Appendix C

Application for National Marine Fisheries Service Incidental Harassment Authorization

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Application for Incidental Harassment Authorization for the Non-Lethal Taking of Whales and Seals in Conjunction with Planned 2010 Exploration Drilling Program Chukchi Sea, Alaska

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Executive Summary

As described herein, during the 2010 drilling season, Shell Gulf of Mexico Inc. (Shell) plans to drill up to three exploration wells at three drill sites in the Chukchi Sea on Outer Continental Shelf (OCS) leases acquired from the U.S. Minerals Management Service (MMS). Shell plans to use the M/V *Frontier Discoverer (Discoverer)* drillship, attended by a minimum of seven support vessels for the purposes of ice management, anchor handling, oil spill response (OSR), refueling, and resupply.

The *Discoverer* is an industry-standard, ice-reinforced drillship similar to those routinely used in the Beaufort and Chukchi Seas since the 1980s, as well as elsewhere in the world's oceans. During drilling and associated operations, the drillship will emit near continuous non-pulse sounds that ensonify only very limited areas of the ocean bottom and intervening water column.

Since the early 1990s, the National Marine Fisheries Service (NMFS) has issued incidental harassment authorizations (IHAs) to industry for the non-lethal taking of small numbers of marine mammals related to the non-pulse, continuous sounds generated by offshore exploration drilling. Shell requests an Incidental Harassment Authorization (IHA) pursuant to Section 101 (a) (5) (D) of the Marine Mammal Protection Act (MMPA), 16 U.S.C. § 1371 (a) (5), to allow non-lethal takes of whales and seals incidental to the exploration drilling program.

Shell has calculated the estimated take of marine mammals from the low-level non-pulse sound generating sources active during drilling and ice management operations and, as detailed herein, determined that any takes that might result from the planned operations would not be of biological significance to marine mammal populations.

The only anticipated impacts to marine mammals associated with the drilling exploration program that might result in a take are propagation of sounds from the drillship, ice management, support vessels, and aircraft. Any impacts to whales and seals would be temporary and result in only short-term displacement of seals and whales from within ensonified zones produced by such sound sources.

For example, an impact analysis of underwater sound generated by the planned 2010 exploration drilling program (included herein) determined that only five bowhead whales and 18 gray whales would be exposed to sounds ≥160 decibels (dB) re 1 µPa rms equaling <1 percent of the respective populations. An even smaller percentage of the ringed, bearded, and spotted seal populations in the Chukchi Sea would be exposed to underwater sounds in excess of 160 dB. Similarly small numbers of beluga whales and killer whales may be exposed. The small numbers of other whale species (e.g. narwhal, fin whale, humpback whale, minke whale) and seals (e.g. ribbon seal) that may occur in the Chukchi Sea are unlikely to be present around the planned exploration drilling activities. In regard to the subsistence harvest of bowhead whale in the Chukchi Sea, as a consequence of Shell's planned mitigation measures any effects on the bowhead whale as a subsistence resource also will be negligible. From a historical perspective, the temporary activity of offshore exploration drilling and associated support vessel activities, collectively and individually, have not resulted in impacts of biological significance to marine mammals of the Arctic, or interference with the subsistence harvest of those marine mammals by the residents of the communities along the Beaufort and Chukchi Seas.

The organization of this request for IHA follows the organization of Chapter 50 Code of Federal Regulations (CFR) 216.104 (a). The remainder of this document is organized as to follow 50CFR§216.104 (a) (1)-(14).

Shell used the following guidance to prepare its request for Incidental Harassment Authorization (IHA).

> 50 CFR 216.104 "Submission of Requests"
>
> (a) In order for the National Marine Fisheries Service (NMFS) to consider authorizing the taking by U.S. citizens of small numbers of marine mammals incidental to a specified activity (other than commercial fishing), or to make a finding that incidental take is unlikely to occur, a written request must be submitted to the Assistant Administrator. All requests must include the following information for their activity:

1. A detailed description of the specific activity or class of activities that can be expected to result in incidental taking of marine mammals:

Information required by 50 CFR§216.104 (a):

Shell plans to conduct an exploration drilling program on U.S. Department of the Interior, Minerals Management Service (MMS) Alaska Outer Continental Shelf (OCS) leases greater than 60 statute miles (mi) [97 kilometers (km)] from the Chukchi Sea coast during the 2010 drilling season (Chukchi Sea 2010 Exploration Drilling Program, hereinafter, the*" drilling program")* (Figure 1-1).

The leases were acquired during the Chukchi Sea Oil and Gas Lease Sales 193 held in February 2008. During the 2010 drilling program Shell plans to drill up to three exploration wells at five possible drill sites on seven possible leases at the prospects known as Burger, Crackerjack, and Southwest Shoebill (Table 1-1). All drilling is planned to be near vertical.

TABLE 1-1. CHUKCHI SEA 2010 EXPLORATION DRILLING PROGRAM – LEASE BLOCKS

Prospect	Protraction	Area	Block	Lease
Burger	NR03-02	Posey	6713	OCS-Y-2266
Burger	NR03-02	Posey	6714	OCS-Y-2267
Burger	NR03-02	Posey	6763	OCS-Y-2279
Burger	NR03-02	Posey	6764	OCS-Y-2280
Burger	NR03-02	Posey	6912	OCS-Y-2321
Crackerjack	NR03-01	Karo	6864	OCS-Y-2111
SW Shoebill	NR03-01	Karo	7007	OCS-Y-2142

The ice reinforced drillship *Discoverer* will be used to drill the wells. Specifications for the *Discoverer* are located in Attachment A. While on location at the drill sites, the *Discoverer* will be affixed to the seafloor using eight 7-ton Stevpris anchors arranged in a radial array.

During the 2010 drilling season, the *Discoverer* will be attended by a minimum of seven vessels that will be used for ice management, anchor handling, oil spill response (OSR), refueling, resupply, and servicing of the drilling operations (Table 1-2).

Resupply between the drill sites and logistics facilities at Dutch Harbor will use a coastwise qualified offshore supply vessel. An ice-capable OSR vessel (OSRV), the *Nanuq*, will be dedicated to Chukchi Sea operations and remain in the vicinity of the drillship when drilling into liquid hydrocarbon zones. An OSR barge (OSRB), with an associated tug, will be staged in the nearshore zone, and an OSR tanker

(OST), the *Affinity*, will be staged to respond to a discharge and provide storage capability for recovered liquids, if necessary.

TABLE 1-2. CHUKCHI SEA 2010 EXPLORATION DRILLING PROGRAM – PROPOSED VESSEL AND AIRCRAFT LIST

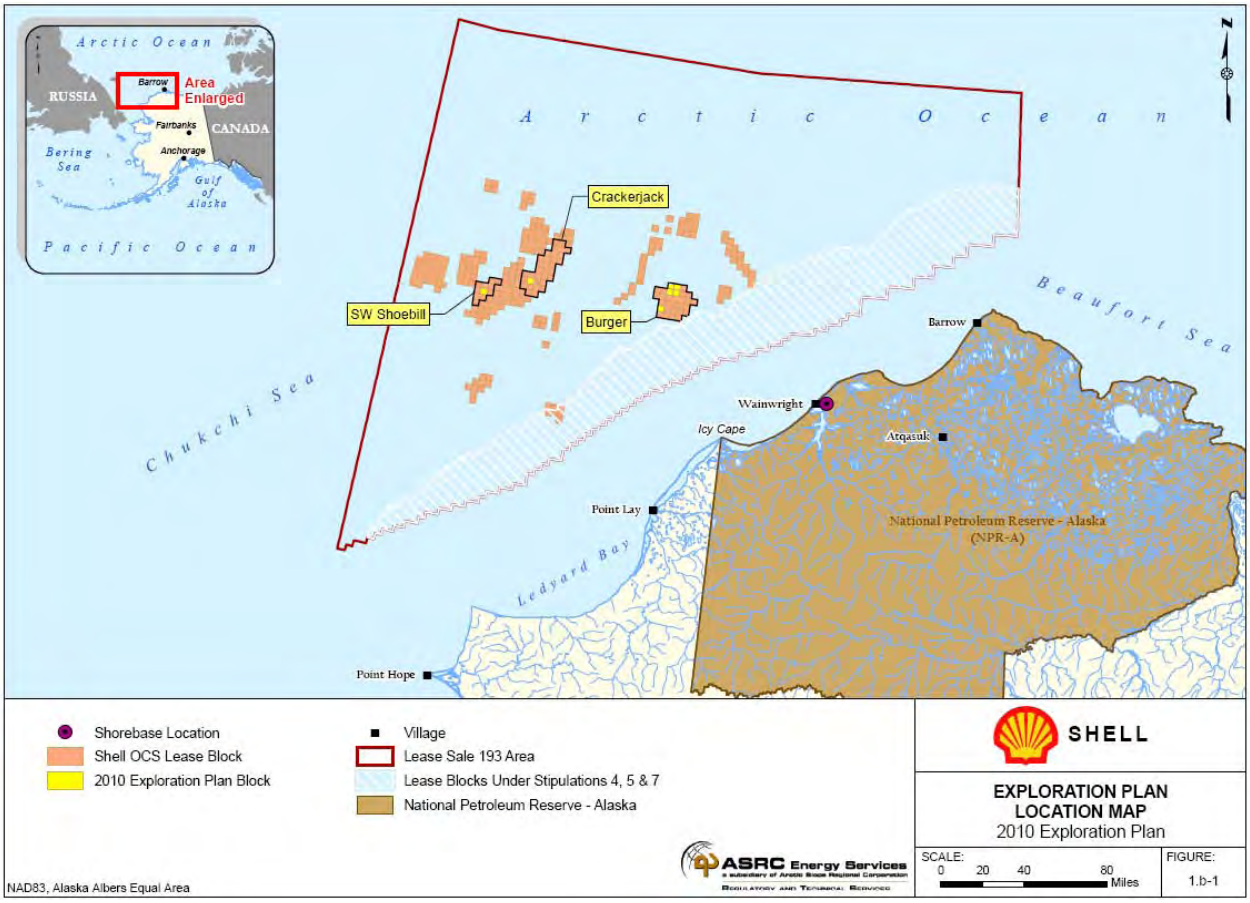
Vessel	Trip Frequency or Duration
Drillship and Drill Support (or similar)	
Frontier Discoverer	Stays in the prospect area throughout 2010 drilling season
Vladimir Ignatjuk – primary ice management vessel	Stays generally upwind of the drillship from 3-25 miles away throughout the 2010 drilling season
Tor Viking – anchor handler	Stays in the area of the drillship throughout the 2010 drilling season
Offshore supply boat	2-4 round trips between Dutch harbor and the drill sites in Chukchi Sea
Oil Spill Response Fleet (or similar)	
Nanuq - OSR vessel	Stays in the area of the drillship throughout the 2010 drilling season
Endeavor -OSRB with associated ice class tug	Will be located near the Chukchi Sea coastline throughout the 2010 drilling season
OSR Workboats (4)	Stays in the area of the drillship throughout the 2010 drilling season
Affinity (OSR Tanker) – recovered liquid storage and diesel fuel supply vessel	Stays in the area of the drillship throughout the 2010 drilling season
Aircraft (or similar)	
AW 139 or EC 255 - crew rotation	Approximately 30 trips per month between land and offshore vessels throughout the 2010 drilling season
Sikorsky 61 helicopter – search-and-rescue	Trips made only in emergency; training flights

The *Discoverer* and associated support vessels will transit through the Bering Strait into the Chukchi Sea on or about July 1, arriving on location in the Chukchi Sea 3-4 days later. Drilling will then commence on or about July 4, as ice, weather, and other conditions allow for safe drilling operations, and may last until October 31.

Helicopters are planned to provide support for crew change, provision re-supply, and search-and-rescue operations during the drilling season.

At the end of the drilling season, the *Discoverer*, ice management vessels, and support vessels will transit south out of the Chukchi Sea through the Bering Strait into the Bering Sea to Dutch Harbor, Alaska.

Figure 1-1 Exploration Plan Location Map



Planned Mitigation

The *Discoverer* and all support vessels will operate in accordance with the provisions of a Plan of Cooperation (POC). Shell prepared a POC to mitigate effects of Shell's planned exploration drilling program where activities would take place in or near a traditional Arctic subsistence hunting area and/or may affect the availability of a species or stock of marine mammal for Arctic subsistence uses. The POC was prepared in consultation with affected Chukchi Sea communities and marine mammal associations. During these meetings, Shell focused on lessons learned from prior years activities and presented mitigation measures for avoiding potential conflicts, which are outlined in the 2010 POC. Shell's POC addresses the issues of vessel transit, drilling and associated activities. The mitigation measures described in Section 12.3 are intended to minimize any adverse effects on the availability of marine mammals for subsistence uses.

2. The dates and duration of such activity and the specific geographic region where it will occur:

Anticipated Duration of this Permit

Shell anticipates that the IHA issued by NMFS for the planned Chukchi Sea 2010 exploration drilling program will be valid for one year from the date of issuance.

Timing of Mobilization and Demobilization of the *Discoverer*

Shell's base plan is for the ice management vessel, the M/V *Vladimir Ignatjuk* and the anchor handler M/V *Tor Viking*, to accompany the *Discoverer* traveling north from Dutch Harbor through the Bering Strait, on or about July 1, 2010, then into the Chukchi Sea, before arriving on location approximately July 4th. Exploration drilling is expected to be complete by October 31. At the end of the drilling season, these support vessels, along with various other support vessels will accompany the *Discoverer* as it travels south out of the Chukchi Sea, through the Bering Strait to Dutch Harbor, Alaska. Subject to ice conditions alternate exit routes may be considered.

Exploration Drilling

The three Shell prospects included in the 2010 EP are Burger, SW Shoebill and Crackerjack (Fig.1). Shell has identified a total of seven 2010 Exploration Plan (EP) lease blocks (Table 1-1 and Fig. 1-1) on these three prospects. All of the seven leases listed on Table 1-1 are located more than 60 statute mi (97 km) off the coast in the Chukchi Sea. During the 2010 exploration season, the *Discoverer* will be used to drill up to three exploration wells on three of the seven possible leases (Table 1-1). For its 2010 exploration drilling program, Shell will mobilize into the Chukchi Sea on or about July 1, and commence drilling at the Burger prospect as soon as ice, weather, and other conditions allow for safe drilling operations. In the event ice and weather conditions prevent the *Discoverer* from reaching the Burger prospect, Shell will mobilize its exploration operations to one of the alternative drill sites in the SW Shoebill or Crackerjack prospects.

Activities associated with the 2010 Chukchi Sea exploration drilling program and analyzed herein include operation of the *Discoverer*, associated support vessels, crew change support and resupply. The *Discoverer* will remain at the location of the designated exploration drill sites except when mobilizing and demobilizing to and from the Chukchi Sea, transiting between drill sites, and temporarily moving off location if it is determined ice conditions require such a move to ensure the safety of personnel and/or the environment in accordance to Shell's Ice Management Plan. The anchor handler and OSR vessels will remain in close proximity to the drillship during drilling operations as indicated above in Table 1-2. The

ice management vessel will generally be working upwind of the drillship from 3-25 miles away. Crew change/resupply vessels will transit to and from the drillship at the estimated frequencies shown in Table 1-2. Helicopter flight support will provide crew changes. Fixed-wing aircraft will transport crews to regional hub airports, and to support aerial survey's for the marine mammal monitoring program.

Shell plans to cease drilling on or before October 31, after which the *Discoverer* will exit the Alaskan Chukchi Sea. Shell anticipates that the exploration drilling program will require approximately 37 days per well including mudline cellar construction. These estimates exclude any down-time for weather or other operational delays. Shell also assumes approximately 10 additional days will be needed for transit, drillship mobilization and mooring, drillship moves between locations, and drillship demobilization.

3. Species and Numbers of Marine Mammals in Area

Marine mammals that occur in the area of the planned exploration drilling activities belong to three taxonomic groups: odontocetes (toothed cetaceans, such as beluga whale and narwhal), mysticetes (baleen whales), and carnivora (pinnipeds and polar bears). Cetaceans and pinnipeds (except Pacific walrus) are the subject of this IHA application to NMFS. In the U.S., Pacific walrus and polar bear are managed by the U.S. Fish & Wildlife Service and these species are not discussed further in this application.

Marine mammal species under the jurisdiction of NMFS that are known to or may occur in the area of the planned exploration drilling activity include nine cetacean species and four species of pinnipeds (Table 3-1). Three of these species, the bowhead, humpback and fin whales, are listed as "Endangered" under the Endangered Species Act. Bowhead whale is more common in the area than the other two species. The fin whale is unlikely to be encountered near the planned drilling activities, but a few sightings in the Chukchi Sea have been reported in recent years. Similarly, humpback whales are not known to regularly occur in the Chukchi Sea, but several humpback sightings were recorded during vessel-based surveys in the Chukchi Sea in 2007 (Reiser et al. 2009). A single humpback whale sighting was recorded in the Beaufort Sea east of Barrow in 2007 (Green et al. 2007) suggesting that humpback whale use of Arctic waters may be increasing.

To avoid redundancy, we have included the required information about the species that are known to or may be present and, insofar as they are known, numbers of these species in Section 4, below.

TABLE 3-1. THE HABITAT, ABUNDANCE , AND CONSERVATION STATUS OF MARINE MAMMALS INHABITING THE AREA

Species	Habitat	Abundance	ESA[1]	IUCN[2]	CITES[3]
Odontocetes					
Beluga whale (*Delphinapterus leucas*)	Offshore, Coastal, Ice edges	50,000[4] 39,257[5]	Not listed	VU	
Narwhal (*Monodon monoceros*)	Offshore, Ice edge	Rare[6]	Not listed	DD	II
Killer whale (*Orcinus orca*)	Widely distributed	Rare	Not listed	LR-cd	II
Harbor Porpoise (*Phocoena phocoena*)	Coastal, inland waters, shallow offshore waters	Common[7]	Not listed	VU	II
Mysticetes					
Bowhead whale (*Balaena mysticetus*)	Pack ice & coastal	10,545[8]	Endangered	LR-cd	I
Gray whale (*Eschrichtius robustus*) (eastern Pacific population)	Coastal, lagoons	488[9] 17,500[10]	Not listed	LR-cd	I

Species	Habitat	Abundance	ESA[1]	IUCN[2]	CITES[3]
Minke whale (*Balaenoptera acutorostrata*)	Shelf, coastal	Small numbers	Not listed	LR-cd	I
Fin whale (*Balaenoptera physalus*)	Slope, mostly pelagic	Rare	Endangered	EN	I
Humpback whale (*Megaptera novaeangliae*)	Shelf, coastal	Rare	Endangered	–	–
Pinnipeds Bearded seal (*Erignathus barbatus*)	Pack ice	300,000-450,000[11] 4863[12]	In review for listing	–	–
Spotted seal (*Phoca largha*)	Pack ice, coastal haulouts	59,214[13]	In review for listing	–	–
Ringed seal (*Pusa hispida*)	Landfast & pack ice	Up to 3.6 million [14] ~208,000-252,000[15]	In review for listing	–	–
Ribbon seal (*Histriophoca fasciata*)	Offshore, pack ice	90-100,000[16]	In review for listing	–	–

[1] U.S. Endangered Species Act.
[2] IUCN Red List of Threatened Species (2003). Codes for IUCN classifications: CR = Critically Endangered; EN = Endangered; VU = Vulnerable; LR = Lower Risk (-cd = Conservation Dependent; -nt = Near Threatened; -lc = Least Concern); DD = Data Deficient.
[3] Convention on International Trade in Endangered Species of Wild Fauna and Flora (UNEP-WCMC 2004).
[4] Total Western Alaska population, including Beaufort Sea animals that occur there during migration and in winter (Small and DeMaster 1995).
[5] Beaufort Sea population (IWC 2000).
[6] Population in Baffin Bay and the Canadian arctic archipelago is ~60,000 (DFO 2004); very few enter the Beaufort Sea.
[7] Vessel-based observations from Industry activities in 2006–2007 (Reiser et al. 2009)
[8] Abundance of bowheads surveyed near Barrow, as of 2001 (George et al. 2004); revised to 10,545 by Zeh and Punt (2005).
[9] Southern Chukchi Sea and northern Bering Sea (Clark and Moore 2002).
[10] North Pacific gray whale population (Rugh 2003 *in* Keller and Gerber 2004) ; see also Rugh et al. (2005).
[11] Alaska population (USDI/MMS 1996).
[12] Eastern Chukchi Sea population (NMML, unpublished data).
[13] Alaskan population (from Rugh et al. 1995 and Lowry et al. 2004 *in* Angliss and Outlaw 2008).
[14] Alaska estimate (Frost et al. 1988 *in* Angliss and Outlaw 2008).
[15] Bering/Chukchi Sea population (Bengtson et al. 2005).
[16] Burns, J.J. 1981a.

4. Status, Distribution and Seasonal Distribution of Affected Species or Stocks of Marine Mammals

Sections 3 and 4 are integrated here to minimize repetition.

Marine mammal species under NMFS jurisdiction most likely to occur in the area of the planned exploration drilling activities in the Chukchi Sea include four cetacean species (beluga, bowhead and gray whales, and harbor porpoise), and three pinniped species (ringed, bearded, and spotted seals). Densities of marine mammals in the area of operations are likely to be higher if the ice edge occurs nearby. The marine mammal species that is likely to be encountered most widely (in space and time) throughout the period of the exploration drilling activities is ringed seal. Encounters with bowhead and gray whales are expected to be limited to particular seasons, as discussed below.

Five additional cetacean species—the narwhal, killer whale, minke whale, humpback whale, and fin whale—could occur, but each of these species is uncommon or rare in the project area and relatively few encounters with these species are expected during the exploration drilling program. The narwhal occurs in Canadian waters and occasionally occurs in the Alaskan Beaufort Sea and the Chukchi Sea, but is considered extralimital in US waters and is not expected to be encountered.

(1) Odontocetes

(a) Beluga (*Delphinapterus leucas*)

The beluga whale is an arctic and subarctic species that includes several populations in Alaska and northern European waters. It has a circumpolar distribution in the Northern Hemisphere and occurs between 50º and 80ºN latitude (Reeves et al. 2002). It is distributed in seasonally ice-covered seas and migrates to warmer coastal estuaries, bays, and rivers in summer for molting (Finley 1982).

In Alaska, beluga whales comprise five distinct stocks: Beaufort Sea, eastern Chukchi Sea, eastern Bering Sea, Bristol Bay, and Cook Inlet (O'Corry-Crowe et al. 1997). For the planned project, only the Beaufort Sea and eastern Chukchi Sea stocks may be encountered.

The ***Beaufort Sea population*** was estimated to contain 39,258 individuals as of 1992 (Angliss and Outlaw 2008). Beluga whales of the Beaufort Sea stock winter in the Bering Sea, summer in the eastern Beaufort Sea, and migrate in offshore waters of western and northern Alaska (Angliss and Outlaw 2008). The majority of belugas in the Beaufort Sea stock migrate through the Chukchi Sea and into the Beaufort Sea in April or May, although some whales may pass Point Barrow as early as late-March and as late as July (Braham et al. 1984; Ljungblad et al. 1984; Richardson et al. 1995). Beluga whales associated with the Beaufort Sea population would be most likely to occur near the planned drilling activities during fall migration through the Chukchi Sea in October.

The most recent estimate of the ***eastern Chukchi Sea*** population is 3710 animals (Angliss and Outlaw 2008). This estimate was based on surveys conducted in 1989–1991. Survey effort was concentrated on the 106 mi (170 km) long Kasegaluk Lagoon where belugas are found during the open-water season. The actual number of beluga whales recorded during the surveys was much lower. Correction factors to account for animals that were underwater and for the proportion of newborns and yearlings that were not observed due to their small size and dark coloration were used to calculate the estimate. The calculation was considered to be a minimum population estimate for the eastern Chukchi Sea stock because the surveys on which it was based did not include offshore areas where belugas are also likely to occur. This population is considered to be stable. It is assumed that beluga whales from the eastern Chukchi stock winter in the Bering Sea (Angliss and Outlaw 2008).

Although beluga whales are known to congregate in Kasegaluk Lagoon during summer, evidence from a small number of satellite-tagged animals suggests that some of these whales may subsequently range into the Arctic Ocean north of the Beaufort Sea. Suydam et al. (2005) put satellite tags on 23 beluga whales captured in Kasegaluk Lagoon in late June and early July 1998–2002. Five of these whales moved far into the Arctic Ocean and into the pack ice to 79–80°N latitude. These and other whales moved to areas as far as 685 mi (1,100 km) offshore between Barrow and the Mackenzie River Delta spending time in water with 90 percent ice coverage.

During aerial surveys in nearshore areas ~23 mi (~37 km) offshore in the Chukchi Sea in 2006 and 2007, peak beluga sighting rates were recorded in July. Lowest monthly sighting rates were recorded in September (Thomas et al. 2009). When data from the two years were pooled, beluga whale sighting rates and number of individuals were highest in the band 16-22 mi (25-35 km) offshore. However the largest single groups were sighted at locations near shore in the band within 3 mi (5 km) of the shoreline.

Beluga whales from the eastern Chukchi Sea stock are an important subsistence resource for residents of the village of Point Lay, adjacent to Kasegaluk Lagoon, and other villages in northwest Alaska. Each year, hunters from Point Lay drive belugas into the lagoon to a traditional hunting location. The belugas have been predictably sighted near the lagoon from late-June through mid- to late-July (Suydam et al. 2001). In 2007, approximately 70 belugas were also harvested at Kivalina located southeast of Point Hope.

Pod structure in beluga groups appears to be along matrilineal lines, with males forming separate aggregations. Small groups are often observed traveling or resting together. Belugas often migrate in groups of 100 to 600 animals (Braham and Krogman 1977). The relationships between whales within groups are not known, although hunters have reported that belugas form family groups with whales of different ages traveling together (Huntington 2000).

Belugas of the eastern Chukchi Sea population could occur in the vicinity of the planned drilling activities throughout the summer months. Based on the results of satellite telemetry data at least some of this stock may also pass the project area during fall migration; however, data from Thomas et. al. (2009) suggests the highest concentration of Belugas may be expected to occur much closer to shore than Shell's planned drilling activities.

(b) Narwhal (*Monodon monoceros*)

Narwhals have a discontinuous Arctic distribution (Hay and Mansfield 1989; Reeves et al. 2002). A large population inhabits Baffin Bay, West Greenland, and the eastern part of the Canadian Arctic Archipelago, while much smaller numbers inhabit the Northeast Atlantic/East Greenland area. Population estimates for the narwhal are scarce, and the IUCN-World Conservation Union lists the species as Data Deficient (IUCN Red List of Threatened Species 2003). Innes et al. (2002) estimated a population size of 45,358 narwhals in the Canadian Arctic although little of the area was surveyed. There are scattered records of narwhal in Alaskan waters where the species is considered extralimital (Reeves et al. 2002). Thus, it is possible, but very unlikely, that individuals could be encountered in the area of the planned exploration drilling activities in the Chukchi Sea.

(c) Killer Whale (*Orcinus orca*)

Killer whales are cosmopolitan and globally fairly abundant. The killer whale is very common in temperate waters, but it also frequents the tropics and waters at high latitudes. Killer whales appear to prefer coastal areas, but are also found in deep water (Dahlheim and Heyning 1999). The greatest abundance is thought to be within 497 mi (800 km) of major continents (Mitchell 1975) and the highest densities occur in areas with abundant prey. Both resident and transient stocks have been described. These are believed to differ in several aspects of morphology, ecology, and behavior including dorsal fin shape, saddle patch shape, pod size, home range size, diet, travel routes, dive duration, and social integrity of pods (Angliss and Outlaw 2008).

Killer whales are known to inhabit almost all coastal waters of Alaska, extending from southeast Alaska through the Aleutian Islands to the Bering and Chukchi seas (Angliss and Outlaw 2008). Killer whales probably do not occur regularly in the Beaufort Sea although sightings have been reported (Lowry et al. 1987, George and Suydam 1998). George et al. (1994) reported that they and local hunters see a few killer whales at Point Barrow each year. Killer whales are more common southwest of Barrow in the southern Chukchi Sea and the Bering Sea. Based on photographic techniques, ~100 animals have been identified in the Bering Sea (ADFG 1994). Killer whales from either the North Pacific resident or transient stock could occur in the Chukchi Sea during the summer or fall. The number of killer whales likely to occur in the Chukchi Sea during the planned activity is unknown. Marine mammal observers (MMOs) onboard industry vessels in the Chukchi Sea recorded one killer whale sighting in 2006 and two sightings in 2007 (Reiser et al. 2009).

(d) Harbor Porpoise (*Phocoena phocoena*)

The harbor porpoise is a small odontocete that inhabits shallow, coastal waters—temperate, subarctic, and arctic—in the Northern Hemisphere (Read 1999). Harbor porpoises occur mainly in shelf areas where they can dive to depths of at least 722 ft (220 m) and stay submerged for more than 5 minutes (Harwood

and Wilson 2001) feeding on small schooling fish (Read 1999). Harbor porpoises typically occur in small groups of only a few individuals and tend to avoid vessels (Richardson et al. 1995).

The subspecies *Pnocoena phocoena vomerina* ranges from the Chukchi Sea, Pribilof Islands, Unimak Island, and the south-eastern shore of Bristol Bay south to San Luis Obispo, California. Point Barrow, Alaska, is the approximate northeastern extent of their regular range (Suydam and George 1992), though there are extralimital records east to the mouth of the Mackenzie River in the Northwest Territories, Canada and recent sightings in the Beaufort Sea in the vicinity of Prudhoe Bay during surveys in 2007 and 2008 (Lyons et al. 2009; LGL Limited, unpublished data).

Although separate harbor porpoise stocks for Alaska have not been identified, Alaskan harbor porpoises have been divided into three groups for management purposes. These groups include animals from southeast Alaska, Gulf of Alaska, and Bering Sea populations. Harbor porpoises present in the Chukchi Sea belong to the Bering Sea group, which includes animals from Unimak Pass northward. Based on aerial surveys in 1999, the Bering Sea population was estimated at 66,078 animals, although this estimate is likely conservative as the surveyed area did not include known harbor porpoise range near the Pribilof Islands or waters north of Cape Newenhan (~55°N latitude; Angliss and Outlaw 2008). Suydam and George (1992) suggested that harbor porpoises occasionally occur in the Chukchi Sea and reported nine records of harbor porpoise in the Barrow area in 1985–1991. More recent vessel-based surveys in the Chukchi Sea found that the harbor porpoise was one of the most abundant cetaceans during summer and fall from 2006–2008 (Haley et al. 2009; Reiser et al. 2009).

Based on recent surveys the harbor porpoise is likely to be one of the most abundant cetaceans encountered throughout the Chukchi Sea and is likely to occur in the vicinity of the planned exploration drilling activities.

(2) Mysticetes

(a) Bowhead Whale (*Balaena mysticetus*)

Bowhead whales only occur at high latitudes in the northern hemisphere and have a disjunct circumpolar distribution (Reeves 1980). The bowhead is one of only three whale species that spend their entire lives in the Arctic. Bowhead whales are found in the western Arctic (Bering, Chukchi, and Beaufort seas), the Canadian Arctic and West Greenland (Baffin Bay, Davis Strait, and Hudson Bay), the Okhotsk Sea (eastern Russia), and the Northeast Atlantic from Spitzbergen westward to eastern Greenland. Four stocks are recognized for management purposes. The largest is the Western Arctic or Bering–Chukchi–Beaufort (BCB) stock, which includes whales that winter in the Bering Sea, and migrate through the Bering Strait, Chukchi Sea, and Alaskan Beaufort Sea to the Canadian Beaufort Sea, where they feed during the summer. These whales migrate west through the Alaskan Beaufort Sea in the fall as they return to wintering areas in the Bering Sea. Satellite tracking data reported by the Alaska Department of Fish and Game (ADF&G) indicate that most bowhead whales continue migrating west past Barrow and through the northern Chukchi Sea to Russian waters before turning south toward the Bering Sea (Quakenbush 2009). Information on the ADF&G bowhead satellite tracking program is available online at http://www.wc.adfg.state.ak.us/index.cfm?adfg=marinemammals.bowhead. Other researchers have also reported a westward movement of bowhead whales through the northern Chukchi Sea during fall migration (Moore et al. 1995; Mate et al. 2000).

The pre-exploitation population of bowhead whales in the Bering, Chukchi, and Beaufort seas is estimated to have been 10,400-23,000 whales. Commercial whaling activities in the late-1800s and early-1900s may have reduced this population to as few as 3000 animals (Woodby and Botkin 1993). Up to the early 1990s, the population size was believed to be increasing at a rate of about 3.2 percent per year (Zeh et al. 1996) despite annual subsistence harvests of 14–74 bowheads from 1973 to 1997 (Suydam et al.

1995). Allowing for an additional census in 2001, the latest estimates are based on an annual population growth rate of 3.4 percent (95 percent Confidence Interval, 1.7–5 percent) from 1978 to 2001 and a population size (in 2001) of ~10,470 animals (George et al. 2004, recently revised to 10,545 by Zeh and Punt (2005). Assuming a continuing annual population growth of 3.4 percent, the 2010 bowhead population may number around 14,247 animals. The large increases in population estimates that occurred from the late 1970s to the early 1990s were partly a result of actual population growth, but were also partly attributable to improved census techniques (Zeh et al. 1993). Although apparently recovering well, the BCB bowhead population is currently listed as Endangered under the ESA and is classified as a ***strategic stock*** by NMFS and ***depleted*** under the MMPA (Angliss and Outlaw 2008).

The BCB stock of bowhead whales winters in the central and western Bering Sea and many of these whales summer in the Canadian Beaufort Sea (Moore and Reeves 1993). Spring migration through the Chukchi Sea occurs through offshore ice leads, generally from March through mid-June (Braham et al. 1984; Moore and Reeves 1993), well before the onset of the planned exploration drilling activities.

Some bowheads arrive in coastal areas of the eastern Canadian Beaufort Sea and Amundsen Gulf in late May and June, but most may remain among the offshore pack ice of the Beaufort Sea until mid- summer. After feeding primarily in the Canadian Beaufort Sea and Amundsen Gulf, bowheads migrate westward from late August through mid- or late-October. Fall migration into Alaskan waters is primarily during September and October. However, in recent years a small number of bowheads have been seen or heard offshore from the Prudhoe Bay region during the last week of August (Treacy 1993; LGL and Greeneridge 1996; Greene 1997; Greene et al. 1999; Blackwell et al. 2004, 2008; Greene et al. 2007; Goetz et al. 2008). Consistent with this, Nuiqsut whalers have stated that the earliest arriving bowheads have apparently reached the Cross Island area earlier in recent years (T. Napageak, personal communication).

Westbound bowheads typically reach the Barrow area in mid-September, and remain there until late October (e.g., Brower 1996). However, over the years, local residents report having seen a small number of bowhead whales feeding off Barrow or in the pack ice off Barrow during the summer. Bowhead whales that are thought to be part of the Western Arctic stock may also occur in small numbers in the Bering and Chukchi seas during the summer (Rugh et al. 2003). Thomas et al. (2009) also reported bowhead sightings in 2006 and 2007 during summer aerial surveys in the Chukchi Sea. All sightings were recorded in the northern portion of the study area, north of 70ºN latitude. Autumn bowhead whaling near Barrow normally begins in mid-September to early October, but may begin as early as August if whales are observed and ice conditions are favorable (USDI/BLM 2005). Whaling near Barrow can continue into October, depending on the quota and conditions.

Most spring-migrating bowhead whales would likely pass through the Chukchi Sea prior to the start of the planned drilling activities. However, a few whales that may remain in the Chukchi Sea during the summer could be encountered during the drilling activities or by transiting vessels. More encounters with bowhead whales would be likely to occur during the westward fall migration in late September through October. However, migrating bowheads may transit across the northern portion of the Chukchi Sea to the Chukotka coast before heading south toward the Bearing Sea. These whales would not be likely to occur near the planned drilling activities that will be conducted greater than 60 statute mi (97 km) offshore in the Chukchi Sea. In addition, Shell will operate in consultation with stakeholders to avoid disturbance to subsistence bowhead whaling activities in the Chukchi Sea, should such a subsistence bowhead hunt occur during the period of Shell's planned 2010 drilling activities.

(b) Gray Whale (*Eschrichtius robustus*)

Gray whales originally inhabited both the North Atlantic and North Pacific oceans. The Atlantic populations are believed to have become extinct by the early 1700s. There are two populations in the

North Pacific. A relic population which survives in the Western Pacific summers near Sakhalin Island far from the area of the planned exploration drilling activities. The larger eastern Pacific or California gray whale population recovered significantly from commercial whaling during its protection under the ESA until 1994 and numbered about 29,758 ±3122 in 1997 (Rugh et al. 2005). However, abundance estimates since 1997 indicate a consistent decline followed by the population stabilizing or gradually recovering. Rugh et al. (2005) estimated the population to be 18,178 ±1,780 in winter 2001-2002 and Rugh et al. (2008) estimated the population in winter 2006-2007 to have been 20,110 ±1,766. The eastern Pacific stock is not considered by NMFS to be Endangered or to be a strategic stock.

Eastern Pacific gray whales breed and calve in the protected waters along the west coast of Baja California and the east coast of the Gulf of California from January to April (Swartz and Jones 1981; Jones and Swartz 1984). At the end of the breeding and calving season, most of these gray whales migrate about 5,000 mi (8,000 km), generally along the west coast of North America, to the main summer feeding grounds in the northern Bering and Chukchi seas (Tomilin 1957, Rice and Wolman 1971, Nerini 1984, Moore et al. 2003, Bluhm et al. 2007).

Most summering gray whales have historically congregated in the northern Bering Sea, particularly off St. Lawrence Island in the Chirikov Basin (Moore et al. 2000), and in the southern Chukchi Sea. More recently, Moore et al. (2003) suggested that gray whale use of Chirikov Basin has decreased, likely as a result of the combined effects of changing currents resulting in altered secondary productivity dominated by lower-quality food. Coyle et al (2007) noted that amplescid amphipod production in the Chirikov Basin had declined by 50 percent from the 1980s to 2002-2003 and that as little as 3-6 percent of the current gray whale population could consume 10-20 percent of the amplescid amphipod annual production. These data support the hypotheses that changes in gray whale distribution may be caused by changes in food production and that gray whales may be approaching or have surpassed the carrying capacity of their summer feeding areas. Bluhm et al. (2007) noted high gray whale densities along ocean fronts and suggested that ocean fronts may play an important role in influencing prey densities in eastern North Pacific gray whale foraging areas. The northeastern-most of the recurring feeding areas is in the northeastern Chukchi Sea southwest of Barrow (Clarke et al. 1989). Gray whales feed by suctioning sediment and filtering benthic invertebrates from the sediment with their short, coarse baleen (Moore et al. 2000).

Gray whales routinely feed in the Chukchi Sea during the summer. Moore et al. (2000) reported that during the summer, gray whales in the Chukchi Sea were clustered along the shore primarily between Cape Lisburne and Point Barrow and were associated with shallow, coastal shoal habitat. In autumn, gray whales were clustered near shore at Point Hope and between Icy Cape and Point Barrow, as well as in offshore waters southwest of Point Barrow at Hanna Shoal and northwest of Point Hope. The distribution of grays was different during aerial surveys in the Chukchi Sea in 2006 and 2007 (Thomas et al. 2009). In 2006, gray whales were most abundant along the coast south of Wainwright and offshore of Wainwright (Thomas et al. 2007), and in 2007, gray whales were most abundant in nearshore areas from Wainwright to Barrow (Thomas et al. 2009). Gray whales occur fairly often near Point Barrow, but historically only a small number of gray whales have been sighted in the Beaufort Sea east of Point Barrow.

Although they are most common in portions of the Chukchi Sea close to shore, gray whales may also occur in offshore areas of the Chukchi Sea, particularly over offshore shoals. Gray whales are likely to be in the vicinity of the planned exploration drilling activities in the Chukchi Sea.

(c) Minke Whale (*Balaenoptera acutorostrata*)

Minke whales have a cosmopolitan distribution at ice-free latitudes (Stewart and Leatherwood 1985), and also occur in some marginal ice areas. Angliss and Outlaw (2008) recognize two minke whale stocks in

U.S. waters: (1) the Alaska stock, and (2) the California/Oregon/Washington stock. There is no abundance estimate for the Alaska stock. Provisional estimates of minke whale abundance based on surveys in 1999 and 2000 are 810 and 1003 whales in the central-eastern and south-eastern Bering Sea, respectively. These estimates have not been corrected for animals that may have been submerged or otherwise missed during the surveys, and only a portion of the range of the Alaskan stock was surveyed. Minke whales range into the Chukchi Sea, but the level of minke whale use of the Chukchi Sea is unknown. Leatherwood et al. (1982, *in* Angliss and Outlaw 2008) indicated that minke whales are not considered abundant in any part of their range, but that some individuals venture north of the Bering Strait in summer. Reiser et al. (2009) reported eight and five minke whale sightings in 2006 and 2007, respectively, during vessel-based surveys in the Chukchi Sea, and Jankowski et al. (2009) reported one minke whale sighting in the Beaufort Sea in 2007. Minke whales could be encountered during the exploration drilling activities in the Chukchi Sea.

(d) Fin Whale (*Balaenoptera physalus*)

Fin whales are widely distributed in all the world's oceans (Gambell 1985), but typically occur in temperate and polar regions. Fin whales feed in northern latitudes during the summer where their prey include plankton, as well as shoaling pelagic fish, such as capelin *Mallotus villosus* (Jonsgård 1966a,b). The North Pacific population's summering grounds span from the Chukchi Sea to California (Gambell 1985), but they do not range into the Alaskan Beaufort Sea or waters of the northern Chukchi Sea. Population estimates for the entire North Pacific population range from 14,620 to 18,630. Reliable estimates of fin whale abundance in the Northeast Pacific are not available (Angliss and Outlaw 2008). Provisional estimates of fin whale abundance in the central-eastern and south-eastern Bering Sea are 3,368 and 683, respectively. No estimates for fin whale abundance during the summer in the Chukchi Sea are available. Reiser et al. (2009) reported a fin whale sighting during vessel-based surveys in the Chukchi Sea in 2006. Fin whale is listed as "Endangered" under the ESA and by IUCN, is classified as a ***strategic stock*** by NMFS, and it is a CITES Appendix I species (Table 3-1). Fin whales could be encountered in very low numbers during the exploration drilling activities in the Chukchi Sea.

(e) Humpback Whale (*Megapter novaeangliae*)

Humpback whales are distributed in major oceans worldwide but are apparently absent from Arctic waters of the North Pacific (Angliss and Outlaw 2008). In general, humpback whales spend the winter in tropical and sub-tropical waters where breeding and calving occur, and migrate to higher latitudes for feeding during the summer.

Humpback whales were hunted extensively during the 20th century and worldwide populations may have been reduced to ~10 percent of their original numbers. The International Whaling Commission banned commercial hunting of humpback whales in the Pacific Ocean in 1965 and humpbacks were listed as "Endangered" under the ESA and depleted under the MMPA in 1973. Most humpback whale populations appear to be recovering well.

Humpbacks feed on euphausiids, copepods, and small schooling fish, notably herring, capelin, and sandlance (Reeves et al. 2002). As with other baleen whales, the food is trapped or filtered when large amounts of water are taken into the mouth and forced out through the baleen plates. Individual humpback whales can often be identified by distinctive patterns on the tail flukes. They are frequently observed breaching or engaged in other surface activities. Adult male and female humpback whales average 46 and 49 ft (14 and 15 m) in length, respectively (Wynne 1997). Humpbacks have large, robust bodies and long pectoral flippers which may reach ⅓ of their body length. The dorsal fin is variable in shape and located well back toward the posterior ⅓ of the body on a hump which is particularly noticeable when the back is arched during a dive (Reeves et al. 2002).

Angliss and Outlaw (2008) reported that at least three humpback whale populations have been identified in the North Pacific. Two of these stocks may be relevant to the planned drilling activities in the Chukchi Sea. The Central North Pacific stock winters in waters near Hawaii and migrates to British Columbia, Southeast Alaska, and Prince William Sound to Unimak Pass to feed during the summer. The Western North Pacific stock winters off the coast of Japan and probably migrates to the Bering Sea to feed during the summer. There may be some overlap between the Central and Western North Pacific stocks.

Humpback whale sightings in the Bering Sea have been recorded southwest of St. Lawrence Island, the southeastern Bering Sea, and north of the central Aleutian Islands (Moore et al. 2002, Angliss and Outlaw 2008). Recently there have been sightings of humpback whales in the Chukchi Sea and a single sighting in the Beaufort Sea (Green et al. 2007). Reiser et al. (2009) reported four humpback whales during vessel-based surveys in the Chukchi Sea in 2007 and Haley et al. (2009) reported one humpback whale sighting during 2008 operations. Green et al. (2007) reported and photographed a humpback whale cow/calf pair east of Barrow near Smith Bay in 2007. Whether these humpback whale sightings in the Chukchi and Beaufort seas are related to climate changes in the Arctic in recent years remains unknown. Small numbers of humpback whales could occur within or near the project area in the Chukchi Sea.

(3) Pinnipeds

(a) Bearded Seal (*Erignathus barbatus*)

Bearded seals are associated with sea ice and have a circumpolar distribution (Burns 1981b). They have occasionally been reported to maintain breathing holes in sea ice and broken areas within the pack ice, particularly if the water depth is <656 ft (<200 m) (e.g., Harwood et al. 2005). Bearded seals apparently also feed on ice-associated organisms when they are present, and this allows a few bearded seals to live in areas where water depth is considerably greater than 656 ft (200 m). During the summer period, bearded seals occur mainly in relatively shallow areas because they are predominantly benthic feeders (Burns 1981b). No reliable estimate of bearded seal abundance is available for the Chukchi Sea (Angliss and Outlaw 2008). The Alaska stock of bearded seals is not classified by NMFS as "Endangered" or a ***strategic stock***, however, there has recently been a petition to list this and other arctic seals due to the potential impact to seal habitats resulting from current warming trends.

Seasonal movements of bearded seals are directly related to the advance and retreat of sea ice and to water depth (Kelly 1988). During winter, most bearded seals in Alaskan waters are found in the Bering Sea. In the Chukchi and Beaufort seas, favorable conditions are more limited, and consequently, bearded seals are less abundant there during winter. From mid-April to June as the ice recedes, some of the bearded seals that overwintered in the Bering Sea migrate northward through the Bering Strait. During the summer they are found near the widely fragmented margin of multi-year ice covering the continental shelf of the Chukchi Sea and in nearshore areas of the central and western Beaufort Sea.

In Alaskan waters, bearded seals occur over the continental shelves of the Bering, Chukchi, and Beaufort Seas (Burns 1981b). The Alaska stock of bearded seals may consist of 300,000–450,000 individuals (MMS 1996). Bengtson et al. (2005) reported bearded seal densities in the Chukchi Sea ranging from 0.18 to 0.36 seals/mi^2 (0.07 to 0.14 seals/km^2) in 1999 and 2000, respectively. No population estimates could be calculated since these densities were not adjusted for haulout behavior. Bearded seals are common in offshore pack ice, but there have been high bearded seal numbers observed near the shore south of the project area near Kivalina. Reiser et al. (2009) reported bearded seal densities ranging from 0.03 to 0.08 seals/mi^2 (0.01 to 0.03 seals/km^2) in the summer and fall, respectively, during vessel-based surveys in the Chukchi Sea. These densities were lower than those reported by Bengtson et al. (2005) but are not directly comparable since the latter densities were based on aerial surveys of seals on sea ice in the late May and early June. Bearded seals are likely to be encountered during exploration drilling

operations, although numbers are expected to be relatively small. Greater numbers of bearded seals are likely to be encountered if the ice edge occurs nearby.

(b) Spotted Seal (*Phoca largha*)

Spotted seals (also known as largha seals) occur in the Beaufort, Chukchi, Bering, and Okhotsk seas, and south to the northern Yellow Sea and western Sea of Japan (Shaughnessy and Fay 1977). They migrate south from the Chukchi Sea and through the Bering Sea in October (Lowry et al. 1998). Spotted seals overwinter in the Bering Sea and inhabit the southern margin of the ice during spring (Shaughnessy and Fay 1977).

An early estimate of the size of the world population of spotted seals was 370,000–420,000, and the size of the Bering Sea population, including animals in Russian waters, was estimated to be 200,000–250,000 animals (Bigg 1981). The total number of spotted seals in Alaskan waters is not known (Angliss and Outlaw 2008), but the estimate is most likely between several thousand and several tens of thousands (Rugh et al. 1997). During the summer, spotted seals are found in Alaska from Bristol Bay through western Alaska to the Chukchi and Beaufort seas. The ADF&G placed satellite transmitters on four spotted seals in Kasegaluk Lagoon and estimated that the proportion of seals hauled out was 6.8 percent. Based on an actual minimum count of 4,145 hauled out seals, Angliss and Outlaw (2008) estimated the Alaskan population at 59,214 animals. The Alaska stock of spotted seals is not classified as "Endangered", "threatened", or as a ***strategic stock*** by NMFS (Angliss and Outlaw 2008), although a petition to list this and other arctic seals was submitted in 2008.

During spring when pupping, breeding, and molting occur, spotted seals are found along the southern edge of the sea ice in the Okhotsk and Bering seas (Quakenbush 1988; Rugh et al. 1997). In late April and early May, adult spotted seals are often seen on the ice in female-pup or male-female pairs, or in male-female-pup triads. Subadults may be seen in larger groups of up to 200 animals. During the summer, spotted seals are found primarily in the Bering and Chukchi seas, but some range into the Beaufort Sea (Rugh et al. 1997; Lowry et al. 1998) from July until September. At this time of year, spotted seals haul out on land part of the time, but also spend extended periods at sea. Spotted seals are commonly seen in bays, lagoons and estuaries, but also range far offshore as far north as 69–72ºN latitude. In summer, they are rarely seen on the pack ice, except when the ice is very near shore. As the ice cover thickens with the onset of winter, spotted seals leave the northern portions of their range and move into the Bering Sea (Lowry et al. 1998).

In the Chukchi Sea, Kasegaluk Lagoon and Icy Cape are important areas for spotted seals. Spotted seals haul out in this region from mid-July until freeze-up in late October or November. Frost and Lowry (1993) reported a maximum count of about 2,200 spotted seals in the lagoon during aerial surveys. No spotted seals were recorded along the shore south of Pt. Lay. Based on satellite tracking data, Frost and Lowry (1993) reported that spotted seals tagged at Kasegaluk Lagoon spent 94 percent of the time at sea. Extrapolating the count of hauled-out seals to account for seals at sea would suggest a Chukchi Sea population of about 36,000 animals. Few spotted seals are expected to occur near the planned exploration drilling activities in the Chukchi Sea.

(c) Ringed Seal (*Phoca hispida*)

Ringed seals have a circumpolar distribution and occur in all seas of the Arctic Ocean (King 1983). They are closely associated with ice and, in the summer, they often occur along the receding ice edges or farther north in the pack ice. In the North Pacific, they occur in the southern Bering Sea and range south to the seas of Okhotsk and Japan. They are found throughout the Beaufort, Chukchi, and Bering seas (Angliss and Outlaw 2008).

Ringed seals are year-round residents in the Chukchi and Beaufort seas and the ringed seal is the most frequently encountered seal species in the area. During winter, ringed seals occupy landfast ice and offshore pack ice of the Bering, Chukchi and Beaufort seas. In winter and spring, the highest densities of ringed seals are found on stable shorefast ice. However, in some areas where there is limited fast ice but wide expanses of pack ice, including the Beaufort Sea, Chukchi Sea and Baffin Bay, total numbers of ringed seals on pack ice may exceed those on shorefast ice (Burns 1970, Stirling et al. 1982, Finley et al. 1983). Ringed seals maintain breathing holes in the ice and occupy lairs in accumulated snow (Smith and Stirling 1975). They give birth in lairs from mid-March through April, nurse their pups in the lairs for 5–8 weeks, and mate in late April and May (Smith 1973, Hammill et al. 1991, Lydersen and Hammill 1993).

No estimate for the size of the Alaska ringed seal stock is currently available (Angliss and Outlaw 2008). Past ringed seal population estimates in the Bering-Chukchi-Beaufort area ranged from 1–1.5 million (Frost 1985) to 3.3–3.6 million (Frost et al. 1988). During aerial surveys in 1999, Bengtson et al. (2005) reported ringed seal densities offshore from Shishmaref to Barrow ranging from 1.0 to 9.5 seals/mi^2 (0.4 to 3.7 seals/km^2) and estimated the total Chukchi Sea population at 245,048 animals. Bengtson et al. (2005) reported ringed seal densities of 5.0 seals/mi^2 (1.9 seals/km^2) in the eastern Chukchi Sea during aerial surveys in 1999. Densities were higher in nearshore than offshore locations. During vessel-based observations from industry activities in the Chukchi Sea, Reiser et al. (2009) reported seal densities (assumed to be almost entirely ringed seals) from 0.10 to 0.28 seals/mi^2 (0.04 to 0.11 seals/km^2) in summer and fall, respectively. The Alaska stock of ringed seals is not Endangered, and is not classified as a strategic stock by NMFS. However, there has recently been a petition to list this and other Arctic seals due to the potential impact to seal habitats resulting from current warming trends. Ringed seal will likely be the most abundant marine mammal species encountered in the Chukchi Sea during exploration drilling operations.

(d) Ribbon Seal (*Histriophoca fasciata*)

Ribbon seals are found along the pack-ice margin in the southern Bering Sea during late winter and early spring and they move north as the pack ice recedes during late spring to early summer (Burns 1970, Burns et al. 1981a). Little is known about their summer and fall distribution, but Kelly (1988) suggested that they move into the southern Chukchi Sea, based on a review of sightings during the summer. However, ribbon seals appeared to be relatively rare in the northern Chukchi Sea. During recent vessel-based surveys in summer and fall of 2006 and 2007 there were only two ribbon seal sightings among the total of 2,679 seal sightings (Reiser et al. 2009). Thus ribbon seals are expected to be rare in the planned project area.

5. Type of Incidental Take Authorization Requested

The only type of incidental taking sought in this application is that of takes by sound energy harassment. The only sources of project–created sound energy for the exploration drilling will be those produced by the drillship *Discoverer* and its support vessels and aircraft. Although the bulk of the activity will be centered in the area of exploration drilling, potential exposures or impacts to marine mammals also will occur as the drillship and ice management vessels mobilize to and from the Chukchi Sea for the exploration drilling program.

Sound energy propagation measurements from *Discoverer* are not presently available. However, measurements of a similar drill ship, *Northern Explorer II*, were performed at two different times and locations in the Beaufort Sea (Miles et al. 1987, Greene 1987). In both cases a support vessel was present in the vicinity of the drillship, thus providing an aggregate source level for modeling the combined drilling activities. These measurement results were used to model the likely sound propagation from the *Discoverer* and its support vessels at the planned drill site locations. These modeled sound radii have been used for calculation of estimated "takes by harassment" in this document. Acoustic source levels for the *Discoverer* and the *Vladimir Ignatjuk* were used for this modeling study; however, direct

measurements were available only for the *Vladimir Ignatjuk*. Source levels for the *Discoverer* were estimated based its similarity to the *Explorer II*, thus the *Explorer II* was used as a proxy source for the *Discoverer*. A comparison of the key specifications for the two vessels is given in Table 5-1.

TABLE 5-1: COMPARISON OF THE SPECIFICATIONS FOR THE *NORTHERN EXPLORER II* AND *FRONTIER DISCOVERER* (WORLD OIL, 2003)

Parameter	*Explorer II*	*Discoverer*
Hull	115 x 30.5 x 8.7 m	155 x 21 x 11 m
Derrick	Pyramid 185'; 1,000,000 lb.	Pyramid, 170'; 1,333,000 lb.
Drawworks	Ideco E 2100	EMSCO E-2100
Pumps	2 x Nat'l 12P-160 triplex	2 x EMSCO FB-1600 triplex
Prime movers	4 x GE 752R, 3,000 bhp	6 x Cat. D-399 diesels, 1,325 hp
Top drive	Varco TDS-3	Varco TDS-3
Rotary table	Ideco LR-375	National C-495

Sound propagation measurements will be performed on the *Discoverer* and support vessels in 2010, once these are on location in Chukchi Sea. The results of those measurements will be used during the season to implement mitigation measures as required by the permit.

6. Numbers of Marine Mammals That May be Taken*:*

Shell seeks authorization for potential "taking" of small numbers of marine mammals under the jurisdiction of the NMFS in the planned region of activity. Species most likely to be encountered include bowhead and gray whales, beluga, harbor porpoise, and ringed, spotted, and bearded seals. Exposure estimates and requests for takes of ribbon seal, fin whale, humpback whale, killer whale, minke whale, and narwhal are also included, but are minimal because sightings of these species in the Chukchi Sea are rare.

The only anticipated impacts to marine mammals are associated with underwater sound propagation from exploration drilling activities and associated support vessels. Impacts would consist of temporary displacement of seals and whales from within ensonified zones produced by such sound sources.

The exploration drilling activities in the Chukchi Sea planned by Shell are not expected to "take" more than small numbers of marine mammals, or have more than a negligible effect on their populations. Discussions of estimated "takes by harassment" are presented below.

6.1 Exposure Estimates for Exploration Drilling

All anticipated takes would be "takes by harassment", involving temporary changes in behavior. The mitigation measures to be applied will minimize the possibility of injurious takes. (However, there is no specific information demonstrating that injurious "takes" would occur even in the absence of the planned mitigation measures.) In the sections below, we describe methods to estimate "take by harassment" and present estimates of the numbers of marine mammals that might be affected during the planned exploration drilling program in the Chukchi Sea. The estimates are based on data obtained during marine mammal surveys in and near the planned exploration drilling sites and on estimates of the sizes of the areas where effects could potentially occur. Adjustments to reported population or density estimates were made to account for seasonal distributions and population increases or declines insofar as possible.

The main sources of distributional and numerical data used in deriving the estimates are described in the next subsection. There is some uncertainty about the representativeness of those data and the assumptions used below to estimate the potential "take by harassment". However, the approach used here is the best available at this time.

Basis for Estimating "Take by Harassment"

This section provides estimates of the area of water potentially exposed to continuous sound levels ≥120 dB and ≥160 dB re 1 µPa rms produced by a single drillship and up to one ice-management vessel, one anchor handler and two support vessels. There is no evidence that avoidance at those levels would have significant biological effects on individual animals or that the subtle changes in behavior or movements would "rise to the level of taking" according to guidance by NMFS (NMFS 2001). Any changes in behavior caused by sounds at or near the 120 dB rms level would likely fall within the normal variation in such activities that would occur in the absence of drilling activities.

Density estimates in the Chukchi Sea have been derived for two time periods, the summer period covering July and August, and the fall period including September and October. Animal densities encountered in the Chukchi Sea during both of these time periods will further depend on the habitat zone within which the operations are occurring: open water or ice margin.

Because few data are available on the densities of marine mammals other than large cetaceans in the Chukchi Sea in the fall, density estimates from the summer and spring have been adjusted to reflect the expected ratio of summer-to-fall densities based on the natural history characteristics of each species. Alternatively, densities were taken from data collected during industry activities from 2006–2008 in the Chukchi Sea.

As noted above, there is some uncertainty about the representativeness of the data and assumptions used in the calculations. To provide some allowance for the uncertainties, "maximum estimates" as well as "average estimates" of the numbers of marine mammals potentially affected have been derived. For a few marine mammal species, several density estimates were available, and in those cases, the mean and maximum estimates were from the reported results. In other cases only one, or no applicable estimate was available, so arbitrary correction factors were used to arrive at "average" and "maximum" estimates. These are described in detail in the following sections. Except where noted, the "maximum" estimates have been calculated as 4× the "average" estimates. The densities presented are believed to be similar to, or in most cases higher than, the densities that will actually be encountered during the survey.

Detectability bias, quantified in part by $f(0)$, is associated with diminishing sightability with increasing lateral distance from the survey trackline. Availability bias, $g(0)$, refers to the fact that there is <100 percent probability of sighting an animal that is present along the survey trackline. Some sources below included these correction factors in the reported densities (e.g. ringed seals in Bengtson et al. 2005) and the best available correction factors were applied to reported results when they had not already been included (e.g. Moore et al. 2000).

Estimated densities of marine mammals in the Chukchi Sea project area during the "summer" (July and August) are presented in Table 6-1. Densities of marine mammals estimated for the fall period of Shell's exploration drilling operations in the Chukchi Sea (September and October) are presented in Table 6-2.

Cetaceans

Nine species of cetaceans are known to occur in the planned project area in the Chukchi Sea. Only four of these (bowhead and gray whales, beluga, and harbor porpoise) are expected to be encountered consistently during the planned exploration drilling activities. Three of the nine species (bowhead, fin, and humpback whales) are listed as "Endangered" under the ESA.

Summer densities of ***belugas*** in offshore waters are expected to be low. Aerial surveys have recorded few belugas in the offshore Chukchi Sea during the summer months (Moore et al. 2000). Additionally, no belugas were observed during >26,100 mi (>42,000 km) of visual effort during good visibility conditions

from industry vessels operating in the Chukchi Sea in 2006 and 2007 (Ireland et al. 2007a,b; Patterson et al. 2007; Reiser et al. 2009). If belugas are present during the summer, they are more likely to occur in or near the ice edge or close to shore during their northward migration. Expected densities were calculated from data in Moore et al. (2000; see Table 6-1).

In the fall, beluga whale densities in the Chukchi Sea are expected to be somewhat higher than in the summer because individuals of the Beaufort Sea stock will be migrating south through the Chukchi Sea to their wintering grounds in the Bering Sea (Angliss and Outlaw 2008). Densities are assumed to be similar in open-water and ice-margin areas. Densities derived from survey results in the northern Chukchi Sea in Moore et al. (2000) were used as the average density for open-water and ice-margin fall season estimates (see Table 6-2).

By July, most ***bowhead whales*** are northeast of the Chukchi Sea, within or migrating toward their summer feeding grounds in the eastern Beaufort Sea, resulting in low density estimates for the Chukchi Sea (Moore et al. 2000). The summer estimate in the Chukchi Sea was calculated by assuming there was one bowhead sighting during the 6,639 mi (10,684 km) of survey effort in the Chukchi Sea during the summer months reported in Moore et al. (2000) although no bowheads were actually observed during those surveys. During the fall, bowhead whales that summered in the Beaufort Sea and Amundsen Gulf migrate west and south to their wintering grounds in the Bering Sea making it more likely that bowheads will be encountered in the Chukchi Sea. However, many bowheads appear to travel through the northern Chukchi Sea to Russian waters near Wrangle Island and the Chukotsk Peninsula (Quakenbush 2009). Thus, a correction factor of ×0.05 has been used to adjust the observed fall densities from the Beaufort Sea (Richardson and Thomson 2002) to estimate densities in the Chukchi Sea, for the following reasons: (1) the migration corridor is narrower in the Beaufort Sea where available data have been obtained, (2) bowheads sometimes linger to feed for extended periods in the Beaufort Sea, but extended feeding has not been documented in the central and eastern Chukchi Sea in fall, (3) the results are similar to densities that have been estimated from vessel-based observations during industry operations in the Chukchi Sea in 2006–2007 (Reiser et al. 2009).

TABLE 6-1. EXPECTED DENSITIES OF CETACEANS AND SEALS IN AREAS OF THE CHUKCHI SEA, ALASKA, FOR THE PLANNED SUMMER (JULY–AUGUST) PERIOD. SPECIES LISTED UNDER THE U.S. ESA AS ENDANGERED ARE IN ITALICS.

	Open Water		Ice Margin	
Species	Average Density (# / km^2)	Maximum Density (# / km^2)	Average Density (# / km^2)	Maximum Density (# / km^2)
Odontocetes				
Monodontidae				
Beluga	0.0008	0.0032	0.0016	0.0064
Narwhal	0.0000	0.0000	0.0000	0.0001
Delphinidae				
Killer whale	0.0001	0.0004	0.0001	0.0004
Phocoenidae				
Harbor porpoise [a]	0.0028	0.0065	0.0028	0.0065
Mysticetes				
Bowhead whale	*0.0004*	*0.0016*	*0.0004*	*0.0016*
Fin whale	*0.0001*	*0.0004*	*0.0001*	*0.0004*
Gray whale	0.0108	0.0432	0.0108	0.0432
Humpback whale	*0.0001*	*0.0004*	*0.0001*	*0.0004*
Minke whale	0.0001	0.0004	0.0001	0.0004
Pinnipeds				
Bearded seal [a]	0.0135	0.0270	0.0180	0.0203
Ribbon seal	0.0001	0.0004	0.0001	0.0004
Ringed seal [a]	0.3900	0.6075	0.5200	0.8100
Spotted seal [a]	0.0078	0.0312	0.0104	0.0416

[a] Maximum density estimate available from the data source was used.

Gray whale densities were estimated from summer aerial surveys by Moore et al. (2000). Moore et al. (2000) found high concentrations of gray whales off the Seward Peninsula, far to the south of planned exploration drilling. The distribution of gray whales in the planned operational area was scattered and limited to nearshore areas where most whales were observed in water less than 114 ft (35 m) deep (Moore et al. 2000). A density calculated from effort and sightings in Moore et al. (2000) in water >114 ft (>35m) in depth was used as the average estimate for the Chukchi Sea during the summer period. In the fall, gray whales may be dispersed more widely through the northern Chukchi Sea, and densities may be slightly higher in the operational area. A density calculated from effort and sightings in water>114 ft (>35 m) deep during autumn in Moore et al. (2000) was used as the average estimate for the Chukchi Sea during the fall period.

Harbor Porpoise densities were estimated from industry data collected during 2007 activities in the Chukchi Sea. Prior to 2006, no reliable estimates were available for the Chukchi Sea and harbor porpoise presence was expected to be very low and limited to nearshore regions. Observers on industry vessels in 2006–2007, however, commonly recorded sightings throughout the Chukchi Sea during the summer and early fall months. Density estimates from 2007 observations during non-seismic periods, available in Reiser et al. (2009), were used for the summer and fall periods. These were similar to results reported for 2006 in Patterson et al. (2007). Different densities for open-water and ice-margin areas were not available, so the same value has been used in both locations, although densities in ice-margin areas are likely to be somewhat lower.

TABLE 6-2. EXPECTED DENSITIES OF CETACEANS AND SEALS IN AREAS OF THE CHUKCHI SEA, ALASKA, FOR THE FALL (SEPTEMBER–OCTOBER) PERIOD. SPECIES LISTED UNDER THE U.S. ESA AS ENDANGERED ARE IN ITALICS.

	Open Water		Ice Margin	
Species	Average Density (# / km^2)	Maximum Density (# / km^2)	Average Density (# / km^2)	Maximum Density (# / km^2)
Odontocetes				
Monodontidae				
Beluga	0.0112	0.0448	0.0112	0.0448
Narwhal	0.0000	0.0000	0.0000	0.0001
Delphinidae				
Killer whale	0.0001	0.0004	0.0001	0.0004
Phocoenidae				
Harbor porpoise [a]	0.0021	0.0065	0.0021	0.0065
Mysticetes				
Bowhead whale	*0.0011*	*0.0060*	*0.0011*	*0.0060*
Fin whale	*0.0001*	*0.0004*	*0.0001*	*0.0004*
Gray whale	0.0148	0.0592	0.0148	0.0592
Humpback whale	*0.0001*	*0.0004*	*0.0001*	*0.0004*
Minke whale	0.0001	0.0004	0.0001	0.0004
Pinnipeds				
Bearded seal [a]	0.0135	0.0270	0.0180	0.0270
Ribbon seal	0.0001	0.0004	0.0001	0.0004
Ringed seal [a]	0.2613	0.5427	0.3484	0.5427
Spotted seal [a]	0.0052	0.0208	0.0069	0.0277

[a] Maximum density estimate available from the data source was used.

The remaining five cetacean species that could be encountered in the Chukchi Sea during Shell's planned exploration drilling program include the humpback whale, killer whale, minke whale, fin whale, and narwhal. Although there is evidence of the occasional occurrence of these animals in the Chukchi Sea, it is unlikely that more than a few individuals will be encountered during the planned drilling program. George and Suydam (1998) reported killer whales, Brueggeman et al. (1990) and Reiser et al. (2009) reported minke whale, Suydam and George (1992) and Reiser et al. (2009) reported harbor porpoise, and Gambell (1985) recorded the northern extent of fin whales to be in the Chukchi Sea.

Pinnipeds

Three species of pinnipeds under NMFS jurisdiction are likely to be encountered in the Chukchi Sea portion of Shell's planned exploration drilling program: ringed seal, bearded seal, and spotted seal. Each of these species, except for the spotted seal, is associated with both the ice margin and the nearshore area. The ice margin is considered preferred habitat (as compared to the nearshore areas) during most seasons. Spotted seals are often considered to be predominantly a coastal species except in the spring when they may be found in the southern margin of the retreating sea ice. However, satellite tagging has shown that they sometimes undertake long excursions into offshore waters during summer (Lowry et al. 1994, 1998). Ribbon seals have been reported in very small numbers within the Chukchi Sea by observers on industry vessels (Patterson et al. 2007, Haley et al. 2009) so minimal values have been used for expected densities.

Ringed seal and ***bearded seals*** "average" and "maximum" summer ice-margin densities (Table 6-1) were available in Bengtson et al. (2005) from spring surveys in the offshore pack ice zone of the northern

Chukchi Sea. Densities of ringed and bearded seals in open water are expected to be somewhat lower in the summer when preferred pack ice habitat may still be present in the Chukchi Sea. Open-water densities have been estimated as 3/4 of the ice margin densities. The ringed seal density estimates calculated from data collected during 2006 and 2007 industry operations were 0.10 and 0.02 seals/mi^2 (0.262 and 0.041seals/km^2), respectively (Jankowski et al. 2007, Reiser et al. 2009). These estimates are lower than those made by Bengtson et al. (2005) which is not surprising given the different survey methods and timing. The fall density of ringed seals in the Chukchi Sea has been estimated as 2/3 the summer densities because ringed seals begin to reoccupy nearshore fast ice areas as the ice forms in the fall. Bearded seal densities in the fall have been assumed to remain unchanged from the summer densities.

Little information on ***spotted seal*** densities in offshore areas of the Chukchi Sea is available. Spotted seal densities in the summer were estimated by multiplying the ringed seal densities by 0.02 (Table 3-1). This was based on the ratio of the estimated Chukchi populations of the two species. Chukchi Sea spotted seal abundance was estimated by assuming that 8 percent of the Alaskan population of spotted seals is present in the Chukchi Sea during the summer and fall (Rugh et al. 1997), the Alaskan population of spotted seals is 59,214 (Angliss and Outlaw 2008), and that the population of ringed seals in the Alaskan Chukchi Sea is >208,000 animals (Bengtson et al. 2005). In the fall, spotted seals show increased use of coastal haulouts so densities were estimated to be 2/3 of the summer densities.

As described in earlier sections, the assumed start date of exploration drilling in the Chukchi Sea using the drillship *Discoverer* and associated support vessels is 4 July. Up to three wells may be drilled, with an average of 37 days at each drill site, including five days of mudline cellar excavation. The order in which the wells will be drilled, ice permitting, will likely be Burger, SW Shoebill, and Crackerjack. Drilling operations are expected to be completed on or before 31 October.

Sea-ice presence and concentration in the Chukchi Sea varies greatly from year to year. If loose pack ice or flows that can be managed by a vessel are present near planned activities in 2010, exploration drilling activities will likely be able to proceed. If necessary, ice-management activities will largely occur in a zone from 3-12 mi (4.8–19.0 km) from the drillship. Shell has estimated that the ice management vessel may be actively managing ice during 38 percent of the operational time. Most of this is likely to occur during the summer season when ice from the previous winter may still be present. Prevailing winds and ocean currents will likely cause ice-management activities to be focused in approximately half of the area surrounding each drill site during the summer. With less ice likely to be present in the fall months, ice-management activities are expected to be focused in just 20 percent of the area surrounding each drill site.

Expected sound propagation from the drillship *Discoverer* and an ice management vessel actively managing ice, the *Vladimir Ignatjuk,* were modeled at the three possible drill sites. Changes in the water column of the Chukchi Sea through the course of the drilling season will likely affect the propagation of sounds produced by drilling activities, so models were run for expected oceanographic conditions in July and October to bracket the seasonal variability. Sounds from the *Discoverer* have not previously been measured in the Arctic or elsewhere, but sounds from a similar drillship, *Explorer II*, were measured twice in the Beaufort Sea (Greene 1987, Miles et al. 1987). The source levels from these measurements, which included sounds from a support vessel operating nearby, were used as a proxy for modeling the sounds likely to be produced by drilling activities from the *Discoverer*. Sounds produced by the *Vladimir Ignatjuk,* formerly named *Kalvik,* were measured by Hall et al. (1994) while breaking ice and Brewer et al. (1993) while transiting. The back-propagated source levels from Hall et al. (1994) during icebreaking were used to model sounds that may be produced during ice-management activities. Results of sound propagation modeling that were used in the calculations of areas exposed to various levels of received sounds are summarized in Table 6-3. If ice conditions permit, the Burger well would be drilled first, SW Shoebill well would be drilled second, and the Crackerjack well would be drilled last.

TABLE 6-3. SOUND PROPAGATION MODELING RESULTS OF DRILLING ACTIVITIES AND ICEBREAKING AT THREE LOCATIONS IN THE CHUKCHI SEA

		Modeling Results		Used in Calculations	
Location	Received Level (dB re 1 µPa)	Drilling (km)	Icebreaking (km)	Drilling (km)	Icebreaking (km)
Burger	120	1.36	6.7	2.04	10.05
(Summer)	160	< 0.10	< 0.10	0.15	0.15
SW Shoebill	120	0.51	5.48	0.77	8.22
(Summer)	160	< 0.10	< 0.10	0.15	0.15
SW Shoebill	120	0.57	4.84	0.86	7.26
(Fall)	160	< 0.10	< 0.10	0.15	0.15
Crackerjack	120	0.59	4.64	0.89	6.96
(Fall)	160	< 0.10	< 0.10	0.15	0.15

Potential Number of "Takes by Harassment"

Numbers of marine mammals that might be present and potentially disturbed are estimated below based on available mammal distribution and density data at different locations and times of the year as described above and summarized in Tables 6-1 and 6-2. Exposure estimates are based on a single drillship (*Discoverer*) and associated support vessels drilling up to three wells in the Chukchi Sea from 4 July through 31 October as described in the previous section.

The number of individuals of each species potentially exposed to received levels ≥160 dB and ≥120 dB re 1 µPa rms, within each season and habitat zone, was estimated by multiplying the anticipated area to be ensonified in the time period and habitat zone to which a density applies, by the expected species density. The numbers of exposures were then summed for each species across the seasons and habitat zones.

Estimated Area Exposed to Sounds ≥160 dB rms

Distances shown in Table 6-3 were used to estimate the area ensonified to ≥160 dB rms around the drillship in the summer and fall seasons. Drilling activities at the SW Shoebill location may occur in both seasons. In order to produce a cautionary estimate of the potential number of takes, the entire area that may be exposed to sounds by operations at the SW Shoebill location have been included in calculations for both seasons using the corresponding distances shown in Table 6-3. The area of water potentially exposed to received sound levels >160 dB by exploration drilling operations during each season was estimated to be 0.14 mi^2 (0.36 km^2), or 0.07 mi^2 (0.18 km^2) × two drill sites.

The estimated ≥160 dB rms distances for both drilling operations and ice-management activities were relatively short, so overlap of sounds ≥160 dB rms is not expected because of the distance away from the drillship that ice-management is likely to occur 3-12 mi (4.8–19.0 km). Ice-management is expected to occur in about 50 percent of the area surrounding the drillship during the summer months when retreating sea ice is more likely to be present and approximately 20 percent of the surrounding area in the fall. The area of water potentially exposed to receive sound levels ≥160 dB rms by ice-management activities was estimated to be 420 mi^2 (1,093 km^2) in the summer and 170 mi^2 (442 km^2) in the fall. Due to rounding error of the very short ≥160 dB rms distances from drilling operations the combined drilling and ice-management ensonified areas are effectively no different than those noted above for ice-management alone.

Estimated Area Exposed to Sounds ≥120 dB rms

Distances shown in Table 6-3 were used to estimate the area ensonified to ≥120 dB rms around the drillship in the summer and fall seasons. As noted above, drilling activities at the SW Shoebill location may occur in both seasons so the entire area that may be exposed to sounds by operations at the SW Shoebill location have been included in calculations for both seasons. The area of water potentially exposed to received sound levels >120 dB rms by exploration drilling operations was estimated to be 5.8 mi^2 (14.9 km^2)in the summer at Burger and SW Shoebill, and 1.9 mi^2 (4.8 km^2) in the fall at SW Shoebill and Crackerjack.

Overlap of sounds from drilling and ice-management activities at the ≥120 dB rms level are possible, if not likely, because of the relatively large estimated radii surrounding ice-management activities. As mentioned above, ice-management is expected to occur more often during the summer months, when the ice coverage is about 50 percent of the area surrounding the drillship when retreating sea ice is more likely to be present and approximately 20 percent of the surrounding area in the fall. The area of water potentially exposed to received sound levels ≥120 dB rms by ice-management activities at the two planned drill sites in the summer is 3436 km^2. This area would entirely overlap the 5.8 mi^2 (14.9 km^2)of area ensonified by drilling operations estimated above. To avoid double counting, the two have not been summed and the total area ensonified to ≥120 dB rms in summer was estimated to be 1,327 mi^2 (3,436 km^2). The potential overlap of ice-management sounds and drilling sounds has also been excluded in the estimated total of 289 mi^2 (749 km^2)of water potentially exposed to received levels ≥120 dB rms during the fall.

Cetaceans

Estimates of the average and maximum number of individual cetaceans that would be exposed to received sound levels ≥120 dB and ≥160 dB rms are shown by season and habitat in Tables 6-4 and 6-5. The totals for each season are summed in Table 6-6 and the average and maximum number of individual cetaceans in descending order are gray whale, beluga, harbor porpoise, and bowhead whale. All other species have an estimated average number of individuals exposed equal to one and are included here for completeness, though are unlikely to be encountered (Table 6-6). Few animals are expected to be exposed to sounds ≥160 dB rms due to the small size of this zone, but estimates have been calculated or minimum values used to account for chance encounters. The estimates show that one endangered cetacean species (bowhead whale) is expected to be exposed to sounds ≥120 dB rms and potentially ≥160 dB rms unless bowheads avoid the area around the exploration drilling activities (Table 6-6). Not all marine mammals will change their behavior when exposed to these sound levels.

TABLE 6-4. THE NUMBER OF POTENTIAL EXPOSURES OF MARINE MAMMALS TO RECEIVED SOUND LEVELS IN THE WATER OF ≥120 DB RMS AND (≥160 DB RMS)

	Number of Exposures to Sound Levels ≥120 dB and (≥160 dB)					
	Summer					
	Open Water		Ice Margin		Total	
	Avg.	Max.	Avg.	Max.	Avg.	Max.
Odontocetes						
Monodontidae						
Beluga	2 (1)	7 (2)	2 (1)	7 (2)	4 (1)	15 (5)
Narwhal	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Delphinidae						
Killer whale	0 (0)	1 (0)	0 (0)	0 (0)	0 (0)	1 (0)
Phocoenidae						
Harbor porpoise	6 (2)	15 (5)	3 (1)	7 (2)	10 (3)	22 (7)
Mysticetes						
Bowhead whale	1 (0)	4 (1)	0 (0)	2 (1)	1 (0)	5 (2)
Fin whale	0 (0)	1 (0)	0 (0)	0 (0)	0 (0)	1 (0)
Gray whale	25 (8)	99 (31)	12 (4)	49 (16)	37 (12)	148 (47)
Humpback Whale	0 (0)	1 (0)	0 (0)	0 (0)	0 (0)	1 (0)
Minke whale	0 (0)	1 (0)	0 (0)	0 (0)	0 (0)	1 (0)
Total Cetaceans	35 (11)	129 (41)	18 (6)	68 (22)	53 (17)	197 (63)
Pinnipeds						
Bearded seal	31 (10)	62 (20)	21 (7)	23 (7)	52 (16)	85 (27)
Ribbon seal	0 (0)	1 (0)	0 (0)	0 (0)	0 (0)	1 (0)
Ringed seal	893 (284)	1392 (443)	596 (189)	928 (295)	1489 (474)	2319 (738)
Spotted seal	18 (6)	71 (23)	12 (4)	48 (15)	30 (9)	119 (38)
Total Pinnipeds	942 (300)	1526 (485)	628 (200)	999 (318)	1571 (500)	2525 (803)

TABLE 6-5. THE NUMBER OF POTENTIAL EXPOSURES OF MARINE MAMMALS TO RECEIVED SOUND LEVELS IN THE WATER OF ≥120 DB RMS AND (≥160 DB RMS)

	Number of Exposures to Sound Levels ≥120 dB and (≥160 dB)					
	Fall					
	Open Water		Ice Margin		Total	
	Avg.	Max.	Avg.	Max.	Avg.	Max.
Odontocetes						
Monodontidae						
Beluga	3 (2)	11 (7)	6 (3)	22 (13)	8 (5)	34 (20)
Narwhal	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Delphinidae						
Killer whale	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Phocoenidae						
Harbor porpoise	1 (0)	2 (1)	1 (1)	3 (2)	2 (1)	5 (3)
Mysticetes						
Bowhead whale	0 (0)	1 (1)	1 (0)	3 (2)	1 (0)	4 (3)
Fin whale	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Gray whale	4 (2)	15 (9)	7 (4)	30 (17)	11 (7)	44 (26)
Humpback Whale	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Minke whale	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Total Cetaceans	7 (4)	29 (17)	15 (9)	59 (35)	22 (13)	89 (52)
Pinnipeds						
Bearded seal	3 (2)	7 (4)	9 (5)	13 (8)	12 (7)	20 (12)
Ribbon seal	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Ringed seal	65 (39)	135 (80)	174 (103)	271 (160)	239 (141)	406 (240)
Spotted seal	1 (1)	5 (3)	3 (2)	14 (8)	5 (3)	19 (11)
Total Pinnipeds	70 (41)	148 (87)	186 (110)	299 (176)	256 (151)	446 (263)

TABLE 6-6. SUMMARY OF THE NUMBER OF POTENTIAL EXPOSURES OF MARINE MAMMALS TO RECEIVED SOUND LEVELS IN THE WATER OF ≥120 DB RMS AND (≥160 DB RMS)

	Number of Exposures to Sound Levels ≥120 dB and (≥160 dB)					
	Summer		Fall		Total	
	Avg.	Max.	Avg.	Max.	Avg.	Max.
Odontocetes						
Monodontidae						
Beluga	4 (1)	15 (5)	8 (5)	34 (20)	12 (6)	48 (24)
Narwhal	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	5 (5)
Delphinidae						
Killer whale	0 (0)	1 (0)	0 (0)	0 (0)	0 (0)	5 (5)
Phocoenidae						
Harbor porpoise	10 (3)	22 (7)	2 (1)	5 (3)	11 (4)	27 (10)
Mysticetes						
Bowhead whale	1 (0)	5 (2)	1 (0)	4 (3)	2 (1)	10 (5)
Fin whale	0 (0)	1 (0)	0 (0)	0 (0)	0 (0)	5 (5)
Gray whale	37 (12)	148 (47)	11 (7)	44 (26)	48 (18)	193 (73)
Humpback Whale	0 (0)	1 (0)	0 (0)	0 (0)	0 (0)	5 (5)
Minke whale	0 (0)	1 (0)	0 (0)	0 (0)	0 (0)	5 (5)
Total Cetaceans	53 (17)	197 (63)	22 (13)	89 (52)		
Pinnipeds						
Bearded seal	52 (16)	85 (27)	12 (7)	20 (12)	64 (24)	105 (39)
Ribbon seal	0 (0)	1 (0)	0 (0)	0 (0)	0 (0)	5 (5)
Ringed seal	1489 (474)	2319 (738)	239 (141)	406 (240)	1728 (615)	2726 (978)
Spotted seal	30 (9)	119 (38)	5 (3)	19 (11)	35 (12)	138 (49)
Total Pinnipeds	1571 (500)	2525 (803)	256 (151)	446 (263)		

Arbitrary estimates have been included in the Total (Max) column to account for chance encounters or where greater numbers may be encountered than calculations suggested.

Pinnipeds

Many of the animals exposed to sound levels near 120 dB rms would not react to those sound levels, particularly pinnipeds, and exposure to this sound level should not be considered as "takes". Even for species that may change their behavior or alter their migration route, those changes are likely to be within the normal range of activities for the animals and may not rise to the level of "taking" based on guidance in NMFS (2001). Animals that divert around the activity at the lower sound levels would not approach close enough that they would alter their behavior to the degree that they would be "taken by harassment." Thus, actual number of animals that will be "taken" lies somewhere between the number exposed to ≥120 and ≥160 dB rms.

Average and maximum estimates of the number of pinnipeds that would be exposed to received sound levels ≥120 dB and ≥160 dB rms are shown by season and habitat in Tables 6-4 and 6-5. The totals for each season are summed in Table 6-6. Ringed seal is the most widespread and abundant pinniped in ice-covered Arctic waters, and there appears to be a great deal of year-to-year variation in abundance and distribution of these marine mammals. Ringed seals account for a large number of marine mammals expected to be encountered during exploration drilling activities, and hence exposed to sounds with received levels ≥120 dB rms. The average (and maximum) estimate is that 1728 (2726) ringed seals might be exposed to sounds with received levels ≥120 dB rms from exploration drilling and ice-management activities, and 615 (978) to sounds ≥160 dB rms.

Two additional pinniped species are expected to be encountered: bearded and spotted seals. Average and maximum estimates for bearded seal exposures to sound levels ≥120 dB were 64 and 105, respectively. For spotted seal, these exposure estimates were 35 and 138, respectively. Ribbon seal may be encountered, but numbers are likely to be very small. Very few bearded or spotted seals are expected to be exposed to ≥160 dB.

Conclusions

The planned exploration drilling activities in the Chukchi Sea will involve one drillship that will introduce continuous sounds into the ocean while it is active, and up to two ice-management vessels that would introduce continuous sounds if they break or push ice. Other routine vessel operations are conventionally assumed not to affect marine mammals sufficiently to constitute "taking."

Cetaceans

Effects on cetaceans are generally expected to be restricted to avoidance of an area around the drilling or ice-management operations and short-term changes in behavior, falling within the MMPA definition of "Level B harassment."

Using the 120 dB re 1 μPa rms criterion, the best (average) estimates of the numbers of individual cetaceans exposed to sounds ≥120 dB represent varying proportions of the populations of each species in the Chukchi Sea and adjacent waters. For species listed as Endangered under the ESA, our estimates include 2–10 bowhead whales. This number is <1 percent of the Bering-Chukchi-Beaufort population of >14,247 assuming 3.4 percent annual population growth from the 2001 estimate of >10,545 animals (Zeh and Punt 2005). Only 1–5 individuals are estimated to be exposed to sounds ≥160 dB if they do not avoid the area near drilling operations. Gray whale is the most common species of cetacean expected to be present during the planned exploration drilling operations. The estimated 48–193 individuals that may be exposed to sounds ≥120 dB rms represent <1 percent of the population. The small numbers of other mysticete whales that may occur in the Chukchi Sea are unlikely to be present around the planned operations. The few that might occur would represent a very small proportion of their respective populations.

Some odontocetes may be exposed to sounds produced by the drilling and ice-management activities, and the numbers potentially affected are small relative to the population sizes (Tables 3-1 and 6-6). The best estimate of the number of belugas that might be exposed to ≥120 dB (12) represents <1 percent of their population. Few animals are expected to be exposed to levels ≥160 dB, although minimal numbers have been requested to allow for chance encounters.

Pinnipeds

A few pinniped species are likely to be encountered in the study area, but ringed seal is by far the most abundant in this area. The best (average) estimates of the numbers of individuals exposed to sounds at received levels ≥120 dB rms during the exploration drilling activities are as follows: ringed seals (1,728), bearded seals (64), and spotted seals (35), all of which represent <1 percent of their respective Chukchi Sea. Pinnipeds are unlikely to react to continuous sounds until they are much stronger than 120 dB rms, so it is probable that only a small percentage of these animals would actually be disturbed. Relatively few pinnipeds are estimated to be exposed to sounds ≥160 dB, although minimal estimates have been included to allow for chance encounters.

7. The anticipated impact of the activity on the species or stock:

The only anticipated impacts to marine mammals associated with the exploration drilling program, respectively are with respect to sound energy propagation from the *Discoverer* and associated support vessels. The *Discoverer*, ice management vessels, other support vessels and aircraft may provide sources of sound energy, while their presence provides a minimal non-acoustic effect to marine mammals involving visual or other clues.

Behavioral Effects

The effects of sound energy on marine mammals are highly variable, and have been categorized (Richardson et al. 1995) as follows:

- Sound energy too weak to be heard at the location of the animal, or lower than the ambient sound level and below the hearing threshold of the animal at select frequencies
- Sound energy which is audible, but not strong enough to exert a behavioral response
- Sound energy that may elicit responses from the animal ranging from temporary alert reaction, to active avoidance
- If the sound energy is repeated exposure, the animal may become habituated and exhibit diminished responsiveness, particularly if this is a frequent and predictable repetitive sound
- Sound energy that is strong enough to elicit a masking effect which reduces the animals ability to hear natural sounds at similar frequencies
- Limited sound energy-induced physiological stress from a sound that persists where the animal remains to perform a biologically important function such as feeding or breeding
- Strong sound energy that have the potential to cause temporary threshold shift (TTS) in an animals hearing ability

Bowhead Whales. The only anticipated impacts to marine mammals associated with the drilling exploration program are propagation of sounds from the drillship, ice management and support vessels, and aircraft. Any impacts to whales and seals would be temporary and result in only short-term displacement of seals and whales from within ensonified zones produced by such sound energy sources. Any impacts on the whale and seal populations of the Chukchi Sea activity area are likely to be short term and transitory arising from the temporary displacement of individuals or small groups from locations they may occupy at the times they are exposed to exploration drilling sounds at the 160-190 db received levels. In the case of bowhead whales that displacement might well take the form of a deflection of the swim paths of migrating bowheads away from (seaward of) received sound energy levels greater than 160 db (Richardson et al. 1999). Experimental studies involving the broadcasting of recorded drilling sounds (Richardson et al. 1985b, 1991; Wartzok et al. 1989), and offshore drilling operation monitoring programs (Johnson et al. 1986; McLaren et al. 1986; Brueggeman et al. 1990, 1991, 1992; Gallagher et al. 1992; Brewer et al. 1993; Hall et al. 1994), indicate that some bowheads are impacted by such activities. Behavioral responses to vessel and aircraft traffic have been studied. Demonstrated effects have been limited to minor changes in behavior, including avoidance of the vicinity of the drillship or vessel, changes in swimming speed or orientation, changes in dive / surface intervals or duration, and other respiratory changes. Though temporary diversions of the swim path of migrating whales have been documented, the whales have generally been observed to resume their initial migratory route within a distance of 6-20 mi (10-30 km) (Davis 1987; Brewer et al. 1993; Hall et al. 1994). The cited and other studies conducted to test the hypothesis of the deflection response of bowheads have determined that bowheads return to the swim paths they were following at relatively short distances after their exposure to

the received sounds. As noted in Section 6, above, it is highly unlikely that animals will be exposed to sounds of such intensity (160-190 db rms) and duration as to physically damage their auditory mechanisms. There is no evidence that bowheads so exposed have incurred injury to their auditory mechanisms. Additionally, there is no conclusive evidence that exposure to sounds exceeding 160 db have displaced bowheads from feeding activity (Richardson and Thomson 2002).

Beluga. Drilling sound energy may result in avoidance by beluga of the vicinity of the drillship; ice breaking, if required, would likely result in avoidance of a larger area. Belugas have been observed to react to helicopter overflights. All of these effects would be temporary behavioral changes, lasting only as long as the activity is on-going, and would not have any affect on the beluga population.

Seals. Bearded, ringed, and/or spotted seals have been observed as close as 3-115 ft (1-35 m) to operating drilling vessels (Gallagher et al. 1992; Brewer et al. 1993; Hall et al. 1994) and have been observed to exhibit little response to the associated sound energy or disturbance. During playback experiments, ringed seals approached and dove within 164 ft (50 m) of the sound source (received level 130 dB). These observations indicate that seals are relatively tolerant and unaffected by drilling. Sound levels > 230 dB that could possibly be injurious to seals (Southall et al. 2007) would not be generated by the planned activities. Further, there is no evidence that seals are more than temporarily displaced from ensonified zones and no evidence that seals have experienced physical damage to their auditory mechanisms even within ensonified zones.

Ringed seals also appear to be relatively tolerant of vessels and ice breaking. Brewer et al. (1993) and Hall et al. (1994) reported that ringed seals were often observed apparently feeding in the wake of ice breakers associated with drilling in the Beaufort. Kanik et al. (1980 as cited in Richardson et al. 1995a) reported that ringed seals remained on the ice unless icebreakers approached within 0.6 mi (1.0 km) of the seals. Brueggeman et al. (1992 as cited in Richardson et al. 1995a) similarly noted that ringed and bearded seals tended to remain on the ice until the vessel came within 0.6 mi (1.0 km) when they would dive into the water. Any such effects from the planned activities would be minor behavioral effects and temporary lasting only minutes or hours after the activity ceased. Alliston (1980, 1981 as cited in Richardson et al. 1995a) found the distribution and density of ringed seals was the same in the year following icebreaking activities in study sites in the Beaufort and off the coast of Labrador. Low-flying helicopters and fixed wing aircraft often cause ringed and bearded seals to dive into the water, but this is not always the case (Burns and Harbo 1972; Burns and Frost 1979; Alliston 1981). Spotted seals hauled out on beaches have been observed to leave the beach and enter the water when survey aircraft flown at altitudes of 1,000-2,500 ft (305-760 m) or more came within 0.6 mi (1.0 km) (Frost and Lowry 1990; Frost et al. 1993; Rugh et al. 1993; Richardson et al. 1995a).

Masking

There may be limited masking of low-frequency sounds by the sounds of the drilling program. Bowhead whales are known to continue calling during impulse sounds such as seismic provides (Greene *et. al.*, 1999) and Shell believes the same will occur during continuous non-pulse sounds of drilling with regard to marine mammals. Masking effects are expected to be absent in the case of belugas, since their communications and important sounds are predominantly at much higher frequencies than drilling.

Injury and Mortality

Shell believes there is no evidence that bowheads or other marine mammals exposed to sounds from drilling, ice management, support vessels, or associated aircraft in the arctic have incurred injury to auditory mechanisms. It is not imagined that TTS is a theoretical risk to animals from the above listed sources of non-pulse sounds. Recently, for impulse sounds such as seismic, scientists have determined

that the received level of a single seismic pulse might need to exceed ~210 dB re 1µPa rms in order to produce brief, mild TTS. Drilling and associated non-pulse sounds would not reach these dB levels so the risk of reaching TTS in marine mammals appears extremely remote. It is likely that baleen whales, odontocetes, and seals would avoid drilling and associated sounds before even being exposed to sounds far below TTS levels. Foremost, the >160 dB rms radii for the *Discoverer* is modeled to extend only 172 ft (35 m X 1.5) from the drillship and the fact that injurious take of marine mammals has not been shown at this level of sound affords the conclusion that no injury or mortality to marine mammals, cetaceans or seals, would occur from sound introduced by the collective sources of the drilling program.

8. The anticipated impact of the activity on the availability of the species or stocks of marine mammals for subsistence uses:

Subsistence hunting continues to be an essential aspect of Inupiat Native life, especially in rural coastal villages. The Inupiat participate in subsistence hunting activities in and around the Chukchi Sea. The animals taken for subsistence provide a significant portion of the food that will last the community through the year. Marine mammals represent on the order of 60-80 percent of the total subsistence harvest. Along with the nourishment necessary for survival, the subsistence activities strengthen bonds within the culture, provide a means for educating the young, provide supplies for artistic expression, and allow for important celebratory events. In this IHA application, Shell specifically discusses the potential impact from the drilling program to subsistence use of the bowhead whale, beluga, and seals, which are the primary marine mammals harvested for subsistence that are also covered under this authorization of incidental take by NMFS.

Bowhead Whale. Most activities associated with Shell's planned exploration drilling program would have no or negligible effects on bowhead whales. Sound energy and general activity associated with drilling and operation of vessels and aircraft have the potential to impact bowhead whales. However, as noted above in Section 7, though temporary diversions of the swim path of migrating whales have been documented, the whales have generally been observed to resume their initial migratory route within a distance of 6-20 mi (10-32 km) (Davis 1987; Brewer et al. 1993; Hall et al. 1994). Drilling noise has not been shown to block or impede migration even in narrow ice leads (Davis 1987; Richardson et al. 1991). Any effects on the bowhead whale as a subsistence resource would be negligible.

Beluga. Beluga are not a prevailing subsistence resource in the communities of Wainwright, Point Hope, and Point Lay, and Barrow the nearest communities to Shell's planned 2010 drilling program. Therefore, any such behavioral responses of avoidance of activity areas by beluga in the Chukchi Sea would have no effect on the subsistence resource.

Seals. Seals are an important subsistence resource and ringed seals make up the bulk of the seal harvest. Most ringed and bearded seals are harvested in the winter or in the spring before Shell's exploration drilling program would commence, but some harvest continues during open water and could possibly be affected by Shell's planned activities. Spotted seals are also harvested during the summer. Shell lease blocks where exploration activities would occur are located more than 60 statute mi (97 km) offshore, so activities within the prospects would have no impact on subsistence hunting for seals. Helicopter traffic between land and the offshore drilling operations could potentially disturb seals and, therefore, subsistence hunts for seals, but any such effects would be minor due to the small number of flights and the altitude at which they typically fly, and the fact that most seal hunting is done during the winter and spring. Any effects on subsistence hunts for seals would be negligible and temporary lasting only minutes after the flight has passed.

9. Anticipated impact on habitat:

Shell's planned 2010 exploration drilling program will not result in any permanent impact on habitats used by marine mammals, or to their prey sources. With regard to migrating cetaceans and seals, any effects would be temporary and of short duration at any one place. The primary potential impacts to all marine mammals are associated with elevated sound levels from exploration drilling operations, its support vessels, and aircraft. The effects to habitat of marine mammals by sounds from the planned drilling program are expected to be negligible.

Fish which are a prey source for odontocetes and seals, are known to hear and react to sounds and to use sound to communicate (Tavolga et al. 1981) and possibly avoid predators (Wilson and Dill 2002), and experiments have shown that fish can sense both the strength and direction of sound (Hawkins 1981). Primary factors determining whether a fish can sense a sound signal, and potentially react to it, are the frequency of the signal and the strength of the signal in relation to the natural background noise level.

The level of sound at which a fish will react or alter its behavior is usually well above the detection level. Fish have been found to react to sounds when the sound level increased to about 20 dB above the detection level of 120 dB re 1 μPa (Ona 1988); however, the response threshold can depend on the time of year and the fish's physiological condition (Engas et al. 1993). In general, fish react more strongly to pulses of sound rather than a continuous signal (Blaxter et al. 1981), and a quicker alarm response is elicited when the sound signal intensity rises rapidly compared to sound rising more slowly to the same level.

Investigations of fish behavior in relation to vessel noise (Olsen et al. 1983; Ona 1988; Ona and Godo 1990) have shown that fish react when the sound from the engines and propeller exceeds a certain level. Avoidance reactions have been observed in fish such as cod and herring when vessels approached close enough that received sound levels are 110 dB to 130 dB (Nakken 1992; Olsen 1979; Ona and Godo 1990; Ona and Toresen 1988). However, other researchers have found that fish such as polar cod, herring, and capeline are often attracted to vessels (apparently by the noise) and swim toward the vessel (Rostad et al. 2006). Typical sound source levels of vessel noise in the audible range for fish are 150 dB to 170 dB re 1 μPa/Hz (Richardson et al. 1995a). In calm weather, ambient noise levels in audible parts of the spectrum lie between 60 dB to 100 dB re 1 μPa.

Ice management would be expected to produce the most intense sounds associated with exploration drilling. Reported source levels for vessels during ice management have ranged from 175 dB to 185 dB (Brewer et al. 1993, Hall et al. 1994). Sound pressures generated while drilling have been measured during past exploration in the Beaufort and Chukchi Seas. Based on these measurements the *Discoverer* is expected to generate sound levels up to about 140 dB (Table 2.8-1; Greene 1985, 1987a). Sounds generated by drilling and ice management are generally low frequency, and within the frequency range detectable by most fish.

Based on reported source levels and ambient sound levels of 80-100 dB, there may be some avoidance by fish of the area near the drillship while drilling, around ice management vessels in transit and during ice management, and around other support and supply vessels when underway. Any avoidance reactions will last only minutes (Mitson and Knudsen 2003; Ona et al. 2007) longer than the vessel is operating at that location or the drillship is drilling, and would be limited to a relatively small area within 164-328 ft (50-100 m) of the drillship or vessel. No important spawning habitats are known to occur at or near the drilling locations. Effects of sound generation on fish will therefore be negligible, localized, and short term. Likewise, the impact to fish as a prey species for odontocetes or seals will therefore be negligible.

10. Anticipated impact of habitat loss or modification:

The effects of the planned exploration drilling program are expected to be negligible. It is estimated that only a small portion of the animals utilizing the areas of the planned program would be temporarily displaced. During the period of the exploration drilling program (July 4-October 31st), most marine mammals would be dispersed throughout the area. The peak of the bowhead whale migration through the Chukchi Sea typically occurs in September and October. Again, some bowheads might be temporarily displaced seaward during this time. The numbers of cetaceans and seals subject to displacement are small in relation to abundance estimates for the mammals addressed under this IHA.

In addition, feeding does not appear to be an important activity by bowheads migrating through the Chukchi Sea in most years. In the absence of important feeding areas, the potential diversion of a small number of bowheads is not expected to have any significant or long-term consequences for individual bowheads or their population. Bowheads, gray, or beluga whales are not predicted to be excluded from any habitat.

The planned drilling program are not expected to have any habitat-related effects that would produce long-term affects to marine mammals or their habitat due to the limited extent of the acquisition areas and timing of the program.

11. The availability and feasibility (economic and technological), methods, and manner of conducting such activity or means of effecting the least practicable impact upon affected species or stock, their habitat, and of their availability for subsistence uses, paying particular attention to rookeries, mating grounds, and areas of similar significance:

Details of the planned mitigations are discussed in the Marine Mammal Monitoring and Mitigation Plan (4MP; Attachment B).

12. Where the proposed activity would take place in or near a traditional Arctic subsistence hunting area and/or may affect the availability of a species or stock of marine mammal for Arctic subsistence uses, the applicant must submit a plan of cooperation or information that identifies what measures have been taken and/or will be taken to minimize any adverse effects on the availability of marine mammals for subsistence uses. A plan must include the following:

12.1 A statement that the applicant has notified and provided the affected subsistence community with a draft plan of cooperation.

Shell has prepared and will implement a Plan of Cooperation (POC or Plan) pursuant to Minerals Management Service (MMS) Lease Sale Stipulation No. 5, which requires that all exploration operations be conducted in a manner that prevents unreasonable conflicts between oil and gas activities and the subsistence activities and resources of residents of the North Slope. This stipulation also requires adherence to, and US Fish and Wildlife Service (USFWS) and National Marine Fisheries Service

(NMFS) regulations, which require an operator to implement a POC to mitigate the potential for conflicts between the proposed activity and traditional subsistence activities (50 CFR § 18.124(c)(4) and 50 CFR § 216.104(a)(12)).

The POC identifies the measures that Shell has developed in consultation with North Slope subsistence communities and will implement during its planned 2010 Beaufort Sea and Chukchi Sea exploration drilling programs to minimize any adverse effects on the availability of marine mammals for subsistence uses. In addition, the POC details Shell's communications and consultations with local subsistence communities concerning its planned 2010 exploration drilling program, potential conflicts with subsistence activities, and means of resolving any such conflicts (50 CFR § 18.128(d) and 50 CFR § 216.104(a) (12) (i), (ii), (iv)). Shell has documented its contacts with the North Slope subsistence communities, as well as the substance of its communications with subsistence stakeholder groups.

The leases within the Burger, SW Shoebill and Crackerjack Prospects were acquired during the Chukchi Sea Oil and Gas Lease Sales 193 held in February 2008. During the 2010 drilling program Shell plans to drill up to three exploration wells on three of seven leases (Table 1-1). All drilling is planned to be near vertical.

Shell's 2010 Chukchi Sea exploration drilling program, which is planned for the Burger, Crackerjack, and SW Shoebill prospects in the Chukchi Sea (Figure 1-1), is set-out in detail in the Chukchi Sea Exploration Plan (EP) and the impacts of the project, as well as the measures Shell will implement to mitigate those impacts, are analyzed in the Chukchi Sea EIA. Shell will implement this POC, and the mitigation measures set-forth herein, for both its Beaufort and Chukchi exploration programs.

The affected subsistence communities that were consulted regarding Shell's 2010 activities include: Barrow, Wainwright, Kotzebue, Kivalina, Point Lay and Point Hope. Several one-on-one meetings were also held throughout the villages.

Beginning in early January 2009, Shell held one-on-one meetings with representatives from NSB and Northwest Arctic Borough (NWAB), subsistence-user group leadership, and Village Whaling Captain Association representatives. These meetings took place at the convenience of the community leaders and in various venues. Meetings were held starting on the 12th of January 2009 and continuing through April of 2009. Shell's primary purpose in holding individual meetings was to inform key leaders, prior to the public meetings, so that they would be prepared to give appropriate feedback on planned activities.

Due to a death in the community, the scheduled meeting in Point Lay had to be postponed after receipt of a request by the Mayor, the scheduled meeting was canceled and rescheduled for late April 2009. Shell presented the proposed project to NWAB Assembly on January 27, to the NSB Assembly on February 2 and to the NSB and NWAB Joint Planning Commission Meeting on March 25. Meetings were also scheduled with various representatives from the AEWC, ICAS, Native Village of Barrow, Ice Seal Commission, ABWC, and the Nanuq Commission. All engagements were directed towards discussing Shell's planned 2010 drilling activities in the Chukchi Sea.

Shell will meet at least twice each year with the commissioners and committee heads of ABC, the Nanuq Commission, EWC, and AISC jointly in co-management meetings. Following the drilling season, Shell will have a post-season co-management meeting with the commissioners and committee heads to discuss results of mitigation measures and outcomes of the preceding season. The goal of the post-season meeting is to build upon the knowledge base, discuss successful or unsuccessful outcomes of mitigation measures, and possibly refine plans or mitigation measures if necessary.

Shell also attended the 2009 Conflict Avoidance Agreement (CAA) negotiation meetings in support of its 2009 Shallow Hazards surveys taking place in the Chukchi Sea. Shell is committed to a CAA process and will demonstrate this by making a good-faith effort to negotiate an agreement every year it has planned activities. Shell will also hold an additional round of POC meetings in May reflecting the mitigation measures developed as a result of the first round of POC meetings.

12.2 A schedule for meeting with the affected subsistence communities to discuss proposed activities and to resolve potential conflicts regarding any aspects of either the operation or the plan of cooperation.

Beginning in early January 2009, Shell held one-on-one meetings with representatives from NSB and Northwest Arctic Borough (NWAB), subsistence-user group leadership, and Village Whaling Captain Association representatives. These meetings took place at the convenience of the community leaders and in various venues. Meetings were held starting on the 12th of January 2009 and continuing through April of 2009. Shell's primary purpose in holding individual meetings was to inform key leaders, prior to the public meetings, so that they would be prepared to give appropriate feedback on planned activities.

The affected subsistence communities that were consulted regarding Shell's 2010 activities include: Barrow, Wainwright, Kotzebue, Kivalina, Point Lay and Point Hope. Several one-on-one meetings were also held throughout the villages.

Shell conducted POC community meetings in the Chukchi Sea villages of Wainwright, Point Hope, and Point Lay, Kivalina, and Kotzebue regarding its Chukchi Sea 2010 exploration drilling program. During these meetings, Shell focused on lessons learned from prior years activities and presented mitigation measures for avoiding potential conflicts, which are outlined in the 2010 POC. Shell will also facilitate meetings with the above-mentioned marine mammal commissions that are focused on ice seals, walrus, polar bears, and beluga.

12.3 A description of what measures the applicant has taken and/or will take to ensure that proposed activities will not interfere with subsistence whaling or sealing;

The following mitigation measures, plans and programs, are integral to this POC and were developed during consultation with potentially affected subsistence groups and communities. These measures, plans, and programs will be implemented by Shell during its 2010 exploration drilling operations in both the Beaufort and Chukchi Seas to monitor and mitigate potential impacts to subsistence users and resources. The mitigation measures Shell has adopted and will implement during its 2010 Camden Bay and Chukchi Sea exploration drilling operations are listed and discussed below. These mitigation measures reflect Shell's experience conducting exploration activities in Alaska over the last three years and its ongoing efforts to engage with local subsistence communities to better understand their concerns and develop appropriate and effective mitigation measures to address those concerns. This most recent version of Shell's planned mitigation measures was presented to community leaders and subsistence user groups starting in January of 2009 and has evolved since in response to information learned during the consultation process.

Subsistence Mitigation Measures

To minimize any cultural or resource impacts from its exploration operations, Shell will implement the following additional measures to ensure coordination of its activities with local subsistence users to minimize further the risk of impacting marine mammals and interfering with the subsistence hunt:

- The drillship and associated support vessels will not enter the Chukchi Sea before July 1 unless authorized by the USFWS based upon a review of seasonal ice conditions and other factors [see 50 CFR 18.118 (a)(3)(i)] to minimize effects on marine mammals and birds that frequent open leads and to minimize effects on spring bowhead whale or beluga hunting.
- To minimize impacts on marine mammals and subsistence hunting activities, vessels that can safely travel outside of the polynya zone will do so, unless it is necessary to break ice (as opposed to managing ice by pushing it out of the way) or if sea state conditions require an alternative route. Shell will notify the local communities of any change in the transit route through the Com Centers. In all cases, vessel transits will follow a route that allows for the highest degree of safety regarding ice conditions and sea states.
- Shell has developed a Communication Plan and will implement the plan before initiating exploration drilling operations to coordinate activities with local subsistence users as well as Village Whaling Associations in order to minimize the risk of interfering with subsistence hunting activities, and keep current as to the timing and status of the bowhead whale migration, as well as the timing and status of other subsistence hunts. The Communication Plan includes procedures for coordination with Communication and Call Centers to be located in coastal villages along the Chukchi and Beaufort Seas during Shell's proposed activities in 2010.
- Shell will employ local Subsistence Advisors from the Beaufort and Chukchi Sea villages to provide consultation and guidance regarding the whale migration and subsistence hunts. A total of nine subsistence advisor-liaisons (one per village) will be hired to work approximately 8-hours per day and 40-hour weeks through Shell's 2010 exploration project. The subsistence advisor will use Traditional Knowledge (TK) to gather data on subsistence lifestyle within the community and advise as to ways to minimize and mitigate potential impacts to subsistence resources during the drilling season. Responsibilities include reporting any subsistence concerns or conflicts; coordinating with subsistence users; reporting subsistence-related comments, concerns, and information; and advising how to avoid subsistence conflicts. A subsistence advisor handbook will be developed prior to the operational season to specify position work tasks in more detail.
- Shell will recycle drilling muds (e.g., use those muds on multiple wells), to the extent practicable based on operational considerations (e.g., whether mud properties have deteriorated to the point where they cannot be used further), to reduce discharges from its operations. At the end of the season excess water base fluid, approximately 1500 bbl, will be pre-diluted to a 30:1 ratio with seawater and then discharged.
- Shell will also implement flight restrictions prohibiting aircraft from flying within 1,000 ft (300 m) of marine mammals or below 1,500 ft (457 m) altitude (except during takeoffs and landings, in emergency situations, or for MMO overflights) while over land or sea.

13. The suggested means of accomplishing the necessary monitoring and reporting that will result in increased knowledge of the species, the level of taking or impacts on the population of marine mammals that are expected to be present while conducting activities and suggested means of minimizing burdens by coordinating such reporting requirements with other schemes already applicable to persons conducting such activity. Monitoring plans should include a description of the survey techniques that would be used to determine the movement and activity of marine mammals near the activity site(s) including migration and other habitat uses, such as feeding:

The planned marine mammal monitoring and mitigation program for the exploration drilling program for 2010 is included as Attachment A and this document addresses the issues in item 13.

14. Suggested means of learning of, encouraging, and coordinating research opportunities, plans, and activities relating to reducing such incidental taking and evaluating its effects:

Various agencies and programs may undertake marine mammal studies in the Chukchi Sea during the course of the 2010 drilling season. It is unclear if these studies might be relevant to Shell's planned exploration drilling program. Shell is prepared to share information obtained during implementation of our marine mammal monitoring and mitigation program with a variety of groups who may find the data useful in their research. A suggested list of recipients includes:

- The NSB Department of Wildlife Management (T. Hepa)
- The USFWS Office of Marine Mammal Management (C. Perham and J. Garlic-Miller)
- The MMS's Bowhead Whale Aerial Survey Program (C. Monnett)
- The Kuukpik Subsistence Oversight Panel (KSOP**)**
- Alaska Eskimo Whaling Commission (H. Brower -Barrow)
- Beluga Whale Committee (W. Goodwin -Kotzebue)
- Inupiat Community of the Arctic Slope (Martha Ipalook Faulk -Barrow)
- North Slope Science Initiative (J. Payne)
- MMS Field Supervisor (Jeff Walker)
- Alaska Department of Natural Resources (D. Perrin)

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Attachment A
Equipment Specifications

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Discoverer Specifications.

TABLE 1.C-1
Frontier Discoverer Specifications

FRONTIER DISCOVERER SPECIFICATIONS

TYPE-DESIGN	Drillship - Sonat Offshore Drilling Discoverer Class
SHAPE	Monohull with sponsons added for ice-resistance
SHIP BUILDERS & YEAR	Namura Zonshno Shipyard, Osaka, Japan - hull number 355
YEAR OF HULL CONSTRUCTION	1965
YEAR OF CONVERSION	1976
DATE OF LAST DRY-DOCKING	2007

FRONTIER DISCOVERER DIMENSIONS

LENGTH	514 ft	156.7 m
LBP	486 ft	148.2 m
MAX HEIGHT (ABOVE KEEL)	274 ft	83.7 m
HEIGHT OF DERRICK ABOVE RIG FLOOR	175 ft	53.3 m

FRONTIER DISCOVERER MOORING EQUIPMENT

Anchor pattern symmetric 8 points system. The unit is fitted with Sonat Offshore Drilling patented roller turret mooring system giving the unit the ability to maintain favorable heading without an interruption of the drilling operations

ANCHORS	Stevpris New Generation 7,000 kg ea 15,400 lb ea
ANCHOR LINES	Chain Wire Combination
SIZE/GRADE	2-3/4" wire 3" ORQ Chain
LENGTH	2,750 ft (838 m) wire + 1,150 ft (351 m) chain (useable) per anchor

FRONTIER DISCOVERER OPERATING WATER DEPTH

MAX WATER DEPTH	1,000 ft with present equipment (can be outfitted to 2,500 ft)

MAX DRILLING DEPTH	20,000 ft

FRONTIER DISCOVERER DRILLING PACKAGE

DRAW WORKS	EMSCO E-2,100, 1,600 hp
ROTARY	National C-495 with 49-1/2" opening
MUD PUMPS	2 x Continental Emsco Model FB-1600 Triple Mud Pumps
DERRICK	Pyramid 170 ft. with 1,300,000 lb nominal capacity
PIPE RACKING	BJ 3 arm system
DRILL STING COMPENSATOR	Shaffer 400 K x 18 ft stroke
RISER TENSIONS	8 x 80k Shaffer 50 ft stroke tensioners
CROWN BLOCK	Pyramid with 9 each 60" diameter sheaves rated at 1,330,000 lb
TRAVELING BLOCK	Continental - Emsco RA60-6
BOP	Cameron 18-3/4" x 10,000 psi
RISER	Cameron RCK type
TOP DRIVE	Varco TDS-3S, with GE-752 motor, 500 ton
BOP HANDLING	Hydraulic skid based system, drill floor

FRONTIER DISCOVERER DISPLACEMENT

FULL LOAD	20,253 Metric Tons (mt)
DRILLING	18,780 mt (Drilling, max load, deep hole, deep water)

FRONTIER DISCOVERER DRAUGHT

DRAFT AT LOAD LINE	27 ft	8.20 m
TRANSIT	27 ft (fully loaded, operating , departure)	8.20 m
DRILLING	25.16 ft	7.67 m

FRONTIER DISCOVERER HELIDECK

MAXIMUM HELICOPTER SIZE	Sikorsky 61N & 92N
FUEL STORAGE	2 ea 720 gallon tanks

FRONTIER DISCOVERER ACCOMODATIONS

NUMBER OF BEDS	124
SEWAGE TREATMENT UNIT	Hamworthy ST-10

FRONTIER DISCOVERER PROPULSION EQUIPMENT

PROPELLER	1 ea 15' 7" diameter, fixed blade
PROPULSION DRIVE UNIT	Marine Diesel, 6 cylinder, 2 cycle, Crosshead type
HORSEPOWER	7,200 hp @ 135 RPM
TRANSIT SPEED	8 knots

GENERAL STORAGE CAPACITIES

SACK STORAGE AREA	934 cubic meters (m^3)
BULK STORAGE BENTONITE/BARITE	180 m^3 - 4 tanks
BULK CEMENT	180 m^3 - 4 tanks
LIQUID MUD	
Active	1,200 Barrels (bbls)
Reserve	1,200 bbls
Total	2,400 bbls
POTABLE WATER	1,670 bbls / 265.5 m^3 (aft peak can be used as add. pot water tank)
DRILL WATER	5,798 bbls / 921.7 m^3
FUEL OIL	6,497 bbls / 1,033 m^3 (2S, 2P, 3S, 3P, 4S and 4P upper wings can be used as additional fuel storage or well test crude tankage)

Attachment B
Marine Mammal Monitoring and Mitigation Plan (4MP)

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Marine Mammal Monitoring and Mitigation Plan

for

Exploration Drilling of Selected Lease Areas in the Alaskan Chukchi Sea in 2010

Shell Gulf of Mexico Inc.
3601 C Street, Suite 1000
Anchorage, Alaska 99503

July 2009

Marine Mammal Monitoring and Mitigation Plan

For

Exploration drilling of selected lease areas in the Alaskan Chukchi Sea

Shell Gulf of Mexico Inc.
3601 C Street, Suite 1000
Anchorage, Alaska 99503

July 2009

TABLE OF CONTENTS

ACRONYMS

4MP	Marine Mammal Monitoring and Mitigation Plan
AEWC	Alaska Eskimo Whaling Commission
dB	decibel
CD	Compact Disc
GPS	Global Positioning System
ft	feet
Hz	Hertz
IHA	Incidental Harassment Authorization
kHz	kilohertz
km	kilometer
LOA	Letter of Authorization
m	meter(s)
mi	mile(s)
MMO	Marine Mammal Observer
MMS	Minerals Management Service
NMFS	National Marine Fisheries Service
NSB	North Slope Borough
NVD	Night-vision Device
rms	Root Mean Square
Scripps	Scripps Institute of Oceanography
Shell	Shell Gulf of Mexico Inc.
SPL	Sound Pressure Level
USFWS	U.S. Fish and Wildlife Service

INTRODUCTION

Shell Gulf of Mexico Inc. (Shell) will conduct a Marine Mammal Monitoring and Mitigation Plan (4MP) for exploration drilling activities in the Chukchi Sea during the 2010 drilling season. The 4MP developed for Shell's 2010 exploration drilling program supports protection of the marine mammal resources in the area, fulfills reporting obligations to the Minerals Management Service (MMS), the National Marine Fisheries Service (NMFS), and the U.S. Fish and Wildlife Service (USFWS), and establishes a means for gathering additional baseline data on marine mammals for future operations planning.

Shell plans to conduct exploration drilling within existing lease holdings in the Chukchi Sea. Drilling will be conducted from the M/V *Frontier Discoverer* (*Discoverer)* drillship owned by Frontier Drilling. The drillship is an ice-class drilling vessel designed, engineered and constructed to safely operate in the Chukchi Sea. The support vessels will include tugs and barges, an icebreaker, anchor handler/ice management vessel, and oil spill response vessels.

Shell's 4MP is a combination of active monitoring of the area of operations and the implementation of mitigation measures designed to minimizing project impacts to marine mammal resources. Monitoring will provide information on the numbers of marine mammals potentially affected by the exploration operations and facilitate real time mitigation to prevent injury of marine mammals by industrial sounds or activities. These goals will be accomplished by conducting vessel-based, aerial, and acoustic monitoring programs to characterize the sounds produced by the drilling activities and support vessels, and to document the potential reactions of marine mammals in the area to those sounds and activities.

Aerial monitoring and reconnaissance of marine mammals in coastal areas of the Chukchi Sea and recordings of ambient sound levels and vocalizations of marine mammals along the Chukchi Sea coast will be used to interpret potential impacts to marine mammals in subsistence use areas. Acoustic measurements will be made to establish safety radii for real time mitigation, if necessary, around the activities. These measurements will be used to determine the sound levels produced by various equipment and to establish any safety and disturbance radii if necessary. An initial sound source analysis will be supplied to NMFS within 120 hours of completion of the measurements, if possible. A detailed report will be issued to NMFS as part of the 90-day report following the end of the drilling season. Shell will continue to measure the sound propagation of the drillship at various times or throughout the drilling program. Sound energy from support vessels will also be measured. Bottom-founded hydrophones will also be placed in a large array across the Chukchi Sea to collect information on the use of the region by marine mammals and additional information on the propagation of sounds from human activities.

VESSEL-BASED MARINE MAMMAL MONITORING PROGRAM

Introduction

The vessel-based operations of Shell's 4MP are designed to meet the requirements of the IHA and the LOA which Shell expects to be issued by the NMFS and the USFWS, respectively, and to meet any other agreements between Shell and other agencies or groups. The objectives of the program will be to ensure that disturbance to marine mammals and subsistence hunts is minimized, that effects on marine mammals are documented, and to collect baseline data on the occurrence and distribution of marine mammals in the project area.

The 4MP will be implemented by a team of experienced marine mammal observers (MMOs). These MMOs will be trained, experienced field observers, including both biologists and Inupiat personnel. The MMOs will be stationed aboard the drillship and associated support vessels throughout the drilling period. The duties of the MMOs will include watching for and identifying marine mammals; recording their numbers, distances, and reactions to the drilling operations; initiating mitigation measures when appropriate; and reporting the results. Reporting of the results of the vessel-based monitoring program will include the estimation of the number of marine mammal "takes" as defined by the NMFS and stipulated in the IHA.

The vessel-based operations of Shell's 4MP will be required to support the vessel based drilling activities in the Chukchi Sea. The dates and operating areas will depend upon ice and weather conditions, along with Shell's arrangements with agencies and stakeholders. Drilling activities are expected to occur from July through October 2010, or intermittently during that time. Vessel-based monitoring for marine mammals will be done throughout the period of drilling operations to comply with provisions in the anticipated IHA and LOA from NMFS and USFWS, respectively.

The vessel-based work will provide:

- the basis for real-time mitigation, if necessary, as required by the various permits that Shell receives,
- information needed to estimate the number of "takes" of marine mammals by harassment, which must be reported to NMFS and USFWS,
- data on the occurrence, distribution, and activities of marine mammals in the areas where the drilling program is conducted,
- information to compare the distances, distributions, behavior, and movements of marine mammals relative to the drillship at times with and without drilling activity,
- a communication channel to coastal communities including Inupiat whalers,
- employment and capacity building for local residents, with one objective being to develop a larger pool of experienced Inupiat MMOs.

The 4MP will be operated and administered consistent with monitoring programs conducted during seismic and shallow hazards surveys in 2006–2008 or such alternative requirements as may be specified in the permits issued to Shell for this project. Any other agreements between Shell and agencies or groups such as MMS, USFWS, the North Slope Borough (NSB), and the Alaska Eskimo Whaling Commission (AEWC) will also be fully incorporated. All MMOs will be provided training through a program approved by NMFS and Shell, as described later. At least one observer on each vessel will be an Inupiat who will have the additional responsibility of communicating with the Inupiat community and (during the various subsistence harvests) directly with Inupiat hunters and whalers. Details of the vessel-based marine mammal monitoring program are described below.

Mitigation Measures during Drilling Activities

Shell's planned exploration drilling program incorporates both design features and operational procedures for minimizing potential impacts on marine mammals and on subsistence hunts. The design features and operational procedures have been described in the IHA and LOA applications submitted to NMFS and USFWS, respectively and are summarized below. Survey design features are

- timing and locating drilling and support activities to avoid interference with the annual subsistence hunting by the peoples of the Chukchi villages,
- conducting pre-season acoustic modeling to establish the appropriate safety zones and behavioral or disturbance radii,
- vessel-based monitoring to implement appropriate mitigation if necessary, and to determine the effects of project activities on marine mammals,
- acoustic monitoring of drilling and vessel sounds and marine mammal vocalizations.

The potential disturbance of marine mammals during drilling operations will be minimized further through the implementation of several ship-based mitigation measures if mitigation becomes necessary.

Safety and Disturbance Zones

Under current NMFS guidelines (e.g., NMFS 2000), "safety radii" for marine mammals around industrial sound sources are customarily defined as the distances within which received pulse levels are ≥180 dB re 1 µPa (rms) for cetaceans and ≥190 dB re 1 µPa (rms) for pinnipeds. These safety criteria are based on an assumption that sound pulses received at lower levels will not injure these animals or impair their hearing abilities, but that higher received levels might have some such effects.

Disturbance or behavioral effects to marine mammals from underwater sound may occur after exposure to sound at distances greater than the safety radii (Richardson et al. 1995). NMFS assumes that marine mammals exposed to underwater pulsed sound levels ≥160 dB rms have the potential to be disturbed behaviorally. In recent years there has also been concern that exposure to sound levels ≥120 dB rms may affect the behavior of bowhead whale cow/calf pairs. The NMFS may require monitoring for cetaceans at a distance within which continuous received levels from drilling operations are ≥120 dB rms. Safety and disturbance zones for marine mammals around continuous sound sources, such as those produced during drilling activity, have not been well established by the NMFS.

Expected safety and disturbance radii based on sound propagation from the drillship *Discoverer* and an ice management vessel actively managing ice, the *Vladimir Ignatjuk*, were modeled by JASCO Applied Sciences at the three potential well locations. Changes in the water column of the Chukchi Sea through the course of the open-water season will likely affect the propagation of sounds produced by drilling activities, so models were run for expected oceanographic conditions in July and October to bracket the seasonal variability. These radii will be used for mitigation purposes, should they be necessary, until direct measurements are available early during the exploration drilling activities. Shell will measure the received levels of underwater sound versus distance and direction from the sound sources using calibrated hydrophones. The acoustic data will be analyzed as quickly as reasonably practicable in the field and used to verify (and if necessary adjust) the safety and disturbance radii.

Sounds from the *Discoverer* have not previously been measured in the Arctic or elsewhere, but sounds from a similar drillship, *Explorer II*, were measured in the Beaufort Sea (Greene 1987; Miles et al. 1987). The underwater received sound pressure level in the 20 to 1000 Hz band for drilling activity by the *Explorer II*, including a nearby support vessel, was 134 dB re 1 µPa at 0.2 km (Greene 1987). Sounds produced by the *Vladimir Ignatjuk*, formerly named *Kalvik*, were measured by Hall et al. (1994) while icebreaking and Brewer et al. (1993) while transiting. The back-propagated source levels from Hall et al. (1994) during icebreaking were used to model sounds that may be produced during ice-management activities. The back propagated sources

levels from Brewer et al. (1993) were found to be questionably high so the results from Hall et al. (1994) were reduced by 15 dB based on observational evidence that icebreakers pushing ice radiate sound ~10-15 dB stronger than while transiting. Estimated source levels from these measurements were 175 dB re 1 μPa (rms) and 181 dB re 1 μPa (rms), for drilling and icebreaking, respectively. The source levels from these measurements were used as a proxy for modeling the sounds likely to be produced by drilling activities from the *Discoverer* and an associated support vessel at the three potential well locations in the Chukchi Sea. Based on the models, source levels are expected to fall below 180 dB rms within tens of meters and below 160 dB rms within 100 m. The largest 120 dB rms radius from the drillship estimated for one of the three possible locations was 6.7 km.

The source levels noted above for exploration drilling and support vessel activities are not high enough to cause a temporary reduction in hearing sensitivity or permanent hearing damage to marine mammals. Consequently, mitigation as described for seismic activities including ramp ups, power downs, and shut downs should not be necessary for drilling activities. However, Shell plans to use MMOs onboard the drillship and the various support vessels to monitor marine mammals and their responses to industry activities and to initiate mitigation measures should in-field measurements of the operations indicate conditions represent a threat to the health and well-being of marine mammals.

Marine Mammal Observers

Vessel-based monitoring for marine mammals will be done by trained MMOs throughout the period of drilling operations to comply with expected provisions in the IHA and LOA that Shell receives. The observers will monitor the occurrence and behavior of marine mammals near the drillship and support vessels during all daylight periods during the drilling operation, and during most periods when drilling is not being conducted. MMO duties will include watching for and identifying marine mammals; recording their numbers, distances, and reactions to the drilling operations; and documenting "take by harassment" as defined by NMFS.

Number of observers

A sufficient number of MMOs will be onboard each vessel to meet the following criteria

- 100 percent monitoring coverage during all periods of drilling operations in daylight
- maximum of four consecutive hours on watch per MMO
- maximum of approximately 12 hours on watch per day per MMO

MMO teams will consist of trained Inupiat and field biologist observers. An experienced field crew leader will be a member of every MMO team aboard the drillship and each support vessel during the drilling program. The total number of MMOs aboard may decrease later in the season as the duration of daylight decreases assuming NMFS does not require continuous nighttime monitoring. Inupiat MMOs will also function as Native language communicators with hunters and whaling crews and with the Communications and Call Centers (Com Centers) in Native villages along the Chukchi Sea coast.

Crew Rotation

Shell anticipates that there will be provision for crew rotation at least every three to six weeks to avoid observer fatigue. During crew rotations detailed hand-over notes will be provided to the incoming crew leader by the outgoing leader. Other communications such as email, fax, and/or phone communication between the current and oncoming crew leaders during each

rotation will also occur when possible. In the event of an unexpected crew change Shell will facilitate such communications to insure monitoring consistency among shifts.

Observer Qualifications and Training

Crew leaders and most other biologists serving as observers in 2010 will be individuals with experience as observers during one or more of the 2006–2009 monitoring projects for Shell or recent experience with other operators in Alaska or the Canadian Beaufort.

Biologist-observers will have previous marine mammal observation experience, and field crew leaders will be highly experienced with previous vessel-based marine mammal monitoring projects. Resumés for those individuals will be provided to NMFS for approval. All observers will be trained and familiar with the marine mammals of the area. A marine mammal observers' handbook, adapted for the specifics of the planned Shell drilling program will be prepared and distributed beforehand to all MMOs (see below).

Most observers will also complete a two-day training and refresher session on marine mammal monitoring, to be conducted shortly before the anticipated start of the 2010 drilling season. Any exceptions will have or receive equivalent experience or training. The training session(s) will be conducted by marine mammalogists with extensive crew-leader experience during previous vessel-based seismic monitoring programs.

Primary objectives of the training include:

- review of the marine mammal monitoring plan for this project, including any amendments adopted, or specified by NMFS or USFWS in the IHA or LOA, by MMS, or other agreements in which Shell may elect to participate,
- review of marine mammal sighting, identification, and distance estimation methods, including any amendments specified by NMFS or USFWS in the 2010 IHA or LOA,
- review of operation of specialized equipment (reticle binoculars, night vision devices, and GPS system),
- review of, and classroom practice with, data recording and data entry systems, including procedures for recording data on mammal sightings, drilling and monitoring operations, environmental conditions, and entry error control. These procedures will be implemented through use of a customized computer database and laptop computers.

MMO Handbook

A Marine Mammal Observers' Handbook will be prepared for Shells's monitoring program. Handbooks contain maps, illustrations, and photographs as well as text and are intended to provide guidance and reference information to trained individuals who will participate as MMOs. The following topics will be covered in the MMO Handbook:

- summary overview descriptions of the project, marine mammals and underwater sound energy, the marine mammal monitoring program (vessel-based, aerial, acoustic measurements, special studies), the NMFS IHA and USFWS LOA and other regulations/permits/agencies, the Marine Mammal Protection Act,
- monitoring and mitigation objectives and procedures, including initial safety radii,
- responsibilities of staff and crew regarding the marine mammal monitoring plan,
- instructions for ship crew regarding the marine mammal monitoring plan,

- data recording procedures: codes and coding instructions, common coding mistakes, electronic database; navigational, marine physical, and drilling data recording, field data sheet,
- use of specialized field equipment (reticle binoculars, Big-eye binoculars, NVDs, laser rangefinders),
- reticle binocular distance scale,
- table of wind speed, Beaufort wind force, and sea state codes,
- data storage and backup procedures,
- list of species that might be encountered: identification, natural history,
- safety precautions while onboard,
- crew and/or personnel discord; conflict resolution among MMOs and crew,
- drug and alcohol policy and testing,
- scheduling of cruises and watches,
- communications,
- list of field gear provided,
- suggested list of personal items to pack,
- suggested literature, or literature cited,
- copies of the NMFS IHA and USFWS LOA will be made available.

Monitoring Methodology

The observer(s) will watch for marine mammals from the best available vantage point on the drillship and support vessels. The observer(s) will scan systematically with the naked eye and 7×50 reticle binoculars, supplemented with Big-eye binoculars and night-vision equipment when needed (see below). Personnel on the bridge will assist the marine mammal observer(s) in watching for pinnipeds and whales.

Information to be recorded by marine mammal observers will include the same types of information that were recorded during previous monitoring projects (e.g., Moulton and Lawson 2002). When a mammal sighting is made, the following information about the sighting will be recorded:

- species, group size, age/size/sex categories (if determinable), behavior when first sighted and after initial sighting, heading (if consistent), bearing and distance from observer, apparent reaction to activities (e.g., none, avoidance, approach, paralleling, etc.), closest point of approach, and behavioral pace,
- time, location, speed, and activity of the vessel, sea state, ice cover, visibility, and sun glare,
- the positions of other vessel(s) in the vicinity of the observer location.

The ship's position, speed, water depth, sea state, ice cover, visibility, and sun glare will also be recorded at the start and end of each observation watch, every 30 minutes during a watch, and whenever there is a change in any of those variables.

Distances to nearby marine mammals will be estimated with binoculars (Fujinon 7×50 binoculars) containing a reticle to measure the vertical angle of the line of sight to the animal relative to the horizon.

Observers may use a laser rangefinder to test and improve their abilities for visually estimating distances to objects in the water. However, previous experience showed that a Class 1 eye-safe device was not able to measure distances to seals more than about 230 feet (ft) [70 meters (m)] away. The device was very useful in improving the distance estimation abilities of the observers at distances up to about 1,968 ft (600 m)—the maximum range at which the device could measure distances to highly reflective objects such as other vessels. Humans observing objects of more-or-less known size via a standard observation protocol, in this case from a standard height above water, quickly become able to estimate distances within about ±20 percent when given immediate feedback about actual distances during training.

Monitoring At Night and In Poor Visibility

Night-vision equipment ("Generation 3" binocular image intensifiers, or equivalent units) will be available for use when needed. However, past experience with night-vision devices (NVDs) in the Beaufort Sea and elsewhere indicates that NVDs are not nearly as effective as visual observation during daylight hours (e.g., Harris et al. 1997, 1998; Moulton and Lawson 2002).

Specialized Field Equipment

Shell will provide or arrange for the following specialized field equipment for use by the onboard MMOs: reticle binoculars, Big-eye binoculars, GPS unit, laptop computers, night vision binoculars, and possibly digital still and digital video cameras.

Field Data-Recording, Verification, Handling, and Security

The observers on the drillship and support vessels will record their observations onto datasheets or directly into handheld computers. During periods between watches and periods when operations are suspended, those data will be entered into a laptop computer running a custom computer database. The accuracy of the data entry will be verified in the field by computerized validity checks as the data are entered, and by subsequent manual checking of the database printouts. These procedures will allow initial summaries of data to be prepared during and shortly after the field season, and will facilitate transfer of the data to statistical, graphical or other programs for further processing. Quality control of the data will be facilitated by (1) the start-of-season training session, (2) subsequent supervision by the onboard field crew leader, and (3) ongoing data checks during the field season.

The data will be backed up regularly onto CDs and/or USB disks, and stored at separate locations on the vessel. If possible, data sheets will be photocopied daily during the field season. Data will be secured further by having data sheets and backup data CDs carried back to the Anchorage office during crew rotations.

In addition to routine MMO duties, observers will be encouraged to record comments about their observations into the "comment" field in the database. Copies of these records will be available to the observers for reference if they wish to prepare a statement about their observations. If prepared, this statement would be included in the 90-day and final reports documenting the monitoring work.

Field Reports

Throughout the drilling program, the biologists will prepare a report each day or at such other interval as required summarizing the recent results of the monitoring program. The reports will summarize the species and numbers of marine mammals sighted. These reports will be provided to NMFS as required.

Reporting

The results of the 2010 vessel-based monitoring, including estimates of "take by harassment", will be presented in the 90-day and final technical report(s). Reporting will address the requirements established by NMFS in the IHA.

The technical report(s) will include:

- summaries of monitoring effort: total hours, total distances, and distribution of marine mammals through study period for sea state, and other factors affecting visibility and detectability of marine mammals,
- analyses of the effects of various factors influencing detectability of marine mammals: sea state, number of observers, and fog/glare,
- species composition, occurrence, and distribution of marine mammal sightings including date, water depth, numbers, age/size/gender categories, group sizes, and ice cover,
- analyses of the effects of drilling operations:
  - sighting rates of marine mammals versus drilling activities (and other variables that could affect detectability),
  - initial sighting distances versus drilling state,
  - closest point of approach versus drilling state,
  - observed behaviors and types of movements versus drilling state,
  - numbers of sightings/individuals seen versus drilling state,
  - distribution around the drillship and support vessels versus drilling state,
  - estimates of "take by harassment".

ACOUSTIC MONITORING PLAN

Drilling Sound Measurements

Objectives

Drilling sounds are expected to vary significantly with time due to variations in the level of operations and the different types of equipment used at different times onboard the drillship. The goals of these measurements are (1) to quantify the absolute sound levels produced by drilling and to monitor their variations with time, distance and direction from the drillship, and (2) to measure the sound levels produced by vessels operating in support of drilling operations. These vessels will include crew change vessels, tugs, ice-management vessels, and spill response vessels.

Equipment

The drilling and vessel sound measurements will be performed using two methods that may be implemented separately or together. The first method will involve real time monitoring using bottom-mounted hydrophones that are cabled back to the drillship. These hydrophones will be positioned between 1,640–3,280 ft (500–1,000 m) from the drillship, depending on the final positions of the anchors used to moor the drillship. Hydrophone cables will be fed to real-time digitization systems on board (see Figure 2).

The second sound-monitoring method will be to deploy hydrophone systems (see Figure 3) at various distances from the drilling operations. Sound level monitoring with one or both

methods will occur on a continuous basis throughout all drilling activities. Both types of systems will be set to record digital acoustic data at sample rate 32 kHz, providing useful acoustic bandwidth to at least 15 kHz. Both the hydrophone systems use Reson TC4032 hydrophones with sensitivity -170 dB re V/μPa. These systems are capable of measuring absolute broadband sound levels between 90 dB re μPa and 180 dB re μPa.

The deployment of drilling sound monitoring equipment will occur as soon as possible once the drillship is on site at any of the prospects where Shell intends to drill an exploration well. Retrieval of these systems will occur following completion of the drilling activities. The long duration recordings will capture many different operations performed at the drillship. Accurate activity logs of drilling operations and nearby vessel activities will be maintained to correlate with these acoustic measurements.

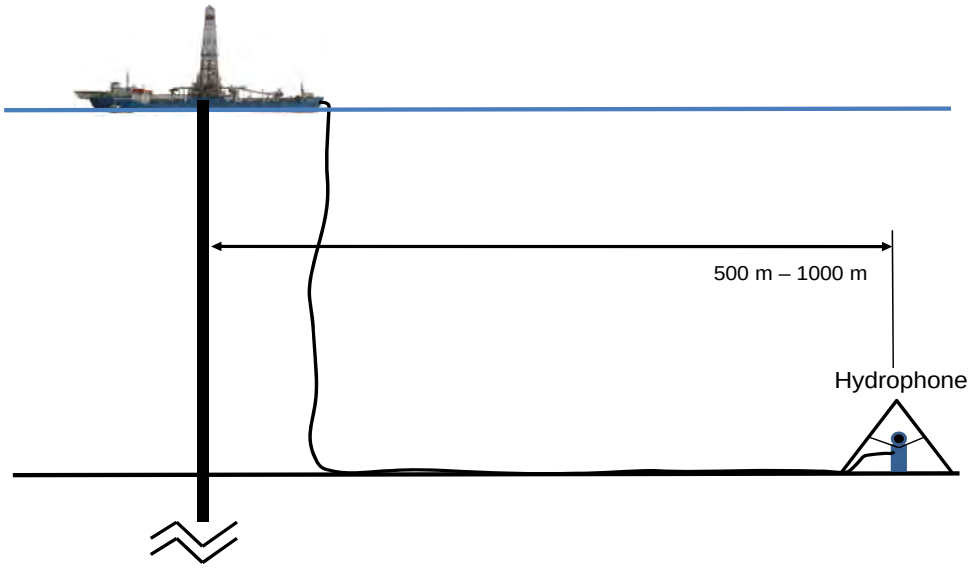

Figure 2: Cabled hydrophone method for real time monitoring of drilling sound energy.

Figure 3: Hydrophone recording system being deployed at sea. The hydrophone system is an autonomous recorder with very high recording resolution. Acoustic data is stored internally on a hard-drive.

Vessel Sounds Monitoring

Sound produced by the vessels supporting drilling operations will be recorded by the drilling sounds monitoring equipment. Logs of vessel position and activity will be used to determine the time varying contribution of each vessel to the overall sound level measurements. Additional dedicated measurements of vessel source levels will be obtained by having the vessels perform sail-pasts of the monitoring locations. These dedicated measurements will provide sound level versus distance from the respective vessels and will also be processed to compute source levels in 1/3-octave bands referenced to 1m range.

Acoustic Data Analyses

Drilling sound data will be analyzed to extract a record of the frequency-dependent sound levels as a function of time. Figure 4 shows the results of this type of analysis. These results are useful also for correlating measured sound energy events with specific survey operations and capturing marine mammal vocalizations. The analysis provides absolute sound levels in finite frequency bands that can be tailored to match the highest-sensitivity hearing ranges for species of interest. For example, bowhead hearing is thought to be most acute in the 100 Hz - 1000 Hz frequency range that corresponds with the blue dotted line in the upper plot of Figure 4.

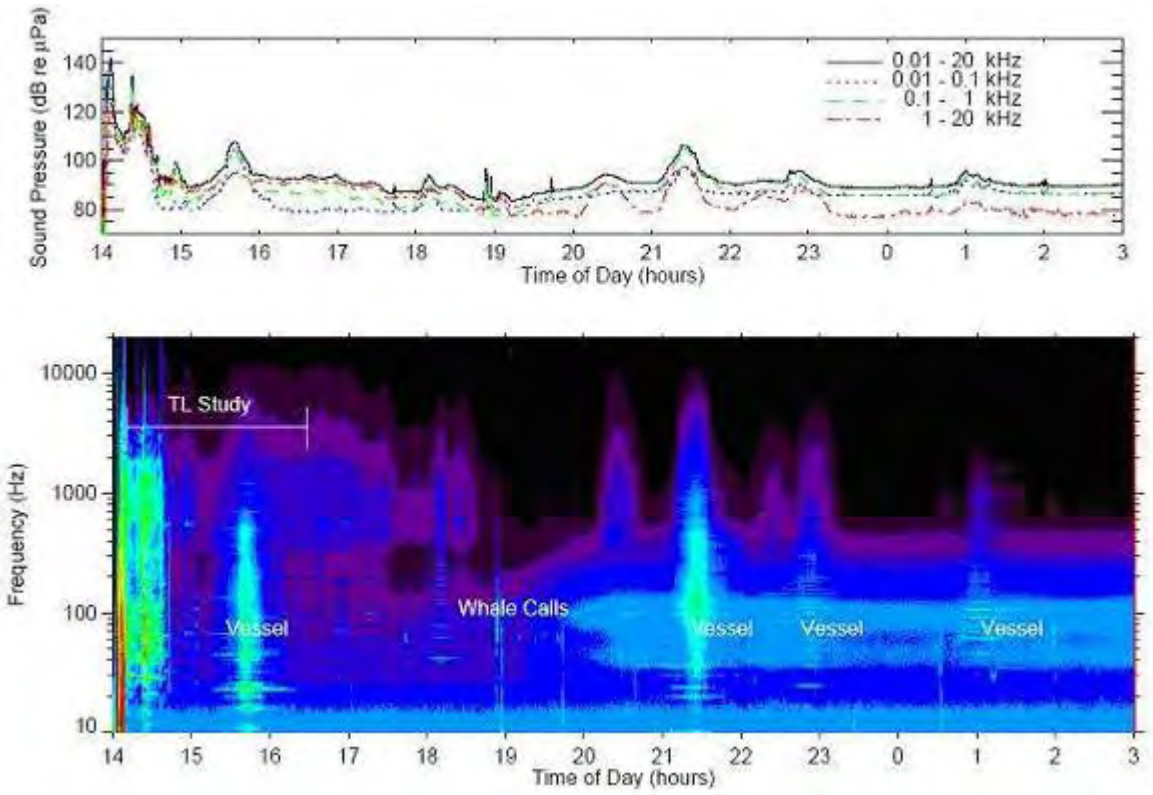

Figure 4: Lower: spectrogram of sound level measurements obtained from a hydrophone recording system. Upper: broadband and selected band level variation with time.

The analyses will also consider sound level integrated through 1-hour durations (referred to as sound energy equivalent level Leq (1-hour). Figure 5 (upper) shows an example of a Leq analysis of hydrophone data. Similar graphs for long time periods will be generated as part of the data analysis performed for indicating drilling sound variation with time in selected frequency bands.

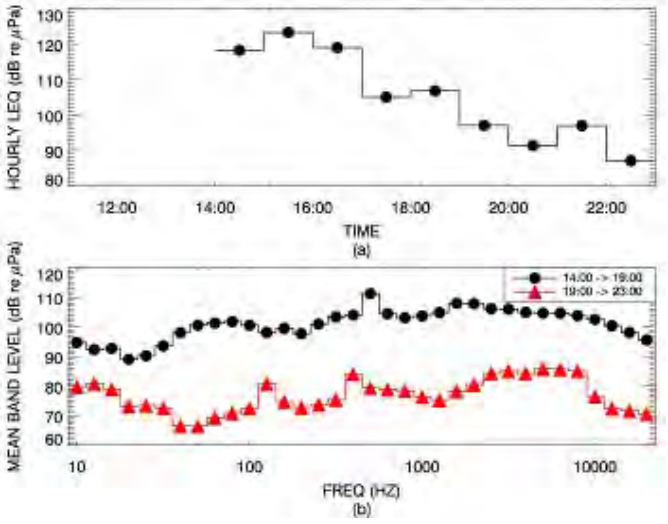

Figure 5: Upper: 1-hour Leq levels that will be calculated from acoustic measurements for use in correlating with bowhead whale deflection data.

Reporting of Results

Acoustic sound level results will be reported in the 90-day and comprehensive reports for this program. The results reported will include:

- sound Source Levels for the drillship and all drilling support vessels,
- spectrogram and band level versus time plots computed from the continuous recordings obtained from the hydrophone systems,
- hourly Leq levels at the hydrophone locations,
- correlation of drilling source levels with the type of drilling operation being performed. These results will be obtained by observing differences in drilling sound associated with differences in the drill rig activity as indicated in detailed drillship logs.

JOINT INDUSTRY STUDIES PROGRAM

This section describes studies that were undertaken from 2006 through 2008 in the Chukchi Sea that will be continued during drilling operations in 2010. Shell plans to conduct aerial surveys consistent with the previous 2006–2008 programs along the Chukchi Sea coast. Additionally, the acoustic net array similar to the one deployed in 2008 will be used to monitor industry sounds and marine mammals across the Chukchi Sea and along coast. Additional recorders will be deployed in the area around any of the prospects where Shell intends to drill.

Chukchi Sea Coastal Aerial Survey

Recent aerial surveys of marine mammals in the Chukchi Sea were conducted over coastal areas to approximately 23 miles (mi) [37kilometers (km)] offshore in 2006–2008 in support of Shell's summer seismic exploration. These surveys provided data on the distribution and abundance of marine mammals in nearshore waters of the Chukchi Sea. Shell plans to conduct an aerial survey program in the Chukchi Sea in 2010 that will be similar to the 2006–2008 programs.

Alaskan Natives from several villages along the east coast of the Chukchi Sea hunt marine mammals during the summer and Native communities are concerned that offshore oil and gas exploration activities may negatively impact their ability to harvest marine mammals. Of particular concern are potential impacts on the beluga harvest at Point Lay and on future bowhead harvests at Point Hope, Point Lay, Wainwright and Barrow. Other species of concern in the Chukchi Sea include the gray whale, bearded, ringed, and spotted seals, and walrus. Gray whale is expected to be the most numerous cetacean species encountered during the planned drilling activities, although beluga whales also occur in the area. The ringed seal is likely to be the most abundant pinniped species. The current aerial survey program will be designed to collect distribution data on cetaceans and will be limited in its ability to collect similar data on pinnipeds.

Objectives

The aerial survey program will be conducted in support of the Shell drilling program in the Chukchi Sea during summer and fall of 2010. The objectives of the aerial survey are:

- to address data deficiencies in the distribution and abundance of marine mammals in coastal areas of the eastern Chukchi Sea,

- to collect and report data on the distribution, numbers, orientation and behavior of marine mammals, particularly beluga whales, near traditional hunting areas in the eastern Chukchi Sea.

Survey Considerations

With agreement from hunters in the coastal villages, aerial surveys of coastal areas to approximately 23 mi (37 km) offshore between Point Hope and Point Barrow will begin in early to mid-July and will continue until drilling operations in the Chukchi Sea are completed. Weather and equipment permitting, surveys will be conducted twice per week during this time period. In addition, during the 2010 drilling season, aerial surveys will be coordinated in cooperation with the aerial surveys conducted by MMS and any other groups conducting surveys in the region.

Survey Procedures

Transects will be flown in a saw-toothed pattern between the shore and 23 mi (37 km) offshore as well as along the coast from Point Barrow to Point Hope (Fig. 6). This design will permit completion of the survey in one to two days and will provide representative coverage of the nearshore region. The surveyed area will include waters where belugas are normally available to subsistence hunters. Survey altitude will be at least 1,000 ft (305 m) with an average survey speed of 110 –120 knots. Sawtooth transects were designed by placing transect start/end points every 34 mi (55 km) along the offshore boundary of this 23 mi (37 km) wide nearshore zone, and at midpoints between those points along the coast. The transect line start/end points will be shifted along both the coast and the offshore boundary for each survey based upon a randomized starting location, but overall survey distance will not vary substantially. The coastline transect will simply follow the coastline or barrier islands. As with past surveys of the Chukchi Sea coast, coordination with coastal villages to avoid disturbance of the beluga whale subsistence hunt will be extremely important. "No-fly" zones around coastal villages or other hunting areas established during communications with village representatives will be in place until the end of the hunting season.

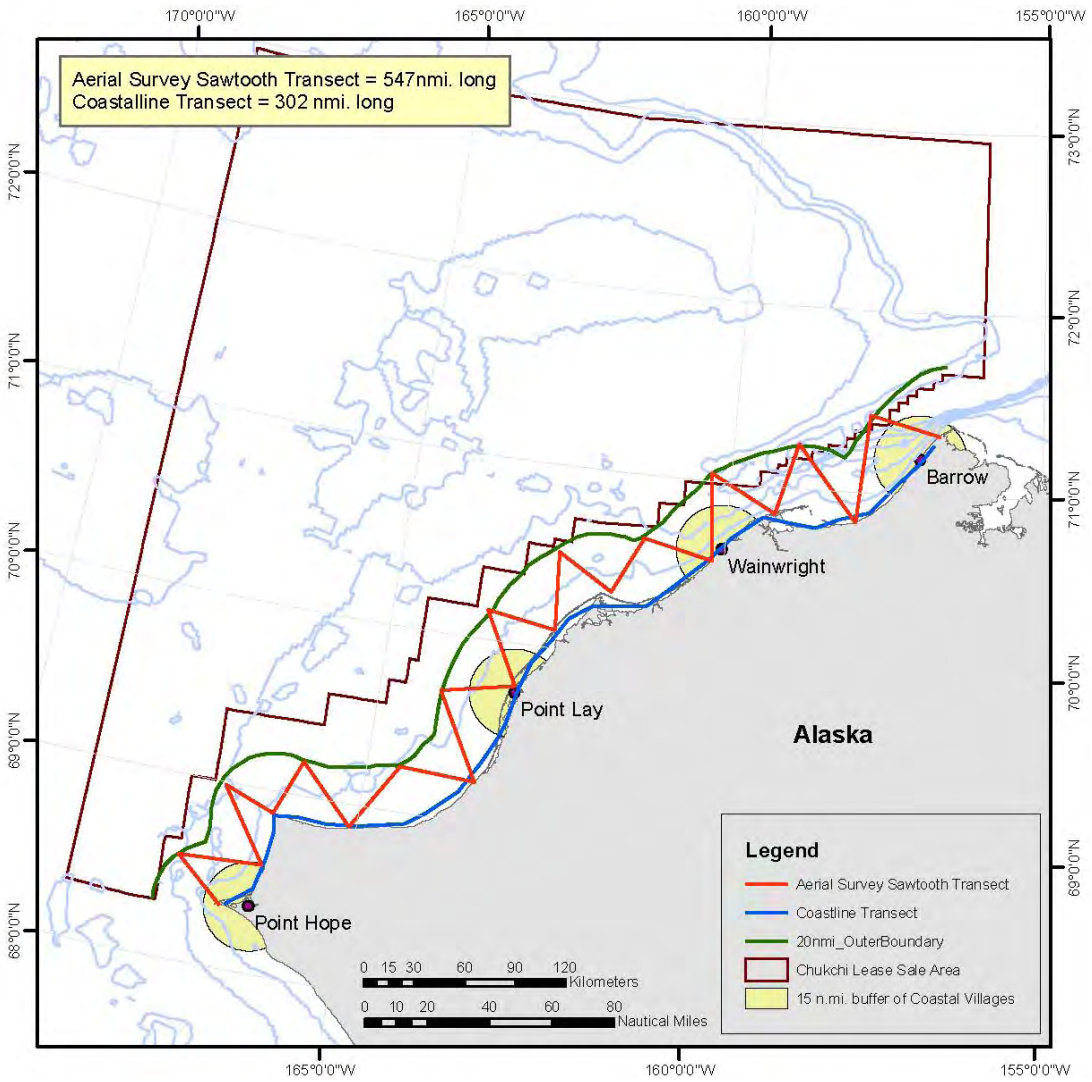

Figure 6. Aerial survey transects location and general pattern for the eastern Chukchi Sea, 2010. Specific transect start-/end-points will be altered randomly from survey to survey, and hunting areas will be avoided when hunting is occurring.

Standard aerial survey procedures used in previous marine mammal projects (by Shell as well as by others) will be followed. This will facilitate comparisons and (as appropriate) pooling with other data, and will minimize controversy about the chosen survey procedures. The aircraft will be flown at 110–120 knots ground speed and usually at an altitude of 1,000 ft (305 m). In accordance with anticipated stipulations in the LOA, survey aircraft will be flown at 1500 ft (457 m) over the Ledyard Bay spectacled eider habitat after 1 July. Aerial surveys at an altitude of 1,000 ft (305 m) do not provide much information about seals but are suitable for bowhead, beluga, and gray whales. The need for a 1,000+ ft (305+ m) cloud ceiling will limit the dates and times when surveys can be flown. Selection of a higher altitude for surveys would result in a significant reduction in the number of days during which surveys would be possible, impairing the ability of the aerial program to meet its objectives.

If large concentrations of belugas are encountered during the survey, the survey may be interrupted to photograph the groups to obtain better counts of the number of animals present. If

whales are photographed in lagoons or other shallow-water concentration areas, the aircraft will climb to ~10,000 ft (3,050 m) altitude to avoid disturbing the whales and cause them to leave the area. If whales are in offshore areas, the aircraft will climb high enough to include all whales within a single photograph; typically about 3,000 ft (914 m) altitude. When in shallow water, belugas and other marine mammals are more sensitive to aircraft over flights and other forms of disturbance than when they are offshore. They frequently leave shallow estuaries when over flown at altitudes of 2,000–3,000 ft (610-904 m), whereas they rarely react to aircraft at 1,500 ft (457 m) when offshore in deeper water. Additionally, if large groups of other marine mammals are encountered on the surveys, such as the large aggregations of walruses seen in 2007, we will attempt to photograph the animals and provide location information to interested stakeholders.

Three MMOs will be aboard the aircraft during surveys. Two observers will be looking for marine mammals within 2.5 km of the survey track line; one each at bubble windows on either side of the aircraft. The third person will record data. When sightings are made, observers will notify the data recorder of the species or species class of the animal(s) sighted, the number of animals present, and the lateral distance (inclinometer angle) of the animals from the flight path of the aircraft. This information, along with time and location data from an onboard GPS, will be entered into a database.

At the start of each transect, the primary observer will record the transect start time and position, ceiling height (ft), cloud cover (in 10ths), wind speed (knots), wind direction (°T) and outside air temperature (°C). In addition, each observer will record the time, visibility (subjectively classified as excellent, good, moderately impaired, seriously impaired or impossible), sea state (Beaufort wind force), ice cover (in 10ths) and sun glare (none, moderate, severe) at the start and end of each transect, and at 2-min intervals along the transect. This will provide data in units suitable for statistical summaries and analyses of effects of these variables on the probability of detecting animals (see Davis et al. 1982; Miller et al. 1999; Thomas et al. 2002, Manley et al. 2004).

The data logger will automatically record time and aircraft position (latitude and longitude) for sightings and transect waypoints, and at pre-selected intervals along the transects. The primary data logger will be a laptop computer with Garmin Mapsource (ver 6.9) GPS software. Mapsource automatically stores the time and aircraft position at pre-selected intervals (typically at 6 seconds for straight-line transect surveys) and stores the records to a file as they are obtained.

Coordination with Other Aerial Surveys

The MMS, the NSB, or other organizations may conduct aerial surveys in the Chukchi Sea during the drilling season. Shell will consult with any groups or organizations conducting aerial surveys along the eastern Chukchi Sea coast regarding coordination during the drilling season. The objectives will be:

- to ensure aircraft separation when both crews conduct surveys in the same general region,
- to coordinate the 2010 aerial survey projects in order to maximize consistency and minimize duplication,
- to maximize consistency with previous years' efforts insofar as feasible.

Analysis of Aerial Survey Data

During the field program, preliminary maps and summaries of the daily surveys will be provided to NMFS as normally required by the terms of the IHA. While in the field data will be

checked for entry errors and files will be backed up to CDs or portable memory drives. Reporting of results will focus on the distribution of the observed species along the coast and the seasonal timing (if any) of the observed species.

Acoustic "Net" Array in Chukchi Sea

Background and Objectives

The acoustic "net" array used during the 2006–2009 field seasons in the Chukchi Sea was designed to accomplish two main objectives. The first was to collect information on the occurrence and distribution of marine mammals (including beluga whale, bowhead whale, and walrus) that may be available to subsistence hunters near villages located on the Chukchi Sea coast and to document their relative abundance, habitat use, and migratory patterns. The second objective was to measure the ambient soundscape throughout the eastern Chukchi Sea and to record received levels of sounds from industry and other activities further offshore in the Chukchi Sea.

Technical Approach

The net array configuration used in 2007–2009 is again proposed for 2010. The basic components of this effort consist of 30 hydrophone systems placed widely across the US Chukchi Sea and a prospect specific array of 12 hydrophones capable of localization of mammal calls. The net array configuration will include hydrophone systems distributed at each of the four primary transect locations: Cape Lisburne, Point Hope, Wainwright and Barrow. The systems comprising the regional array will be placed at locations shown in Figure 7. These offshore systems will capture exploration drilling sounds, if present, over large distances to help characterize the sound transmission properties in the Chukchi Sea. They will also provide a large amount of information related to marine mammals in the Chukchi Sea.

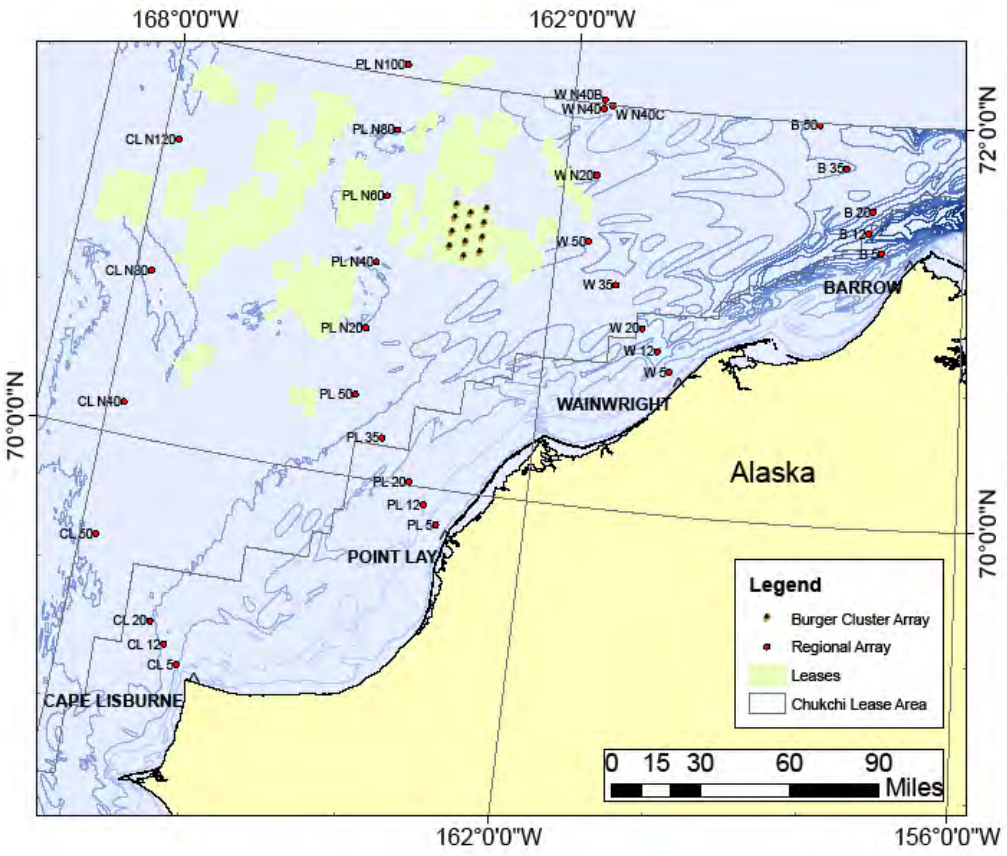

Figure 7. Deployment locations of Hydrophones in acoustic arrays in the eastern Chukchi Sea, Alaska 2010. Depiction of hydrophone array at Burger is not scaled correctly based on description below (12 km by 18 km)

The regional acoustic monitoring program, will be augmented in 2010 by an array of twelve additional acoustic recorders to be deployed on a grid pattern over a 7.2 mi (12 km) by 10.8 mi (18 km) area extending over several of Shell's lease blocks near locations of highest interest for drilling in 2010. The cluster array will operate at a sampling frequency of 16 kHz, which is sufficient to capture vocalizations from bowhead, beluga, walrus, gray whale, fin whale, humpback, killer whale and most other marine mammals known to be present in the Chukchi Sea. The cluster deployment configuration was defined to allow tracking of vocalizing animals that pass through the immediate area of these lease blocks. Maximum separation between adjacent recorders is 3.6 mi (5.8 km). At this spacing we expect that individual whale calls will be detected on at least 3 different recorders when the calling animals are within the boundary of the deployment pattern. Bowhead and other mysticete calls should be detectable simultaneously on more than 3 recorders due to their relatively higher sound source levels compared to other marine mammals. In calm weather conditions, when ambient underwater sound levels are low, we expect to have detection of most other marine mammal calls on more than 3 recorders. The goal of simultaneous detection on multiple recorders is to allow for triangulation of the call positions, which also requires accurate time synchronization of the recorders. When small numbers of whales are vocalizing Shell hopes to be able to identify and track the movements of specific individuals within the deployment area. It will not be possible to track individual whales if many

whales are calling due to abundant overlapping calls. In this case analyses will show the general distribution of calls in the vicinity of the recorders.

Analysis and Reporting

The Chukchi Net Arrays of 30 recorders and Cluster Array, deployed for up to 3 months, will produce an extremely large dataset comprising several Terabytes of acoustic data. The analyses of these data require identification of marine mammal vocalizations. Because of the very large amount of data to be processed, the analysis methods will incorporate the automated vocalization detection algorithms developed at Scripps Institute of Oceanography (Scripps). Scripps personnel will be assigned to assist in application of these algorithms for this analysis. While the hydrophones used in the net array are not directional, and therefore not capable of accurate localization of detections, the number of vocalizations detected on each of the sensors will provide good measurement of the relative spatial density distribution of various marine mammals. These results will therefore provide information such as timing of migrations and routes of migration for belugas and bowheads.

A second purpose of the Chukchi net array is to monitor the amplitude of drilling sounds reaching the near-shore region. It is expected that sounds from drilling activities will be detectable on hydrophone systems when ambient sound energy conditions are low. The drilling sound levels at recorder locations will be quantified and reported.

Analysis of all acoustic data will be prioritized to address the primary questions. The primary data analysis questions are to (a) determine when, where, and what species of animals are acoustically detected on each recorder (b) analyze data as a whole to determine offshore distributions as a function of time, (c) quantify spatial and temporal variability in the ambient sound energy, and (d) measure received levels of drilling survey events and drillship activities. The detection data will be used to develop spatial and temporal animal detection distributions. Statistical analyses will be used to test for changes in animal detections and distributions as a function of different variables (e.g., time of day, season, environmental conditions, ambient sound energy, and drilling or vessel sound levels).

COMPREHENSIVE REPORT ON INDUSTRY ACTIVITIES AND MARINE MAMMAL MONITORING EFFORTS IN THE BEAUFORT AND CHUKCHI SEAS

Following the 2010 drilling season a comprehensive report describing the acoustic, vessel-based, and aerial monitoring programs will be prepared. The comprehensive report will describe the methods, results, conclusions and limitations of each of the individual data sets in detail. The report will also integrate (to the extent possible) the studies into a broad based assessment of industry activities and their impacts on marine mammals in the Chukchi Sea during 2010. The report will help to establish long term data sets that can assist with the evaluation of changes in the Chukchi Sea ecosystems. The report will attempt to provide a regional synthesis of available data on industry activity in offshore areas of northern Alaska that may influence marine mammal density, distribution and behavior.

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Appendix D

Marine Mammal Monitoring and Mitigation Plan

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Marine Mammal Monitoring and Mitigation Plan

for

Exploration Drilling of Selected Lease Areas in the Alaskan Chukchi Sea in 2010

Shell Gulf of Mexico Inc.
3601 C Street, Suite 1000
Anchorage, Alaska 99503

July 2009

Marine Mammal Monitoring and Mitigation Plan

For

Exploration drilling of selected lease areas in the Alaskan Chukchi Sea

Shell Gulf of Mexico Inc.
3601 C Street, Suite 1000
Anchorage, Alaska 99503

July 2009

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ACRONYMS

4MP	Marine Mammal Monitoring and Mitigation Plan
AEWC	Alaska Eskimo Whaling Commission
dB	decibel
CD	Compact Disc
GPS	Global Positioning System
ft	feet
Hz	Hertz
IHA	Incidental Harassment Authorization
kHz	kilohertz
km	kilometer
LOA	Letter of Authorization
m	meter(s)
mi	mile(s)
MMO	Marine Mammal Observer
MMS	Minerals Management Service
NMFS	National Marine Fisheries Service
NSB	North Slope Borough
NVD	Night-vision Device
rms	Root Mean Square
Scripps	Scripps Institute of Oceanography
Shell	Shell Gulf of Mexico Inc.
SPL	Sound Pressure Level
USFWS	U.S. Fish and Wildlife Service

INTRODUCTION

Shell Gulf of Mexico Inc. (Shell) will conduct a Marine Mammal Monitoring and Mitigation Plan (4MP) for exploration drilling activities in the Chukchi Sea during the 2010 drilling season. The 4MP developed for Shell's 2010 exploration drilling program supports protection of the marine mammal resources in the area, fulfills reporting obligations to the Minerals Management Service (MMS), the National Marine Fisheries Service (NMFS), and the U.S. Fish and Wildlife Service (USFWS), and establishes a means for gathering additional baseline data on marine mammals for future operations planning.

Shell plans to conduct exploration drilling within existing lease holdings in the Chukchi Sea. Drilling will be conducted from the M/V *Frontier Discoverer* (*Discoverer)* drillship owned by Frontier Drilling. The drillship is an ice-class drilling vessel designed, engineered and constructed to safely operate in the Chukchi Sea. The support vessels will include tugs and barges, an icebreaker, anchor handler/ice management vessel, and oil spill response vessels.

Shell's 4MP is a combination of active monitoring of the area of operations and the implementation of mitigation measures designed to minimizing project impacts to marine mammal resources. Monitoring will provide information on the numbers of marine mammals potentially affected by the exploration operations and facilitate real time mitigation to prevent injury of marine mammals by industrial sounds or activities. These goals will be accomplished by conducting vessel-based, aerial, and acoustic monitoring programs to characterize the sounds produced by the drilling activities and support vessels, and to document the potential reactions of marine mammals in the area to those sounds and activities.

Aerial monitoring and reconnaissance of marine mammals in coastal areas of the Chukchi Sea and recordings of ambient sound levels and vocalizations of marine mammals along the Chukchi Sea coast will be used to interpret potential impacts to marine mammals in subsistence use areas. Acoustic measurements will be made to establish safety radii for real time mitigation, if necessary, around the activities. These measurements will be used to determine the sound levels produced by various equipment and to establish any safety and disturbance radii if necessary. An initial sound source analysis will be supplied to NMFS within 120 hours of completion of the measurements, if possible. A detailed report will be issued to NMFS as part of the 90-day report following the end of the drilling season. Shell will continue to measure the sound propagation of the drillship at various times or throughout the drilling program. Sound energy from support vessels will also be measured. Bottom-founded hydrophones will also be placed in a large array across the Chukchi Sea to collect information on the use of the region by marine mammals and additional information on the propagation of sounds from human activities.

VESSEL-BASED MARINE MAMMAL MONITORING PROGRAM

Introduction

The vessel-based operations of Shell's 4MP are designed to meet the requirements of the IHA and the LOA which Shell expects to be issued by the NMFS and the USFWS, respectively, and to meet any other agreements between Shell and other agencies or groups. The objectives of the program will be to ensure that disturbance to marine mammals and subsistence hunts is minimized, that effects on marine mammals are documented, and to collect baseline data on the occurrence and distribution of marine mammals in the project area.

The 4MP will be implemented by a team of experienced marine mammal observers (MMOs). These MMOs will be trained, experienced field observers, including both biologists and Inupiat personnel. The MMOs will be stationed aboard the drillship and associated support vessels throughout the drilling period. The duties of the MMOs will include watching for and identifying marine mammals; recording their numbers, distances, and reactions to the drilling operations; initiating mitigation measures when appropriate; and reporting the results. Reporting of the results of the vessel-based monitoring program will include the estimation of the number of marine mammal "takes" as defined by the NMFS and stipulated in the IHA.

The vessel-based operations of Shell's 4MP will be required to support the vessel based drilling activities in the Chukchi Sea. The dates and operating areas will depend upon ice and weather conditions, along with Shell's arrangements with agencies and stakeholders. Drilling activities are expected to occur from July through October 2010, or intermittently during that time. Vessel-based monitoring for marine mammals will be done throughout the period of drilling operations to comply with provisions in the anticipated IHA and LOA from NMFS and USFWS, respectively.

The vessel-based work will provide:

- the basis for real-time mitigation, if necessary, as required by the various permits that Shell receives,
- information needed to estimate the number of "takes" of marine mammals by harassment, which must be reported to NMFS and USFWS,
- data on the occurrence, distribution, and activities of marine mammals in the areas where the drilling program is conducted,
- information to compare the distances, distributions, behavior, and movements of marine mammals relative to the drillship at times with and without drilling activity,
- a communication channel to coastal communities including Inupiat whalers,
- employment and capacity building for local residents, with one objective being to develop a larger pool of experienced Inupiat MMOs.

The 4MP will be operated and administered consistent with monitoring programs conducted during seismic and shallow hazards surveys in 2006–2008 or such alternative requirements as may be specified in the permits issued to Shell for this project. Any other agreements between Shell and agencies or groups such as MMS, USFWS, the North Slope Borough (NSB), and the Alaska Eskimo Whaling Commission (AEWC) will also be fully incorporated. All MMOs will be provided training through a program approved by NMFS and Shell, as described later. At least one observer on each vessel will be an Inupiat who will have the additional responsibility of communicating with the Inupiat community and (during the various subsistence harvests) directly with Inupiat hunters and whalers. Details of the vessel-based marine mammal monitoring program are described below.

Mitigation Measures during Drilling Activities

Shell's planned exploration drilling program incorporates both design features and operational procedures for minimizing potential impacts on marine mammals and on subsistence hunts. The design features and operational procedures have been described in the IHA and LOA applications submitted to NMFS and USFWS, respectively and are summarized below. Survey design features are

- timing and locating drilling and support activities to avoid interference with the annual subsistence hunting by the peoples of the Chukchi villages,
- conducting pre-season acoustic modeling to establish the appropriate safety zones and behavioral or disturbance radii,
- vessel-based monitoring to implement appropriate mitigation if necessary, and to determine the effects of project activities on marine mammals,
- acoustic monitoring of drilling and vessel sounds and marine mammal vocalizations.

The potential disturbance of marine mammals during drilling operations will be minimized further through the implementation of several ship-based mitigation measures if mitigation becomes necessary.

Safety and Disturbance Zones

Under current NMFS guidelines (e.g., NMFS 2000), "safety radii" for marine mammals around industrial sound sources are customarily defined as the distances within which received pulse levels are ≥180 dB re 1 µPa (rms) for cetaceans and ≥190 dB re 1 µPa (rms) for pinnipeds. These safety criteria are based on an assumption that sound pulses received at lower levels will not injure these animals or impair their hearing abilities, but that higher received levels might have some such effects.

Disturbance or behavioral effects to marine mammals from underwater sound may occur after exposure to sound at distances greater than the safety radii (Richardson et al. 1995). NMFS assumes that marine mammals exposed to underwater pulsed sound levels ≥160 dB rms have the potential to be disturbed behaviorally. In recent years there has also been concern that exposure to sound levels ≥120 dB rms may affect the behavior of bowhead whale cow/calf pairs. The NMFS may require monitoring for cetaceans at a distance within which continuous received levels from drilling operations are ≥120 dB rms. Safety and disturbance zones for marine mammals around continuous sound sources, such as those produced during drilling activity, have not been well established by the NMFS.

Expected safety and disturbance radii based on sound propagation from the drillship *Discoverer* and an ice management vessel actively managing ice, the *Vladimir Ignatjuk*, were modeled by JASCO Applied Sciences at the three potential well locations. Changes in the water column of the Chukchi Sea through the course of the open-water season will likely affect the propagation of sounds produced by drilling activities, so models were run for expected oceanographic conditions in July and October to bracket the seasonal variability. These radii will be used for mitigation purposes, should they be necessary, until direct measurements are available early during the exploration drilling activities. Shell will measure the received levels of underwater sound versus distance and direction from the sound sources using calibrated hydrophones. The acoustic data will be analyzed as quickly as reasonably practicable in the field and used to verify (and if necessary adjust) the safety and disturbance radii.

Sounds from the *Discoverer* have not previously been measured in the Arctic or elsewhere, but sounds from a similar drillship, *Explorer II*, were measured in the Beaufort Sea (Greene 1987; Miles et al. 1987). The underwater received sound pressure level in the 20 to 1000 Hz band for drilling activity by the *Explorer II*, including a nearby support vessel, was 134 dB re 1 µPa at 0.2 km (Greene 1987). Sounds produced by the *Vladimir Ignatjuk*, formerly named *Kalvik*, were measured by Hall et al. (1994) while icebreaking and Brewer et al. (1993) while transiting. The back-propagated source levels from Hall et al. (1994) during icebreaking were used to model sounds that may be produced during ice-management activities. The back propagated sources

levels from Brewer et al. (1993) were found to be questionably high so the results from Hall et al. (1994) were reduced by 15 dB based on observational evidence that icebreakers pushing ice radiate sound ~10-15 dB stronger than while transiting. Estimated source levels from these measurements were 175 dB re 1 μPa (rms) and 181 dB re 1 μPa (rms), for drilling and icebreaking, respectively. The source levels from these measurements were used as a proxy for modeling the sounds likely to be produced by drilling activities from the *Discoverer* and an associated support vessel at the three potential well locations in the Chukchi Sea. Based on the models, source levels are expected to fall below 180 dB rms within tens of meters and below 160 dB rms within 100 m. The largest 120 dB rms radius from the drillship estimated for one of the three possible locations was 6.7 km.

The source levels noted above for exploration drilling and support vessel activities are not high enough to cause a temporary reduction in hearing sensitivity or permanent hearing damage to marine mammals. Consequently, mitigation as described for seismic activities including ramp ups, power downs, and shut downs should not be necessary for drilling activities. However, Shell plans to use MMOs onboard the drillship and the various support vessels to monitor marine mammals and their responses to industry activities and to initiate mitigation measures should in-field measurements of the operations indicate conditions represent a threat to the health and well-being of marine mammals.

Marine Mammal Observers

Vessel-based monitoring for marine mammals will be done by trained MMOs throughout the period of drilling operations to comply with expected provisions in the IHA and LOA that Shell receives. The observers will monitor the occurrence and behavior of marine mammals near the drillship and support vessels during all daylight periods during the drilling operation, and during most periods when drilling is not being conducted. MMO duties will include watching for and identifying marine mammals; recording their numbers, distances, and reactions to the drilling operations; and documenting "take by harassment" as defined by NMFS.

Number of observers

A sufficient number of MMOs will be onboard each vessel to meet the following criteria

- 100 percent monitoring coverage during all periods of drilling operations in daylight
- maximum of four consecutive hours on watch per MMO
- maximum of approximately 12 hours on watch per day per MMO

MMO teams will consist of trained Inupiat and field biologist observers. An experienced field crew leader will be a member of every MMO team aboard the drillship and each support vessel during the drilling program. The total number of MMOs aboard may decrease later in the season as the duration of daylight decreases assuming NMFS does not require continuous nighttime monitoring. Inupiat MMOs will also function as Native language communicators with hunters and whaling crews and with the Communications and Call Centers (Com Centers) in Native villages along the Chukchi Sea coast.

Crew Rotation

Shell anticipates that there will be provision for crew rotation at least every three to six weeks to avoid observer fatigue. During crew rotations detailed hand-over notes will be provided to the incoming crew leader by the outgoing leader. Other communications such as email, fax, and/or phone communication between the current and oncoming crew leaders during each

rotation will also occur when possible. In the event of an unexpected crew change Shell will facilitate such communications to insure monitoring consistency among shifts.

Observer Qualifications and Training

Crew leaders and most other biologists serving as observers in 2010 will be individuals with experience as observers during one or more of the 2006–2009 monitoring projects for Shell or recent experience with other operators in Alaska or the Canadian Beaufort.

Biologist-observers will have previous marine mammal observation experience, and field crew leaders will be highly experienced with previous vessel-based marine mammal monitoring projects. Resumés for those individuals will be provided to NMFS for approval. All observers will be trained and familiar with the marine mammals of the area. A marine mammal observers' handbook, adapted for the specifics of the planned Shell drilling program will be prepared and distributed beforehand to all MMOs (see below).

Most observers will also complete a two-day training and refresher session on marine mammal monitoring, to be conducted shortly before the anticipated start of the 2010 drilling season. Any exceptions will have or receive equivalent experience or training. The training session(s) will be conducted by marine mammalogists with extensive crew-leader experience during previous vessel-based seismic monitoring programs.

Primary objectives of the training include:

- review of the marine mammal monitoring plan for this project, including any amendments adopted, or specified by NMFS or USFWS in the IHA or LOA, by MMS, or other agreements in which Shell may elect to participate,
- review of marine mammal sighting, identification, and distance estimation methods, including any amendments specified by NMFS or USFWS in the 2010 IHA or LOA,
- review of operation of specialized equipment (reticle binoculars, night vision devices, and GPS system),
- review of, and classroom practice with, data recording and data entry systems, including procedures for recording data on mammal sightings, drilling and monitoring operations, environmental conditions, and entry error control. These procedures will be implemented through use of a customized computer database and laptop computers.

MMO Handbook

A Marine Mammal Observers' Handbook will be prepared for Shells's monitoring program. Handbooks contain maps, illustrations, and photographs as well as text and are intended to provide guidance and reference information to trained individuals who will participate as MMOs. The following topics will be covered in the MMO Handbook:

- summary overview descriptions of the project, marine mammals and underwater sound energy, the marine mammal monitoring program (vessel-based, aerial, acoustic measurements, special studies), the NMFS IHA and USFWS LOA and other regulations/permits/agencies, the Marine Mammal Protection Act,
- monitoring and mitigation objectives and procedures, including initial safety radii,
- responsibilities of staff and crew regarding the marine mammal monitoring plan,
- instructions for ship crew regarding the marine mammal monitoring plan,

- data recording procedures: codes and coding instructions, common coding mistakes, electronic database; navigational, marine physical, and drilling data recording, field data sheet,
- use of specialized field equipment (reticle binoculars, Big-eye binoculars, NVDs, laser rangefinders),
- reticle binocular distance scale,
- table of wind speed, Beaufort wind force, and sea state codes,
- data storage and backup procedures,
- list of species that might be encountered: identification, natural history,
- safety precautions while onboard,
- crew and/or personnel discord; conflict resolution among MMOs and crew,
- drug and alcohol policy and testing,
- scheduling of cruises and watches,
- communications,
- list of field gear provided,
- suggested list of personal items to pack,
- suggested literature, or literature cited,
- copies of the NMFS IHA and USFWS LOA will be made available.

Monitoring Methodology

The observer(s) will watch for marine mammals from the best available vantage point on the drillship and support vessels. The observer(s) will scan systematically with the naked eye and 7×50 reticle binoculars, supplemented with Big-eye binoculars and night-vision equipment when needed (see below). Personnel on the bridge will assist the marine mammal observer(s) in watching for pinnipeds and whales.

Information to be recorded by marine mammal observers will include the same types of information that were recorded during previous monitoring projects (e.g., Moulton and Lawson 2002). When a mammal sighting is made, the following information about the sighting will be recorded:

- species, group size, age/size/sex categories (if determinable), behavior when first sighted and after initial sighting, heading (if consistent), bearing and distance from observer, apparent reaction to activities (e.g., none, avoidance, approach, paralleling, etc.), closest point of approach, and behavioral pace,
- time, location, speed, and activity of the vessel, sea state, ice cover, visibility, and sun glare,
- the positions of other vessel(s) in the vicinity of the observer location.

The ship's position, speed, water depth, sea state, ice cover, visibility, and sun glare will also be recorded at the start and end of each observation watch, every 30 minutes during a watch, and whenever there is a change in any of those variables.

Distances to nearby marine mammals will be estimated with binoculars (Fujinon 7×50 binoculars) containing a reticle to measure the vertical angle of the line of sight to the animal relative to the horizon.

Observers may use a laser rangefinder to test and improve their abilities for visually estimating distances to objects in the water. However, previous experience showed that a Class 1 eye-safe device was not able to measure distances to seals more than about 230 feet (ft) [70 meters (m)] away. The device was very useful in improving the distance estimation abilities of the observers at distances up to about 1,968 ft (600 m)—the maximum range at which the device could measure distances to highly reflective objects such as other vessels. Humans observing objects of more-or-less known size via a standard observation protocol, in this case from a standard height above water, quickly become able to estimate distances within about ±20 percent when given immediate feedback about actual distances during training.

Monitoring At Night and In Poor Visibility

Night-vision equipment ("Generation 3" binocular image intensifiers, or equivalent units) will be available for use when needed. However, past experience with night-vision devices (NVDs) in the Beaufort Sea and elsewhere indicates that NVDs are not nearly as effective as visual observation during daylight hours (e.g., Harris et al. 1997, 1998; Moulton and Lawson 2002).

Specialized Field Equipment

Shell will provide or arrange for the following specialized field equipment for use by the onboard MMOs: reticle binoculars, Big-eye binoculars, GPS unit, laptop computers, night vision binoculars, and possibly digital still and digital video cameras.

Field Data-Recording, Verification, Handling, and Security

The observers on the drillship and support vessels will record their observations onto datasheets or directly into handheld computers. During periods between watches and periods when operations are suspended, those data will be entered into a laptop computer running a custom computer database. The accuracy of the data entry will be verified in the field by computerized validity checks as the data are entered, and by subsequent manual checking of the database printouts. These procedures will allow initial summaries of data to be prepared during and shortly after the field season, and will facilitate transfer of the data to statistical, graphical or other programs for further processing. Quality control of the data will be facilitated by (1) the start-of-season training session, (2) subsequent supervision by the onboard field crew leader, and (3) ongoing data checks during the field season.

The data will be backed up regularly onto CDs and/or USB disks, and stored at separate locations on the vessel. If possible, data sheets will be photocopied daily during the field season. Data will be secured further by having data sheets and backup data CDs carried back to the Anchorage office during crew rotations.

In addition to routine MMO duties, observers will be encouraged to record comments about their observations into the "comment" field in the database. Copies of these records will be available to the observers for reference if they wish to prepare a statement about their observations. If prepared, this statement would be included in the 90-day and final reports documenting the monitoring work.

Field Reports

Throughout the drilling program, the biologists will prepare a report each day or at such other interval as required summarizing the recent results of the monitoring program. The reports will summarize the species and numbers of marine mammals sighted. These reports will be provided to NMFS as required.

Reporting

The results of the 2010 vessel-based monitoring, including estimates of "take by harassment", will be presented in the 90-day and final technical report(s). Reporting will address the requirements established by NMFS in the IHA.

The technical report(s) will include:

- summaries of monitoring effort: total hours, total distances, and distribution of marine mammals through study period for sea state, and other factors affecting visibility and detectability of marine mammals,
- analyses of the effects of various factors influencing detectability of marine mammals: sea state, number of observers, and fog/glare,
- species composition, occurrence, and distribution of marine mammal sightings including date, water depth, numbers, age/size/gender categories, group sizes, and ice cover,
- analyses of the effects of drilling operations:
  - sighting rates of marine mammals versus drilling activities (and other variables that could affect detectability),
  - initial sighting distances versus drilling state,
  - closest point of approach versus drilling state,
  - observed behaviors and types of movements versus drilling state,
  - numbers of sightings/individuals seen versus drilling state,
  - distribution around the drillship and support vessels versus drilling state,
  - estimates of "take by harassment".

ACOUSTIC MONITORING PLAN

Drilling Sound Measurements

Objectives

Drilling sounds are expected to vary significantly with time due to variations in the level of operations and the different types of equipment used at different times onboard the drillship. The goals of these measurements are (1) to quantify the absolute sound levels produced by drilling and to monitor their variations with time, distance and direction from the drillship, and (2) to measure the sound levels produced by vessels operating in support of drilling operations. These vessels will include crew change vessels, tugs, ice-management vessels, and spill response vessels.

Equipment

The drilling and vessel sound measurements will be performed using two methods that may be implemented separately or together. The first method will involve real time monitoring using bottom-mounted hydrophones that are cabled back to the drillship. These hydrophones will be positioned between 1,640–3,280 ft (500–1,000 m) from the drillship, depending on the final positions of the anchors used to moor the drillship. Hydrophone cables will be fed to real-time digitization systems on board (see Figure 2).

The second sound-monitoring method will be to deploy hydrophone systems (see Figure 3) at various distances from the drilling operations. Sound level monitoring with one or both

methods will occur on a continuous basis throughout all drilling activities. Both types of systems will be set to record digital acoustic data at sample rate 32 kHz, providing useful acoustic bandwidth to at least 15 kHz. Both the hydrophone systems use Reson TC4032 hydrophones with sensitivity -170 dB re V/μPa. These systems are capable of measuring absolute broadband sound levels between 90 dB re μPa and 180 dB re μPa.

The deployment of drilling sound monitoring equipment will occur as soon as possible once the drillship is on site at any of the prospects where Shell intends to drill an exploration well. Retrieval of these systems will occur following completion of the drilling activities. The long duration recordings will capture many different operations performed at the drillship. Accurate activity logs of drilling operations and nearby vessel activities will be maintained to correlate with these acoustic measurements.

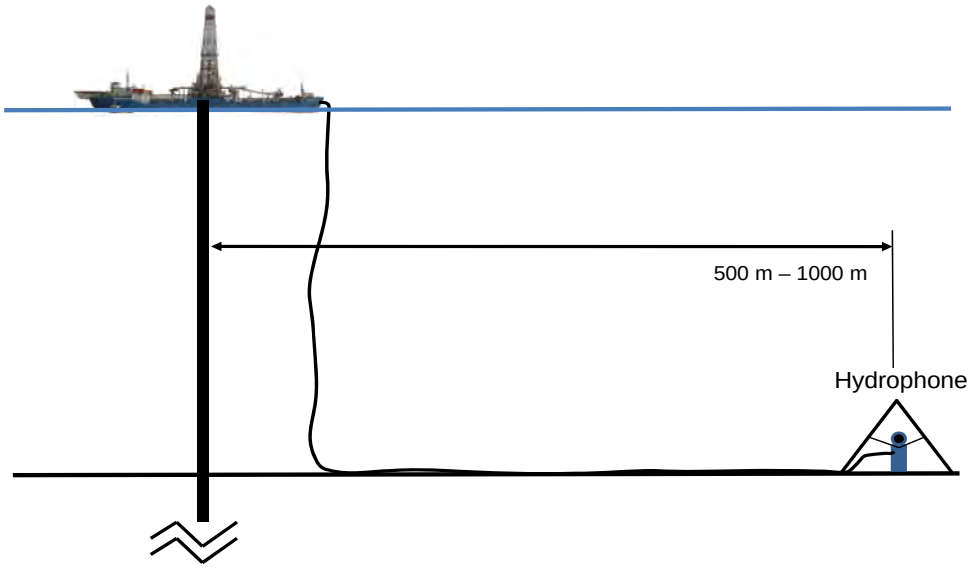

Figure 2: Cabled hydrophone method for real time monitoring of drilling sound energy.

Figure 3: Hydrophone recording system being deployed at sea. The hydrophone system is an autonomous recorder with very high recording resolution. Acoustic data is stored internally on a hard-drive.

Vessel Sounds Monitoring

Sound produced by the vessels supporting drilling operations will be recorded by the drilling sounds monitoring equipment. Logs of vessel position and activity will be used to determine the time varying contribution of each vessel to the overall sound level measurements. Additional dedicated measurements of vessel source levels will be obtained by having the vessels perform sail-pasts of the monitoring locations. These dedicated measurements will provide sound level versus distance from the respective vessels and will also be processed to compute source levels in 1/3-octave bands referenced to 1m range.

Acoustic Data Analyses

Drilling sound data will be analyzed to extract a record of the frequency-dependent sound levels as a function of time. Figure 4 shows the results of this type of analysis. These results are useful also for correlating measured sound energy events with specific survey operations and capturing marine mammal vocalizations. The analysis provides absolute sound levels in finite frequency bands that can be tailored to match the highest-sensitivity hearing ranges for species of interest. For example, bowhead hearing is thought to be most acute in the 100 Hz - 1000 Hz frequency range that corresponds with the blue dotted line in the upper plot of Figure 4.

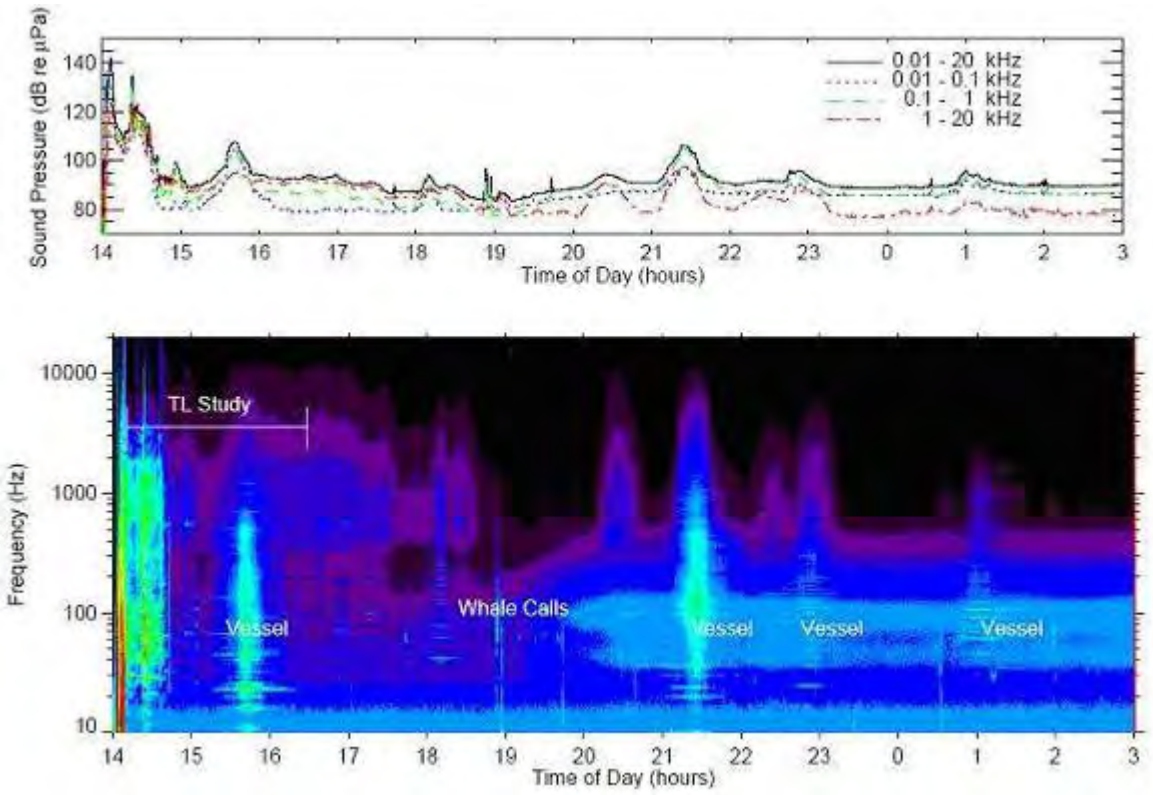

Figure 4: Lower: spectrogram of sound level measurements obtained from a hydrophone recording system. Upper: broadband and selected band level variation with time.

The analyses will also consider sound level integrated through 1-hour durations (referred to as sound energy equivalent level Leq (1-hour). Figure 5 (upper) shows an example of a Leq analysis of hydrophone data. Similar graphs for long time periods will be generated as part of the data analysis performed for indicating drilling sound variation with time in selected frequency bands.

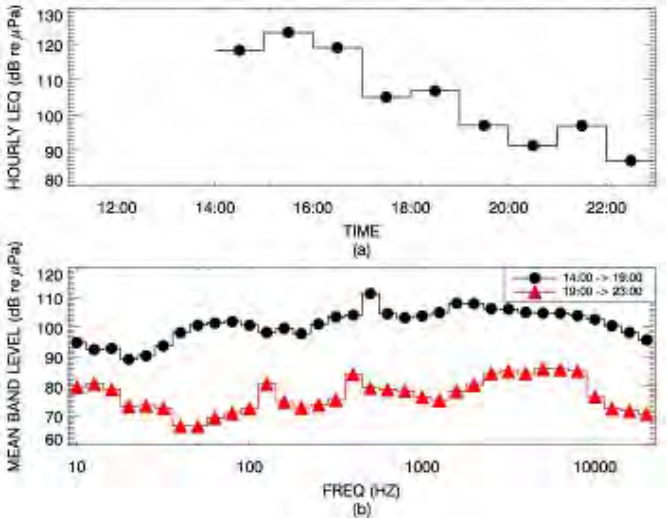

Figure 5: Upper: 1-hour Leq levels that will be calculated from acoustic measurements for use in correlating with bowhead whale deflection data.

Reporting of Results

Acoustic sound level results will be reported in the 90-day and comprehensive reports for this program. The results reported will include:

- sound Source Levels for the drillship and all drilling support vessels,
- spectrogram and band level versus time plots computed from the continuous recordings obtained from the hydrophone systems,
- hourly Leq levels at the hydrophone locations,
- correlation of drilling source levels with the type of drilling operation being performed. These results will be obtained by observing differences in drilling sound associated with differences in the drill rig activity as indicated in detailed drillship logs.

JOINT INDUSTRY STUDIES PROGRAM

This section describes studies that were undertaken from 2006 through 2008 in the Chukchi Sea that will be continued during drilling operations in 2010. Shell plans to conduct aerial surveys consistent with the previous 2006–2008 programs along the Chukchi Sea coast. Additionally, the acoustic net array similar to the one deployed in 2008 will be used to monitor industry sounds and marine mammals across the Chukchi Sea and along coast. Additional recorders will be deployed in the area around any of the prospects where Shell intends to drill.

Chukchi Sea Coastal Aerial Survey

Recent aerial surveys of marine mammals in the Chukchi Sea were conducted over coastal areas to approximately 23 miles (mi) [37kilometers (km)] offshore in 2006–2008 in support of Shell's summer seismic exploration. These surveys provided data on the distribution and abundance of marine mammals in nearshore waters of the Chukchi Sea. Shell plans to conduct an aerial survey program in the Chukchi Sea in 2010 that will be similar to the 2006–2008 programs.

Alaskan Natives from several villages along the east coast of the Chukchi Sea hunt marine mammals during the summer and Native communities are concerned that offshore oil and gas exploration activities may negatively impact their ability to harvest marine mammals. Of particular concern are potential impacts on the beluga harvest at Point Lay and on future bowhead harvests at Point Hope, Point Lay, Wainwright and Barrow. Other species of concern in the Chukchi Sea include the gray whale, bearded, ringed, and spotted seals, and walrus. Gray whale is expected to be the most numerous cetacean species encountered during the planned drilling activities, although beluga whales also occur in the area. The ringed seal is likely to be the most abundant pinniped species. The current aerial survey program will be designed to collect distribution data on cetaceans and will be limited in its ability to collect similar data on pinnipeds.

Objectives

The aerial survey program will be conducted in support of the Shell drilling program in the Chukchi Sea during summer and fall of 2010. The objectives of the aerial survey are:

- to address data deficiencies in the distribution and abundance of marine mammals in coastal areas of the eastern Chukchi Sea,

- to collect and report data on the distribution, numbers, orientation and behavior of marine mammals, particularly beluga whales, near traditional hunting areas in the eastern Chukchi Sea.

Survey Considerations

With agreement from hunters in the coastal villages, aerial surveys of coastal areas to approximately 23 mi (37 km) offshore between Point Hope and Point Barrow will begin in early to mid-July and will continue until drilling operations in the Chukchi Sea are completed. Weather and equipment permitting, surveys will be conducted twice per week during this time period. In addition, during the 2010 drilling season, aerial surveys will be coordinated in cooperation with the aerial surveys conducted by MMS and any other groups conducting surveys in the region.

Survey Procedures

Transects will be flown in a saw-toothed pattern between the shore and 23 mi (37 km) offshore as well as along the coast from Point Barrow to Point Hope (Fig. 6). This design will permit completion of the survey in one to two days and will provide representative coverage of the nearshore region. The surveyed area will include waters where belugas are normally available to subsistence hunters. Survey altitude will be at least 1,000 ft (305 m) with an average survey speed of 110 –120 knots. Sawtooth transects were designed by placing transect start/end points every 34 mi (55 km) along the offshore boundary of this 23 mi (37 km) wide nearshore zone, and at midpoints between those points along the coast. The transect line start/end points will be shifted along both the coast and the offshore boundary for each survey based upon a randomized starting location, but overall survey distance will not vary substantially. The coastline transect will simply follow the coastline or barrier islands. As with past surveys of the Chukchi Sea coast, coordination with coastal villages to avoid disturbance of the beluga whale subsistence hunt will be extremely important. "No-fly" zones around coastal villages or other hunting areas established during communications with village representatives will be in place until the end of the hunting season.

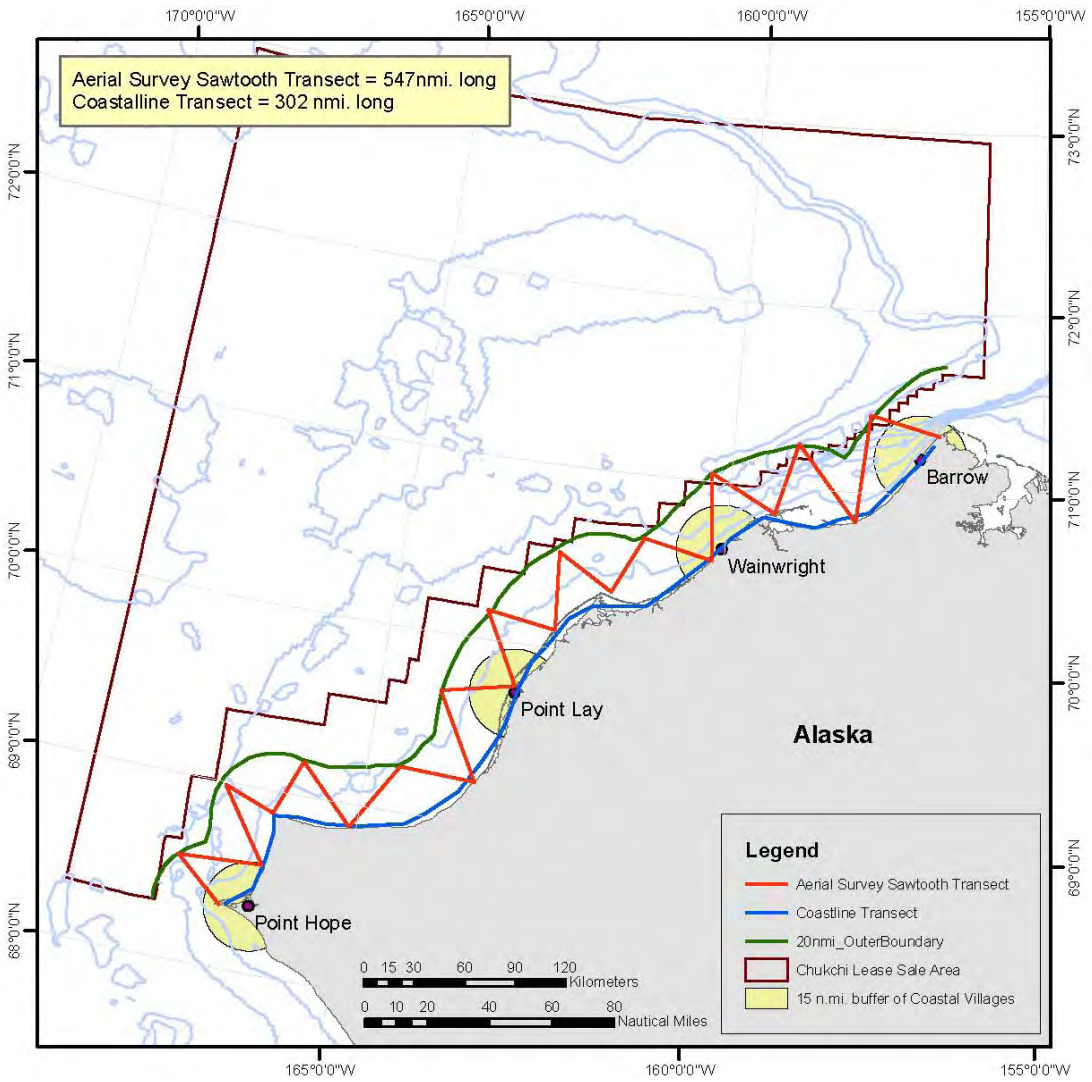

Figure 6. Aerial survey transects location and general pattern for the eastern Chukchi Sea, 2010. Specific transect start-/end-points will be altered randomly from survey to survey, and hunting areas will be avoided when hunting is occurring.

Standard aerial survey procedures used in previous marine mammal projects (by Shell as well as by others) will be followed. This will facilitate comparisons and (as appropriate) pooling with other data, and will minimize controversy about the chosen survey procedures. The aircraft will be flown at 110–120 knots ground speed and usually at an altitude of 1,000 ft (305 m). In accordance with anticipated stipulations in the LOA, survey aircraft will be flown at 1500 ft (457 m) over the Ledyard Bay spectacled eider habitat after 1 July. Aerial surveys at an altitude of 1,000 ft (305 m) do not provide much information about seals but are suitable for bowhead, beluga, and gray whales. The need for a 1,000+ ft (305+ m) cloud ceiling will limit the dates and times when surveys can be flown. Selection of a higher altitude for surveys would result in a significant reduction in the number of days during which surveys would be possible, impairing the ability of the aerial program to meet its objectives.

If large concentrations of belugas are encountered during the survey, the survey may be interrupted to photograph the groups to obtain better counts of the number of animals present. If

whales are photographed in lagoons or other shallow-water concentration areas, the aircraft will climb to ~10,000 ft (3,050 m) altitude to avoid disturbing the whales and cause them to leave the area. If whales are in offshore areas, the aircraft will climb high enough to include all whales within a single photograph; typically about 3,000 ft (914 m) altitude. When in shallow water, belugas and other marine mammals are more sensitive to aircraft over flights and other forms of disturbance than when they are offshore. They frequently leave shallow estuaries when over flown at altitudes of 2,000–3,000 ft (610-904 m), whereas they rarely react to aircraft at 1,500 ft (457 m) when offshore in deeper water. Additionally, if large groups of other marine mammals are encountered on the surveys, such as the large aggregations of walruses seen in 2007, we will attempt to photograph the animals and provide location information to interested stakeholders.

Three MMOs will be aboard the aircraft during surveys. Two observers will be looking for marine mammals within 2.5 km of the survey track line; one each at bubble windows on either side of the aircraft. The third person will record data. When sightings are made, observers will notify the data recorder of the species or species class of the animal(s) sighted, the number of animals present, and the lateral distance (inclinometer angle) of the animals from the flight path of the aircraft. This information, along with time and location data from an onboard GPS, will be entered into a database.

At the start of each transect, the primary observer will record the transect start time and position, ceiling height (ft), cloud cover (in 10ths), wind speed (knots), wind direction (°T) and outside air temperature (°C). In addition, each observer will record the time, visibility (subjectively classified as excellent, good, moderately impaired, seriously impaired or impossible), sea state (Beaufort wind force), ice cover (in 10ths) and sun glare (none, moderate, severe) at the start and end of each transect, and at 2-min intervals along the transect. This will provide data in units suitable for statistical summaries and analyses of effects of these variables on the probability of detecting animals (see Davis et al. 1982; Miller et al. 1999; Thomas et al. 2002, Manley et al. 2004).

The data logger will automatically record time and aircraft position (latitude and longitude) for sightings and transect waypoints, and at pre-selected intervals along the transects. The primary data logger will be a laptop computer with Garmin Mapsource (ver 6.9) GPS software. Mapsource automatically stores the time and aircraft position at pre-selected intervals (typically at 6 seconds for straight-line transect surveys) and stores the records to a file as they are obtained.

Coordination with Other Aerial Surveys

The MMS, the NSB, or other organizations may conduct aerial surveys in the Chukchi Sea during the drilling season. Shell will consult with any groups or organizations conducting aerial surveys along the eastern Chukchi Sea coast regarding coordination during the drilling season. The objectives will be:

- to ensure aircraft separation when both crews conduct surveys in the same general region,
- to coordinate the 2010 aerial survey projects in order to maximize consistency and minimize duplication,
- to maximize consistency with previous years' efforts insofar as feasible.

Analysis of Aerial Survey Data

During the field program, preliminary maps and summaries of the daily surveys will be provided to NMFS as normally required by the terms of the IHA. While in the field data will be

checked for entry errors and files will be backed up to CDs or portable memory drives. Reporting of results will focus on the distribution of the observed species along the coast and the seasonal timing (if any) of the observed species.

Acoustic "Net" Array in Chukchi Sea

Background and Objectives

The acoustic "net" array used during the 2006–2009 field seasons in the Chukchi Sea was designed to accomplish two main objectives. The first was to collect information on the occurrence and distribution of marine mammals (including beluga whale, bowhead whale, and walrus) that may be available to subsistence hunters near villages located on the Chukchi Sea coast and to document their relative abundance, habitat use, and migratory patterns. The second objective was to measure the ambient soundscape throughout the eastern Chukchi Sea and to record received levels of sounds from industry and other activities further offshore in the Chukchi Sea.

Technical Approach

The net array configuration used in 2007–2009 is again proposed for 2010. The basic components of this effort consist of 30 hydrophone systems placed widely across the US Chukchi Sea and a prospect specific array of 12 hydrophones capable of localization of mammal calls. The net array configuration will include hydrophone systems distributed at each of the four primary transect locations: Cape Lisburne, Point Hope, Wainwright and Barrow. The systems comprising the regional array will be placed at locations shown in Figure 7. These offshore systems will capture exploration drilling sounds, if present, over large distances to help characterize the sound transmission properties in the Chukchi Sea. They will also provide a large amount of information related to marine mammals in the Chukchi Sea.

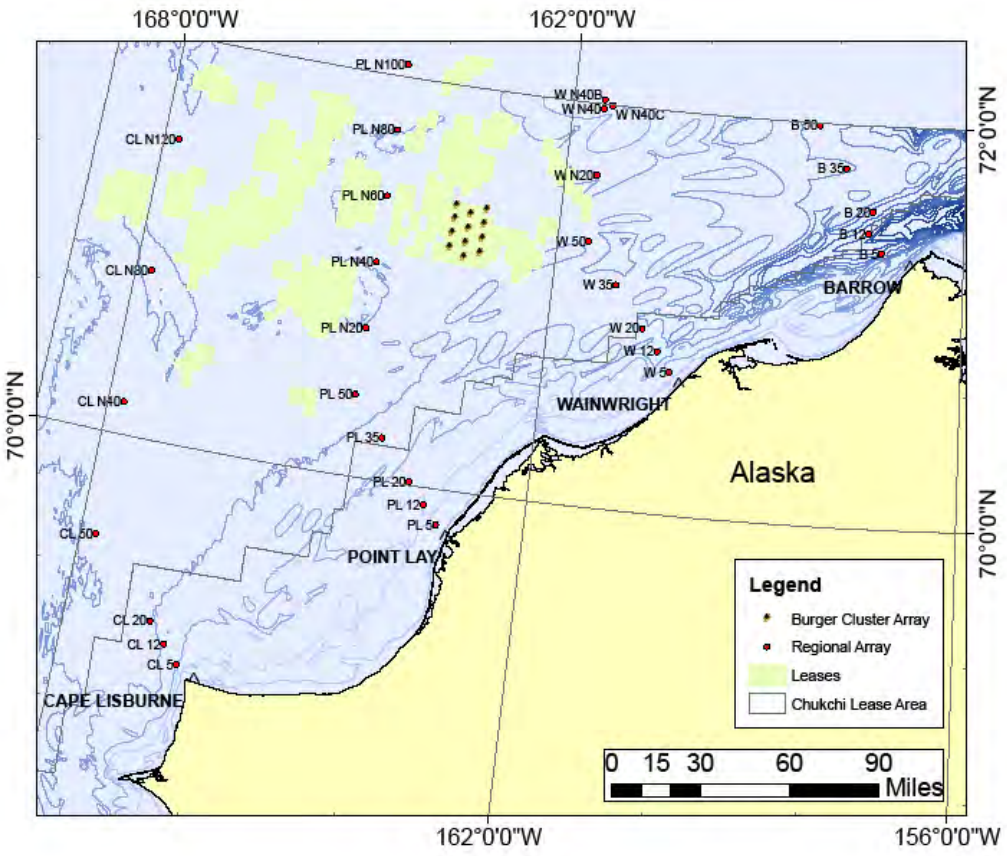

Figure 7. Deployment locations of Hydrophones in acoustic arrays in the eastern Chukchi Sea, Alaska 2010. Depiction of hydrophone array at Burger is not scaled correctly based on description below (12 km by 18 km)

The regional acoustic monitoring program, will be augmented in 2010 by an array of twelve additional acoustic recorders to be deployed on a grid pattern over a 7.2 mi (12 km) by 10.8 mi (18 km) area extending over several of Shell's lease blocks near locations of highest interest for drilling in 2010. The cluster array will operate at a sampling frequency of 16 kHz, which is sufficient to capture vocalizations from bowhead, beluga, walrus, gray whale, fin whale, humpback, killer whale and most other marine mammals known to be present in the Chukchi Sea. The cluster deployment configuration was defined to allow tracking of vocalizing animals that pass through the immediate area of these lease blocks. Maximum separation between adjacent recorders is 3.6 mi (5.8 km). At this spacing we expect that individual whale calls will be detected on at least 3 different recorders when the calling animals are within the boundary of the deployment pattern. Bowhead and other mysticete calls should be detectable simultaneously on more than 3 recorders due to their relatively higher sound source levels compared to other marine mammals. In calm weather conditions, when ambient underwater sound levels are low, we expect to have detection of most other marine mammal calls on more than 3 recorders. The goal of simultaneous detection on multiple recorders is to allow for triangulation of the call positions, which also requires accurate time synchronization of the recorders. When small numbers of whales are vocalizing Shell hopes to be able to identify and track the movements of specific individuals within the deployment area. It will not be possible to track individual whales if many

whales are calling due to abundant overlapping calls. In this case analyses will show the general distribution of calls in the vicinity of the recorders.

Analysis and Reporting

The Chukchi Net Arrays of 30 recorders and Cluster Array, deployed for up to 3 months, will produce an extremely large dataset comprising several Terabytes of acoustic data. The analyses of these data require identification of marine mammal vocalizations. Because of the very large amount of data to be processed, the analysis methods will incorporate the automated vocalization detection algorithms developed at Scripps Institute of Oceanography (Scripps). Scripps personnel will be assigned to assist in application of these algorithms for this analysis. While the hydrophones used in the net array are not directional, and therefore not capable of accurate localization of detections, the number of vocalizations detected on each of the sensors will provide good measurement of the relative spatial density distribution of various marine mammals. These results will therefore provide information such as timing of migrations and routes of migration for belugas and bowheads.

A second purpose of the Chukchi net array is to monitor the amplitude of drilling sounds reaching the near-shore region. It is expected that sounds from drilling activities will be detectable on hydrophone systems when ambient sound energy conditions are low. The drilling sound levels at recorder locations will be quantified and reported.

Analysis of all acoustic data will be prioritized to address the primary questions. The primary data analysis questions are to (a) determine when, where, and what species of animals are acoustically detected on each recorder (b) analyze data as a whole to determine offshore distributions as a function of time, (c) quantify spatial and temporal variability in the ambient sound energy, and (d) measure received levels of drilling survey events and drillship activities. The detection data will be used to develop spatial and temporal animal detection distributions. Statistical analyses will be used to test for changes in animal detections and distributions as a function of different variables (e.g., time of day, season, environmental conditions, ambient sound energy, and drilling or vessel sound levels).

COMPREHENSIVE REPORT ON INDUSTRY ACTIVITIES AND MARINE MAMMAL MONITORING EFFORTS IN THE BEAUFORT AND CHUKCHI SEAS

Following the 2010 drilling season a comprehensive report describing the acoustic, vessel-based, and aerial monitoring programs will be prepared. The comprehensive report will describe the methods, results, conclusions and limitations of each of the individual data sets in detail. The report will also integrate (to the extent possible) the studies into a broad based assessment of industry activities and their impacts on marine mammals in the Chukchi Sea during 2010. The report will help to establish long term data sets that can assist with the evaluation of changes in the Chukchi Sea ecosystems. The report will attempt to provide a regional synthesis of available data on industry activity in offshore areas of northern Alaska that may influence marine mammal density, distribution and behavior.

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Appendix E

Application for U.S. Fish and Wildlife Service Letter of Authorization

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Shell Exploration & Production

May 22, 2009

U.S. Fish and Wildlife Service
Marine Mammals Management
Attn: Craig Perham
1011 East Tudor Road, MS-341
Anchorage, AK 99503

Shell
3601 C Street, Suite 1000
Anchorage, AK 99503
Tel. (907) 646-7112
Email susan.childs@shell.com
Internet http://www.shell.com/

RE: Request for Letter of Authorization (LOA) for the Incidental Take of Polar Bears and Pacific Walrus, and the Intentional Take of Polar Bears by Harassment; 2010 Outer Continent Shelf Lease Exploration Plan, Chukchi Sea, Alaska

Dear Mr. Perham:

Shell Gulf of Mexico, Inc. (Shell) hereby requests a Letter of Authorization (LOA) from the U.S. Fish and Wildlife Service (USFWS) for the non-lethal incidental, unintentional "take" of small numbers of polar bears and Pacific walrus, and the intentional take of polar bears by harassment, which may occur during Shell's planned 2010 Outer Continental Shelf Lease Exploration Plan, Chukchi Sea, Alaska. This letter is submitted to fulfill the requirements regarding incidental, unintentional take of protected marine mammals pursuant to 50 Code of Federal Regulations (CFR) Part 18. The governing regulations are entitled, *Nonlethal Taking of Marine Mammals Incidental to Oil and Gas Exploration, Development, and Production Activities in the Chukchi Sea.*

As described in the attached supporting documentation, Shell's exploration drilling program is planned for various U.S. Department of Interior, Minerals Management Service (MMS) OCS lease blocks in the Chukchi Sea. Exploration drilling activities in Chukchi Sea are planned to begin on or about July 4 and run through October 31, 2010, depending on ice and weather.

As part of the application for obtaining an LOA, Shell has developed a Plan of Cooperation (POC) in accordance with 50 CFR § 18.124(c)(4). The POC will mitigate effects of Shell's planned exploration drilling program where exploration activities would take place in or near a traditional Arctic subsistence hunting area and/or may affect the availability of a species or stock of marine mammal for Arctic subsistence uses. The POC was prepared in consultation with affected Chukchi Sea communities and marine mammal associations. During these meetings, Shell focused on lessons learned from prior years activities and presented mitigation measures for avoiding potential conflicts, which are outlined in the 2010 POC.

Any potential impacts from the planned projects on the polar bear and Pacific walrus populations of the Chukchi Sea will be short-term and transitory (i.e., the temporary displacement of individuals or small groups of marine mammals that may be exposed to the planned activities). The planned activities will not result in any permanent impact on habitats used by marine mammals or their prey. As outlined in the attached documents, Shell will take appropriate measures to prevent unreasonable impacts on the availability of marine mammals for subsistence users.

Items required pursuant to 50 CFR 18 are attached. Those include: (1) the Polar Bear, Pacific Walrus, and Grizzly Bear Avoidance and Human Encounter/Interaction Plan (which includes a complete description of planned activities) (Attachment A); (2) the Marine Mammal Monitoring and Mitigation Plan (Attachment B); and the POC (Attachment C).

If you have any questions regarding this submission, please contact me at (907) 770-3700 or at Susan.Childs@shell.com, or Walt Sandel at (907) 646-7154 or at walter.sandel@shell.com.

Sincerely,

Susan Childs
Regulatory Affairs Manager, Alaska Venture

Attachments:

- Polar Bear, Pacific Walrus, and Grizzly Avoidance and Human Encounter/Interaction Plan
- Marine Mammal Monitoring and Mitigation Plan
- Plan of Cooperation

cc with attachment:

Jeff Walker,	Minerals Management Service, Anchorage
Joel Garlich-Miller,	Marine Mammals Management, Anchorage
Don Perrin,	Alaska Department of Natural Resources, Anchorage
John Goll,	Minerals Management Service, Anchorage
Project File	
Administrative Record	

Polar Bear, Pacific Walrus, and Grizzly Bear Avoidance and Human Encounter/Interaction Plan 2010 Exploration Drilling Program Chukchi Sea, Alaska

May 2009

Prepared by:

Shell Gulf of Mexico Inc.
3601 C Street, Suite 1000
Anchorage, Alaska 99503

Table of Contents

List of Figures

Attachments

ACRONYMS

4MP	Marine Mammal Monitoring and Mitigation Plan
ADF&G	Alaska Department of Fish and Game
CFR	Code of Federal Regulations
Discoverer	M/V *Frontier Discoverer*
ESA	Endangered Species Act
ft	foot/feet
FR	Federal Register
IHA	Incident Harassment Authorization
km	kilometer(s)
LOA	Letter of Authorization
m	meter(s)
mi	statute mile(s)
MMPA	Marine Mammal Protection Act
MMO	Marine Mammal Observer(s)
NMFS	National Marine Fisheries Service
OSR	Oil Spill Response
Plan	Polar Bear, Pacific Walrus, and Grizzly Bear Avoidance and Human Encounter/ Interaction Plan
POC	Plan of Cooperation
Shell	Shell Gulf of Mexico Inc.
USFWS	U. S. Fish and Wildlife Service
USGS	U.S. Geological Survey

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1.0 INTRODUCTION

This Polar Bear, Pacific Walrus, and Grizzly Bear Avoidance and Human Encounter/Interaction Plan (Plan) has been developed by Shell Gulf of Mexico Inc. (Shell) in support of its 2010 exploration drilling program in the Chukchi Sea. This Plan will cover Chukchi Sea drilling activities in 2010.

1.1 Background

The Plan details the policies and procedures adopted by Shell and to be implemented at its operations across Alaska's North Slope and in the Chukchi Sea in 2010. The Plan is intended to support activities that may encounter polar bears (*Ursus maritimus*) and Pacific walrus (*Odobenus rosmarus divergens*), both trust species of the U.S. Fish and Wildlife Service (USFWS), as well as grizzly bears (*Ursus arctos horribilis*), which are under the jurisdiction of the Alaska Department of Fish and Game (ADF&G).

Even though the chance of interactions with grizzly bears is extremely remote in this offshore exploration drilling program, the Plan includes discussion and guidance for avoiding them at shorebases and other areas where they might be encountered.

The Plan ensures that workers are familiar with the issues and safety precautions associated with working in bear country. The goal of this document is to standardize bear interaction and avoidance protocol and wildlife reporting efforts for the project. With proper knowledge and training, workers will detect the presence of bears and walrus quickly and respond appropriately through monitoring, avoidance, and/or, if necessary, active deterrence by USFWS certified bear hazers. The awareness and prevention of human/bear and human/walrus interactions will ensure the safety of workers as well as wildlife.

This Plan is intended to fulfill the requirement for a "site specific polar bear awareness and interaction plan," as required by 50 Code of Federal Regulation (CFR) 18.124(c)(3), which is part of the requirements for a Letter of Authorization (LOA) for the incidental, non-lethal, unintentional take of polar bear and Pacific walrus as specified under 50 CFR 18, Subpart J. This Plan also applies to the intentional take of polar bears by hazing pursuant to section 101(a)(4)(A), 109(h), and 12(e) of the Marine Mammal Protection Act (MMPA). The MMPA prohibits, with certain exceptions, the "taking" of marine mammals. "Take" is defined to mean, "to harass, hunt, capture, or kill, or attempt to harass, hunt, capture or kill any marine mammal." The "taking" of polar bears is allowed for Alaska Native subsistence or to protect human life. The MMPA and supporting regulations make provision to "take" marine mammals in the course of scientific research and other legitimate work in polar bear habitat.

In May 2008, the polar bear was listed as a threatened species under the Endangered Species Act (ESA). In June 2008, a special rule under authority of section 4(d) of the ESA was adopted which states that the regulatory requirements under the ESA are met by following the requirements of the MMPA, including obtaining a LOA. Like polar bears, Pacific walrus are also protected under the MMPA, but not as a threatened species. The grizzly bear is not protected in Alaska under the MMPA or ESA, but is protected by State game laws.

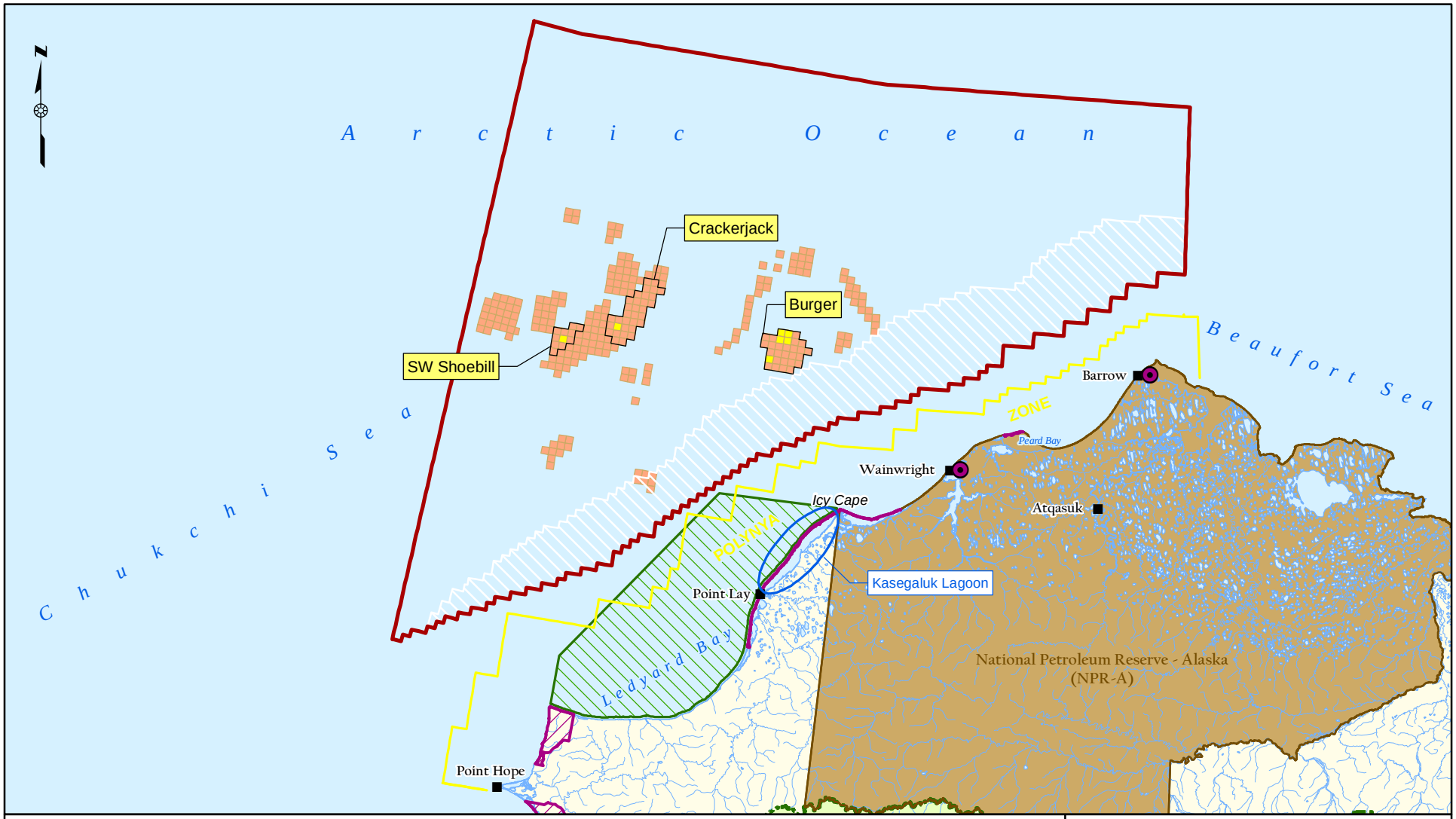
1.2 Proposed Exploration Plan

The locations of lease blocks where the planned exploration drill sites, and locations where activities in support of drilling, will occur are found on Figure 1.2-1. Shell plans to use one drillship, the M/V *Frontier Discoverer* (*Discoverer*), to drill the exploration wells. The *Discoverer* will be accompanied by ice management vessels, an oil spill response (OSR) fleet, and other support vessels during the 2010 program.

Drilling related activities will be conducted at least 60 statute miles (mi) [97 kilometers (km)] out in the Chukchi Sea with limited marine vessel traffic (resupply) in and out of Wainwright and Barrow, and limited resupply from Dutch Harbor through the Bering Strait. The *Discoverer* and its primary support vessels will transit from Dutch Harbor through the Bering Sea into the Chukchi Sea on or about July 1, 2010 and be mobilized directly to a drill site as soon as ice conditions permit. The drillship is expected to begin drilling operations on or about July 4, 2010. The July 1 entry is responsive to concerns voiced by residents of the local communities of Wainwright and Point Lay who requested entry into the Chukchi Sea be delayed until after their walrus and beluga hunts. The approximate travel route for mobilization of the *Discoverer* from Dutch Harbor through the Bering and Chukchi Sea to the prospects is indicated on Figure 1.2-1. Drilling is expected to be complete for the season on or before October 31. The drillship and primary support vessels will transit from the Chukchi Sea for the season shortly thereafter via the same routes and under the same conditions as entry.

No drilling program activities are planned to occur onshore. However, nearshore or onshore incursions by drilling program support activities will occur at shorebases in Wainwright and Barrow. Shorebases will be used for aviation operations to shuttle materials, and for crew changes between land and the drillship. Shorebases will provide temporary housing for these crewmembers and serve as an equipment and materials storage area along with facilities for minor aircraft maintenance and communications. Barrow and Wainwright have been selected as the temporary shorebase locations for the 2010 exploratory drilling program. It is estimated that there will be 2-4 trips with a shallow draft vessel per week between the Wainwright shorebase and offshore OSR vessels for training and drills.

The Plan therefore includes interaction and awareness guidance for Program workers regarding grizzly bears, and polar bears that may be present in the nearshore area or land. Interactions with grizzly bears are highly unlikely offshore, and at the shorebases as well. Pacific walrus are present in offshore and nearshore waters of the Chukchi Sea including the area of Shell's prospects, and observations of walrus are likely to occur during the drilling program. All three species are addressed in this plan, although interactions and encounters grizzly bears are considered unlikely for this project.



SHELL

2010 CHUKCHI SEA EXPLORATION PLAN LOCATION MAP

Bear and Walrus Avoidance and Interaction Plan

AES-RTS: 09-054-001.mxd, 05/18/09, R00

2.0 POLAR BEAR, PACIFIC WALRUS, AND GRIZZLY BEAR PRESENCE DURING PLANNED DRILLING ACTIVITIES OFFSHORE CHUKCHI SEA

2.1 Polar Bear

Polar bears are widely distributed at low densities throughout the Arctic. About 2,000 polar bears can be found in the Chukchi-Bering Sea stock which inhabits an area as far west as the extreme eastern portion of the Eastern Siberian Sea, as far east as Point Barrow, and as far south as the Bering Sea. A small portion of the Southern Beaufort Sea stock of polar bears also utilizes the Chukchi Sea, primarily during the ice-covered season.

Polar bears spend most of their time during summer on the drifting pack ice (ADF&G 2008a). Polar bears typically remain widely distributed in their range, as they are predominantly solitary animals. Polar bears in the Chukchi Sea spend most of their time near pack and annual ice over shallow, productive waters where their predominant prey of ice seals exist. Predominant polar bear distribution in the Chukchi Sea retreats north in the spring/summer with the retreating ice pack, then returns south in the fall as the ice pack again extends south. Polar bears traverse along the barrier island corridor throughout the year. During the summer months increased numbers are anticipated in the area, particularly durng the months of August and September.

In the area of Shell's planned drilling activities of the Chukchi Sea, polar bears are more abundant in May and June, then again in late October and November, but may be found in the area of Shell's prospects at any time throughout the drilling season. Polar bears were encountered near Shell's prospects during previous drilling efforts in 1989-1991, and a small number were observed during recent Shell baseline surveys conducted in the prospects in August and September of 2008.

Shell's drilling program activities will begin approximately July 4 and will end on or before October 31. There will likely be some sightings of polar bears during the exploration drilling program, with the number of bears depending on the amount of ice in the area. Nearshore sightings or encounters only are envisioned if Shell's marine vessels traveling to a shorebase observed such a bear. Bears have been known to venture inland, but this is not common. When polar bears emerge from dens with their cubs in the spring they start traveling on drifting sea ice and forage for food. Extra care is necessary at these times to properly store and dispose of food waste to prevent polar bear attraction and their entry into work areas. Polar bears will generally avoid human activities if they are not attracted by food and food wastes. U.S. Geologic Service (USGS) data document polar bear sightings and den locations (Fishbach et al. 2007). Polar bears typically exit their dens in March or April; therefore, there would be no active dens during the exploration drilling program.

2.2 Pacific Walrus

A single stock of Pacific walrus inhabits the shallow continental shelf waters of the Bering and Chukchi seas. The distribution of walrus varies seasonally from the winter concentrations in the Bering Sea, to open leads, polynyas, on pack ice, and island or shoreline haul outs. Most Pacific walrus migrate northward following the retreating ice pack during spring and return south during the fall. Migrations are directly related to the seasonal advance and retreat of the sea ice (ADF&G 2008b). During the summer months, Pacific walrus are widely distributed across the shallow continental shelf of the Chukchi Sea with the most significant concentrations in the ice pack within 62 mi (100 km) of the leading edge of the ice pack. If pack ice is not suitable, walrus haul out on land, but usually remain near their prey base. There

are haul-outs along the eastern Chukchi shoreline at Cape Thompson, Cape Lisburne, and Icy Cape. Pacific walrus can also be expected in shallow waters near the coast or on ice closer to land.

USFWS surveys have estimated up to 101,213 walrus on the Chukchi Sea pack ice in September. Walrus distributions in the Chukchi Sea are highly dependent on the distribution and extent of seasonal pack ice. Walrus were observed in the area of the drillship and support vessels in previous exploration drilling efforts in 1989-1991, and some were observed in the vicinity of Shell's prospects during baseline surveys conducted July-October of 2008. When the drillship is on location, most walrus are expected to be within the pack ice north of the prospects. The number of walrus that will be encountered during the planned exploration drilling program will depend on the amount of ice in the area.

2.3 Grizzly Bear

Grizzly bears are present on the North Slope during the summer months and may be present along the shoreline where they forage for food, taking advantage of whale or seal carcasses or eating human refuse. Given that the vast majority of the drilling program activities are over 60 mi (97 km) offshore, and the habitat of grizzly bear is onshore, it is extremely unlikely that interactions with grizzly bears will happen during drilling activities with except, possibly, at shorebases.

3.0 THE PLAN – SPECIFIC OBJECTIVES AND ACTIONS

Because exploration drilling activities and/or support activities will be occurring in polar bear habitat and in areas where Pacific walrus and grizzly bear may occasionally be found, the absence of these animals is not assured. However, precautions detailed in this document can reduce the chances of human encounters and problems with bears and walrus.

Objectives of the Plan are to:

- Prevent adverse bear/human and walrus/human encounters and interactions
- Educate workers about the controls used to prevent encounters and interactions
- Protect workers, bears and walrus
- Implement reporting and observation procedures

3.1 Prevent Polar and Grizzly Bear/Human Interactions

There is always the potential for bear encounters during field activities even when all precautions are taken to avoid and eliminate attractants. Early detection of bears in the vicinity of operations is an essential element to prevent bear/human encounters. Bear avoidance and encounter procedures are presented in Attachment A. Workers will regularly and frequently observe their surroundings to detect bears in project areas. Marine Mammal Observers (MMOs) are the most likely personnel to notice bears or walrus because of their job description requires them to look for and identify marine mammals near project activities. They will be the primary support for project activities with the potential to encounter bears.

In contact situations, the main concern is to maintain the safety of personnel. The goal is to avoid and minimize potential conflict during bear/human interactions.

Actions to take if bears are in the area:

- If a bear is observed all on-site personnel must be alerted so work activities can be altered or stopped to avoid interactions. Bear sightings will be reported to the designated representative.
- Depending on the distance between the bear and the activities, retreating to the safety of vessels, emergency shelter, or buildings or vehicles if an encounter occurs in developed onshore areas may be necessary.
- Personnel should give bears plenty of room and should **not** approach or crowd bears. Every bear has "personal space" – the distance in which they feel threatened. The greater the distance between the worker and the bear, the better for conflict avoidance.
- Personnel are forbidden from feeding bears or any other wildlife.

3.2 Protecting Workers and Bears

Worker safety is a priority. The following procedures will be implemented to ensure worker awareness and knowledge about their own safety concerning bears. A copy of the Bear Encounter and Avoidance Procedures are provided as Attachment A.

- Personnel will be made aware that bears will hide behind structures, and to be conscientious of this. To avoid surprise encounters personnel exiting a vessel or other facility will check behind doors, blind spots, and access areas prior to exiting to avoid a surprise encounter
- Areas will be illuminated during hours of darkness when workers are present
- Periodic safety sessions will be conducted to address and elevate awareness of bear avoidance techniques and activities
- Outdoor work crews will survey the surrounding area to ensure bears cannot enter without being detected
- Workers will become familiar with the local environment
- A "buddy system" will be employed to ensure fellow workers are informed about activities that may bring workers in contact with bears
- Workers and facility occupants will be alerted if a bear is observed
- A Bear Guard will be designated, if necessary, to monitor for the presence of bears. The Bear Guard may also hold another work position that would allow him or her to monitor for the presence of bears, such as equipment operator
- Bear hazing will be approved by the designated representative (e.g., site manager). Only a designated properly trained and authorized Bear Hazer will be permitted to haze bears. Personnel other than the designated Bear Hazer will not attempt to haze a bear
- A 0.5-mi [800-meters (m)] exclusion zone will be enforced around bears observed on land or ice during vessel travel. Concentrations of polar bears and walrus will be avoided by observing the 0.5-mi (800-m) exclusion zone cited above
- Aircraft will maintain a 1,500 feet (ft) (457 m) minimum altitude within 0.5 mi (800 m) of bears hauled out onto land or ice, unless weather does not permit this altitude
- When within 1,000 ft (300 m) of polar bears in water, vessels will reduce speed, and avoid multiple changes of direction
- Vessel speed to be reduced during inclement weather conditions in order to avoid collisions with bears

Polar bear monitoring, reporting, and survey activities will be conducted in accordance with the regulations that implement the MMPA as outlined in 71 Federal Register (FR) 26770. The basic monitoring and reporting requirements are:

- Observers are to follow a chain-of-reporting process when responding to polar bear sightings. Attachment B depicts the Wildlife Notification Flow Chart.
- A qualified individual or individuals is/are to observe, record, and report the effects of the activity on polar bears. A USFWS-approved monitoring plan requires trained onboard MMOs. MMOs will monitor the exclusion zone for bears. If a bear is sighted, mitigation measures as specified in the Marine Mammal Monitoring and Mitigation Plan (4MP) will be implemented.

3.3 Protecting Workers and Walrus

Again, worker safety is priority. The following procedures are to ensure worker awareness and knowledge about their own safety concerning walrus:

- Drilling support vessels will observe a 0.5 mi (800 m) exclusion zone around walrus observed on land or ice during travel status
- Aircraft will maintain a 1,500 ft (457 m) minimum altitude within 0.5 mi (800 m) of Pacific walrus hauled-out onto land or ice, unless weather does not permit this altitude
- When within 1,000 ft (300 m) of walruses in water, vessels will reduce speed, and avoid multiple changes of direction
- Vessel speed to be reduced during inclement weather conditions in order to avoid collisions with walruses.

Walrus monitoring, reporting, and survey activities will be conducted in accordance with those outlined in 71 FR 26770 of the MMPA. The basic monitoring and reporting requirements are:

- Observers will follow a chain-of-reporting process when responding to walrus sightings. Attachment B depicts the Wildlife Notification Flow Chart
- A qualified individual or individuals is/are to observe, record, and report the effects of the activity on walrus. A USFWS-approved monitoring plan requires trained onboard MMOs. MMOs will monitor the exclusion zone for walrus. If a walrus is sighted, mitigation measures as specified in the 4MP will be implemented

4.0 FOOD WASTE MANAGEMENT PLAN

The most important factor in the avoidance of attracting bears to active operations is to correctly handle food and associated waste. Proper handling of food and food-associated waste is important in reducing the potential for bears to associate humans and facilities with food. The following practices will be implemented.

- Food wastes will not be discharged overboard from the drillship; all food wastes are to be incinerated
- Personnel will separate food waste from other solid wastes. Food and food-associated waste will be place only into containers secured from wildlife access onboard vessels or in vehicles. Personnel will use only designated receptacles for food and associated waste inside facilities or those that are secure from wildlife access

- No food-associated wastes may be placed into solid-waste containers
- Containers will be located where there is good visibility and away from high-traffic areas
- Personnel will back-haul food-associated waste to approved bear-proof containers
- Dedicated receptacles will be secured – there should be no food-associated attractants in the containers
- Back-hauled food-associated waste will not be left in unmanned facilities, vessels, or unsecured vehicles

5.0 SAFETY AND COMMUNICATION

The following safety and communication practices will be implemented:

- Tthe designated Bear Guard or designated representative can be contacted to receive the most recent bear sighting information
- If a bear is sighted, the area should be canvassed for other bears while moving to a safe location. Other workers in the area are to be alerted. Attempt to scare the bear away should not be made. The bear is not to be approached for any reason. Once in a secure location, the bear sighting should be reported to the on-site Shell representative. Only trained personnel are authorized to deal with animal problems. Attempts to photograph a bear should not be made unless all personnel are in a secure location. Early bear detection is essential to limit human/bear encounters
- The "buddy system" is to be used during outside jobs
- All personnel are to be trained to operate radios or other communication equipment
- Personnel should make noise before walking into an area with poor visibility
- Food should not be taken out of a secure area. If it is necessary to eat away from the camp mess at the shorebase, personnel are to make sure that all food is safely stored inside secure containers
- All operations are to be coordinated to ensure that activities are compatible with bear avoidance and protection

6.0 TRAINING

6.1 Marine Mammal Observer Training

Prior to any vessel departure, MMOs will have completed a training course to recognize marine mammals, including polar bear and Pacific walrus, in water, on land, or on ice, to properly record sightings, and to advise what mitigation measures should be followed. The MMO training curriculum will be pre-approved by USFWS and the National Marine Fisheries Service (NMFS). Trained MMOs will receive a document to verify course completion. Course information will include:

- Overview of MMPA and relevance to drilling activity and mammals
- Overview of drilling activities
- Overview of mitigation measures
- MMO roles and responsibilities

- MMO regulatory requirements
- Identification of arctic marine mammals by species, sex, and age
- Search methods for marine mammals
- Overview of data collection and reporting requirements

6.2 Bear Guard Training

Bear guards will undergo an intensive training program performed by USFWS. Training will include:

- Bear habits, range, and habitat
- How to minimize the number of human/bear interactions
- The proper use of deterrents and projectiles to haze bears
- How to report a bear sighting, hazing, and/or fatal taking
- Weapons handling/safety qualification

6.3 Other Training Materials and Meetings

Employees will be provided training that describes bear behavior and safety concerns, including hazing (e.g., new employee orientation, safety discussions). All hazing will be performed by a designated person who is trained in appropriate hazing tactics and firearms safety. The employee safety training program will include:

- Bear Avoidance Action Plan
- USFWS or ADF&G (or comparable) Bear Encounter/Hazing Training
- Firearms training for designated Bear Guards
- Bear awareness reinforced at daily safety meetings
- Video training material:
  - "Human/Polar Bear Interaction" (Alaska Oil and Gas Association)
  - Working in Polar Bear Country, for Industrial Managers, Supervisors and Workers
  - Staying Safe in Polar Bear Country, A Behavioral-based Approach to Reducing Risk

7.0 AT-RISK LOCATIONS AND SITUATIONS

Work areas during the exploration drilling program will be exclusively offshore and distant from most prospective at-risk locations. Also, given that all personnel will be vessel-based, the prospect of at risk situations are remote for offshore exploration workers. However, in the event that exceptional circumstances occur, the following lists locations/situations where the risk of a bear encounter may be higher and where attention to mitigating these risks is essential:

- Sea ice floes, during ice management by vessels
- Coastal bluffs
- Barrier islands

- Small watercraft (i.e., oil spill response drills or onshore equipment inspections)
- Marine vessels
- Waste generation and collection facilities
- "Blind" areas that are obscured by facilities, equipment or other obstacles

At-risk situations and activities include:

- Transit in sea ice, and ice management by vessels
- Activities on or around barrier islands
- Any portable, temporary shelter (i.e., oil spill response drills or equipment cacheing)
- Emerging from vessels or facilities
- Dark/unlighted and visually obscured areas

8.0 REPORTING

Sightings of bears or walrus by MMOs or other workers during the exploration drilling program will be recorded and reported to USFWS and ADF&G by a Shell Regulatory Affairs staff designee. Given that MMOs will be drillship-, and vessel-based the majority of sightings/observations are expected to be marine mammals. Polar bear sightings will be reported according to the procedures and process described in Section 8.1 of this Plan, grizzly bear sightings will be reported in accordance with Section 8.2, and walrus sightings will be reported in accordance with Section 8.3.

Shell will develop and implement a 4MP for its 2010 program activities in the Chukchi Sea. The 4MP supports protection of the marine mammal resources in the area by adhering to mitigation measures, fulfilling wildlife sighting/observation and reporting obligations to the USFWS (and NMFS), and providing data useful for understanding the impacts of exploration drilling activities on Pacific walrus and polar bear. The 4MP dedicates multiple personnel 24-hours per day to the task of watching for, recording observations of, and instituting mitigation measures for wildlife observed, most notably those protected by the MMPA, ESA, or both. The outcome of conducting the 4MP will be resolute reporting of polar bear and Pacific walrus observed in the vicinities of the exploration drilling program activities. The 4MP for 2010 program activities is provided as an appendix to the LOA application included in the exploration plan.

After the appropriate bear or walrus encounter procedures have been followed, workers will be required to report the presence of a bear or walrus using the procedure outlined below. A copy of the Wildlife Notification Flow Chart is presented as Attachment B.

- Workers are required to notify immediately the on-site Shell representative of a bear or walrus sighting and complete the appropriate sighting/observation form (attachments C through E).

- Workers are to document any interactions (such as the use of cracker shells, vehicle horns, or other auditory devices; using vehicles or equipment to deter bears from an area; taking direct action to harass a bear out of an area; etc.) in the sighting/observation form.

- If the bear or walrus was sited within an exclusion zone or human/bear interaction took place (i.e., actions listed under bullet 2 above), the on-site Shell representative must promptly contact Shell Regulatory Affairs at 907-830-7435 (24 hrs) or 907-646-7152 (business hrs). The on-site

Shell representative must also fax or e-mail the completed sighting/observation form to the Shell Regulatory Affairs designee in Anchorage at 907-646-7145 (fax). The Shell Regulatory Affairs designee will send (fax or e-mail) the completed sighting/observation form to within 24 hrs of the bear observation to the USFWS or ADF&G agency contact .

- If the bear or walrus was sighted outside an exclusion zone and no human/bear interaction took place, the MMO will provide the sighting/observation information to the Shell Regulatory Affairs designee in Anchorage by email in the daily MMO report.

8.1 Polar Bear Reporting

Actions will be taken to the maximum extent practicable to avoid and minimize potential interactions with polar bears. MMOs will be assigned to project vessels to identify potential encounters and record polar bear behavior. Using the procedure provided in Section 8.0 and in the Wildlife Notification Flow Chart (Attachment B), the Shell Regulatory Affairs designee will be informed of polar bear sightings/observations. All relevant information must be recorded. The Polar Bear Sighting Report (Attachment C) must be completed to the greatest extent possible prior to submission. Regular reports of polar bear sightings in accordance with the LOA stipulations will be made to the USFWS.

Primary polar bear contact:

Craig Perham
USFWS – Marine Mammals Section
1011 East Tudor Road
Anchorage, Alaska 99503
Telephone: 907-786-3810 (direct); 907-786-3800 (main office)
Fax: 907-786-3816

Alternate Polar Bear Contact:

Terry DeBruyn
USFWS – Marine Mammals Section
1011 East Tudor Road
Anchorage, Alaska 99503
Telephone: 907-786-3812 (direct); 907-786-3800 (main office)
Fax: 907-786-3816

8.2 Grizzly Bear Reporting

Actions will be taken to the maximum extent practicable to avoid and minimize potential interactions with grizzly bears. Using the procedure provided in Section 8.0 and in the Wildlife Notification Flow Chart (Attachment B), the Shell Regulatory Affairs designee will be informed of grizzly bear sightings/observations. All relevant information must be recorded. The Grizzly Bear Observation Form (Attachment D) is a typical report form must be completed to the greatest extent possible prior to submission. Regular reports of grizzly bear sightings will be made to the ADFG.

The ADF&G grizzly bear contact is:

Dick Shideler
Alaska Department of Fish & Game
1300 College Road

Fairbanks, AK 99709-4173
Phone: 907-459-7283
Fax: 907-459-3091
E-mail: dick.shideler@alaska.gov

Local Contact:

Geoff Carroll, ADF&G
Area Wildlife Biologist
P.O. Box 1284
Barrow, Alaska 99723-1284
Phone: 907-852-3464
Fax: 907-852-3465
E-mail: geoff.carroll@alaska.gov

8.3 Walrus Reporting

Vessel traffic will avoid any walrus to the maximum extent practicable to avoid and minimize potential interactions. MMOs will be assigned to project vessels to identify potential encounters and record walrus behavior. Weekly reports of walrus sightings would be made to the USFWS using the Walrus Sighting Report Form (Attachment E).

Actions will be taken to the maximum extent practicable to avoid and minimize potential interactions with walrus. MMOs will be assigned to project vessels to identify potential encounters and record walrus behavior. Using the procedure provided in Section 8.0 and in the Wildlife Notification Flow Chart (Attachment B), the Shell Regulatory Affairs designee will be informed of walrus sightings/observations. All relevant information must be recorded. The Walrus Sighting Report Form (Attachment E) is a typical report form must be completed to the greatest extent possible prior to submission. Regular reports of walrus sightings in accordance with the LOA stipulations will be made to the USFWS.

Primary Pacific walrus contact:

Craig Perham
USFWS – Marine Mammals Section
1011 East Tudor Road
Anchorage, Alaska 99503
Telephone: 907-786-3810 (direct); 907-786-3800 (main office)
Fax: 907-786-3816

Secondary Pacific walrus contact:

Joel Garlich-Miller
USFWS – Marine Mammals Section
1011 East Tudor Road
Anchorage, Alaska 99503
Telephone: 907-786-3820 (direct); 907-786-3800 (main office)
Fax: 907-786-3816

9.0 INTENTIONAL“TAKE” ACTIONS

Early detection and worker awareness will reduce chance encounters with a bear. If a bear remains on site for an extended period, the on-site Shell representative/Shell Regulatory Affairs designee will contact

USFWS or ADF&G (as appropriate) for advice. Firearms with bean bags or rubber bullets, noisemakers, or other appropriate materials will available on site to provide deliberate and intentional harassment of bears to ensure worker safety. These actions constitute a "take". If a lethal or non-lethal "take" occurs, despite preventative action to protect human life, the following information must be recorded and actions performed:

All details of the event including time, exact location, bear's behavior, preventive measures followed, etc. are to be recorded. In addition:

- Aall witness statements are to be recorded.
- Polar Bears - Craig Perham with USFWS is to be notified at (907) 786-3810 (direct line) or (907) 786-3800 (main office). An alternate contact is Terry DeBruyn with USFWS at 907-786-3812 (direct line) or 907-786-3800 (main office).
- Grizzly Bears – Immediately notify Dick Shideler (Fairbanks ADF&G) at (907) 459-7283 and Geoff Carroll (Barrow ADF&G) at (907) 852-3464 are to be immediately notified.
- In the unlikely event that there is a lethal "take", the entire animal carcass will be transported to Barrow for sealing and processing under the direction of either a responsible USFWS agent designee (polar bear) or ADF&G agent designee (grizzly bear). The agent designee will determine disposition of useable meat (e.g., donation to a Native village).

The trained bear Guard (or Watch) or designated representative is responsible for:

- Recording all the event details including time, exact location, bear's behavior, preventive measures followed, etc.
- Recording all witness statements

10.0 PLAN OF COOPERATION

A Plan of Cooperation (POC) has been developed as a required component of a LOA application under 50 CFR 18.128(d). A POC is also required as part of an application for an Incident Harassement Authorization (IHA) from NMFS under 50 CFR § 216.104(a) (12), and under the lease stipulation 5 for lease sales 195 and 202. The POC for the 2010 exploration drilling activities in the Chukchi Sea is included as Appendix I of the Exploration Plan.

The POC identifies the measures that Shell has developed in consultation with North Slope communities and will implement during its planned 2010 Chukchi Sea exploration drilling program to minimize any adverse effects on the availability of marine mammals for subsistence uses. In addition, the POC details Shell's communications and consultations with local communities concerning its proposed 2010 exploration drilling program, potential conflicts with subsistence activities and means of resolving any such conflicts. Shell has documented its contacts with the North Slope communities, as well as the substance of its communications with subsistence stakeholder groups.

11.0 REFERENCES

Alaska Department of Fish and Game (ADF&G). 2008a. *Wildlife Notebook Series*, accessed February 2008. http://www.adfg.state.ak.us/pubs/notebook/marine/ .

Alaska Department of Fish and Game (ADF&G). 2008b. *Wildlife Notebook Series*, accessed February 2008. http://www.adfg.state.ak.us/pubs/notebook/marine/walrus.php .

Fischbach, A., S. Amstrup, and D. Douglas. 2007. Landward shift of Alaksan polar bear denning associated with recent sea ice changes. Polar Biol. 30:1395-1405.

Attachment A
Bear Avoidance and Encounter Procedures

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Attachment A

Bear Avoidance and Encounter Procedures

All personnel should understand and follow the procedures listed below to detect the presence of bears in work areas and avoid human/ bear encounters.

If your work assignment requires you to be outside of areas that are secure from bears (buildings, heavy equipment cabs, etc.) check directly with your supervisor for the latest report from the designated representative Bear Guard to find out whether bears or bear sign were reported. Potential at-risk situations are walking between enclosed structures at the shore base, outside vehicles and at various work locations.

Arrange with your crew foreman to maintain radio or visual contact with the designated Bear Guard so that you can be alerted immediately to select a secure place if a bear is sighted. Plan the best route in advance to reach safe locations at the shore base or on a vessel from your work area.

Be especially alert in dark conditions and areas of poor visibility outside where most pedestrian areas are illuminated.

Do NOT take food with you. If it is necessary to eat away from the vessel galley or shore base mess unit, make sure that all food is safely stored inside containers aboard ship or inside secure vehicles.

Do NOT leave food wastes or other material that may attract bears outside.

Report all bear sightings (including sign and tracks) immediately to the designated Shell representative when you are in a secure location. Do not expose yourself to look at the bear. Do not try to photograph a bear unless you are in a secure location. Early bear detection is essential to limit human/ bear encounters.

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Attachment B
Wildlife Notification Flow Chart

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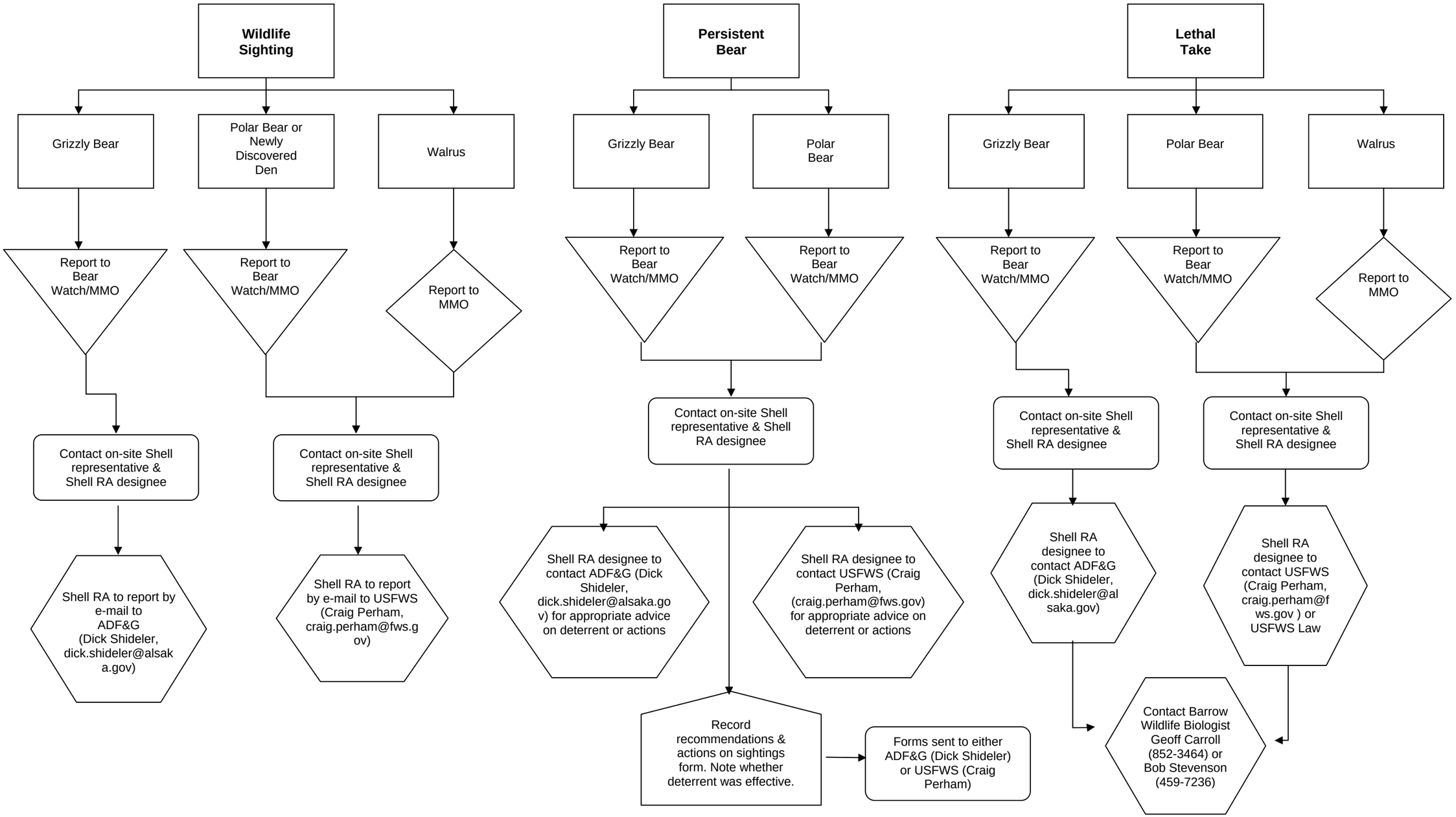
WILDLIFE NOTIFICATION FLOW CHART



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Attachment C
Polar Bear Sighting Report

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United States Department of the Interior

FISH AND WILDLIFE SERVICE
1011 E. Tudor Road
Anchorage, Alaska 99503-6199

POLAR BEAR SIGHTING REPORT

Date:_____ Observer name:_____
Time:_____ Contact number/email:_____

Location: _____
_____
Latitude:_____ Longitude_____ Datum:_____

Weather conditions: Fog_____ Snow_____ Rain_____ Clear_____ Temperature_____ F/C

Wind speed_____ mph/kts
Wind direction_____

Visibility: Poor _____
Fair _____
Good _____
Excellent_____

Number of bears:
_____ Adult M/F
_____ Sub-adult
_____ Unknown
_____ Sow/cub(s)
_____ Sow/yearling(s)
_____ Sow/2YO(s)

Estimated distance of bear(s) from personnel_____ (meters) and facility:___ (meters)
(closest point) (closest point)

Bear behavior (Initial Contact): _____

Bear behavior (After Contact): _____

Description of encounter:_____
_____
_____
_____

Duration of encounter:_____ **Possible attractants present:_____**

Deterrents used/distance:
_____ Crackershell
_____ Vehicle
_____ Rubber bullet
_____ Bean bag
_____ Horn/siren
_____ Spotlight/Headlight
_____Other _____

Agency/Contacts:
USFWS_Craig Perham (786-3810) (FAX: 786-3816)_____ Time_____ Date_____
ADF&G_Dick Shideler (459-7283) (FAX: 456-3091)_____ Time_____ Date_____

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Attachment D
Grizzly Bear Observation Form

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Bear 10# ____ (ADF&G only)

GRIZZLY OBSERVATION FORM

Observer: _____ Company / Agency: _____

Observation Date: _____ Time: Start _____ Stop _____

Observation from: ☐ Vehicle ☐ Ground ☐ Building ☐ Other _____

Observer's distance from bear: _____ meters

General Location: ☐ Barrow ☐ Wainright ☐ Point Lay ☐ Pt Hope

☐ Other (latitude/longitude if known): _____

Specific Location: _____ meters _____ (direction) of _____ (facility name)

Dumpster present: ☐ Yes ☐ No ☐ Unknown

Weather: _____ ºF ☐ Clear / Partly Cloudy ☐ Rain ☐ Fog ☐ Snow

Direction of wind: _____ at _____ mph

Bear Identification: Earflag color: Right _____ Left _____

(Note: "right" / "left" of bear, not observer)

Natural Markings (scars, torn ear, etc.): _____

Other Bears Present: ☐ None ☐ Cubs: # of cubs _____ # of yearlings _____ # of other _____

Bear Activity: When 1st seen, the bear was: ☐ Resting ☐ Feeding (natural food)

☐ Feeding (garbage) ☐ Feeding/Traveling ☐ Traveling

☐ Other: _____

Bear's reaction to observer: ☐ Ignore ☐ Approach ☐ Avoid

Were other people in area (i.e. not with observer): ☐ Yes ☐ No ☐ Unknown

Bear's reaction to other people: ☐ Ignore ☐ Approach ☐ Avoid

Comments: _____

Deterrence Action Taken: ☐ Yes ☐ No If "Yes", did you use:

☐ Horn ☐ Siren ☐ Plastic Slugs ☐ Cracker Shell ☐ Firecracker

☐ Birdshot ☐ Other: _____

Bear Reaction: ☐ Ignore ☐ Approach ☐ Withdraw

Additional Remarks: _____

Please return to: Dick Shideler, Alaska Department of Fish & Game
1300 College Road, Fairbanks, Alaska 99701
Phone: 907-459-7283, FAX: 907-459-3091

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Attachment E
Walrus Sighting Report

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United States Department of the Interior

FISH AND WILDLIFE SERVICE
1011 E. Tudor Road
Anchorage, Alaska 99503-6199

WALRUS SIGHTING REPORT

Date: _____
Time: _____

Location: (include GPS coordinates if possible) _____
_____

Observer name: _____

Weather conditions: Fog_____ Snow_____ Rain_____ Clear_____ Approx. temperature_____

Wind speed_____ Wind direction_____

Total number of walrus: Adult_____ Sub-adult_____ Unknown_____

Estimated distance of walrus from personnel/facility:_____

Possible attractants present:_____

Walrus behavior: Curious_____ Aggressive_____ Predatory_____ Other_____

Description of encounter: _____
_____
_____

Duration of encounter: _____

Deterrents used/distance: Vehicle_____ Noise-maker_____ Firearms_____ Other_____

Injuries sustained: Personnel: _____
Walrus:
_____

Agency/Contacts:

USFWS_____ Time_____ Date_____
ADF&G_____ Time_____ Date_____
CLIENT_____ Time_____ Date_____

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