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

Shell Gulf of Mexico Inc.

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ACRONYMS & ABBREVIATIONS

°C	degrees Celsius
°T	degrees True North
µPa	micropascal(s)
4MP	Marine Mammal Monitoring and Mitigation Plan
AEWC	Alaska Eskimo Whaling Commission
BOEMRE	Bureau of Ocean Energy Management, Regulation and Enforcement
dB	decibel
CDs	compact discs
cm^3	cubic centimeter(s)
Com Center	Communications and Call Center
Discoverer	Motor Vessel *Noble Discoverer*
GPS	Global Positioning System
ft	feet
ft^2	square feet
Hz	Hertz
in^3	cubic inch(es)
IHA	Incidental Harassment Authorization
JASCO	JASCO Applied Sciences
kHz	kilohertz
km	kilometer(s)
km^2	square kilometer(s)
lb	pound(s)
Leq	sound energy equivalent level
LOA	Letter of Authorization
m	meter(s)
m^2	square meter(s)
mi	mile(s)
mi^2	square mile(s)
MMO	Marine Mammal Observer
MMPA	Marine Mammal Protection Act
MMS	Minerals Management Service
M/V	Motor Vessel
NMFS	National Marine Fisheries Service
Noble	Noble Corporation
NSB	North Slope Borough
NVD	night-vision device
psi	pounds per square inch
rms	root mean squared
Shell	Shell Gulf of Mexico Inc.
USB	universal serial bus
USFWS	U.S. Fish and Wildlife Service
VSI	vertical seismic imager
VSP	vertical seismic profile
ZVSP	zero-offset vertical seismic profile

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 2012 exploration drilling season. The 4MP developed for Shell's exploration drilling program supports protection of the marine mammal resources in the area, fulfills reporting obligations to the Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE), the National Marine Fisheries Service (NMFS), and the U.S. Fish and Wildlife Service (USFWS), and establishes a means for gathering additional data on marine mammals for future operations planning.

Shell plans to conduct exploration drilling within existing lease holdings in the Chukchi Sea. Exploration drilling will be conducted from the drillship Motor Vessel (M/V) *Noble Discoverer* (*Discoverer*) owned and operated by Noble Corporation. The drillship is an ice-strengthened drilling vessel designed, engineered and constructed to safely operate in arctic waters like the Chukchi Sea. In addition to the drillship, several support vessels will be used. The support vessels will include tugs and barges, a primary ice management vessel, an anchor handler/ice management vessel, and oil spill response vessels.

At, or near the end of each well, a zero-offset vertical seismic profile (ZVSP) likely will be conducted. During ZVSP surveys, an airgun array is deployed adjacent to the drillship, while receivers are placed (temporarily anchored) in the wellbore. The sound source (airgun array) is fired repeatedly, and the reflected sonic waves are recorded by receivers (geophones) located in the wellbore. The survey will last 10-14 hours as the receivers are moved through the length of the wellbore and the airguns are fired 5-7 times after each movement. The purpose of the ZVSP is to gather geophysical information at various depths, which can then be used to tie-in or ground-truth geophysical information from the previous seismic surveys with geological data collected within the wellbore.

Shell's 4MP is a combination of active monitoring of the area of operations and the implementation of mitigation measures designed to minimize project impacts to marine 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 document the potential reactions of marine mammals in the area to the various sounds and activities and to characterize the sounds produced by the exploration drilling activities, support vessels, and ZVSP.

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 exploration drilling season. Shell will continue to measure the sound

propagation of the drillship at various times or throughout the exploration 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 Incidental Harassment Authorization (IHA) and the Letter of Authorization (LOA) which Shell requested from the NMFS and the USFWS, respectively, and to meet any other stipulated 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 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 exploration drilling period. The duties of the MMOs will include watching for and identifying marine mammals; recording their numbers, distances, and reactions to the exploration 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 exploration 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. The *Discoverer* and associated support vessels will transit through the Bering Strait into the Chukchi Sea on or about July 1, arriving on location at the Burger Prospect as soon as ice and weather conditions allow. Exploration drilling will then commence on or about July 4, as ice, weather, and other conditions allow for safe exploration drilling operations, and may last until October 31. Vessel-based monitoring for marine mammals will be done throughout the period of exploration 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 exploration 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 exploration drilling activity;
    - a communication channel to coastal communities including Inupiat whalers; and
    - 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 2006–2010 or such alternative requirements as may be specified in the IHA and LOA received from NMFS and USFWS, respectively for this project. Any other agreements between Shell and agencies or groups such as BOEMRE, 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, USFWS (if so stipulated) and Shell, as described in the MMO section of this 4MP. 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 Exploration Drilling Activities and Zero-Offset Vertical Seismic Profile Surveys

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 of the mitigation measures have been described in the IHA (Section 12 of the IHA application to which this 4MP is appended) and LOA applications submitted to NMFS and USFWS respectively, and are not repeated in entirety here. Survey design features include:

- timing and locating exploration 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 drillship and vessel sounds and marine mammal vocalizations; and
- seismic activity mitigation measures during performance of ZVSP surveys.

The potential disturbance of marine mammals during operations will be minimized further through the implementation of several vessel-based mitigation measures (see Section 12 of the IHA application to which this 4MP is appended) 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 decibels (dB) re 1micropascal (µPa) root mean squared (rms) for cetaceans and ≥190 dB re 1 µPa (rms) for pinnipeds. These safety criteria are based on an assumption that sound energy 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 impulsive sounds at received levels ≥160 dB (rms) have the potential to exhibit behavioral reactions great enough to meet the definition of "harassment" in the MMPA. For continuous sounds NMFS has established a similar disturbance threshold at ≥120 dB (rms).

Exploration Drilling Activities

Expected safety and disturbance radii based on sound propagation from the drillship *Discoverer* were modeled by JASCO Applied Sciences (JASCO) at the three potential drill sites (JASCO 2009). Changes in the water column of the Chukchi Sea through the course of the exploration 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. 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. However, measurements of sounds produced by the *Discoverer* were made in the South China Sea in 2009 (Austin and Warner 2010). The results of those measurements were used to model the sound propagation from the *Discoverer* (including a nearby support vessel) at planned drilling locations in the Chukchi and Beaufort seas (Warner and Hannay 2011). Broadband source levels of sounds produced by the *Discoverer* varied by activity and direction from the ship, but were generally between 177 and 185 dB re 1 µPa @ 1 m rms (Austin and Warner 2010). Propagation modeling at the Burger prospect resulted in an estimated distance of 0.814 miles (mi) (1.31 kilometers [km]) to the point at which drillings sounds would likely fall below 120 dB. The estimated 0.814 mi (1.31 km) distance was multiplied by 1.5 (= 1.22 mi [1.97 km]) as a further precautionary measure before calculating the total area that may be exposed to continuous sounds ≥120 dB re 1 µPa rms by the *Discoverer* at each drill site on the Burger prospect. Assuming one well will be drilled in each season (summer and fall), the total area of water ensonified to ≥120 dB rms in each season is estimated to be 4.6 square miles (mi^2) (12 square kilometers [km^2]). As noted above, broadband source levels from the *Discoverer* generally were close to 180 dB rms (Austin and Warner 2010). Source levels by definition are measured at a 1 m distance. Therefore the 180 dB rms distance is 1 m. The distance to which sounds ≥160 are expected to propagate are estimated to be less than 33 feet (ft) (10 meters [m]) from the vessel and were not included in modeling results.

The source levels noted above for exploration drilling 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 exploration drilling activities, but will be employed during the ZVSP survey described below. 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.

ZVSP Surveys

The sound source likely to be used by Shell for the ZVSP survey in 2012 will be similar to the ITAGA eight-airgun array, which consists of four 150 cubic inches ($in.^3$) (2,458 cubic centimeters [cm^3]) airguns and four 40 $in.^3$ (655 cm^3) airguns. These airguns can be activated in any combination and Shell would utilize the minimum airgun volume required to obtain an acceptable signal. A similar airgun source was used in the region in 2008 during the BP Liberty seismic survey. Preseason estimates of the propagation of airgun sounds from the ITAGA vertical seismic profile (VSP) sound source have been estimated based on the measurements of the seismic source reported in BP's 90-day report (Aerts et al. 2008). The BP liberty source was also an eight-airgun array, but had a slightly larger total volume of 880 $in.^3$ (14,421 cm^3). Because the number of airguns is the same, and the difference in total volume only results in an estimated 0.4 dB decrease in the source level of the ZVSP source, the 100^{th} percentile propagation model from the measurements of the BP Liberty source is almost directly applicable. However, the BP Liberty source was towed at a depth of 5.9 ft (1.8 m), while the ZVSP source will be lowered to a target depth of 13 ft (4 m) (from 10-23 ft [3-7 m]). The lower depth of the ZVSP source has the potential to increase the source strength by as much as 6 dB. Thus, the constant term in the propagation equation from the BP Liberty source has been increased from 235.4 to 241.4 while the remainder of the equation (-18*LogR – 0.0047*R) has been left unchanged. This equation results in the following estimated distances to maximum received levels: 190 dB = 1,719 ft (524 m); 180 dB = 4,068 ft (1,240 m); 160 dB = 12,041 ft (3,670 m); 120 dB = 34,449 ft (10,500 m).

MMOs on the drillship will initially use these estimated safety radii for monitoring and mitigation purposes. An acoustics contractor will perform direct measurements of the received levels of underwater sound versus distance and direction from the ZVSP array using calibrated hydrophones. The acoustic data will be analyzed as quickly as reasonably practicable (within 5 days) in the field and used to verify (and if necessary adjust) the safety distances. The mitigation measures to be implemented will include pre-ramp up watches, ramp ups, power downs and shut downs as described below.

Ramp Ups

A ramp up of an airgun array provides a gradual increase in sound levels, and involves a step-wise increase in the number and total volume of airguns firing until the full volume is achieved. The purpose of a ramp up (or "soft start") is to "warn" cetaceans and pinnipeds in the vicinity of the airguns and to provide the time for them to leave the area and thus avoid any potential injury or impairment of their hearing abilities.

During the proposed ZVSP surveys, the operator will ramp up the airgun arrays slowly. Full ramp ups (i.e., from a cold start when no airguns have been firing) will begin by firing a single airgun in the array. A full ramp up will not begin until there has been a minimum of 30 minutes

of observation of the safety zone by MMOs to assure that no marine mammals are present. The entire safety zone must be visible during the 30-minute lead-in to a full ramp up. If the entire safety zone is not visible, then ramp up from a cold start cannot begin. If a marine mammal(s) is sighted within the safety zone during the 30-minute watch prior to ramp up, ramp up will be delayed until the marine mammal(s) is sighted outside of the safety zone or the animal(s) is not sighted for at least 15-30 minutes: 15 minutes for small odontocetes and pinnipeds, or 30 minutes for baleen whales and large odontocetes.

Power Downs and Shut Downs

A power down is the immediate reduction in the number of operating energy sources from all firing to some smaller number. A shut down is the immediate cessation of firing of all energy sources. The arrays will be immediately powered down whenever a marine mammal is sighted approaching close to or within the applicable safety zone of the full arrays, but is outside the applicable safety zone of the single source. If a marine mammal is sighted within the applicable safety zone of the single energy source, the entire array will be shut down (i.e., no sources firing).

Marine Mammal Observers

Vessel-based monitoring for marine mammals will be done by trained MMOs throughout the period of exploration 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 exploration drilling operation, and during most periods when exploration drilling is not being conducted. MMO duties will include watching for and identifying marine mammals; recording their numbers, distances, and reactions to the exploration 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 exploration drilling operations in daylight;
- maximum of four consecutive hours on watch per MMO; and
- 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 exploration 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 2012 will be individuals with experience as observers during one or more of the 2006–2010 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 so that NMFS (and USFWS if so stipulated) can review and accept their qualifications. All observers will be trained and familiar with the marine mammals of the area. A MMO handbook, adapted for the specifics of the planned Shell exploration 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 2012 exploration 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 BOEMRE, or other agreements in which Shell may elect to participate;
- review of marine mammal sighting, identification, (photographs and videos) and distance estimation methods, including any amendments specified by NMFS or USFWS in the 2012 IHA or LOA;
- review of operation of specialized equipment (reticle binoculars, night vision devices, and global positioning system [GPS] system);
- review of, and classroom practice with, data recording and data entry systems, including procedures for recording data on mammal sightings, exploration 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; and
- review of specific tasks of the Inupiat communicator.

MMO Handbook

A MMO Handbook will be prepared for Shell's monitoring program. The Handbook will contain maps, illustrations, and photographs as well as copies of important documents and descriptive 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 4MP (vessel-based, aerial, acoustic measurements, special studies), the NMFS IHA and USFWS LOA and other regulations/permits/agencies, the Marine Mammal Protection Act (MMPA);
- monitoring and mitigation objectives and procedures, including initial safety radii,
- responsibilities of staff and crew regarding the 4MP;
- instructions for ship crew regarding the 4MP;
- data recording procedures: codes and coding instructions, common coding mistakes, electronic database; navigational, marine physical, and exploration drilling data recording, field data sheet;
- use of specialized field equipment: reticle binoculars, Big-eye binoculars, night vision devices (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; and
- 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. Ideally this vantage point is an elevated stable platform from which the MMO has an unobstructed 360-degree view of the water. 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 MMO(s) in watching for pinnipeds and whales. New or inexperienced MMOs will be paired with an experienced MMO or experienced field biologist so that the quality of marine mammal observations and data recording is kept consistent.

Information to be recorded by MMOs 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 carefully and accurately recorded:

- species, group size, age/size/sex categories (if determinable);
- physical description of features that were observed or determined not to be present in the case of unknown or unidentified animals;
- 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; on support ships the distance and bearing to the drillship will also be recorded; and
- 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 ft (70 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 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 compact discs (CDs) and/or universal serial bus (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.

Both Inupiat and trained-biologist observers will be encouraged to record comments about their observations into the "comment" field in the marine mammal sightings database. Observer training will emphasize the use of "comments" for sightings that may be considered unique or not fully captured by standard data codes.

In addition to the standard marine mammal sightings forms, a specialized form was developed for recording traditional knowledge and natural history observations. MMOs will be encouraged to use this form to capture observations related to any aspect of the arctic environment and the marine mammals found within it. Examples might include relationships between ice and marine mammal sightings, marine mammal behaviors, comparisons of observations among different years/seasons, etc. Copies of these records will be available to all observers for reference if they wish to prepare a statement about their observations for reporting purposes. If prepared, this statement would be included in the 90-day and final reports documenting the monitoring work.

Field Reports

Throughout the exploration drilling program, the observers 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, USFWS, BOEMRE, and Shell as required.

Reporting

The results of the 2012 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, and USFWS in the LOA (if so stipulated).

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 (when discernable), group sizes, and ice cover; and
- analyses of the effects of exploration drilling operations:
    - sighting rates of marine mammals during periods with and without exploration 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, and
    - estimates of "take by harassment".

Data will be visualized by plotting sightings relative to the position of the drillship. We will also overlay the sightings data with acoustic data that indicates the sound levels associated with the exploration drilling activity and with maps of call locations determined by the seafloor recorders. Additionally, sightings data will be incorporated into animations of the call locations around the exploration drilling activity. Seafloor recorders used in the Chukchi Sea do not have the ability to localize calls. Larger groups of recorders, however, can localize calls using arrival times of the calls captured on several nearby recorders.

Shell will consider requests for data collected during the marine mammal monitoring only after the data have been put through a quality control/quality assurance program. Such requests may include incorporating the data with other companies' data and/or integrating the raw data with data from other marine mammal studies.

ACOUSTIC MONITORING PLAN

Exploration Drilling Sound Measurements

Objectives

Exploration 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:

- to quantify the absolute sound levels produced by exploration drilling and to monitor their variations with time, distance and direction from the drillship.
- to measure the sound levels produced by vessels operating in support of exploration drilling operations. These vessels will include crew change vessels, tugs, ice-management vessels, and spill response vessels.
- to measure the sound levels produced by an end-of-hole ZVSP survey using a stationary sound source.

Equipment

The drillship, support vessels, and ZVSP sound measurements will be performed using one of two methods, both of which involve real-time monitoring. The first method would involve use of bottom-founded hydrophones cabled back to the drillship (Figure 1). These hydrophones weigh approximately 88 pounds (lb) (40 kilograms) with a footprint of approximately 2.7 square feet (ft^2) (0.25 square meters [m^2]) and would be positioned between 1,640 ft (500 m) and 3,281 ft (1,000 m) from the drillship, depending on the final positions of the anchors used to hold the drillship in place. Hydrophone cables would be fed to real-time digitization systems on board. In addition to the cabled system, a separate set of bottom-founded hydrophones (Figure 2) may be deployed at various distances from the exploration drilling operation for storage of acoustic data to be retrieved and processed at a later date.

As an alternative to the cabled hydrophone system (and possible inclusion of separate bottom-founded hydrophones), the second (or alternative) monitoring method would involve a radio buoy approach deploying four spar buoys 4-5 mi (6-8 km) from the drillship. Additional hydrophones may be deployed closer to the drillship if necessary to better determine sound source levels. Monitoring personnel and recording/receiving equipment would be onboard one of the support vessels with 24-hour monitoring capacity. The system would allow for collection and processing of real-time data similar to that provided by the cabled system but from a wider range of locations. Processing would provide real-time localization of sound sources including seals and whales.

Sound level monitoring with either method will occur on a continuous basis throughout all exploration drilling activities. Both types of systems will be set to record digital acoustic data at sample rate 32 kilohertz (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 and 180 dB re

μPa. The long duration recordings will capture many different operations performed from the drillship. Retrieval of these systems will occur following completion of the exploration drilling activities.

These recorders will provide a capability to examine sound levels produced by different exploration drilling activities and practices and possibly to develop real time noise reduction measures. This system will not have the capability to locate calling marine mammals and will indicate only relative proximity. The system will be evaluated during operations for its potential to improve MMO observations through notification of MMOs on vessel and aircraft of high levels of call detections and their general locations.

The deployment of exploration 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 exploration drilling activities. The long duration recordings will capture many different operations performed at the drillship. Accurate activity logs of exploration drilling operations and nearby vessel activities will be maintained to correlate with these acoustic measurements.

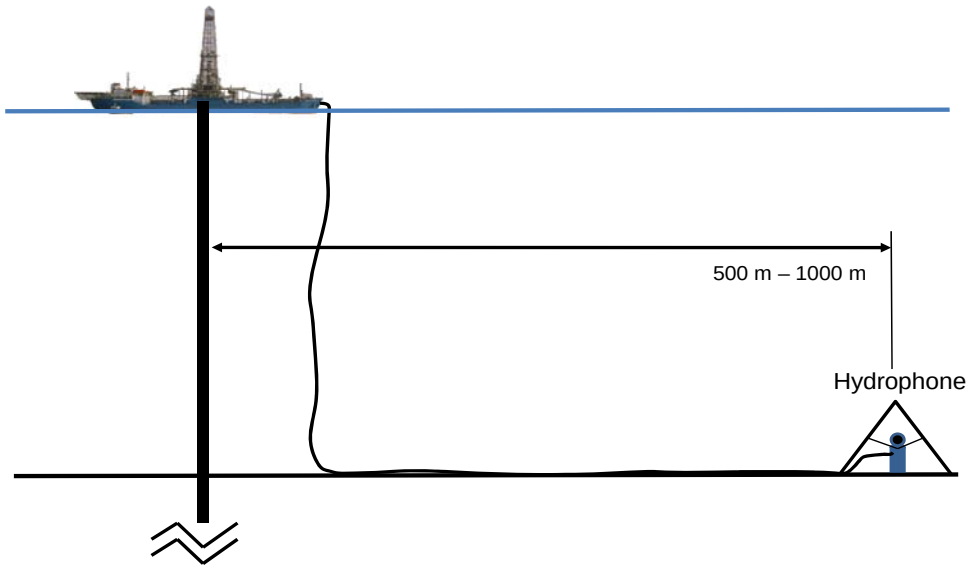


Figure 1. Cabled hydrophone method for real time monitoring of drilling sound energy.

Figure 2. 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

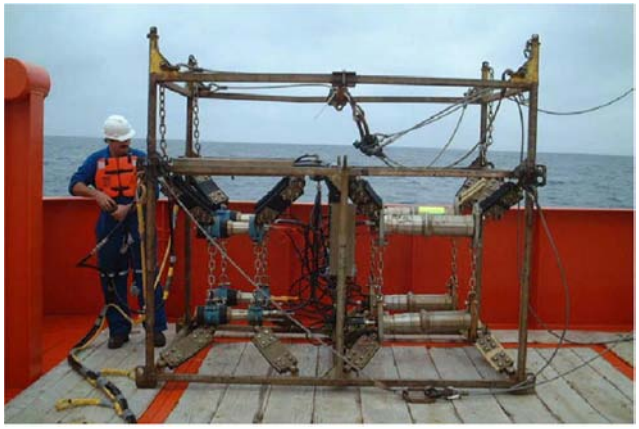
Sound produced by the vessels supporting exploration drilling operations will be recorded by the drilling sounds monitoring equipment. Logs of vessel position and activity will be used to determine the time varying contribution of each vessel to the overall sound level measurements. Additional dedicated 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 3 ft (1.0 m) range.

Zero Offset Vertical Seismic Profiling Sounds Monitoring

Sounds produced by the ZVSP survey at, or near the end of each well will be recorded using the drilling sounds monitoring equipment. During ZVSP surveys, an airgun array, which is typically much smaller than those used for routine seismic surveys, is deployed at a location near or adjacent to the drillship, while receivers are placed (temporarily anchored) in the wellbore. The sound source (airgun array) is fired repeatedly, and the reflected sonic waves are recorded by receivers (geophones) located in the wellbore. The geophones, typically in a string, are then raised up to the next interval in the wellbore and the process is repeated until the entire wellbore has been surveyed. The purpose of the ZVSP is to gather geophysical information at various depths, which can then be used to tie-in or ground-truth geophysical information from the previous seismic surveys with geological data collected within the wellbore.

During the ZVSP, the sound source is maintained at a constant location near the wellbore (Figure 3). A typical sound source that likely would be used by Shell in 2012 is the ITAGA eight-airgun array, which consists of four 150-in.^{3} (2,458-cm^3) airguns and four 4-in.^{3} (66-cm^3) airguns. These airguns can be activated in any combination and Shell would utilize the minimum airgun volume required to obtain an acceptable signal. Current specifications of the array are provided in Table 1. The airgun array is depicted within its frame or sled, which is approximately 6 ft (2 m) x 5 ft (1.5 m) x 10 ft (3 m), in the photograph below. Typical receivers would consist of a

Schlumberger wireline four level vertical seismic imager (VSI) tool, which has four receivers 50-ft (15.2-m) apart.



Photograph of ITAGA 8-airgun Array in Sled

Table 1 Typical Sound Source (Airgun Array) Specifications for ZVSP Surveys

Source Type	Number of Sources	Max Total Chamber Size	Pressure	Source Depth	Calibrated Peak-Peak Vertical Amplitude	Zero-Peak Sound Pressure Level[1]
ITAGA Sleeve Array	8 airguns (4) 150 $in.^3$ (2,458 cm^3) (4) 40 $in.^3$ (655 cm^3)	760 $in.^3$ 12,454 cm^3	2,000 psi 138 bar	9.8 ft / 3.0 m 16.4 ft / 5.0 m	16 bar @1m 23 bar @1m	238 dB 241 dB

[1] dB re1μPa @1m

A ZVSP survey is normally conducted at each well after total depth is reached but may be conducted at a shallower depth. For each survey, Shell would deploy the sound source (airgun array) over the side of the drillship *Discoverer* with a crane (sound source will be 50-200 ft / 15-61 m from the wellhead depending on crane location), to a depth of approximately 10-23 ft (3-7 m) below the water surface. The VSI with its four receivers will be temporarily anchored in the wellbore at depth. The sound source will be pressured up to 2,000 pounds per square inch (psi) (138 bar), and activated 5-7 times at approximately 20-second intervals. The VSI will then be moved to the next interval of the wellbore and re-anchored, after which the airgun array will again be activated 5-7 times. This process will be repeated until the entire wellbore is surveyed in this manner. The interval between anchor points for the VSI is usually between 200-300 ft (61-91 m). A normal ZVSP survey is conducted over a period of about 10-14 hours depending on the depth of the well and the number of anchoring points.

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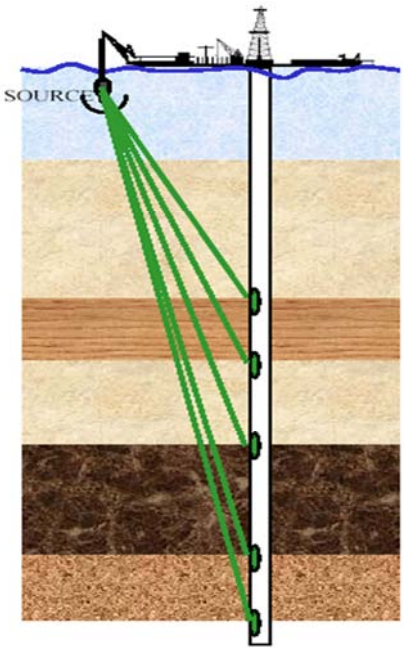

Figure 3. Schematic of ZVSP

Acoustic Data Analyses

Exploration 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 Hertz (Hz) - 1000 Hz frequency range that corresponds with the blue dotted line in the upper plot of Figure 4.

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 exploration drilling sound variation with time in selected frequency bands.

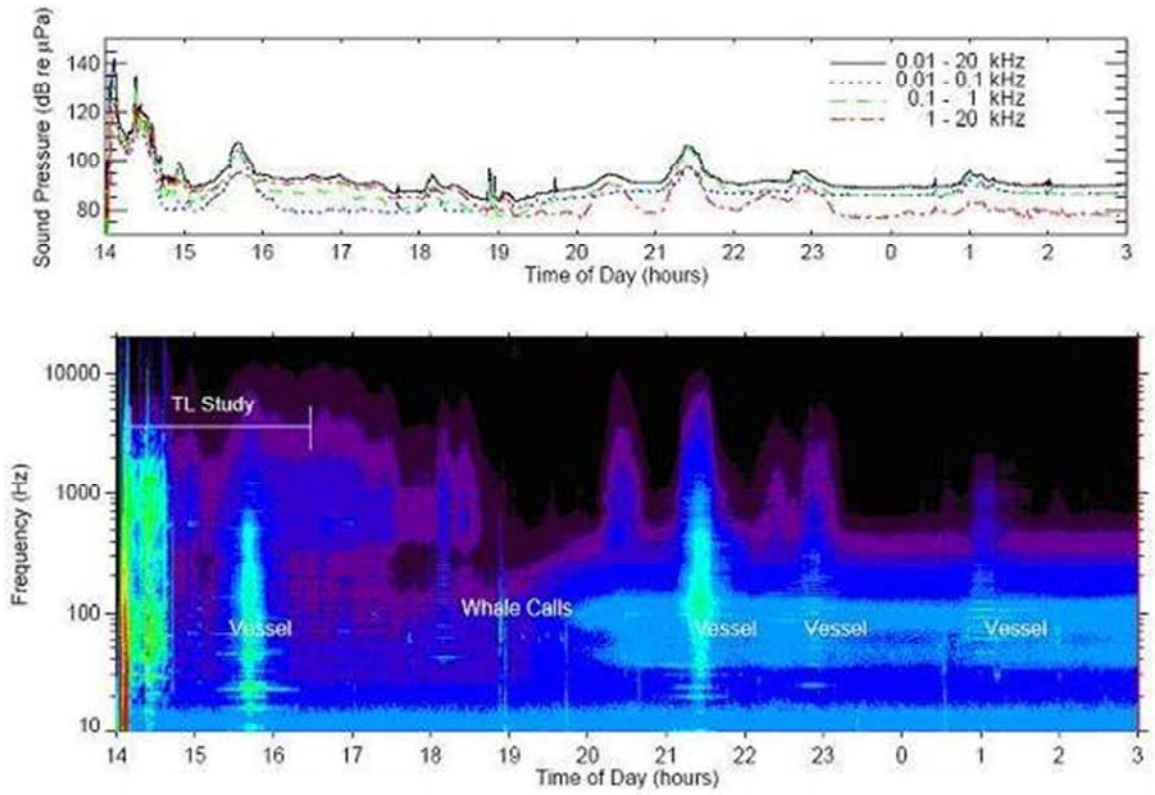

Figure 4. Lower: spectrogram of sound level measurements obtained from a hydrophone recording system. Upper: broadband and selected band level variation with time.

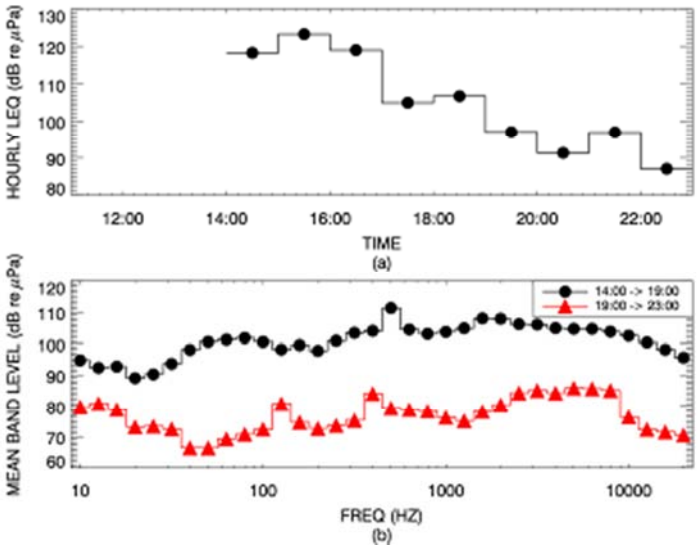

Figure 5. Upper: 1-hour Leq levels that will be calculated from acoustic measurements for use in correlating with bowhead whale deflection data.

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

JOINT MONITORING PROGRAM

This section describes studies that were undertaken in the Chukchi Sea from 2006 through 2010, will be undertaken again in 2011, and will be conducted during exploration drilling operations in 2012. Shell plans to conduct aerial surveys consistent with the previous 2006–2008 and 2010 programs along the Chukchi Sea coast. Additionally, an acoustic net array similar to the one deployed in 2010 is planned for 2011 and 2012 will be used to monitor industry and marine mammal sounds across the Chukchi Sea and along coast. Additional recorders will be deployed in the area around prospects where Shell intends to drill.

Chukchi Sea Coastal Aerial Survey

Nearshore aerial surveys of marine mammals in the Chukchi Sea were conducted over coastal areas to approximately 23 mi (37 km) offshore in 2006–2008 and 2010 in support of Shell's open-water marine survey exploration activities. 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 2012 that will be similar to the previous programs.

Alaskan Natives from 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 and harbor porpoise are expected to be the most numerous cetacean species encountered during the proposed aerial survey, although harbor porpoise are difficult to detect from aircraft. Beluga whales may occur in high numbers early in the season. 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 but will be limited in its ability to collect similar data on pinnipeds.

Objectives

The aerial survey program objectives in 2012 will be:

- to collect data on the distribution and abundance of marine mammals in coastal areas of the eastern Chukchi Sea; and
- 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 exploration 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 2012 exploration drilling season, aerial surveys will be coordinated in cooperation with the aerial surveys funded by BOEMRE and conducted by NMFS 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 (Figure 6). This design will permit completion of the survey in one to two days and will provide representative coverage of the nearshore region. Saw-tooth 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.

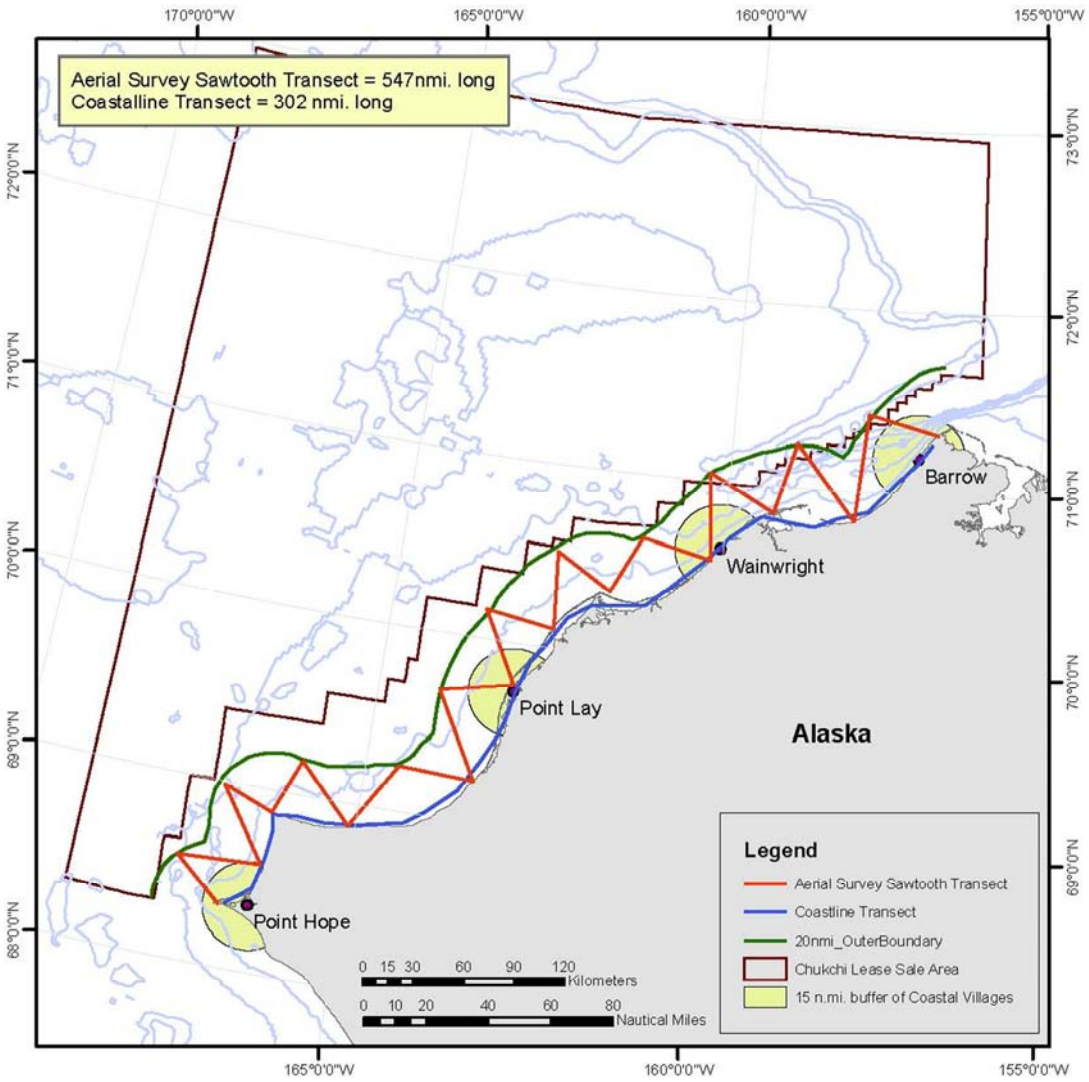

Figure 6. Aerial survey transects location and general pattern for the eastern Chukchi Sea, 2012. Specific transect start-/end-points will be altered randomly from survey to survey, and hunting areas will be avoided when hunting is occurring.

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 1,500 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.

The surveyed area will include waters where belugas are normally available to subsistence hunters. 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 (3,048 m) altitude to avoid disturbing the whales and causing 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 overflights and other forms of disturbance than when they are offshore (see Richardson et al. 1995 for a review). 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 and 2010, we will attempt to photograph the animals and provide location information to interested stakeholders.

Two primary observers will be seated at bubble windows on either side of the aircraft and a third observer will observe part-time and record data the rest of the time. All observers need bubble windows to facilitate downward viewing. For each marine mammal sighting, the observer will dictate the species, number, size/age/sex class when determinable, activity, heading, swimming speed category (if traveling), sighting cue, ice conditions (type and percentage), and inclinometer reading to the marine mammal into a digital recorder. The inclinometer reading will be taken when the animal's location is 90° to the side of the aircraft track, allowing calculation of lateral distance from the aircraft trackline.

Transect information, sighting data and environmental data will be entered into a GPS-linked computer by the third observer, and simultaneously recorded on digital voice recorders for backup and validation. At the start of each transect, the observer recording data will record the transect start time and position, ceiling height (ft), cloud cover (in 10ths), wind speed (knots), wind direction degrees True North (°T) and outside air temperature degrees Celsius (°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-minute intervals along the transect. This will provide data in units suitable for statistical summaries and analyses of effects of these variables (and position relative to the drillship) on the probability of detecting animals (Davis et al. 1982; Miller et al. 1999; Thomas et al. 2002). 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.

Coordination with Other Aerial Surveys

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

- to ensure aircraft separation when both crews conduct surveys in the same general region;

- to coordinate the 2012 aerial survey projects in order to maximize consistency and minimize duplication; and
- 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 2006–2010 field seasons is again proposed for 2011 and 2012 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 2007–2010 is again proposed for 2011 and 2012. The basic components of this effort consist of 30 hydrophone systems placed widely across the U.S. 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.

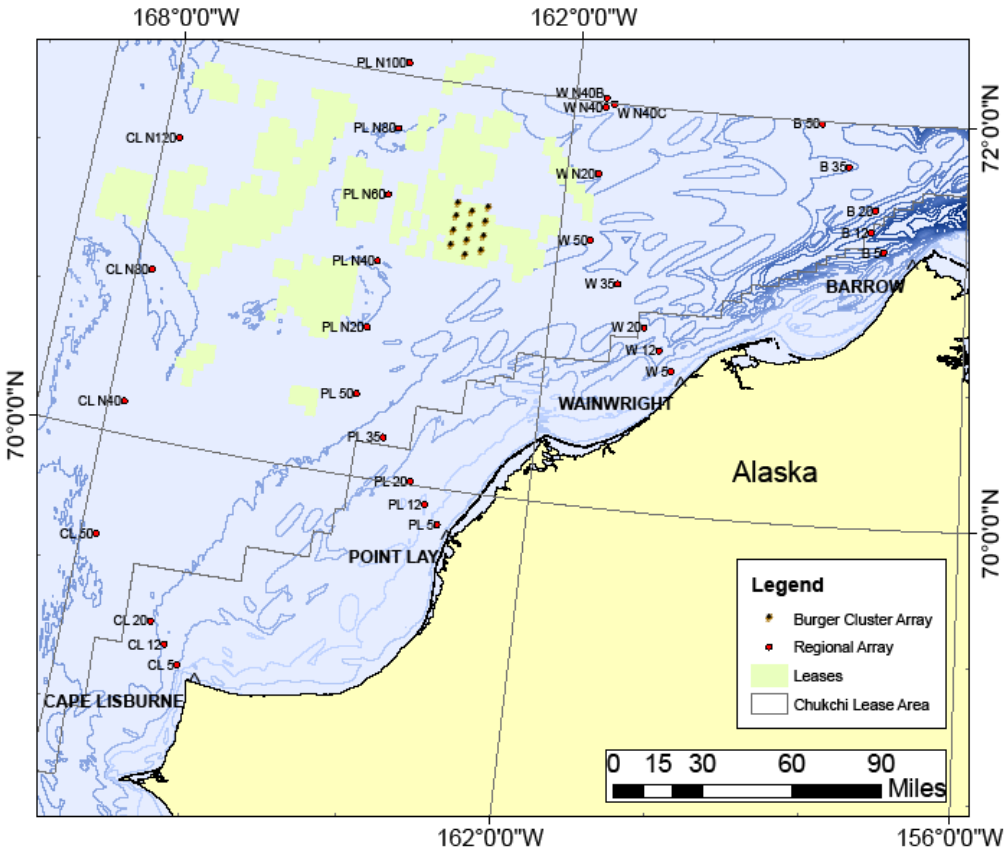

Figure 7. Deployment locations of Hydrophones in acoustic arrays in the eastern Chukchi Sea, Alaska 2012. Depiction of hydrophone array at Burger is not scaled correctly based on description below (12 km by 18 km)

The regional acoustic monitoring program, will be augmented in 2012 by an array of additional acoustic recorders to be deployed on a grid pattern over a 7.2 mi (12 km) by 10.8 mi (17.4 km) area extending over several of Shell's lease blocks near locations of highest interest for exploration drilling in 2012. 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 three 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 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 automated vocalization detection algorithms. 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 may provide a measure of the relative spatial distribution of some marine mammal species, assuming that vocalization patterns are consistent within a species across the spatial and geographic distribution of the hydrophone array. These results may 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 exploration drilling sounds reaching the near-shore region. It is expected that sounds from exploration drilling activities will be detectable on hydrophone systems when ambient sound energy conditions are low. The exploration 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 exploration 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 exploration drilling or vessel sound levels).

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

Following the 2012 exploration 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. 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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