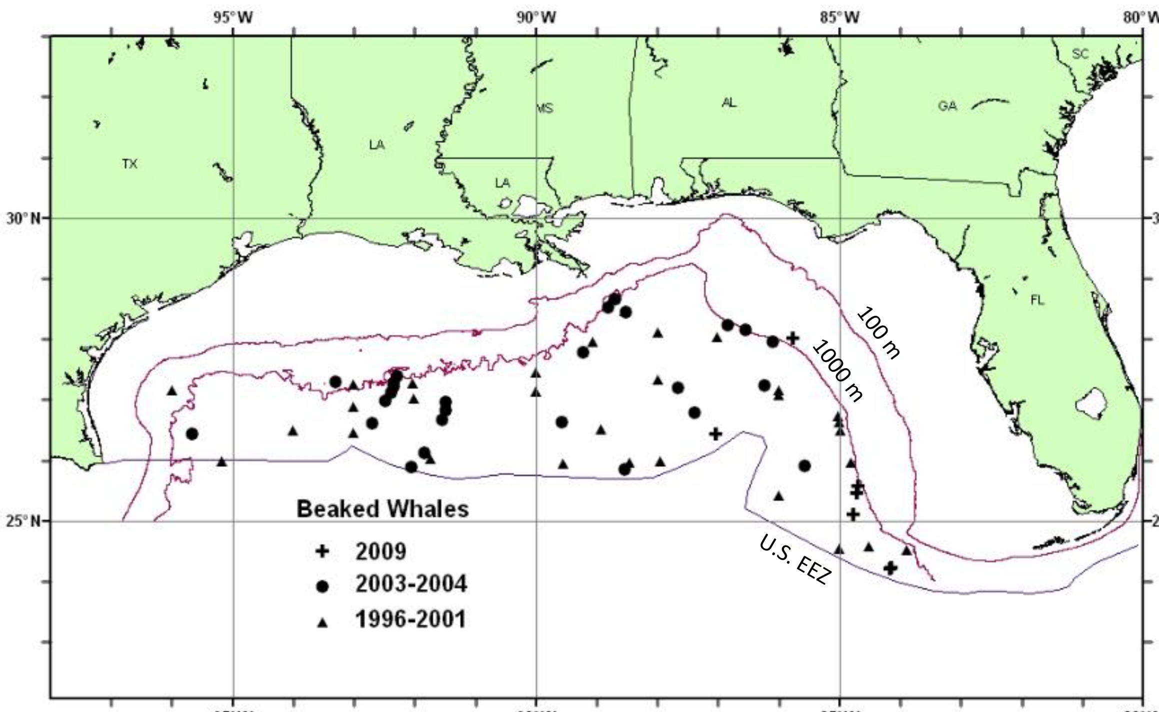


Figure 4 Distribution of beaked whale sightings from Southeast Fisheries Science Center shipboard vessel surveys during spring 1996-2001, summer 2003 and spring 2004, and summer 2009. Solid pink lines indicate the 100 m and 1000 m isobath and the solid purple line indicates the limit of U.S. EEZ, where all the surveys were performed (top panel). Note that these surveys include all beaked whales (Blainville's, Cuvier's, and Gervais'). *Figure and legend modified from the last species stock assessment report (NMFS 2012).*

2.6 Habitat

Cuvier's beaker whales prefer deep pelagic waters within the Gulf of Mexico, usually greater than 3,300 feet (1000 m) along the continental slope/edge and canyons (Schorr et al. 2014 p. 4; NMFS 2017). Past studies show the species appeared to be confined to the 10 ºC isotherm and 1000 m deep (Tyack et al. 2006 p. 4243), but recent satellite tagging studies have shown that Cuvier's beaked whale can forage in deeper waters > 1000 m (Schorr et al. 2014 p. 4), where temperature are certainly < 10 ºC. Outside the Gulf, Cuvier beaked whales can be found in tropical, subtropical and temperate waters (even boreal waters) along continental shelfs, deep banks, seamounts, and deep canyons, especially with a steep sea bottom (Baird 2016 p. 193; NMFS 2017). Cuvier's beaked whales often dive over steep geologic features, such as canyons or seamounts, generally diving along steep and hard substrate habitats, although they also spend time in areas of fine-grained sediments (Auster & Watling 2010 p. 231).

Recent studies have suggested that Cuvier's beaked whales may prefer areas with high productivity such as current boundaries, eddies, and core ring features (McSweeney et al. 2007a p. 683; Schorr et al. 2011; Lanfredi et al. 2016 p. 11; Baird et al. 2016 p. 6). A recent study that used habitat-based cetacean density models confirm the importance of the continental slope, canyons and seamounts as preferred habitat to beaked whales in the Gulf of Mexico, including Cuvier's beaked whales (Fig. 5, Roberts et al. 2016 p. 7). This study predicted that beaked whales (as a group) have a patchy distribution within the Northern Gulf of Mexico, concentrated in deep waters with high relief bathymetry (Roberts et al. 2016 p. 7), which are often associated with high prey density (Moors-Murphy 2014 p. 10). In this particular study, habitat-based models predicted a preference for near off-shelf submarine canyons at the mouth of the Mississippi River and the central region of the Gulf (Roberts et al. 2016 p. 7). Thus, deeper habitat along the continental edge, including canyons and sea mounts must be considered for critical habitat designation (Figs. 4 and 5).

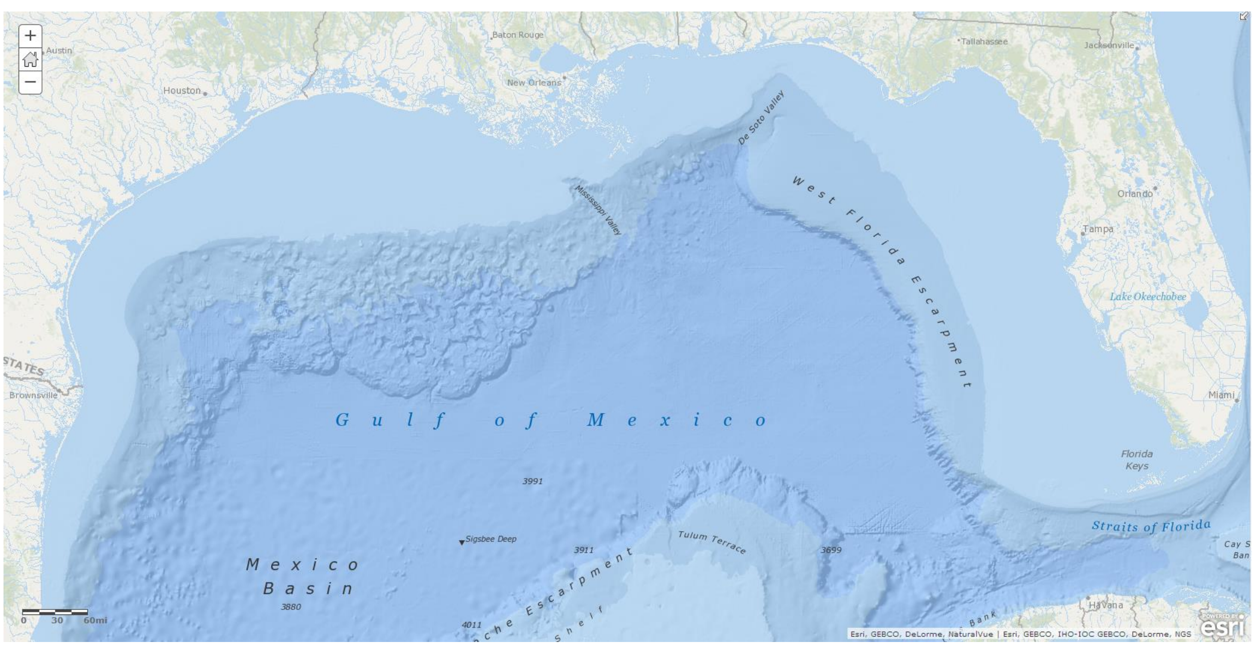


Figure 5 Northern Gulf of Mexico basin map showing the continental shelf edge, canyons and sea mounts that are preferred habitat for beaked whales. *Map created from the Ocean Basemap of ArcGIS Online.*

2.7 Behavior

Cuvier beaked whales exhibit particular and cryptic behavior. Typically found individually (mostly males) or in small groups from two to a dozen individuals, Cuvier's beaked whales are skittish and avoid approaching vessels (Baird 2016 p. 196; NMFS 2017). Relatively larger groups of up to six individuals have been reported (Baird et al. 2016 p. 6). When at the surface, the species does not display an active behavior (Heyning & Mead 2003; Schorr et al. 2014 p. 5; Baird 2016 p. 194; NMFS 2017). However, they occasionally breach and completely clear the water, which can been seen from a long distance due to their relative medium body size (Baird 2016 p. 184). Surfacing is brief with blows occurring in 20-30 seconds interval, making them barely visible to observers (NMFS 2017). Fluke displaying often occurs when the animals prepared for a deep and vertical dive, arching their backs more than normal and rolling high out of the water (Baird 2016 p. 184).

Among all deep diving marine mammals, Cuvier's beaked whale is the species with the deepest recorded dive. This species is capable of diving down to at least 2,992 m for approximately 138 minutes to feed on cephalopods (Schorr et al. 2014 p. 4). Surveys of satellite-linked tagged individuals off Southern California coast showed average deep dives of 1,401 m , with a dive duration of ~ 64 min, and an interval between deep dives of ~ 102 m (Schorr et al. 2014 p. 5). In general, deep dives can last from 40 minutes to over one hour with longer surfacing time after each dive (Tyack et al. 2006 p. 4247). Occasional back-to-back deep dives have been observed (Tyack et al. 2006 p. 4247) and surfacing bouts last an average of less than two minutes in these cases (Schorr et al. 2014 p. 4). Dives may occur during the day or at night (Baird 2016 p. 195).

See rare drone footage of Cuvier's beaked whales in the *Reserva de la Biosfera Isla Guadalupe, Mexico* from May 2017. The video shows surfacing behavior of mother and calf, and adults. The sighting of mother and calf in this area may suggest that waters around Guadalupe Island could be breeding grounds for Cuvier's beaked whales in this region.

2.8 Abundance and minimum population estimate in the Gulf of Mexico

The most current and best abundance estimate for the Cuvier's beaked whale population in the Northern Gulf of Mexico is 74 individuals (CV=1.04) from the summer of 2009 (Fig.1, Table 1, NMFS 2012a p. 126). This abundance estimate was based on oceanic line-transect surveys covering deeper waters beyond the 200 m isobath to the extent of the U.S. economic exclusive zone. The survey lines were stratified based on depth (i.e., along the same isobath) and the location of the Loop Current that reaches the Northern Gulf of Mexico (Fig. 4, NMFS 2012a p. 125). In the stock assessment report, NMFS acknowledged that this last abundance estimate was negatively biased because not all species of beaked whales counted were identified to species (NMFS 2012a). As such, the abundance estimate for unidentified beaked whales was also 74 individuals (CV=1.04), which include Blainville's (*Mesoplodon densirostris*), Cuvier's, and Gervais' (*Mesopodon europaeus*) beaked whales (NMFS 2012a p. 125). Beaked whales are often grouped together in these stocks assessment because accurate species identification is difficult due the cryptic and skittish behavior and relatively short surfacing times (NMFS 2012a p. 125).

Population abundance estimate of Cuvier's beaked whale in the Northern Gulf of Mexico has remained relatively low (30 to 95 individuals) since the early 1990s (Table 1). However, historical population levels are not known. The estimate numbers of Cuvier's beaked whales within the Northern Gulf of Mexico was 30 (CV=0.50) for the 1991-1994 period (Hansen et al. 1995 p. 15) and 95 (CV=0.47) for 1996-2001 (Mullin & Fulling 2004 p. 795). Like the last population estimate, these abundance were likely negatively biased due to the limited sightings of Cuvier's beaked whales that could be identified to species (NMFS 2012a p. 125). From 1991 to 2011, approximately 146 (CV=0.46) unidentified beaked whales were counted, which may have included several Cuvier's beaked whales (NMFS 2012a, Table 1). These earlier abundance population estimates were derived from distance sampling analysis (Buckland et al. 2001) and line-transect survey data gathered from ships throughout the oceanic portion of the Northern Gulf of Mexico, from 200-m isobath towards the U.S EEZ. Annual surveys during spring from 1991 to 1994, and from 1996 to 2001 (except 1998) were conducted along a fixed plankton-sampling trackline (Fig. 4, NMFS 2012a). These survey efforts were weighted to account to limited efforts in estimating average abundance (NMFS 2012a p. 196). In contrast, during the summer of 2003 (Jun-Aug) and spring of 2004 (Apr-Jun), surveys were conducted along transect lines across an uniformly-spaced grid (Fig. 4, Mullin 2007). The best population abundance estimate of Cuvier's beaked whales during these surveys was 65 (CV=0.67) with 337 (CV=0.40) unidentified beaked whales, which may have included an unknown number of Cuvier's beaked whales (Table 1).

Table 1 Abundance estimates for Cuvier's beaked and unidentified beaked whales from oceanic waters of the Northern Gulf of Mexico, from the 200 m isobath to the limit of the U.S. EEZ. Months and years for each survey, best population estimate of Cuvier's beaked whale (N_{Cuvier}), number of unidentified beaked whales ($N_{unID\ beaked}$). Data obtained from the last stock assessment report (NMFS 2012a).

Survey months/years	N_{Cuvier}	CV	N_{unID}	CV	Reference
Apr-Jun 1991-1994	30	0.50			Hansen et al 1995
Apr-Jun 1996-2001 (not 1998)	95	0.47	146	0.46	Mullin & Fulling 2004
Jun-Aug 2003, Apr-Jun 2004	65	0.67	337	0.40	Mullin 2007
Jun-Aug 2009	74	1.04	74	1.04	NMFS 2012

The number of Cuvier's beaked whales beyond U.S. waters but within the Gulf of Mexico is unknown. There are no reports of live Cuvier's beaked whales from Mexico or Northern Cuba waters within the Gulf (NMFS 2012a p. 125). Outside the Gulf of Mexico, Cuvier's beaked whales have a global estimated abundance of over 100,000 individuals (Taylor et al. 2008 p. 4). The global population, however, is comprised of genetically distinct populations, geographically isolated with no known movement among ocean basins, and with long-term high site fidelity (Dalebout et al. 2005 p. 3356; McSweeney et al. 2007a p. 679; Schorr et al. 2011; Baird et al. 2016 p. 6). This information may suggest the existence of potential subspecies or at least genetically isolated populations.

NMFS concluded in the last stock assessment that the minimum population estimate for the Northern Gulf of Mexico Cuvier's beaked whales was 36 individuals (NMFS 2012a p. 127). This was calculated as the value of the lower limit of the two-tailed 60% confidence interval of the log-normal distributed abundance estimate (NMFS 2012a p. 126). This estimate also equals the 20th percentile of the log-normal distributed abundance as specified in the guidelines for marine mammal stock assessment (Wade & Angliss 1997 p. 56).

The current number of Cuvier's beaked whales in the Northern Gulf of Mexico is less than 8% of the abundance that the ecosystem could support under current environmental conditions. Habitat-based density model studies predicted that the number of all beaked whale species (Blainsville's, Cuvier's, and Gervais') that the Northern Gulf of Mexico could support was ~ 2,910 individuals (Fig. 6, Roberts et al. 2016 p. 7). These models are based on available population surveys that take in consideration current physiographic covariates (e.g., depth, slope, canyons, seamounts), physical oceanographic variables (e.g., sea surface temperature, eddies, wind speed), and biological factors (e.g., chlorophyll concentration, zooplankton biomass) (Roberts et al. 2016 p. 9). Due to the difficulty to identify beaked whale species in the field, population abundance of Blainsville's and Gervais' beaked whale within the Gulf are often a combined estimate (*Mesoplodon* spp.) in stock assessments, representing 2/3 of the total beaked whales in the region (NMFS 2012b, 2012c, 2012a). Assuming that one third of the total beaked whales from habitat-based models (i.e., 2,910) are Cuvier's beaked whales, the Northern Gulf of Mexico continental shelf habitat may potentially support ~ 970 individuals. Based on the best available data, the current population estimate of Cuvier's beaked whales is 74 individuals. This represents ~ 7.6 % (74/970) of the potential abundance that the entire Northern Gulf of Mexico could support estimated from habitat-based models. However, the habitat-based population model number assumes beaked whales are uniformly distributed when habitat conditions are ideal and do not explicitly take in consideration current threats (e.g., noise, fishery interactions, pollution) and ecological interactions (e.g., competition and predation) that limit population abundance (Roberts et al. 2016). Furthermore, Roberts et al. (2016) combined three species of beaked whales and did not provide a species-specific habitat-based abundance estimate for Cuvier's beaked whales alone. As such, the potential abundance of Cuvier's beaked whales that the Northern Gulf of Mexico could support may be significantly lower due to their habitat preferences toward deep canyons and continental shelfs.

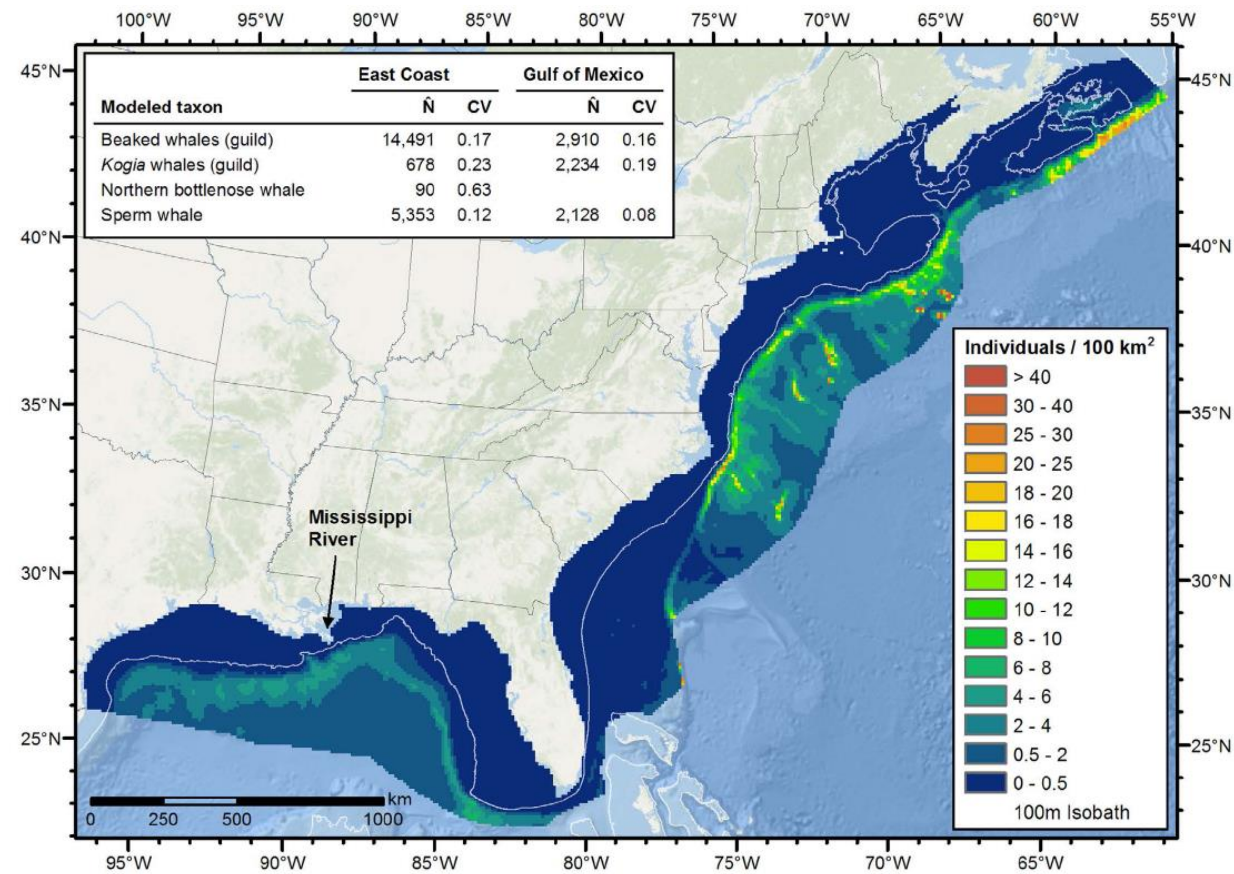


Figure 6 Predicted total number and mean density for beaked and sperm whales in the Gulf of Mexico and along the East coast of the United States and Canada. The inset table lists the estimated mean abundance (number of individuals, N) and associated coefficient of variation (CV) for each taxon. *Figure and legend modified after Roberts et al (2016).*

2.9 Current population trend in the Gulf of Mexico

Current population trend in the Gulf of Mexico is unknown based only on four abundance estimates from 1991 to 2009 (NMFS 2012a p. 126), but it is likely declining based on increasing threats in the region. To determine a potentially significant population change, population trend models should include covariates such as season, survey conditions, and survey methodology that could have a differential weight on different abundance estimates. In the last stock assessment, NMFS did not calculate population trend for this species within the Northern Gulf of Mexico within U.S. waters where all surveys have been performed (NMFS 2012a). However, the best population estimates within U.S. waters in the Gulf of Mexico have remained relatively low since the early 1990s (NMFS 2012a p. 126) and anthropogenic threats are certainly increasing (Rosel et al. 2016 pp. 23–81). Other cetacean species that face similar threats within the Gulf of Mexico have high extinction risk and are candidates or already listed under the ESA, including the endangered candidate Bryde’s whale (*Balaenoptera edeni*) (Rosel et al. 2016) and endangered sperm whale (*Physeter microcephalus*) (NMFS 2016a; Elliott 2017). Thus, given that anthropogenic threats within the Gulf are high and are predicted to increase in the near future (Muirhead et al. 2015; Sidorovskaia et al. 2016 p. 1008) and that the number of Cuvier's beaked whales have remained relatively low for almost two decades, it is likely the population trend is declining within the region.

3. The Gulf of Mexico Cuvier's beaked whale qualifies as a species under the ESA

The Gulf of Mexico Cuvier's beaked whale qualifies as species under the ESA because is a distinct population segment of vertebrate which interbreeds when mature. Under NMFS/FWS policy, a distinct population segment must be both "discrete" and "significant" to be considered for listing under the Act. The Gulf of Mexico Cuvier's beaked whale meets both of these criteria and thus is a distinct population segment under the ESA.

3.1 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 (61 Fed. Reg. 4725).

The Gulf of Mexico Cuvier's beaked whale satisfies both conditions: it is markedly separated from other Cuvier's beaked whale populations as consequences of physical and ecological factors; and is delimited by international governmental boundaries within which there are differences in management and regulations. The Gulf of Mexico Cuvier's beaked whale is physically separated from other populations of the eastern Caribbean and the northwestern Atlantic Ocean, exhibit high site fidelity, and is resident to the Gulf of Mexico because is geographically isolated from other Cuvier's beaked whales. Furthermore, NMFS has managed the Gulf of Mexico Cuvier's beaked whale as an independent stock under the Marine Mammal Protection Act since the 1990s (NMFS 2012a). The species is under more comprehensive, albeit still ineffective, regulatory mechanisms than those found in Gulf waters that belong to Mexico and Cuba.

3.1.1 Physically separated from other populations of the Atlantic basin

The Gulf of Mexico Cuvier's beaked whale is markedly and physically separated from other populations of Cuvier's beaked whales across the eastern Caribbean and Northwest Atlantic due the geographic barrier that the semi-enclosed waters of the Gulf of Mexico creates. The waters of the Gulf of Mexico are semi-enclosed by land on all sides, with two openings that lead to the Caribbean Sea through the Yucatan Channel and to the Northwest Atlantic Ocean through the Strait of Florida. The best available scientific information indicates that the Gulf of Mexico Cuvier's beaked whale remains along the continental shelf and deep water canyons of the

Northern Gulf of Mexico (NMFS 2012a) associated with its preferred habitat (Roberts et al. 2016 p. 7). Most historical and current sightings have occurred within the Northern Gulf of Mexico (Jefferson & Schiro 1997; Davis et al. 2000, 2002; Mullin & Fulling 2004; Mullin 2007; NMFS 2012a). But a limited numbers of unconfirmed sightings have been reported from pelagic waters of the Yucatan channel (Niño-Torres et al. 2015), northern Cuba (Whitt et al. 2014), or the Florida straight (Jefferson & Lynn 1994).

3.1.2 Exhibits high fidelity to the Gulf of Mexico and thus is ecologically separated

The Gulf of Mexico Cuvier's beaked whale qualifies as a distinct population segment (DPS) because is a discrete population that is ecologically separated from other populations. This indicates that ecological processes such as reproduction, communication, and foraging occurs independently from other potential overlapping or adjacent populations. The best available scientific information from regions around the world (e.g., Hawaii, Northwestern Atlantic, the Mediterranean Sea) shows that Cuvier's beaked whales exhibit high long-term site fidelity with limited migration between nearby geographic locations (McSweeney et al. 2007a p. 680; Schorr et al. 2011; Podestà et al. 2016; Baird et al. 2016).

Instructive for the Gulf of Mexico population, some studies have recorded sightings of the same individual for up to 15 years in the same location in relatively small area (McSweeney et al. 2007a p. 666). For example, a study off the Island of Hawaii, which used a long-term photographic dataset, reported resightings in multiple seasons, suggesting that Cuvier's beaked whales used this area year-round, with 40% of individuals being resighted on more than one occasion (McSweeney et al. 2007a p. 678). Long term high site-fidelity can be underestimated in Cuvier's beaked whales, because these whales are difficult to detect and body marks can change relatively quickly due to aging, encounters with predators, encounters between hostile males, and encounters with boats or fishing gear that can lead to individual misidentification (McSweeney et al. 2007a p. 668). Among individuals that were resighted in photographs with geographic coordinates, both the mean and the maximum horizontal distance between resighting locations ranged from 2.88 to 88.73 km, which is relatively small. This study provides evidence that Cuvier's beaked whales demonstrate high site fidelity (McSweeney et al., 2007).

High long-term site fidelity is strong evidence that these populations, including in the Gulf of Mexico, remain relatively isolated for neighboring populations. For example, a population of Cuvier's beaked whales showed high site fidelity in a small and open area of the Northwestern Atlantic (the Point, ~50 km off Cape Hatteras), where the Gulf Stream cross the continental shelve and veers northeast (Baird et al. 2016). Satellite tracked individuals (n=9) remained in the area for up to two months (Baird et al. 2016 p. 6). Similarly, photo-identification studies of marked individuals show that high site fidelity may extend seasons and years (A. Read unpublished data). Year-round residence in this area has also been confirmed by aerial surveys (McLellan et al. 2015). Therefore, based on the best available scientific information from other regions around the world, it is highly likely that Cuvier's beaked whales of the Gulf of Mexico also exhibits high fidelity to this region, and thus this population remains ecologically isolated from other populations of the eastern Caribbean and the Northwestern Atlantic Ocean.

3.1.3 Delimited by international governmental boundaries

The Cuvier's beaked in the Gulf of Mexico is delimited by the international governmental boundaries of Mexico and Cuba. Although the species is rarely sighted in pelagic waters of the Gulf within Mexico and Cuba, conservation measures and resources for the protection of cetaceans in these two countries are fairly limited in comparison with those of the United States. There are markedly differences in control of exploitation, habitat management, and regulatory mechanisms among these countries that are highly significant in light of section 4(a)(1)(D) of the ESA (see section below on inadequacy of regulatory mechanisms).

3.1.4 Constitute a marine mammal stock under the MMPA

Furthermore, the Gulf of Mexico Cuvier's beaked whale constitutes provisional stock under the Marine Mammal Protection Act (MMPA). Under the MMPA, a population stock is defined as "a group of marine mammals of the same species or smaller taxa in a common spatial arrangement that interbreed when mature" (16 U.S.C. § 1362(11)). Guidelines elaborate that a stock "identifies a demographically isolated biological population," which means that "the population dynamics of the affected group is more a consequence of births and deaths within the group (internal dynamics) rather than immigration or emigration (external dynamics)" (NMFS, 2005). In other words, the "exchange of individuals between population stocks is not great enough to prevent the depletion of one of the populations as a result of increased mortality or lower birth rates." (NMFS 2005).

NMFS has treated the Gulf of Mexico Cuvier's beaked whale population as a separate stock for management purposes since marine mammal stock assessment reports started in 1995 (NMFS 2012a), pursuant to the MMPA (16 U.S.C. § 1386). NMFS divided the biological species of Cuvier's beaked whales in several management units (stocks) based on distinct oceanographic regions (Wade & Angliss 1997 p. 11; Moore et al. 2011 p. 22). These management units include Cuvier's beaked whales from Alaska, California-Oregon-Washington, Hawaii, Puerto Rico and the U.S. Virgin Islands, Western North Atlantic, and the Northern Gulf of Mexico. To designate management 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. The classification of the Cuvier's beaked whale in the Northern Gulf of Mexico was based on distributional data. NMFS considers the stock as "strategic" due to uncertainty regarding population size, direct evidence of mortality caused by human activities, and injuries related to acoustic pollution (e.g., sonar) (NMFS 2017). While stock determinations under the MMPA differ from DPS analysis under the NMFS/FWS policy, the classification of the Gulf of Mexico Cuvier's beaked whales as a stock, partially delimited by international boundaries, supports the analysis that the population is discrete and can be classified as a distinct population segment under the ESA.

3.2 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:

A. Persistence of the discrete population segment in an ecological setting unusual or unique to this taxon;
B. Evidence that loss of the discrete population would result in a significant gap in the range of a taxon;
C. 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;
D. Evidence that the discrete population segment differs markedly from other populations of the species in its genetic characteristics.

The Gulf of Mexico Cuvier's beaked whale meets at least two of these significance criteria (A and D), as well as other criteria that highlight the significance of the population.

3.2.1 Discrete population segment in an ecological setting unique to this taxon

Cuvier's beaked whales within the Gulf of Mexico are a discrete population segment with high long-term site fidelity in an ecological setting unusual or unique to this taxon. Although Cuvier's beaked whales are distributed throughout the world, most genetically unique populations inhabit relatively open oceanic pelagic regions (e.g., Eastern North Atlantic, Western Tropical Atlantic, Eastern-Central North Pacific, Western North Pacific, South Pacific, Indian Ocean) (Dalebout et al. 2005 p. 3355). However, the Cuvier's beaked whale population in the Gulf of Mexico (as well as the in the Mediterranean Sea) occupies a semi-enclosed body of water with unique geomorphological characteristics (e.g., canyons, sea mounts) (Gardner et al. 2007; Harris & Whiteway 2011), physical oceanographic conditions (e.g., temperature, surface and deep currents, eddies) (Sturges & Lugo-Fernandez 2005), chemical oceanographic conditions (e.g., oxygen distribution) (Rabalais et al. 2002), and biological oceanographic conditions (e.g., chlorophyll concentration, primary productivity) (Rabalais et al. 2002), which are markedly different from major ocean basins. These unique oceanographic conditions within the Gulf of Mexico drive unique ecological settings for Cuvier's beaked whales in this region. Therefore, the Gulf of Mexico population of Cuvier's beaked whale occupies an ecologically unique area, geographically and ecologically separated from other populations of the same taxon and satisfies the first criterion for significance.

Cuvier's beaked whales in the Gulf of Mexico use a diversity of deep habitats for foraging, including continental shelf and slopes, canyons and depressions, and sea mounts unique of the northern Gulf. These habitats have a high diversity of marine life and are ecologically distinct from other marine ecosystems because the unique physical, chemical and biological conditions of the region. For example, the collision of the warm loop current, which reaches the Northern Gulf of Mexico, with the western continental shelf produce transitions zones that are reach in nutrients, increasing productivity (Biggs 1992; Vidal et al. 1992) and thus potential food supply for cetaceans including beaked whales (Davis et al. 2002 p. 137). The resulting seasonal cycles of productivity are critical for supporting lower trophic levels, and thus the entire food web that Cuvier beaked whales depend on. These seasonal cycles may explain the difference in spatial and temporal density distribution found by seasons for beaked whales within the Gulf (Hildebrand et al. 2015 p. 2).

3.2.2 Genetically distinct from other Cuvier's beaked whales

The Gulf of Mexico Cuvier's beaked whale is likely genetically distinct from other Cuvier's beaked whales from the Atlantic Ocean populations as studies suggest genetic differentiation among ocean basins, high degree of geographic isolation, and high basin-home fidelity. The genus *Ziphius* is a single independent genetic entity highly differentiated from other beaked whale species (Dalebout et al. 2004 p. 459, 2005 p. 3362). A global study of Cuvier's beaked whales, using control region sequences of mitochondrial DNA (mtDNA) of tissue samples collected around the world (from stranding events, incidental fisheries, biopsies, and whale-meat markets), showed strong haplotype frequency differences among ocean basins, indicating strong phylogeographic patterns (Dalebout et al. 2005 p. 3362). In this study, an analysis of molecular variance also showed high differentiation among ocean basins, confirming the phylogeographic differences (Dalebout et al. 2005 p. 3360). The authors concluded that based on mtDNA sampling, Cuvier's beaked populations of the North Atlantic Ocean, Mediterranean Sea, North Pacific, and Southern Hemisphere are genetically different and highly isolated (Dalebout et al. 2005 p. 3360). Dalebout et al. (2005) collected only one sample from the Gulf of Mexico (Texas) and thus they could not differentiate this population from the rest of the Western Atlantic. Thus, the best available science indicates that Cuvier's beaked whales in the Gulf of Mexico are distinct and highly isolated from populations of the North Atlantic based on genetic differences among ocean basins, high degree of isolation, and high site-fidelity that can be inferred from this and other studies (Dalebout et al. 2005; McSweeney et al. 2007b; Schorr et al. 2011; Baird et al. 2016).

4. Threats to the species and factors for listing

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 now or in the foreseeable future. 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 Cuvier's beaked 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.

4.1 Present or threatened destruction, modification, or curtailment of its habitat or range

4.1.1 Impact of oil, fumes and dispersant from the Deepwater Horizon spill

Cuvier's beaked whales, as other cetaceans, are vulnerable to toxic contamination by petroleum compounds and dispersants throughout the Gulf of Mexico. In general, the severity of oil and dispersant exposure impact on marine cetaceans depend on the chemicals involved, amount, exposure time and frequency, exposure routes (e.g., direct skin contact, inhaled, ingested, or absorbed), and the physiological and health conditions of the animal when exposure occurs (Geraci 1990). Direct external contact with oil and dispersants can cause skin irritation, chemical burns, and promote infections (Wise et al. 2014 p. 336). Inhalation of volatile compounds from oil and dispersant fumes can cause tissue irritation and injuries of the respiratory tract that could lead to pneumonia, lung inflammation, and irreversible damage of the nervous system such as adrenal toxicity (Schwacke et al. 2013 p. G, 2017 p. 275; Venn-Watson et al. 2015 p. 23; Smith et al. 2017 p. 132). Ingestion of petroleum compounds and dispersants can also cause injures of the gastrointestinal tract affecting digestion and food assimilation (Aichinger Dias et al. 2017 p. 120). Absorption of oil compounds and dispersants can damage the normal functioning of internal organs such as the kidneys, liver, and the brain, as well as causing short to long-term physiological dysfunctions such as immune suppression, anemia, reproductive failure, and decrease survival rate (Geraci 1990, NOAA 2010b).

The main and direct impact that this population has faced related to this threat was the oil spill and associated cleaning activities of the *Deepwater Horizon* drilling platform disaster, which exploded and sank in April 2010 (Aichinger Dias et al. 2017 p. 121). This oil spill was the largest in U.S. history where ~ 4.9 million barrels of crude oil gushed out of the wellhead for 87 days and into the Northern Gulf of Mexico waters (DHSG 2011). During and after the oil spill, aerial surveys reported several species of marine mammals swimming and directly affected by the oil slick that included bottlenose dolphins, Risso's dolphins, spinner dolphins, spotted dolphins, striped dolphins, and sperm whales (DHSG 2011; DHNRDA Trustees 2016 pp. 1–5; Aichinger Dias et al. 2017). Based on passive acoustic monitoring, Cuvier's beaked whales were detected in several sites within the large spill zone during and following the Deepwater Horizon oil spill (2010-2013), and thus it is highly likely that they were also directly affected by the oil spill and dispersant envelope (Hildebrand et al. 2015 p. 2). In fact, reports indicated that at least 13 beaked whales were directly affected by the oil footprint, including a confirmed Cuvier's beaked whales next to the Deepwater Horizon sinking platform (Aichinger Dias 2015 p. 2). The number of Cuvier's beaked whales stranded due to the Deepwater Horizon spill is not known, but at least 1,141 cetaceans were stranded (5% alive, and 95% dead) from 2010 to 2014 in response to the spill (NOAA Fisheries 2016).

Response activities to oil spills also harmed marine life and gulf ecosystems due to the extensive use of surface and demersal dispersants, in-situ surface oil burning, and frequent vessel traffic.

The oil spill and response impacted and is still impacting the entire marine food web of the northern Gulf from tiny marine invertebrates, to fish, reptiles, birds and marine mammals found from deeper ecosystems to shallow coastal areas (Wise Jr et al. 2014, 2014; DHNRDA Trustees 2016; Aichinger Dias et al. 2017; Kellar et al. 2017; Peterson et al. 2017). It is highly likely that the Gulf environment will be contaminated for decades because strong evidence suggest that contamination still remains in areas that has been impacted by oil spills many decades ago such as Prince William Sound, Alaska by the Exxon Valdez disaster (Peterson et al. 2003 p. 2082).

There is not information on status and population abundance data after 2009 and thus it is unknown the extent that the Cuvier's beaked whale population was or has been affected during and after this major oil spill. However, passive acoustic monitoring data collected during and following the spill provides some limited information of potential impacts (Hildebrand et al. 2015 p. 9, 2016 p. 8). Based on passive acoustic monitoring, Cuvier's beaked whales (as other beaked whales) were detected in the area of the spill, at low density during the summers after the spill, and higher densities during the winter from 2010 to 2013, especially in the northeastern part of the Gulf (Fig. 7, Hildebrand et al. 2015 p. 2). Thus, Cuvier's beaked whales were highly likely to have been exposed to oil and dispersant, particularly within the Mississippi Canyon, an area predicted to be an important habitat for foraging (Roberts et al. 2016 p. 7).

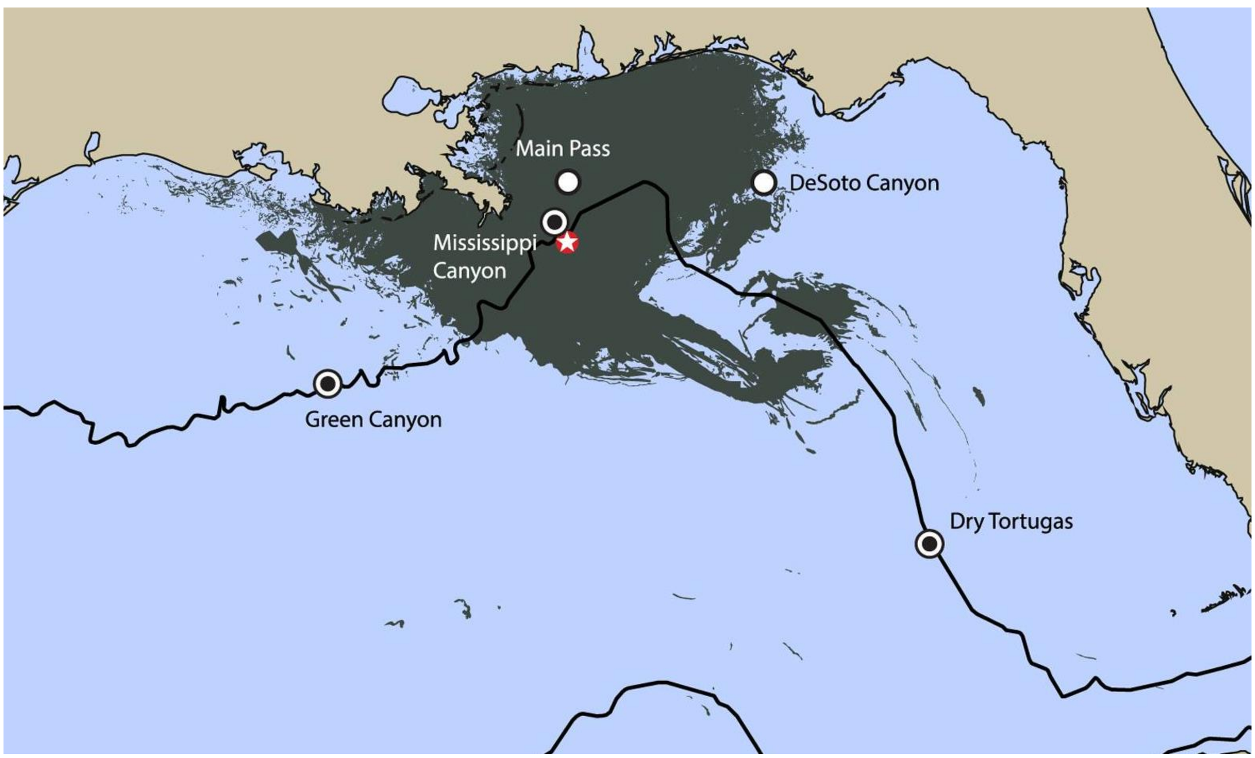


Figure 7 Three sites in the Gulf of Mexico with detections of beaked whales (dot within circle): Green Canyon, Mississippi Canyon, and Dry Tortugas; and two sites with no beaked whale detections (open circle): Main Pass, and DeSoto Canyon. *Figure and legend modified after Hildebrand et al 2015.*

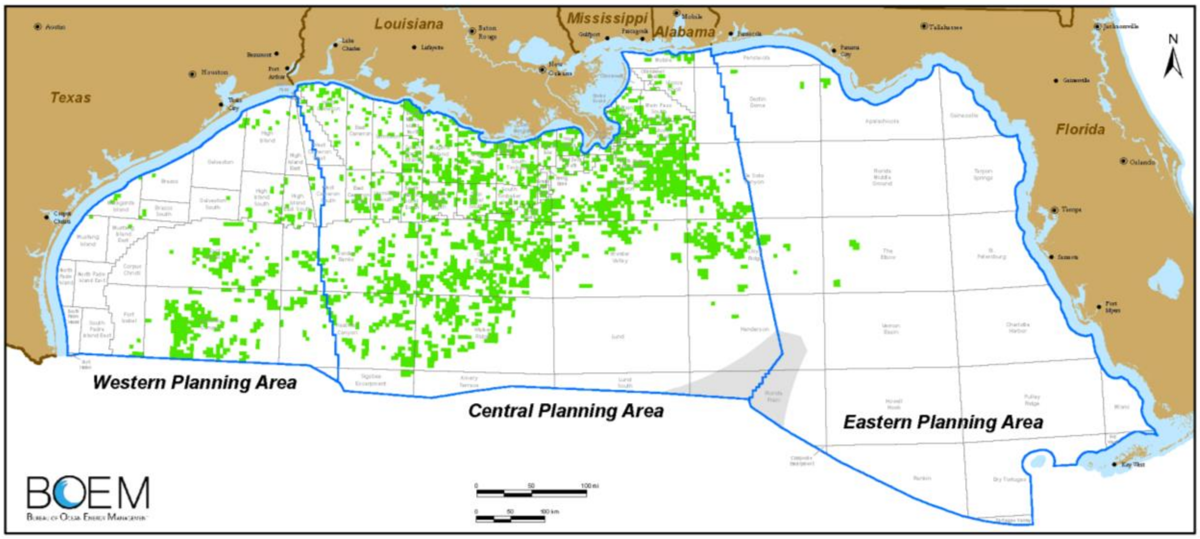
Dispersants used in oil spill cleanups can also be directly and indirectly toxic for deep diving cetaceans (Wise et al. 2014 p. 337), and their direct and indirect impact on Cuvier's beaked whales around the Macondo well site may have been underestimated. Dispersants can also make oil spill more toxic and bio-available for marine species (Ramachandran et al. 2004 p. 301; Schein et al. 2009 p. 600). During the Deepwater Horizon cleanup, ~766,099 gallons of dispersants were deployed to break up large oil slicks at the water surface (e.g., Corexit 9527 and 9500A) and at the wellhead spill site (e.g., Corexit 9500A) (Kujawinski et al. 2011). The release of bottom dispersants such as Corexit 9500A was extensive, and the chemical was detected more than 300 km from the wellhead at a depth of approximately 1,100 m, after 64 days of being used (Kujawinski et al. 2011), well within the preferable forage depth of Cuvier's beaked whales (Santos et al. 2001; Schorr et al. 2014). Dispersant use in the Gulf of Mexico during the Deepwater Horizon spill were cytotoxic and genotoxic on cultures skin cells of sperm whales (a deep diving cetacean) (Wise et al. 2014 p. 337). Furthermore, dispersants such as Corexit at concentration as low as 14.5 mg/L can be toxic to fish, mollusk, and crustaceans (Mitchell & Holdway 2000; Wise & Wise 2011) that may be potential prey for Cuvier's beaked whales in deep waters. Bioaccumulation to toxic chemical through the food web is a major threat that will take decades to measure and may slowly have negative effects on these whales by disrupting growth, reproduction and decreasing survival. As discussed below, cetaceans are particularly vulnerable to toxic chemicals and persistent organic pollutants due to the direct trans-placental and lactational transference of blood and milk from the mother to calf during gestation (Metcalfe et al. 2004 p. 259; Bachman et al. 2014 p. 122)

In summary, the best available scientific and commercial information suggest that the Deepwater Horizon oil spill and response activities directly and indirectly harmed the Gulf of Mexico Cuvier's beaked whales. The species status review team should investigate more into this topic.

4.1.2 Risk of injury and contamination from oil and gas production will increase

The risk of injury associated with oil and gas exploration and exploitation activities (e.g., vessel strikes, oil spills, marine noise, toxic pollution, etc.) will certainly increase in the future, jeopardizing the survival of Cuvier's beaked whales and the habitat they depend on. The Northern Gulf of Mexico has the highest concentration of oil and gas wells of the entire continent, with a monthly average of ~ 33 active wells in 2015 (U.S. Energy Information Administration 2015), but more than 27,000 wells abandoned by the U.S. government and industries (The Associated Press 2010). However, there are approximately 15,444,793 acres leased with 2,912 active leases in the Gulf of Mexico, where exploration and extraction is currently happening (Fig. 8). The probabilities of major oil spills within active leased areas are high. Since active leased areas cover most of the preferable habitat of Cuvier's beaked whales (Fig. 6 and 8), the negative direct and indirect impacts on Cuvier's beaked whale is also high.

The less exploited northeastern Gulf of Mexico could become heavily targeted for oil and gas exploration and exploitation in the near future. Those activities will increase the risk of injury for marine animals, particularly cetaceans within an area that today has relatively few oil wells. This is particularly relevant as the current U.S. administration is already opening new areas in the Gulf of Mexico for leasing at reduced royalty rates (Oil & Gas 2017). The Bureau of Ocean Energy Management (BOEM) estimated that the northeastern Gulf of Mexico has a possible yield of 4.3 billion barrels of oil and 21.51 trillion cubic feet of gas (Humphries 2013 p. 2). Leases may be offered throughout the eastern region after a congressional moratorium for the entire eastern Gulf of Mexico expires in June 2022. BOEM already intends to lease 10 new blocks within the western and central Gulf from 2017 to 2022 (BOEM 2017a), and it is expected that oil and gas exploration and extraction will considerably increase elsewhere in the Gulf in the coming years. The opening of the eastern planning area will increase injury risk for Cuvier's beaked whales and other cetaceans in the near future.



Planning Areas	Total Blocks	Total Acres	Number of Leases	Acres Leased
Western	5,240	28,576,813	452	2,554,002
Central	12,409	66,446,351	2,426	12,690,121
Eastern	11,537	64,357,859	37	200,670
Sub-Totals	29,186	159,381,023	2,915	15,444,793
CPA / EPA Shared Blocks*	(86)		(3)	
Totals	**29,100**	**159,381,023**	**2,912**	**15,444,793**

Active Lease
Exclusive Economic Zone
Northern Portion of the Eastern Gap
Planning Area Boundary

* CPA and EPA contain 86 shared blocks of which 3 are leased. These blocks are given both a CPA and EPA designation in the data which accounts for a higher block total.

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Figure 8 Blocks and active leases by planning areas of the Gulf of Mexico OCS region. Note how the active leased areas (green) overlap the preferred habitat of Cuvier's beaked whale based on observations (see Fig. 4), and predicted from habitat-based models (see Fig. 6, Roberts et al. 2016). *Map and data as of August 1, 2017(BOEM 2017)*

4.1.3 Potential for increased levels of other toxic chemicals

Cetaceans, including Cuvier's beaked whales are vulnerable to bioaccumulation of contaminants due to their long-lived status as predators. Persistent organic pollutants (POPs) from agricultural runoff and oil and gas exploration and extraction activities, and toxic chemicals in produced waters from oil and gas exploration are among the most common contaminants that cetaceans are exposed in the Gulf of Mexico.

POPs are organic molecules that have been increasing in marine and terrestrial environments for several decades. Studies have suggested that POPs cause immunosuppression in delphinoid cetaceans, including species from the Gulf of Mexico (Houde et al. 2005 p. 39; Krahn et al. 2007 p. 1907; Kucklick et al. 2011 p. F; Balmer et al. 2015). For example, Kucklick et al. (2011) found POPs in bottlenose dolphins blubber from several sampling locations throughout the Gulf of Mexico. Some POPs are widely present in industrial and commercial products that are used in oil and gas exploration and extraction activities and agriculture. Contaminant levels in the Northern Gulf of Mexico are high, particularly across the Mississippi delta due to the heavy influx of polluted freshwater from the river basin.

Cuvier's beaked whales in the Gulf of Mexico are also exposed to high concentrations of produced waters – a complex pollutant associated with oil and gas productions that contain several chemicals toxic to aquatic life. The composition of produced waters can include thousands of chemicals with environmental concerns that vary in concentration. These compounds include dispersed oils, aromatic hydrocarbons and alkylphenols, heavy metals, biocides, corrosion inhibitors, emulsion breakers, coagulants, oxygen scavengers, and naturally occurring radioactive materials (Neff et al. 2011 p. 3). Most common metals in produced waters are arsenic, cadmium, copper, chromium, lead, mercury, nickel, and zinc (Bakke et al. 2013 p. 155). In addition, produced waters can contain substantial amounts of organic material, inorganic salts, small particles, organic acids (e.g., acetic acid and propionic acid), and can have high levels of sulfur and sulphide (Bakke et al. 2013 p. 155).

Several compounds in produced waters are known to have negative biological effects. The effects of produced waters on marine organisms have been mostly studied in fish and invertebrates. Polycyclic aromatic hydrocarbons and alkylphenols, which are abundant in produced waters, are potent carcinogens causing DNA damage (Aas et al. 2000 p. 241) and may lead to oxidative stress in fish (Hasselberg et al. 2004 p. 103; Sturve et al. 2006 p. S73). In additions, these compounds can cause cardiac function defeats (Incardona et al. 2004), embryotoxicity in fish (Carls et al. 2008), reduction of lysosomal membrane stability in kidney cells (Holth et al. 2011 p. 127), and neoplasia of fish liver (Myers et al. 1991). In particular, Alkylphenols in produced waters have hormone-disrupting effects in fish (Arukwe et al. 2000 p. 159, 2001 p. 7; Meier et al. 2007 p. 214), can change the lipid composition in hepatic cells of free-living Atlantic cod and haddock (Grøsvik et al. 2010), lead to cytotoxicity in liver cells in rainbow trout (Tollefsen et al. 2008), disrupt normal larval pigmentation and increase jaw deformities in Atlantic cod, which reduces feeding ability and results in larval mortality (Meier et al. 2010 p. 2). Similarly, chemicals in produced waters have sublethal and lethal effects on marine invertebrates. For example, chronic exposure to produced waters causes somatic growth reduction and mortality in sea scallops (Cranford et al. 1999 p. 246), DNA damages on mussels (Brooks et al. 2011).

Toxic chemicals accumulated in fish and invertebrates can be transferred to higher trophic levels through the food web and bio-accumulate in top predators such as Cuvier's beaked whales. Furthermore, produced waters undergo several changes following discharge to the ocean including, dilution, biodegradation, adsorption, evaporation, and photo-oxidation (Neff 2002). These transformation processes may produce other chemicals that are more bioavailable and toxic for marine organisms than the original chemicals and can transfer through the food web to cetaceans such as Cuvier's beaked whales (Fig. 9). The rate of biodegradation of chemicals in produced waters is thought to be variable and mostly unknown but it depends on the persistence of the chemicals in the water column (Neff 2002).

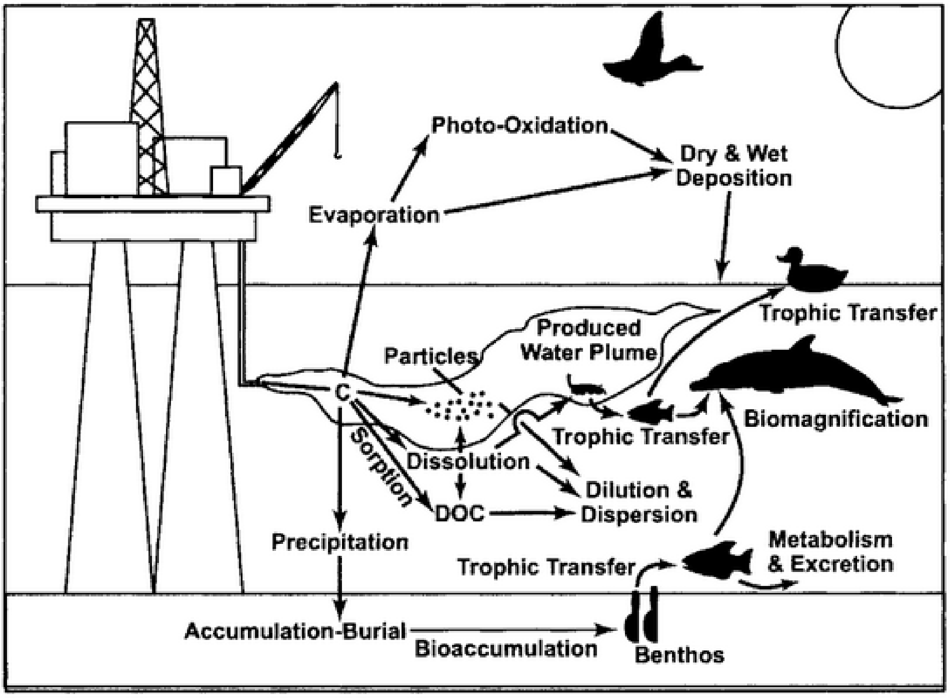

Figure 9 Environmental fates of inorganic and organic chemicals (C) from produced water in seawater following the discharge of treated produced water to the ocean. *Figure and legend after Neff (2002).*

Habitat degradation due to produced waters is high near outfalls (and decreases with distance) affecting more marine organisms closer to the pollution source. Most produced waters contain relatively high concentration of several metals with barium, iron, and manganese being the most abundant (Neff 2002). These metals tend to rapidly precipitate from the plume, forming barium sulfate and oxides of iron and manganese on sediment surfaces over large areas around the produced water discharges. Evidence suggests that effects of discharges of produced waters in the water column and on the seabed are local and in general have higher impacts within 1 or 2 km from the outfall sources (Bakke et al. 2013). However, the published literature has not yet been able to demonstrate with high confidence that the effects of produced waters are only local. Studies have shown that benthic communities require at least 5-10 years to recover from wastes accumulated on the seabed from produced waters (Bakke et al. 2011, 2013).

The discharge of produced waters associated with oil and gas productions also creates a plume of pollution in the water column, which directly impact marine organisms in its path. Negative biological effects of produced waters following discharge depends on discharge temperature, density of produced water, current speed, mixing regime, depth of the outfall, water column stratification, and seasonal environmental conditions (Brandsma & Smith 1996; Neff 2002). In general, produced waters dilute quickly upon discharge in well-mixed marine waters (Neff 2002). Modeled dilutions of produced waters discharged to the Gulf of Mexico vary greatly depending on discharge rate and current speed (Brandsma & Smith 1996). For example, under typical conditions in the Gulf of Mexico, concentration of produced waters at 100 m from the outfall and similar current speed, is up to 0.1 % with typical discharge rates of 115,740 liters per day, and as high as 0.3 % with maximum allowable discharge rates of about 4 million liters per day (Brandsma & Smith 1996). Plume dilution generally slows down during slack currents and increases during strong currents.

Some produced waters are highly buoyant and the plume spread as a thin layer of one or two meters thick on the water surface with limited vertical or lateral dispersion in very calm waters. This dilution pattern is particularly harmful for cetaceans that surface often and can be directly exposed to high concentration of produced waters. Clearly, marine organisms close to discharge points are exposed to the highest chemical concentrations. Most laboratory and field studies show that substantial biological impacts on pelagic aquatic organisms are limited to a distance of less than one kilometer from the outfall due to dilution and exposure time (Bakke et al. 2013). However, most studies have a limited sensitivity capacity to detect impacts of produced water at very low concentrations.

4.1.1 Hypoxia and dead zones

Hypoxia related to seasonal dead zones indirectly affects Cuvier’s beaked whales in the Northern Gulf of Mexico by disrupting the food web that their principal prey such as cephalopods and mesopelagic fish depend on. The Northern Gulf of Mexico is infamous for its seasonal and geographically large dead zone to the west of the Mississippi delta related to agriculture runoff (Rabalais et al. 2002; Diaz & Rosenberg 2008). In July of 2017, the Gulf of Mexico dead zone reached the biggest area ever recorded with ~8,776 square miles of ocean, an area the size of New Jersey (Fig. 10, NOAA 2017).

The direct impacts of the seasonal dead zone on Cuvier’s beaked whales have not been studied, but it has been demonstrated that hypoxia across this large geographically scale has tremendous negative effects for the entire food web of the northern Gulf shallower areas with ecological and economic consequences for the region (Craig et al. 2001; Bianchi et al. 2010; Rabotyagov et al. 2014). Among the major ecological impacts are changes in the distribution and abundance of demersal fish and invertebrate biomass that may affect species higher in the food web (Keller et al. 2010; Craig 2012). Aerial survey sightings indicates that large-scale hypoxia during the summer months significantly changes the distribution patterns of seas turtles and bottlenose dolphins in the northwestern Gulf of Mexico (Craig et al. 2001). Hypoxia has also been predicted to reduce the total biomass of one of the most important fisheries in the Gulf, the red snapper (*Lutjanus campechanus*) (de Mutsert et al. 2016). Hypoxia can also amplify the effects of ocean acidification, reducing potential prey abundance (Melzner et al. 2012; Chan et al. 2016; Gobler & Baumann 2016).

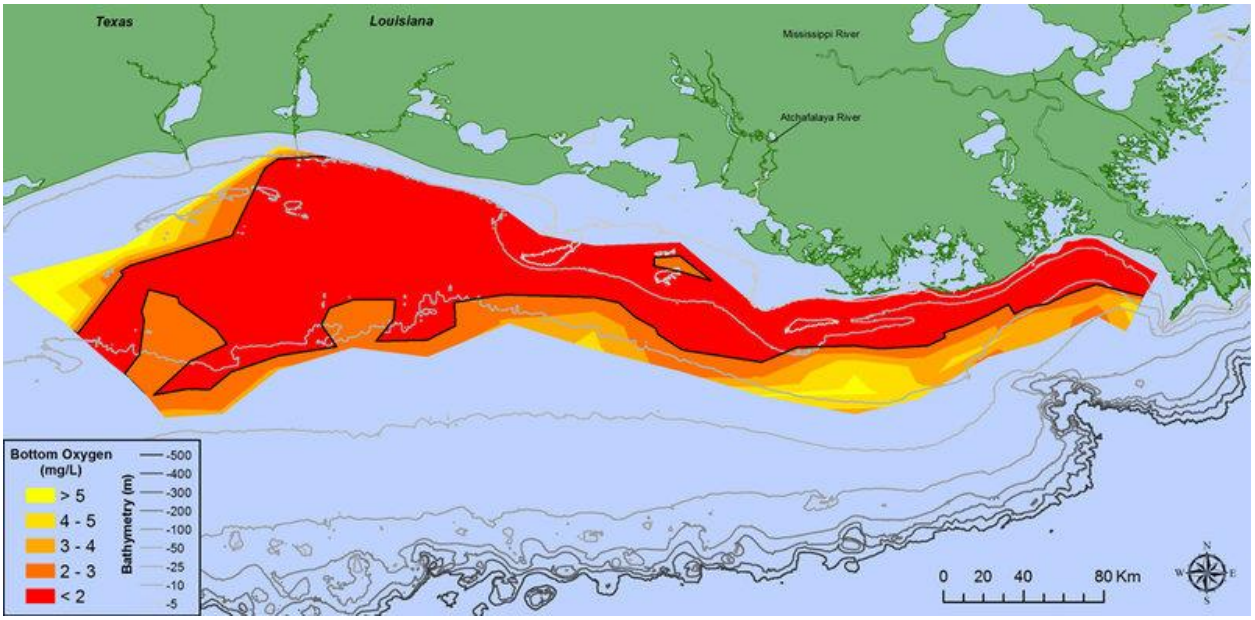

Figure 10 Distribution of the dead zone in the Northern Gulf of Mexico measure as bottom oxygen concentration in mg/L as in July 2017 when it reached the biggest area ever recorded with ~8,776 square miles of ocean. *Map from NOAA.*

4.2 Over-utilization for commercial, recreational, scientific, or educational purposes

While Cuvier's beaked whales have not been directly targeted in recreational or commercial fisheries within the Gulf of Mexico, the species has been taken as bycatch in fisheries across Caribbean Islands (Jefferson et al. 1993; Heyning & Mead 2003). Fishing-related mortality for this species is mostly unknown in the Gulf of Mexico. Although there was no reported fishing-related mortality of Cuvier's beaked whales from 1998 to 2010 or strandings from 2006 to 2010 in the Gulf of Mexico, (NMFS 2012a); existing data are limited and likely underestimate the magnitude of mortality or injuries related to fisheries. Underestimates result because not all individuals that die are found, reported, or wash ashore; and for those that are found and studied is often difficult to determine the cause of death.

4.3 Disease or predation

Several diseases including parasite and virus infections have been reported to affect Cuvier's beaked whales. For example, severe chronic arteritis in Cuvier's beaked whales has been associated with renal parasitism by nematodes (Díaz-Delgado et al. 2016). Adult nematodes from the species *Crassicaula* sp have been found in renal arteries and veins, the renal parenchyma, and ureter of stranded Cuvier's beaked whales in the Canary Islands (Díaz-Delgado et al. 2016). This parasitic condition leads to vascular compliance, chronic renal disease, predisposition to development of disseminated intravascular coagulation, and multi-organ failure (Díaz-Delgado et al. 2016). In addition, cetacean morbillivirus, which often causes stranding and mortality in dolphins (Domingo et al. 1990) and in some whale species (Van Bressem et al. 2014; West et al.

2015), has been found for the first time in a subadult Cuvier's beaked whales stranded at Molakaii in Hawaii (Jacob et al. 2016 p. 218) and in a calf stranded on the Southern Italy coast (Centelleghe et al. 2017). Similarly, herpesvirus infection with severe lymphoid necrosis was the cause of death found in an adult female stranded in the Canary Islands in 2010 (Arbelo et al. 2010). The prevalence and impact of parasitic and virus infections on Cuvier's beaked whale population in the Gulf of Mexico is unknown.

Diffused hemorrhages and gas bubble-associated lesions and fat embolism are conditions often found in mass stranded individuals following naval sonar activities. Lesions in Cuvier's beaked whales similar to those of acute decompression-sickness-like disease in humans and lab animals have been commonly found in mass stranded individuals associated with acute acoustic impacts such as active sonar (Jepson et al. 2003, 2005; Fernández et al. 2005). Decompression sickness signs are often expressed as diffuse hemorrhages around the acoustic jaw fat tissue, ears, brain, kidneys, as well as, gas bubble–associated lesions and fat embolism in blood vessels and parenchyma tissue of vital organs such as the brain and spinal cord (Fig. 11, Fernández et al. 2005 p. 450). Such signs are the direct results of physical harm by mid-frequency sonars and the product of rapid ascends that facilitate the formation of nitrogen bubbles in bloods vessels and tissue (Rommel et al. 2005; Costidis & Rommel 2016).

Predation of Cuvier's beaked whales may be opportunistic. Large apex predators such as tiger sharks and white sharks are natural predators of Cuvier's beaked whales (Baird 2016). For example, there is evidence of Cuvier's beaked whales in Hawaii with wounds from large sharks (Baird 2016) and Cuvier's beaked whales have been killed by white sharks in the west coast of the United States (Long & Jones 1996). In the Gulf of Mexico, tiger and white sharks are likely to prey on Cuvier's beaked whales. Small predators such as cookiecutter sharks often prey on Cuvier's beaked whales, including in the Gulf of Mexico (Pérez-Zayas et al. 2002; Cárdenas-Hinojosa et al. 2015; Baird 2016), leaving obvious scars on most (if not all) individuals identified (Fig. 3).

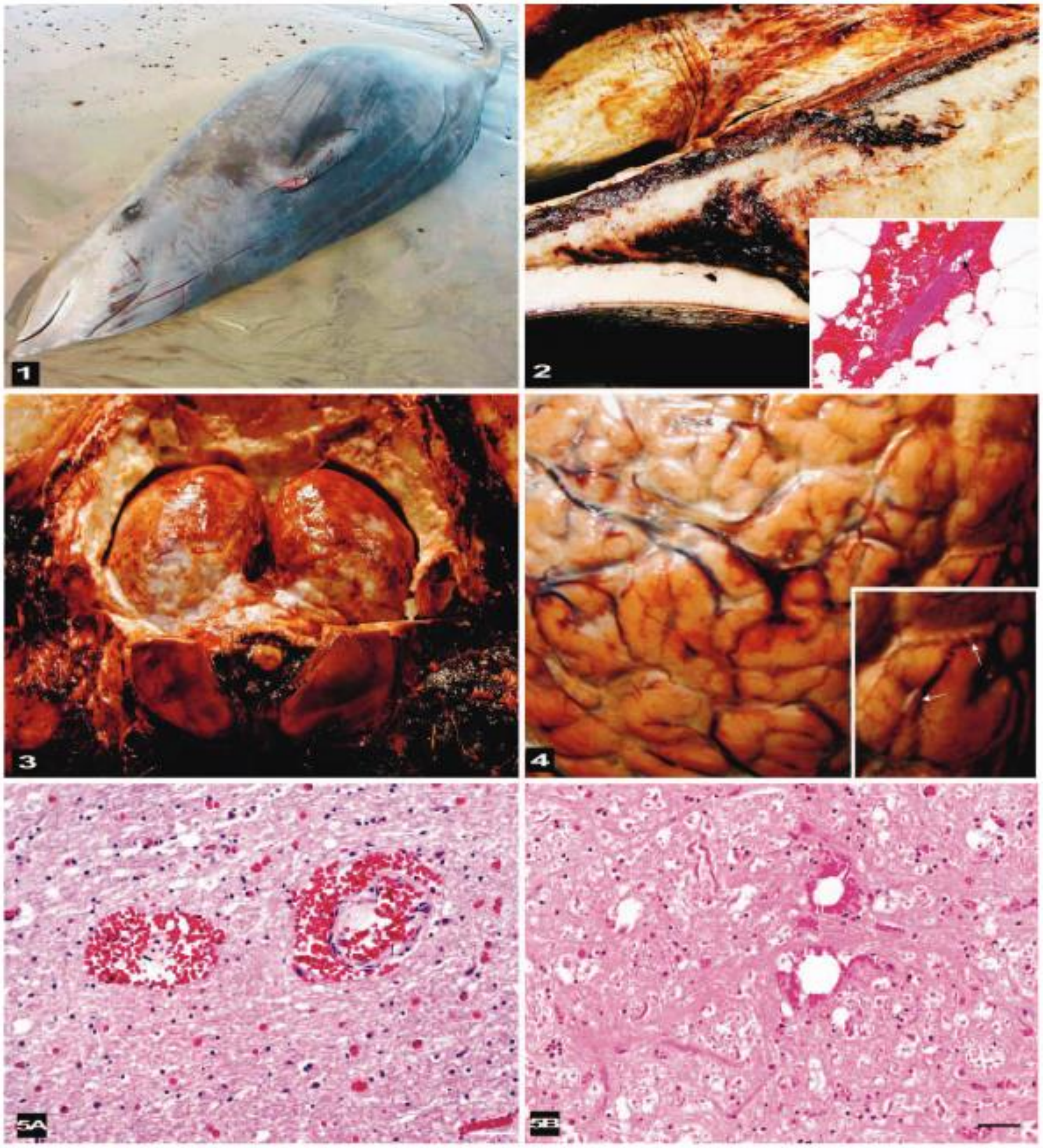

Figure 11 Signs of physical harm and decompression sickness found in stranded Cuvier's beaked whales following naval sonar activities. (1) A freshly stranded Cuvier's beaked whale (*Ziphius cavirostris*) without cutaneous lesions that would be an indication of collision trauma, terminal struggling, or predation. (2) Mandible of beaked whale with hemorrhage in the acoustic fat of the jaw. Inset: Photomicrograph of perivascular hemorrhage in the acoustic fat with non-staining, intravascular bubbles/emboli (arrow) (bar = 25 µm). (3) The exposed caudal aspect of the brain and spinal cord shows congestion of the meninges and severe congestion and hemorrhage in the epidural, vascular plexus around the spinal cord. (4) Cerebral cortex of beaked whale showing how the gyri of the cortex are swollen and have focal, subarachnoidal hemorrhaging. Inset: Intravascular gas bubbles (arrows) are prominent within a meningeal

vessel. (5a) Brainstem of beaked whale with hemorrhage surrounds two blood vessels. Note that numerous capillaries are congested (bar = 25 µm). (5b) Erythrocytes within a hemorrhage are disrupted by discrete, round, non-staining air vacuoles (bar = 25 µm). *Figure and legend modified after figures 1-5 in Fernandez et al (2005) p. 450.*

4.4 Inadequacy of existing regulatory mechanisms

4.4.1 State regulations

Stater waters within the Gulf of Mexico are governed by Florida, Alabama, Mississippi, Louisiana, and Texas. Each state has its own statutes and regulations that extend to marine mammals but their applicability and effectiveness in protecting Cuvier's beaked whales is limited or non-existent.

The Florida Endangered and Threatened Species Act of 1977 provides funding for research and management to conserve and protect imperiled 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 or 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 the state nor federal law currently lists the Northern Gulf of Mexico Cuvier's beaked 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. In addition, Cuvier's beaked whale sightings within the Gulf are mostly reported beyond the 1000 m isobath (Fig. 4, NMFS 2012) well beyond 3 nm from shore, the limited of state water jurisdiction. Thus, regulations and statuses of the state of Florida do not adequately protect Cuvier's beaked whales in the Gulf of Mexico.

The state of Alabama also has statutes and regulations that extend to marine mammals, but as in Florida, their applicability is limited or non-existing in conserving Cuvier's beaked whales. The Alabama Regulations on Game Fish and Fur Bearing Animals, published annually by the Alabama Department of Conservation and Natural Resources, provides some species protections. In particular, Nongame Species Regulation 220-2-.92 provides a list of state protected species; however, Cuvier's beaked whales are not protected. The Alabama Coastal Area Management Program (ACAMP), administrated by the Alabama Department of Environmental Management, establishes rules and procedures for permitting, regulatory, and enforcement functions for coastal development (e.g., construction of marinas, piers, and canals), but do not address protection of marine mammals. Furthermore, the Alabama Marine Mammal Protection Act of 1976 (§ 9-11-390 *et seq.*) prohibits taking marine mammals or marine mammal products. As in Florida, both ACAMP and the Alabama Marine Mammal Protection Act, are constrained to Alabama shallower coastal waters, where Cuvier's beaked whales are rarely (if never) reported. As such, regulations and statuses of the state of Alabama do not adequately protect Cuvier's beaked whales in the Gulf of Mexico.

The state of Mississippi has a set of 22 environmental regulations that address wildlife and plants (Mississippi Title 22), which are managed by the Mississippi Department of Marine Resources (MDMR) through the Mississippi Commission on Marine Resources. However, most of these regulations are tailored to aquaculture (e.g., oyster farming), fisheries (e.g., bag and catch limits), or wetland permitting (e.g., collection for commercial and scientific purposes) (Title, Part 1 to 22). Only one regulation related with leased areas for monitoring of aquaculture programs addresses threatened or endangered marine mammals: "The MDMR shall be notified immediately upon the injury or death of any threatened or endangered species, marine mammal or raptor within the leased area" (Title 22, Part 13, Chapter 7, 103). The state also has a system of coastal preserves that protect and manage sensitive coastal wetland habitats along the Mississippi Gulf Coast, including six coastal islands (e.g., Round, Ship, Petit Bois, Horn, Deer, and Cat islands). These preserves are small and do not extend to the open ocean (see Mississippi Department of Marine Resources' Coastal Preserves Program). The same sites are part of the Gulf Ecological Management Site (GEMS) program that includes preserves across coastal ecosystems of the other Gulf States (FL, AL, LA, and TX). No regulations directly address Cuvier's beaked whales or even cetaceans in the portion of the Gulf of Mexico under Mississippi jurisdiction.

The state of Louisiana has several statuses that address wildlife and fisheries but none of them directly address Cuvier's beaked whales. Louisiana's wildlife and fisheries regulations (Title 56) are managed by the Louisiana Wildlife and Fisheries Commission. Louisiana has also a system of wildlife management areas, including several coastal ecosystems. For example, the Pass a Loutre Wildlife Management Area protects the marshes of the southernmost tip of the Mississippi delta, but does not extend to the Mississippi Canyon, an important foraging area for Cuvier's beaked whales. Cuvier's beaked whale are not listed as threatened or endangered under state law, even though other whales and dolphins are listed as accidental in Louisiana (e.g., Sei whale, blue whale, fin whale, sperm whale and bottlenose dolphin)(LWF 2017).

The state of Texas has a set of wildlife protection regulations managed by Texas Parks and Wildlife Department (TPWD). Surprisingly, the Cuvier's beaked whale and the Gervais' beaked whale are both listed as threatened species with S1 state rank under the Texas Threatened and Endangered Nongame Species rule of the Texas Administrative Code (TAC) (31 TAC § 65.175, TPWD 2017). Texas rank species (Global and State) using the conservation status systems established by NatureServe (Master et al. 2012). Thus, a species with a state or subnational rank of S1 is defined as a species "critically imperiled— at very high risk of extirpation in the jurisdiction due to very restricted range, very few populations or occurrences, very steep declines, severe threats, or other factors" (Master et al. 2012 p. 48). Under the state rule, an endangered animal species is "species of fish or wildlife indigenous to Texas […] if listed on the United States List of Endangered Native Fish and Wildlife or the list of fish or wildlife threatened with statewide extinction as filed by the director of the TPWD". A threatened species is "any species that TPWD has determined is likely to become endangered in the future." Under the state rule, "no person may capture, trap, take, or kill, or attempt to capture, trap, take, or kill, threatened or endangered fish or wildlife." See more details concerning state endangered or threatened animal species in Chapter 67 (Nongame Species), Chapter 68 (Endangered Species) of the Texas Parks and Wildlife Code and Sections 65.171 - 65.176 (Threatened and Endangered Nongame Species) of Title 31 of the Texas Administrative Code .

4.4.2 Federal regulations

4.4.2.1 Marine Mammal Protection Act

The Gulf of Mexico Cuvier's beaked whale is protected under the Marine Mammal Protection Act (MMPA, 16 U.S.C. §§ 1361-1423). The MMPA was enacted in 1972 to reduce human impacts on marine mammals. The MMPA has specific provisions to reduce incidental take of marine mammals in commercial fishing (16 U.S.C. §§ 1371(a)(5), 1374, 1387). However, the MMPA's protections are inadequate either due to lack of compliance, enforcement, or meaningful mitigation.

Under the MMPA, NMFS considers the Northern Gulf of Mexico Cuvier's beaked whale population as a "strategic stock" due to uncertainty about population size and evidence of human-caused serious injury and mortality related to acoustic impacts (NMFS 2017). However, Cuvier's beaked whale has not benefited from such designation because NMFS's funds allocated for fisheries observers, under the requirements of the MMPA, go first towards species listed as endangered or threatened under the ESA, with a lower priority to strategic stocks (16 U.S.C. § 1387(d)(4)(B)). In fact, the last stock assessment report was published in 2012, with data from 2009; thus current information is lacking. Currently, the NOAA Pelagic Observer Program has an 8 % observer coverage across the entire western Atlantic and Gulf of Mexico pelagic fishery fleet (NOAA Fisheries 2017), which is grossly inadequate to detect low abundance and hard to identify Cuvier's beaked whales.

The MMPA has also proven inadequate to protect Cuvier's beaked whales from acoustic impacts from seismic activities and vessel traffic within the Gulf of Mexico, one of the heaviest impacted areas in the United States. The oil industry conducts dozens of seismic exploration surveys to search for oil and gas in the Northern Gulf of Mexico each year, especially within the ~ 15.4 million acres of active leases (Fig. 8). Seismic surveys typically employ several arrays of high-volume air-guns that release intense blasts of compressed air, from the water surface to the bottom, at ~10-12 seconds for weeks or even months (Hildebrand 2009). These Gulf of Mexico surveys have received insufficient oversight under the MMPA despite its clear prohibitions against marine mammal take because not issued authorization or conducted public reviews of seismic activities.

As a result of litigation over the repeated violations of the take prohibitions under the MMPA in the Gulf of Mexico, a settlement agreement regarding airgun explorations was adopted in 2013 (*NRDC v. Jewell*, No. 10-cv-01882 (E.D. La. June 18, 2013)), which provided only short term benefits (30 months from June 24, 2013) to highly vulnerable Cuvier's beaked whales in the Gulf. Furthermore, exclusion of airgun surveys from some biologically important areas (e.g., the DeSoto Canyon) did not extend to other habitats preferred by Cuvier's beaked such as canyons within BOEM's central Gulf of Mexico planning areas or within active leased areas. In addition, the agreement addressed neither the Department of the Interior's current plans to open new areas for exploration and exploitation within the Central and Western Gulf (Oil & Gas 2017) nor new areas in the future, including the eastern Gulf after its congressional moratorium expires in 2022.

The MMPA does not adequately protect Cuvier's beaked whales (or any marine mammal) in the Gulf of Mexico from vessel-strikes. Under the MMPA, NMFS has not set speed-restriction regulations in any area within the Gulf of Mexico, even though the region is one of the busiest areas for vessel traffic. Thus, without restrictions on ship speed in the Gulf of Mexico, the MMPA does not protect Cuvier's beaked whales from vessel strikes.

Chronic acoustic impacts are also mostly unregulated by the MMPA. Commercial and recreational vessel traffic is a major source of noise in the Northern Gulf of Mexico with potential negative effects to Cuvier's beaked whales. The Northern Gulf of Mexico region is one of the heaviest navigated areas of the entire Gulf (e.g., shipping, fishing, cargo, tug and towing, tankers, passenger), mainly due to oil and gas exploration, extraction, and transportation activities. Acoustic impacts from heavy vessel traffic are not addressed under the MMPA, although they should be.

Acoustic impact related to U.S. Navy training and testing activities are partially regulated under the MMPA. The Navy has committed to avoid military activities "when feasible" within biologically important areas in the Gulf (e.g., DeSoto Canyon) (50 C.F.R. § 218.84(a)(3)(iv)(A)), although explosive activities are not banned. The effectiveness of the MMPA's on protecting Cuvier's beaked whales from Navy activities relies on monitoring from ship-based observers. However, human ship-based observers are highly inefficient in detecting beaked whales at night, during rough waters, and stormy conditions, times when Navy activities continue (Barlow & Gisiner 2004, 2006; Moretti et al. 2014). Thus, marine observers alone do not adequately protect Cuvier's beaked whales from Navy activities and associated acoustic impacts. Because of the relatively small number of Cuvier's beaked whales in the Gulf of Mexico, the serious injury or death of even a single individual could be catastrophic for the population. In fact, the potential biological removal (PBR) for this populations is 0.4 (NMFS 2012a), meaning that the population could not lose more than one individual every two and half years and reach its optimum sustainable population.

Furthermore, MMPA's general authorization provisions are not presently used to regulate other threats to Cuvier's beaked whales, including overfishing of prey species, toxic contamination, future oil spills, and the increasing impacts of climate change such as ocean warming and acidification. Thus, the MMPA has not adequately protected, and will not protect the Gulf of Mexico Cuvier's beaked whale from increasing extinction risk driven by ongoing and increasing threats.

4.4.2.2 Magnuson-Stevens Fishery Conservation and Management Act

The Magnuson-Stevens Fishery Conservation and Management Act, enacted in 1976 (16 U.S.C. §§ 1801-1884) is the leading federal statute governing marine fisheries in U.S. waters and the EEZ. The Act establishes several Regional Fishery Management Councils throughout the United States that develop 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). Although the Magnuson-Stevens Act provides some authority to protect marine mammals, it does not have regulatory mechanisms adequate to conserve the Gulf of Mexico Cuvier's beaked whale.

The Magnuson-Stevens Act regulations generally do not consider ecological factors when setting catch limits for fishery stocks, and thus have proven inadequate to address overfishing of potential prey of marine mammals. The Act mandates regional councils to develop 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 Act specifies that optimum yield should consider "social, economic, and ecological factors" including impacts on marine mammals (50 C.F.R. § 600.310). However, as written these regulations are inadequate in protecting marine mammals because it is often difficult to calculate the negative impacts that targeted fisheries could have on the preferred prey of marine mammals. For Cuvier's beaked whales in the Gulf of Mexico that feed on cephalopods as the main prey and occasionally fish, there is not reliable information on how targeted fisheries may affect food availability in deeper waters.

Finally, the Magnuson-Stevens Act has not been successful in preventing the depletion of fisheries within the Gulf of Mexico (Baum & Myers 2004; Baum et al. 2005; Hesselgrave & Sheeran 2012), which may well impact prey abundance and availability for Cuvier's beaked whales. Overall, fisheries catch of several targeted species (e.g., gag, greater amberjack, red snapper) in the Gulf of Mexico has declined dramatically in the last two decades due to overfishing (Hesselgrave & Sheeran 2012), potentially impacting the trophic web that Cuvier's beaked whales depend one for long-term population growth and survival. Thus, the regulatory mechanisms of the Magnuson-Stevens Act are inadequate for the protection and recovery of Cuvier's beaked whales in the Gulf of Mexico.

4.4.2.3 Coastal Zone Management Act

The Coastal Zone Management Act is also inadequate in conserving Cuvier's beaked whales in the Gulf of Mexico. On October of 1972, the Coastal Zone Management Act (CZMA) was enacted to encourage coastal states to develop comprehensive programs to manage competing uses and impacts to coastal resources (16 U.S.C § 1456). The CZMA has powerful tools that coastal states can use to manage the use of coastal resources as well as to facilitate cooperation with federal agencies. For example, activities permitted or funded by federal government with reasonably foreseeable coastal effects are required to follow state level coastal management programs' policies. However, because Cuvier's beaked whales mostly inhabit pelagic waters within the Gulf and are rarely reported in coastal waters, effects on Cuvier's beaked whales are rarely considered under the CZMA during analysis of potential activities (e.g., construction of oil rig platforms, or oil spill cleanups).

4.4.2.4 Outer Continental Shelf Lands Act

The Outer Continental Shelf Lands Act (OCSLA) is inadequate in protecting Cuvier's beaked whales in the Gulf. OCLSA was adopted on August 7, 1953, and oversees the mineral exploration and development of all submerged lands lying seaward of state coastal waters under U.S. jurisdiction. Under OCSLA, the Secretary of the Interior regulates and grants leases for oil and gas exploration and development on the continental shelf. One objective of OCSLA is "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)). Furthermore, OCSLA requires environmental impact studies of oil and gas leases on the continental shelf, including potential impacts on the marine biota (43 U.S.C. § 1346). However, OCSLA has provided limited protection for Cuvier's beaked whales from oil spills even with new regulations to reduce oil spills (76 Fed. Reg. 6431). For example, OCSLA regulations or environmental review provisions did not foresee or prevent the *Deepwater Horizon* disaster in 2010 and have not prevented several smaller oil spills that have occurred after that (BSEE 2013), which continue to threaten cetaceans in the Gulf. In addition, the current administration's roll-back of regulations, which safeguard against accidents such as the Deepwater Horizon blowout, increases the probability of future oil spill events. Thus, Cuvier's beaked whales are not adequately protected by OCSLA from the risk of oil and gas activities, including oil spills. Finally, OCSLA does not address ongoing threats to Cuvier's beaked whales such as, toxic contamination, vessel strikes, entanglement, and climate change related impacts like ocean warming and ocean acidification.

4.4.3 Foreign and international regulations

The Gulf of Mexico Cuvier's beaked whales are protected under few foreign and international regulations that offer minimal (if any) protection from current ongoing threats.

Furthermore, no international conventions or agreements exist that substantively address existing threats to this species. Gulf of Mexico Cuvier's beaked whales are not included in the Convention on Migratory Species since they reside within the northern Gulf and do not generally move across U.S. boundaries (Convention on Migratory Species 2014). Cuvier's beaked whales are included in 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 Gulf of Mexico population.

Likewise, while the global population of Cuvier's beaked 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 (CITES, 12 I.L.M. 1088 (1973)), international trade of Cuvier's beaked whales and whale parts does not represent an existing threat to the Northern Gulf of Mexico stock.

4.5 Other natural or manmade factors affecting its continued existence

4.5.1 Overfishing and prey reduction

Overfishing and prey reduction threaten Cuvier's beaked whales in the Gulf. Cuvier's beaked whales feed on a wide range of species that inhabit deep areas of the continental slope, including mostly cephalopods (squids and octopus) and fish and crustaceans (Santos et al. 2001; MacLeod et al. 2003). While no fisheries are extensively targeting cephalopods within the region of the Gulf at present, there are strong indications that Gulf of Mexico targeted populations are overfished. In general, commercial fisheries catch in the Gulf of Mexico has declined from 2.6 billion pounds in 1984 to only 1.3 billion pounds in 2010 due in part to overfishing (Hesselgrave & Sheeran 2012). This potential reduction in biomass likely impacts the trophic web that

Cuvier's beaked whales depend on. High fishing intensity in potentially important foraging areas could reduce potential prey, through targeted fisheries and associated bycatch, indirectly affecting food availability for Cuvier's beaked whales. Similarly, additional fishing pressure may come from recreational anglers, who substantially contribute to the total fisheries catch within the Gulf, specially of red snapper (Gillig et al. 2000; Coleman et al. 2004).

4.5.2 Entanglement in fishing gear and bycatch

Beaked whales have been entangled in fishing gear over the past 10 years within the Gulf of Mexico, although most reports do not identify the species of beaked whale entangled. Since Cuvier's beaked whales are the most commonly sighted from all the beaked whales in the Gulf (NMFS 2012a, 2017), it is likely the species is also the most commonly entangled in fishing gear. In general, the Gulf of Mexico pelagic tuna and swordfish pelagic longline fisheries are the most likely fisheries to have entanglement interactions with large- and medium-size whales (Waring et al. 2016). Although few confirmed cases of Cuvier's beaked whale entanglement were reported from 1998 to 2010 (Johnson et al. 1999; Yeung 2001; Garrison 2003, 2005, 2007; Fairfield-Walsh & Garrison 2006; Garrison et al. 2008; Moore et al. 2009; Garrison & Stokes 2010, 2012; NMFS 2012a); this may be unreliable for a cryptic species and because reporting chronically underestimates true bycatch.

Beaked whales have been entangled in pelagic longline fishing gear within the Gulf of Mexico. For example, one unidentified beaked whale was released alive after was entangled with a pelagic longline fishery gear in 2007 (Fairfield & Garrison 2008). In 2013, a beaked whale was seriously injured and died due to entanglement in pelagic longlines (Garrison & Stokes 2014), while in 2014, a beaked whale was caught and safely released without injuries in similar fishery gear (Garrison & Stokes 2016). It is likely that the number of entangled Cuvier's beaked whale in the Gulf of Mexico is grossly underestimated because, among other reasons already described, NOAA's observer corps covers only ~ 8% of fishing vessels in the region, which include the U.S. pelagic longline fleet ranging from Newfoundland along the Western Atlantic to Brazil and throughout the Gulf of Mexico (NOAA Fisheries 2017).

Fishery bycatch of Cuvier's beaked whales has also been reported across the North Atlantic fisheries, suggesting that the population in the Gulf of Mexico may be also vulnerable. For example, Cuvier's beaked whales have occurred in bycatch in longline fisheries in the Caribbean between Cuba and Haiti (Garrison 2003, 2005; Fairfield-Walsh & Garrison 2006; Fairfield & Garrison 2008; Garrison & Stokes 2010). Bycatch of this species has also been present in the Italian pelagic driftnet fishery for swordfish in the Mediterranean Sea (Podesta et al. 2005) and the North Atlantic sword fisheries (Waring et al. 2016).

Based on bycatch and entanglement data, Cuvier's beaked whales mostly interact with pelagic longlines (Garrison 2003; Garrison et al. 2008; NMFS 2012a, 2017, Garrison & Stokes 2014, 2016). To reduce bycatch of marine mammals and sea turtles, NMFS made changes to the pelagic longline fisheries in the Gulf of Mexico through the 2006 Consolidated Atlantic Highly Migratory Species Fishery Management Plan (NMFS 2006). However, proposals have threatened to rollback many of these changes. For example, the DeSoto Canyon was designated as closed area to pelagic longline fisheries (50 C.F.R. § 635.21), but a new proposed amendment in 2014 was considering to open this biological important area to pelagic longlines (78 F.R. 75327).

Although documentation of fishing entanglements for Gulf of Mexico Cuvier's beaked whale is limited, fishing is a threat to this population and its habitat. There is broad consensus that documented entanglements of marine mammals vastly underestimate actual take in fisheries (Moore et al. 2009; Garrison & Stokes 2016).

4.5.3 Vessel strikes

Gulf of Mexico Cuvier's beaked whales are at risk of collisions with vessels. Vessel strikes remain one of the main threats facing large marine mammals, including large delphinoids such as beaked whales (Laist et al. 2001; Hoop et al. 2015; Rockwood et al. 2017). Vessel strikes cause lethal wounds in whales and dolphins and are highly prevalent in heavily fished areas and major transportation routes (Laist et al. 2001; Jensen & Silber 2004; Pace 2011; Bezamat et al. 2014; Hoop et al. 2015; Rockwood et al. 2017). Analyses showed that vessel collisions can substantially contribute to population declines of some cetacean species; e.g., to 2% annual loss in North Atlantic right whales (Van Der Hoop et al. 2012; Conn & Silber 2013).

The amount of vessel collisions with cetaceans, and thus on Cuvier's beaked whales, is certainly underestimated since lethal and sublethal interactions can go un-noticed, trauma due to collision is not always detected from visual monitoring, and animals that die after collisions can drift away and sink and never be found (Rockwood et al. 2017). In the Gulf of Mexico, carcass recovery rates for Cuvier's beaked whales are extremely low, with 6.2 % recovery on average (Williams et al. 2011 p. 3), and thus individuals struck by vessels likely go undetected. Vessel strikes are often underestimated for commonly reported coastal species, such as humpback whales, right whales, and dolphins (Jensen & Silber 2004; Rockwood et al. 2017) with higher carcass recovery rates (Williams et al. 2011; Wells et al. 2015). In addition, since Cuvier's beaked whales use mostly offshore and pelagic habitats, carcasses can drift away by the prevalent surface currents and eventually sink as decomposition happens without even reaching the shore.

Several factors affect the incidence and severity of vessel strikes including cetaceans diving behavior, level of vessel traffic, overlap of cetaceans preferred habitat with shipping lanes and fishing areas, and vessel speed. For example, vessel speed is one the main drivers of vessel collisions with marine mammals (Vanderlaan & Taggart 2007; Conn & Silber 2013). Vessel speed regulations have been proven to be one of the best strategies to significantly reduce collisions with marine mammals (e.g., for North Atlantic right whales; Conn & Silber 2013; Laist et al. 2014; Silber et al. 2014). However, the Northern Gulf of Mexico does not have vessel speed regulations that protect marine mammals from vessel collisions, and thus vessel strikes constitute a major threat.

The Northern Gulf of Mexico is a region with a high probability of vessel-cetacean collisions due to high ship traffic (Fig. 12). Ports across the U.S. Gulf of Mexico accounted for nearly half of the total tonnage transported to and from all U.S. in 2013, with the port of South Louisiana (Louisiana) and Houston (Texas) transporting ~20% of the total cargo (US Army Corps of Engineers 2016). The ports of South Louisiana (Louisiana), Houston (Texas), New Orleans

(Louisiana), and Corpus Christi (Texas) are among the ten busiest ports (as measured by cargo volume) in the United States (US Army Corps of Engineers 2016). In addition, vessel traffic in the Gulf of Mexico is substantially increasing as the number of vessel calls doubled from 17,200 in 2002 to 34,700 in 2013 (MARAD 2014).

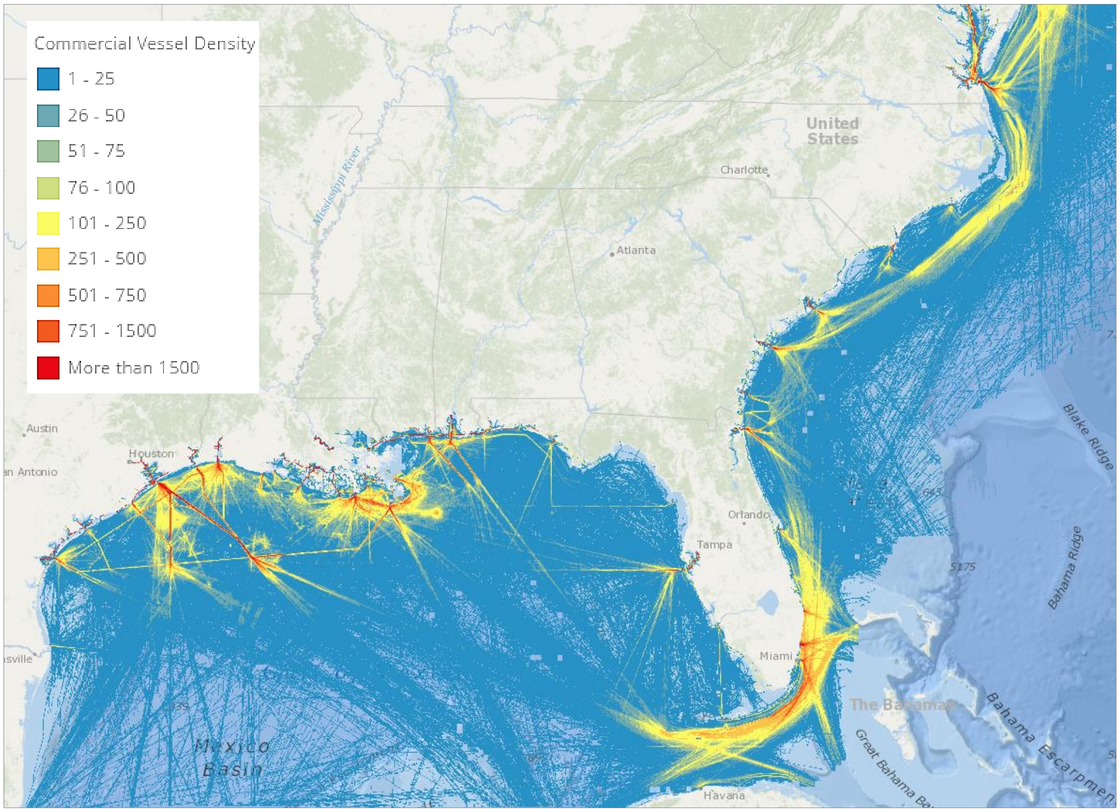

Figure 12 Total number of commercial vessel transit from October 2009 to October 2010. Note that heavy vessel traffic overlaps with Cuvier's beaked whale sightings in the Gulf of Mexico (Fig. 4). *Map obtained from the Marine Cadastre National Viewer.*

The risk of vessel-strike will certainly increase in the near future as vessel traffic is projected to increase throughout the Northern Gulf of Mexico due to the oil and shipping industries. For example, a substantial amount of vessel traffic will be related to projected diversion of shipping traffic from ports of the U.S. West Coast to ports located along the Gulf and East coast (Muirhead et al. 2015). This increase in shipping traffic to and from the Gulf was directly related to the expansion of the Panama Canal completed on June of 2016.[2] It is estimated that containerized tonnage moving through the new expanded Panama Canal will increase at an average of approximately 5.6 % per year, from 98 million Panama Canal net tons in 2005 to nearly 296 million in 2025 (Panama Canal Authority 2016). Such increase will definitely

[2] The Panama Canal expansion project doubled the capacity of the Panama Canal by adding a new lane of traffic. This expansion allowed for larger ship size and numbers that can carry over twice as much cargo. The new expanded Panama Canal began commercial operation on June 26, 2016. Panama Canal Authority https://www.pancanal.com/eng/

increase the probability of ship strike for all species of cetaceans in the Gulf including Cuvier's beaked whale, since shipping lanes cross over preferred habitat (see Figs. 4, 6 , and 12).

Given the relatively low abundance of Cuvier's beaked whales in the Gulf of Mexico, serious injury or death of a single individual due to vessel strike would be undoubtedly detrimental to population recovery, especially since the current potential biological removal number is 0.4 (one whale every 2.5 years).

4.5.4 Acoustic impacts

Cuvier's beaked whales in the Gulf of Mexico are threatened by noise pollution. The Gulf of Mexico is exposed to relatively high levels of human-caused oceanic noise from oil-and-gas exploration and extraction, military sonar activities, shipping, and fishing activities (Estabrook et al. 2016; Wiggins et al. 2016). The cumulative effects of chronic and acute marine noise cause by anthropogenic activities threaten the Cuvier's beaked whale population's growth and increase the probability of extinction.

Beaked whales are highly sensitive to acoustic impacts due to their deep-diving, cranial morphology, and use of echolocation for foraging. Mortalities and population level impacts from acoustic effects are difficult to quantify because deaths are often underestimated (Williams et al. 2011). Assessing the impacts from acoustic effects are also difficult to identify on carcasses that are often semi-decomposed (Barlow & Gisiner 2006). In addition, acoustic impacts may result on non-lethal behavioral changes (e.g., rapid ascend, avoidance, cessation of foraging) that may not result in death, but still may have population-level impacts (Barlow & Gisiner 2006; Stimpert et al. 2014). Evidence of strandings correlated with military activities (D'Amico et al. 2009) and behavior changes associated with other sources of noise pollution such as ship traffic (Aguilar Soto et al. 2006) suggests varying degrees of harm from noise disruption noise.

4.5.4.1 Military sonar and mass strandings

There is strong evidence that Cuvier's beaked whales are highly vulnerable to acoustic impacts and susceptible to strandings after acute acoustic stress from active sonar and seismic exploration (Balcomb III & Claridge 2001; Malakoff 2002; Cox et al. 2006; Aguilar Soto et al. 2006; D'Amico et al. 2009; Tyack et al. 2011; DeRuiter et al. 2013; Ketten 2014). In fact, Cuvier's beaked whales are considered among species most susceptible to acoustic impacts from all cetaceans (Jepson et al. 2003; Rommel et al. 2005; Ketten 2014).

Unusual mass strandings of Cuvier's beaked whales have been directly related to naval military activities, active sonar, and seismic activities. The first mass stranding of Cuvier's beaked whales associated with active sonar occurred in May of 1996 in different locations of the Kyparissiakos Gulf in Greece, when 14 individuals stranded (Frantzis 1998). Similar mass strandings have been documented from the Bahamas in 2000 (Balcomb III & Claridge 2001), Caribbean Sea, Canary Islands in 2002 (Jepson et al. 2003; Fernández et al. 2005), Greece in 1996, 1997, 2011, and 2014 (Jasny 2014), Gulf of California (Malakoff 2002), Madeira Islands in 2000 (Freitas

2004), and the Mediterranean Sea in 1996 (Frantzis 1998). For example, multiple mass strandings of this species occurred during the mid to late 1980s around the Canary Islands (Simmonds & Lopez-Jurado 1991). Low frequency active sonar testing conducted by the North Atlantic Treaty Organization was the cause of the death of twelve Cuvier's beaked whales that stranded and died in the Mediterranean Sea on May 1996 (Frantzis 1998, 2004). In March 2000, about 14 beaked whales stranded alive in the Bahamas because tissue trauma associated with acoustic or impulse injury (Balcomb III & Claridge 2001; Evans et al. 2001). Five Cuvier's beaked whales later died due to physiological stress of stranding (e.g., catecholamine release, hyperthermia) and four were returned to sea, which fate are unknown (Balcomb III & Claridge 2001; Evans et al. 2001; Cox et al. 2006). These incidents demonstrate that Cuvier's beaked whales are threatened by high-intensity noise, and Cuvier's beaked whales in the Gulf of Mexico are threatened by such noise pollution.

Mid-frequency active sonar physically harms marine mammals, especially beaked whales. Examinations of beaked whales stranded concurrently with military's sonar activity show trauma that experts believe may have been caused by sound, such as hemorrhages in the inner ear (Evans et al. 2001; Freitas 2004; Ketten 2004, 2012, 2014; Fernández et al. 2005). One potential mechanism for the harm caused by active sonar is changes in behavior or physiological responses to acute noise during deep diving that increases the concentration of nitrogen bubbles in tissue and blood, increasing the risk of decompression sickness (Fig. 12) (Fahlman et al. 2014). For example, active sonar can disrupt the normal behavior of beaked whales during deep-diving, leading to rapid ascends, decompression sickness (i.e., the bends), and strandings.

Plausible mechanisms of the negative impact of sonar (and seismic activities) on Cuvier's beaked whale may involve behavioral change, physiological changes and tissue damage that ultimately lead to stranding and could eventually result in death (Fig. 13, Cox et al. 2006). Reports of gas emboli (i.e., air in the blood stream) in tissue of beaked whales (including Cuvier's whales) stranded during and after naval sonar exercises suggest that drastic changes in depth during deep diving may make them particularly vulnerable to decompression sickness (Freitas 2004; Podesta et al. 2005; Rommel et al. 2005; Fernández et al. 2005; DeRuiter et al. 2013; Moretti et al. 2014; Schorr et al. 2014). Models of breath-hold diving indicates that during natural diving behavior there are not problems with embolism during relatively slow ascends (Tyack et al. 2006; Tyack & Janik 2013). However, under acute acoustic stress, such as mid-frequency active sonar or seismic activities, decompression sickness result from rapid ascend and erratic diving (Rommel et al. 2005; Fernández et al. 2005; Tyack et al. 2011; DeRuiter et al. 2013; Ketten 2014; Moretti et al. 2014; Stimpert et al. 2014).

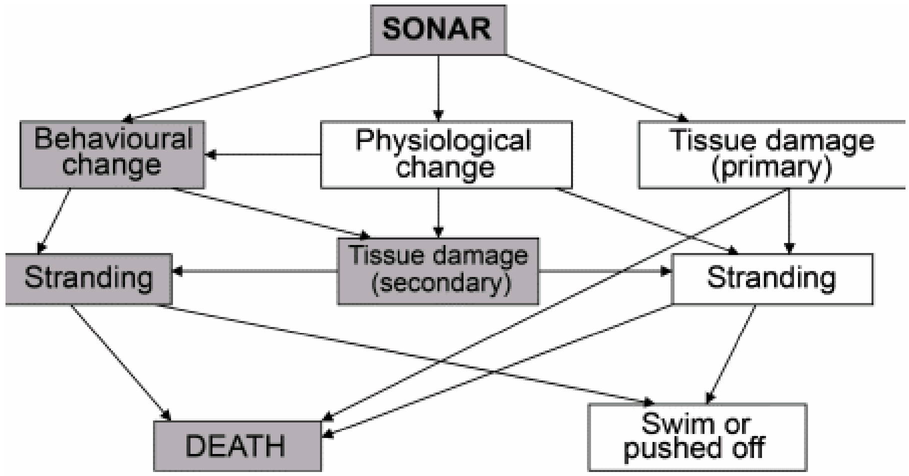

Figure 13 Potential mechanistic pathways by which beaked whales are affected by sonar. Whereas we are unable to eliminate any pathways as implausible given current data, most of our discussions focus on the left side (shaded boxes) of the diagram. Note that death will not necessarily be the end result of sonar exposure in every case and that behavioral change, physiological change, primary tissue damage, secondary tissue damage, or stranding may occur without leading to death. *Figure and legend from Cox et al. (2006).*

Acute noise pollution from military activities can disrupt the normal behavior of Cuvier's beaked whales. NMFS considers a sound pressure level above 178 dB for continuous noise as "take" threshold under the MMPA for mid-frequency cetaceans such as beaked whales (NMFS 2016b). Sound level above 140 dB is also known as a conservative threshold that scientists have determined to disrupt the normal diving behavior of beaked whales (Tyack et al. 2011). For example, whales tracked by satellite tagging and monitored acoustically responded similarly to simulated sonar and killer whale's calls by silencing and swimming away from the sound source (Tyack et al. 2011). Passive acoustic monitoring has shown that sounds above 140 dB causes these whales to stop foraging and to move away from the noise source (Tyack et al. 2011).

While the U.S. Navy conducts only limited training in the Gulf of Mexico, compared to other regions, its Panama City and Pensacola operations areas and its Naval Surface Warfare Center-Panama City Testing Range all overlap with biological important areas such as the DeSoto Canyon (Fig. 14). Several studies have raised serious concerns on the negative impacts of mid-frequency active sonar on beaked whales (McCarthy et al. 2011; DeRuiter et al. 2013; Moretti et al. 2014; Simonis et al. 2016). The distribution of Cuvier's beaked whales overlaps areas that the Navy uses for training and testing with a heavy use of mid-frequency sonars. In these areas, the Navy often performs explosives training and gunnery exercises (78 F.R. 33357; 79 F.R. 13568), that could cause additional harm and mortality of Cuvier's beaked whales within the Gulf.

Figure 14 Operating areas for training and testing by the U.S. Navy in the Gulf of Mexico and a portion of the western Atlantic. *Map obtained from Global Security.org* *http://www.globalsecurity.org/military/facility/images/lantflt-training.gif*

Naval sonar activities proceed with inadequate mitigation and monitoring to protect Cuvier's beaked whales in the Gulf of Mexico. As a result of these studies, the Navy has set a specific threshold for beaked whales at 140 dB (Zirbel et al. 2011) even though additional studies indicates that some cetaceans altered dive behavior and increase speed at much lower sound exposure levels (~100 to 140 dB) when exposed to sonar or chronic and acute noise (Southall et al. 2016). In addition, lookouts and shutdowns may not protect Cuvier's beaked whales from Navy sonar because this is a deep-diving species that are difficult to see from ships. For example, "only 23 % of Cuvier's beaked whales . . . are estimated to be seen on ship surveys if they are located directly on the survey trackline" (Barlow 1999).

4.5.4.1 Chronic marine noise from vessel traffic

Chronic marine noise from high vessel ship traffic threatens Cuvier's beaked whales. In general, ocean noise have negative effects on marine mammals, including hearing loss, masking of biologically significant sounds, and disruption of foraging and other vital behaviors such as mating and nursing (Foote et al. 2004; Aguilar Soto et al. 2006; Weilgart 2007; Finneran & Schlundt 2010; Pirotta et al. 2012; Tyack & Janik 2013).

The Northern Gulf of Mexico is noisy due high vessel traffic. Commercial and industrial shipping is a major contributor to chronic noise in the Gulf, with the ports of South Louisiana (Louisiana), Houston (Texas), New Orleans (Louisiana), and Corpus Christi (Texas) among the ten busiest ports (as measured by cargo volume) in the United States (US Army Corps of Engineers 2016). For example, Snyder (2007) recorded average chronic ambient noise of >90 dB re 1 μPa^2/Hz at 25–50 Hz at a site ~300 km south of Panama City (off Florida in the northeast

Gulf of Mexico) and about 3,000 m deep near local shipping lanes from 2004 to 2005. At these frequencies, this chronic noise levels were similar to areas exposed to heavy commercial shipping in the Northeast Pacific Ocean (Chapman & Price 2011). The intensive shipping and oil-and-gas development in the Northern Gulf of Mexico currently produces chronic continuous sound pressure levels of 80-120 dB in deep waters from 831 to 1,370 m (see Fig. 2 in Estabrook et al. 2016).

While the impact of shipping and vessel traffic on Gulf of Mexico Cuvier's beaked whales has not been directly measured, energy exploration and production in the Gulf is heavily concentrated along the continental shelf and slope west of the Mississippi River Delta (Fig. 8), a habitat that Cuvier's beaked whales likely prefer for foraging (Fig. 6, Roberts et al. 2016). This concentrated shipping and vessel traffic activity together with oil and gas exploration in the central and western Gulf is believe to be the main reason of the population contraction of the endangered Bryde's whale to the eastern Gulf (Rosel & Wilcox 2014; Rosel et al. 2016).

Chronic noise from vessel traffic due to shipping and the oil industry are already impacting endangered cetaceans in the Gulf of Mexico and are likely affecting Cuvier's beaked whales. For example, there is evidence that intense ship noise disrupts the natural foraging behavior of Cuvier's beaked whales during deep diving by reducing the ability to use echolocation to find food during foraging (Aguilar Soto et al. 2006). In a controlled playback experiment beaked whales would respond to shipping noise that was at received levels similar to mid-frequency sonar (~136-138 dB sound pressure level) (Tyack et al. 2011). In addition, heavy shipping traffic may be already disrupting the normal foraging patterns and communication behavior of deep-diving cetaceans such as sperm whales (Azzara 2012; Azzara et al. 2013), and thus could affect Cuvier's beaked whales that show similar deep-diving behaviors.

Chronic noise from vessel traffic may also mask the natural sounds that Cuvier's beaked whales use for foraging, communication, and navigation during deep diving, where visibility is zero (Aguilar Soto et al. 2006). Masking is identified as the main auditory negative impact of vessel noise on marine mammals (Richardson et al. 2013). Furthermore, high ambient noise levels can constrain the range of communication among individuals, which has been found in right whales (Hatch et al. 2012), and can induce chronic stress responses as observed in other beaked whale species (Cox et al. 2006; Wright et al. 2007, 2011).

4.5.4.1 Acute noise from seismic exploration

Acute noise from seismic exploration such as airguns is also major contributor to acute noise in the Northern Gulf of Mexico. The Gulf of Mexico is perhaps the most heavily prospected body of water in the world. Several areas within the Gulf experience chronic and high sound pressure spectrum levels in deep waters (e.g., >90 dB re 1 $\mu Pa^2/Hz$ at <40 Hz), which are associated with background noise from seismic exploration (Snyder 2007; Wiggins et al. 2016). Airguns are constant source of noise in the Gulf of Mexico due to seismic explorations and produce a peak noise output at low frequency in the 5-300 Hz range but that can be of high level and fired frequently (e.g., 250-260 dB re 1 μPa^2 at 1 m, typically fired at 10-20 s) (Hildebrand 2009). Although Cuvier's beaked whale echolocation calls are within an average frequency in 20-60 kHz range (Baumann-Pickering et al. 2013), the high-intensity source level and high rate of repetition indicate that exposure is quite high for Cuvier's beaked whales. The last Gulf of Mexico Programmatic Environmental Impact Statement addressing proposed geological and geophysical activities within the northern Gulf estimated ~492,637 instances of takes of beaked whales associated with acoustic impacts (BOEM 2017b).

Acute exposures may also act cumulatively with chronic effects, potentially leading to population fitness problems (see Wright et al., 2007). Regardless of whether noise is chronic or acute, any disruption in normal foraging patterns, communication among individuals, or breeding will likely have a negative impact at the population level that is concerning particularly with relatively small population size.

4.5.5 Plastic pollution and debris

Plastic pollution is also a threat for Cuvier's beaked whale survival. Suction feeders such as Cuvier's beaked whales are highly at risk due to consumption of plastic and marine debris (Simmonds 2012). Mortality due to consumption of plastic bags and marine debris has often been reported in beaked whales, including Cuvier's (Poncelet et al. 2000; Lusher et al. 2015; Fernandez 2017).

There are several reported cases of Cuvier's beaked whale deaths directly related to consumption of plastic bags and marine debris. At least 20 reported instances of debris interactions with Cuvier's beaked whale have been documented (Baulch & Perry 2014 see Table 1 Appendix A). For example, several Cuvier's beaked whales were found with plastic debris in their stomachs from stranded individuals in Galicia, Spain and North Uist, Scotland in the 1990s (Santos et al. 2001). Plastic bags and plastic straw were found in the stomach of Cuvier's beaked whales stranded in Virginia and California in the late 1990s (Laist, 1997). Among the most choking examples of whale-debris interaction was a beaked whale was found stranded and emaciated along the French Atlantic coast in 1999, with 378 plastic bags and sheets – approximately 33 kg of plastic – in its stomach, and not signs of prey (Poncelet et al. 2000). Marine debris have also been found in dead Cuvier's beaked whales from waters off the Canary Islands, off Croatia in the Adriatic Sea, off Japan, and around the UK, with at least two death direclty caused by debris ingestion from 2000 to 2012 (Baulch & Perry 2014 p. 214). In addition, the Smithsonian Whale Collection contains records of 10 Cuvier's beaked whales found with plastics in their stomachs (Smithsonian National Museum of Natural History, 2014). Recently in 2015, a 20 feet-long Cuvier's beaked whale that stranded on the Isle of Skye, Scotland, had over 4 kg of plastic bags in its stomach, which caused its death (Fernandez 2017). Similarly, a Cuvier's beaked whale died off the coast of Bergen, Norway after eating large numbers of plastic bags (Fernandez 2017).

Plastic comprises 60% to 80% of all marine debris (Derraik 2002) and are the majority of human-produce debris ingested by cetaceans with derelict of fishing gear as the second most common component (Baulch & Perry 2014). Scientists have said that plastic bags drifting in the oceans (from the bottom to the surface) may be a major threat for Cuvier's beaked whales "because the way this species behave and/or feed makes them particularly vulnerable to the effects of plastic in the marine environment" (Fernandez 2017). Based on the number of dead

Cuvier's beaked whales found with plastic debris in their guts, it appears that debris ingestion is a greater problem than entanglement in fishing gear (Baulch & Perry 2014). However, given the low carcass detection rate for this species, it is highly likely that the number of individuals affected by debris and entanglement is grossly underestimated, especially because only 3-10% of cetacean entanglements are detected (Robbins & Mattila 2004; Knowlton et al. 2005).

Microplastics ingestion is an additional threat for Cuvier's beaked whales in the Gulf. Ingestion of microplastics could occur via consumption of cephalopod and fish prey that have ingested microplastics and even via inhalation at the air-water interface. Microplastics ingestion have been reported in other beaked whale species (Lusher et al. 2015) Microplastics and associated contaminants can accumulated in these individuals and cause sublethal effects associated with the release of toxic compounds (Wright et al. 2013). For example, leached plastic additives have been found in fin whales of the Mediterranean indicating chronic exposures to plastic contaminants (Fossi et al. 2012). The toxicological implications of microplastic accumulation in cetaceans are a new research area, but based on studies of pollutant effects, it is likely that the physiological consequences of microplastic pollution are considerable negative. Exposures to toxic contaminants from plastics are known to cause immunosuppression (De Guise et al. 1995), increase the risk of cancer (Martineau et al. 2002), and increase first calf mortality in cetaceans (Hall et al. 2006). Microplastic bio-accumulation in top predatory cetaceans due to ingestion is a serious threat due to the difficulty of removal and thus is a major challenge (Gall & Thompson 2015).

Based on all these studies, plastic pollution and debris in the Gulf of Mexico represents a direct threat to the survival of Cuvier's beaked whales.

4.5.6 Ocean warming and acidification

Climate change related threats such as ocean warming and acidification can adversely affect Cuvier's beaked whales in the Gulf of Mexico through changes in food distribution, availability and abundance, changes in distribution of individuals within the Gulf due to changes in water temperatures, and increase the susceptibility to diseases. Ocean warming can alter oceanographic conditions by altering surface currents and reducing primary productivity (diatoms) and zooplankton (copepods), disrupting food web dynamic and affecting prey availability for cetaceans (Learmonth et al. 2006; MacLeod 2009; Simmonds & Eliott 2009; Davidson et al. 2012). For example, Cuvier's beaked whale abundance have declined throughout the California Current across the U.S. west coast and could be related, at least in part, to a decline of mesopelagic fish due to deep water hypoxia related to climate change (Moore & Barlow 2013).

Ocean acidification and warming affect the preferred prey of Cuvier's beaked whales, squids. For example, experimental studies have shown that embryo survival of the squid (*Loligo vulgaris*) significantly decreases by ~47% at water pH of 7.5 units during summer temperatures of 19 ºC, which suggest negative consequences during the summer spawning times (Rosa et al. 2014). In addition, warming conditions lead to premature hatching with a high incidence of mantle detachment and deformities (Rosa et al. 2014). Similarly, Atlantic longfin squid

(*Doryteuthis pealeii*), an ecologically important taxon in the Gulf of Mexico, shows substantial developmental and physiological abnormalities under elevated pCO_2, which may impact larvae survival in the wild, and species that depend on them for food (Kaplan et al. 2013). These studies demonstrate that squid are vulnerable to future ocean acidification and warming directly affecting food availability for predators such as Cuvier's beaked whales that feed mostly on cephalopods.

Furthermore, ocean acidification is well documented in changing oceanic carbonate chemistry (Orr et al. 2005; Feely et al. 2010; Doney et al. 2012) and together with hypoxia is already having a tremendous impact in coastal waters of the Gulf of Mexico (Melzner et al. 2012; Wanninkhof et al. 2015; Ekstrom et al. 2015; Kurman et al. 2017; Laurent et al. 2017). Hypoxia and ocean acidification could negatively affect the survival and abundance of mesopelagic fish, cephalopods, and crustaceans, all prey of Cuvier's beaked whales.

4.5.7 Risks inherent to small populations

Cuvier's beaked whales in the Gulf of Mexico are at high risk of extinction due to their small population size. The discrete population of Cuvier's beaked whale in the Gulf of Mexico is relatively small with only approximately 74 individuals, based on the best available abundance estimate from the last stock assessment report (NMFS 2012a). There is an inherent extinction risk for small and isolated populations since any major stochastic events (e.g., large oil spill) could eliminate all or the majority individuals in the population. Overall, at least four factors place small populations at high risk of extinction: 1) high trophic level, 2) low population density, 3) slow life history, and 4) small geographic range size (Purvis et al. 2000; Cardillo et al. 2005). The Gulf of Mexico Cuvier's beaked whale meets each one of these factors. Cuvier's beaked whales are top predators that feed on cephalopod and mesopelagic fish, and they may be only killed by apex predator such as tiger and white sharks (Baird 2016). Throughout the Northern Gulf of Mexico, Cuvier's beaked whales have a low population density, and could only support less than 1-5 individuals per 100 km^2 (Roberts et al. 2016) . Cuvier's beaked whales have a slow life history because they usually reach sexual maturity late (7-11 years of age), gestation takes a year, and females give birth to a single calf every 2-3 years (NMFS 2017). Finally, Cuvier's beaked whales in the Gulf of Mexico have a relatively small geographic range size in the semi-enclosed body of water of the Gulf, which is further restricted to preferred pelagic habitat associated with the continental slope and edge, canyon, and sea mounts (Fig. 6, Roberts et al. 2016)

Relatively medium-size marine mammals, geographically isolated, and with small population size are particularly vulnerable to extinction due to high risk inherent to demographic and environmental stochasticity, local catastrophic events, slow rates of new environmental adaptation, deleterious effects of inbreeding, genetic drift, and reproductive failure due to Allee effect (Lande et al. 2003; Cardillo et al. 2005). For example, demographic stochasticity can rapidly reduce demographic parameters such as reproductive rate and population growth; while environmental stochasticity, through a drastic change in environmental or ecological conditions (e.g., oceanographic productivity, disease outbreak, oil spill), can have sudden negative effects on the population's survival rate (Cardillo et al. 2005). Small populations are also at high risk of deleterious genetic effects due to inbreeding, low genetic variability, and expression of harmful alleles that suddenly appear (e.g., genetic defects), which compromise population's health, growth, and survival overtime (Purvis et al. 2000; O'Grady et al. 2006). Thus, small populations may have a reduced capacity for genetic adaptation to new environmental conditions when genetic diversity is low. In addition, the low population density of Cuvier's beaked whales in the Gulf comprises the ability of individuals in the population to find mates (the Allee effect) and thus successfully reproduce. This population depensation can cause a decline in per capita reproduction at low population density and reduces the recovery capacity of marine mammals (Fujiwara & Caswell 2001; Haider et al. 2017).

4.5.8 Cumulative and synergistic impacts

The threats to Gulf of Mexico Cuvier's beaked whales outlined above can have cumulative and synergistic impacts on the population. Isolated threats may cause sublethal effects (e.g., contamination with persistent organochlorine pollutants, hearing loss due to noise) at the individual level that can contribute cumulatively towards reducing survival and reproductive success at the population level, preventing positive population growth. For example, decline in reproductive success from toxic contamination or acoustic impacts combined with low population density and small population size will have a negative toll in population growth rate and long term population viability, increasing extinction risk. Similarly, lethal impacts that increases mortality rates (e.g., vessel strikes or lethal stranding due to sonar and seismic activities) combined with low population abundance substantially increases extinction risk as directly reduce population abundance.

Synergistic effects, when the effect of multiple stressors is greater than the sum of the stressors considered in isolation, increase extinction risk at the population level. Synergistic effects have been studied between stress and contaminant in cetaceans (Martineau 2007), but may also be observed between several factors. For example, a potential reduction in prey abundance (due to fishing or climate change) combined with toxic contamination, can compromise the health condition of adults that result in less stored fat and reduced milk production for newborns that may eventually die of malnutrition. This chain of events have been hypothesized and demonstrated in several marine mammals including Southern Resident killer whales (Matkin et al. 2017; Wasser et al. 2017), California sea lions (McClatchie et al. 2016), harbor seals (Hanson et al. 2013), Hawaiian monk seals (Baker et al. 2012), and may be partially responsible for the population decline of Cuvier's beaked whales across the California Current (Moore & Barlow 2013).

5. Requested designation and conclusion

The Center hereby requests that the National Marine Fisheries Service list the Gulf of Mexico Cuvier's beaked whale (*Ziphius cavirostris*) as "endangered" or "threatened" under the ESA as it qualifies as a distinct population segment. Alternatively, the Center requests that NMFS list the Cuvier's beaked whale because it is threatened or endangered in a significant portion of its range. ESA listing of Cuvier's beaked whale of the Gulf of Mexico is warranted, given the combination of the small population size (~74 individuals), geographical isolation, and the formidable number of threats that this population is facing.

Cuvier's beaked whales in the Gulf of Mexico are clearly threatened by at least three of the five listing factors under the ESA: the present destruction or modification of habitat due oil spills and water pollution; inadequate existing regulatory mechanisms; and a whole suit of several natural or manmade factors affecting its continued existence that can act cumulatively and synergistically such as reduction of prey, entanglement in fishing gear, vessel strikes, acoustic impacts, plastic pollution, climate change, and risk inherent to small population size. The loss of this population would represent a significant loss for the species' diversity.

ESA listing will promote the designation of critical habitat and the development of a comprehensive recovery plan for the conservation of the species within the Gulf of Mexico. Listing this species could also increase awareness and promote research on the effect that acoustic impacts such as mid-frequency sonar and seismic exploration have in one of the most vulnerable marine mammals in the world. ESA protection may be the regulatory mechanism that would shield this species from localized extinction within the Gulf of Mexico, since existing laws have proven inadequate to increase population abundance and address ongoing threats.

Given the high extinction risks inherent to small populations and the potential cumulative effects of the above threats, the Gulf of Mexico Cuvier's beaked whale must be listed as an endangered or threatened species under the ESA.

6. References (all references are in a CD attached to a hard copy of this petition sent via mail)

Aas E, Baussant T, Balk L, Liewenborg B, Andersen OK. 2000. PAH metabolites in bile, cytochrome P4501A and DNA adducts as environmental risk parameters for chronic oil exposure: a laboratory experiment with Atlantic cod. Aquatic Toxicology **51**:241–258.

Aguilar Soto N, Johnson M, Madsen PT, Tyack PL, Bocconcelli A, Fabrizio Borsani J. 2006. Does Intense Ship Noise Disrupt Foraging in Deep-Diving Cuvier's Beaked Whales (ziphius Cavirostris)? Marine Mammal Science **22**:690–699.

Aichinger Dias L. 2015. Evidence of marine mammals' direct exposure to petroleum products during the Deepwater Horizon Oil Spill in the Gulf of Mexico DWH NRDA Marine Mammal Technical Working Group Report. Page 18. Cooperative Institute for Marine and Atmospheric Studies, Rosenstlel School of Marine and Atmospheric Science, University of Miami, Miami, Florida.

Aichinger Dias L, Litz J, Garrison L, Martinez A, Barry K, Speakman T. 2017. Exposure of cetaceans to petroleum products following the Deepwater Horizon oil spill in the Gulf of Mexico. Endangered Species Research **33**:119–125.

Allen BM, Brownell RL, Mead JG. 2012. Species review of Cuvier's beaked whale, Ziphius cavirostris. Reports of International Whaling Commission. Available from http://swfsc.noaa.gov/publications/CR/2011/2011Allen2.pdf (accessed July 28, 2017).

Arbelo M, Sierra E, Esperón F, Watanabe TT, Belliere EN, de los Monteros AE, Fernandez A. 2010. Herpesvirus infection with severe lymphoid necrosis affecting a beaked whale stranded in the Canary Islands. Diseases of aquatic organisms **89**:261–264.

Arukwe A, Celius T, Walther BT, Goksøyr A. 2000. Effects of xenoestrogen treatment on zona radiata protein and vitellogenin expression in Atlantic salmon (Salmo salar). Aquatic toxicology **49**:159–170.

Arukwe A, Kullman SW, Hinton DE. 2001. Differential biomarker gene and protein expressions in nonylphenol and estradiol-17β treated juvenile rainbow trout (Oncorhynchus mykiss). Comparative Biochemistry and Physiology Part C: Toxicology & Pharmacology **129**:1–10.

Auster PJ, Watling L. 2010. Beaked whale foraging areas inferred by gouges in the seafloor. Marine mammal science **26**:226–233.

Azzara AJ. 2012. Impacts of vessel noise perturbations on the resident sperm whale population in the Gulf of Mexico. Texas A&M University. Available from http://search.proquest.com/openview/f0a3c5991e847d1eaccb17d5ab43c4f4/1?pq-origsite=gscholar&cbl=18750&diss=y (accessed August 10, 2017).

Azzara AJ, von Zharen WM, Newcomb JJ. 2013. Mixed-methods analytic approach for determining potential impacts of vessel noise on sperm whale click behavior. The Journal of the Acoustical Society of America **134**:4566–4574.

Bachman MJ, Keller JM, West KL, Jensen BA. 2014. Persistent organic pollutant concentrations in blubber of 16 species of cetaceans stranded in the Pacific Islands from 1997 through 2011. Science of The Total Environment **488–489**:115–123.

Baird R. 2016. The lives of Hawaii's dolphins and whales: natural history and conservation. Available from http://www.uhpress.hawaii.edu/p-9708-9780824859985.aspx (accessed August 2, 2017).

Baird RW, Webster DL, Swaim Z, Foley HJ, Anderson DB, Read AJ. 2016. Spatial Use by Odontocetes Satellite Tagged off Cape Hatteras, North Carolina in 2015. Final Report. Prepared for U.S. Fleet Forces Command. Submitted to Naval Facilities Engineering Command Atlantic, Norfolk, Virginia, under Contract No. N62470- 10- 3011, Task Order 57 and N62470- 15- 8006, Task Order 07, issued to HDR Inc.,. Virginia Beach, Virginia.

Baker JD, Howell EA, Polovina JJ. 2012. Relative influence of climate variability and direct anthropogenic impact on a sub-tropical Pacific top predator, the Hawaiian monk seal. Marine Ecology Progress Series **469**:175–189.

Bakke T, Green AMV, Iversen PE. 2011. Offshore Environmental Effects Monitoring in Norway–Regulations, Results and Developments. Pages 481–491 Produced Water. Springer. Available from http://link.springer.com/chapter/10.1007/978-1-4614-0046-2_25 (accessed September 17, 2016).

Bakke T, Klungsøyr J, Sanni S. 2013. Environmental impacts of produced water and drilling waste discharges from the Norwegian offshore petroleum industry. Marine Environmental Research **92**:154–169.

Balcomb III K, Claridge D. 2001. A mass stranding of cetaceans caused by naval sonar in the Bahamas. Bahamas Journal of Science **8**:2–12.

Balmer BC et al. 2015. Persistent organic pollutants (POPs) in blubber of common bottlenose dolphins (Tursiops truncatus) along the northern Gulf of Mexico coast, USA. Science of the Total Environment **527**:306–312.

Barlow J. 1999. Trackline detection probability for long-diving whales. Marine Mammal Survey and Assessment Methods. Balkema, Rotterdam, The Netherlands:209–221.

Barlow J, Gisiner R. 2004. Mitigation and monitoring. Page Marine Mammal Commission Beaked Whale Technical Workshop. Available from https://www.researchgate.net/profile/Jay_Barlow/publication/268355154_Mitigation_and_Monitoring/links/55c4b38408aeb9756741e59a.pdf (accessed August 9, 2017).

Barlow J, Gisiner R. 2006. Mitigating, monitoring and assessing the effects of anthropogenic sound on beaked whales. Journal of Cetacean Research and Management **7**:239–249.
Baulch S, Perry C. 2014. Evaluating the impacts of marine debris on cetaceans. Marine Pollution Bulletin **80**:210–221.
Baum JK, Kehler D, Myers RA. 2005. Robust estimates of decline for pelagic shark populations in the northwest Atlantic and Gulf of Mexico. Fisheries **30**:27.
Baum JK, Myers RA. 2004. Shifting baselines and the decline of pelagic sharks in the Gulf of Mexico. Ecology Letters **7**:135–145.
Baumann-Pickering S et al. 2013. Species-specific beaked whale echolocation signals. The Journal of the Acoustical Society of America **134**:2293–2301.
Bezamat C, Wedekin LL, Simões-Lopes PC. 2014. Potential ship strikes and density of humpback whales in the Abrolhos Bank breeding ground, Brazil. Aquatic Conservation: Marine and Freshwater Ecosystems:n/a-n/a.
Bianchi TS, DiMarco SF, Cowan JH, Hetland RD, Chapman P, Day JW, Allison MA. 2010. The science of hypoxia in the Northern Gulf of Mexico: a review. Science of the Total Environment **408**:1471–1484.
Biggs DC. 1992. Nutrients, plankton, and productivity in a warm-core ring in the western Gulf of Mexico. Journal of Geophysical Research: Oceans **97**:2143–2154.
BOEM. 2017a. 2017 - 2022 Lease Sale Schedule | BOEM. Available from https://www.boem.gov/2017-2022-Lease-Sale-Schedule/ (accessed August 8, 2017).
BOEM. 2017b. Gulf of Mexico OCS Proposed Geological and Geophysical Activities Western, Central, and Eastern Planning Areas Final Programmatic Environmental Impact Statement. OCS EIS/EA BOEM 2017-051. U.S. Department of the Interior Bureau of Ocean Energy Management Gulf of Mexico OCS Region, New Orleans, LA. Available from https://www.boem.gov/BOEM-2017-051-v1/.
Brandsma MG, Smith JP. 1996. Dispersion modeling perspectives on the environmental fate of produced water discharges. Pages 215–224 Produced Water 2. Springer. Available from http://link.springer.com/chapter/10.1007/978-1-4613-0379-4_20 (accessed September 12, 2016).
Brooks S, Harman C, Zaldibar B, Izagirre U, Glette T, Marigómez I. 2011. Integrated biomarker assessment of the effects exerted by treated produced water from an onshore natural gas processing plant in the North Sea on the mussel Mytilus edulis. Marine pollution bulletin **62**:327–339.
BSEE. 2013. Spills | Bureau of Safety and Environmental Enforcement. Available from https://www.bsee.gov/stats-facts/offshore-incident-statistics/spills (accessed August 9, 2017).
Buckland ST, Anderson DR, Burnham KP, Laake JL, Borchers DL, Thomas L. 2001. Introduction to distance sampling estimating abundance of biological populations. Available from http://www.citeulike.org/group/342/article/1349739 (accessed August 3, 2017).
Cárdenas-Hinojosa G, Hoyos-Padilla M, Rojas-Bracho L. 2015. Occurrence of Cuvier’s beaked whales (Ziphius cavirostris) at Guadalupe Island, Mexico, from 2006 to 2009. Latin American Journal of Aquatic Mammals **10**:38–47.
Cardillo M, Mace GM, Jones KE, Bielby J, Bininda-Emonds ORP, Sechrest W, Orme CDL, Purvis A. 2005. Multiple Causes of High Extinction Risk in Large Mammal Species. Science **309**:1239–1241.

Carls MG, Holland L, Larsen M, Collier TK, Scholz NL, Incardona JP. 2008. Fish embryos are damaged by dissolved PAHs, not oil particles. Aquatic toxicology **88**:121–127.
Centelleghe C et al. 2017. Dolphin Morbillivirus in a Cuvier's Beaked Whale (Ziphius cavirostris), Italy. Frontiers in Microbiology **8**. Available from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC5281547/ (accessed August 31, 2017).
Chan F et al. 2016. The West Coast Ocean Acidification and Hypoxia Science Panel: Major Findings, Recommendations, and ctions. Page 40. California Ocean Science Trust, Oakland, California. Available from http://westcoastoah.org/wp-content/uploads/2016/04/OAH-Panel-Key-Findings-Recommendations-and-Actions-4.4.16-FINAL.pdf.
Chapman NR, Price A. 2011. Low frequency deep ocean ambient noise trend in the Northeast Pacific Ocean. The Journal of the Acoustical Society of America **129**:EL161–EL165.
Coleman FC, Figueira WF, Ueland JS, Crowder LB. 2004. The impact of United States recreational fisheries on marine fish populations. science **305**:1958–1960.
Conn PB, Silber GK. 2013. Vessel speed restrictions reduce risk of collision-related mortality for North Atlantic right whales. Ecosphere **4**:1–16.
Convention on Migratory Species. 2014. Species added to appendices I and II by the 11th meeting of the conference of the parties to CMS. UNEP/CMS/COP11/REPORT ANNEX VII. Quito, Ecuador. Available from http://www.cms.int/sites/default/files/document/Annex_VII_Species_added_to_CMS_Appendices_I%26II_En.pdf.
Costidis AM, Rommel SA. 2016. The extracranial arterial system in the heads of beaked whales, with implications on diving physiology and pathogenesis. Journal of Morphology **277**:5–33.
Cox TM, Ragen TJ, Read AJ, Vos E, Baird RW, Balcomb K, Barlow J, Caldwell J, Cranford T, Crum L. 2006. Understanding the impacts of anthropogenic sound on beaked whales. J. CETACEAN RES. MANAGE **7**:177–187.
Craig JK. 2012. Aggregation on the edge: effects of hypoxia avoidance on the spatial distribution of brown shrimp and demersal fishes in the Northern Gulf of Mexico. Marine Ecology Progress Series **445**:75–95.
Craig JK, Crowder LB, Gray CD, McDaniel CJ, Kenwood TA, Hanifen JG. 2001. Ecological effects of hypoxia on fish, sea turtles, and marine mammals in the northwestern Gulf of Mexico. Coastal hypoxia: consequences for living resources and ecosystems:269–291.
Cranford PJ, Gordon Jr DC, Lee K, Armsworthy SL, Tremblay G-H. 1999. Chronic toxicity and physical disturbance effects of water-and oil-based drilling fluids and some major constituents on adult sea scallops (Placopecten magellanicus). Marine Environmental Research **48**:225–256.
Dalebout ML, Baker CS, Mead JG, Cockcroft VG, Yamada TK. 2004. A comprehensive and validated molecular taxonomy of beaked whales, family Ziphiidae. Journal of Heredity **95**:459–473.
Dalebout ML, Robertson KM, Frantzis A, Engelhaupt DAN, MIGNUCCI-GIANNONI AA, ROSARIO-DELESTRE RJ, Baker CS. 2005. Worldwide structure of mtDNA diversity among Cuvier's beaked whales (Ziphius cavirostris): implications for threatened populations. Molecular Ecology **14**:3353–3371.
D'Amico A, Gisiner RC, Ketten DR, Hammock JA, Johnson C, Tyack PL, Mead J. 2009. Beaked Whale Strandings and Naval Exercises. Aquatic Mammals **35**:452–472.

Davidson AD, Boyer AG, Kim H, Pompa-Mansilla S, Hamilton MJ, Costa DP, Ceballos G, Brown JH. 2012. Drivers and hotspots of extinction risk in marine mammals. Proceedings of the National Academy of Sciences **109**:3395–3400.

Davis RW, Evans WE, Würsig B. 2000. Cetaceans, Sea Turtles and Seabirds in the Northern Gulf of Mexico: Distribution, Abundance and Habitat Associations Volume I: Executive Summary. Texas A&M, OCS MMS **2**. Available from https://cybercemetery.unt.edu/archive/mms/20100629082502/http://www.gomr.mms.gov/PI/PDFImages/ESPIS/3/3152.pdf (accessed August 25, 2017).

Davis RW, Ortega-Ortiz JG, Ribic CA, Evans WE, Biggs DC, Ressler PH, Cady RB, Leben RR, Mullin KD, Würsig B. 2002. Cetacean habitat in the northern oceanic Gulf of Mexico. Deep Sea Research Part I: Oceanographic Research Papers **49**:121–142.

De Guise S, Martineau D, Béland P, Fournier M. 1995. Possible mechanisms of action of environmental contaminants on St. Lawrence beluga whales (Delphinapterus leucas). Environmental Health Perspectives **103**:73–77.

de Mutsert K, Steenbeek J, Lewis K, Buszowski J, Cowan JH, Christensen V. 2016. Exploring effects of hypoxia on fish and fisheries in the northern Gulf of Mexico using a dynamic spatially explicit ecosystem model. Ecological Modelling **331**:142–150.

Derraik JG. 2002. The pollution of the marine environment by plastic debris: a review. Marine pollution bulletin **44**:842–852.

DeRuiter SL et al. 2013. First direct measurements of behavioural responses by Cuvier's beaked whales to mid-frequency active sonar. Biology Letters **9**:20130223.

DHNRDA Trustees. 2016. Deepwater Horizon Oil Spill: Final Programmatic Damage Assessment and Restoration Plan and Final Programmatic Environmental Impact Statement. Page 70. Available from http://www.gulfspillrestoration.noaa.gov/sites/default/files/wp-content/uploads/Front-Matter-and-Chapter-1_Introduction-and-Executive-Summary_508.pdf.

DHSG. 2011. Final Report on the Investigation of the Macondo Well Blowout. Page 126. The University of California, Berkeley. Available from http://ccrm.berkeley.edu/pdfs_papers/bea_pdfs/dhsgfinalreport-march2011-tag.pdf.

Diaz RJ, Rosenberg R. 2008. Spreading dead zones and consequences for marine ecosystems. science **321**:926–929.

Díaz-Delgado J et al. 2016. Verminous Arteritis Due to Crassicauda sp. in Cuvier's Beaked Whales (Ziphius Cavirostris). Veterinary Pathology **53**:1233–1240.

Dizon AE, Lockyer C, Perrin WF, Demaster DP, Sisson J. 1992. Rethinking the Stock Concept: A Phylogeographic Approach. Conservation Biology **6**:24–36.

Domingo M, Ferrer L, Pumarola M, Marco A, Plana J, Kennedy S, McAliskey M, Rima BK, others. 1990. Morbillivirus in dolphins. Nature (London) **348**. Available from https://www.cabdirect.org/cabdirect/abstract/19912216800 (accessed August 31, 2017).

Doney SC et al. 2012. Climate Change Impacts on Marine Ecosystems. Annual Review of Marine Science **4**:11–37.

Ekstrom JA et al. 2015. Vulnerability and adaptation of US shellfisheries to ocean acidification. Nature Climate Change **5**:207–214.

Elliott B. 2017. Analyzing the Role of Sound in the Endangered Species Act: A Petition for Sperm Whale (Physeter macrocephalus) Critical Habitat in the Gulf of Mexico. Duke University. Available from https://dukespace.lib.duke.edu/dspace/handle/10161/14144 (accessed May 9, 2017).

Estabrook BJ, Ponirakis DW, Clark CW, Rice AN. 2016. Widespread spatial and temporal extent of anthropogenic noise across the northeastern Gulf of Mexico shelf ecosystem. Endangered Species Research **30**:267–282.

Evans D, England GR, Lautenbacher C, Morrissey S, Hogarth W, others. 2001. Joint Interim Report Bahamas Marine Mammal Stranding Event of 15-16 March 2000. US Department of Commerce, US Secretary of the Navy. Available from https://pdfs.semanticscholar.org/fd60/ab901f1d5f3f4a67bfc12421060d6509e0ba.pdf (accessed August 4, 2017).

Fahlman A, Tyack PL, Miller PJO, Kvadsheim PH. 2014. How man-made interference might cause gas bubble emboli in deep diving whales. Frontiers in Physiology **5**. Available from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3904108/ (accessed January 7, 2016).

Fairfield CP, Garrison LP. 2008. Estimated bycatch of marine mammals and sea turtles in the US Atlantic pelagic longline fleet during 2007. NOAA Technical Memorandum NOAA NMFS-SEFSC-572. US Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center, Panama City, Florida. Available from https://www.sefsc.noaa.gov/P_QryLDS/download/TM556_TM-572.pdf?id=LDS (accessed August 4, 2017).

Fairfield-Walsh C, Garrison LP. 2006. Estimated bycatch of marine mammals and turtles in the US Atlantic pelagic longline fleet during 2005. NOAA Tech. Memo. NOAA NMFS-SEFSC-539. Available from http://docs.lib.noaa.gov/noaa_documents/NMFS/SEFSC/TM_NMFS_SEFSC/NMFS_SEFSC_TM_560.pdf (accessed August 4, 2017).

Feely RA, Alin SR, Newton J, Sabine CL, Warner M, Devol A, Krembs C, Maloy C. 2010. The combined effects of ocean acidification, mixing, and respiration on pH and carbonate saturation in an urbanized estuary. Estuarine, Coastal and Shelf Science **88**:442–449.

Fernández A, Edwards JF, Rodríguez F, Monteros AE de los, Herráez P, Castro P, Jaber JR, Martín V, Arbelo M. 2005. “Gas and Fat Embolic Syndrome” Involving a Mass Stranding of Beaked Whales (Family Ziphiidae) Exposed to Anthropogenic Sonar Signals. Veterinary Pathology Online **42**:446–457.

Fernandez C. 2017, June 20. Cuvier’s beaked whale had 4kg of plastic bags in its stomach. Available from http://www.dailymail.co.uk/~/article-4622564/index.html (accessed August 6, 2017).

Fertl D, Schiro AJ, Collier S, Worthy GAJ. 1997. Stranding of a Cuvier’s beaked whale(Ziphius cavirostris) in southern Texas, with comments on stomach contents. Gulf of Mexico Science **15**:92–93.

Finneran JJ, Schlundt CE. 2010. Frequency-dependent and longitudinal changes in noise-induced hearing loss in a bottlenose dolphin (Tursiops truncatus). The Journal of the Acoustical Society of America **128**:567–570.

Foote AD, Osborne RW, Hoelzel AR. 2004. Environment: Whale-call response to masking boat noise. Nature **428**:910–910.

Fordyce RE, Barnes LG. 1994. The evolutionary history of whales and dolphins. Annual Review of Earth and Planetary Sciences **22**:419–455.

Fossi MC, Panti C, Guerranti C, Coppola D, Giannetti M, Marsili L, Minutoli R. 2012. Are baleen whales exposed to the threat of microplastics? A case study of the Mediterranean fin whale (Balaenoptera physalus). Marine Pollution Bulletin **64**:2374–2379.
Frantzis A. 1998. Does acoustic testing strand whales? Nature **392**:29.
Frantzis A. 2004. The first mass stranding that was associated with the use of active sonar (Kyparissiakos Gulf, Greece, 1996). ECS Newsletter **42**:14–20.
Freitas L. 2004. The stranding of three Cuvier's beaked whales Ziphius cavirostris in Madeira Archipelago–May 2000. ECS Newsletter **42**:28–32.
Fujiwara M, Caswell H. 2001. Demography of the endangered North Atlantic right whale. Nature **414**:537.
Gall SC, Thompson RC. 2015. The impact of debris on marine life. Marine Pollution Bulletin **92**:170–179.
Gardner JV, Calder BR, Clarke JH, Mayer LA, Elston G, Rzhanov Y. 2007. Drowned shelf-edge deltas, barrier islands and related features along the outer continental shelf north of the head of De Soto Canyon, NE Gulf of Mexico. Geomorphology **89**:370–390.
Garrison L, Stokes L. 2010. Estimated Bycatch of Marine Mammals and Sea Turtles in the U.S. Atlantic Pelagic Longline Fleet During 2009. Page 64. NOAA Technical Memorandum NMFS-SEFSC-607. U.S. Department of Commerce National Oceanic and Atmospheric Administration National Marine Fisheries Service Southeast Fisheries Science Center, Miami, Florida. Available from https://www.sefsc.noaa.gov/turtles/TM_NMFS_SEFSC_607.pdf.
Garrison L, Stokes L. 2012. Estimated Bycatch of Marine Mammals and Sea Turtles in the U.S. Atlantic Pelagic Longline Fleet During 2010. Page 59. NOAA Technical Memorandum NMFS-SEFSC-624. U.S. Department of Commerce National Oceanic and Atmospheric Administration National Marine Fisheries Service Southeast Fisheries Science Center, Miami, Florida. Available from https://www.sefsc.noaa.gov/turtles/TM_NMFS_SEFSC_667_Garrison_Stokes.pdf.
Garrison L, Stokes L. 2014. Estimated Bycatch of Marine Mammals and Sea Turtles in the U.S. Atlantic Pelagic Longline Fleet During 2013. Page 67. NOAA Technical Memorandum NMFS-SEFSC-667. U.S. Department of Commerce National Oceanic and Atmospheric Administration National Marine Fisheries Service Southeast Fisheries Science Center, Miami, Florida. Available from https://www.sefsc.noaa.gov/turtles/TM_NMFS_SEFSC_667_Garrison_Stokes.pdf.
Garrison L, Stokes L. 2016. Estimated Bycatch of Marine Mammals and Sea Turtles in the U.S. Atlantic Pelagic Longline Fleet During 2014. Page 66. NOAA Technical Memorandum NMFS-SEFSC-696. U.S. Department of Commerce National Oceanic and Atmospheric Administration National Marine Fisheries Service Southeast Fisheries Science Center, Miami, Florida. Available from https://www.sefsc.noaa.gov/turtles/TM_NMFS_SEFSC_667_Garrison_Stokes.pdf.
Garrison LP. 2003. Estimated bycatch of marine mammals and turtles in the US Atlantic Pelagic Longline Fleet during 2001-2002. NOAA Tech. Mem. NOAA FISHERIES-SEFSC-515.
Garrison LP. 2005. Estimated bycatch of marine mammals and sea turtles in the US Atlantic pelagic longline fleet during 2004. NOAA Technical Memorandum NMFS-SEFSC-667. US Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center, Miami, Florida. Available from

http://docs.lib.noaa.gov/noaa_documents/NMFS/SEFSC/TM_NMFS_SEFSC/NMFS_SEFSC_TM_667.pdf (accessed August 4, 2017).
Garrison LP. 2007. Interactions between marine mammals and pelagic longline fishing gear in the US Atlantic Ocean between 1992 and 2004. Fishery Bulletin **105**:408–417.
Garrison LP, Stokes L, Fairfield CP. 2008. Estimated bycatch of marine mammals and sea turtles in the U.S. Atlantic pelagic longline fleet during 2007. Page 62. NOAA Technical Memorandum NOAA NMFS-SEFSC-572. US Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center. Available from http://docs.lib.noaa.gov/noaa_documents/NMFS/SEFSC/TM_NMFS_SEFSC/NMFS_SEFSC_TM_667.pdf (accessed August 4, 2017).
Geraci JR. 1990. Physiologic and toxic effects on cetaceans. Pages167-197 in: JR Geraci and DJ St. Aubin (eds.) Sea mammals and oil: Confronting the risks. Academic Press, New York.
Gillig D, Ozuna Jr T, Griffin WL. 2000. The value of the Gulf of Mexico recreational red snapper fishery. Marine Resource Economics **15**:127–139.
Gobler CJ, Baumann H. 2016. Hypoxia and acidification in ocean ecosystems: coupled dynamics and effects on marine life. Biology Letters **12**:20150976.
Grøsvik BE, Meier S, Liewenborg B, Nesje G, Westrheim K, Fonn M, Kjesbu OS, Skarphéḥinsdóttir H, Klungsøyr J. 2010. PAH and biomarker measurements in fish from condition monitoring in Norwegian waters in 2005 and 2008. ICES. Available from https://brage.bibsys.no/xmlui/handle/11250/102572 (accessed September 17, 2016).
Haider HS, Oldfield SC, Tu T, Moreno RK, Diffendorfer JE, Eager EA, Erickson RA. 2017. Incorporating Allee effects into the potential biological removal level. Natural Resource Modeling. Available from http://onlinelibrary.wiley.com/doi/10.1111/nrm.12133/full (accessed August 11, 2017).
Hall AJ, McConnell BJ, Rowles TK, Aguilar A, Borrell A, Schwacke L, Reijnders PJ, Wells RS. 2006. Individual-based model framework to assess population consequences of polychlorinated biphenyl exposure in bottlenose dolphins. Environmental Health Perspectives **114**:60.
Hansen LJ, Mullin KD, Jefferson TA, Scott GP. 1996. Visual surveys aboard ships and aircraft. pp. 55-132. In: R.W. Davis and G.S. Fargion (eds.) Distribution and abundance of marine mammals in the north-central and western Gulf of Mexico: Final report. Technical report. OCS Study MMS 96-0027. Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA.
Hansen LJ, Mullin KD, Roden CL. 1995. Estimates of cetacean abundance in the northern Gulf of Mexico from vessel surveys. Available from http://aquaticcommons.org/id/eprint/20472 (accessed August 4, 2017).
Hanson N, Thompson D, Duck C, Moss S, Lonergan M. 2013. Pup mortality in a rapidly declining harbour seal (Phoca vitulina) population. PloS one **8**:e80727.
Harris PT, Whiteway T. 2011. Global distribution of large submarine canyons: Geomorphic differences between active and passive continental margins. Marine Geology **285**:69–86.
Hasselberg L, Meier S, Svardal A. 2004. Effects of alkylphenols on redox status in first spawning Atlantic cod (Gadus morhua). Aquatic Toxicology **69**:95–105.

Hatch LT, Clark CW, Van Parijs SM, Frankel AS, Ponirakis DW. 2012. Quantifying loss of acoustic communication space for right whales in and around a US National Marine Sanctuary. Conservation Biology **26**:983–994.

Hesselgrave T, Sheeran K. 2012. Economic costs of historic overfishing on recreational fisheries: South Atlantic & Gulf of Mexico regions. Report to the Pew Charitable Trusts. Ecotrust. Available from http://www-aws.pewtrusts.org/~/media/legacy/uploadedfiles/peg/publications/report/ecotrustserecfishingpdf.pdf (accessed August 4, 2017).

Heyning JE, Mead JG. 2003. Cuvier's Beaked Whale: Ziphius cavirostris. Page Encyclopedia of marine mammals. Elsevier Inc.

Hildebrand JA. 2009. Anthropogenic and natural sources of ambient noise in the ocean. Marine Ecology Progress Series **395**:5–20.

Hildebrand JA et al. 2015. Passive acoustic monitoring of beaked whale densities in the Gulf of Mexico. Scientific reports **5**. Available from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4642294/ (accessed January 12, 2017).

Hildebrand JA, Baumann-Pickering S, Giddings A, Brewer A, Jacobs ER, Trickey JS, Wiggins SM, McDonald MA. 2016. Progress Report on the Application of Passive Acoustic Monitoring to Density Estimation of Cuvier's Beaked Whales. Available from http://cetus.ucsd.edu/Publications/Reports/HildebrandMPLTM606-2016.pdf (accessed September 19, 2016).

Holth TF, Beckius J, Zorita I, Cajaraville MP, Hylland K. 2011. Assessment of lysosomal membrane stability and peroxisome proliferation in the head kidney of Atlantic cod (Gadus morhua) following long-term exposure to produced water components. Marine environmental research **72**:127–134.

Hoop JM, Vanderlaan AS, Cole TV, Henry AG, Hall L, Mase-Guthrie B, Wimmer T, Moore MJ. 2015. Vessel strikes to large whales before and after the 2008 Ship Strike Rule. Conservation Letters **8**:24–32.

Houde M, Hoekstra PF, Solomon KR, Muir DC. 2005. Organohalogen contaminants in delphinoid cetaceans. Pages 1–57 Reviews of environmental contamination and toxicology. Springer. Available from http://link.springer.com/chapter/10.1007/0-387-27565-7_1 (accessed August 8, 2017).

Humphries M. 2013. US crude oil and natural gas production in federal and non-federal areas. Washington: Congressional Research Service. Available from https://cdn.westernenergyalliance.org/sites/default/files/CRS%20U.S.%20Crude%20Oil%20and%20Natural%20Gas%20Production.pdf (accessed August 8, 2017).

Incardona JP, Collier TK, Scholz NL. 2004. Defects in cardiac function precede morphological abnormalities in fish embryos exposed to polycyclic aromatic hydrocarbons. Toxicology and applied pharmacology **196**:191–205.

Jacob JM, West KL, Levine G, Sanchez S, Jensen BA. 2016. Initial characterization of novel beaked whale morbillivirus in Hawaiian cetaceans. Diseases of aquatic organisms **117**:215–227.

Jasny M. 2014. U.S. Navy Implicated in New Mass Stranding of Whales. Available from https://www.nrdc.org/experts/michael-jasny/us-navy-implicated-new-mass-stranding-whales (accessed August 29, 2017).

Jefferson TA, Leatherwood S, Webber MA. 1993. Marine mammals of the world. Food & Agriculture Org. Available from https://books.google.com/books?hl=en&lr=&id=W4Cbz0WphN0C&oi=fnd&pg=PA1&dq=Jefferson+1993+cuvier+beaked+whale&ots=nOu6m-ErF_&sig=4_9mnmtEJLe_EZ4f1_EGxm7vSCk (accessed August 7, 2017).

Jefferson TA, Leatherwood S, Webber MA. 1994. Marine mammals of the world: a comprehensive guide to their identificationFAO and UNEP. Academic Press, Rome, Italy. Available from https://swfsc.noaa.gov/uploadedFiles/Divisions/PRD/Publications/Jeffersonetal93(14).pdf (accessed August 1, 2017).

Jefferson TA, Lynn SK. 1994. Marine mammal sightings in the Caribbean Sea and Gulf of Mexico, summer 1991. Caribbean Journal of Science **30**:83–89.

Jefferson TA, Schiro AJ. 1997. Distribution of cetaceans in the offshore Gulf of Mexico. Mammal Review **27**:27–50.

Jensen A, Silber G. 2004. Large Whale Ship Strike Database. US Department of Commerce. National Oceanic and Atmospheric Administration. Technical Memorandum NMFS-OPR.

Jepson PD et al. 2003. Gas-bubble lesions in stranded cetaceans. Nature **425**:575–576.

Jepson PD, Deaville R, Patterson I a. P, Pocknell AM, Ross HM, Baker JR, Howie FE, Reid RJ, Colloff A, Cunningham AA. 2005. Acute and Chronic Gas Bubble Lesions in Cetaceans Stranded in the United Kingdom. Veterinary Pathology Online **42**:291–305.

Johnson DR, Yeung C, Brown CA. 1999. Estimates of marine mammal and marine turtle bycatch by the US Atlantic pelagic longline fleet in 1992-1997. US Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center. Available from https://www.sefsc.noaa.gov/P_QryLDS/download/TM410_TM-418.pdf?id=LDS (accessed August 4, 2017).

Johnson M, Madsen PT, Zimmer WM, De Soto NA, Tyack PL. 2004. Beaked whales echolocate on prey. Pages S383–S386 Proc. R. Soc. Lond. B. The Royal Society. Available from http://rspb.royalsocietypublishing.org/content/271/Suppl_6/S383.short (accessed August 29, 2017).

Kaplan MB, Mooney TA, McCorkle DC, Cohen AL. 2013. Adverse Effects of Ocean Acidification on Early Development of Squid (Doryteuthis pealeii). PLOS ONE **8**:e63714.

Kellar N et al. 2017. Low reproductive success rates of common bottlenose dolphins Tursiops truncatus in the northern Gulf of Mexico following the Deepwater Horizon disaster (2010-2015). Endangered Species Research **33**:143–158.

Keller AA, Simon V, Chan F, Wakefield WW, Clarke ME, Barth JA, Kamikawa DAN, Fruh EL. 2010. Demersal fish and invertebrate biomass in relation to an offshore hypoxic zone along the US West Coast. Fisheries Oceanography **19**:76–87.

Ketten DR. 2004. Marine mammal auditory systems: a summary of audiometric and anatomical data and implications for underwater acoustic impacts. Polarforschung **72**:79–92.

Ketten DR. 2012. Marine Mammal Auditory System Noise Impacts: Evidence and Incidence. Pages 207–212 in A. N. Popper and A. Hawkins, editors. The Effects of Noise on Aquatic Life. Springer New York. Available from http://link.springer.com/chapter/10.1007/978-1-4419-7311-5_46 (accessed January 7, 2016).

Ketten DR. 2014. Sonars and strandings: Are beaked Whales the Aquatic Acoustic Canary? Acoustics Today **10**:46–56.
Knowlton AR, Marx MK, Pettis HM, Hamilton PK, Kraus SD. 2005. Analysis of Scarring on North Atlantic Right Whales (Eubalaena Glacialis): Monitoring Rates of Entanglement Interaction, 1980-2002. New England Aquarium. Available from https://docs.lib.noaa.gov/noaa_documents/NOAA_related_docs/Analysis_Scarring_North_Atlantic_Right_Whales.pdf (accessed September 1, 2017).
Krahn MM et al. 2007. Persistent organic pollutants and stable isotopes in biopsy samples (2004/2006) from Southern Resident killer whales. Marine Pollution Bulletin **54**:1903–1911.
Kucklick J et al. 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 EB, Kido Soule MC, Valentine DL, Boysen AK, Longnecker K, Redmond MC. 2011. Fate of dispersants associated with the Deepwater Horizon oil spill. Environmental science & technology **45**:1298–1306.
Kurman MD, Gómez CE, Georgian SE, Lunden JJ, Cordes EE. 2017. Intra-Specific Variation Reveals Potential for Adaptation to Ocean Acidification in a Cold-Water Coral from the Gulf of Mexico. Frontiers in Marine Science **4**. Available from http://journal.frontiersin.org.libproxy.lib.unc.edu/article/10.3389/fmars.2017.00111/full (accessed May 9, 2017).
Laist DW, Knowlton AR, Mead JG, Collet AS, Podesta M. 2001. Collisions Between Ships and Whales. Marine Mammal Science **17**:35–75.
Laist DW, Knowlton AR, Pendleton D. 2014. Effectiveness of mandatory vessel speed limits for protecting North Atlantic right whales. Endangered Species Research **23**:133–147.
Lambert O, Bianucci G, Post K. 2010. Tusk-bearing beaked whales from the Miocene of Peru: sexual dimorphism in fossil ziphiids? Journal of Mammalogy **91**:19–26.
Lande R, Engen S, Saether B-E. 2003. Stochastic population dynamics in ecology and conservation. Oxford University Press on Demand. Available from https://books.google.com/books?hl=en&lr=&id=6KClauq8OekC&oi=fnd&pg=PR9&dq=lande+2003+small+populations&ots=BigbbqKHEj&sig=YgTCI1UDswSVs4avJsLtgKQo1yU (accessed August 11, 2017).
Lanfredi C, Azzellino A, D'Amico A, Centurioni L, Rella MA, others. 2016. Key Oceanographic Characteristics of Cuvier's Beaked Whale (Ziphius cavirostris) Habitat in the Gulf of Genoa (Ligurian Sea, NW Mediterranean). J Oceanogr Mar Res **4**:2.
Laurent A, Fennel K, Cai W-J, Huang W-J, Barbero L, Wanninkhof R. 2017. Eutrophication-induced acidification of coastal waters in the northern Gulf of Mexico: Insights into origin and processes from a coupled physical-biogeochemical model. Geophysical Research Letters **44**:946–956.
Learmonth JA, MacLeod CD, Santos MB, Pierce GJ, Crick HQP, Robinson RA. 2006. Potential effects of climate change on marine mammals. Oceanography and Marine Biology **44**:431.
Leatherwood S, Reeves RR. 1983. The Sierra Club handbook of whales and dolphins. Available from http://www.sidalc.net/cgi-bin/wxis.exe/?IsisScript=FCL.xis&method=post&formato=2&cantidad=1&expresion=mfn=006499 (accessed July 28, 2017).

Long DJ, Jones RE. 1996. White shark predation and scavenging on cetaceans in the eastern North Pacific Ocean. Great white sharks: the biology of Carcharodon carcharias:293–307.

Lusher AL, Hernandez-Milian G, O'Brien J, Berrow S, O'Connor I, Officer R. 2015. Microplastic and macroplastic ingestion by a deep diving, oceanic cetacean: The True's beaked whale Mesoplodon mirus. Environmental Pollution **199**:185–191.

LWF. 2017. Species by Parish List | Louisiana Department of Wildlife and Fisheries. Available from http://www.wlf.louisiana.gov/wildlife/species-parish-list?order=field_srank_value&sort=asc&tid=All&type_1=fact_sheet_animal (accessed September 1, 2017).

MacLeod CD. 2009. Global climate change, range changes and potential implications for the conservation of marine cetaceans: a review and synthesis. Endangered Species Research **7**:125–136.

MacLeod CD, Santos MB, Pierce GJ. 2003. Review of Data on Diets of Beaked Whales: Evidence of Niche Separation and Geographic Segregation. Journal of the Marine Biological Association of the United Kingdom **83**:651–665.

Malakoff D. 2002. Suit ties whale deaths to research cruise. Science **298**:722–723.

MARAD. 2014. MARAD Open Data Portal | Maritime Data & Statistics. Available from https://www.marad.dot.gov/resources/data-statistics/ (accessed August 28, 2017).

Martineau D. 2007. Potential synergism between stress and contaminants in free-ranging cetaceans. International Journal of Comparative Psychology **20**. Available from http://escholarship.org/uc/item/866341xp.pdf (accessed August 11, 2017).

Martineau D, Lemberger K, Dallaire A, Labelle P, Lipscomb TP, Michel P, Mikaelian I. 2002. Cancer in Wildlife, a Case Study: Beluga from the St. Lawrence Estuary, Québec, Canada. Environmental Health Perspectives **110**:285.

Master LL, Faber-Langendoen D, Bittman R, Hammerson GA, Heidel B, Ramsay L, Snow K, Teucher A, Tomaino A. 2012. NatureServe conservation status assessments: factors for evaluating species and ecosystem risk. NatureServe, Arlington, VA:76.

Matkin CO, Moore MJ, Gulland FM. 2017. Review of recent research on Southern Resident Killer Whales to detect evidence of poor body condition in the population. Independent Science Panel, Woods Hole, MA. Available from http://hdl.handle.net/1912/8803 (accessed March 23, 2017).

Maze-Foley K, Mullin KD. 2007. Cetaceans of the oceanic northern Gulf of Mexico: Distributions, group sizes and interspecific associations. Journal of Cetacean Research and Management **8**:203.

McCarthy E, Moretti D, Thomas L, DiMarzio N, Morrissey R, Jarvis S, Ward J, Izzi A, Dilley A. 2011. Changes in spatial and temporal distribution and vocal behavior of Blainville's beaked whales (Mesoplodon densirostris) during multiship exercises with mid-frequency sonar. Marine Mammal Science **27**:E206–E226.

McClatchie S, Field J, Thompson AR, Gerrodette T, Lowry M, Fiedler PC, Watson W, Nieto KM, Vetter RD. 2016. Food limitation of sea lion pups and the decline of forage off central and southern California. Open Science **3**:150628.

McLellan W, McAlarney R, Cummings E, Bell J, Read A, Pabst DA. 2015. Year-round Presence of Beaked Whales off Cape Hatteras North Carolina. San Francisco, CA.

McSweeney DJ, Baird RW, Mahaffy SD. 2007a. Site fidelity, associations, and movements of Cuvier's (Ziphius cavirostris) and Blainville's (Mesoplodon densirostris) beaked whales off the island of Hawai 'i. Marine Mammal Science **23**:666–687.
McSweeney DJ, Baird RW, Mahaffy SD. 2007b. Site fidelity, associations, and movements of Cuvier's (Ziphius cavirostris) and Blainville's (Mesoplodon densirostris) beaked whales off the island of Hawai 'i. Marine Mammal Science **23**:666–687.
Mead JG. 1975. A fossil beaked whale (Cetacea: Ziphiidae) from the Miocene of Kenya. Journal of paleontology:745–751.
Meier S et al. 2010. Development of Atlantic cod (Gadus morhua) exposed to produced water during early life stages: Effects on embryos, larvae, and juvenile fish. Marine Environmental Research **70**:383–394.
Meier S, Andersen TE, Norberg B, Thorsen A, Taranger GL, Kjesbu OS, Dale R, Morton HC, Klungsøyr J, Svardal A. 2007. Effects of alkylphenols on the reproductive system of Atlantic cod (Gadus morhua). Aquatic Toxicology **81**:207–218.
Melzner F, Thomsen J, Koeve W, Oschlies A, Gutowska MA, Bange HW, Hansen HP, Körtzinger A. 2012. Future ocean acidification will be amplified by hypoxia in coastal habitats. Marine Biology **160**:1875–1888.
Metcalfe C, Koenig B, Metcalfe T, Paterson G, Sears R. 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.
Mitchell E. 1968. Northeast Pacific stranding distribution and seasonality of Cuvier's beaked whale Ziphius cavirostris. Canadian Journal of Zoology **46**:265–279.
Mitchell FM, Holdway DA. 2000. The acute and chronic toxicity of the dispersants Corexit 9527 and 9500, water accommodated fraction (WAF) of crude oil, and dispersant enhanced WAF (DEWAF) to Hydra viridissima (green hydra). Water Research **34**:343–348.
Moore JE et al. 2011. Guidelines for Assessing Marine Mammal Stocks: Report of the GAMMS III Workshop, February 15-18, 2011, La Jolla, California. US Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Protected Resources. Available from https://pdfs.semanticscholar.org/f45e/9f5c22f1a73a39590eb8d0d116aa8b562990.pdf (accessed August 1, 2017).
Moore JE, Barlow JP. 2013. Declining Abundance of Beaked Whales (Family Ziphiidae) in the California Current Large Marine Ecosystem. PLoS ONE **8**:e52770.
Moore JE, Wallace BP, Lewison RL, Žydelis R, Cox TM, Crowder LB. 2009. A review of marine mammal, sea turtle and seabird bycatch in USA fisheries and the role of policy in shaping management. Marine Policy **33**:435–451.
Moors-Murphy HB. 2014. Submarine canyons as important habitat for cetaceans, with special reference to the Gully: A review. Deep Sea Research Part II: Topical Studies in Oceanography **104**:6–19.
Moretti D et al. 2014. A Risk Function for Behavioral Disruption of Blainville's Beaked Whales (Mesoplodon densirostris) from Mid-Frequency Active Sonar. PLoS ONE **9**:e85064.
Muirhead JR, Minton MS, Miller WA, Ruiz GM. 2015. Projected effects of the Panama Canal expansion on shipping traffic and biological invasions. Diversity and Distributions **21**:75–87.

Mullin KD. 2007. Abundance of cetaceans in the oceanic northern Gulf of Mexico from 2003 and 2004 ship surveys. Available from http://aquaticcommons.org/15062/ (accessed August 4, 2017).

Mullin KD, Fulling GL. 2004. Abundance of cetaceans in the oceanic northern Gulf of Mexico, 1996–2001. Marine Mammal Science **20**:787–807.

Mullin KD, Hoggard W. 2000. Visual surveys of cetaceans and sea turtles from aircraft and ships. Cetaceans, sea turtles and seabirds in the northern Gulf of Mexico: Distribution, abundance and habitat associations **2**:96–0027.

Myers MS, Landahl JT, Krahn MM, McCain BB. 1991. Relationships between hepatic neoplasms and related lesions and exposure to toxic chemicals in marine fish from the US West Coast. Environmental Health Perspectives **90**:7.

Neff J, Lee K, DeBlois EM. 2011. Produced water: overview of composition, fates, and effects. Pages 3–54 Produced water. Springer. Available from http://link.springer.com/chapter/10.1007/978-1-4614-0046-2_1 (accessed September 16, 2016).

Neff JM. 2002. Bioaccumulation in Marine Organisms: Effect of Contaminants from Oil Well Produced Water. Elsevier.

Niño-Torres CA, García-Rivas M del C, Castelblanco-Martínez DN, Padilla-Saldívar JA, Blanco-Parra M del P, de la Parra-Venegas R. 2015. Aquatic mammals from the Mexican Caribbean; a review. Hidrobiológica **25**. Available from http://www.redalyc.org/resumen.oa?id=57842742013 (accessed August 25, 2017).

NMFS. 2006. Final Consolidated Atlantic Highly Migratory Species Fishery Management Plan. Page 1600. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Sustainable Fisheries, Highly Migratory Species Management Division, Silver Spring, MD. Available from http://www.nmfs.noaa.gov/sfa/hms/documents/fmp/consolidated/total.pdf.

NMFS. 2012a. Stock Assessment Report: Cuvier's Beaked Whale (Ziphius cavirostris): Northern Gulf of Mexico Stock. Page 6. National Marine Fisheries Service. Available from https://www.nefsc.noaa.gov/publications/tm/tm223/141_CuviersGMex.pdf.

NMFS. 2012b. Stock Assessment Report: Gervais' Beaked Whale (Mesoplodon europaeus): Northern Gulf of Mexico Stock. Page 6. Stock Assessment Report. National Marine Fisheries Service. Available from https://www.nefsc.noaa.gov/publications/tm/tm223/153_GervaisGMex.pdf.

NMFS. 2012c. Stock Assessment Report: Blainvile's Beaked Whale (Mesoplodon densirostris): Northern Gulf of Mexico Stock. Page 6. Stock Assessment Report. National Marine Fisheries Service. Available from https://www.nefsc.noaa.gov/publications/tm/tm223/153_GervaisGMex.pdf.

NMFS. 2016a. Stock Assessment Report: SPERM WHALE (Physeter macrocephalus): Northern Gulf of Mexico Stock. Page 8. Available from http://www.nmfs.noaa.gov/pr/sars/pdf/stocks/atlantic/2015/f2015_spermgmex.pdf'.

NMFS. 2016b. Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing: Underwater Acoustic Thresholds for Onset of Permanent and Temporary Threshold Shifts. Page 189. NOAA Technical Memorandum NMFS-OPR-55. U.S. Dept. of Commer., NOAA. Available from http://www.nmfs.noaa.gov/pr/acoustics/Acoustic%20Guidance%20Files/opr-55_acoustic_guidance_tech_memo.pdf (accessed August 3, 2016).

NMFS. 2017. Cuvier's Beaked Whale (Ziphius cavirostris) :: NOAA Fisheries. Available from http://www.fisheries.noaa.gov/pr/species/mammals/whales/cuviers-beaked-whale.html (accessed August 2, 2017).

NOAA. 2017. Gulf of Mexico "dead zone" is the largest ever measured | National Oceanic and Atmospheric Administration. Available from http://www.noaa.gov/media-release/gulf-of-mexico-dead-zone-is-largest-ever-measured (accessed August 11, 2017).

NOAA Fisheries. 2016. Cetacean Unusual Mortality Event in Northern Gulf of Mexico (2010-2014): CLOSED :: NOAA Fisheries. Available from http://www.nmfs.noaa.gov/pr/health/mmume/cetacean_gulfofmexico.htm (accessed August 31, 2017).

NOAA Fisheries. 2017. Pelagic Observer Program, Southeast Fisheries Science Center - NOAA - National Marine Fisheries Service. Available from https://www.sefsc.noaa.gov/fisheries/observers/pelagic.htm (accessed August 4, 2017).

O'Grady JJ, Brook BW, Reed DH, Ballou JD, Tonkyn DW, Frankham R. 2006. Realistic levels of inbreeding depression strongly affect extinction risk in wild populations. Biological Conservation **133**:42–51.

Oil & Gas. 2017, July 17. BOEM Offers GOM Leases at Reduced Royalty Rate for Shallow Water Leases. Available from https://www.oilandgas360.com/744181-2/ (accessed August 8, 2017).

Orr JC et al. 2005. Anthropogenic ocean acidification over the twenty-first century and its impact on calcifying organisms. Nature **437**:681–686.

Pace RM. 2011. Frequency of Whale and Vessel Collisions on the US Eastern Seaboard: Ten Years Prior and Two Years Post Ship Strike Rule. Available from https://nefsc.noaa.gov/publications/crd/crd1115/crd1115.pdf (accessed January 4, 2016).

Panama Canal Authority. 2016. Expanded Panama Canal. Available from http://micanaldepanama.com/expansion/ (accessed August 10, 2017).

Pauly D, Trites AW, Capuli E, Christensen V. 1998. Diet composition and trophic levels of marine mammals. ICES journal of Marine Science **55**:467–481.

Pérez-Zayas JJ, Mignucci-Giannoni AA, Toyos-González GM, Rosario-Delestre RJ, Williams EH. 2002. Incidental predation by a largetooth cookiecutter shark on a Cuvier's beaked whale in Puerto Rico. Aquatic Mammals **28**:308–311.

Peterson CH, Rice SD, Short JW, Esler D, Bodkin JL, Ballachey BE, Irons DB. 2003. Long-Term Ecosystem Response to the Exxon Valdez Oil Spill. Science **302**:2082–2086.

Peterson CT, Grubbs RD, Mickle A. 2017. An Investigation of Effects of the Deepwater Horizon Oil Spill on Coastal Fishes in the Florida Big Bend Using Fishery-Independent Surveys and Stable Isotope Analysis. Southeastern Naturalist **16**:G93–G108.

Pirotta E, Milor R, Quick N, Moretti DJ, DiMarzio NA, Tyack PL, Boyd IL, Hastie G. 2012. Vessel noise affects beaked whale behavior: results of a dedicated acoustic response study. Available from http://darchive.mbl.edu/handle/1912/5402 (accessed January 7, 2016).

Podestà M, Azzellino A, Cañadas A, Frantzis A, Moulins A, Rosso M, Tepsich P, Lanfredi C. 2016. Chapter Four-Cuvier's Beaked Whale, Ziphius cavirostris, Distribution and Occurrence in the Mediterranean Sea: High-Use Areas and Conservation Threats. Advances in marine biology **75**:103–140.

Podesta M, D Amico A, Pavan G, Drougas A, Komnenou A, Portunato N. 2005. A review of Cuvier's beaked whale strandings in the Mediterranean Sea. Journal of Cetacean Research and Management **7**:251.

Poncelet E, Van Canneyt O, Boubert J-J. 2000. Considerable amount of plastic debris in the stomach of a Cuvier's beaked whale (Ziphius cavirostris) washed ashore on the French Atlantic coast. European Research on Cetaceans **14**:44–47.

Purvis A, Gittleman JL, Cowlishaw G, Mace GM. 2000. Predicting extinction risk in declining species. Proceedings of the Royal Society of London B: Biological Sciences **267**:1947–1952.

Rabalais NN, Turner RE, Wiseman Jr WJ. 2002. Gulf of Mexico hypoxia, aka "The dead zone." Annual Review of ecology and Systematics **33**:235–263.

Rabotyagov SS, Kling CL, Gassman PW, Rabalais NN, Turner RE. 2014. The economics of dead zones: Causes, impacts, policy challenges, and a model of the Gulf of Mexico hypoxic zone. Review of Environmental Economics and Policy **8**:58–79.

Ramachandran SD, Hodson PV, Khan CW, Lee K. 2004. Oil dispersant increases PAH uptake by fish exposed to crude oil. Ecotoxicology and Environmental Safety **59**:300–308.

Read AJ. 2000. The Marine Mammals of the Gulf of Mexico. Academic Press.

Richardson WJ, Greene Jr CR, Malme CI, Thomson DH. 2013. Marine mammals and noise. Academic press. Available from https://books.google.com/books?hl=en&lr=&id=j6bYBAAAQBAJ&oi=fnd&pg=PP1&ots=B9Rsyi7uW8&sig=UdwEcXrqyZRV6Vk_FJznFHxdIkY (accessed January 5, 2016).

Robbins J, Mattila DK. 2004. Estimating humpback whale (Megaptera novaeangliae) entanglement rates on the basis of scar evidence. Final report. Northeast Fisheries Science Center, Woods Hole, Massachusetts. Available from http://www.coastalstudies.org/pdf/Robbins_and_Mattila_2004.pdf (accessed September 1, 2017).

Roberts JJ et al. 2016. Habitat-based cetacean density models for the U.S. Atlantic and Gulf of Mexico. Scientific Reports **6**. Available from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4776172/ (accessed September 19, 2016).

Rockwood RC, Calambokidis J, Jahncke J. 2017. High mortality of blue, humpback and fin whales from modeling of vessel collisions on the U.S. West Coast suggests population impacts and insufficient protection. PLOS ONE **12**:e0183052.

Rommel SA et al. 2005. Elements of beaked whale anatomy and diving physiology and some hypothetical causes of sonar-related stranding. Journal of Cetacean Research and Management **7**:189.

Rosa R, Trübenbach K, Pimentel MS, Boavida-Portugal J, Faleiro F, Baptista M, Dionísio G, Calado R, Pörtner HO, Repolho T. 2014. Differential impacts of ocean acidification and warming on winter and summer progeny of a coastal squid (Loligo vulgaris). Journal of Experimental Biology **217**:518–525.

Rosel PE, Corkeron P, Engleby L, Epperson D, Mullin KD, Soldevilla MS, Taylor B. 2016. Status Review of Bryde's Whales (Balaenoptera edeni) in the Gulf of Mexico under the Endangered Species Act. NOAA Technical Memorandum NMFS-SEFSC **692**. Available from http://www.cio.noaa.gov/services_programs/prplans/pdfs/ID337_BrydesWhale_FinalProduct.pdf (accessed August 4, 2017).

Rosel PE, Wilcox LA. 2014. Genetic evidence reveals a unique lineage of Bryde's whales in the northern Gulf of Mexico. Endangered Species Research **25**:19–34.

Santos MB, Pierce GJ, Herman J, Lopez A, Guerra A, Mente E, Clarke MR. 2001. Feeding ecology of Cuvier's beaked whale (Ziphius cavirostris): a review with new information on the diet of this species. Journal of the Marine Biological Association of the United Kingdom **81**:687–694.

Schein A, Scott JA, Mos L, Hodson PV. 2009. Oil dispersion increases the apparent bioavailability and toxicity of diesel to rainbow trout (Oncorhynchus mykiss). Environmental Toxicology and Chemistry **28**:595–602.

Schorr GS, Falcone EA, Moretti DJ, Andrews RD. 2014. First Long-Term Behavioral Records from Cuvier's Beaked Whales (Ziphius cavirostris) Reveal Record-Breaking Dives. PLoS ONE **9**:e92633.

Schorr GS, Falcone EA, Moretti DJ, McCarthy EM, Hanson MB, Andrews RD. 2011. The bar is really noisy, but the food must be good: High site fidelity and dive behavior of Cuvier's beaked whales (Ziphius cavirostris) on an anti-submarine warfare range. Page Proceedings of the 19th Biennial Conference on the Biology of Marine Mammals. Tampa, US.

Schwacke LH et al. 2013. Health of common bottlenose dolphins (Tursiops truncatus) in Barataria Bay, Louisiana, following the Deepwater Horizon oil spill. Environmental science & technology **48**:93–103.

Schwacke LH, Thomas L, Wells RS, McFee WE, Hohn AA, Mullin KD, Zolman ES, Quigley BM, Rowles TK, Schwacke JH. 2017. Quantifying injury to common bottlenose dolphins from the Deepwater Horizon oil spill using an age-, sex-and class-structured population model. Endangered Species Research **33**:265–279.

Shaffer ML, Stein BA. 2000. Safeguarding our precious heritage. Pages 301–302 Precious Heritage: The Status of Biodiversity in the United StatesStein BA, Kutner LS, Adams JS, . Oxford University Press, New York.

Sidorovskaia NA, Ackleh AS, Tiemann CO, Ma B, Ioup JW, Ioup GE. 2016. Passive Acoustic Monitoring of the Environmental Impact of Oil Exploration on Marine Mammals in the Gulf of Mexico. Pages 1007–1014 The Effects of Noise on Aquatic Life II. Springer, New York, NY. Available from https://link.springer.com/chapter/10.1007/978-1-4939-2981-8_125 (accessed August 25, 2017).

Silber GK, Adams JD, Fonnesbeck CJ. 2014. Compliance with vessel speed restrictions to protect North Atlantic right whales. PeerJ **2**:e399.

Simmonds MP. 2012. Cetaceans and marine debris: the great unknown. Journal of Marine Biology **2012**. Available from https://www.hindawi.com/journals/jmb/2012/684279/abs/ (accessed August 28, 2017).

Simmonds MP, Eliott WJ. 2009. Climate change and cetaceans: concerns and recent developments. Journal of the Marine Biological Association of the United Kingdom **89**:203–210.

Simmonds MP, Lopez-Jurado LF. 1991. Whales and the military. Nature **351**:448–448.

Simonis A, Thayre B, Oleson E, Baumann-Pickering S. 2016. Mid-frequency active sonar and beaked whale acoustic activity in the Northern Mariana Islands. The Journal of the Acoustical Society of America **140**:3413–3413.

Smith C et al. 2017. Slow recovery of Barataria Bay dolphin health following the Deepwater Horizon oil spill (2013-2014), with evidence of persistent lung disease and impaired stress response. Endangered Species Research **33**:127–142.
Snyder MA. 2007. Long-term ambient noise statistics in the Gulf of Mexico. University of New Orleans. Available from http://search.proquest.com/openview/0b4677fe49b13a288af243e2cc2427af/1?pq-origsite=gscholar&cbl=18750&diss=y (accessed August 10, 2017).
Southall BL, Nowacek DP, Miller PJO, Tyack PL. 2016. REVIEW Experimental field studies to measure behavioral responses of cetaceans to sonar. Endangered Species Research **31**:293–315.
Stimpert AK, DeRuiter SL, Southall BL, Moretti DJ, Falcone EA, Goldbogen JA, Friedlaender A, Schorr GS, Calambokidis J. 2014. Acoustic and foraging behavior of a Baird's beaked whale, Berardius bairdii, exposed to simulated sonar. Scientific Reports **4**:7031.
Sturges W, Lugo-Fernandez A. 2005. Circulation in the Gulf of Mexico: observations and models. Washington DC American Geophysical Union Geophysical Monograph Series **161**. Available from http://adsabs.harvard.edu/abs/2005GMS...161.....S (accessed August 29, 2017).
Sturve J, Hasselberg L, Fälth H, Celander M, Förlin L. 2006. Effects of North Sea oil and alkylphenols on biomarker responses in juvenile Atlantic cod (Gadus morhua). Aquatic toxicology **78**:S73–S78.
Taylor BL, Baird R, Barlow J, Dawson S, Ford J, Mead JG, Notarbartolo di Sciara G, Wade PR, Pitman RL. 2008. Ziphius cavirostris. The IUCN Red List of Threatened Species 2008: e.T23211A9429826. Available from http://dx.doi.org/10.2305/IUCN.UK.2008.RLTS.T23211A9429826.en (accessed August 5, 2017).
The Associated Press. 2010. 27,000 abandoned oil and gas wells in Gulf of Mexico ignored by government, industry. Available from http://www.nola.com/news/gulf-oil-spill/index.ssf/2010/07/27000_abandoned_oil_and_gas_we.html (accessed August 4, 2017).
Tollefsen K-E, Blikstad C, Eikvar S, Finne EF, Gregersen IK. 2008. Cytotoxicity of alkylphenols and alkylated non-phenolics in a primary culture of rainbow trout (Onchorhynchus mykiss) hepatocytes. Ecotoxicology and environmental safety **69**:64–73.
TPWD. 2017. TPWD: Texas Nongame and Rare Species Program: Federal and State Listed Mammals in Texas. Available from https://tpwd.texas.gov/huntwild/wild/wildlife_diversity/nongame/listed-species/mammals.phtml (accessed September 1, 2017).
Tyack PL et al. 2011. Beaked Whales Respond to Simulated and Actual Navy Sonar. PLOS ONE **6**:e17009.
Tyack PL, Janik VM. 2013. Effects of Noise on Acoustic Signal Production in Marine Mammals. Pages 251–271 in H. Brumm, editor. Animal Communication and Noise. Springer Berlin Heidelberg. Available from http://link.springer.com/chapter/10.1007/978-3-642-41494-7_9 (accessed January 7, 2016).
Tyack PL, Johnson M, Soto NA, Sturlese A, Madsen PT. 2006. Extreme diving of beaked whales. Journal of Experimental Biology **209**:4238–4253.

US Army Corps of Engineers. 2016. CY 2015 Tonnage for Selected U.S. Ports by Port Names. Available from http://www.navigationdatacenter.us/wcsc/porttons15 (accessed August 10, 2017).
U.S. Energy Information Administration. 2015. U.S. Gulf of Mexico share of global active offshore rigs declines since 2000. Available from https://www.eia.gov/todayinenergy/detail.php?id=23032 (accessed August 4, 2017).
Van Bressem M-F et al. 2014. Cetacean morbillivirus: current knowledge and future directions. Viruses **6**:5145–5181.
Van Der Hoop JM, Vanderlaan AS, Taggart CT. 2012. Absolute probability estimates of lethal vessel strikes to North Atlantic right whales in Roseway Basin, Scotian Shelf. Ecological Applications **22**:2021–2033.
Vanderlaan AS, Taggart CT. 2007. Vessel collisions with whales: the probability of lethal injury based on vessel speed. Marine mammal science **23**:144–156.
Venn-Watson S et al. 2015. Adrenal Gland and Lung Lesions in Gulf of Mexico Common Bottlenose Dolphins (Tursiops truncatus) Found Dead following the Deepwater Horizon Oil Spill. PLoS ONE **10**:e0126538.
Vidal V, Vidal FV, Pérez-Molero JM. 1992. Collision of a Loop Current anticyclonic ring against the continental shelf slope of the western Gulf of Mexico. Journal of Geophysical Research: Oceans **97**:2155–2172.
Wade PR, Angliss RP. 1997. Guidelines for assessing marine mammal stocks: Report of the GAMMS Workshop, April 3-5, 1996, Seattle, Washington. US Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Protected Resources. Available from https://alaskafisheries.noaa.gov/sites/default/files/bkgrnd_ref_3_gamms.pdf (accessed June 1, 2017).
Wanninkhof R, Barbero L, Byrne R, Cai W-J, Huang W-J, Zhang J-Z, Baringer M, Langdon C. 2015. Ocean acidification along the Gulf Coast and East Coast of the USA. Continental Shelf Research **98**:54–71.
Waring GT, Josephson E, Maze-Foley K, Rosel PE. 2016. US Atlantic and Gulf of Mexico. MarineMammal Stock Assessments–2015. NOAA Technical Memorandum NMFS-NE **238**. Available from https://www.nefsc.noaa.gov/nefsc/publications/tm/tm238/ (accessed January 12, 2017).
Wasser SK, Lundin JI, Ayres K, Seely E, Giles D, Balcomb K, Hempelmann J, Parsons K, Booth R. 2017. Population growth is limited by nutritional impacts on pregnancy success in endangered Southern Resident killer whales (Orcinus orca). PloS one **12**:e0179824.
Weilgart LS. 2007. The impacts of anthropogenic ocean noise on cetaceans and implications for management. Canadian Journal of Zoology **85**:1091–1116.
Wells RS, Allen JB, Lovewell G, Gorzelany J, Delynn RE, Fauquier DA, Barros NB. 2015. Carcass-recovery rates for resident bottlenose dolphins in Sarasota Bay, Florida. Marine Mammal Science **31**:355–368.
West KL, Levine G, Jacob J, Jensen B, Sanchez S, Colegrove K, Rotstein D. 2015. Coinfection and vertical transmission of Brucella and Morbillivirus in a neonatal sperm whale (Physeter macrocephalus) in Hawaii, USA. Journal of wildlife diseases **51**:227–232.
West KL, Walker WA, Baird RW, Mead JG, Collins PW. 2017. Diet of Cuvier's beaked whales Ziphius cavirostris from the North Pacific and a comparison with their diet world-wide. Marine Ecology Progress Series **574**:227–242.

Whitt AD, Jefferson TA, Blanco M, Fertl D, Rees D. 2014. A review of marine mammal records of Cuba. Latin American Journal of Aquatic Mammals **9**:65–122.

Wiggins SM, Hall JM, Thayre BJ, Hildebrand JA. 2016. Gulf of Mexico low-frequency ocean soundscape impacted by airguns. The Journal of the Acoustical Society of America **140**:176–183.

Williams R, Gero S, Bejder L, Calambokidis J, Kraus SD, Lusseau D, Read AJ, Robbins J. 2011. Underestimating the damage: interpreting cetacean carcass recoveries in the context of the Deepwater Horizon/BP incident. Conservation Letters **4**:228–233.

Wise CF, Wise JT, Wise SS, Thompson WD, Wise Jr JP, Wise Sr JP. 2014. Chemical dispersants used in the Gulf of Mexico oil crisis are cytotoxic and genotoxic to sperm whale skin cells. Aquatic Toxicology **152**:335–340.

Wise J, Wise JP. 2011. A review of the toxicity of chemical dispersants. Reviews on environmental health **26**:281–300.

Wise Jr JP, Wise JT, Wise CF, Wise SS, Gianios Jr C, Xie H, Thompson WD, Perkins C, Falank C, Wise Sr JP. 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 & technology **48**:2997–3006.

Wright AJ et al. 2007. Do Marine Mammals Experience Stress Related to Anthropogenic Noise? International Journal of Comparative Psychology **20**. Available from http://escholarship.org/uc/item/6t16b8gw (accessed January 6, 2016).

Wright AJ, Deak T, Parsons ECM. 2011. Size matters: Management of stress responses and chronic stress in beaked whales and other marine mammals may require larger exclusion zones. Marine Pollution Bulletin **63**:5–9.

Wright SL, Thompson RC, Galloway TS. 2013. The physical impacts of microplastics on marine organisms: a review. Environmental Pollution **178**:483–492.

Würsig B. 2017. Marine mammals of the Gulf of Mexico. Pages 1489–1587 Habitats and Biota of the Gulf of Mexico: Before the Deepwater Horizon Oil Spill. Springer. Available from https://link.springer.com/chapter/10.1007/978-1-4939-3456-0_5 (accessed July 27, 2017).

Yeung C. 2001. Estimates of marine mammal and marine turtle bycatch by the US Atlantic pelagic longline fleet in 1999-2000. US Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center. Available from https://www.sefsc.noaa.gov/P_QryLDS/download/TM450_tm_467.pdf?id=LDS (accessed August 4, 2017).

Zirbel K, Balint P, Parsons ECM. 2011. Navy sonar, cetaceans and the US Supreme Court: A review of cetacean mitigation and litigation in the US. Marine Pollution Bulletin **63**:40–48.