NOAA's National Marine Fisheries Service
Endangered Species Act Section 7 Consultation

Biological Opinion

Agency: Permits, Conservation, and Education Division of the Office of Protected Resources, NOAA's National Marine Fisheries Service

Activity Considered: Biological Opinion on the proposal to issue Permit Number 15682 to Mithriel MacKay of Texas A&M University at Galveston to authorize research on humpback whales in the Atlantic Ocean and Caribbean Sea surrounding Puerto Rico, pursuant to Section 10(a)(1)(A) of the Endangered Species Act of 1973

Consultation Conducted by: Endangered Species Act Interagency Cooperation Division of the Office of Protected Resources, NOAA's National Marine Fisheries Service

Approved by: _____

Date: DEC 16 2011

Section 7(a)(2) of the Endangered Species Act of 1973, as amended (ESA) (16 U.S.C. 1536(a)(2)) requires that each federal agency shall ensure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of critical habitat of such species. When the action of a federal agency "may affect" a listed species or critical habitat designated for them, that agency is required to consult with either NOAA's National Marine Fisheries Service (NMFS) or the U.S. Fish and Wildlife Service, depending upon the listed resources that may be affected. For the action described in this document, the action agency is the NMFS' Office of Protected Resources – Permits, Conservation, and Education Division. The consulting agency is the NMFS' Office of Protected Resources – Endangered Species Act Interagency Cooperation Division.

This document represents the NMFS' biological opinion (Opinion) of the effects of the proposed research on the endangered humpback whale and has been prepared in accordance with Section 7 of the ESA. This Opinion is based on our review of the Permits, Conservation, and Education Division's draft Environmental Assessment, draft permit 15682, the permit application from Mithriel MacKay, the most current marine mammal stock assessment reports, recovery plans for listed species, scientific and technical reports from government agencies, peer-reviewed literature, biological opinions on similar research, and other sources of information.

Consultation history

The NMFS' Permits, Conservation, and Education Division (Permits Division) requested consultation with the NMFS' Endangered Species Act Interagency Cooperation Division on the proposal to issue scientific research permit authorizing studies on humpback whales. Issuance of the permit constitutes a federal action, which may affect marine species listed under the ESA.

On October 6, 2011, the Permits Division requested initiation of Section 7 consultation to issue a new permit to Mithriel MacKay. In response, the Endangered Species Act Interagency Cooperation Division formally initiated consultation with the Permits Division.

Description of the proposed action

NMFS' Office of Protected Resources – Permits, Conservation, and Education Division proposes to issue a permit for scientific research pursuant to Section 10(a)(1)(A) of the ESA and to the Marine Mammal Protection Act of 1972, as amended (MMPA; 16 U.S.C. 1361 et seq., Section 104). Issuance of permit 15682 to Mithriel MacKay would authorize research on humpback whales in the Atlantic Ocean and Caribbean Sea surrounding Puerto Rico, to the extent of the U.S. EEZ.

The applicant proposes to approach humpback whales, including neonates, for photo-identification, behavioral observation, and passive acoustic recording year-round, with efforts focused from October through July when humpbacks are known to be present. If issued, the permit would be valid for five years.

Vessel surveys would be conducted from a 30-ft inboard diesel motor vessel (150HP) beginning at first light and continuing until environmental conditions prevent data collection. Researchers would use high magnification binoculars and high-resolution digital photography equipment to identify features on individuals, record focal behaviors, and determine the sex of animals. Whales would be approached to a minimum of approximately 25 m by vessel. Close vessel approach (within 100 m) would last no longer than 30 min for photography and up to 60 min with the motor off during acoustic recording of mother calf pairs. Individual whales could be approached multiple times annually.

In an effort to minimize disturbance to target animals, researchers plan to:

- maintain a parallel course between the vessel and target whales while photographing the side of an individual;
- position the vessel directly behind an individual at a distance of 50 m while photographing flukes;
- approach whales gradually;
- not approach or move away from mothers with calves if calves are nursing or if there is evidence that the activity may be interfering with pair-bonding or other vital functions;
- not place the vessel between mother-calf pairs;
- approach individual whales once per day.

The applicant has requested a permit to approach up to 700 humpback whales, including neonates, for photo-identification, behavioral observation, and passive acoustic recording year-round, with efforts focused from October through July when humpbacks are known to be present.

Permit conditions

The proposed permit lists general and special conditions to be followed as part of the proposed research activities. These conditions are intended to minimize the potential adverse effects of the research activities on targeted endangered species and include the following that are relevant to the proposed permit:

- In the event of serious injury or mortality or if the permitted "take" is exceeded, researchers must suspend permitted activities and contact the Permits Division by phone within two business days, and submit a written incident report. The Permits Division may grant authorization to resume permitted activities.
- Permit holders must exercise caution when approaching animals and must retreat from animals if behaviors indicate the approach may be interfering with reproduction, feeding, or other vital functions.
- Any "approach," defined as a continuous sequence of maneuvers (episode) involving a vessel, including drifting, directed toward a cetacean or group of cetaceans closer than 100 yards for large whales, constitutes a "take" by harassment under the MMPA and must be counted and reported. No individual animal may be "taken" more than 3 times in one day.
- The Permit Holder must exercise caution when approaching animals and must retreat from animals if behaviors indicate the approach may be interfering with reproduction, feeding, or other vital functions.
- When females with calves are authorized to be taken, researchers must terminate efforts if there is any evidence that the activity may be interfering with pair-bonding or other vital functions; must not position the research vessel between mother and calf; must approach mothers and calves gradually to minimize or avoid any startle response; and must not approach when calf is actively nursing.
- The Permit Holder must submit annual, final, and incident reports to the Permits Division

Approach to the assessment

The NMFS approaches its Section 7 analyses of agency actions through a series of steps. The first step identifies those aspects of proposed actions that are likely to have direct and indirect physical, chemical, and biotic effects on listed species or on the physical, chemical, and biotic environment of an action area. As part of this step, we identify the spatial extent of these direct and indirect effects, including changes in that spatial extent over time. The result of this step includes defining the *Action area* for the consultation. The second step of our analyses identifies the listed resources that are likely to co-occur with these effects in space and time and the nature of that co-occurrence (these represent our *Exposure analyses*). In this step of our analyses, we try to identify the number, age

(or life stage), and gender of the individuals that are likely to be exposed to an action's effects and the populations or subpopulations those individuals represent. Once we identify which listed resources are likely to be exposed to an action's effects and the nature of that exposure, we examine the scientific and commercial data available to determine whether and how those listed resources are likely to respond given their exposure (these represent our *Response analyses*).

The final steps of our analyses – establishing the risks those responses pose to listed resources – are different for listed species and designated critical habitat (these represent our *Risk analyses*). Our jeopardy determinations must be based on an action's effects on the continued existence of threatened or endangered species as those species have been listed, which can include true biological species, subspecies, or distinct population segments of vertebrate species. The continued existence of these species depends on the fate of the populations that comprise them. Similarly, the continued existence of populations are determined by the fate of the individuals that comprise them – populations grow or decline as the individuals that comprise the population live, die, grow, mature, migrate, and reproduce (or fail to do so).

Our risk analyses reflect these relationships between listed species, the populations that comprise that species, and the individuals that comprise those populations. Our risk analyses begin by identifying the probable risks actions pose to listed individuals that are likely to be exposed to an action's effects. Our analyses then integrate those individual risks to identify consequences to the populations those individuals represent. Our analyses conclude by determining the consequences of those population-level risks to the species those populations comprise.

We measure risks to listed individuals using the individual's "fitness," or the individual's growth, survival, annual reproductive success, and lifetime reproductive success. In particular, we examine the scientific and commercial data available to determine if an individual's probable lethal, sub-lethal, or behavioral responses to an action's effect on the environment (which we identify during our *Response analyses*) are likely to have consequences for the individual's fitness.

When individual listed plants or animals are expected to experience reductions in fitness in response to an action, those fitness reductions are likely to reduce the abundance, reproduction, or growth rates (or increase the variance in these measures) of the populations those individuals represent (see Stearns 1992). Reductions in at least one of these variables (or one of the variables we derive from them) is a necessary condition for reductions in a population's viability, which is itself a necessary condition for reductions in a species' viability. As a result, when listed plants or animals exposed to an action's effects are not expected to experience reductions in fitness, we would not expect the action to have adverse consequences on the viability of the populations those individuals represent or the species those populations comprise (e.g., Brandon 1978; Anderson 2000; Mills and Beatty 1979; Stearns 1992). As a result, if we conclude that listed plants or animals are not likely to experience reductions in their fitness, we would conclude our assessment.

Although reductions in fitness of individuals is a necessary condition for reductions in a population's viability, reducing the fitness of individuals in a population is not always

sufficient to reduce the viability of the population(s) those individuals represent. Therefore, if we conclude that listed plants or animals are likely to experience reductions in their fitness, we determine whether those fitness reductions are likely to reduce the viability of the populations the individuals represent (measured using changes in the populations' abundance, reproduction, spatial structure and connectivity, growth rates, variance in these measures, or measures of extinction risk). In this step of our analysis, we use the population's base condition (established in the *Environmental baseline* and *Status of listed resources* sections of this Opinion) as our point of reference. If we conclude that reductions in individual fitness are not likely to reduce the viability of the populations those individuals represent, we would conclude our assessment.

Reducing the viability of a population is not always sufficient to reduce the viability of the species those populations comprise. Therefore, in the final step of our analyses, we determine if reductions in a population's viability are likely to reduce the viability of the species those populations comprise using changes in a species' reproduction, numbers, distribution, estimates of extinction risk, or probability of being conserved. In this step of our analyses, we use the species' status (established in the *Status of listed resources* section of this Opinion) as our point of reference. Our final determinations are based on whether threatened or endangered species are likely to experience reductions in their viability and whether such reductions are likely to be appreciable.

To conduct these analyses, we rely on all of the evidence available to us. This evidence consists of

- reports from the NMFS Science Centers
- reports prepared by natural resource agencies in States and other countries
- reports from non-governmental organizations involved in marine conservation issues
- the information provided by the NMFS Permits Division when it initiates formal consultation
- the general scientific literature

We supplement this evidence with reports and other documents – environmental assessments, environmental impact statements, and monitoring reports – prepared by other federal and state agencies.

During the consultation, we conducted electronic searches of the general scientific literature. We supplemented these searches with electronic searches of doctoral dissertations and master's theses. These searches specifically tried to identify data or other information that supports a particular conclusion as well as data that do not support that conclusion. When data were equivocal or when faced with substantial uncertainty, our decisions are designed to avoid the risks of incorrectly concluding that an action would not have an adverse effect on listed species when, in fact, such adverse effects are likely (i.e., Type II error).

Action Area

The proposed activities would occur in the Atlantic Ocean and Caribbean Sea surrounding Puerto Rico, to the extent of the U.S. EEZ, year-round, with efforts focused from October through July when humpbacks are known to be present.

Status of listed resources

NMFS has determined that the actions considered in this Opinion may affect the following listed resources provided protection under the ESA of 1973, as amended (16 U.S.C. 1531 *et seq*.):

Cetaceans		
Fin whale	*Balaenoptera physalus*	Endangered
Humpback whale	*Megaptera novaeangliae*	Endangered
Sperm whale	*Physeter macrocephalus*	Endangered
Invertebrates		
Elkhorn coral*	*Acropora palmata*	Threatened
Staghorn coral*	*Acropora cervicornis*	Threatened
Sea Turtles		
Green sea turtle* – most areas	*Chelonia mydas*	Threatened
Florida and Mexico's Pacific coast breeding colonies		Endangered
Hawksbill sea turtle*	*Eretmochelys imbricate*	Endangered
Leatherback sea turtle*	*Dermochelyts coriacea*	Endangered
Loggerhead sea turtle	*Caretta caretta*	Threatened
Northwest Atlantic Ocean DPS		

* Critical habitat exists for these species within the action area.

Species not considered further in this opinion

To refine the scope of this Opinion, NMFS used two criteria (risk factors) to determine whether any endangered or threatened species or critical habitat are not likely to be adversely affected by vessel traffic, aircraft traffic, or human disturbance associated with the proposed actions. The first criterion was *exposure*: if we conclude that particular endangered or threatened species or designated critical habitat are not likely to be exposed to vessel traffic, aircraft traffic, or human disturbance, we must also conclude that those listed species or designated critical habitat are not likely to be adversely affected by the proposed action. The second criterion is *susceptibility* upon exposure: species or critical habitat may be exposed to vessel traffic, aircraft traffic, or human disturbance, but may not be affected by those activities—either because of the circumstances associated with the exposure or the intensity of the exposure-- are also not likely to be adversely affected by the vessel traffic, aircraft traffic, or human disturbance. This section summarizes the results of our evaluations.

Fin and sperm whales, and green, hawksbill, leatherback, and loggerhead sea turtles may occur in the action area, but we do not expect them to be exposed to the proposed activities. If a protected whale is observed in the action area, it would be avoided and the vessel would operate at a reduced speed, following marine mammal viewing guidelines. Similarly, if researchers observe a sea turtle during research, they would avoid it. Elkhorn and staghorn corals could also occur in the action area, but we do not expect them to be adversely affected by the proposed action. Researchers would not be anchoring and would be mindful of the presence of threatened coral species in the area.

Green, hawksbill and leatherback sea turtles and elkhorn and staghorn corals have critical habitat designated within the action area. The elements of habitat that are considered

essential for hawksbill sea turtles are natal development habitat, refuge from predation, shelter between foraging periods, and food for hawksbill sea turtle prey. The important aspect of the designated critical habitat for leatherback sea turtles in the US Virgin Islands, which is within the Puerto Rican EEZ and could therefore overlap with the proposed action, is its use as nesting habitat. For both species of sea turtles, the proposed action would not adversely modify or destroy the designated critical habitat.

The designation for both corals indicated natural consolidated hard substrate or dead coral skeleton that are free from fleshy or turf macroalgae cover and sediment cover as the primary constituent element for the corals' critical habitat. The proposed action would not affect this element, and therefore we do not expect it to adversely modify or destroy elkhorn and staghorn critical habitat.

Although these listed resources may occur in the action area, we believe they are either not likely to be exposed to the proposed research or are not likely to be adversely affected. Therefore, they will not be considered further in this Opinion.

Status of species considered in this opinion

The species narratives that follow focus on attributes of life history and distribution that influence the manner and likelihood that these species may be exposed to the proposed action, as well as the potential response and risk when exposure occurs. Consequently, the species' narrative is a summary of a larger body of information on localized movements, population structure, feeding, diving, and social behaviors. Summaries of the status and trends of humpback whales are presented to provide a foundation for the analysis of the species as a whole. We also provide a brief summary of the species' status and trends as a point of reference for the jeopardy determination, made later in this Opinion. That is, we rely on a species' status and trend to determine whether an action's direct or indirect effects are likely to increase the species' probability of becoming extinct. Similarly, each species narrative is followed by a description of its critical habitat with particular emphasis on any essential features of the habitat that may be exposed to the proposed action and may warrant special attention.

Humpback whale

Description of the species

Humpback whales are a cosmopolitan species that occur in the Atlantic, Indian, Pacific, and Southern oceans. Humpback whales migrate seasonally between warmer, tropical or sub-tropical waters in winter months and cooler, temperate or sub-Arctic waters in summer months (Gendron and Urban 1993). In both regions, humpback whales tend to occupy shallow, coastal waters. However, migrations are undertaken through deep, pelagic waters (Winn and Reichley 1985).

Stock designations

North Atlantic. Humpback whales range from the mid-Atlantic bight and the Gulf of Maine across the southern coast of Greenland and Iceland to Norway in the Barents Sea. Whales migrate to the western coast of Africa and the Caribbean Sea during the winter. Humpback whales aggregate in four summer feeding areas: Gulf of Maine and eastern

Canada, west Greenland, Iceland, and Norway (Katona and Beard 1990; Smith et al. 1999).

The principal breeding range for Atlantic humpback whales lies from the Antilles and northern Venezuela to Cuba (Balcomb and Nichols 1982; Whitehead and Moore 1982; Winn *et al.* 1975).

The largest breeding aggregations occur off the Greater Antilles where humpback whales from all North Atlantic feeding areas have been photo-identified (Katona and Beard 1990; Clapham *et al.* 1993; Mattila *et al.* 1994; Palsbøll *et al.* 1997; Smith *et al.* 1999; Stevick *et al.* 2003b). However, the possibility of historic and present breeding further north remains plausible (Smith and G.Pike 2009).

Winter aggregations also occur at the Cape Verde Islands in the eastern North Atlantic and along Angola (Reiner *et al.* 1996; Reeves *et al.* 2002; Weir 2007). Accessory and historical aggregations also occur in the eastern Caribbean (Winn *et al.* 1975; Mitchell and Reeves 1983; Reeves *et al.* 2001a; Reeves *et al.* 2001b; Smith and Reeves 2003; Schwartz 2003; Swartz *et al.* 2003; Levenson and Leapley 1978).

North Pacific. Based on genetic and photo-identification studies, NMFS currently recognizes four stocks of humpback whales in the North Pacific Ocean: two Eastern North Pacific stocks, one Central North Pacific stock, and one Western Pacific stock (Hill and DeMaster 1998). Humpback whales summer in coastal and inland waters from Point Conception, California, north to the Gulf of Alaska and the Bering Sea, and west along the Aleutian Islands to the Kamchatka Peninsula and into the Sea of Okhotsk (Nemoto 1957; Johnson and Wolman 1984; Tomilin 1967). These whales migrate to Hawaii, southern Japan, the Mariana Islands, and Mexico during winter. The central North Pacific stock winters in the waters around Hawaii while the eastern North Pacific stock (also called the California-Oregon-Washington-Mexico stock) winters along Central America and Mexico. However, Calambokidis et al. (1997) identified individuals from several stocks wintering in the areas of other stocks, highlighting the paucity of knowledge on stock structure and the potential fluidity of stock structure.

Separate feeding groups of humpback whales are thought to inhabit western U.S. and Canadian waters, with the boundary between them located roughly at the U.S./Canadian border (Carretta et al. 2006). Humpback whales primarily feed along the shelf break and continental slope do not appear to frequent offshore waters in the region (Green et al. 1992; Tynan et al. 2005)

Southern Hemisphere. Eight proposed stocks of humpback whales occur in waters off Antarctica. A separate population of humpback whales appears to reside in the Arabian Sea in the Indian Ocean off the coasts of Oman, Pakistan, and India and movements of this group are poorly known (Mikhalev 1997; Rasmussen et al. 2007).

Reproduction

Humpback whale calving and breeding generally occurs during winter at lower latitudes. Gestation takes about 11 months, followed by a nursing period of up to 1 year (Baraff and Weinrich 1993). Sexual maturity is reached at between 5-7 years of age in the western North Atlantic, but may take as long as 11 years in the North Pacific, and perhaps over 11 years of age in the North Pacific (e.g., southeast Alaska, Gabriele et al.

2007). Females usually breed every 2-3 years, although consecutive calving is not unheard of (Clapham and Mayo 1987; 1990; Weinrich et al. 1993; Glockner-Ferrari and Ferrari 1985).

In calving areas, males sing long complex songs directed towards females, other males, or both. The breeding season can best be described as a floating lek or male dominance polygamy (Clapham 1996). Calving occurs in the shallow coastal waters of continental shelves and oceanic islands worldwide (Perry et al. 1999).

Feeding

During the feeding season, humpback whales form small groups that occasionally aggregate on concentrations of food that may be stable for long-periods of times. Humpbacks use a wide variety of behaviors to feed on various small, schooling prey including krill and fish (Jurasz and Jurasz 1979; Hain et al. 1982; Hain et al. 1995; Weinrich et al. 1992). The principal fish prey in the western North Atlantic are sand lance, herring, and capelin (Kenney et al. 1985). There is good evidence of some territoriality on feeding and calving areas (Tyack 1981; Clapham 1996; Clapham 1994).

Status and trends

Humpback whales were originally listed as endangered in 1970 (35 FR 18319), and this status remains under the ESA. Winn and Reichley (1985) argued that the global humpback whale population consisted of at least 150,000 whales in the early 1900s, mostly in the Southern Ocean. In 1987, the global population of humpback whales was estimated at about 10,000 (NMFS 1987). Although this estimate is outdated, it appears that humpback whale numbers are increasing.

North Atlantic. The best available estimate of North Atlantic abundance comes from 1992-1993 mark-recapture data, which generated an estimate of 11,570 humpback whales (Stevick *et al.* 2003a). Estimates of animals in Caribbean breeding grounds exceed 2,000 individuals (Balcomb and Nichols 1982). The rate of increase for this stock varies from 3.2-9.4%, with rates of increase slowing over the past two decades (Katona and Beard 1990; Barlow and Clapham 1997; Stevick *et al.* 2003a). If the North Atlantic population has grown according to the estimated instantaneous rate of increase ($r = 0.0311$), this would lead to an estimated 18,400 individual whales in 2008 (Stevick *et al.* 2003a).

In the West Indies, the majority of whales are found in the waters of the Dominican Republic, notably on Silver Bank and Navidad Bank, and in Samana Bay (Balcomb and Nichols 1982; Whitehead and Moore 1982; Mattila *et al.* 1989; Mattila *et al.* 1994). Humpback whales are also found at much lower densities throughout the remainder of the Antillean arc, from Puerto Rico to the coast of Venezuela (Winn *et al.* 1975; Mattila and Clapham 1989; Levenson and Leapley 1978; Price 1985).

North Pacific. The pre-exploitation population size of North Pacific humpback whales may have been as many as 15,000 humpback whales, and current estimates are 6,000-8,000 whales (Calambokidis et al. 1997; Rice 1978). From 1905 to 1965, nearly 28,000 humpback whales were taken in whaling operations, reducing the number of all North Pacific humpback whale to roughly 1,000 (Perry et al. 1999). Population estimates have risen over time from 1,407-2,100 in the 1980s to 6,010 in 1997 (Baker 1985; Baker and Herman 1987; Darling and Morowitz 1986; Calambokidis et al. 1997). Tentative

estimates of the eastern North Pacific stock suggest an increase of 6-7% annually, but fluctuations have included negative growth in the recent past (Angliss and Outlaw 2005). Based upon surveys between 2004 and 2006, Calambokidis et al. (2008) estimated that the current population of humpback whales in the North Pacific consists of about 18,300 whales, not counting calves. Almost half of these whales likely occur in wintering areas around the Hawaiian Islands.

Southern Hemisphere. The IWC recently compiled population data on humpback whales in the Southern Hemisphere. Approximately 42,000 Southern Hemisphere humpbacks can be found south of 60° S during the austral summer feeding season (IWC 2007).

Critical habitat

NMFS has not designated critical habitat for humpback whales.

Environmental baseline

By regulation, environmental baselines for Opinions include the past and present impacts of all state, federal, or private actions and other human activities in the action area, the anticipated impacts of all proposed federal projects in the action area that have already undergone formal or early Section 7 consultation, and the impact of state or private actions that are contemporaneous with the consultation in process (50 CFR §402.02). The *Environmental baseline* for this Opinion includes the effects of several activities affecting the survival and recovery of ESA-listed humpback whales in the action area. The *Environmental baseline* focuses primarily on past and present impacts to these species.

A number of human activities have contributed to the current status of these species in the action area. Although some of those activities, such as commercial whaling, occurred extensively in the past, ceased, and no longer appear to affect these whale populations, the effects of these types of exploitation persist today. Other human activities, such as commercial fishing and vessel operations, are ongoing and continue to affect these species.

The following discussion summarizes the natural and human phenomena in the action area that may affect the likelihood these species will survive and recover in the wild. These include predation, disease and parasitism, commercial and subsistence harvest, fisheries interactions, ship strikes, contaminants, marine debris, noise, habitat degradation and climate change, and scientific research.

Directed harvest

Directed harvest has affected humpback whales. U.S. Commercial harvest of large whale species no longer occurs, and the IWC has moratoriums in place to protect species from commercial whaling internationally. Nonetheless, historical whaling significantly reduced large whale abundance, and the effects of these reductions likely still persist.

Fisheries interactions

Entrapment and entanglement in fishing gear is a frequently documented source of human-caused mortality in large whale species (see Dietrich et al. 2007). These entanglements also make whales more vulnerable to additional dangers (e.g., predation

and ship strikes) by restricting agility and swimming speed. Some marine mammals that die from entanglement in commercial fishing gear may sink rather than strand ashore, thus making it difficult to accurately determine the extent of such mortalities.

In the NMFS records for 2005 through 2009, there were 6 reports of humpback mortalities as a result of entanglement (Henry *et al.* 2011). From 1990 to 2005, one humpback whale was reported as entangled in Puerto Rican waters, and there was no injury from the entanglement (A. Henry, unpublished data).

Ship strikes

In the Western Atlantic Ocean, various types and sizes of vessels have been involved in ship strikes with large whales, including container/cargo ships/freighters, tankers, steamships, U.S. Coast Guard vessels, Navy vessels, cruise ships, ferries, recreational vessels, fishing vessels, whale-watching vessels, and other vessels (Jensen and Silber 2003). Vessel speed (if recorded) at the time of a large whale collision has ranged from 2 to 51 knots (Jensen and Silber 2003). Vessels can be damaged during ship strikes (occasionally, collisions with large whales have even harmed or killed humans on board the vessels); of 13 recorded vessels that reported damages from a strike, all were traveling at a speed of at least 10 knots (Jensen and Silber 2003).

In the NMFS records for 2005 through 2009, there were 7 reports of humpback mortalities as a result of collision with a vessel (Henry *et al.* 2011); however, from 1990 to 2005, no ship strikes of humpbacks in Puerto Rican waters have been reported (A. Henry, unpublished data).

Noise

The marine mammals that occur in the action area are regularly exposed to several sources of natural and anthropogenic sounds. Anthropogenic noises that could affect ambient noise arise from the following general types of activities in and near the sea, any combination of which can contribute to the total noise at any one place and time. These noises include transportation, dredging, construction; oil, gas, and mineral exploration in offshore areas; geophysical (seismic) surveys; sonars; explosions; and ocean research activities (Richardson et al. 1995).

Noise in the marine environment has received a lot of attention in recent years and is likely to continue to receive attention in the foreseeable future. Several investigators have argued that anthropogenic sources of noise have increased ambient noise levels in the ocean over the last 50 years (Jasny et al. 2005; NRC 1994; NRC 2000; NRC 2003; NRC 2005; Richardson et al. 1995). Much of this increase is due to increased shipping as ships become more numerous and of larger tonnage (NRC 2003).

Commercial fishing vessels, cruise ships, transport boats, airplanes, helicopters and recreational boats all contribute sound into the ocean (NRC 2003). The military uses sound to test the construction of new vessels, as well as for naval operations. In some areas where oil and gas production takes place, noise originates from the drilling and production platforms, tankers, vessel and aircraft support, seismic surveys, and the explosive removal of platforms (NRC 2003). Many researchers have described behavioral responses of marine mammals to the sounds produced by helicopters and

fixed-wing aircraft, boats and ships, as well as dredging, construction, geological explorations, etc. (Richardson et al. 1995). Most observations have been limited to short-term behavioral responses, which included cessation of feeding, resting, or social interactions. Several studies have demonstrated short-term effects of disturbance on humpback whale behavior (Baker et al. 1983; Bauer and Herman 1986; Krieger and Wing 1984; Hall 1982) but the long-term effects, if any, are unclear or not detectable. Carretta et al. (2001) and Jasny et al. (2005) identified the increasing levels of anthropogenic noise as a habitat concern for whales because of its potential effect on their ability to communicate.

Surface shipping is the most widespread source of anthropogenic, low frequency (0 to 1,000 Hz) noise in the oceans (Simmonds and Hutchinson. 1996). The radiated noise spectrum of merchant ships ranges from 20 to 500 Hz and peaks at approximately 60 Hz. Ross (1976) has estimated that between 1950 and 1975 shipping had caused a rise in ambient ocean noise levels of 10 dB. He predicted that this would increase by another 5 dB by the beginning of the 21st century.

Predation

Based upon prevalence of tooth marks, attacks by killer whales are known to occur (Whitehead and Glass 1985). Juveniles appear to be the primary age group targeted. Humpback whales engage in grouping behavior, flailing tails, and rolling extensively to fight off attacks. Calves remain protected near mothers or within a group; however, long-term photo-identification studies suggest that nearly all scars on humpback whales in the Gulf of Maine from killer whales were obtained while still calves (Ford and Reeves 2008).

Disease and parasitism

Urinary tract diseases and kidney failure caused by nematode *Crassicauda boopis* could affect humpback whale populations (Lambertsen 1986; Lambertsen 1992), and several other species of large whale are known to carry similar parasites (Rice 1977). Parasites and biotoxins from red-tide blooms are other potential causes of mortality of humpback whales (Perry et al. 1999).

Contaminants

The accumulation of stable pollutants is a possible human-induced source of mortality in long-lived high trophic level animals (Waring et al. 2004; NMFS 2005), and some researchers have correlated contaminant exposure to possible adverse health effects in marine mammals. Contaminants may be introduced by rivers, coastal runoff, wind, ocean dumping, dumping of raw sewage by boats and various industrial activities, including offshore oil and gas or mineral exploitation. Due to their large amount of blubber and fat, marine mammals readily accumulate lipid-soluble contaminants (O'Hara and Rice 1996).

Humpback whale blubber has been shown to contain PCB and DDT (Gauthier et al. 1997). Contaminant levels are relatively high in humpback whales, compared to blue whales; humpback whales feed higher on the food chain, where prey carry higher contaminant loads than the krill that blue whales feed on.

Scientific research

There is currently one permit which authorizes research on humpback whales in the action area of Puerto Rico. Permit No. 1128-1922 authorizes acoustical playbacks to humpback whales in the waters off Puerto Rico.

Effects of the proposed actions

Pursuant to Section 7(a)(2) of the ESA, federal agencies are required to ensure that their activities are not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat. The proposed permit by the Permits Division would expose humpback whales and Hawaiian insular false killer whales to actions that constitute "take". In this section, we describe the potential physical, chemical, or biotic stressors associated with the proposed actions, the probability of individuals of listed species being exposed to these stressors based on the best scientific and commercial evidence available, and the probable responses of those individuals (given probable exposures) based on the available evidence. As described in the *Approach to the assessment* section, for any responses that would be expected to reduce an individual's fitness (i.e., growth, survival, annual reproductive success, and lifetime reproductive success), the assessment would consider the risk posed to the viability of the population. The purpose of this assessment is to determine if it is reasonable to expect the proposed studies to have effects on listed species affected by this permit that could appreciably reduce the species' likelihood of surviving and recovering in the wild.

For this consultation, we are particularly concerned about behavioral disruptions that may result in animals that fail to feed or breed successfully or fail to complete their life history because these responses are likely to have population-level, and therefore species level, consequences. The proposed permit would authorize non-lethal "takes" by harassment of listed species during research activities. The ESA does not define harassment nor has NMFS defined the term pursuant to the ESA through regulation. However, the Marine Mammal Protection Act of 1972, as amended, defines harassment as any act of pursuit, torment, or annoyance which has the potential to injure a marine mammal or marine mammal population in the wild or has the potential to disturb a marine mammal or marine mammal population in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering [16 U.S.C. 1362(18)(A)]. For this Opinion, we define harassment similarly: an intentional or unintentional human act or omission that creates the probability of injury to an individual animal by disrupting one or more behavioral patterns that are essential to the animal's life history or its contribution to the population the animal represents.

Potential stressors

The assessment for this consultation identified several possible stressors associated with the proposed permitted activities. These include close approaches by research vessels, photo-identification from vessels, and passive acoustic recording.

Exposure analysis

Exposure analyses identify the co-occurrence of ESA-listed species with the action's effects in space and time, and identify the nature of that co-occurrence. The *Exposure*

analysis identifies, as possible, the number, age or life stage, and gender of the individuals likely to be exposed to the action's effects and the populations(s) or subpopulation(s) those individuals represent.

The Permits Division proposes to issue a five-year permit for scientific research to Mithriel MacKay, to approach up to 700 humpback whales, including neonates, for photo-identification, behavioral observation, and passive acoustic recording. Research would be conducted in the Atlantic Ocean and Caribbean Sea surrounding Puerto Rico, to the extent of the U.S. EEZ, year-round, with efforts focused from October through July when humpbacks are known to be present.

The researcher has based the requested number of whales that could be affected by this research on the numbers of humpbacks seen from shoreline observations during a pilot study. From December 2010 through April 2011, the researchers used binoculars from shore, and recorded the sightings of 0-6 humpback whales per day, with an average of 3 whales per day of effort. Additional information suggested that the shoreline observations were not able to sight all whales present in the area on particular days. Therefore, given the duration of the field season, we consider the applicant's request for 700 takes reasonable.

Close vessel approach (within 100 m) would last no longer than 30 min for photography and up to 60 min with the motor off during acoustic recording of mother calf pairs. Individual whales could be approached multiple times annually.

Response analysis

As discussed in the *Approach to the assessment* section of this Opinion, response analyses determine how listed resources are likely to respond after being exposed to an action's effects on the environment or directly on listed species themselves. For the purposes of consultation, our assessments try to detect potential lethal, sub-lethal (or physiological), or behavioral responses that might reduce the fitness of individuals. Ideally, response analyses would consider and weigh evidence of adverse consequences as well as evidence suggesting the absence of such consequences.

Evidence indicates that wild animals respond to human disturbance in the same way they respond to predators (Lima 1998; Beale and Monaghan 2004; Frid and Dill 2002; Frid 2003; Gill et al. 2001; Romero 2004). These responses may manifest themselves as stress responses, interruptions of essential behavioral or physiological events, alteration of an animal's time budget, or some combinations of these responses (Frid and Dill 2002; Romero 2004; Sapolsky et al. 2000; Walker et al. 2005).

Response to close approaches by research vessels

For all research activities, the presence of vessels can lead to disturbance of marine mammals, although the animals' reactions are generally short term and low impact. Reactions range from little to no observable change in behavior to momentary changes in swimming speed, pattern, orientation; diving; time spent submerged; foraging; and respiratory patterns. Responses may also include aerial displays like tail flicks and lobtailing and may possibly influence distribution (Watkins *et al.* 1981; Bauer and Herman 1986; Baker *et al.* 1983; Clapham *et al.* 1993; Jahoda *et al.* 2003). The degree of

disturbance by vessel approaches is highly varied. Whales may respond differently depending upon what behavior the individual or pod is engaged in before the vessel approaches (Wursig et al. 1998; Hooker et al. 2001) and the degree to which they have become accustomed to vessel traffic (Lusseau 2004; Richter et al. 2006); reactions may also vary by species or individuals within a species (Gauthier and Sears 1999). In addition, Baker et al. (1988) reported that changes in whale behavior corresponded to vessel speed, size, and distance from the whale, as well as the number of vessels operating in the proximity. Based on experiments conducted by Clapham and Mattila (1993), experienced, trained personnel approaching whales slowly would result in fewer whales exhibiting responses that might indicate stress.

For humpback whales, studies found patterns of disturbance in response to vessel activity that indicate such approaches are probably stressful to the humpback whales, but the consequences of this stress on the individual whales remains unknown (Baker and Herman 1989; Baker et al. 1983). Baker et al. (1983) described two responses of whales to vessels: "horizontal avoidance" of vessels 2,000 to 4,000 meters away characterized by faster swimming and fewer long dives; and "vertical avoidance" of vessels from 0 to 2,000 meters away during which whales swam more slowly, but spent more time submerged.

Hall (1982) reported that humpback whales closely approached by survey vessels in Prince William Sound, Alaska, often reacted by diving and surfacing further from the vessel or with an altered direction of travel. The author noted that whale feeding activity and social behavior did not appear to be disturbed by the approaches; however, cow-calf pairs appeared to be wary and avoided the vessel. Other studies have found that humpbacks respond to the presence of boats by increasing swimming speed, with some evidence that swimming speed then decreased after boats left the area (Au and Green 2000; Scheidat et al. 2004). A number of studies involving the close approach of humpback whales by research vessels for biopsying and tagging indicate that responses are generally minimal to non-existent when approaches were slow and careful.

When more pronounced behavioral changes occur, the responses appear to be short-lived (Gauthier and Sears 1999; Weinrich et al. 1992; Clapham and Mattila 1993; Weinrich et al. 1991). The slow and careful approach to humpback whales is important and is supported by studies conducted by Clapham and Mattila (1993) on the reactions of humpback whales to close approaches for biopsy sampling in Caribbean breeding areas. The investigators concluded that the way a vessel approached a group of whales had a major influence on the whale's response to the approach, particularly for cow and calf pairs. Smaller pods of whales and pods with calves also seem more responsive to approaching vessels (Bauer and Herman 1986; Bauer 1986). Based on their experiments with different approach strategies, researchers concluded that experienced, trained personnel approaching humpback whales slowly would result in fewer whales exhibiting responses that might indicate stress.

Although close approaches conducted under the proposed permit might still be stressful for some individuals, and might temporarily interrupt behaviors such as foraging, evidence from investigators and in the literature suggests that responses would be short-lived. Assuming an animal is no longer disturbed after it returns to pre-approach

behavior, we do not expect a negative fitness consequence for the individuals approached.

Cumulative effects

Cumulative effects include the effects of future state, tribal, local or private actions that are reasonably certain to occur in the action area considered by this Opinion. Future federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA. Sources queried include state legislature websites and Nexis.

After reviewing available information, NMFS is not aware any future non-federal activities in the action area that would not require federal authorization or funding and are reasonably certain to occur during the foreseeable future.

Integration and synthesis of the effects

As explained in the *Approach to the Assessment* section, risks to listed individuals are measured using changes to an individual's "fitness" – i.e., the individual's growth, survival, annual reproductive success, and lifetime reproductive success. When listed plants or animals exposed to an action's effects are not expected to experience reductions in fitness, we would not expect the action to have adverse consequences on the viability of the population(s) those individuals represent or the species those populations comprise (Anderson 2000; Brandon 1978; Mills and Beatty 1979; Stearns 1992). As a result, if the assessment indicates that listed plants or animals are not likely to experience reductions in their fitness, we conclude our assessment.

The NMFS Permits Division proposes to issue a scientific research permit to Mithriel MacKay of Texas A&M University at Galveston to authorize research on humpback whales in the Atlantic Ocean and Caribbean Sea surrounding Puerto Rico.

The *Status of listed resources* and *Environmental baseline* described the factors that have contributed to the reduction in population size of the humpback whale, including commercial whaling, fisheries interactions, and ship strikes. NMFS expects that the current natural and anthropogenic threats will continue.

Each year of the five-year proposed permit, up to 700 humpback whales could be closely approached by research vessels, photographed, and passively recorded. We believe short-lived stress responses due to close approach are possible for a few individuals, as are short-term interruptions in behaviors such as foraging; however, we do not expect these responses to lead to reduced opportunities for foraging or reproduction for targeted individuals. Overall, no individual whale is expected to experience a fitness reduction, and therefore no fitness consequence would be experienced at a population or species level.

Conclusion

After reviewing the current *Status of listed resources*; the *Environmental baseline* for the *Action area*; the anticipated effects of the proposed activities; and the *Cumulative effects*, it is NMFS' Opinion that the activities authorized by the proposed issuance of scientific research permit 15682, as proposed, is not likely to jeopardize the continued existence of

humpback whales, and we do not anticipated the destruction or adverse modification of the designated critical habitat within the action area.

Incidental take statement

Section 9 of the ESA and federal regulation pursuant to Section 4(d) of the ESA prohibit the "take" of endangered and threatened species, respectively, without special exemption. "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by the NMFS to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of Sections 7(b)(4) and 7(o)(2), taking that is incidental and not intended as part of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

As discussed in the accompanying Opinion, only the species targeted by the proposed research activities would be harassed as part of the intended purpose of the proposed action. Therefore, the NMFS does not expect the proposed action would incidentally take threatened or endangered species.

Conservation recommendations

Section 7(a)(1) of the ESA directs federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

We recommend the following conservation recommendations, which would provide information for future consultations involving the issuance of marine mammal permits that may affect endangered whales as well as reduce harassment related to authorized activities:

1. *Cumulative impact analysis.* The Permits Division should encourage the marine mammal research community, working with the Marine Mammal Commission as applicable, to identify a research program with sufficient power to determine cumulative impacts of existing levels of research on whales. This includes the cumulative sub-lethal and behavioral impacts of research permits on listed species.

2. *Coordination meetings*. The Permits Division should continue to work with NMFS' Regional Offices and Science Centers to conduct meetings among permit holders conducting research within a region and future applicants to ensure that the results of all research programs or other studies on specific threatened or endangered species are coordinated among the different investigators.

3. *Data sharing*. The Permits Division should continue to encourage permit holders planning to be in the same geographic area during the same year to coordinate their efforts by sharing research vessels and the data they collect as a way of reducing

duplication of effort and the level of harassment threatened and endangered species experience as a result of field investigations.

In order for the NMFS' Endangered Species Act Interagency Cooperation Division to be kept informed of actions minimizing or avoiding adverse effects on, or benefiting, listed species or their habitats, the Permits Division should notify the Endangered Species Act Interagency Cooperation Division of any conservation recommendations they implement in their final action.

Reinitiation notice

This concludes formal consultation on the proposal to issue scientific research permit No. 15682 to Mithriel MacKay of Texas A&M University at Galveston to authorize research on humpback whales in the Atlantic Ocean and Caribbean Sea surrounding Puerto Rico. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this Opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this Opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of authorized take is exceeded, the NMFS Permits Division must immediately request reinitiation of Section 7 consultation.

References

Anderson, J. J. 2000. A vitality-based model relating stressors and environmental properties to organism survival. Ecological Monographs 70(3):445-470.

Angliss, R. P. and R. B. Outlaw. 2005. Alaska marine mammal stock assessments, 2005. U.S. Department of Commerce, NOAA Technical Memorandum NMFSAFSC-161, 250 p.

Au, W. W. L. and M. Green. 2000. Acoustic interaction of humpback whales and whale-watching boats. Marine Environmental Research 49:469-481.

Baker, C. S. 1985. The behavioral ecology and populations structure of the humpback whale (*Megaptera novaeangliae*) in the central and eastern Pacific. Unpublished Dissertation. University of Hawaii at Manoa.

Baker, C. S. and L. M. Herman. 1987. Alternative population estimates of humpback whales in Hawaiian waters. Canadian Journal of Zoology 65(11):2818-2821.

Baker, C. S. and L. M. Herman. 1989. Behavioral responses of summering humpback whales to vessel traffic: Experimental and opportunistic observations. Kewalo Basin Marine Mammal Lab, Univ HI, Honolulu. Final Report for the U.S. NPS, Anchorage, Alaska. 50p.

Baker, C. S., L. M. Herman, B. G. Bays, and G. B. Bauer. 1983. The impact of vessel traffic on the behavior of humpback whales in southeast Alaska: 1982 season. Report submitted to the National Marine Mammal Laboratory, Seattle, WA. 78pp.

Baker, C. S., A. Perry, and G. Vequist. 1988. Conservation update-- humpback whales of Glacier Bay, Alaska. Whalewatcher 22(3):13-17.

Balcomb, K. C. and G. Nichols, Jr. 1982. Humpback whale censuses in the West Indies. Report of the International Whaling Commission 32:401-406.

Baraff, L. and M. T. Weinrich. 1993. Separation of humpback whale mothers and calves on a feeding ground in early autumn. Marine Mammal Science 9(4):431-434.

Barlow, J. and P. J. Clapham. 1997. A new birth-interval approach to estimating demographic parameters of humpback whales. Ecology 78(2):535-546.
Bauer, G. and L. M. Herman. 1986. Effects of vessel traffic on the behavior of humpback whales in Hawaii. National Marine Fisheries Service, Honolulu, Hawaii.
Bauer, G. B. 1986. The behavior of humpback whales in Hawaii and modification of behavior induced by human interventions. Ph.D. dissertation:University of Hawaii, Honolulu.
Beale, C. M. and P. Monaghan. 2004. Human disturbance: people as predation-free predators? Journal of Applied Ecology 41:335-343.
Brandon, R. 1978. Adaptation and evolutionary theory. Studies in the History and Philosophy of Science 9:181-206.
Calambokidis, J., E. A. Falcone, T. J. Quinn II, A. M. Burdin, P. J. Clapham, J. K. B. Ford, C. M. Gabriele, R. G. LeDuc, D. K. Mattila, L. Rojas-Bracho, J. M. Straley, B. L. Taylor, J. Urbân, R. D. W. Weller, B. H. Witteveen, M. Yamaguchi, A. Bendlin, D. Camacho, K. R. Flynn, A. Havron, J. Huggins, and N. Maloney. 2008. SPLASH: Structure of populations, levels of abundance, and status of humpback whales in the North Pacific. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Seattle, Washington.
Calambokidis, J., G. H. Steiger, J. M. Straley, T. Quinn, L. M. Herman, S. Cerchio, D. R. Salden, M. Yamaguchi, F. Sato, J. R. Urban, J. Jacobson, O. von Zeigesar, K. C. Balcomb, C. M. Gabriele, M. E. Dahlheim, N. Higashi, S. Uchida, J. K. B. Ford, Y. Miyamura, P. Ladrón de Guevara, S. A. Mizroch, L. Schlender, and K. Rasmussen. 1997. Abundance and population structure of humpback whales in the North Pacific basin. Final Report under contract No. 5ABNF500113. NMFS Southwest Fisheries Science Center; La Jolla, California.
Carretta, J. V., J. Barlow, K. A. Forney, M. M. Muto, and J. Baker. 2001. U.S. Pacific Marine Mammal Stock Assessments: 2001. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Science Center, NOAA-TM-NMFS-SWFSC-317.
Carretta, J. V., K. A. Forney, M. M. Muto, J. Barlow, J. Baker, B. Hanson, and M. S. Lowry. 2006. U.S. Pacific Marine Mammal Stock Assessments: 2005. U.S. Department of Commerce NOAA Technical Memorandum NOAA-TM-NMFS-SWFSC-388. 325p.
Clapham, P. J. 1994. Maturational changes in patterns of association among male and female humpback whales. Journal of Zoology 71:440-443.
Clapham, P. J. 1996. The social and reproductive biology of humpback whales: an ecological perspective. Mammal Review 26:27-49.
Clapham, P. J., L. S. Baraff, C. A. Carlson, M. A. Christian, D. K. Mattila, C. A. Mayo, M. A. Murphy, and S. Pittman. 1993. Seasonal occurrence and annual return of humpback whales, Megaptera novaeangliae, in the southern Gulf of Maine. Canadian Journal of Zoology 71(2):440-443.
Clapham, P. J. and D. K. Mattila. 1993. Reactions of humpback whales to skin biopsy sampling on a West Indies breeding ground. Marine Mammal Science 9(4):382-391.
Clapham, P. J. and C. A. Mayo. 1987. Reproduction and recruitment of individually identified humpback whales, *Megaptera novaeangliae*, observed in Massachusetts Bay, 1979-1985. Canadian Journal of Zoology 65:2853-2863.
Clapham, P. J. and C. A. Mayo. 1990. Reproduction of humpback whales (*Megaptera novaeangliae*) observed in the Gulf of Maine. Report of the International Whaling Commission Special Issue 12:171-175.
Darling, J. D. and H. Morowitz. 1986. Census of Hawaiian humpback whales (*Megaptera novaeangliae*) by individual identification. Canadian Journal of Zoology 64(1):105-111.
Dietrich, K. S., V. R. Cornish, K. S. Rivera, and T. A. Conant. 2007. Best practices for the collection of longline data to facilitate research and analysis to reduce bycatch of

protected species. NOAA Technical Memorandum NMFS-OPR-35. 101p. Report of a workshop held at the International Fisheries Observer Conference Sydney, Australia, November 8,.
Ford, J. K. B. and R. R. Reeves. 2008. Fight or flight: antipredator strategies of baleen whales. Mammal Review 38(1):50-86.
Frid, A. 2003. Dall's sheep responses to overflights by helicopter and fixed-wing aircraft. Biological Conservation 110:387-399.
Frid, A. and L. Dill. 2002. Human-caused disturbance stimuli as a form of predation risk. Conservation Ecology 6:11.
Gabriele, C. M., J. M. Straley, and J. L. Neilson. 2007. Age at first calving of female humpback whales in southeastern Alaska. Marine Mammal Science 23(1):226-239.
Gauthier, J. and R. Sears. 1999. Behavioral response of four species of balaenopterid whales to biopsy sampling. Marine Mammal Science 15(1):85-101.
Gauthier, J. M., C. D. Metcalfe, and R. Sears. 1997. Chlorinated organic contaminants in blubber biopsies from Northwestern Atlantic Balaenopterid whales summering in the Gulf of St Lawrence. Marine Environmental Research 44(2):201-223.
Gendron, D. and J. Urban. 1993. Evidence of feeding by humpback whales (Megaptera novaeangliae) in the Baja California breeding ground, Mexico. Marine Mammal Science 9:76-81.
Gill, J. A., K. Norris, and W. J. Sutherland. 2001. Why behavioural responses may not reflect the population consequences of human disturbance. Biological Conservation 97:265-268.
Glockner-Ferrari, D. A. and M. J. Ferrari. 1985. Individual identification, behavior, reproduction, and distribution of humpback whales, Megaptera novaeangliae, in Hawaii. U.S. Marine Mammal Commission, Washington, D.C.; National Technical Information Service, Springfield, Virginia: 36p.
Green, G. A., J. J. Brueggerman, R. A. Grotefendt, C. E. Bowlby, M. L. Bonnell, and K. C. Balcomb III. 1992. Cetacean distribution and abundance off Oregon and Washington, 1989-1990. Oregon and Washington Marine Mammal and Seabird Surveys. Minerals Management Service Contract Report 14-12-0001-30426.
Hain, J. H. W., G. R. Carter, S. D. Kraus, C. A. Mayo, and H. E. Winn. 1982. Feeding behavior of the humpback whale, *Megaptera novaeangliae*, in the western North Atlantic. Fishery Bulletin 80(2):259-268.
Hain, J. H. W., S. L. Ellis, R. D. Kenney, P. J. Clapham, B. K. Gray, M. T. Weinrich, and I. G. Babb. 1995. Apparent bottom feeding by humpback whales on Stellwagen Bank. Marine Mammal Science 11(4):464-479.
Hall, J. D. 1982. Prince William Sound, Alaska: Humpback whale population and vessel traffic study. Final Report, Contract No. 81-ABG-00265. NMFS, Juneau Management Office, Juneau, Alaska. 14p.
Henry, A. G., T. V. N. Cole, M. Garron, and L. Hall. 2011. Mortality and Serious Injury Determinations for Baleen Whale Stocks along the Gulf of Mexico, United States and Canadian Eastern Seaboards, 2005-2009. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 11-18; 24 p.
Hill, P. S. and D. P. DeMaster. 1998. Alaska marine mammal stock assessments, 1998.
Hooker, S. K., R. W. Baird, S. Al-Omari, S. Gowans, and H. Whitehead. 2001. Behavioral reactions of northern bottlenose whales (*Hyperoodon ampullatus*) to biopsy darting and tag attachment procedures. Fishery Bulletin 99(2):303-308.
IWC. 2007. Whale Population Estimates. International Whaling Commission. Accessed 02/07/2007 online at: http://www.iwcoffice.org/conservation/estimate.htm.
Jahoda, M., C. L. Lafortuna, N. Biassoni, C. Almirante, A. Azzellino, S. Panigada, M. Zanardelli, and G. N. Di Sciara. 2003. Mediterranean fin whale's (*Balaenoptera physalus*) response

to small vessels and biopsy sampling assessed through passive tracking and timing of respiration. Marine Mammal Science 19(1):96-110.
Jasny, M., J. Reynolds, C. Horowitz, and A. Wetzler. 2005. Sounding the depths II: The rising toll of sonar, shipping and industrial ocean noise on marine life. Natural Resources Defense Council, New York, New York.
Jensen, A. S. and G. K. Silber. 2003. Large Whale Ship Strike Database. U.S. Department of Commerce, NOAA Technical Memorandum. NMFS-OPR-25, 37 pp.
Johnson, J. H. and A. A. Wolman. 1984. The humpback whale, *Megaptera novaeangliae.* Marine Fisheries Review 46(4):30-37.
Jurasz, C. M. and V. Jurasz. 1979. Feeding modes of the humpback whale, Megaptera novaeangliae, in southeast Alaska. Scientific Reports of the Whales Research Institute, Tokyo 31:69-83.
Katona, S. K. and J. A. Beard. 1990. Population size, migrations and feeding aggregations of the humpback whale (*Megaptera novaeangliae*) in the western North Atlantic Ocean. Report of the International Whaling Commission (Special Issue 12):295-306.
Kenney, R. D., M. A. M. Hyman, and H. E. Winn. 1985. Calculation of standing stocks and energetic requirements of the cetaceans of the northeast United States Outer Continental Shelf. NOAA Technical Memorandum NMFS-F/NEC-41. 99pp.
Krieger, K. and B. L. Wing. 1984. Hydroacoustic surveys and identifications of humpback whale forage in Glacier Bay, Stephens Passage, and Frederick Sound, southeastern Alaska, Summer 1983. U.S. Department of Commerce, NMFS/NWC-66.
Lambertsen, R. H. 1986. Disease of the common fin whale (*Balaenoptera physalus*): Crassicaudiosis of the urinary system. Journal of Mammalogy 67(2):353-366.
Lambertsen, R. H. 1992. Crassicaudosis: a parasitic disease threatening the health and population recovery of large baleen whales. Rev. Sci. Technol., Off. Int. Epizoot. 11(4):1131-1141.
Levenson, C. and W. T. Leapley. 1978. Distribution of humpback whales (Megaptera novaeangliae) in the Caribbean determined by a rapid acoustic method. Journal of the Fisheries Research Board of Canada 35(8):1150-1152.
Lima, S. L. 1998. Stress and decision making under the risk of predation. . Advances in the Study of Behavior 27:215-290.
Lusseau, D. 2004. The hidden cost of tourism: detecting long-term effects of tourism using behavioral information. Ecology and Society 9(1):2.
Mattila, D. K. and P. J. Clapham. 1989. Humpback whales, Megaptera novaeangliae, and other cetaceans on Virgin Bank and in the northern Leeward Islands, 1985 and 1986. Canadian Journal of Zoology 67(9):2201-2211.
Mattila, D. K., P. J. Clapham, S. K. Katona, and G. S. Stone. 1989. Population composition of humpback whales, Megaptera novaeangliae, on Silver Bank, 1984. Canadian Journal of Zoology 67(2):281-285.
Mattila, D. K., P. J. Clapham, O. Vasquez, and R. S. Bowman. 1994. Occurrence, population composition, and habitat use of humpback whales in Samana Bay, Dominican Republic. Canadian Journal of Zoology 72(11):1898-1907.
Mikhalev, Y. A. 1997. Humpback whales *Megaptera novaeangliae* in the Arabian Sea. Marine Ecology Progress Series 149:13-21.
Mills, S. K. and J. H. Beatty. 1979. The propensity interpretation of fitness. Philosophy of Science 46:263-286.
Mitchell, E. and R. R. Reeves. 1983. Catch history, abundance and present status of northwest Atlantic humpback whales. Report of the International Whaling Commission (Special Issue 5):153-212.
Nemoto, T. 1957. Foods of baleen whales in the northern Pacific. . Scientific Reports of the Whales Research Institute, Tokyo 12:33-89.

NMFS. 1987. Marine Mammal Protection Act of 1972 - Annual Report 1986/87. National Marine Fisheries Service.
NMFS. 2005. Draft environmental impact statement for amending the Atlantic Large Whale Take Reduction Plan: Broad-based gear modifications. Draft EIS prepared by Industrial Economics, Incorporated, and NOAA's National Marine Fisheries Service.
NRC. 1994. Low-frequency sound and marine mammals, current knowledge and research needs. (National Research Council). National Academy Press, Washington, D.C.
NRC. 2000. Marine Mammals and low-frequency sound: Progress since 1994. National Research Council.
NRC. 2003. Ocean Noise and Marine Mammals.National Research Council: Committee on Potential Impacts of Ambient Noise in the Ocean on Marine Mammals.
NRC. 2005. Marine mammal populations and ocean noise: Determining when noise causes biologically significant events. National Academies Press, Washington, D.C.
O'Hara, T. M. and C. Rice. 1996. Polychlorinated biphenyls. Pp.71-86 In: Noninfectious Diseases of Wildlife, 2nd edition, A. Fairbrother, L.Locke, and G. Hoff (eds.). Iowa State University Press, Ames, Iowa.
Palsbøll, P. J., J. Allen, M. Bérubé, P. J. Clapham, T. P. Feddersen, R. R. Hudson, H. Jørgensen, S. Katona, A. H. Larsen, F. Larsen, J. Lien, D. K. Mattila, J. Sigurjónsson, R. Sears, T. Smith, R. Sponer, P. Stevick, and N. Øien. 1997. Genetic tagging of humpback whales. Nature 388:767-769.
Perry, S. L., D. P. DeMaster, and G. K. Silber. 1999. The Great Whales: History and Status of Six Species Listed as Endangered Under the U.S. Endangered Species Act of 1973. Marine Fisheries Review 61(1):1-74.
Price, W. S. 1985. Caribbean whaling: Historical perspective and current status. Sixth Biennial Conference on the Biology of Marine Mammals, 22-26 November Vancouver B.C. Canada. p.61.
Rasmussen, K., D. M. Palacios, J. Calambokidis, M. T. Saborío, L. D. Rosa, E. R. Secchi, G. H. Steiger, J. M. Allen, and G. S. Stone. 2007. Southern Hemisphere humpback whales wintering off Central America: insights from water temperature into the longest mammalian migration. Biology Letters 3:302-305.
Reeves, R. R., P. J. Clapham, and S. E. Wetmore. 2002. Humpback whale (*Megaptera novaeangliae*) occurrence near the Cape Verde Islands, based on American 19th century whaling records. Journal of Cetacean Research and Management 4(3):235-253.
Reeves, R. R., J. A. Khan, R. R. Olsen, S. L. Swartz, and T. D. Smith. 2001a. History of whaling in Trinidad and Tobago. Journal of Cetacean Research and Management 3(1):45-54.
Reeves, R. R., S. L. Swartz, S. E. Wetmore, and P. J. Clapham. 2001b. Historical occurrence and distribution of humpback whales in the eastern and southern Caribbean Sea, based on data from American whaling logbooks. Journal of Cetacean Research and Management 3(2):117-129.
Reiner, F., M. E. Dos Santos, and F. W. Wenzel. 1996. Cetaceans of the Cape Verde archipelago. Marine Mammal Science 12(3):434-443.
Rice, D. W. 1977. Synopsis of biological data on the sei whale and Bryde's whale in the eastern North Pacific. Report of the International Whaling Commission (Special Issue 1):92-97.
Rice, D. W. 1978. The humpback whale in the North Pacific: distribution, exploitation, and numbers. In K. S. Norris and R. R. Reeves (Editors), Report on a Workshop on Problems Related to Humpback Whales (*Megaptera novaeangliae*) in Hawaii. Contr. Rep. to U.S. Mar. Mammal Comm., NTIS PB-280-794.pp. 29–44.
Richardson, W. J., C. R. Greene, Jr., C. I. Malme, and D. H. Thomson. 1995. Marine mammals and noise. Academic Press, Inc., San Diego, CA.
Richter, C., S. Dawson, and E. Slooten. 2006. Impacts of commercial whale watching on male sperm whales at Kaikoura, New Zealand. Marine Mammal Science 22(1):46-63.

Romero, L. M. 2004. Physiological stress in ecology: lessons from biomedical research. Trends in Ecology and Evolution 19(5):249-255.
Ross, D. 1976. Mechanics of unterwater noise. Pergamon Press, New York.
Sapolsky, R. M., L. M. Romero, and A. U. Munck. 2000. How do glucocorticoids influence stress responses? Integrating permissive, suppressive, stimulatory, and preparative actions. Endocrine Reviews 21(1):55-89.
Scheidat, M., C. Castro, J. Gonzalez, and R. Williams. 2004. Behavioural responses of humpback whales (*Megaptera novaeangliae*) to whalewatching boats near Isla de la Plata, Machalilla National Park, Ecuador. Journal of Cetacean Research and Management 6(1):63-68.
Schwartz, F. J. 2003. Bilateral asymmetry in the rostrum of the smalltooth sawfish, *Pristis pectinata* (Pristiformes: Family Pristidae). Journal of the North Carolina Academy of Science 119(2):41-47.
Simmonds, M. P. and J. D. Hutchinson. 1996. The conservation of whales and dolphins. John Wiley and Sons, Chichester, U.K.
Smith, T. D., J. Allen, P. J. Clapham, P. S. Hammond, S. Katona, F. Larsen, J. Lien, D. Mattila, and P. J. Palsbøll. 1999. An ocean-basin-wide mark-recapture study of the North Atlantic humpback whale (*Megaptera novaeangliae*). Marine Mammal Science 15(1):1-32.
Smith, T. D. and D. G.Pike. 2009. The enigmatic whale: the North Atlantic humpback. Nammco Scientific Publications 7:161-178.
Smith, T. D. and R. R. Reeves. 2003. Estimating American 19th century catches of humpback whales in the West Indies and Cape Verde Islands. Caribbean Journal of Science 39(3):286-297.
Stearns, S. C. 1992. The evolution of life histories.Oxford University Press, 249p.
Stevick, P., J. Allen, P. J. Clapham, N. Friday, S. K. Katona, F. Larsen, J. Lien, D. K. Mattila, P. J. Palsbøll, J. Sigujónsson, T. D. Smith, N. Øien, and P. S. Hammond. 2003a. North Atlantic humpback whale abundance and rate of increase four decades after protection from whaling. Marine Ecology Progress Series 258:263-273.
Stevick, P. T., J. Allen, M. Berube, P. J. Clapham, S. K. Katona, F. Larsen, J. Lien, D. K. Mattila, Palsbøll, J. Robbins, J. Sigurjónsson, T. D. Smith, N. Øien, and P. S. Hammond. 2003b. Segregation of migration by feeding ground origin in North Atlantic humpback whales (*Megaptera novaeangliae*). Journal of Zoology 259:231-237.
Swartz, S. L., T. Cole, M. A. McDonald, J. A. Hildebrand, E. M. Oleson, A. Martinez, P. J. Clapham, J. Barlow, and M. Jones. 2003. Acoustic and visual survey of humpback whales (*Megaptera novaeangliae*) distribution in the Eastern and Southeastern Caribbean Sea. Caribbean Journal of Science 39(2):195-208.
Tomilin, A. G. 1967. Mammals of the USSR, and adjacent countries. Volume 9, Cetacea. Israel Program Sci. Transl. No. 124, National Technical Information Service TT 65-50086. Springfield, Virginia (Translation of Russian text published in 1957).
Tyack, P. L. 1981. Interactions between singing Hawaiian humpback whales and conspecifics nearby. Behavioral Ecology and Sociobiology 8:105-116.
Tynan, C. T., D. G. Ainley, J. A. Barth, T. J. Cowles, S. D. Pierce, and L. B. Spear. 2005. Cetacean distributions relative to ocean processes in the northern California Current System. Deep-Sea Research II 52:145-167.
Walker, B. G., P. D. Boersma, and J. C. Wingfield. 2005. Physiological and behavioral differences in magellanic Penguin chicks in undisturbed and tourist-visited locations of a colony. Conservation Biology 19(5):1571-1577.
Waring, G. T., R. M. Pace, J. M. Quintal, C. P. Fairfield, and K. Maze-Foley. 2004. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments - 2003. NOAA Technical Memorandum NMFS-NE-182:Woods Hole, Massachusetts, 300p.

Watkins, W. A., K. E. Moore, D. Wartzok, and J. H. Johnson. 1981. Radio tracking of finback (Balaenoptera physalus), and humpback (Megaptera novaeangliae) whales in Prince William Sound, Alaska, USA. Deep Sea Research Part A. Oceanographic Research Papers 28(6):577-588.

Weinrich, M. T., J. Bove, and N. Miller. 1993. Return and survival of humpback whale (*Megaptera novaeangliae*) calves born to a single female in three consecutive years. Marine Mammal Science 9(3):325-328.

Weinrich, M. T., R. H. Lambertsen, C. S. Baker, M. R. Schilling, and C. R. Belt. 1991. Behavioral responses of humpback whales (*Megaptera novaeangliae*) in the southern Gulf of Maine to biopsy sampling. Report of the International Whaling Commission (Special Issue 13):91-98.

Weinrich, M. T., R. H. Lambertsen, C. R. Belt, M. Schilling, H. J. Iken, and S. E. Syrjala. 1992. Behavioral reactions of humpback whales *Megaptera novaeangliae* to biopsy procedures. Fishery Bulletin 90:588-598.

Weir, C. R. 2007. Observations of marine turtles in relation to seismic airgun sound off Angola. Marine Turtle Newsletter 116:17-20.

Whitehead, H. and C. Glass. 1985. Orcas (killer whales) attack humpback whales. (Orcinus orca). Journal of Mammalogy 66(1):183-185.

Whitehead, H. and M. J. Moore. 1982. Distribution and movements of West Indian humpback whales in winter. (Megaptera novaeangliae). Canadian Journal of Zoology 60(9):2203-2211.

Winn, H. E., R. K. Edel, and A. G. Taruski. 1975. Population estimate of the humpback whale in the West Indies by visual and acoustic techniques. Journal of the Fisheries Research Board of Canada 32:499–506.

Winn, H. E. and N. E. Reichley. 1985. Humpback whale - *Megaptera novaeangliae*. Handbook of Marine Mammals: Vol. 3 The Sirenians and Baleen Whales:241-274.

Wursig, B., S. K. Lynn, T. A. Jefferson, and K. D. Mullin. 1998. Behaviour of cetaceans in the northern Gulf of Mexico relative to survey ships and aircraft. Aquatic Mammals 24(1):41-50.