MARINE MAMMAL COMMISSION

28 December 2012

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Office of Habitat Conservation
National Marine Fisheries Service
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Dear Mr. Doley:

The National Oceanic and Atmospheric Administration (NOAA) has a key role on the Deepwater Horizon Natural Resource Damage Assessment Trustee Council, which is charged with assessing injuries to natural resources resulting from the Deepwater Horizon oil spill and with developing a restoration plan to address those injuries, including injuries to marine mammals and their habitats. The Marine Mammal Protection Act established the Marine Mammal Commission to oversee and advise federal officials regarding activities that may adversely affect marine mammals and the ecosystems upon which they depend. In that capacity, the Commission offers the following recommendations and rationale to assist the Council in restoration planning for the Gulf.

RECOMMENDATIONS

The Marine Mammal Commission recommends that NOAA work with the other co-Trustees to include in the restoration plan—

- specific projects that will assess, over the long term (20 years or more), injuries to marine mammals and recovery from injuries resulting from the Deepwater Horizon oil spill and associated response activities; recommended projects include—
    - marine mammal stock assessment surveys;
    - enhancement of the Gulf marine mammal stranding program;
    - live capture/release health assessments;
    - contaminants analyses;
    - assessment of the physiological effects of oil and chemical dispersants on marine mammals and model species;
    - environmental studies (including prey studies);
- activities to ensure long-term monitoring, assessment, and recovery of all of the marine mammal stocks found in inshore, coastal, and offshore ecosystems throughout the northern Gulf; and
- projects to minimize other risk factors that may impede recovery of Gulf marine mammals; recommended projects include—
    - establishing or expanding fishery observer coverage;
    - minimizing incidental takes in fisheries and indirect effects of fishing on important prey species;
    - monitoring sound levels;
    - minimizing effects of sound;

- reducing other environmental impacts.

<u>The Marine Mammal Commission further recommends</u> that NOAA work with the other co-Trustees to—

- ensure that restoration projects include long-term monitoring to determine whether the projects are achieving their goals and injured resources are indeed being restored;
- develop a science-based, multidisciplinary project selection process that is open to all appropriate researchers and encourages data sharing; and
- manage restoration projects using an adaptive management approach that informs and guides management of Gulf resources over the long term.

RATIONALE

The Oil Pollution Act of 1990 requires that federal, state, and tribal Natural Resource Trustees conduct a Natural Resource Damage Assessment to evaluate the degree and extent of injuries resulting from an oil discharge event. Evaluating injuries includes compiling information on environmental conditions pre- and post-spill to determine the short- and long-term environmental effects of the spill and response activities. The Trustees use that information to identify appropriate restoration activities—i.e., activities that will bring natural resources back to pre-spill conditions—and compensate the public for interim losses.

Restoration planning is based on the assumption that we know not only what injuries occurred from a spill, but also the pre-spill conditions to which the ecosystem must be restored. However, for the Deepwater Horizon oil spill, we lack the necessary baseline information on the status and ecology of most Gulf marine mammal populations. We also lack a sufficient understanding of the potential effects of oil spills and response activities on marine mammals living in different habitats. The following summarizes available information on pre-spill baseline conditions, potential injurious effects based on past research and oil spill events, and effects that may have occurred from the Deepwater Horizon oil spill. Based on that information, the Commission has identified a number of restoration projects to (1) assess long-term injuries resulting from the oil spill and response activities, and promote recovery from those injuries, and (2) address other risk factors for the Gulf's marine mammal stocks.

Baseline information on Gulf of Mexico marine mammal stocks

Twenty-one cetacean and one sirenian species reside in or regularly visit the inshore, coastal, and offshore waters of the Gulf of Mexico (Waring et al. 2010). They comprise 57 stocks, 37 of which are bottlenose dolphin stocks. Existing information on the status and life history of marine mammal stocks in the Gulf falls well short of that needed to assess their pre-spill status and vulnerability to various risk factors, including oil spills (Table 1). Most pre-spill studies focused on specific activities and specific species (e.g., responses of sperm whales to seismic surveys). Despite the fact that the Gulf is highly industrialized and has been the site of multiple marine mammal unusual mortality events over the past 20 years, few studies have been directed toward developing the baseline information needed to assess the vulnerability of marine mammals to oil and gas development, oil spills, and other risk factors.

Under ideal conditions, scientists would be able to respond to a spill by tracking the oil and its dispersion, characterizing the interactions between the oil and marine mammals, documenting the resulting physical and physiological effects, and judging their significance to the animals' reproduction, foraging, survival, and movements (e.g. whether they abandoned or lost access to important habitat). This reductionist or mechanistic approach could provide a robust understanding of the means by which a spill affects marine mammals, but it requires detailed knowledge of the affected species under pre-spill conditions. However, a reductionist approach is rarely possible and scientists often must resort to a more general approach by comparing the endpoint of whatever mechanism(s) might be behind the impacts (i.e. pre- and post-spill status (abundance and trends)) of a population and inferring effects based on the observed changes. In the Deepwater Horizon spill, even a general approach has not been possible because of the lack of baseline (pre-spill) information on population status.

Indeed, extensive data collection efforts by NOAA and the Fish and Wildlife Service for the pre-assessment phase of the natural resource damage assessment began immediately after the spill. Those data are useful to a degree, such as for characterizing marine mammal movements and behavior before, during, and after oil and chemical dispersants reached key coastal and deepwater habitats (and thus providing a partial basis for estimating the effects of the spill and response activities on marine mammals), but do not provide information about natural variability in movements and behavior over time that would be provided by proper baseline studies.

Potential effects of the oil spill and response activities on marine mammals

Given the gaps in information related to the Deepwater Horizon spill, one option is to infer possible effects based on information from other regions and contexts. Current understanding of the effects on marine mammals of exposure to oil is based primarily on information from (1) observations made of marine mammals during other oil spills (Geraci and St. Aubin 1990, Loughlin et al. 1994, Smultea and Würsig 1995, Bickham et al. 1998, Bodkin et al. 2002, Boehm et al. 2007, and Matkin et al. 2008), (2) a small number of controlled exposure studies using captive marine mammals (Geraci et al. 1983, Smith et al. 1983, St. Aubin et al. 1985), (3) simulation and in vitro studies (Braithwaite et al. 1983, Godard et al. 2004), and (4) observations of the effects of accidental and controlled oil exposure on species other than marine mammals (Bickham et al. 1998, Mazet et al. 2001, Golet et al. 2002, Mohr et al. 2007, Esler et al. 2010).

That information provides ample evidence that exposure to oil can harm marine mammals. Inhalation of specific volatile organics from some types of oil can cause respiratory irritation, inflammation, or emphysema. Similarly, ingestion of oil can cause gastrointestinal inflammation, ulcers, bleeding, diarrhea, or maldigestion. Certain inhaled and ingested chemicals in oil also can damage organs such as the liver, kidney, adrenal glands, spleen or brain; cause anemia, cancer, congenital defects, and immune system suppression; or lead to reproductive failure. Chemical contact can cause skin and eye irritation and inflammation; burns to mucous membranes in the mouth and nares; or increased susceptibility to infection. Oil mixtures also can physically foul the baleen of mysticete whales, which they use for filtering food.[1]

[1] The Bryde's whale is the only mysticete whale occurring regularly in the Gulf. North Atlantic right whales are sighted rarely in the Gulf and fin whales have stranded there occasionally, but are not regular inhabitants.

Response activities to contain and remove spilled oil also can injure marine mammals. Increased vessel and air traffic can disrupt foraging, habitat use, daily or migratory movements, and other behavior (e.g., breathing and resting) (Nowacek et al. 2001, Constantine et al. 2004, Williams et al. 2006, Stensland and Berggren 2007, Lusseau et al. 2009). Increased vessel traffic also adds to the risk of vessel strikes (Laist et al. 2001, Fish and Wildlife Service 2001, Bechdel et al. 2009), although no strikes were reported during the prolonged Deepwater Horizon spill and response phase. Noise from seismic surveys (such as those used to detect potential leaks around the wellhead in the present case) or other response-related activities may cause disturbance or displacement, hearing loss (temporary or possibly permanent), or other physical injury to marine mammals (McCauley et al. 2000, National Research Council 2003). Responders to the Deepwater Horizon spill used large quantities of dispersants at the surface (e.g., Corexit 9527, Corexit 9500A) and at the wellhead (Corexit 9500A) (Kujawinski et al. 2011, www.restorethegulf.gov) even though the long-term effects of Corexit and other dispersants on marine mammals are largely unknown (National Research Council 2005). Responders also used booms and skimmers to contain and collect surface oil and in-situ burning to remove it. These activities could have affected marine mammals through direct interaction (entrapment) and/or through displacement from habitat. Burning reduces the overall amount of oil in the water but leaves behind a residue of uncertain composition and toxicity (Benner et al. 1990, Wang et al. 1999). It also puts additional chemicals into the air, posing inhalation risks.

Oil spills also may affect marine mammals indirectly by altering the marine ecosystem and key features of their habitat (Paine et al. 1996, Golet et al. 2002, Peterson et al. 1996, National Research Council 2002). Such alterations could include reductions in prey or seagrass biomass (the latter for manatees), shifts in prey or seagrass distribution, or contamination of prey or seagrass. The oil from the *Exxon Valdez* spill that accumulated in sediments continues to contaminate nearshore environments in southeast Alaska, and this contamination appears to have impeded the recovery of sea otters in the region (Bodkin et al. 2002). How long that effect will persist is uncertain (Page et al. 2002, Rice et al. 2003, Neff et al. 2006, Boehm et al. 2007). Predictions that spilled oil that had accumulated in coastal and offshore bottom sediments in the Gulf would be released during hurricanes and storms were realized after Hurricane Isaac hit the Louisiana coast in September 2012 (www.huffingtonpost.com/2012/09/06/gulf-oil-spill-hurricane-isaac_n_1861657.html). Thus, strong storms are likely to result in intermittent, recurring effects on the marine ecosystem from the release of oil from sediments for a considerable time into the future (Machlis and McNutt 2010). Further research is needed to characterize physical and biogeochemical degradation rates of this oil in the Gulf of Mexico to evaluate the potential persistence of such long-lasting effects.

Preliminary assessment of marine mammals affected by the oil spill

The scope and significance of injuries to Gulf marine mammals as a result of the Deepwater Horizon oil spill have yet to be fully determined by the Trustees. However, any assessment of oil spill-related injuries to marine mammals should consider the following—

- 155 bottlenose dolphins, two sperm whales, two *Kogia* spp. (dwarf and pygmy sperm whales), two melon-headed whales, and six spinner dolphins stranded in the northern Gulf during the response phase of the spill (30 April 2010 through 17 April 2011), representing significantly more stranded animals than the mean number reported from this region in the same months during 2002-2009 (www.nmfs.noaa.gov/pr/health/oilspill/);
- some of those strandings may have been part of what has been deemed an unusual mortality event, involving a significantly higher than average number of deaths of bottlenose dolphins

and other cetaceans (Figure 1, (www.nmfs.noaa.gov/pr/health/mmume/cetacean_gulfofmexico2010.htm) in the Gulf after early 2010 which could have had a significant effect on the resilience and survival of affected stocks;

- health assessments of coastal bottlenose dolphins in Barataria Bay, Louisiana, an area heavily affected by the spill, indicated high rates of poor health and suppressed metabolic and immune function (www.gulfspillrestoration.noaa.gov/2012/03/study-shows-some-gulf-dolphins-severely-ill/); and
- movements of sperm whales with home ranges near the spill site indicate that although whales remained in the area after the oil spill, they avoided the most heavily surface-oiled areas (www.gulfspillrestoration.noaa.gov/wp-content/uploads/2012/05/2011_10_12_MAMMAL _Sperm_Whale_Tagging_LA-signature_Redacted3.pdf).

Information collected and analyses conducted to date are not sufficient to allow unambiguous conclusions about the spill and response actions as contributing factors. Therefore, the Commission believes that the Trustees should be taking a precautionary approach by assuming that the spill and response efforts likely contributed to the injury of the above-mentioned Gulf marine mammal species. It also is likely that other species and stocks of marine mammals that occur in the same habitats were injured but their injuries were not detected (Williams et al. 2011).

Restoration priority 1: Assessing long-term injuries resulting from the oil spill and response activities and promoting recovery from those injuries

A comprehensive assessment of marine mammal injuries resulting from the spill could take many years—longer than the timeframe available for consideration during the initial stage of restoration planning. Wildlife studies have revealed chronic, delayed, and indirect effects of the *Exxon Valdez* spill that lasted longer and were more severe than expected or assumed (Peterson et al. 2003). Exposure to oil from that spill was still impeding recovery of certain sea otter and killer whale populations 15 years later (Ballachey et al. 2007, Matkin et al. 2008). The Deepwater Horizon oil spill differs in some important respects from the *Exxon Valdez* spill, but long-term effects are a significant concern for Gulf marine mammals because of the vastly greater amount of oil spilled, the greater quantity of dispersants applied at the surface and wellhead, the similarly low recovery rates of spilled oil, uncertainty regarding the eventual disposition of both oil and dispersants, and uncertainty regarding the sub-lethal effects of the spill and spill response on marine mammals and on ecosystem elements important to marine mammals.

Although past studies and injury assessments have fallen short in many respects, much could be learned from careful assessment of current and future conditions and changes. Ensuring the effectiveness of restoration efforts for marine mammals and other natural resources requires a science-based, hypothesis-driven approach that integrates all available and pertinent information collected before, during, and after the spill and builds on and expands our current understanding of expected effects. Without a strong scientific follow-up to this spill, restoration efforts may be misguided, shortsighted, ineffective, or even harmful.

To ensure that restoration is guided by sufficient information, the Commission—with input from staff at NOAA and other federal agencies—prepared the enclosed report entitled "Assessing the Long-term Effects of the BP Deepwater Horizon Oil Spill on Marine Mammals in the Gulf of Mexico: A Statement of Research Needs." The report was intended to guide assessment of the spill's long-term effects on marine mammal populations, to guide mitigation and restoration efforts, and to help track the changes in the Gulf ecosystem, including those resulting from recovery and restoration. In it, the Commission summarized potential effects of oil exposure and response activities on marine mammals and identified areas of study that should be given high priority in an assessment of long-term effects. Such areas of study include the following.

- Evaluating the effect of exposure to oil or dispersant-related contaminants on physiological functions (immune, reproductive, and other vital systems): This involves assessing the health status, contaminant loads, and markers of contaminant exposure of stranded or live-captured animals; conducting necropsies of dead animals; assessing reproductive rates and indicators of reproductive failure (e.g., aborted fetuses, malformed offspring), controlled exposure experiments on model species (e.g., mink); and genomic analyses;
- Assessing oil- and/or response-related changes in the ecosystem that reduce prey availability: This involves evaluating the body condition of live and stranded animals, looking for changes in diet as determined by observations of foraging behavior and stomach/intestinal content and tissue analyses (e.g., fatty acids, stable isotope studies), and prey surveys to assess biomass and changes therein over space and time;
- Evaluating how oil and/or response activities may have led to ecosystem changes (e.g., harmful algal blooms, hypoxia or anoxia) that are harmful to marine mammals: This involves observations of stranded animals and stranding patterns; analyses of fluids, tissues, and prey of marine mammals for evidence of toxins; and monitoring of harmful algal blooms and hypoxic/anoxic zones; and
- Determining the extent to which exposure to oil and/or response activities leads to a deterioration in status of marine mammal populations involving individual fitness, population vital rates (survival and reproduction), population abundance and trends, and habitat use patterns: This involves observations of mortality rates and evidence of reproductive failure, and aerial, vessel, shoreline, and acoustic surveys to assess relative or absolute changes in the number and distribution of animals, especially mother/calf pairs.

For the most part, the Trustees have incorporated these priorities into the various workplans developed to assess spill-related injuries to marine mammals and other natural resources in the Gulf. However, an ongoing assessment of marine mammal injuries should be included in the Trustee's restoration plan to account for and address long-term injuries. As the Trustees develop a better understanding of the effects of the oil spill on marine mammals, they can adapt restoration projects to target marine mammal species and habitats that are most at risk. An adaptive approach that builds on information obtained from continued injury assessment is a critical component of effective restoration planning. As noted by the National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling in its 2011 *Deep Water* report, "A sophisticated understanding of the full range of impacts from a large-scale oil spill is critical to effective recovery and restoration efforts" (Oil Spill Commission 2011).

For these reasons, the Marine Mammal Commission recommends that NOAA work with the other co-Trustees to include in the restoration plan specific projects that will assess, over the long term (20 years or more), injuries to marine mammals and recovery from injuries resulting from the Deepwater Horizon oil spill and associated response activities. The plan should include a combination of projects targeted at studying both direct biological effects on individuals (such as exposure to oil, disturbance, displacement from preferred habitats, injury, or other physiological effects) as well as indirect effects on the ecosystem as a whole (such as a decrease or displacement of key prey species or an increased vulnerability to harmful algal blooms or hypoxia/anoxia). Where studies of individual animals are not feasible, studies to track population-level changes in abundance or vital rates over time may help in assessing chronic effects resulting from the oil spill or associated response activities. Attributing changes in vital rates or population abundance to exposure likely will require a "weight of evidence" approach based on a range of studies focused on individuals, populations, and the ecosystem.

Projects that should be included in an ongoing assessment of injuries to marine mammals and their habitats resulting from the Deepwater Horizon oil spill and associated response activities include—

- <u>Marine mammal stock assessment surveys</u>: Surveys to assess the abundance and distribution of marine mammal stocks are necessary to provide the baseline against which changes in the status of a stock can be measured. Stock assessments require a basic understanding of stock structure, as stocks comprise the basic units of conservation within a species. The inadequacy of information on stock structure for many Gulf species, particularly coastal, bay, and estuarine bottlenose dolphins, is a significant impediment to current stock assessment efforts. Stock assessment methods differ depending on the stocks being assessed, but typically involve either a combination of vessel and aerial surveys or mark-recapture methods using photo-identification or genetic sampling. Stock assessment surveys should be conducted at least every other year for each stock, and should cover all portions of a stock's range and all seasons of the year.
- <u>Enhancement of the Gulf marine mammal stranding program</u>: Marine mammal stranding programs provide information on the presence of marine mammal species and stocks, movement patterns, reproduction, age structure, health, toxin exposure, and sources of mortality. Stranding programs in the Gulf played a key role during the oil spill by monitoring coastal areas for stranded animals, collecting tissues for various types of analyses, and caring for live-stranded animals and moving them to facilities that could provide the necessary care. However, those programs operate primarily on a volunteer basis, often with limited or inconsistent institutional support. Existing support is not sufficient to sustain those programs and the kind of effort needed to assess the long-term effects of the spill. Particular focus should be on building capacity for stranding programs throughout the northern Gulf, including investments in training, equipment, supplies, data management, sample analyses, and rehabilitation facilities. Support should be provided to bring in experienced researchers and veterinarians from other regions to train local responders and to ensure that information collected from stranded animals is integrated with other assessment studies and contributes to a better understanding of the long-term effects of the oil spill and other human activities on Gulf marine mammals.
- <u>Live capture/release health assessments</u>: The health of individual animals can be an important indicator of the adverse effects of risk factors, including exposure to oil, dispersants, and response activities. Coupled with information collected from dead stranded animals, in-depth assessments of live stranded or captured animals have provided important information on marine mammal health, disease, and causes of mortality. Live capture/release is a proactive means to evaluate risk factors and assess health conditions within populations, and it has been used in studies of coastal and estuarine bottlenose dolphin populations in the

Gulf and elsewhere. Health assessments typically require collaboration among researchers from federal agencies, private institutions, aquaria, and not-for-profit organizations.

- Contaminants analyses: Determining whether marine mammals have been exposed to oil, dispersants, or other spill-related contaminants is important for estimating injuries from spills and response activities. Data on contaminant exposure also are important to investigation of the ongoing unusual mortality event in the northern Gulf—an event involving several hundred bottlenose dolphins to date. However, many of the samples collected from marine mammals during and after the Deepwater Horizon oil spill have yet to be analyzed for contaminants, including polycyclic aromatic hydrocarbons and dispersants. Research is needed to determine the types of samples that are the best indicators of exposure. Such research will require the development of reliable, standardized methods for determining and quantifying exposure levels. Development of such methods should be a priority, followed by contaminant analyses of the available tissues. If some types of contaminants cannot be reliably detected in marine mammal tissues (e.g., due to rapid elimination or other processes), then NOAA should give high priority to development of alternative methods for determining exposure.
- Assessment of the physiological effects of oil and chemical dispersants on marine mammals and model species: Additional research is needed to better understand how marine mammals respond physiologically to oil and chemical dispersants. Controlled exposure experiments using captive marine mammals as test subjects are the best option from a scientific perspective. The use of non-marine mammal model species (such as mink) may be logistically more feasible, but such approaches require the assumption that marine mammals will respond similarly, which may not be the case. Simulations and in-vitro studies offer alternative approaches to studying physiological effects and, for ethical reasons, may be preferred for certain types of studies.
- Environmental studies (including prey studies): Large-scale changes in community structure or prey abundance caused by the oil spill and response efforts can affect the carrying capacity and distribution of marine mammal populations. Quantifying those effects will require an integrated, multi-disciplinary approach. Tracking the movement and disposition of oil and dispersants throughout the water column relative to the distribution of marine mammals and their prey species in the ecosystem seems essential for characterizing the ecological effects of oil, dispersants, and other response activities.

Because the species and stocks vulnerable to—and likely affected by—the spill are found in a range of inshore, coastal, and offshore ecosystems, the Marine Mammal Commission recommends that NOAA work with the other co-Trustees to include in the restoration plan activities to ensure long-term monitoring, assessment, and recovery of all of the marine mammal stocks found in inshore, coastal, and offshore ecosystems throughout the northern Gulf.

Restoration priority 2: Addressing other risk factors for the Gulf's marine mammal stocks

In all likelihood, the oil spill is having effects on marine mammals in addition to those cumulative impacts from other human activities that are affecting marine mammal populations. Returning marine mammal stocks to a healthy state will thus not only require addressing the effects of the oil spill, but also the other risk factors from human activities in the Gulf of Mexico. Seismic surveys used to locate oil and gas reserves or monitor their depletion generate high energy, low frequency sounds that can cause permanent or temporary hearing damage in marine mammals

(Gordon et al. 2004), cause them to change their behavior, and cause them to change their habitat use patterns. Commercial fishing gear used in the Gulf can entangle and drown marine mammals (Garrison 2007). Dolphins frequently ingest and become entangled in recreational fishing gear (monofilament fishing lines and hooks), which generally leads to death (Powell and Wells 2011, Wells et al. 1998, Wells et al. 2008). Commercial and recreational vessel traffic and commercial tour operations directed at marine wildlife can disturb or displace marine mammals (Bejder et al. 2006, Nowacek et al. 2001). Commercial shipping also introduces a large amount of low-frequency sound energy into the Gulf (Snyder 2007). Military activities also can generate significant sound that can be injurious to certain marine mammals (Jepson et al. 2003). Agricultural runoff can cause excess nutrients to enter the Gulf. These nutrients lead to blooms of algae that die and degrade, depleting the oxygen in the water and creating hypoxic zones that cannot sustain marine life (Craig et al. 2001). Other blooms result in the production of toxic substances that effectively poison invertebrates, fish, and marine mammals (Magaña et al. 2003, Twiner et al. 2011). Table 2 provides a more complete list of natural and human-caused risk factors to marine mammals in the Gulf. Addressing the risk factors will help build resilience in Gulf marine mammal populations and accelerate recovery from the harmful effects of the spill.

To minimize other risk factors that may impede recovery of Gulf marine mammals, the Marine Mammal Commission recommends that NOAA work with the other co-Trustees to include in the restoration plan the following projects—

- Establishing or expanding fisheries observer coverage: An expansion of current observer coverage is necessary to quantify and minimize incidental takes of marine mammals in Gulf commercial and recreational fisheries, including the menhaden purse seine, shrimp trawl, shark gillnet, pelagic longline, reef fish, and charter boat/headboat fisheries;
- Minimizing incidental takes in fisheries and indirect effects of fishing on important prey species: Conduct additional research and testing of alternative fishing gear, time-area restrictions on fishing activities, and other measures to reduce incidental takes of marine mammals in Gulf commercial and recreational fisheries and also the indirect effects of fishing on important prey species of marine mammals;
- Monitoring sound levels: Establish a monitoring program to assess sound levels and sound-related effects on marine mammals from a variety of human activities, including commercial shipping, oil and gas development (including seismic studies), and military operations and training;
- Minimizing effects of sound: Develop measures to minimize the direct, indirect, and cumulative effects of human-caused sound on marine mammals and their prey species; and
- Reducing other environmental impacts: Implement measures to reduce the occurrence and extent of hypoxic and anoxic zones and harmful algal blooms.

The Marine Mammal Commission further recommends that NOAA work with the other co-Trustees to ensure that restoration projects include long-term monitoring to determine whether the projects are achieving their goals and injured resources are indeed being restored. Long-term monitoring will provide critical information on the effectiveness of various projects and will help focus restoration efforts on activities that are having the greatest benefit. Monitoring also will help identify projects that might be having adverse impacts on targeted or other natural resources, and assist in minimizing those adverse impacts. Information on the effectiveness of restoration efforts is critical not just for ensuring the best use of restoration resources in the Gulf, but also to help guide restoration planning efforts for other, future oil spill events.

Selection of assessment and restoration projects

A comprehensive and effective injury assessment and restoration plan should outline not only the types of projects that will be needed, but also specify the standards and criteria those projects must meet to be considered for funding. At a minimum, assessment projects should have clear goals and objectives, include scientifically robust data collection and analysis procedures, and require timely publication of results in peer-reviewed literature. The Trustees also must ensure that the selection of assessment and restoration projects is an independent, science-based, review process. Selection of projects should be based on scientific merit, appropriateness, and cost-effectiveness. Awards should not necessarily be limited to researchers based in the Gulf region. This is especially critical for marine mammal projects for which scientific expertise and capacity exist largely outside the Gulf region. Researchers should be encouraged to work across disciplines and to make assessment and monitoring data available in raw form after a certain period of time to other interested researchers and to the public. Finally, restoration projects should be designed such that outcomes inform and guide adaptive management of Gulf resources over the long term. To those ends, the Marine Mammal Commission recommends that NOAA work with the other co-Trustees to develop a science-based, multidisciplinary project selection process that is open to all appropriate researchers and encourages data sharing. These restoration projects should be managed using an adaptive management approach that informs and guides management of Gulf resources over the long term.

The Commission hopes NOAA finds the Commission's report and the recommendations provided here to be helpful as the agency works with the other co-Trustees for the Deepwater Horizon oil spill on developing a restoration plan for Gulf natural resources. Please feel free to share the Commission's recommendations and comments with the other co-Trustees.

Sincerely,

Michael L. Gosliner for

Timothy J. Ragen, Ph.D.
Executive Director

Enclosure: Assessing the Long-term Effects of the BP Deepwater Horizon Oil Spill on Marine Mammals in the Gulf of Mexico: A Statement of Research Needs (Marine Mammal Commission, August 2011).

cc: Helen Golde, Acting Director, National Marine Fisheries Service Office of Protected Resources
Dr. Roy Crabtree, Regional Administrator, National Marine Fisheries Service Southeast Regional Office
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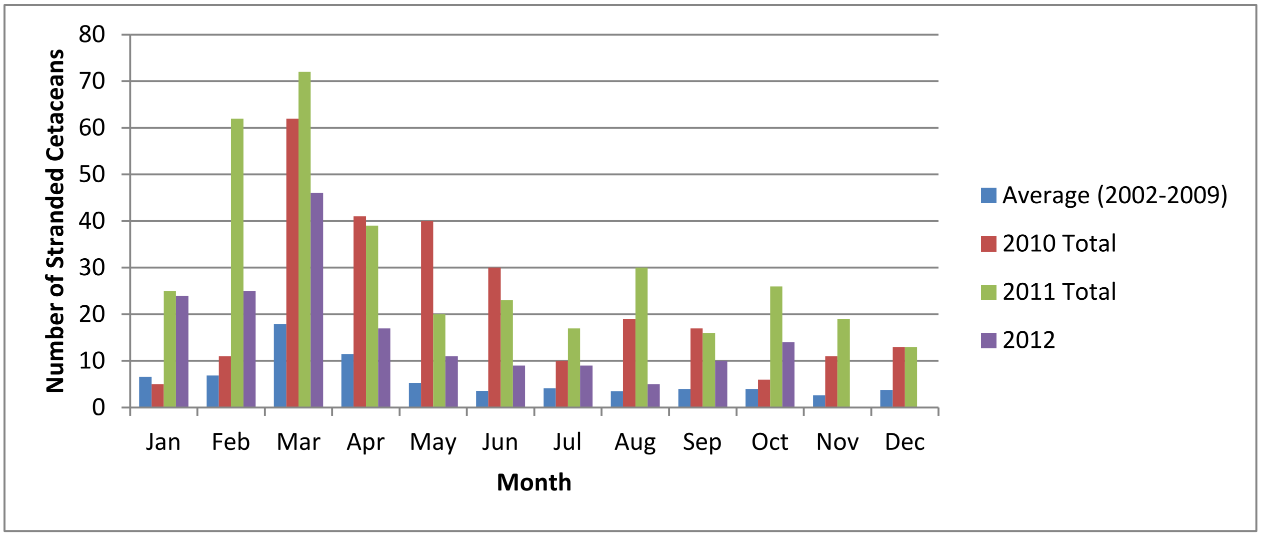

Figure 1. Cetaceans (dolphins and whales) stranded in the northern Gulf of Mexico from Franklin County, Florida, to the Texas/Louisiana border, by month (Source: NOAA, www.nmfs.noaa.gov/pr/health/mmume/cetacean_gulfofmexico2010.htm)

Table 1. Baseline information for marine mammal species in the Gulf of Mexico. The population information is from Waring et al. (2010) and the information regarding prey species is from Jefferson et al. (2008). For all stocks, the information is not sufficient to meet the requirements of the Marine Mammal Protection Act. CV=coefficient of variation, N_{best}=best estimate of abundance, N_{min}=minimum estimate of abundance, PBR=potential biological removal level, E=endangered under the Endangered Species Act, S=strategic under the Marine Mammal Protection Act). *As identified in Waring et al. (2010), although many sources of mortality and serious injury also may be applicable to other species.

Species/stock (E=endangered, S=strategic)	Abundance – N_{best} (CV) N_{min} PBR	Distribution and movement patterns	Stock structure	Social structure	Vital rates	Health status	Prey species	Total human-caused mortality/ serious injury	Possible sources of human-caused mortality/ serious injury*
Sperm whale (*Physeter macrocephalus*) (E/S)	N_{best} = 1,665 (CV = 0.20) N_{min} = 1,409 PBR = 2.8	Oceanic throughout the Gulf	Gulf stock distinct from other Atlantic Ocean stocks	Highly social, with adult females and juveniles of both sexes occurring together in mixed groups	Unknown	Unknown	Primarily deepwater cephalopods and fishes	Unknown	Oil and gas operations (seismic surveys), pollution
Sperm whale (*Physeter macrocephalus*) (E/S) Puerto Rico and US Virgin Islands stock	Unknown, PBR undetermined	Continental slope and oceanic waters surrounding Puerto Rico and the U.S. Virgin Islands	Limited information to distinguish from other Atlantic Ocean or Gulf stocks	Highly social, with adult females and juveniles of both sexes occurring together in mixed groups	Unknown	Unknown	Primarily deepwater cephalopods and fishes	Unknown	Coastal pollution, ship strikes
Bryde's whale (*Balaenoptera edeni*) (S)	N_{best} = 15 (CV = 1.98) N_{min} = 5 PBR = 0.1	Primarily along the shelf break (200 m) in the northeastern Gulf	Unknown	Generally found as singles or pairs, no calves observed	Unknown	Unknown	Small schooling fishes	Unknown	Ship strikes, other sources unknown
Cuvier's beaked whale (*Ziphius cavirostris*)	N_{best} = 65 (CV = 0.67) N_{min} = 39 PBR = 0.4	Oceanic throughout the Gulf	Unknown	Very cryptic, usually in groups of less than 5	Unknown	Unknown	Primarily squids, also deepwater fishes and crustaceans	Unknown	Unknown, possible military activities (sonar) in Atlantic Ocean

Species/stock (E=endangered, S=strategic)	Abundance – N_{best} (CV) N_{min} PBR	Distribution and movement patterns	Stock structure	Social structure	Vital rates	Health status	Prey species	Total human-caused mortality/ serious injury	Possible sources of human-caused mortality/ serious injury*
Blainville's beaked whale (*Mesoplodon densirostris*)	N_{best} = 57 (CV = 1.40) N_{min} = 24 (Estimate for all *Mesoplodon* sp.) PBR = 0.2	Oceanic throughout the Gulf	Unknown	Very cryptic, usually in groups of less than 5	Unknown	Unknown	Primarily squids, also deepwater fishes	Unknown	Unknown, possible military activities (SONAR) in Atlantic Ocean
Gervais' beaked whale (*Mesoplodon europaeus*)	N_{best} = 57 (CV = 1.40) N_{min} = 24 (Estimate for all *Mesoplodon* sp.) PBR = 0.2	Oceanic throughout the Gulf	Unknown	Very cryptic, usually in groups of less than 5	Unknown	Unknown	Primarily squids, also deepwater fishes	Unknown	Unknown, possible military activities (sonar) in Atlantic Ocean and fisheries interactions
Bottlenose dolphin (*Tursiops truncatus*) continental shelf stock	Unknown, survey data more than 8 years old, PBR undetermined	Waters from 20 to 200 m throughout the Gulf	Uncertain but complex, stock is a mixture of genetically distinct coastal and offshore ecotypes	Highly social	Unknown	Unknown	Generalist, preference for sciaenids, scombrids, and mugilids, with squids more important in deeper waters	Unknown	Fisheries interactions, gunshot wounds, vessel strikes, oil rig removals, marine debris entanglement and ingestion
Bottlenose dolphin (*Tursiops truncatus*) eastern coastal stock	N_{best} = 7,702 (CV = 0.19) N_{min} = 6,551 PBR = 66	Mainland shore to waters 20 m deep east of 84° W	Uncertain but complex, coastal stocks divided for management purposes based on dissimilar habitat characteristics	Highly social	Unknown	Limited health assessment data from Sarasota Bay	Generalist, preference for sciaenids, scombrids, and mugilids, with squids more important in deeper waters	Unknown, minimum estimates from stranding data not distinguished by stock	Fisheries interactions, dredging, harmful algal blooms, disease, gunshot wounds, mutilations, vessel strikes, oil rig removals, marine debris entanglement and ingestion

Species/stock (E=endangered, S=strategic)	Abundance – N_{best} (CV) N_{min} PBR	Distribution and movement patterns	Stock structure	Social structure	Vital rates	Health status	Prey species	Total human-caused mortality/ serious injury	Possible sources of human-caused mortality/ serious injury*
Bottlenose dolphin (*Tursiops truncatus*) northern coastal stock	N_{best} = 2,473 (CV = 0.25) N_{min} = 2,004 PBR = 20	Mainland shore to waters 20 m deep from the Mississippi River Delta east to 84°W	Coastal stocks divided for management purposes based on dissimilar habitat characteristics	Highly social	Unknown	Limited health assessment data from St. Joseph Bay	Generalist, preference for sciaenids, scombrids, and mugilids, with squids more important in deeper waters	Unknown, minimum estimates from stranding data not distinguished by stock	Fisheries interactions, dredging, red tide, disease, gunshot wounds, mutilations, vessel strikes, oil rig removals, marine debris entanglement and ingestion
Bottlenose dolphin (*Tursiops truncatus*) western coastal stock (S)	Unknown, survey data more than 8 years old, PBR undetermined	Mainland shore to waters 20 m deep west of the Mississippi River Delta	Uncertain but complex, coastal stocks divided for management purposes based on dissimilar habitat characteristics	Highly social	Unknown	Unknown	Generalist, preference for sciaenids, scombrids, and mugilids, with squids more important in deeper waters	Unknown, minimum estimates from stranding data not distinguished by stock	Fisheries interactions, dredging, red tide, disease, gunshot wounds, mutilations, vessel strikes, oil rig removals, marine debris entanglement and ingestion
Bottlenose dolphin (*Tursiops truncatus*) oceanic stock	N_{best} = 3,708 (CV = 0.42) N_{min} = 2,641 PBR = 26	Upper continental slope (200-1000 m) throughout the Gulf	Uncertain but assumed complex	Offshore morphotype, groups as big as 200 but typically around 20	Unknown	Unknown	Generalist, preference for sciaenids, scombrids, and mugilids, with squids more important in deeper waters	Unknown, minimum estimates from stranding data not distinguished by stock	Fisheries interactions, disease, gunshot wounds, mutilations, vessel strikes, oil rig removals, marine debris entanglement and ingestion

Species/stock (E=endangered, S=strategic)	Abundance – N_{best} (CV) N_{min} PBR	Distribution and movement patterns	Stock structure	Social structure	Vital rates	Health status	Prey species	Total human-caused mortality/ serious injury	Possible sources of human-caused mortality/ serious injury*
Bottlenose dolphin (*Tursiops truncatus*) St. Joseph Bay stock (S)	N_{best} = 81 (CV = 0.14) N_{min} = 72 PBR=0.7	St. Joseph Bay	Stocks provisionally based on discrete communities, supported by genetics data	Community-based, some individuals exhibit extreme philopatry	Some data regarding individual reproduc-tive rates, stock-wide rates unknown	Limited health assessment data	Preference for sciaenids, scombrids, and mugilids	Unknown, minimum estimates from stranding data not distinguished by stock	Fisheries interactions, ecotourism, red tide, marine debris entanglement and ingestion
Bottlenose dolphin (*Tursiops truncatus*) St. Vincent Sound/ Appalachicola Bay/ St. George Sound stock (S)	N_{best} = 537 (CV = 0.09) N_{min} = 498PBR = 5	St. Vincent Sound/ Appalachicola Bay/ St. George Sound	Stocks provisionally based on discrete communities, supported by genetics data	Community-based, some individuals exhibit extreme philopatry	Some data regarding individual reproduc-tive rates, stock-wide rates unknown	Unknown	Preference for sciaenids, scombrids, and mugilids	Unknown, minimum estimates from stranding data not distinguished by stock	Fisheries interactions, ecotourism, red tide, marine debris entanglement and ingestion
Bottlenose dolphin (*Tursiops truncatus*) Barataria Bay stock (S)	N_{best} = 138 (CV = 0.08) N_{min} = 129 PBR = 1.3	Barataria Bay	Stocks provisionally based on discrete communities, supported by genetics data	Community-based, some individuals exhibit extreme philopatry	Some data regarding individual reproduc-tive rates, stock-wide rates unknown	Unknown	Preference for sciaenids, scombrids, and mugilids	Unknown, minimum estimates from stranding data not distinguished by stock	Fisheries interactions, ecotourism, red tide, marine debris entanglement and ingestion
Bottlenose dolphin (*Tursiops truncatus*) 29 remaining bay, sound, and estuarine stocks (S)	Unknown, survey data more than 8 years old, PBR undetermined for remaining 30 stocks	Bays, sounds, and estuaries throughout the Gulf	Stocks provisionally based on discrete communities, supported by genetics data	Community-based, some individuals exhibit extreme philopatry	Some data regarding individual reproduc-tive rates, stock-wide rates unknown	Unknown	Preference for sciaenids, scombrids, and mugilids	Unknown, minimum estimates from stranding data not distinguished by stock	Fisheries interactions, ecotourism, red tide, marine debris entanglement and ingestion

Species/stock (E=endangered, S=strategic)	Abundance – N_{best} (CV) N_{min} PBR	Distribution and movement patterns	Stock structure	Social structure	Vital rates	Health status	Prey species	Total human-caused mortality/ serious injury	Possible sources of human-caused mortality/ serious injury*
Atlantic spotted dolphin (*Stenella frontalis*)	Unknown, survey data more than 8 years old, PBR undetermined	Continental shelf throughout the Gulf, generally in waters 20-200 m	Unknown, separate from Atlantic stock for management purposes, supported by genetics data	Typical group sizes are less than 50, associate with smaller groups of bottlenose dolphins in some cases	Unknown	Unknown	Small epi- and mesopelagic fishes and squids, and benthic invertebrates	Unknown	Fisheries interactions, dredging, red tides
Pantropical spotted dolphin (*Stenella attenuata*)	N_{best} = 34,067 (CV = 0.18) N_{min} = 29,311 PBR = 293	Oceanic throughout the Gulf	Unknown, separate from Atlantic stock for management purposes	Typical groups are less than 100 dolphin but as many as 650 dolphins in a group have been observed	Unknown	Unknown	Small epi- and mesopelagic fishes, squids and crustaceans	Unknown	Unknown
Striped dolphin (*Stenella coeruleoalba*)	N_{best} = 3,325 (CV = 0.48) N_{min} = 2,266 PBR = 23	Oceanic throughout the Gulf	Unknown, separate from Atlantic stock for management purposes	Typical groups consist of about 50 dolphins	Unknown	Unknown	Small epi- and mesopelagic fishes and squids	Unknown	Vessel strike
Spinner dolphin (*Stenella longirostris*)	N_{best} = 1,989 (CV = 0.48) N_{min} = 1,356 PBR = 14	Continental slope (200-2000 m), primarily in the eastern Gulf	Unknown, separate from Atlantic stock for management purposes	Occur in very large cohesive groups of up to 800 dolphins	Unknown	Unknown	Small epi- and mesopelagic fishes and squids	Unknown	Fisheries interactions
Rough-toothed dolphin (*Steno bredanensis*)	Unknown, survey data more than 8 years old, PBR undetermined	Oceanic throughout the Gulf and, less commonly, the continental shelf	Unknown, separate from Atlantic stock for management purposes	Typically in groups of less than 25 dolphins, associated with Sargassum in many cases	Unknown	Limited info from rehab animals	Fish, including larger species (mahi mahi) and squids	Unknown	Unknown

Species/stock (E=endangered, S=strategic)	Abundance – N_{best} (CV) N_{min} PBR	Distribution and movement patterns	Stock structure	Social structure	Vital rates	Health status	Prey species	Total human-caused mortality/ serious injury	Possible sources of human-caused mortality/ serious injury*
Clymene dolphin (*Stenella clymene*)	N_{best} = 6,575 (CV = 0.36) N_{min} = 4,901 PBR = 49	Oceanic throughout the Gulf but more common west of the Mississippi River	Unknown, separate from Atlantic stock for management purposes	Occur in large groups of up to 300 dolphins	Unknown	Unknown	Little known, small epi – and mesopelagic fishes and squids	Unknown	Unknown
Fraser's dolphin (*Lagenodelphis hosei*)	Unknown (no recent sightings) PBR undetermined	Oceanic throughout the Gulf	Unknown, separate from Atlantic stock for management purposes	Extremely rare, associated with melon-headed whales in some cases	Unknown	Unknown	Small midwater fishes, squids, and crustaceans	Unknown	Unknown
Killer whale (*Orcinus orca*)	N_{best} = 49 (CV = 0,77) N_{min} = 28 PBR = 0.3	Oceanic throughout the Gulf	Unknown, separate from Atlantic stock for management purposes	Groups typically of 6-10 whales. Photo-identification indicates wide ranging but with some habitat fidelity	Unknown	Unknown	Gulf prey largely unknown, one instance of predation on pantropical spotted dolphins	Unknown	Unknown
False killer whale (*Pseudorca crassidens*)	N_{best} = 777 (CV = 0.56) N_{min} = 501 PBR = 5	Oceanic throughout the Gulf	Unknown, separate from Atlantic stock for management purposes	Occur in cohesive groups that average 25 whales	Unknown	Unknown	Fish including larger species (dolphin fish) and squids	Unknown	Fisheries interaction
Pygmy killer whale (*Feresa attenuata*)	N_{best} = 323 (CV = 0.60) N_{min} = 203 PBR = 2	Oceanic throughout the Gulf	Unknown, separate from Atlantic stock for management purposes	Little known, occur in groups of less than 20 whales	Unknown	Unknown	Fishes and squids	Unknown	Unknown

Species/stock (E=endangered, S=strategic)	**Abundance – N_{best} (CV) N_{min} PBR**	**Distribution and movement patterns**	**Stock structure**	**Social structure**	**Vital rates**	**Health status**	**Prey species**	**Total human-caused mortality/ serious injury**	**Possible sources of human-caused mortality/ serious injury***
Dwarf sperm whale (*Kogia sima*)	N_{best} = 453 (CV = 0.35) N_{min} = 340 (Estimate for all *Kogia* spp.) PBR = 3.4	Oceanic throughout the Gulf	Unknown, separate from Atlantic stock for management purposes	Very cryptic, usually in groups of less than 5	Unknown	Unknown	Primarily deepwater cephalopods	Unknown, minimum estimates from stranding data	Fisheries interactions, ingestion of marine debris
Pygmy sperm whale (*Kogia breviceps*)	N_{best} = 453 (CV = 0.35) N_{min} = 340 (Estimate for all *Kogia* spp.) PBR = 3.4	Oceanic throughout the Gulf	Unknown, separate from Atlantic stock for management purposes	Very cryptic, usually in groups of less than 5	Unknown	Limited data from captive animals	Primarily deepwater cephalopods	Unknown, minimum estimates from stranding data	Fisheries interactions, ingestion of marine debris
Melon-headed whale (*Peponocephala electra*)	N_{best} = 2,283 (CV = 0.76) N_{min} = 1,293 PBR = 13	Oceanic throughout the Gulf but more common west of the Mississippi River	Unknown, separate from Atlantic stock for management purposes	Occur in large cohesive groups of up to 275 whales	Unknown	Unknown	Small fishes and squids	Unknown, minimum estimates from stranding data	Unknown
Risso's dolphin (*Grampus griseus*)	N_{best} = 1,589 (CV = 0.27) N_{min} = 1,271 PBR = 13	Shelf break area and oceanic throughout the Gulf	Unknown, separate from Atlantic stock for management purposes	Multiple groups of 5-10 dolphins typically occur over large areas	Unknown	Limited data from captive animals	Crustaceans, squids, and other cephalopods	Unknown, minimum estimates from stranding data	Fisheries interactions, red tide
Pilot whale, short finned (*Globicephala macrorhyncus*)	N_{best} = 716 (CV = 0.34) N_{min} = 542 PBR = 5.4	Oceanic throughout the Gulf but more common west of the Mississippi River	Unknown, separate from Atlantic stock for management purposes	Highly social, in groups of 20 or more	Unknown	Unknown	Primarily squids but also fishes	Unknown, minimum estimates from stranding data	Fisheries interactions

Species/stock (E=endangered, S=strategic)	**Abundance – N_{best} (CV) N_{min} PBR**	**Distribution and movement patterns**	**Stock structure**	**Social structure**	**Vital rates**	**Health status**	**Prey species**	**Total human-caused mortality/ serious injury**	**Possible sources of human-caused mortality/ serious injury***
West Indian Manatee (*Trichechus manatus*) (E/S)	N_{min} (via aerial surveys) = 5,067 (2,779 on east coast of Florida, 2,288 on west coast of Florida) PBR = 12	In freshwater, brackish and marine environments along the Gulf, from Florida to Louisiana	Florida manatees considered a single stock, but separated into management units	Disperse in the warmer months to feed, breed and socialize, aggregate in warm-water refuges during colder times of year, calves typically stay with their mothers for 2 years	Rmax= 6.2%	Limited studies provide data on contamin-ants, hormone levels, and nutrition	Herbivores, feed on an extensive range of aquatic vegetation	Minimum estimates from stranding data	Vessel strikes, cold water exposure, red tides, drowning in water control structures, fisheries interactions, marine debris entanglement and ingestion

Table 2. Anthropogenic and natural risk factors in the Gulf of Mexico and potential consequences to marine mammals.

Activities	**Specific risk factor**	**Potential consequences**
Oil and gas development	Oil spills and leaks	Direct exposure: skin irritation/inflammation, necrosis, respiratory effects, organ damage Indirect: shifts in or loss of prey, habitat degradation
	Noise (seismic surveys, construction and decommissioning of platforms, and general operations)	Physical trauma, permanent or temporary hearing loss, avoidance of preferred habitat
	Vessel operations	Vessel collisions (injury/mortality), avoidance of preferred habitat
	Production waste (drill fluids and cuttings, produced water, deck drainage, municipal wastes, and debris)	Organ damage and impaired immune system function from heavy metal contamination, habitat degradation (decreased water quality), loss of prey
Commercial and recreational fishing	Fishing with nets, lines, pots/traps	Entanglement in and ingestion of fishing gear
	Fishing for prey species	Depletion of prey species, habitat alteration
	Vessel operations	Vessel collisions (injury/mortality), avoidance of preferred habitat
Shipping and vessel traffic	Noise, vessel operations	Vessel collisions (injury/mortality), avoidance of preferred habitat
Military activities	Vessel operations	Vessel collisions (injury/mortality), avoidance of preferred habitat
	Noise (SONAR training and testing, explosives)	Acoustic and non-acoustic physical trauma, avoidance of preferred habitat, mortality in severe cases
Agriculture	Runoff of land-based pollutants (resulting in harmful algal blooms, anoxic or hypoxic "dead" zones)	Direct: injury/mortality Indirect: habitat degradation, shifts in or loss of prey species
Coastal development	Noise from pile driving for marina and bridge/causeway construction	Acoustic trauma (at short range), acoustic disturbance, avoidance of preferred habitat
	Dredging	Loss of sea grass beds, habitat degradation
	Loss of coastal wetlands and other coastal habitats	Loss of prey habitat, habitat degradation
Renewable energy	Pile driving for anchoring wind and wave turbines	Acoustic trauma (at short range), acoustic disturbance, avoidance of preferred habitat
	Turbine operations	Physical trauma, electromagnetic disturbance, avoidance of preferred habitat
Greenhouse gas emissions	Ocean acidification	Shifts in or loss of prey species
	Warming seas	Habitat degradation, shifts in or loss of prey
	Increased storm activity and increased severity of storms	Shifts in prey, avoidance of preferred habitat
	Sea level rise, leading to coastal habitat loss	Loss of prey habitat, habitat degradation
Natural events	Seepage of oil	Direct: organ damage Indirect: habitat degradation
	Harmful algal blooms (e.g., red tide)	Injury/mortality, shifts in prey
	Predation	Injury/mortality
	Large-scale ecosystem fluctuations	Shifts in or loss of prey
	Hurricanes	Shifts in prey, avoidance of preferred habitat, displacement of animals, habitat degradation or destruction
	Water temperature anomalies	Shifts in prey, avoidance of preferred habitat, cold stress