APPENDIX A: NATIONAL MARINE FISHERIES SERVICE IHA

DEPARTMENT OF COMMERCE

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

NATIONAL MARINE FISHERIES SERVICE

Incidental Harassment Authorization

Shell Offshore, Inc. and WesternGeco, Inc.(SOI/WG) are hereby authorized under section 101(a)(5)(D) of the Marine Mammal Protection Act (16 U.S.C. 1371 (a)(5)(D)) and 50 CFR 216.107, to take by Level B harassment only, small numbers of marine mammals incidental to conducting a marine seismic survey program in the Chukchi and Beaufort seas in Arctic Ocean waters under the jurisdiction of the United States, contingent upon the following conditions:

1. This Authorization is valid from the date of this Authorization through August 1, 2008, or until a new Incidental Harassment Authorization is issued to SOI/WG, whichever is earlier.

2. This Authorization is valid only for activities (including support vessels and aircraft) associated with the *M/V Gilavar* and *M/V Henry Christoffersen* conducting deep and shallow-hazard seismic survey programs in the Chukchi and Beaufort seas, as specified in SOI's November 22, 2006 application.

3 (a) The species authorized for incidental harassment takings are: bowhead whales (*Balaena mysticetus*), gray whales (*Eschrichtius robustus*), beluga whales (*Delphinapterus leucas*), killer whales (*Orcinus orca*), harbor porpoise (*Phocoena phocoena*), ringed seals (*Phoca hispida*), spotted seals (*Phoca largha*), and bearded seals (*Erignathus barbatus*).

(b) The authorization for taking by harassment is limited to the following acoustic sources without an amendment to this Authorization:

(i) On the *M/V Gilavar*:

(A) A Bolt-seismic airgun array of 3147 in^3 composed of 3 identically tuned 1049-in^3 Bolt-gun sub-arrays operating at an air pressure of 2,000 psi;
(B) a subbottom profiler (1 - 12.0 kHz);
(C) a boomer/sparker/ airgun (400-800 Hz);
(D) a hi-resolution multi-channel seismic system (20-300 Hz);
(E) a multi-beam bathymetric sonar (200-500 kHz) ; and
(F) a side-scan sonar system.

(ii) On the *M/V Henry Christoffersen*:

(A) a dual frequency subbottom profiler, Datasonics CAP6000 Chirp II (2-7kHz

or 8-23kHz)
(B) a medium penetration Subbottom profiler, Datasonics SPR-1200 Bubble Pulser (400 Hz);
(C)a hi-resolution multi-channel seismic system consisting of 2 subarrays of 2-10 in^3 (2X10) airgun array (0-150 Hz);
(D) a multi-beam bathymetric sonar, Seabat 8101 (240 kHz); and
(E) a side-scan sonar system, Datasonics SIS-1500 (190kHz - 210 kHz)

(c) The taking of any marine mammal in a manner prohibited under this Authorization must be reported within 24 hours of the taking to the Alaska Regional Administrator (907-586-7221) or his designee in Anchorage (907-271-3023), NMFS and the Chief of the Permits, Conservation and Education Division, Office of Protected Resources, National Marine Fisheries Service, at (301) 713-2289, ext 110, or his designee.

4. The holder of this Authorization is required to cooperate with the National Marine Fisheries Service and any other Federal, state or local agency with authority to monitor the impacts of the activity on marine animals. The holder must notify the Chief of the Permits, Conservation and Education Division, Office of Protected Resources at least 48 hours prior to the start of collecting seismic data (unless constrained by the date of issuance of this Authorization in which case notification shall be made as soon as possible), whenever moving between the Chukchi Sea and the Beaufort Sea, and whenever not conducting seismic for more than 48 hours.

5. Prohibitions

(a) The taking, by incidental harassment only, is limited to the species listed under condition 3(a) above. The taking by serious injury or death of these species or the taking by behavioral harassment, injury or death of any other species of marine mammal is prohibited and may result in the modification, suspension or revocation of this Authorization.

(b) The taking of any marine mammal whenever the required seismic vessel marine mammal observer (MMO), required by condition 7(a)(i)), is not onboard in conformance with condition 7(a)(i), or the coastal or offshore aerial, and/or the dedicated vessel and passive acoustic monitoring programs have not been fully implemented as required by this Authorization.

(c) The taking of any marine mammals by seismic sounds when the seismic vessel is within 15 miles of another operating seismic vessel.

6. Mitigation.

(a) General Mitigation: The holder of this Authorization is required to:

(i) (A) Avoid concentrations or groups of whales by all vessels and aircraft under the direction of SOI or WG. Operators of support vessels and aircraft should, at all times,

conduct their activities at the maximum distance possible from such concentrations of whales. Under no circumstances, other than an emergency, should aircraft operate at an altitude lower than 1,000 feet when within 500 lateral yards of groups of whales. Helicopters may not hover or circle above such areas or within 500 lateral yards of such areas; and (B) When weather conditions do not allow a 1,000-ft flying altitude, such as during severe storms or when cloud cover is low, aircraft may be operated below the 1,000-ft altitude stipulated above. However, when aircraft are operated at altitudes below 1,000 feet because of weather conditions, the operator must avoid known whale concentration areas and should take precautions to avoid flying directly over or within 500 yards of groups of whales.

(ii) take every precaution to avoid harassment of whale concentrations when a vessel is operated near these animals. Vessels should reduce speed when within 300 yards of whales and those vessels capable of steering around such groups should do so. Vessels may not be operated in such a way as to separate members of a group of whales from other members of the group.

(iii) avoid multiple changes in direction and speed when within 300 yards of whales. In addition, operators should check the waters immediately adjacent to a vessel to ensure that no whales will be injured when the vessel's propellers (or screws) are engaged.

(iv) not operate support vessels (including small boats) at a speed that would make collisions with whales likely.

(v) when weather conditions require, such as when visibility drops, vessels should adjust speed accordingly to avoid the likelihood of injury to whales.

(vi) (A) Operate in full compliance with the agreed-upon Conflict Avoidance Agreement; or (B) If the signed Conflict Avoidance Agreement has expired or been nullified by the Holder of this Authorization, the following mitigation measures must be fully implemented:

(I) for the purposes of reducing or eliminating conflicts between subsistence whaling activities and Shell's seismic program, the Holder of this Authorization will establish and operate at least five Communication Centers to be staffed by Inupiat operators. The Com-Centers will be operated 24 hours/day during the 2007 fall subsistence bowhead whale hunt.

(II) Plan all vessel and aircraft routes to minimize any potential conflict with bowhead whale subsistence whaling activities. All vessels shall avoid areas of active or anticipated whaling activity.

(III) During the bowhead whaling season, aircraft shall not operate below 1500 ft unless approaching, landing or taking off, or unless engaged in providing assistance to a whaler or in poor weather (low ceilings) or other emergency situations.

(IV) All geophysical activity in the Beaufort Sea and Chukchi seas shall be restricted from conducting seismic as set forth below:

(*1*) *Kaktovik*: No geophysical activity from the Canadian border to the Canning River (~146 deg. 4 min. W) from 25th August to the end of the fall bowhead whale hunt

in Kaktovik and Nuiqsut;

(2) *Nuiqsut*: No geophysical activity from the Canning River (~146 deg. 4 min. W) to Point Storkersen (~ 148 deg. 45 min. W) from August 25th to the end of the fall bowhead whale hunt in Nuiqsut;

(3) *Barrow*: No geophysical activity from Pitt Point on the east side of Smith Bay (~ 152 deg. 15 min. W) to a location about half way between Barrow and Peard Bay (~157 deg. 20 min. W) from September 10 to the end of the fall bowhead whale hunt in Barrow.

(4) *Chukchi Sea*: Geophysical exploration may occur beginning July 20, but in any case geophysical exploration activities may not occur closer than 60 miles from the Chukchi Sea coast at any point.

(5) Seismic vessel transits in the Chukchi Sea spring lead system must not occur prior to July 1, 2008.

(V) Upon notification by Communication Center operator of an at-sea emergency, the Holder of this Authorization shall provide such assistance as necessary to prevent the loss of life.

(VI) Upon request for emergency assistance made by a subsistence whale hunting organization, or by a member of such an organization in order to prevent the loss of a whale, the Holder of this Authorization shall assist towing of a whale taken in a traditional subsistence whale hunt.

(VII) Geophysical exploration may resume following the close of the fall 2007 bowhead whale subsistence hunt in Barrow, Wainwright, and Point Hope.

(VIII)(*a*) Post-Season Review: No later than 90 days following the end of the fall 2007 bowhead subsistence hunt, Shell will host a joint meeting with all whaling captains of the Villages of Nuiqsut, Kaktovik and Barrow, the Inupiat Communicator(s) and with the Chairman and Executive Director of the AEWC at a mutually agreed upon place on the North Slope to review the results of the 2007 fall season (unless it is agreed by all designated individuals or their representatives that such a meeting should be held at a different location, should be postponed, or is not necessary).

(*b*) No later than 90 days following completion of geophysical operations in the Chukchi Sea, Shell will host a meeting in each of the following villages: Wainwright, Point Hope, and Barrow (or a joint meeting of the whaling captain from all these villages if the whaling captains agree to a joint meeting) to review the results of operations and to discuss any concerns residents of those villages might have regarding the operations.

(b) Seismic Vessel Mitigation: The holder of this Authorization is required to:

(i) Reduce the volume of the airgun array during vessel turns while running seismic lines.

(ii) To the extent practicable, whenever a marine mammal is detected outside the exclusion zone radius, and based on its position and motion relative to the ship track is likely to enter the safety radius, an alternative ship speed or track will be calculated and implemented.

(iii) Exclusion and Monitoring-Safety Zones:

(A) Establish and monitor with trained observers a preliminary exclusion zone for cetaceans surrounding the seismic airgun array on the *M/V Gilavar* where the received level would be 180 dB re 1 µPa rms. For purposes of the field verification test, described in condition 7(d), this radius is estimated to be 0.75 mi (1.2 km) from the seismic source.

(B) Establish and monitor with trained observers a preliminary exclusion zone for pinnipeds surrounding the seismic airgun array on the *M/V Gilavar* where the received level would be 190 dB re 1 µPa rms. For purposes of the field verification test described in condition 7(d), this radius is estimated to be 0.3 mi (0.5 km) from the seismic source.

(C) Establish and monitor with trained observers a preliminary exclusion zone for cetaceans and pinnipeds surrounding the high-resolution seismic airgun array on the *M/V Henry Christoffersen* where the received level would be 180 dB and 190 dB re 1 µPa rms, respectively.

(D) Immediately upon completion of data analysis of the field verification measurements required under condition 7(d) below, establish and monitor the new 180-dB and 190-dB marine mammal exclusion zones.

(E) Cetacean Monitor (Safety) Zones:

(I) Whenever the support "chase" vessel monitoring program described in condition 7(b) below detects an aggregation of 12 or more non-migratory balaenopterid whales within an acoustically verified 160-dB rms zone ahead of, or perpendicular to, the seismic vessel track, the holder of this Authorization must: (a) Immediately power-down the seismic airgun array and/or other acoustic sources to ensure that sound pressure levels at the shortest distance to the aggregation do not exceed 160 dB rms; and (b) Not proceed with powering up the seismic airgun array until biological observers on board the support "chase" vessel(s) or survey aircraft confirm that no balaenopterid aggregations have been detected within the 160-dB zone based upon ship course, direction and distance from last sighting and the last aggregation sighting appropriate safety zones;

(II) Whenever the aerial monitoring program described in conditions 7(c) below detects 4 bowhead whale cow/calf pairs within an acoustically-verified 120-dB monitoring zone, the holder of this Authorization must: (a) Immediately power-down the seismic airgun array and/or other acoustic sources to ensure that sound pressure levels are reduced by at least 50 percent ; and (b) not proceed with ramping up the seismic airgun array until two consecutive

aerial surveys confirm that there are no more than 3 bowhead cow/calf pairs within the area to be seismically surveyed within the next 24 hours.

(iv) Power-down/Shut-down.

(A) Immediately power-down the seismic airgun array and/or other acoustic sources, whenever any cetaceans are sighted approaching close to or within the area delineated by the 180 dB (re 1 μPa_{rms}), or pinnipeds are sighted approaching close to or within the area delineated by the 190 dB re 1 µPa rms isopleth as established under condition 6(b)(iii) for the authorized seismic airgun array. If the power-down operation cannot reduce the received sound pressure level at the cetacean or pinniped to 180 dB or 190 dB, whichever is appropriate, the Holder of this Authorization must immediately shut-down the seismic airgun array and/or other acoustic sources.

(B) Not proceed with powering up the seismic airgun array unless the marine mammal exclusion zones described in condition 6(b)(iii)(A), (B), and (C) are visible and no marine mammals are detected within the appropriate safety zones; or until 15 minutes (for small odontocetes, pinnipeds) or a minimum of 30 minutes (for mysticetes/large odontocetes) after there has been no further visual detection of the animal(s) within the safety zone and the trained MMO on duty is confident that no marine mammals remain within the appropriate safety zone.

(C) Emergency shut-down. If observations are made or credible reports are received that one or more marine mammals are within the area of this activity in an injured or mortal state, or are indicating acute distress, the seismic airgun array will be immediately shut down and the Chief of the Permits, Conservation and Education Division, Office of Protected Resources or a staff member contacted. The airgun array will not be restarted until review and approval has been given by the Director, Office of Protected Resources or his designee.

(v) Ramp-up

(A) Prior to commencing ramp-up described in condition 6 (b)(v)(C), conduct a 30-minute period of marine mammal observations by at least one trained MMO (1) at the commencement of seismic operations and (2) at any time electrical power to the airgun array is discontinued for a period of 10 minutes or more and the MMO watch has been suspended;

(B) If the complete safety radii are not visible for at least 30 minutes prior to ramp-up in either daylight or nighttime, do not commence ramp-up unless the seismic source has maintained a sound pressure level at the source of at least 180 dB re 1 µPa rms during the interruption of seismic survey operations.

(C) If no marine mammals are observed while undertaking mitigation conditions 6(v)(A) and (B), ramp-up airgun arrays no greater than approximately 6 dB per 5-minute period starting with the smallest airgun in the array and then adding additional guns in sequence, until

the full array is firing: (1) At the commencement of seismic operations, and (2), anytime after the airgun array has been powered down for more than 10 minutes;

7. Monitoring.

(a) Vessel Monitoring:

(i) Seismic Vessel: The holder of this Authorization must designate biologically-trained, on-site individuals to be onboard the *M/V Gilavar* and *M/V Henry Christoffersen*, and designated support vessels conducting marine mammal observations or surveys, approved in advance by National Marine Fisheries Service (one may be an Inupiat), to conduct the visual monitoring programs required under this Authorization and to record the effects of seismic surveys and the resulting noise on marine mammals. The minimum number of observers required are:

(A) Between August 16 and September 15, 2007, there must be at least 4 MMOs onboard each source vessel at any one time during all seismic operations;

(B) Between September 16 and the end of the 2007 survey, there must be at least 3 MMOs onboard each source vessel at any time during all seismic operations.

(C) Between July 20, 2008 and August 1, 2008, there must be at least 5 MMOs onboard each source vessel at any one time during all seismic operations.

(ii) To the extent possible, MMOs should be on duty for 4 consecutive hours or less, although more than one 4-hour shift per day is acceptable.

(iii) Monitoring is to be conducted by the MMOs described in condition 7(a)(i) above, onboard each active seismic vessel, to (A) ensure that no marine mammals enter the appropriate safety zone whenever the seismic array is on, and (B) to record marine mammal activity as described in condition 7(a)(vi) below, at least two observers must be on watch during ramp ups and the 30 minutes prior to full ramp ups, and for as large a fraction of the other operating hours as possible. At all other times, at least one observer must be on active watch whenever the seismic airgun array is operating during all daytime airgun operations, during any nighttime power-ups of the airguns and at night, whenever daytime monitoring resulted in one or more power-down situations due to marine mammal presence.

(iv) At all times, the crew must be instructed to keep watch for marine mammals. If any are sighted, the bridge watch-stander must immediately notify the biological observer on-watch. If a marine mammal is within, or closely approaching, its designated safety zone, the airgun array must be immediately powered down.

(v) Observations by the biological observers described in condition 7(a)(i) above

on marine mammal presence and activity will begin a minimum of 30 minutes prior to the estimated time that the seismic source is to be turned on and/or ramped-up.

(vi) Monitoring will consist of recording: (i) the species, group size, age/size/sex categories (if determinable), the general behavioral activity, heading (if consistent), bearing and distance from seismic vessel, sighting cue, behavioral pace, and apparent reaction of all marine mammals seen near the seismic vessel and/or its airgun array (e.g., none, avoidance, approach, paralleling, etc) and; (ii) the time, location, heading, speed, and activity of the vessel (shooting or not), along with sea state, visibility, cloud cover and sun glare at (1) any time a marine mammal is sighted, (2) at the start and end of each watch, and (3) during a watch (whenever there is a change in one or more variable); and, (iii) the identification of all vessels that are visible within 5 km of the seismic vessel whenever a marine mammal is sighted, and the time observed, bearing, distance, heading, speed and activity of the other vessel(s).

(vii) All biological observers must be provided with and use appropriate night-vision devices, Big Eyes, and reticulated and/or laser range finding binoculars.

(b) Chase Boat Monitoring:

(i) At least one "chase boat"and/or support vessel will assist in monitoring safety and monitoring zones during active seismic survey operations in the Chukchi and Beaufort Seas. The chase boat and support vessel will have at least two MMOs onboard to collect marine mammal observations.

(ii) During all active seismic survey activity, the chase boat will conduct marine mammal surveys no less than every 48 hours or 3 times per 7 days, and at all other times except during re-supply operations, of the 160-dB area to be seismically surveyed over the next 24 hours. MMOs will search for aggregations of bowhead and gray whale feeding utilizing a survey designed approved in advance by the National Marine Fisheries Service.

(iii) The MMOs on the chase boat will immediately contact the seismic survey ship if marine mammals are sited within the 180/190-dB safety zone or aggregations of 12 or more non-migratory bowhead whales or gray whales are sited within the surveyed 160-dB zone.

(iv) MMOs onboard chase boats will be limited to 4 hrs in length and 12 hrs total in a 24 hr period.

(c) Aerial Surveys: Beaufort Sea:

(i) In accordance with the survey design described in Shell's revised Beaufort Sea monitoring plan, the holder of this Authorization must conduct aerial surveys of the seismic area and nearby waters (A) biweekly through August 31, 2007, and (B) daily, weather permitting, from September 1, 2007, until 3 days after the conclusion of the seismic program.

(ii) Using standard aerial survey procedures for marine mammal surveys, monitoring is to be conducted by 2 primary biological observer(s) and a third observer for part-time observations and data logging.

(iii) Aerial monitoring will consist of noting the marine mammal species, number, age/size/sex class (if determinable), general activity, heading (if consistent), swimming speed category (if traveling), sighting cue, ice conditions, and inclinometer reading.

(iv) As proposed by SOI, after September 1, 2007, the aerial survey will look for migratory cow/calf pairs during normal survey activity. If the biological observers onboard the aircraft see 4 or more migratory bowhead whale cow/calf pairs within the surveyed portion of the 120-dB isopleth from the seismic survey vessel, the lead observer or his/her designee will contact the MMO on watch onboard the seismic vessel of the observation. The location, bearing and approximate speed of the migratory bowhead whales will be recorded.

(d) Field Source Verification Using a bottom founded hydrophone system, the holder of this Authorization is required to measure and report within 5 days of completing the test:

(i)(A) the empirical distances from the airgun array to broadband received levels of 190, 180, 170, 160, and 120 dB(rms) re 1 microPa, and

(i)(B) the radiated sounds vs. distance from the primary seismic vessels supporting the survey.

(ii) Measurements are to be made at the beginning of the survey for locations not previously modeled in the Chukchi Sea and Beaufort Sea in water depths shallower than 200 m (656 ft) and water depths greater than 200 m (656 ft).

8. Research

(a) The holder of the Authorization, in cooperation with other oil company participants must conduct all research described in the "Marine Mammal Monitoring and Mitigation Plan for Seismic Exploration in the Alaskan Chukchi and Beaufort Seas, 2007." Research will include establishment of:(i) an acoustic program to measure sounds produced by seismic vessels (required under condition 7(d); (ii) an aerial monitoring and reconnaissance of marine mammals available for subsistence harvest along the Chukchi Sea coast; (iii) deployment, and later analysis of data from, bottom-founded autonomous acoustic recorder arrays along the coast of the Chukchi Sea to record ambient sound levels, vocalizations of marine mammals, and received levels of seismic operations should they be detectable and, (iv) an acoustic study of bowhead deflections in the Beaufort Sea.

9. Reporting.

(a) Field Source Verification and the distances to the various radii are to be reported to the National Marine Fisheries Service within 5 days of completing the measurements. In addition to reporting the radii of specific regulatory concern, distances to other sound isopleths down to 120 dB rms (if measurable) will be reported in increments of 10 dB.

(b) Seismic Vessel Monitoring Program: A draft report will be submitted to the National Marine Fisheries Service within 90 days after the end of Shell's seismic survey program in the Arctic Ocean. The report will describe in detail (i) the operations that were conducted, (ii) the results of the acoustical measurements to verify the safety radii, (iii) the methods, results, and interpretation pertaining to all monitoring tasks; (iv) the results of the 2007 shipboard marine mammal monitoring;; (v), a summary of the dates and locations of seismic operations, including summaries of power downs, shut downs, and ramp up delays; (vi) marine mammal sightings (species, numbers, dates, times and locations; age/size/gender, environmental correlates, activities, associated seismic survey activities), (vii) estimates of the amount and nature of potential take (exposure) of marine mammals (by species) by harassment or in other ways to industry sounds; (viii) an analysis of the effects of seismic operations (e.g., on sighting rates, sighting distances, behaviors, movement patterns of marine mammals); (ix) provide an analysis of factors influencing detectability of marine mammals; and (x) provide summaries on communications with hunters and potential effects on subsistence uses.

(c) The draft report will be subject to review and comment by the National Marine Fisheries Service. Any recommendations made by the National Marine Fisheries Service must be addressed in the final report prior to acceptance by the National Marine Fisheries Service. The draft report will be considered the final report for this activity under this Authorization if the National Marine Fisheries Service has not provided comments and recommendations within 90 days of receipt of the draft report.

(d) A draft comprehensive report describing the acoustic, vessel-based, and aerial monitoring programs will be prepared and submitted within 240 days of the date of this Authorization. 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 all industry activities and their impacts on marine mammals in the Arctic Ocean during 2007.

(e) The draft comprehensive report will be reviewed by participants at the 2008 Open Water Scientific Meeting to be held in Anchorage AK in the spring of 2008. The draft comprehensive report will be accepted by the National Marine Fisheries Service as the final comprehensive report upon incorporation of recommendations by the workshop participants.

10. Activities related to the monitoring described in this Authorization do not require a separate scientific research permit issued under section 104 of the Marine Mammal Protection Act.

11. The Plan of Cooperation and the Conflict Avoidance Agreement outlining the steps that will be taken to cooperate and communicate with the native communities to ensure the availability of marine mammals for subsistence uses, must be implemented to the extent one exists.

12. This Authorization may be modified, suspended or withdrawn if the holder fails to abide by the conditions prescribed herein or if the authorized taking is having more than a negligible impact on the species or stock of affected marine mammals, or an unmitigable adverse impact on the availability of such species or stocks for subsistence uses.

13. A copy of this Authorization must be in the possession of each seismic vessel operator taking marine mammals under the authority of this Incidental Harassment Authorization.

8/20/07

James H. Lecky
Director, Office of Protected Resources
National Marine Fisheries Service

Date

APPENDIX B: U.S. FISH AND WILDLIFE SERVICE IHA

United States Department of the Interior

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

IN REPLY REFER TO:

AFES/MMM

JUL 2 0 2007

Ms. Susan Childs
Shell Exploration & Production Company
3601 C Street, Suite 1334
Anchorage, Alaska 99503

Dear Ms. Childs:

This responds to your request dated, April 4, 2007, for an incidental take authorization (IHA) for the non-lethal, incidental take of polar bears and Pacific walrus in the northern Chukchi Sea in association with the 2007 Shell Offshore Incorporated (SOI) open-water geophysical (seismic) program. This letter is to transmit the final IHA and its relevant operational conditions, monitoring and reporting requirements to Shell.

This incidental take authorization is issued in accordance with provisions of the Marine Mammal Protection Act, as amended, described in the U.S. Fish and Wildlife Service publication listed at 72 FR 30670, dated June 1, 2007. Should you have any further questions, please contact Mr. Craig Perham of our Marine Mammals Management Office at (907) 786-3800 or 786-3810.

Sincerely,

Acting Regional Director

Enclosure

cc: FFWFO
LE
Rance Wall, Minerals Management Service

TAKE PRIDE IN AMERICA

FINDING OF NO SIGNIFICANT IMPACT

AUTHORIZATION GOVERNING THE INCIDENTAL TAKING OF MARINE MAMMALS BY HARASSMENT

Based on a review and evaluation of the information contained in the supporting reference below, I have concluded that approval and promulgation of procedural regulations governing the incidental harassment of small numbers of marine mammals during specific activities (other than commercial fishing) at specific geographical areas would not significantly affect the quality of the human environment, and that the preparation of an Environmental Impact Statement on this action is not required by section 102(2) of the National Environmental Policy Act or its implementing regulations.

Supporting References

1. U.S. Fish and Wildlife Service - Environmental Assessment, Incidental Harassment Authorization to Take of Small Numbers of Polar Bear (Ursus maritimus) and Pacific Walrus (Odobenus rosmarus divergens) During Oil and Gas Industry Seismic Activities in the Chukchi Sea.

Date: 20 July 07

Acting Regional Director, Region 7
U.S. Fish and Wildlife Service

ISSUED: July 20, 2007
EXPIRES: November 30, 2007

INCIDENTAL TAKE AUTHORIZATION
(IHA-07-01)

Shell Offshore Inc. (SOI) is hereby authorized under section 101(a)(5)(D) of the Marine Mammal Protection Act (16 U.S.C. 1371 (a)(5)(D)) to harass small numbers of walruses and polar bears incidental to conducting a marine seismic survey program in the Chukchi Sea in Arctic Ocean waters under the jurisdiction of the United States, contingent upon the following conditions:

1. The Operations Manager will be fully aware, understand and capable of implementing the conditions of this authorization.

2. This Authorization is valid only for activities (including support vessels and aircraft) associated with SOI's 2007 Open Water Seismic Program, as specified in SOI's April 4, 2007 application.

3. The following documents are hereby approved, and all provisions unless specifically noted are incorporated into this authorization by reference:

(a) *Marine Mammal Monitoring and Mitigation Plan for Seismic Exploration in the Alaskan Chukchi and Beaufort Seas, 2007*, May 2007. Received by the Service July 5, 2007.

(b) *Polar Bear Interaction Plan* (Alaska North Slope, Chukchi and Beaufort Seas Bear Avoidance, Encounter, and Interaction Plan, June 2007; V. 3).

(c) *Plan of Cooperation: 2007 Open Water Program for Beaufort Sea and Chukchi Sea*, Shell Offshore Inc., June 2007. Amended on July 11, 2007. Received by the Service July 12, 2007. The Service acknowledges that the Plan of Cooperation (POC) is a dynamic document and as such SOI will be engaged with potentially affected communities in the development and implementation of the POC throughout the SOI operational period. Additional amendments must be approved by the Service prior to implementation.

4. The species authorized for takings, by Level B Harassment only, are: Pacific walrus (*Odobenus rosmarus divergens*), and polar bear (*Ursus maritimus*). The taking of any walrus or polar bear in a manner prohibited under this authorization must be reported within 24 hours of the taking to the U.S. Fish and Wildlife Service (Service) Incidental Take Coordinator in Anchorage Alaska (907-786-3800), or their designee, as specified in condition 10(d).

5. The holder of this Authorization is required to cooperate with the Service and any other Federal, state or local agency monitoring the impacts of the activity on walruses and polar bears. The holder must notify the Service Incidental Take Coordinator at least 24 hours prior to the start of collecting seismic data.

6. At the discretion of the Service, the operator will allow the Service to place an observer on site (vessels and aircraft) to monitor the impacts of the activity on Pacific walruses and polar bears.

7. Prohibitions:

(a) The taking, by incidental Level B harassment only, is limited to the species listed under condition 4 above. The taking by Level A harassment, serious injury, or death of these species is prohibited and may result in the modification, suspension or revocation of this Authorization.

(b) The taking of any walrus or polar bear whenever the required marine mammal mitigation and monitoring measures (conditions 8 and 9) have not been fully implemented as required by this Authorization, is prohibited.

(c) The taking of any walrus or polar bear by seismic sounds when the seismic source vessel is within a 40-mile radius of the communities of Point Hope, Point Lay, Wainwright and Barrow is prohibited.

(d) Seismic airgun operation, including sound source verification, prior to July 20 is prohibited.

8. Mitigation:

(a) *General Mitigation*:
The holder of this Authorization is required to:

(i) (A) Avoid concentrations or groups of walruses and polar bears hauled out onto land or ice by all vessels and aircraft under the direction of SOI. Operators of support vessels and aircraft should, at all times, conduct their activities at the maximum distance possible from known or observed concentrations of animals. Under no circumstances, other than an emergency, should vessels operate within ½ mile (805 meters) of walruses or polar bears observed on land or ice. Under no circumstances, other than an emergency, should aircraft operate at an altitude lower than 1,000 feet (305 meters) when within ½ mile of any walrus or polar bear observed on land or ice; and,

(B) When weather conditions do not allow a 1,000-foot flying altitude, such as during severe storms or when cloud cover is low, aircraft may be operated below the 1,000-foot altitude stipulated above. However, when aircraft are operated at altitudes below 1,000 feet because of weather conditions, the operator must avoid known walrus and polar bear concentration areas and should take precautions to avoid flying directly over or within ½ mile of known walrus and polar bear concentration areas.

(ii) Take every precaution to avoid harassment of walruses or polar bears in water when a vessel is operated near these animals. Vessels must reduce speed when within 300 yards (274 meters) of walruses or polar bears observed in water and vessels capable of steering around these animals must do so. Vessels may not be operated in such a way as to separate members of a group of walruses or polar bears from other members of the group. Vessels should avoid multiple changes in direction and speed when within 300 yards of walruses or polar bears.

(iii) Operate in full compliance with the terms identified in the approved documents identified in Condition 3.

(b) *Seismic Vessel Mitigation:*
The holder of this Authorization is required to:

(i) Reduce the volume of the airgun array during vessel turns while running seismic lines.

(ii) To the extent practical, whenever a marine mammal is detected outside the exclusion zone radius but appears likely to enter the exclusion zone radius, an alternative ship speed or track will be calculated and implemented.

(iii) Exclusion and Monitoring-Safety Zones:

(A) Establish and monitor with trained observers a preliminary exclusion zone for walruses surrounding the seismic airgun array where the received level would be 180 dB.

(B) Establish and monitor with trained observers a preliminary exclusion zone for polar bear surrounding the seismic airgun array where the received level would be 190 dB.

(C) As soon as possible, arrange for the direct field measurements of received levels of underwater sound versus distance and direction from the airgun arrays using calibrated hydrophones. Immediately upon completion of data analysis of the field verification measurements establish and monitor new 180-dB and 190-dB marine mammal exclusion zones.

(iv) Power-down/Shut-down:

(A) Immediately shut-down or power-down the seismic airgun array and/or other acoustic sources, whenever any walruses are sighted approaching close to or within the area delineated by the 180 dB isopleth, or polar bear are sighted approaching close to or within the area delineated by the 190 dB isopleth established under condition 8(b)(iii).

(B) Not proceed with ramping up the seismic airgun array unless the safety zones described in condition 8(b)(iii) are visible and no walruses and polar bears are detected within the appropriate safety zones; or until 30 minutes after there has been no further visual detection of the animal(s) within the safety zone

and the trained marine mammal observer on duty is confident that no walruses and polar bears remain within the appropriate safety zone.

(C) Emergency shut-down. If observations are made or credible reports are received that one or more walruses and polar bears are within the area of the seismic survey are in an injured or mortal state, or are indicating acute distress due to seismic noise, the seismic airgun array will be immediately shut down and the Service Incidental Take Coordinator contacted. The airgun array will not be restarted until review and approval has been given by either the Service Incidental Take Coordinator or their designee.

(v) Ramp-up:

(A) Prior to commencing ramp-up described in condition 8 (b)(v)(C) below, conduct a 30-minute period of marine mammal observations by at least one trained marine mammal observer at the commencement of seismic operations and at any time electrical power to the airgun array is discontinued for a period of 10 minutes or more and the marine mammal observer watch has been suspended;

(B) If the safety radii are not completely visible for at least 30 minutes prior to ramp-up in either daylight or nighttime, do not commence ramp up unless the seismic source has maintained a sound pressure level of at least 180 dB during the interruption of seismic survey operations.

(C) If the complete 180 dB safety range is visible and no walruses and polar bears are observed while undertaking pre-ramp-up monitoring under conditions 8(b)(v)(A) and (B), ramp-up airgun arrays slowly over a period of at least 20 minutes starting with the smallest airgun in the array and then adding additional guns in sequence, until the full array is firing: (1) At the commencement of seismic operations, and (2), anytime after the airgun array has been powered down for more than 10 minutes.

(D) Do not proceed with ramp-up whenever the entire 180 dB safety zone is not visible and more than 2 power-downs due to marine mammal presence within the 180 dB safety zone have occurred within the past 12 hours.

9. Monitoring:

(a) *Seismic Vessel Monitoring*:

(i) The holder of this Authorization must designate biologically-trained, marine mammal observers (MMOs) to be onboard the seismic source vessel and designated support vessels.

(ii) MMOs will monitor to:

(A) Ensure that no walruses and polar bears enter the appropriate safety zones established under condition 8(b)(iii), whenever the seismic array is on.

(B) Record marine mammal activity as described in condition 9(a)(v) below. At least two observers must be on watch during ramp-ups and the 30 minutes prior to full ramp-ups, and for as large a fraction of the other operating hours as possible. At all other times, at least one observer must be on active watch whenever the seismic airgun array is operating during all daytime airgun

operations, during any nighttime power-ups of the airguns and at night, whenever that day's monitoring resulted in one or more power-downs due to marine mammal presence.

(iii) The crew also must be instructed to keep watch for walruses and polar bears at all times. If any are sighted, the bridge watch-stander must immediately notify the MMO on watch.
(iv) Observations by the MMOs on marine mammal presence and activity will begin a minimum of 30 minutes prior to the estimated time that the seismic source is to be turned on and/or ramped-up.

(v) For each walrus or polar bear sighting, MMOs will record the following:
(A) Species, group size, age/size/sex categories (if determinable), behavioral activity, heading (if consistent), bearing and distance from seismic vessel, sighting cue, behavioral pace, and apparent reaction of animals seen near the seismic vessel and/or its airgun array.
(B) Time, location, heading, speed, and activity of the vessel, along with sea state, ice cover, visibility, cloud cover and sun glare at (1) any time a marine mammal is sighted, (2) at the start and end of each watch, and (3) during a watch (whenever there is a change in one or more variable)
(C) The identification of all vessels that are visible within 5 km of the seismic vessel whenever a marine mammal is sighted, and the time observed, bearing, distance, heading, speed and activity of the other vessel(s).

(vi) All MMOs must be provided with and use appropriate night-vision devices, Big Eyes, and reticulated and/or laser range finding binoculars.

(vii) The operator of the seismic vessel must maintain a log of seismic activity noting the date and time of all changes in seismic activity (e.g. ramp up, power down, shut down, changes in the number of active airguns or the volume of airgun arrays) and any corresponding changes in monitoring radii.

(b) *Chase Boat Monitoring:*

(i) At least one "chase boat" will assist in monitoring safety and monitoring zones during active seismic survey operations. The chase boat will have at least two MMOs onboard to collect marine mammal observations.

(ii) The MMOs on the chase boat will immediately contact the seismic survey ship if walruses and polar bears are sighted within the 180/190-dB safety zone.

10. Reporting:
(a) *Marine mammal observer training manual and data collection protocols*. Prior to the initiation of seismic operations, the operator must provide the Service with:

(i) A description and documentation of the MMO training program;

(ii) a copy of the MMO field manual and/or operating procedures; and,

(iii) a key to MMO data codes, including definitions and descriptions of all data fields.
(b) *Sound source verification report.* The results of field source verification and the distances to the various sound radii are to be reported to the Service within 72 hours of completing the measurements.

(c) *Weekly summary of walrus and polar bear sightings.* The operator must tabulate and report all walrus and polar bear sightings recorded by the MMOs to the Service on a weekly basis. For each walrus or polar bear sighting include:

(i) a unique sighting identification number;

(ii) species, group size, age/size/sex categories, and substrate (on ice, in water, both);

(iii) date, time and location (for pre-lease seismic surveys, specific location information may be withheld until the results of the next lease sale are announced);

(iv) environmental conditions including: water depth (meters), sea state (Beaufort scale), visibility 1 (#km), visibility 2 (light/dark), visibility 3 (glare: none, little, moderate, severe), ice condition 1 (estimated % ice cover in vicinity of sighting), ice condition 2 (estimated distance (km) to pack ice);

(v) estimated range (meters) at first sighting, estimated range (meters) at closest approach;

(vi) the behavior of animals sighted (if determinable);

(vii) Whether animals appeared to react to the presence of the ship (yes, no), if yes, describe the reaction of the animal(s);

(viii) vessel activity at time of sighting including: vessel name; vessel speed (knots); seismic activity code; action taken by operator in response to sighting? (yes, no) If yes, specify (e.g. powerdown, shutdown); and,
(ix) any MMO comments or notes

(d) *Notification of incident report.* The operator must report:
(A) any incidental lethal take or injury of a polar bear or walrus; and,
(B) observations of walruses or polar bears within the prescribed safety zones (180/190 dB radii around seismic arrays, or 0.5 mile marine/aircraft buffer areas) to the Service within 24 hours. Reports should include all information

specified under 10(c) as well as a full written description of the encounter and any actions taken by the operator.

(e) *Post season seismic monitoring report*: A draft report will be submitted to the Service within 90 days after the end of the seismic survey program in the Chukchi Sea. The report will describe in detail:
(i) Operations that were conducted;

(ii) Results of the acoustical measurements to verify the safety radii;
(
iii) Methods, results, and interpretation pertaining to all monitoring tasks;

(iv) Results of the 2007 shipboard marine mammal monitoring;

(v) A summary of the dates and locations of seismic operations, including summaries of power downs, shut downs, and ramp up delays;

(vi) Marine mammal sightings (species, numbers, dates, times and locations; age/size/gender, environmental correlates, activities, associated seismic survey activities);

(vii) Estimates of the amount and nature of potential take (exposure) of walruses and polar bears (by species) by harassment or in other ways to industry sounds;

(viii) Analysis of the effects of seismic operations (e.g., on sighting rates, sighting distances, behaviors, movement patterns of walruses and polar bears);

(ix) Analysis of factors influencing detectability of walruses and polar bears and;

(x) Summaries on communications with hunters and potential effects on subsistence uses.

The draft report will be subject to review and comment by the Service. Any recommendations made by the Service must be addressed in the final report prior to acceptance by the Service. The draft report will be considered the final report for this activity under this Authorization if the Service has not provided comments and recommendations within 90 days of receipt of the draft report.

(f) *Seismic monitoring data*: An electronic copy of all seismic monitoring data described in condition 9(a)(v) and (vii) will be submitted to the Service within 90 days after the end of the seismic survey program.

11. Activities related to the monitoring described in this Authorization do not require a separate scientific research permit issued under section 104 of the Marine Mammal Protection Act.

12. A copy of this Authorization, the Service-approved Marine Mammal Monitoring and Mitigation Plan, the Service-approved Polar Bear Interaction Plan, and the Service-approved Plan of Cooperation must be in the possession of the operator of all vessels and aircraft engaging in the activity operating under the authority of this Incidental Harassment Authorization.

Acting Alaska Regional Director
US Fish and Wildlife Service

APPENDIX C: RESULTS OF MARINE MAMMAL MONITORING

TABLE C.1 Visual observation effort for cetaceans from daylight MMO watches during the summer Chukchi Sea survey (21 Jul. - 12 Sept.) from the *Gilavar* and its chase vessels. Effort categories include kilometers, hours and miles, subdivided by Beaufort wind force and airgun status. Ramp-up effort is included in the "Seismic" category.

	Daylight MMO Watch Effort								
Beaufort Wind Force	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	***Total***
Gilavar									
Effort in km									
Non-seismic	33	322	678	737	262	455	302	157	***2945***
Post seismic[a]	0	0	0	0	0	0	0	0	***0***
Seismic	0	37	295	823	589	229	76	16	***2065***
Total	***33***	***359***	***974***	***1559***	***850***	***683***	***378***	***173***	***5009***
Effort in h									
Non-seismic	4	35	75	81	31	43	31	22	***324***
Post seismic[a]	0	0	0	0	0	0	0	0	***0***
Seismic	0	5	34	97	68	26	9	2	***241***
Total	***4***	***40***	***109***	***177***	***100***	***70***	***40***	***24***	***565***
Effort in mi									
Non-seismic	20	200	421	458	163	283	188	97	***1830***
Post seismic[a]	0	0	0	0	0	0	0	0	***0***
Seismic	0	23	184	511	366	142	47	10	***1283***
Total	***20***	***223***	***605***	***969***	***528***	***425***	***235***	***108***	***3113***
Chase Vessels									
Effort in km									
Non-seismic	20	529	1317	1590	608	303	100	83	***4548***
Post seismic[a]	0	10	79	39	37	0	0	0	***166***
Seismic	0	131	753	487	183	226	99		***1879***
Total	***20***	***670***	***2149***	***2115***	***828***	***529***	***199***	***83***	***6593***
Effort in h									
Non-seismic	1	39	90	109	37	26	7	8	***317***
Post seismic[a]	0	1	4	2	2	0	0	0	***9***
Seismic	0	14	76	49	19	25	10		***193***
Total	***1***	***53***	***170***	***160***	***58***	***52***	***17***	***8***	***519***
Effort in mi									
Non-seismic	12	328	818	988	378	188	62	51	***2826***
Post seismic[a]	0	7	49	24	23	0	0	0	***103***
Seismic	0	82	468	302	114	141	61	0	***1167***
Total	***12***	***417***	***1335***	***1314***	***515***	***329***	***123***	***51***	***4096***
Total Effort in km	***52***	***1029***	***3122***	***3674***	***1679***	***1212***	***577***	***256***	***11602***
Total Effort in h	***5***	***93***	***280***	***337***	***158***	***122***	***58***	***32***	***1084***
Total Effort in mi	***32***	***639***	***1940***	***2283***	***1043***	***753***	***358***	***159***	***7209***

[a] For *Gilavar*: Period encompassing 3 min. to 2 hrs. after all airguns are shut down. For chase vessels: Periods encompassing 3 min. to 2 hrs. after all airguns are shut down and 3 min. to 2 hrs. after transiting beyond the 120-decibel sound level radius.

TABLE C.2. Visual observation effort for pinnipeds and polar bears from daylight MMO watches during the summer Chukchi Sea survey (21 Jul. - 12 Sept.) from the *Gilavar* and its chase vessels. Effort categories include kilometers, hours and miles, subdivided by Beaufort wind force and airgun status. Ramp-up effort is included in the "Seismic" category.

	Daylight MMO Watch Effort								
Beaufort Wind Force	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	***Total***
Gilavar									
Effort in km									
Non-seismic	33	322	678	737	262	455	302	157	***2945***
Post seismic[a]	0	0	0	0	0	0	0	0	***0***
Seismic	0	37	295	823	589	229	76	16	***2065***
Total	***33***	***359***	***974***	***1559***	***850***	***683***	***378***	***173***	***5009***
Effort in h									
Non-seismic	4	35	75	81	31	43	31	22	***324***
Post seismic[a]	0	0	0	0	0	0	0	0	***0***
Seismic	0	5	34	97	68	26	9	2	***241***
Total	***4***	***40***	***109***	***177***	***100***	***70***	***40***	***24***	***564***
Effort in mi									
Non-seismic	20	200	421	458	163	283	188	97	***1830***
Post seismic[a]	0	0	0	0	0	0	0	0	***0***
Seismic	0	23	184	511	366	142	47	10	***1283***
Total	***20***	***223***	***605***	***969***	***528***	***425***	***235***	***108***	***3113***
Chase Vessels									
Effort in km									
Non-seismic	20	605	1637	1691	699	394	146	83	***5274***
Post seismic[a]	0	20	54	64	22	15	13	0	***188***
Seismic	0	45	457	360	108	121	39	0	***1130***
Total	***20***	***670***	***2149***	***2115***	***828***	***529***	***199***	***83***	***6593***
Effort in h									
Non-seismic	1	47	117	117	45	36	12	8	***382***
Post seismic[a]	0	2	5	5	2	2	1	0	***16***
Seismic	0	5	49	38	12	14	4	0	***121***
Total	***1***	***53***	***170***	***160***	***58***	***52***	***17***	***8***	***519***
Effort in mi									
Non-seismic	12	376	1017	1051	434	245	91	51	***3277***
Post seismic[a]	0	13	34	40	13	9	8	0	***117***
Seismic	0	28	284	224	67	75	25	0	***702***
Total	***12***	***417***	***1335***	***1314***	***515***	***329***	***123***	***51***	***4096***
Total Effort in km	***52***	***1029***	***3122***	***3674***	***1679***	***1212***	***577***	***256***	***11602***
Total Effort in h	***5***	***93***	***279***	***337***	***158***	***122***	***58***	***32***	***1084***
Total Effort in mi	***32***	***639***	***1940***	***2283***	***1043***	***753***	***358***	***159***	***7209***

[a] Period encompassing 3 min. to 1 hr. after all airguns are shut down.

TABLE C.3. Visual observation effort for cetaceans from daylight MMO watches during the fall Chukchi Sea survey (8 Oct. - 5 Nov.) from the Gilavar and its chase vessels. Effort categories include kilometers, hours and miles, subdivided by Beaufort Wind Force and airgun status. Ramp-up effort is included in the "Seismic" category.

	Daylight MMO Watch Effort								
Beaufort Wind Force	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	***Total***
Gilavar									
Effort in km									
Non-seismic	0	16	29	76	146	149	51	12	***479***
Post seismic[a]	0	0	0	0	0	0	0	0	***0***
Seismic	0	11	32	116	234	282	250	20	***945***
Total	***0***	***27***	***60***	***192***	***380***	***431***	***301***	***32***	***1423***
Effort in h									
Non-seismic	0	2	4	8	12	10	4	1	***40***
Post seismic[a]	0	0	0	0	0	0	0	0	***0***
Seismic	0	1	3	14	28	33	29	3	***110***
Total	***0***	***3***	***6***	***22***	***40***	***43***	***33***	***3***	***150***
Effort in mi									
Non-seismic	0	10	18	47	91	93	32	7	***298***
Post seismic[a]	0	0	0	0	0	0	0	0	***0***
Seismic	0	7	20	72	145	176	155	13	***587***
Total	***0***	***17***	***38***	***119***	***236***	***268***	***187***	***20***	***884***
Chase Vessels									
Effort in km									
Non-seismic	0	49	150	375	485	404	232	47	***1743***
Post seismic[a]	0	2	0	112	111	87	14	0	***327***
Seismic	0	0	180	524	361	329	181	39	***1613***
Total	***0***	***51***	***330***	***1011***	***956***	***820***	***427***	***86***	***3682***
Effort in h									
Non-seismic	0	3	13	26	31	32	19	4	***128***
Post seismic[a]	0	0	0	8	7	6	2	0	***23***
Seismic	0	0	17	48	34	32	20	5	***156***
Total	***0***	***3***	***30***	***82***	***72***	***70***	***41***	***9***	***307***
Effort in mi									
Non-seismic	***0***	***30***	***93***	***233***	***301***	***251***	***144***	***29***	***1083***
Post seismic[a]	***0***	***1***	***0***	***70***	***69***	***54***	***9***	***0***	***203***
Seismic	***0***	***0***	***112***	***325***	***224***	***204***	***112***	***24***	***1002***
Total	***0***	***32***	***205***	***628***	***594***	***509***	***265***	***54***	***2288***
Total Effort in km	***0***	***78***	***390***	***1203***	***1337***	***1251***	***728***	***118***	***5105***
Total Effort in h	***0***	***6***	***37***	***104***	***112***	***113***	***74***	***12***	***457***
Total Effort in mi	***0***	***49***	***243***	***747***	***830***	***778***	***452***	***74***	***3172***

[a] For *Gilavar:* Period encompassing 3 min. to 2 hrs. after all airguns are shut down. For chase vessels: Periods encompassing 3 min. to 2 hrs. after all airguns are shut down and 3 min. to 2 hrs. after transiting beyond the 120-decibel safety radius.

TABLE C.4. Visual observation effort for pinnipeds and polar bears from daylight MMO watches during the fall Chukchi Sea survey (21 Jul. - 12 Sept.) from the Gilavar and its chase vessels. Effort categories include kilometers, hours and miles, subdivided by Beaufort Wind Force and airgun status. Ramp-up effort is included in the "Seismic" category.

	Daylight MMO Watch Effort								
Beaufort Wind Force	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	***Total***
Gilavar									
Effort in km									
Non-seismic	0	16	29	76	146	149	51	12	***479***
Post seismic[a]	0	0	0	0	0	0	0	0	***0***
Seismic	0	11	32	116	234	282	250	20	***945***
Total	***0***	***27***	***60***	***192***	***380***	***431***	***301***	***32***	***1423***
Effort in h									
Non-seismic	0	2	4	8	12	10	4	1	***40***
Post seismic[a]	0	0	0	0	0	0	0	0	***0***
Seismic	0	1	3	14	28	33	29	3	***110***
Total	***0***	***3***	***6***	***22***	***40***	***43***	***33***	***3***	***150***
Effort in mi									
Non-seismic	0	10	18	47	91	93	32	7	***298***
Post seismic[a]	0	0	0	0	0	0	0	0	***0***
Seismic	0	7	20	72	145	176	155	13	***587***
Total	***0***	***17***	***38***	***119***	***236***	***268***	***187***	***20***	***884***
Chase Vessels									
Effort in km									
Non-seismic	0	51	193	624	696	603	304	63	***2534***
Post seismic[a]	0	0	59	166	95	116	65	15	***516***
Seismic	0	0	78	221	166	101	58	8	***632***
Total	***0***	***51***	***330***	***1011***	***956***	***820***	***427***	***86***	***3682***
Effort in h									
Non-seismic	0	3	18	45	46	49	27	6	***194***
Post seismic[a]	0	0	5	16	10	12	8	2	***52***
Seismic	0	0	6	21	15	10	6	1	***60***
Total	***0***	***3***	***30***	***82***	***72***	***70***	***41***	***9***	***307***
Effort in mi									
Non-seismic	0	32	120	388	432	375	189	39	***1575***
Post seismic[a]	0	0	36	103	59	72	40	9	***320***
Seismic	0	0	49	137	103	63	36	5	***393***
Total	***0***	***32***	***205***	***628***	***594***	***509***	***265***	***54***	***2288***
Total Effort in km	***0***	***78***	***390***	***1203***	***1337***	***1251***	***728***	***118***	***5105***
Total Effort in h	***0***	***6***	***37***	***104***	***112***	***113***	***74***	***12***	***457***
Total Effort in mi	***0***	***49***	***243***	***747***	***830***	***778***	***452***	***74***	***3172***

[a] Period encompassing 3 min. to 1 hr. after all airguns are shut down.

TABLE C.5. All marine mammal sightings (number of individuals) recorded by *Gilavar* and chase vessels MMOs in the Chukchi Sea from 21 Jul - 12 Sep and 8 Oct - 5 Nov 2007. Numbers include animals observed during daylight, darkness, when MMOs were on watch, and any opportunistic off-watch sightings.

Species	*Gilavar*	Chase Vessels	*Total*
Cetaceans			
Bowhead Whale	3 (4)	1 (3)	***4 (7)***
Gray Whale	2 (2)	22 (46)	***24 (48)***
Harbor Porpoise	3 (4)	0	***3 (4)***
Humpback Whale	2 (3)	1 (2)	***3 (5)***
Killer Whale	1 (1)	0	***1 (1)***
Unidentified Mysticete Whale	3 (3)	1 (2)	***4 (5)***
Unidentified Whale	9 (13)	5 (11)	***14 (24)***
Total Cetaceans	***23 (30)***	***30 (64)***	***53 (94)***
Seals and Sea Lions			
Bearded Seal	2 (2)	25 (26)	***27 (28)***
Ringed and Spotted Seals[a]	16 (16)	165 (192)	***181 (208)***
Stellar's Sea Lion	0	1 (1)	***1 (1)***
Total Seals and Sea Lions	***18 (18)***	***191 (219)***	***209 (237)***
Pacific Walruses			
In Water	269 (1279)	136 (303)	***405 (1582)***
On Ice	1 (404)	5 (988)	***6 (1392)***
Unidentified Pinniped[b]	6 (7)	4 (4)	***10 (11)***
Total Pacific Walruses	***276 (1690)***	***145 (1295)***	***421 (2985)***
Grand Total of All Sightings	***317 (1738)***	***366 (1578)***	***683 (3316)***

[a] Includes all records of ringed, spotted, and unidentified seals.

[b] Ten of 10 total unidentified pinniped sightings were added to "Pacific Walruses In Water" based on the ratio of identified large pinniped sightings in water (27 bearded seal to 405 Pacific walrus). All unidentified pinnipeds were sighted in water at times when Pacific walrus sightings were common.

TABLE C.6. Numbers of marine mammal sightings (number of individuals) by seismic state during daylight MMO watches during the summer Chukchi Sea survey (21 Jul – 12 Sep 2007) from the Gilavar and its chase vessels.

Species	Seismic	Post-Seismic	Non-Seismic	*Total*
Gilavar				
Cetaceans	8 (13)	0	11 (13)	***19 (26)***
Seals and Sea Lions in Water	3 (3)	0	11 (11)	***14 (14)***
Pacific Walruses*	40 (67)	0	221 (1593)	***261 (1660)***
Gilavar Total Marine Mammals	***51 (83)***	***0***	***243 (1617)***	***294 (1700)***
Chase Vessels				
Cetaceans	8 (17)	0	21 (46)	***29 (63)***
Seals and Sea Lions in Water	21 (21)	1 (1)	115 (131)	***137 (153)***
Pacific Walruses*	54 (99)	8 (14)	79 (1163)	***141 (1276)***
Chase Vessels Total Marine Mammals	***83 (137)***	***9 (15)***	***215 (1340)***	***307 (1492)***
Grand Total Marine Mammals	***134 (220)***	***9 (15)***	***458 (2957)***	***601 (3192)***

* Ten of 10 total "unidentified pinniped" sightings were included in the "Pacific Walruses" table based on the ratio of identified large pinniped sightings in water (14 bearded seal to 386 Pacific walrus).

TABLE C.7. Numbers of marine mammal sightings (number of individuals) by seismic state during daylight MMO watches during the fall Chukchi Sea survey (8 Oct – 5 Nov 2007) from the *Gilavar* and its chase vessels.

Species	Seismic	Post-Seismic	Non-Seismic	*Total*
Gilavar				
Cetaceans	0	0	2 (2)	***2 (2)***
Seals	2 (2)	0	1 (1)	***3 (3)***
Pacific Walruses	0	0	0	***0***
Gilavar Total Marine Mammals	***2 (2)***	***0***	***3 (3)***	***5 (5)***
Chase Vessels				
Cetaceans	0	0	0	***0***
Seals	7 (7)	7 (7)	35 (35)	***49 (49)***
Pacific Walruses	1 (1)	0	0	***1 (1)***
Chase Vessels Total Marine Mammals	**8 (8)**	**7 (7)**	**35 (35)**	***50 (50)***
Grand Total Marine Mammals	***10 (10)***	***7 (7)***	***38 (38)***	***55 (55)***

TABLE C.8. Numbers of sightings (number of individuals) of cetaceans observed by seismic states during daylight MMO watches during the summer Chukchi Sea survey (21 Jul – 12 Sep 2007) from the *Gilavar* and its chase vessels.

Species	Seismic	Post-Seismic	Non-Seismic	*Total*
Gilavar				
Cetaceans				
Unidentified Whale	6 (10)	0	2 (2)	***8 (12)***
Mysticetes				
Bowhead Whale	0	0	3 (4)	***3 (4)***
Humpback Whale	1 (2)	0	0	***1 (2)***
Gray Whale	0	0	2 (2)	***2 (2)***
Unidentified Mysticete Whale	1 (1)	0	0	***1 (1)***
Odontocetes				
Harbor Porpoise	0	0	3 (4)	***3 (4)***
Killer Whale	0	0	1 (1)	***1 (1)***
Gilavar Total Cetaceans	***8 (13)***	***0***	***11 (13)***	**19 (26)**
Chase Vessels				
Cetaceans				
Unidentified Whale	5 (11)	0	0	***5 (11)***
Mysticetes				
Humpback Whale	0	0	1 (2)	***1 (2)***
Bowhead Whale	1 (3)	0	0	***1 (3)***
Gray Whale	1 (1)	0	20 (44)	***21 (45)***
Unidentified Mysticete Whale	1 (2)	0	0	***1 (2)***
Chase Vessels Total Cetaceans	***8 (17)***	***0***	***21 (46)***	**29 (63)**
Grand Total Cetaceans	***16 (30)***	***0***	***32 (59)***	***48 (89)***

TABLE C.9. Numbers of sightings (number of individuals) of cetaceans observed by different seismic states during daylight MMO watches during the fall Chukchi Sea survey (8 Oct – 8 Nov 2007) from the *Gilavar* and its chase vessels.

Species	Seismic	Post-Seismic	Non-Seismic	*Total*
Gilavar				
Cetaceans				
Mysticetes				
Humpback Whale	0	0	1 (1)	***1 (1)***
Unidentified Mysticete Whale	0	0	1 (1)	***1 (1)***
Gilavar Total Cetaceans	***0***	***0***	***2 (2)***	**2 (2)**
Chase Vessels				
Cetaceans	0	0	0	0
Chase Vessels Total Cetaceans	***0***	***0***	***0***	***0***
Grand Total Cetaceans	***0***	***0***	***2 (2)***	***2 (2)***

TABLE C.10. Sighting rates for cetacean sightings during different seismic states from daylight MMO watch effort during the summer Chukchi Sea survey (21 Jul - 12 Sep 2007) from the *Gilavar* and its chase vessels. "Ramp-up" and "Power-up" effort is included in the *Seismic* category.

Seismic State	No. of Sightings	Effort (km)	Sighting Rate (No./1000 km)
Gilavar			
Cetaceans			
Seismic	8	2065	**3.9**
Post-Seismic	0	0	**0.0**
Non-Seismic	11	2945	**3.7**
Gilavar Total	**19**	**5009**	**3.8**
Chase Vessels			
Cetaceans			
Seismic	8	1879	**4.3**
Post-Seismic	0	166	**0.0**
Non-Seismic	21	4548	**4.6**
Chase Vessels Total	**29**	**6593**	**4.4**
Grand Total	**48**	**11602**	**4.1**

Seismic State	No. of Sightings	Effort (mi)	Sighting Rate (No./1000 mi)
Gilavar			
Cetaceans			
Seismic	8	1283	**6.2**
Post-Seismic	0	0	**0.0**
Non-Seismic	11	1830	**6.0**
Gilavar Total	**19**	**3113**	**6.1**
Chase Vessels			
Cetaceans			
Seismic	8	1167	**6.9**
Post-Seismic	0	103	**0.0**
Non-Seismic	21	2826	**7.4**
Chase Vessels Total	**29**	**4096**	**7.1**
Grand Total	**48**	**7209**	**6.7**

TABLE C.11. Sighting rates for cetacean sightings during different seismic states from daylight MMO watch effort during the fall Chukchi Sea survey (8 Oct - 8 Nov 2007) from the *Gilavar* and its chase vessels. "Ramp-up" and "Power-up" effort is included in the S*eismic* category.

Seismic State	No. of Sightings	Effort (km)	Sighting Rate (No./1000 km)
Gilavar			
Cetaceans			
Seismic	0	945	**0.0**
Post-Seismic	0	0	**0.0**
Non-Seismic	2	479	**4.2**
Gilavar Total	**2**	**1423**	**1.4**
Chase Vessels			
Cetaceans			
Seismic	0	1613	**0.0**
Post-Seismic	0	327	**0.0**
Non-Seismic	0	1743	**0.0**
Chase Vessels Total	**0**	**3682**	**0.0**
Grand Total	**2**	**5105**	**0.4**

Seismic State	No. of Sightings	Effort (mi)	Sighting Rate (No./1000 mi)
Gilavar			
Cetaceans			
Seismic	0	587	**0.0**
Post-Seismic	0	0	**0.0**
Non-Seismic	2	298	**6.7**
Gilavar Total	**2**	**884**	**2.3**
Chase Vessels			
Cetaceans			
Seismic	0	1002	**0.0**
Post-Seismic	0	203	**0.0**
Non-Seismic	0	1083	**0.0**
Chase Vessels Total	**0**	**2288**	**0.0**
Grand Total	**2**	**3172**	**0.6**

TABLE C.12. Numbers of sightings (number of individuals) of seals and sea lions observed by different seismic states during daylight MMO watches during the summer Chukchi Sea survey (21 Jul – 12 Sep 2007) from the *Gilavar* and its chase vessels.

Species	Seismic	Post-Seismic	Non-Seismic	*Total*
Gilavar				
Seals and Sea Lions in Water				
Bearded Seal	0	0	0	***0***
Ringed Seal	0	0	0	***0***
Spotted Seal	0	0	1 (1)	***1 (1)***
Unidentified Seal	3 (3)		10 (10)	***13 (13)***
Gilavar Total Seals and Sea Lions	***3 (3)***	***0***	***11 (11)***	***14 (14)***
Chase Vessels				
Seals and Sea Lions in Water				
Steller Sea Lion	0	0	1 (1)	***1 (1)***
Bearded Seal	2 (2)	0	12 (13)	***14 (15)***
Ringed Seal	14 (14)	0	67 (75)	***81 (89)***
Spotted Seal	4 (4)	0	6 (8)	***10 (12)***
Unidentified Seal	1 (1)	1 (1)	29 (34)	***31 (36)***
Chase Vessels Total Seals and Sea Lions	***21 (21)***	***1 (1)***	***115 (131)***	***137 (153)***
Grand Total Seals and Sea Lions	***24 (24)***	***1***	***126 (142)***	***151 (167)***

TABLE C.13. Numbers of sightings (number of individuals) of seals observed by different seismic states during daylight MMO watches during the fall Chukchi Sea survey (8 Oct – 8 Nov 2007) from the *Gilavar* and its chase vessels.

Species	Seismic	Post-Seismic	Non-Seismic	*Total*
Gilavar				
Seals				
Bearded Seal	2 (2)	0	0	***2 (2)***
Unidentified Seal	0	0	1 (1)	***1 (1)***
Gilavar Total Seals	***2 (2)***	***0***	***1 (1)***	**3 (3)**
Chase Vessels				
Seals				
Bearded Seal	1 (1)	4 (4)	4 (4)	***9 (9)***
Ringed Seal	4 (4)	1 (1)	10 (10)	***15 (15)***
Spotted Seal	1 (1)	1 (1)	4 (4)	***6 (6)***
Unidentified Seal	1 (1)	1 (1)	17 (17)	***19 (19)***
Chase Vessels Total Seals	***7 (7)***	***7 (7)***	***35 (35)***	**49 (49)**
Grand Total Seals	***9 (9)***	***7 (7)***	***36 (36)***	***52 (52)***

TABLE C.14. Sighting rates for seal and sea lion sightings during different seismic states from daylight MMO watch effort during the summer Chukchi Sea survey (21 Jul - 12 Sep 2007) from the *Gilavar* and its chase vessels. "Ramp-up" and "Power-up" effort is included in the *Seismic* category. There were no seals or sea lions observed on ice during this survey.

Seismic State	No. of Sightings	Effort (km)	Sighting Rate (No./1000 km)
Gilavar			
Seals and Sea Lions in Water			
Seismic	3	2065	**1.5**
Post-Seismic	0	0	**0.0**
Non-Seismic	11	2945	**3.7**
Gilavar Total	**14**	**5009**	**2.8**
Chase Vessels			
Seals and Sea Lions in Water			
Seismic	21	1130	**18.6**
Post-Seismic	1	188	**5.3**
Non-Seismic	115	5274	**21.8**
Chase Vessels Total	**137**	**6592**	**20.8**
Grand Total	**151**	**11601**	**13.0**

Seismic State	No. of Sightings	Effort (mi)	Sighting Rate (No./1000 mi)
Gilavar			
Seals and Sea Lions in Water			
Seismic	3	1283	**2.3**
Post-Seismic	0	0	**0.0**
Non-Seismic	11	1830	**6.0**
Gilavar Total	**14**	**3113**	**4.5**
Chase Vessels			
Seals and Sea Lions in Water			
Seismic	21	702	**29.9**
Post-Seismic	1	117	**8.6**
Non-Seismic	115	3277	**35.1**
Chase Vessels Total	**137**	**4096**	**33.4**
Grand Total	**151**	**7209**	**20.9**

TABLE C.15. Sighting rates for seal sightings during different seismic states from daylight MMO watch effort during the fall Chukchi Sea survey (8 Oct - 5 Nov 2007) from the *Gilavar* and its chase vessels. "Ramp-up" and "Power-up" effort is included in the S*eismic* category. There were no seals or sea lions observed on ice during this survey.

Seismic State	No. of Sightings	Effort (km)	Sighting Rate (No./1000 km)
Gilavar			
Seals in Water			
Seismic	2	945	**2.1**
Post-Seismic	0	0	**0.0**
Non-Seismic	1	479	**2.1**
Gilavar Total	**3**	**1423**	**2.1**
Chase Vessels			
Seals in Water			
Seismic	7	632	**11.1**
Post-Seismic	7	516	**13.6**
Non-Seismic	35	2534	**13.8**
Chase Vessels Total	**49**	**3682**	**13.3**
Grand Total	**52**	**5105**	**10.2**

Seismic State	No. of Sightings	Effort (mi)	Sighting Rate (No./1000 mi)
Gilavar			
Seals in Water			
Seismic	2	587	**3.4**
Post-Seismic	0	0	**0.0**
Non-Seismic	1	298	**3.4**
Gilavar Total	**3**	**884**	**3.4**
Chase Vessels			
Seals in Water			
Seismic	7	393	**17.8**
Post-Seismic	7	321	**21.8**
Non-Seismic	35	1575	**22.2**
Chase Vessels Total	**49**	**2288**	**21.4**
Grand Total	**52**	**3172**	**16.4**

TABLE C.16. Numbers of sightings (number of individuals) of Pacific walruses observed during daylight MMO watches during the summer Chukchi Sea survey (21 Jul – 12 Sep 2007) from the *Gilavar* and its chase vessels during the different seismic states.

Species	Seismic	Post-Seismic	Non-Seismic	*Total*
Gilavar				
Pacific Walruses in Water				
Pacific Walrus	39 (66)	0	215 (1183)	***254 (1249)***
Unidentified Pinniped*	1 (1)	0	5 (6)	***6 (7)***
Pacific Walruses on Ice				
Pacific Walrus	0	0	1 (404)	***1 (404)***
Gilavar Total Pacific Walruses	***40 (67)***	***0***	***221 (1593)***	**261 (1660)**
Chase Vessels				
Pacific Walruses in Water				
Pacific Walrus	54 (99)	8 (14)	70 (171)	***132 (284)***
Unidentified Pinniped*	0	0	4 (4)	***4 (4)***
Pacific Walruses on Ice				
Pacific Walrus	0	0	5 (988)	***5 (988)***
Chase Vessels Total Pacific Walruses	***54 (99)***	***8 (14)***	***79 (1163)***	**141 (1276)**
Grand Total Pacific Walruses	***94 (166)***	***8 (14)***	***300 (2756)***	***402 (2936)***

* Ten of 10 total "unidentified pinniped" sightings were included in the "Pacific Walruses" table based on the ratio of identified large pinniped sightings in water (14 bearded seal to 386 Pacific walrus).

TABLE C.17. Numbers of sightings (number of individuals) of Pacific walruses observed during daylight MMO watches during the fall Chukchi Sea survey (8 Oct – 8 Nov 2007) from the *Gilavar* and its chase vessels during the different seismic states.

Species	Seismic	Post-Seismic	Non-Seismic	*Total*
Gilavar				
Pacific Walruses in Water	0	0	0	***0***
Gilavar Total Pacific Walruses	***0***	***0***	***0***	***0***
Chase Vessels				
Pacific Walruses in Water	1 (1)	0	0	***1 (1)***
Chase Vessels Total Pacific Walruses	***1 (1)***	***0***	***0***	***1 (1)***
Grand Total Pacific Walruses	***1 (1)***	***0***	***0***	***1 (1)***

TABLE C.18. Sighting rates for Pacific walrus sightings during different seismic states from daylight MMO watch effort during the summer Chukchi Sea survey (21 Jul - 12 Sep 2007) from the *Gilavar* and its chase vessels. "Ramp-up" and "Power-up" effort is included in the *Seismic* category.

Seismic State	No. of Sightings[a]	Effort (km)	Sighting Rate (No./1000 km)
Gilavar			
Pacific Walrus in Water			
Seismic	40	2065	**19.4**
Post-Seismic	0	0	**0.0**
Non-Seismic	220	2945	**74.7**
Pacific Walrus on Ice			
Seismic	0	2065	**0.0**
Post-Seismic	0	0	**0.0**
Non-Seismic	1	2945	**0.3**
Gilavar Total	**261**	**5009**	**52.1**
Chase Vessels			
Pacific Walrus in Water			
Seismic	54	1130	**47.8**
Post-Seismic	8	188	**42.6**
Non-Seismic	74	5274	**14.0**
Pacific Walrus on Ice			
Seismic	0	1130	**0.0**
Post-Seismic	0	188	**0.0**
Non-Seismic	5	5274	**0.9**
Chase Vessels Total	**141**	**6592**	**21.4**
Grand Total	**402**	**11601**	**34.7**

[a] Ten of 10 total "unidentified pinniped" sightings were included in the "Pacific Walruses" table based on the ratio of identified large pinniped sightings in the water (14 bearded seal to 386 Pacific walrus).

Seismic State	No. of Sightings[a]	Effort (mi)	Sighting Rate (No./1000 mi)
Gilavar			
Pacific Walrus in Water			
Seismic	40	1283	**31.2**
Post-Seismic	0	0	**0.0**
Non-Seismic	220	1830	**120.2**
Pacific Walrus on Ice			
Seismic	0	1283	**0.0**
Post-Seismic	0	0	**0.0**
Non-Seismic	1	1830	**0.5**
Gilavar Total	**261**	**3113**	**83.8**
Chase Vessels			
Pacific Walrus in Water			
Seismic	54	702	**76.9**
Post-Seismic	8	117	**68.5**
Non-Seismic	74	3277	**22.6**
Pacific Walrus on Ice			
Seismic	0	702	**0.0**
Post-Seismic	0	117	**0.0**
Non-Seismic	5	3277	**1.5**
Chase Vessels Total	**141**	**4096**	**34.4**
Grand Total	**402**	**7209**	**55.8**

[a] Ten of 10 total "unidentified pinniped" sightings were included in the "Pacific Walruses" table based on the ratio of identified large pinniped sightings in the water (14 bearded seal to 386 Pacific walrus).

TABLE C.19. Pacific walrus sighting rates during different seismic states from daylight MMO watch effort during the fall Chukchi Sea survey (8 Oct - 5 Nov 2007) from the *Gilavar* and its chase vessels. "Ramp-up" and "Power-up" effort is included in the S*eismic* category. There were no Pacific walruses observed on the ice during this survey

Seismic State	No. of Sightings	Effort (km)	Sighting Rate (No./1000 km)
Gilavar			
Pacific walrus in Water			
Seismic	0	945	***0.0***
Post-Seismic	0	0	***0.0***
Non-Seismic	0	479	***0.0***
Gilavar Total	***0***	***1423***	***0.0***
Chase Vessels			
Pacific Walrus in Water			
Seismic	1	632	***1.6***
Post-Seismic	0	516	***0.0***
Non-Seismic	0	2534	***0.0***
Chase Vessels Total	***1***	***3682***	***0.3***
Grand Total	***1***	***5105***	***0.2***

Seismic State	No. of Sightings	Effort (mi)	Sighting Rate (No./1000 mi)
Gilavar			
Pacific walrus in Water			
Seismic	0	587	***0.0***
Post-Seismic	0	0	***0.0***
Non-Seismic	0	298	***0.0***
Gilavar Total	***0***	***884***	***0.0***
Chase Vessels			
Pacific Walrus in Water			
Seismic	1	393	***2.5***
Post-Seismic	0	321	***0.0***
Non-Seismic	0	1575	***0.0***
Chase Vessels Total	***1***	***2288***	***0.4***
Grand Total	***1***	***3172***	***0.3***

TABLE C.20. Visual observation effort during daylight hours from the *Gilavar* and its chase/monitoring vessels within the Beaufort Sea (12 Sep – 8 Oct 2007), in ***(A)*** hours, and ***(B)*** kilometers, subdivided by Beaufort wind force and seismic state. Ramp-up effort is included in the "Seismic" category. See following table for version in miles.

	Beaufort Wind Force									
Seismic State	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	***Total***
Gilavar										
A. Effort in h										
Seismic	0.3	2.0	4.4	5.3	27.7	49.0	40.1	9.3	0.0	***138.1***
Post-seismic (3 min–2 h)	0.0	0.0	0.0	0.5	2.4	1.0	0.0	0.4	0.0	***4.3***
Non-seismic	0.0	0.7	5.4	16.0	22.0	19.6	7.3	1.5	0.0	***72.4***
Total h	***0.3***	***2.6***	***9.8***	***21.8***	***52.1***	***69.6***	***47.3***	***11.2***	***0.0***	**214.8**
B. Effort in km										
Seismic	2.6	16.4	39.2	44.4	283.8	467.6	336.4	72.0	0.0	***1262.4***
Post-seismic (3 min–2 h)	0.0	0.0	0.0	4.2	18.9	8.6	0.0	2.5	0.0	***34.2***
Non-seismic	0.0	5.7	37.4	123.7	185.6	184.1	62.6	12.4	0.0	***611.5***
Total km	***2.6***	***22.0***	***76.6***	***172.3***	***488.2***	***660.3***	***399.0***	***86.9***	***0.0***	**1908.1**
Chase Vessels										
A. Effort in h										
Seismic	0.0	3.8	8.7	57.5	82.3	19.2	15.9	6.9	5.4	***199.6***
Post-seismic (3 min–2 h)	0.0	2.1	4.4	8.1	6.8	2.2	5.2	9.8	1.1	***39.6***
Non-seismic	0.0	6.8	33.1	54.3	26.8	16.3	4.4	5.6	1.0	***148.1***
Total h	***0.0***	***12.7***	***46.1***	***119.9***	***115.8***	***37.6***	***25.4***	***22.3***	***7.5***	**387.3**
B. Effort in km										
Seismic	0.0	51.6	96.8	565.5	795.0	166.7	159.7	66.8	45.7	***1947.7***
Post-seismic (3 min–2 h)	0.0	23.6	48.1	96.4	98.6	23.0	63.1	79.1	5.7	***437.7***
Non-seismic	0.0	35.3	455.7	700.6	385.2	172.2	48.2	39.0	12.5	***1848.6***
Total km	***0.0***	***110.5***	***600.5***	***1362.5***	***1278.8***	***361.9***	***271.0***	***184.9***	***63.9***	**4234.1**
All Vessels Total h	***0.3***	***15.3***	***55.9***	***141.7***	***167.9***	***107.2***	***72.7***	***33.5***	***7.5***	**602.0**
All Vessels Total km	***2.6***	***132.5***	***677.1***	***1534.8***	***1767.0***	***1022.2***	***670.0***	***271.9***	***63.9***	**6142.2**

	Beaufort Wind Force									
Seismic State	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	***Total***
Gilavar										
A. Effort in h										
Seismic	0.3	2.0	4.4	5.3	27.7	49.0	40.1	9.3	0.0	***138.1***
Post-seismic (3 min–2 h)	0.0	0.0	0.0	0.5	2.4	1.0	0.0	0.4	0.0	***4.3***
Non-seismic	0.0	0.7	5.4	16.0	22.0	19.6	7.3	1.5	0.0	***72.4***
Total h	***0.3***	***2.6***	***9.8***	***21.8***	***52.1***	***69.6***	***47.3***	***11.2***	***0.0***	**214.8**
B. Effort in mi										
Seismic	1.6	10.2	24.4	27.6	176.2	290.4	208.9	44.7	0.0	***784.0***
Post-seismic (3 min–2 h)	0.0	0.0	0.0	2.6	11.7	5.3	0.0	1.6	0.0	***21.3***
Non-seismic	0.0	3.5	23.2	76.8	115.2	114.3	38.9	7.7	0.0	***379.7***
Total mi	***1.6***	***13.7***	***47.6***	***107.0***	***303.2***	***410.1***	***247.8***	***54.0***	***0.0***	**1184.9**
Chase Vessels										
A. Effort in h										
Seismic	0.0	3.8	8.7	57.5	82.3	19.2	15.9	6.9	5.4	***199.6***
Post-seismic (3 min–2 h)	0.0	2.1	4.4	8.1	6.8	2.2	5.2	9.8	1.1	***39.6***
Non-seismic	0.0	6.8	33.1	54.3	26.8	16.3	4.4	5.6	1.0	***148.1***
Total h	***0.0***	***12.7***	***46.1***	***119.9***	***115.8***	***37.6***	***25.4***	***22.3***	***7.5***	**387.3**
B. Effort in mi										
Seismic	0.0	32.0	60.1	351.2	493.7	103.5	99.2	41.5	28.4	***1209.5***
Post-seismic (3 min–2 h)	0.0	14.7	29.8	59.9	61.2	14.3	39.2	49.1	3.6	***271.8***
Non-seismic	0.0	21.9	283.0	435.1	239.2	107.0	29.9	24.2	7.8	***1148.0***
Total mi	***0.0***	***68.6***	***372.9***	***846.1***	***794.1***	***224.8***	***168.3***	***114.8***	***39.7***	**2629.4**
All Vessels Total h	***0.3***	***15.3***	***55.9***	***141.7***	***167.9***	***107.2***	***72.7***	***33.5***	***7.5***	**602.0**
All Vessels Total mi	***1.6***	***82.3***	***420.5***	***953.1***	***1097.3***	***634.8***	***416.1***	***168.8***	***39.7***	**3814.3**

TABLE C.21. Numbers of sightings (number of individuals) of marine mammals observed during daylight MMO watches in the Beaufort Sea (17 Aug – 14 Oct 2007) from each vessel, including opportunistic sightings when MMOs were not officially on-watch and sightings from the chase/monitoring vessels when they were not conducting chase/monitoring vessel duties.

Species	*Gilavar*	*Gulf Provider*	*Norseman II*	*Kilabuk*	*Total*
Cetaceans					
Unidentified Whale	5 (8)	0	3 (3)	0	***8 (11)***
Mysticetes					
Bowhead Whale	6 (11)	7 (12)	22 (45)	4 (10)	***39 (78)***
Gray Whale	0	0	1 (1)	0	***1 (1)***
Minke Whale	0	1 (1)	0	0	***1 (1)***
Unidentified Mysticete Whale	4 (7)	5 (9)	5 (12)	0	***14 (28)***
Total Cetaceans	***15 (26)***	***13 (22)***	***31 (61)***	***4 (10)***	**63 (119)**
Seals in Water					
Bearded Seal	0	0	9 (14)	2 (2)	***11 (16)***
Ringed Seal	2 (2)	14 (14)	21 (22)	5 (5)	***42 (43)***
Spotted Seal	0	6 (6)	37 (47)	0	***43 (53)***
Unidentified Seal	4 (4)	5 (5)	98 (123)	9 (16)	***116 (148)***
Seals on Ice or Land					
Ringed Seal	0	0	1 (1)	2 (5)	***3 (6)***
Unidentified Seal	0	0	0	7 (20)	***7 (20)***
Total Seals	***6 (6)***	***25 (25)***	***166 (207)***	***25 (48)***	**222 (286)**
Pacific Walruses in Water					
Pacific Walrus	0	2 (3)	0	0	***2 (3)***
Unidentified Pinniped[a]	1 (1)	0	0	0	***1 (1)***
Total Pacific Walrus	***1 (1)***	***2 (3)***	***0***	***0***	**3 (4)**
Polar Bears in Water	***0***	***1 (5)***	***0***	***0***	***1 (5)***
Polar Bears on Ice or Land	***0***	***2 (11)***	***6 (32)***	***0***	***8 (43)***
Total Polar Bears	***0***	***3 (16)***	***6 (32)***	***0***	**9 (48)**
Total All Marine Mammals	***22 (33)***	***43 (66)***	***203 (300)***	***29 (58)***	***297 (457)***

[a]The single "unidentified pinniped" sighting was included as a Pacific walrus, based on the ratio of identified large pinnipeds in the Beaufort Sea.

TABLE C.22. Numbers of sightings (number of individuals) of cetaceans observed during daylight in the Beaufort Sea (12 Sep – 8 Oct 2007) from ***(A)*** the *Gilavar*, and ***(B)*** its chase/monitoring vessels, during the different seismic states.

Species	Seismic	Post-Seismic[a]	Non-Seismic	*Total*
A. Gilavar				
Cetaceans				
Unidentified Whale	4 (7)	1 (1)	0	***5 (8)***
Mysticetes				
Bowhead Whale	6 (11)	0	0	***6 (11)***
Minke Whale	0	0	0	***0***
Unidentified Mysticete Whale	3 (5)	0	0	***3 (5)***
Total Cetaceans	***13 (23)***	***1 (1)***	***0***	**14 (24)**
B. Chase Vessels				
Cetaceans				
Unidentified Whale	0	0	1 (1)	***1 (1)***
Mysticetes				
Bowhead Whale	6 (8)	5 (10)	5 (14)	***16 (32)***
Minke Whale	0	0	1 (1)	***1 (1)***
Unidentified Mysticete Whale	5 (9)	0	2 (8)	***7 (17)***
Total Cetaceans	***11 (17)***	***5 (10)***	***9 (24)***	**25 (51)**

[a]The post-seismic period for cetaceans is from 3 min – 2 h after the airguns are shut down, and in the case of the chase vessels, also 3 min – 2 h after the vessel has left a 15 km radius around the operating seismic vessel.

TABLE C.23. Numbers of sightings (number of individuals) of seals observed during daylight in the Beaufort Sea (12 Sep – 8 Oct 2007) from ***(A)*** the *Gilavar*, and ***(B)*** its chase/monitoring vessels, during the different seismic states.

Species	Seismic	Post-Seismic[a]	Non-Seismic	*Total*
A. Gilavar				
Seals in Water				
Bearded Seal	0	0	0	***0***
Ringed Seal	2 (2)	0	0	***2 (2)***
Spotted Seal	0	0	0	***0***
Unidentified Seal	2 (2)	0	2 (2)	***4 (4)***
Total Seals	***4 (4)***	***0***	***2 (2)***	**6 (6)**
B. Chase Vessels				
Seals in Water				
Bearded Seal	1 (1)	0	1 (1)	***2 (2)***
Ringed Seal	6 (6)	1 (1)	13 (13)	***20 (20)***
Spotted Seal	5 (5)	1 (1)	0	***6 (6)***
Unidentified Seal	4 (4)	0	6 (6)	***10 (10)***
Total Seals	***16 (16)***	***2 (2)***	***20 (20)***	**38 (38)**

[a]The post-seismic period for pinnipeds is from 3 min – 1 h after the airguns are shut down, and in the case of the chase vessels, also 3 min – 1 h after the vessel has left a 5 km radius around the operating seismic vessel.

TABLE C.24. Numbers of sightings (number of individuals) of Pacific walruses and polar bears observed during daylight in the Beaufort Sea (12 Sep – 8 Oct 2007) from ***(A)*** the *Gilavar*, and ***(B)*** its chase/monitoring vessels, during the different seismic states.

Species	Seismic	Post-Seismic[a]	Non-Seismic	*Total*
A. Gilavar				
Pacific Walruses in Water				
Pacific Walrus	0	0	0	***0***
Unidentified Pinniped[b]	1 (1)	0	0	***1 (1)***
Total Pacific Walrus	***1 (1)***	***0***	***0***	**1 (1)**
Polar Bears on Ice or Land				
Polar Bear	***0***	***0***	***0***	**0**
B. Chase Vessels				
Pacific Walruses in Water				
Pacific Walrus	1 (2)	0	1 (1)	***2 (3)***
Unidentified Pinniped	0	0	0	***0***
Total Pacific Walrus	***1 (2)***	***0***	***1 (1)***	**2 (3)**
Polar Bears on Ice or Land				
Polar Bear	***0***	***0***	***1 (3)***	**1 (3)**

[a]The post-seismic period for pinnipeds and Polar bears is from 3 min – 1 h after the airguns are shut down, and in the case of the chase vessels, also 3 min – 1 h after the vessel has left a 5 km radius around the operating seismic vessel.

[b]The single "unidentified pinniped" sighting was included as a Pacific walrus, based on the ratio of identified large pinnipeds in the Beaufort Sea.

TABLE C.25. Detection rates (# groups per 1000 km) for marine mammal sightings during the different Beaufort wind forces by ***(A)*** the *Gilavar*, and ***(B)*** its chase/monitoring vessels during the Beaufort Sea cruise (12 Sep – 8 Oct 2007). See following table for version in miles.

Beaufort Wind Force	No. of Sightings	Effort (km)	Detection Rate (No./1000 km)
A. Gilavar			
0	1	2.6	377.4
1	1	22.0	45.4
2	1	76.6	13.1
3	2	172.3	11.6
4	3	488.2	6.1
5	9	660.3	13.6
6	3	399.0	7.5
7	1	86.9	11.5
8	0	0.0	0.0
B. Chase Vessels			
0	0	0	0.0
1	11	110.5	99.6
2	6	600.5	10.0
3	18	1362.5	13.2
4	20	1278.8	15.6
5	5	361.9	13.8
6	3	271.0	11.1
7	1	184.9	5.4
8	2	63.9	31.3

Beaufort Wind Force	No. of Sightings	Effort (mi)	Detection Rate (No./1000 mi)
A. Gilavar			
0	1	1.6	607.7
1	1	13.7	73.1
2	1	47.6	21.0
3	2	107.0	18.7
4	3	449.7	6.7
5	9	608.1	14.8
6	3	247.8	12.1
7	1	54.0	18.5
8	0	0.0	0.0
B. Chase Vessels			
0	0	0	0.0
1	11	68.6	160.4
2	6	372.9	16.1
3	18	846.1	21.3
4	20	794.1	25.2
5	5	224.8	22.2
6	3	168.3	17.8
7	1	114.8	8.7
8	2	39.7	50.4

TABLE C.26. Detection rates (# groups per 1000 km) for marine mammal sightings during watches with different numbers of observers by ***(A)*** the *Gilavar*, and ***(B)*** its chase/monitoring vessels during the Beaufort Sea cruise (12 Sep – 8 Oct 2007). See following table for version in miles.

Number of Observers	No. of Sightings	Effort (km)	Detection Rate (No./1000 km)
A. Gilavar			
1	8	1066.6	7.5
2	13	840.4	15.5
3	0	1.1	0.0
B. Chase Vessels			
1	50	3385.7	14.8
2	16	838.3	19.1
3	0	10.1	0.0

Number of Observers	No. of Sightings	Effort (mi)	Detection Rate (No./1000 mi)
A. Gilavar			
1	8	662.4	12.1
2	13	521.9	24.9
3	0	0.7	0.0
B. Chase Vessels			
1	50	2102.5	23.8
2	16	520.6	30.7
3	0	6.3	0.0

TABLE C.27. Detection rates (# groups per 1000 km) for cetacean sightings during the different seismic states from MMO daylight effort by ***(A)*** the *Gilavar*, and ***(B)*** its chase/monitoring vessels during the Beaufort Sea cruise (12 Sep – 8 Oct 2007). Ramp up effort is included in the "Seismic" category. See following table for version in miles.

Seismic State	No. of Sightings	Effort (km)	Detection Rate (No./1000 km)
A. Gilavar			
Cetaceans			
Seismic	13	1262.4	10.3
Post-Seismic	1	33.9	29.5
Non-Seismic	0	611.7	0.0
B. Chase Vessels			
Cetaceans			
Seismic	11	1947.7	5.6
Post-Seismic	5	437.7	11.4
Non-Seismic	9	1848.6	4.9

Seismic State	No. of Sightings	Effort (mi)	Detection Rate (No./1000 mi)
A. Gilavar			
Cetaceans			
Seismic	13	784.0	16.6
Post-Seismic	1	21.1	47.5
Non-Seismic	0	379.9	0.0
B. Chase Vessels			
Cetaceans			
Seismic	11	1209.5	9.1
Post-Seismic	5	271.8	18.4
Non-Seismic	9	1148.0	7.8

TABLE C.28. Detection rates (# groups per 1000 km) for seal sightings during the different seismic states from daylight effort by ***(A)*** the *Gilavar*, and ***(B)*** its chase/monitoring vessels during the Beaufort Sea cruise (12 Sep – 8 Oct 2007). Ramp-up effort is included in the "Seismic" category. See following table for version in miles.

Seismic State	No. of Sightings	Effort (km)	Detection Rate (No./1000 km)
A. Gilavar			
Seals in Water			
Seismic	4	1262.4	3.2
Post-Seismic	0	18.6	0.0
Non-Seismic	2	627.1	3.2
B. Chase Vessels			
Seals in Water			
Seismic	16	1235.6	12.9
Post-Seismic	2	276.3	7.2
Non-Seismic	20	2722.2	7.3

Seismic State	No. of Sightings	Effort (mi)	Detection Rate (No./1000 mi)
A. Gilavar			
Seals in Water			
Seismic	4	784.0	5.1
Post-Seismic	0	11.6	0.0
Non-Seismic	2	389.4	5.1
B. Chase Vessels			
Seals in Water			
Seismic	16	767.3	20.9
Post-Seismic	2	171.6	11.7
Non-Seismic	20	1690.5	11.8

TABLE C.29. Detection rates (# groups per 1000 km) for Pacific walrus sightings during the different seismic states from daylight effort by ***(A)*** the *Gilavar*, and ***(B)*** its chase/monitoring vessels during the Beaufort Sea cruise (12 Sep – 8 Oct 2007). Ramp-up effort is included in the "Seismic" category. See following table for version in miles.

Seismic State	No. of Sightings	Effort (km)	Detection Rate (No./1000 km)
A. Gilavar			
Pacific Walruses in Water[a]			
Seismic	1	1262.4	0.8
Post-Seismic	0	18.6	0.0
Non-Seismic	0	627.1	0.0
B. Chase Vessels			
Pacific Walruses in Water			
Seismic	1	1235.6	0.8
Post-Seismic	0	276.3	0.0
Non-Seismic	1	2722.2	0.4

[a] Includes a single sighting of an Unidentified Pinniped.

Seismic State	No. of Sightings	Effort (mi)	Detection Rate (No./1000 mi)
A. Gilavar			
Pacific Walruses in Water[a]			
Seismic	1	784.0	1.3
Post-Seismic	0	11.6	0.0
Non-Seismic	0	389.4	0.0
B. Chase Vessels			
Pacific Walruses in Water			
Seismic	1	767.3	1.3
Post-Seismic	0	171.6	0.0
Non-Seismic	1	1690.5	0.6

[a] Includes a single sighting of an Unidentified Pinniped.

TABLE C.30. Detection rates (# groups per 1000 km) for polar bear sightings during the different seismic states from daylight effort by ***(A)*** the *Gilavar*, and ***(B)*** its chase/monitoring vessels during the Beaufort Sea cruise (12 Sep – 8 Oct 2007). Ramp-up effort is included in the "Seismic" category. See following table for version in miles.

Seismic State	No. of Sightings	Effort (km)	Detection Rate (No./1000 km)
A. Gilavar			
Polar bears on Ice or Land			
Seismic	0	1262.4	0.0
Post-Seismic	0	18.6	0.0
Non-Seismic	0	627.1	0.0
B. Chase Vessels			
Polar bears on Ice or Land			
Seismic	0	1235.6	0.0
Post-Seismic	0	276.3	0.0
Non-Seismic	1	2722.2	0.4

Seismic State	No. of Sightings	Effort (mi)	Detection Rate (No./1000 mi)
A. Gilavar			
Polar bears on Ice or Land			
Seismic	0	784.0	0.0
Post-Seismic	0	11.6	0.0
Non-Seismic	0	389.4	0.0
B. Chase Vessels			
Polar bears on Ice or Land			
Seismic	0	767.3	0.0
Post-Seismic	0	171.6	0.0
Non-Seismic	1	1690.5	0.6

TABLE C.31. Visual observation effort from the *Henry C.* during daylight hours in the Beaufort Sea (16 Aug. – 2 Oct. 2007), subdivided by Beaufort wind force and seismic state.

	Beaufort Wind Force						
Seismic State	**1**	**2**	**3**	**4**	**5**	**8**	***Total***
Henry C.							
Effort in h							
Seismic	9.4	5.2	0.0	0.2	0.0	0.0	***14.7***
Post-seismic (3 min–2 h)	3.4	2.6	0.0	0.8	0.0	0.0	***6.8***
Non-seismic	132.5	109.6	73.9	27.1	2.4	0.5	***346.0***
Total	***145.2***	***117.4***	***73.9***	***28.1***	***2.4***	***0.5***	***367.5***
Effort in km							
Seismic	65.946	32.1	0.0	1.9	0.0	0.0	***100.0***
Post-seismic (3min- 2h)	25.7	20.1	0.0	9.7	0.0	0.0	***55.6***
Non-seismic	937.4	911.8	654.9	135.5	21.0	6.8	***2667.2***
Total	***1029.0***	***964.0***	***654.9***	***147.1***	***21.0***	***6.8***	***2822.8***

	Beaufort Wind Force						
Seismic State	**1**	**2**	**3**	**4**	**5**	**8**	***Total***
Henry C.							
Effort in h							
Seismic	9.4	5.2	0.0	0.2	0.0	0.0	***14.7***
Post-seismic (3 min–2 h)	3.4	2.6	0.0	0.8	0.0	0.0	***6.8***
Non-seismic	132.5	109.6	73.9	27.1	2.4	0.5	***346.0***
Total	***145.2***	***117.4***	***73.9***	***28.1***	***2.4***	***0.5***	***367.5***
Effort in mi							
Seismic	41.0	20.0	0.0	1.2	0.0	0.0	***62.1***
Post-seismic (3min- 2h)	16.0	12.5	0.0	6.0	0.0	0.0	***34.5***
Non-seismic	582.5	566.5	406.9	84.2	13.0	4.2	***1657.4***
Total	***639.4***	***599.0***	***406.9***	***91.4***	***13.0***	***4.2***	***1754.0***

TABLE C.32. Total number of groups (individuals in parentheses) of marine mammals observed from the *Henry C.* (16 Aug.- 2 Oct. 2007) by species and seismic activity during the shallow hazards survey. See Table C.28 for the total number of daylight sightings.

	Periods within Beaufort Sea Study Area			Off-watch within Beaufort Sea Study Area	*Total*	
Species	**Seismic**	**Post-Seismic**	**Non-seismic**		**Sightings**	**Indiv.**
Cetacenas						
Bowhead Whale	0(0)	1(1)	7(19)	1(2)	***9***	***(22)***
Unidenified Mysticete Whale	0(0)	0(0)	2(2)	0(0)	***2***	***(2)***
Unidentified Whale	0(0)	0(0)	1(1)	0(0)	***1***	***(1)***
Seals						
Bearded Seal	0(0)	0(0)	32(34)	0(0)	***32***	***(34)***
Ringed Seal	1(1)	0(0)	89(105)	0(0)	***90***	***(106)***
Spotted Seal	0(0)	0(0)	10(13)	0(0)	***10***	***(13)***
Unidentified Seal	1(1)	0(0)	70(72)	0(0)	***71***	***(73)***
Polar Bears in Water						
Polar Bear	0(0)	0(0)	2(4)	1(2)	***3***	***(6)***
Polar Bears on Land						
Polar Bear	0(0)	0(0)	16(27)	6(20)	***22***	***(47)***
Total	***2(2)***	***1(1)***	***229(277)***	***8(24)***	***240***	***(304)***

TABLE C.33. Detection rates of marine mammals from the *Henry C.* during different seismic states during the shallow hazards survey in the Beaufort Sea (16 Aug. – 2 Oct. 2007).

Seismic State	**No. of Sightings**	**Effort (km)**	**Detection Rate (No./1000 km)**
Henry C.			
Seismic	2	100.0	20.0
Post-seismic	1	55.6	18.0
Non-seismic	229	2667.2	85.9
Henry C. Total	***232***	***2822.8***	***82.2***

Seismic State	**No. of Sightings**	**Effort (mi)**	**Detection Rate (No./1000 mi)**
Henry C.			
Seismic	2	62.1	32.2
Post-seismic	1	34.5	29.0
Non-seismic	229	1657.3	138.2
Henry C. Total	***232***	***1754.0***	***132.3***

TABLE C.34. Detection rates of cetaceans from the *Henry C.* in different seismic states during daylight effort during the shallow hazards survey (16 Aug. – 2 Oct. 2007).

Seismic State	No. of Sightings	Effort (km)	Detection Rate (No./1000 km)
Henry C.			
Cetaceans			
Seismic	0	100.0	0.0
Post-Seismic	1	55.6	18.0
Non-Seismic	10	2667.2	3.7

Seismic State	No. of Sightings	Effort (mi)	Detection Rate (No./1000 mi)
Henry C.			
Cetaceans			
Seismic	0	62.1	0.0
Post-Seismic	1	34.5	29.0
Non-Seismic	10	1657.3	6.0

TABLE C.35. Detection rates for seals from the *Henry C.* in different seismic states during daylight effort during the shallow hazards survey (16 Aug. – 2 Oct. 2007).

Seismic State	No. of Sightings	Effort (km)	Detection Rate (No./1000 km)
Henry C.			
Seals			
Seismic	2	98.1	20.4
Post-Seismic	0	19.3	0.0
Non-Seismic	201	2705.4	74.3

Seismic State	No. of Sightings	Effort (mi)	Detection Rate (No./1000 mi)
Henry C.			
Seals			
Seismic	2	61.0	32.8
Post-Seismic	0	12.0	0.0
Non-Seismic	201	1681.1	119.6

TABLE C.36. Closest observed points of approach (CPA) of marine mammals to the airguns of the *Henry C.* during seismic and non-seismic periods of the shallow hazards survey (16 Aug. – 2 Oct. 2007).

Taxonomic Group	*n*	Mean CPA (m)	s.d.	Range (m)
Cetaceans				
Seismic	--	--	--	--
Post-Seismic[a]	1	464	--	464
Non-Seismic	10	829.9	615.16	114-2064
Seals in Water				
Seismic	2	131	17.68	118-143
Post-Seismic[b]	--	--	--	--
Non-Seismic	201	168.4	118.34	54-1056
Polar Bears in Water				
Seismic	--	--	--	--
Post-Seismic[b]	--	--	--	--
Non-Seismic	2	1072.5	589.02	656-1489
Polar Bears on Land				
Seismic	--	--	--	--
Post-Seismic[b]	--	--	--	--
Non-Seismic	16	1615.3	765.29	870-3396

[a] Post-seismic for cetaceans: Period encompassing 3 min. to 2 hrs. after all airguns are shut down.
[b] Post-seismic for seals and polar bears: Period encompassing 3 min. to 1 hr after all airguns are shut down.

Taxonomic Group	*n*	Mean CPA (yd)	s.d.	Range (yd)
Cetaceans				
Seismic	--	--	--	--
Post-Seismic[a]	1	507.4	--	507.4
Non-Seismic	10	907.6	615.2	124.7-2257.2
Seals in Water				
Seismic	2	143.3	17.7	129.1-156.4
Post-Seismic[b]	--	--	--	--
Non-Seismic	201	184.2	118.3	59.1-1154.9
Polar Bears in Water				
Seismic	--	--	--	--
Post-Seismic[b]	--	--	--	--
Non-Seismic	2	1172.9	589.0	717.4-1628.4
Polar Bears on Land				
Seismic	--	--	--	--
Post-Seismic[b]	--	--	--	--
Non-Seismic	16	1766.5	765.3	951.4-3713.9

[a] Post-seismic for cetaceans: Period encompassing 3 min. to 2 hrs. after all airguns are shut down.
[b] Post-seismic for seals and polar bears: Period encompassing 3 min. to 1 hr after all airguns are shut down.

TABLE C.37. Initial behaviors of marine mammals observed from the Henry C. in daylight during the shallow hazards survey (Aug. 16- 2 Oct. 2007).

Taxonomic Group	Dive	Feed	Look	Rest	Surface Active	Swim	Walk	*Total*
Cetaceans								
Seismic	0	0	0	0	0	0	0	***0***
Post-seismic[a]	0	0	0	0	1	0	0	***1***
Non-seismic	0	1	0	0	8	1	0	***10***
Total	0	***1***	0	0	***9***	***1***	0	**11**
Pinnipeds								
Seismic	1	0	0	0	1	0	0	***2***
Post-seismic[b]	0	0	0	0	0	0	0	***0***
Non-seismic	3	0	90	1	102	5	0	***201***
Total	***4***	0	***90***	***1***	***102***	***5***	0	**203**
Polar Bears in Water								
Seismic	0	0	0	0	0	0	0	0
Post-seismic[b]	0	0	0	0	0	0	0	0
Non-seismic	0	0	0	0	1	1	0	***2***
Total	0	0	0	0	***1***	***1***	0	**2**
Polar Bears on Land								
Seismic	0	0	0	0	0	0	0	0
Post-seismic[b]	0	0	0	0	0	0	0	0
Non-seismic	0	0	5	1	0	0	10	***16***
Total	0	0	***5***	***1***	0	0	***10***	**16**

[a] Post-seismic for cetaceans: Period encompassing 3 min. to 2 hrs. after all airguns are shut down.
[b] Post-seismic for seals and polar bears: Period encompassing 3 min. to 1 hr after all airguns are shut down.

APPENDIX D: ENGLISH UNITS TABLES AND FIGURES

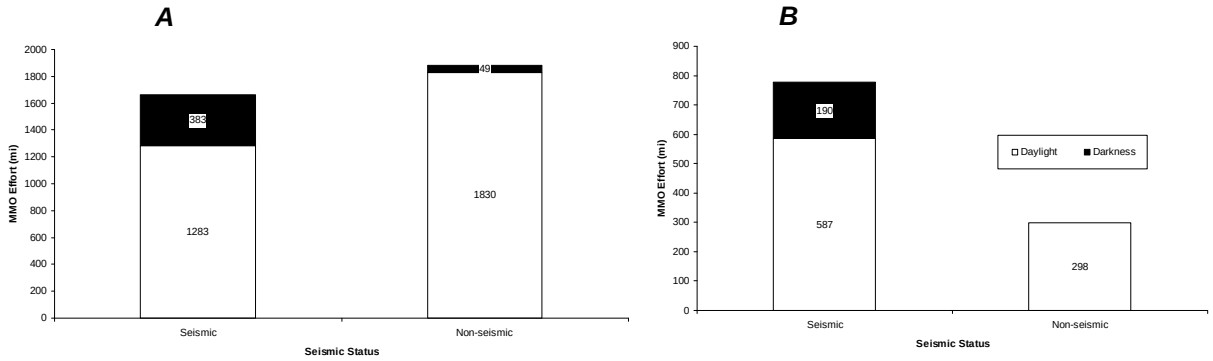


FIGURE D.1. Total marine mammal observer effort (mi) during Chukchi (***A***) summer and (***B***) fall seismic surveys from the *Gilavar* in the Chukchi Sea study area by seismic period in daylight and darkness, 2007. No post seismic effort occurred during the the summer or fall Chukcki Sea surveys from the *Gilavar*.

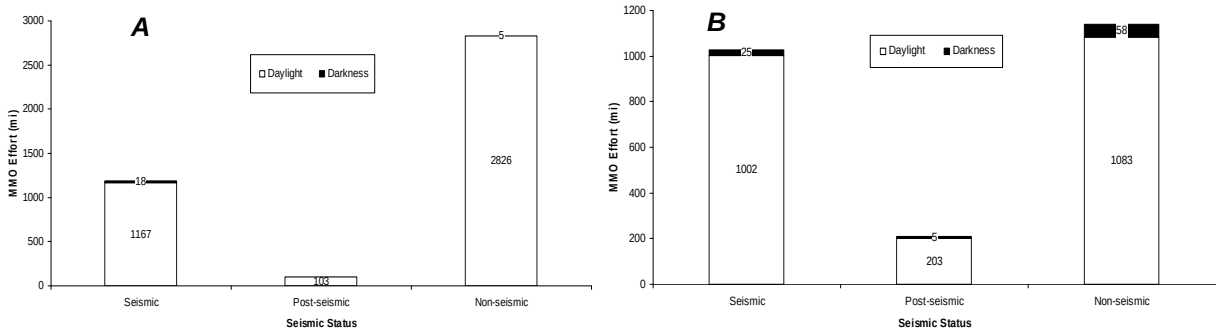


FIGURE D.2. Total marine mammal observer effort (mi) during Chukchi (**A**) summer and (**B**) fall seismic surveys from the chase vessels in the Chukchi Sea study area by seismic period in daylight and darkness, summer 2007.

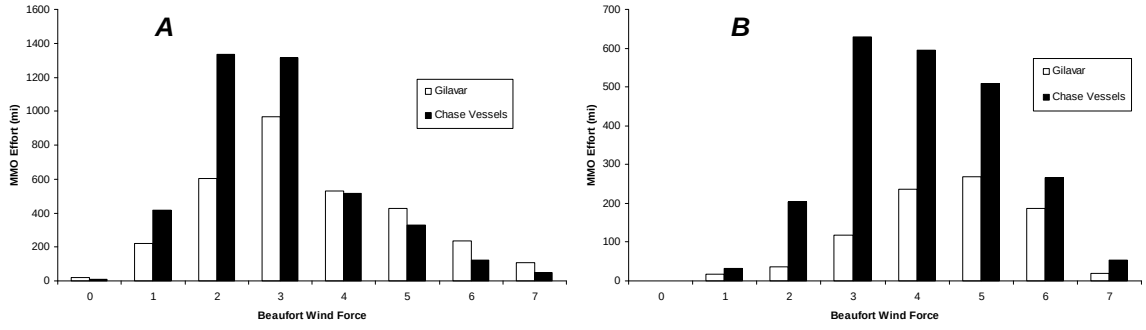


FIGURE D.3. Total daylight marine mammal observer effort (mi) in the Chukchi Sea study area from the *Gilavar* and chase vessels by Beaufort wind force in (**A**) summer and (**B**) fall 2007

TABLE D.3. Sighting rates for marine mammal sightings during different seismic states from daylight MMO watch effort during the summer Chukchi Sea survey (21 Jul - 12 Sep) from the *Gilavar* and its chase vessels. "Ramp-up" effort is included in the *Seismic* category.

Seismic State	No. of Sightings	Effort (mi)	Sighting Rate (No./1000 mi)
Gilavar			
Seismic	51	1283	**39.8**
Post-Seismic	0	0	**0.0**
Non-Seismic	243	1830	**132.8**
Gilavar Total	**294**	**3113**	**94.5**
Chase Vessels			
Seismic	83	1167	**71.1**
Post-Seismic	9	103	**87.3**
Non-Seismic	215	2826	**76.1**
Chase Vessels Total	**307**	**4096**	**74.9**
Grand Total	**601**	**7209**	**83.4**

TABLE D.4. Sighting rates for marine mammal sightings during different seismic states from daylight MMO watch effort during the fall Chukchi Sea survey (8 Oct - 5 Nov) from the *Gilavar* and its chase vessels. "Ramp-up" and “Power-up” effort is included in the *Seismic* category.

Seismic State	No. of Sightings	Effort (mi)	Sighting Rate (No./1000 mi)
Gilavar			
Seismic	2	587	**3.4**
Post-Seismic	0	0	**0.0**
Non-Seismic	3	298	**10.1**
Gilavar Total	**5**	**884**	**5.7**
Chase Vessels			
Seismic	8	1002	**8.0**
Post-Seismic	7	203	**34.5**
Non-Seismic	35	1083	**32.3**
Chase Vessels Total	**50**	**2288**	**21.9**
Grand Total	**55**	**3172**	**17.3**

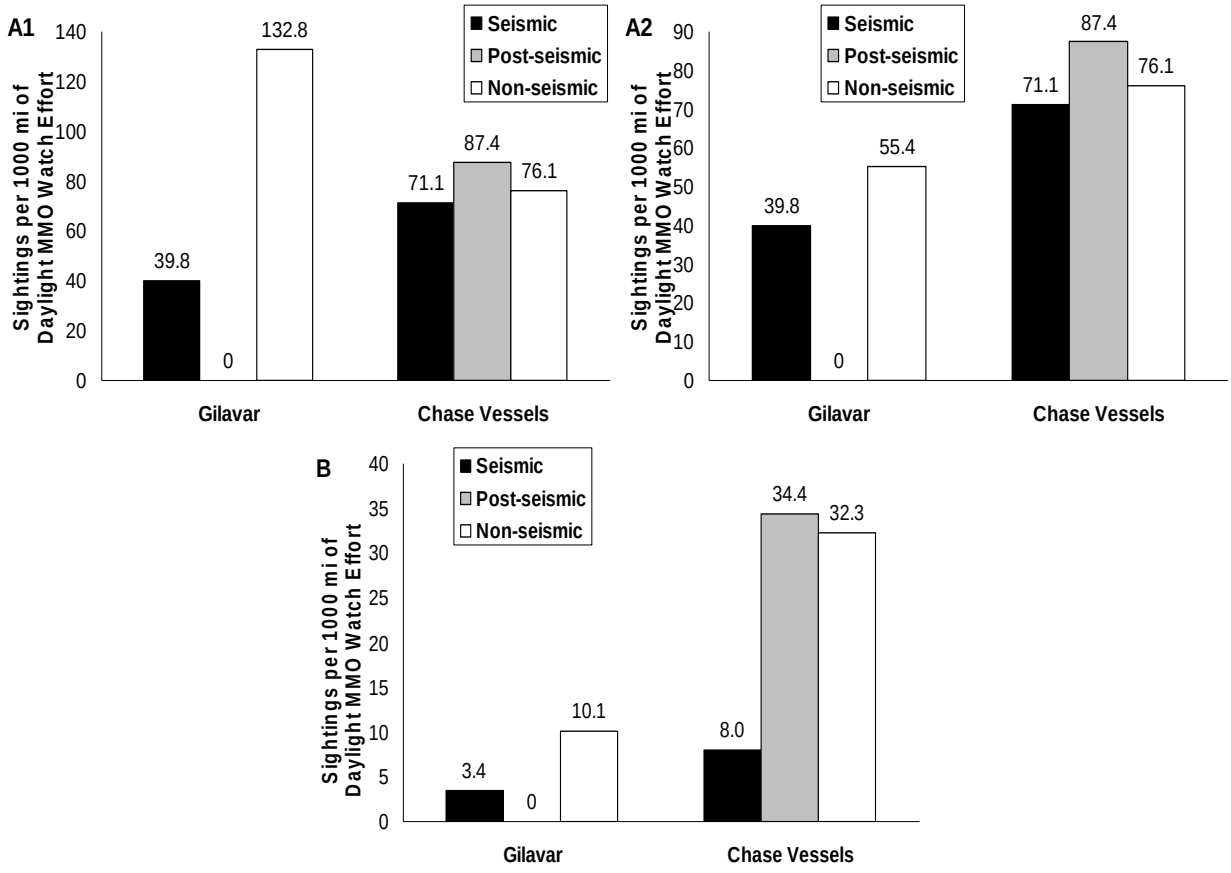


FIGURE D.6. Marine mammal sighting rates by seismic state for the *Gilavar* and its chase vessels during **(A1)** summer (21 Jul – 12 Sep 2007), (**A2**) summer excluding *Gilavar* 24 Aug sightings, and (**B**) fall (8 Oct – 5 Nov 2007) Chukchi Sea surveys.

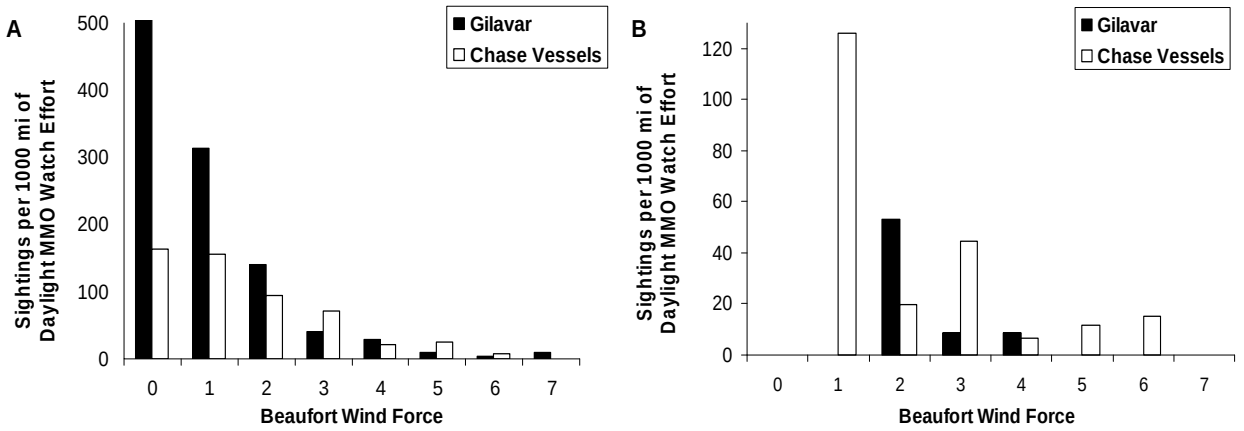


FIGURE D.7. Marine mammal sighting rates by Beaufort wind force from the *Gilavar* and its chase vessels during **(A)** summer (21 Jul – 12 Sep 2007) and (**B**) fall (8 Oct – 5 Nov 2007) Chukchi Sea surveys. Note *Gilavar* summer rate at Beaufort wind force of 0 is truncated at 500 – the actual value approaches 3900 but was inflated as a result of the 24 Aug Pacific walrus sightings event in calm conditions and is not representative of the majority of the season.

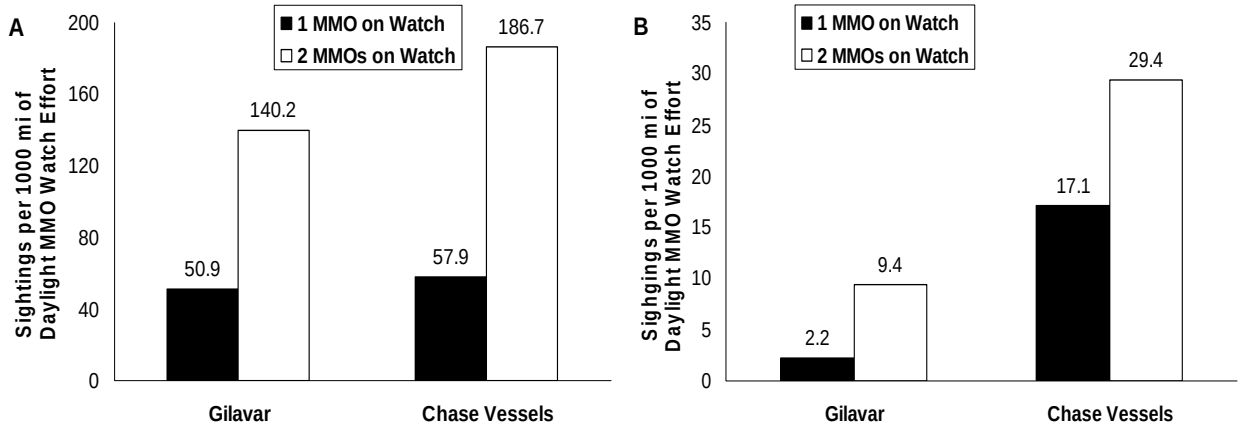


FIGURE D.8. Marine mammal sighting rates by number of MMOs on watch from the *Gilavar* and its Chase vessels during **(A)** summer (21 Jul – 12 Sep 2007) and (**B**) fall (8 Oct – 5 Nov 2007) Chukchi Sea surveys.

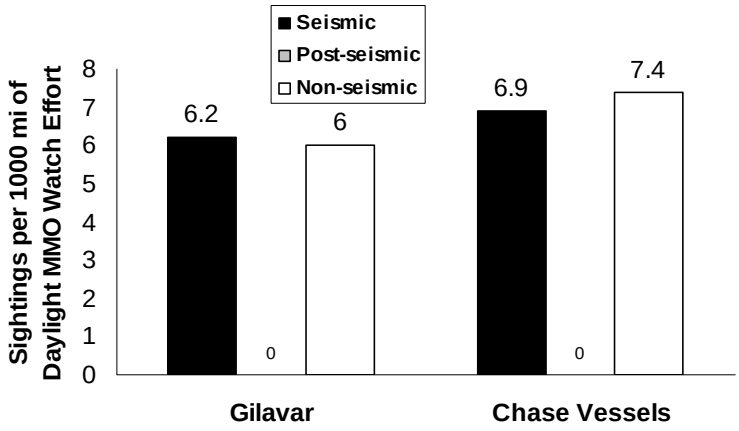


FIGURE D.10. Cetacean sighting rates by seismic state for the *Gilavar* and its chase vessels during the summer Chukchi Sea survey (21 Jul – 12 Sep 2007).

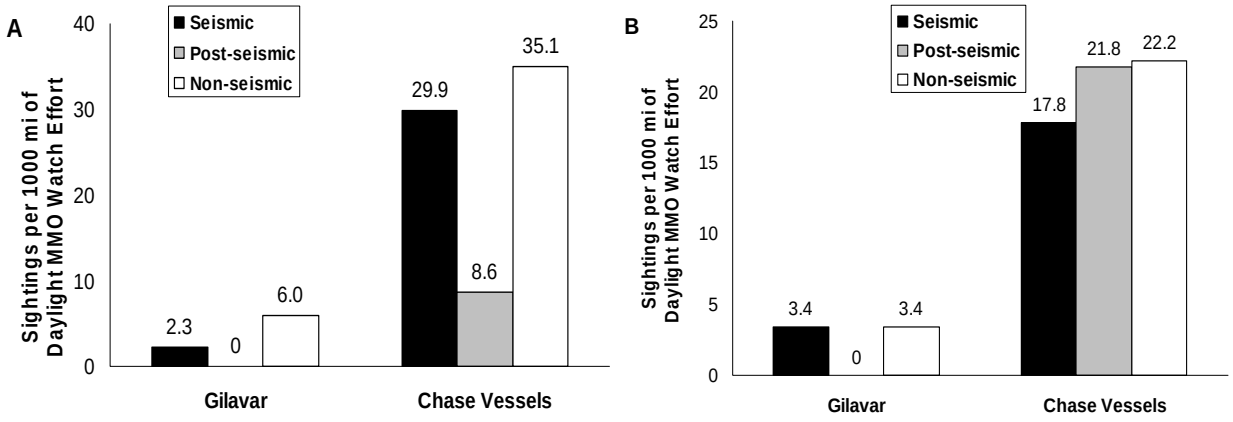


FIGURE D.12. Sighting rates for seal and sea lion sightings by seismic state for the *Gilavar* and its chase vessels during **(A)** summer (21 Jul – 12 Sep 2007) and (**B**) fall (8 Oct – 5 Nov 2007) Chukchi Sea surveys.

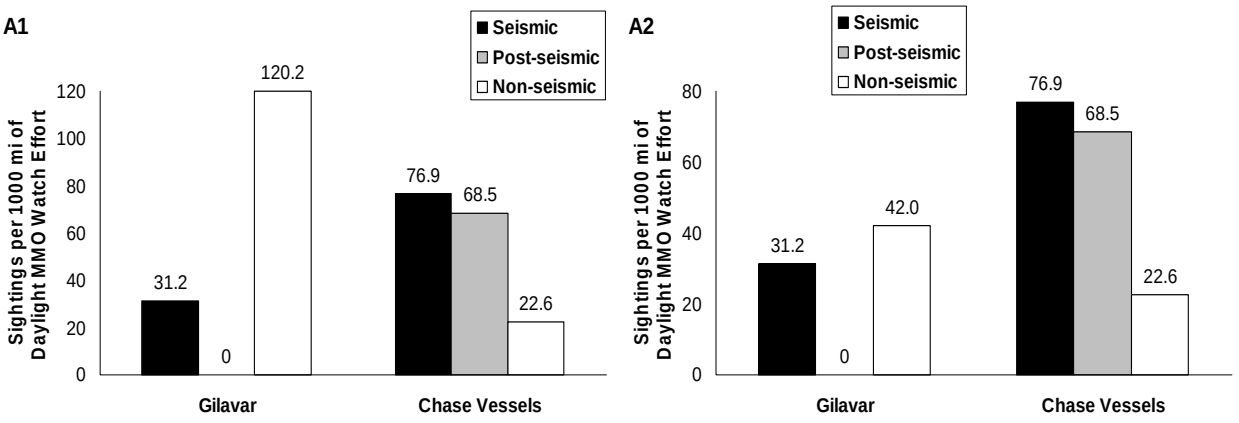


FIGURE D.15. Pacific walrus sighting rates by seismic state for the *Gilavar* and its chase vessels during (**A1**) the summer Chukchi Sea survey (21 Jul – 12 Sep 2007) and (**A2**) the summer Chukchi Sea survey excluding the *Gilavar's* 24 August walrus sightings (*n* = 148).

TABLE D.10. Comparison of cetacean CPA distances by seismic period from daylight MMO watches aboard the *Gilavar* and its chase vessels during the summer Chukchi Sea survey (21 Jul - 12 Sep 2007).

Vessel and Seismic Status	Mean CPA[a] (yd)	s.d.	Range (yd)	*n*
***Gilavar* Seismic**	3004	3404	697-11009	8
***Gilavar* Non-seismic**	1500	1246	338-3285	11
***Gilavar* Overall Mean**	***2134***	***2439***	***338-11009***	***19***
Chase Vessels Seismic	2167	1265	411-3743	8
Chase Vessels Non-seismic	2069	2507	77-8749	21
Chase Vessels Overall Mean	***2096***	***2211***	***77-8749***	***29***

[a] CPA = *Closest Point of Approach*. For *Gilavar* this value is the marine mammal's closest point of approach to the airgun array, for chase vessels this value is the marine mammal's closest point of approach to the MMO/vessel.

Table D.13. Comparison of seal and sea lion CPA distances by seismic period from daylight MMO watches aboard the *Gilavar* and its chase vessels during the summer Chukchi Sea survey (21 Jul - 12 Sep 2007).

Vessel and Seismic Status	Mean CPA[a] (yd)	s.d.	Range (yd)	*n*
***Gilavar* Seismic**	762	169	570-891	3
***Gilavar* Non-seismic**	570	727	143-2662	11
***Gilavar* Overall Mean**	***611***	***646***	***143-2662***	***14***
Chase Vessels Seismic	144	122	11-383	21
Chase Vessels Non-seismic	145	151	1-606	115
Chase Vessels Overall Mean	***144***	***147***	***1-606***	***136***

[a] CPA = *Closest Point of Approach*. For *Gilavar* this value is the marine mammal's closest point of approach to the airgun array, for chase vessels this value is the marine mammal's closest point of approach to the MMO/vessel.

Table D.14. Comparison of seal CPA distances by seismic period from daylight MMO watches aboard the *Gilavar* and its chase vessels during the fall Chukchi Sea survey (8 Oct - 5 Nov 2007).

Vessel and Seismic Status	Mean CPA[a] (yd)	s.d.	Range (yd)	*n*
***Gilavar* Seismic**	300	249	124-477	2
***Gilavar* Non-seismic**	183	NA	183	1
***Gilavar* Overall Mean**	***261***	***189***	***124-477***	***3***
Chase Vessels Seismic	153	154	22-366	7
Chase Vessels Non-seismic	163	134	11-586	35
Chase Vessels Overall Mean	***161***	***136***	***11-586***	***42***

[a] CPA = *Closest Point of Approach*. For *Gilavar* this value is the marine mammal's closest point of approach to the airgun array, for chase vessels this value is the marine mammal's closest point of approach to the MMO/vessel.

TABLE D.19. Comparison of Pacific walrus CPA distances by seismic period from daylight MMO watches aboard the *Gilavar* and its chase vessels during the summer Chukchi Sea survey (21 Jul - 12 Sep 2007).

Vessel and Seismic Status	Mean CPA[a] (yd)	s.d.	Range (yd)	*n*
***Gilavar* Seismic**	725	571	90-2542	39
***Gilavar* Non-seismic**	977	753	78-4991	221
***Gilavar* Overall Mean**	***938***	***733***	***78-4991***	***260***
Chase Vessels Seismic	295	319	1-1784	54
Chase Vessels Non-seismic	398	536	1-3743	79
Chase Vessels Overall Mean	***356***	***462***	***1-3743***	***133***

[a] CPA = *Closest Point of Approach*. For *Gilavar* this value is the marine mammal's closest point of approach to the airgun array, for chase vessels this value is the marine mammal's closest point of approach to the MMO/vessel.

TABLE D.21A. List of power downs for marine mammals sighted in the *Gilavar*'s ≥180 dB safety radius (2470 m) during the summer Chukchi Sea seismic survey (21 Jul - 12 Sep 2007).

Sighting ID	Species	Group Size	Day in 2007 UTC	Water Depth (yd)	Reaction to Vessel[a]	Distance (yd) to airguns at first detection	CPA[b] (yd) to airguns
286	Pacific walrus	1	29-Aug	45.3	IS	259	259
291	Pacific walrus	2	30-Aug	15.4	LO	966	966
294	Pacific walrus	2	31-Aug	45.6	IS	183	183
295	Pacific walrus	2	31-Aug	45.6	NO	370	362
297	Pacific walrus	2	3-Sep	44.1	LO	521	521
300	Pacific walrus	3	4-Sep	45.7	IS	230	230
302	Pacific walrus	2	5-Sep	44.9	LO	620	620
304	Pacific walrus	3	5-Sep	43.5	NO	449	147
*305	Pacific walrus	2	6-Sep	45.9	*NA*	1590	1592
306	Pacific walrus	1	6-Sep	45.7	LO	586	90
*307	Pacific walrus	2	6-Sep	46.5	*NA*	2307	2277
*308	Pacific walrus	1	6-Sep	43.9	*NA*	2494	2229
309	Pacific walrus	3	7-Sep	43.7	LO	118	118
*311	Pacific walrus	1	7-Sep	43.0	*NA*	2041	1767
*312	Pacific walrus	2	7-Sep	44.3	*NA*	2403	2111
*313	Pacific walrus	2	7-Sep	44.9	*NA*	2466	1836
*318	Pacific walrus	2	7-Sep	44.5	*NA*	2663	2543
319	Pacific walrus	1	7-Sep	44.8	LO	1229	1229
329	Pacific walrus	1	7-Sep	44.3	LO	417	417
331	Pacific walrus	2	8-Sep	44.2	NO	1239	1187
340	Pacific walrus	2	8-Sep	45.8	LO	396	341
*343	Pacific walrus	2	9-Sep	45.8	*NA*	2585	2421
*346	Pacific walrus	2	9-Sep	46.2	*NA*	2647	2702
347	Pacific walrus	2	10-Sep	44.3	LO	405	405
348	Pacific walrus	2	11-Sep	43.4	LO	509	509
349	Pacific walrus	3	11-Sep	45.6	NO	1002	441

TABLE D.21B. The single power down in the *Gilavar*'s ≥190 dB safety radius (550 m) during the fall Chukchi Sea seismic survey (8 Oct - 5 Nov 2007).

Sighting ID	Species	Group Size	Day in 2007 UTC	Water Depth (yd)	Reaction to Vessel[a]	Distance (yd) to airguns at first detection	CPA (yd) to airguns
419	Bearded Seal	1	2-Nov	42.7	LO	476	476

* Indicates animal(s) sighted by chase vessel and determined to be within the 180 dB safety radius

[a] Observed reaction of animal to vessel: IS=Increase Speed, LO=Look at Vessel, NO=None, *NA* =Not Applicable as sighting was reported by *Chase Vessel*

[b] CPA=Closest Point of Approach

TABLE D.23. Densities of marine mammals in offshore areas of the Alaskan Chukchi Sea by useable and daylight sightings criteria (see Chapter 4 for more details) for the summer Chukchi Sea survey (21 Jul - 12 Sep 2007). Densities are corrected for *f*(0) and *g*(0) biases.

	Non-seismic Densities		**Seismic Densities**	
	(No. individuals / 1000 mi^2)		(No. individuals / 1000 mi^2)	
Species	**Useable**	**Daylight**	**Useable**	**Daylight**
Cetaceans				
Unidentified Whale	0.141	0.250	0	4.978
Harbor Porpoise	3.306	1.465	0	0
Killer Whale	0.304	0.269	0	0
Bowhead Whale	0.884	0.783	0	1.116
Gray Whale	5.462	5.708	0	0.236
Humpback Whale	0.308	0.273	0	0.518
Unidentified Mysticete Whale	0	0.105	0	0.597
Cetacean Total	***10.405***	***8.851***	***0***	***7.445***
Seals and Sea Lions				
Unidentified Seal	37.661	57.634	9.757	13.478
Bearded Seal	15.873	20.095	0	7.953
Ringed Seal	136.671	181.494	0	87.152
Spotted Seal	9.487	11.878	0	13.581
Steller Sea Lion	0.252	0.245	0	0
Seal and Sea Lion Total	***199.944***	***271.347***	***9.757***	***122.164***
Pacific Walruses*				
Pacific Walrus	306.337	532.652	11.799	134.459
Unidentified Pinniped	6.446	8.967	0	2.307
Pacific Walrus Total	***312.783***	***541.619***	***11.799***	***136.765***

* Daylight Non-seismic density for Pacific Walrus decreases from 541.619 animals per 1000 mi^2 to 329.722 animals per 1000 mi^2 when *Gilavar* 24 Aug sightings are excluded from calculations.

TABLE D.24. Densities of marine mammals in offshore areas of the Alaskan Chukchi Sea by useable and daylight sightings criteria (see Chapter 5 for more details) for the fall Chukchi Sea survey (8 Oct - 5 Nov 2007). Densities are corrected for *f*(0) and *g*(0) biases.

	Non-seismic Densities		**Seismic Densities**	
	(No. individuals / 1000 mi^2)		(No. individuals / 1000 mi^2)	
Species	**Useable**	**Daylight**	**Useable**	**Daylight**
Cetaceans				
Humpback Whale	0	0.460	0	0
Unidentified Mysticete Whale	0	0.353	0	0
Cetacean Total	***0***	***0.813***	***0***	***0***
Seals				
Unidentified Seal	34.925	64.316	0	6.827
Bearded Seal	5.152	16.866	0	24.168
Ringed Seal	64.523	66.012	0	50.449
Spotted Seal	0	0	0	6.879
Seal Total	***104.601***	***161.595***	***0***	***88.322***
Pacific Walruses				
Pacific Walrus	0	0	0	1.651
Pacific Walrus Total	***0***	***0***	***0***	***1.651***

TABLE D.25. Estimated areas (mi^2) ensonified with various sound levels during the summer (21 Jul – 12 Sep) and fall (8 Oct – 5 Nov) Chukchi Sea seismic surveys in 2007.

	Level of ensonification (dB re1µPa (rms))				
Area (mi^2)	**120**	**160**	**170**	**180**	**190**
Summer					
Including Overlap Area	339,703	17,906	8,326	4,169	849
Excluding Overlap Area	9,527	970	624	467	220
Fall					
Including Overlap Area	244,620	14,866	7,287	3,734	779
Excluding Overlap Area	10,032	1,087	751	532	229

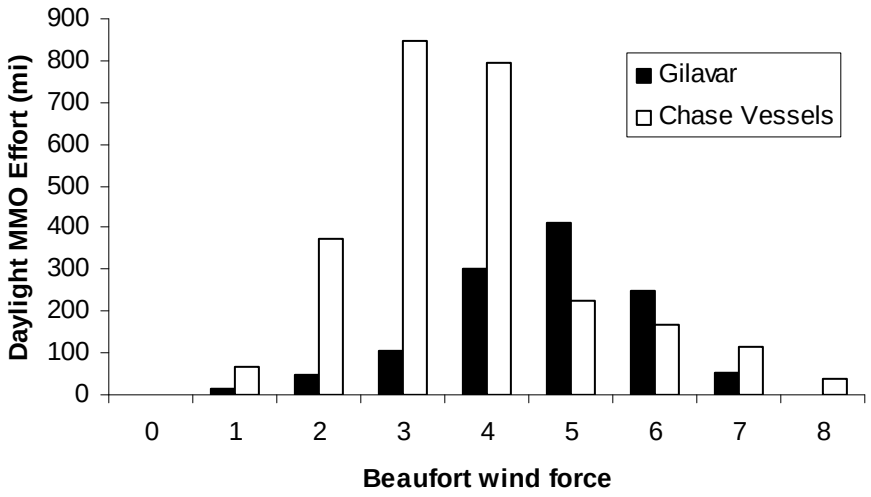


FIGURE D.39. Total daylight marine mammal observer effort (mi) in the Beaufort Sea study area from the *Gilavar* and its chase/monitoring vessels by Beaufort wind force, 12 Sep – 8 Oct 2007.

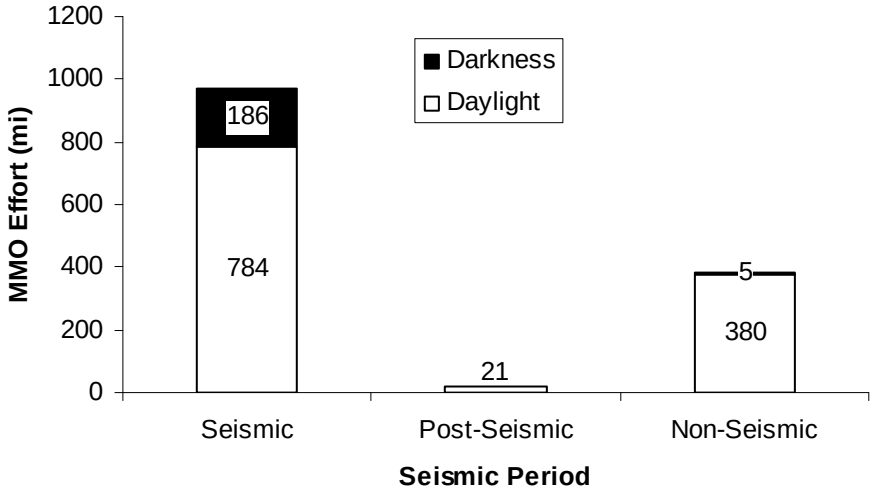


FIGURE D.40. Total marine mammal observer effort (mi) from the *Gilavar* in the Beaufort Sea study area by seismic period, in daylight and darkness, 12 Sep – 8 Oct 2007.

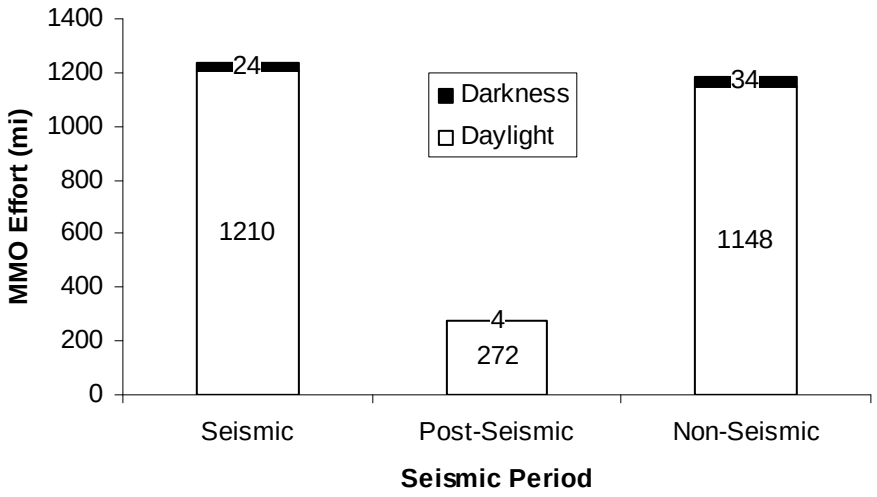


FIGURE D.41. Total marine mammal observer effort (mi) from chase/monitoring vessels in the Beaufort Sea study area by seismic period, in daylight and darkness, 12 Sep – 8 Oct 2007. Numbers in figure are rounded.

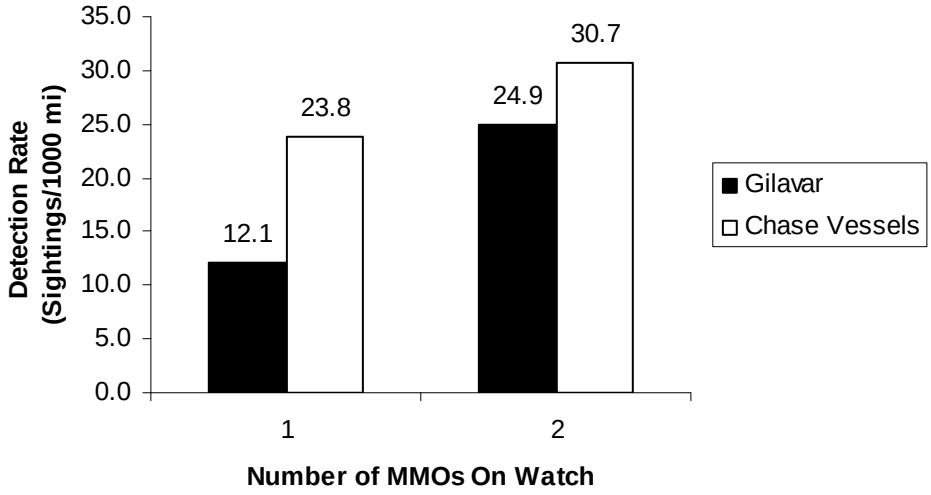


FIGURE D.44. Marine mammal detection rates (sightings per 1000 mi of daylight MMO effort) for the *Gilavar* and its chase/monitoring vessels during watches with one or two observers in the Beaufort Sea (12 Sep – 8 Oct 2007).

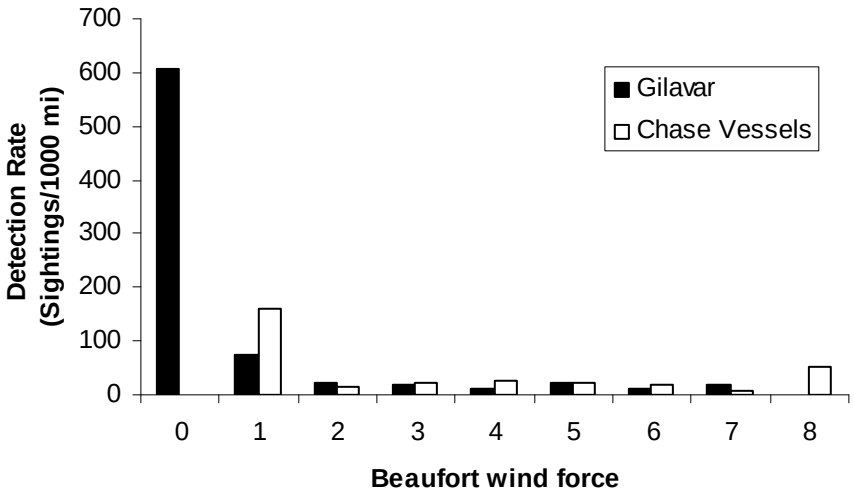


FIGURE D.45. Marine mammal detection rates (sightings per 1000 mi of daylight MMO effort) from the *Gilavar* and its chase/monitoring vessels during different Beaufort wind force conditions during the Beaufort Sea survey (12 Sep – 8 Oct 2007).

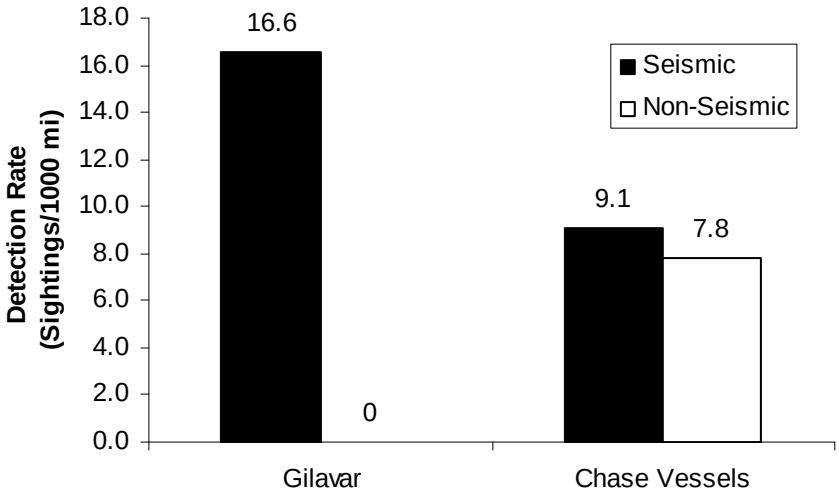


FIGURE D.46. Detection rates (sighings per 1000 mi daylight MMO effort) for cetaceans during seismic versus non-seismic periods during the Beaufort Sea survey (12 Sep – 8 Oct 2007) from the *Gilavar* and its chase/monitoring vessels. "Ramp-up" effort is included in the *Seismic* category.

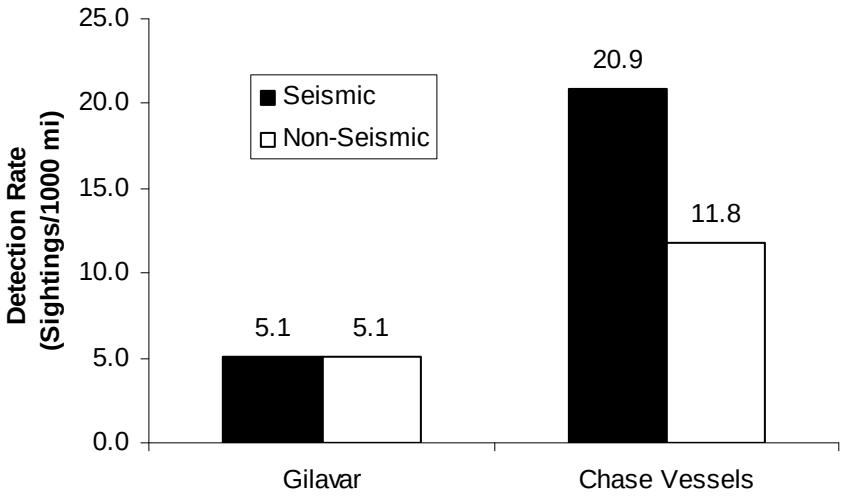


FIGURE D.47. Detection rates (sighings per 1000 mi daylight MMO effort) for seals during seismic versus non-seismic periods during the Beaufort Sea survey (12 Sep – 8 Oct 2007) from the *Gilavar* and its chase/monitoring vessels. "Ramp-up" effort is included in the *Seismic* category.

TABLE D.32. Comparison of cetacean CPA distances by seismic period from daylight MMO watches aboard the *Gilavar* and its chase vessels during the Beaufort Sea survey (12 Sep - 8 Oct).

Vessel and Seismic Status	Mean CPA[a] (yd)	s.d.	Range (yd)	*n*
***Gilavar* Seismic**	2198	823	1028-4033	13
***Gilavar* Non-seismic**	N/A	N/A	N/A	0
***Gilavar* Overall Mean**	2198	823	1028-4033	13
***Chase Vessels* Seismic**	760	382	230-1277	11
***Chase Vessels* Non-seismic**	728	819	73-2743	9
***Chase Vessels* Overall Mean**	873	808	73-2743	20

[a] CPA = Closest Point of Approach. For Gilavar this value is the marine mammal's closest point of approach to the airgun array, for Chase Vessels this value is the marine mammal's closest point of approach to the MMO/vessel.

Table D.33. Comparison of seal CPA distances by seismic period from daylight MMO watches aboard the *Gilavar* and its chase vessels during the Beaufort Sea survey (12 Sep - 8 Oct).

Vessel and Seismic Status	Mean CPA[a] (yd)	s.d.	Range (yd)	*n*
***Gilavar* Seismic**	216	139	107-418	4
***Gilavar* Non-seismic**	100	29	79-120	2
***Gilavar* Overall Mean**	177	124	79-418	6
***Chase Vessels* Seismic**	151	139	5-390	16
***Chase Vessels* Non-seismic**	95	81	9-316	20
***Chase Vessels* Overall Mean**	120	112	5-390	36

[a] CPA = Closest Point of Approach. For the *Gilavar* this value is the marine mammal's closest point of approach to the airgun array, for Chase Vessels this value is the marine mammal's closest point of approach to the MMO/vessel.

TABLE D.34. List of power downs for cetaceans sighted in the *Gilavar*'s ≥180 dB safety radius (2057 yd) during the Beaufort Sea seismic survey (12 Sep – 8 Oct 2007).

Sighting ID	Species	Group Size	Day in 2007 UTC	Water Depth (ft)	Reaction to Vessel[a]	Distance (yd) to Airguns at First Detection	CPA[b] (yd) to Airguns
382	unidentified whale	1	19-Sep	98	NO	1280	1280
383	bowhead whale	2	19-Sep	92	SP	1755	1755
386	bowhead whale	1	19-Sep	86	NO	1280	1280
391	unidentified whale	3	26-Sep	110	NO	1028	1028

[a] Observed reaction of animal to vessel:SP=splash, NO=none

[b] CPA=Closest Point of Approach

TABLE D.35. List of power downs for pinnipeds sighted in the *Gilavar*'s ≥180 dB safety radius (786 yd) during the Beaufort Sea seismic survey (12 Sep – 8 Oct 2007).

Sighting ID	Species	Group Size	Day in 2007 UTC	Water Depth (ft)	Reaction to Vessel[a]	Distance (yd) to Airguns at First Detection	CPA[b] (yd) to Airguns
377	ringed seal	1	18-Sep	91	LO	147	147
378	unidentified seal	1	18-Sep	91	LO	107	107

[a] Observed reaction of animal to vessel:LO=Look at Vessel

[b] CPA=Closest Point of Approach

TABLE D.36. Expected densities of marine mammals in offshore areas of the Alaskan Beaufort Sea (see Chapter 5 for more details). Densities are corrected for f(0) and g(0) biases. A lack of "useable" effort required that 1) all daylight observations and effort were used in calculating densities, and 2) that data from all vessels operating in the Beaufort was used instead of data from only the Gilavar and its chase vessels.

	Seismic	**Non-seismic**
Species	(No. individuals /1000 mi^2)	(No. individuals /1000 mi^2)
Cetaceans		
Unidentified Whale	0.0003	0.0001
Unidentified Mysticete	0.0005	0.0004
Bowhead Whale	0.0013	0.0012
Minke Whale		0.0000
Pinnipeds		
Unidentified Pinniped	0.0004	
Odobenids		
Pacific Walrus	0.0003	0.0001
Phocids		
Unidentified Seal	0.0039	0.0038
Bearded Seal	0.0008	0.0006
Ringed Seal	0.0095	0.0115
Spotted Seal	0.0032	
Ursids		
Polar Bear		0.0002

TABLE D.37. The areas (mi^2) potentially ensonified to various levels by the Gilavar's airgun array volumes, operating within the study area during seismic periods of the Beaufort Sea cruise, 12 Sep − 8 Oct 2007. Maximum area ensonified is shown with overlapping areas counted multiple times, total area ensonified shown with overlapping areas counted only once.

	Level of ensonification (dB re1µPa (rms))				
Area (mi^2)	**120**	**160**	**170**	**180**	**190**
Including Overlap Area	439,054	26,357	8,711	2,633	931
Excluding Overlap Area	11,436	1,396	755	394	249

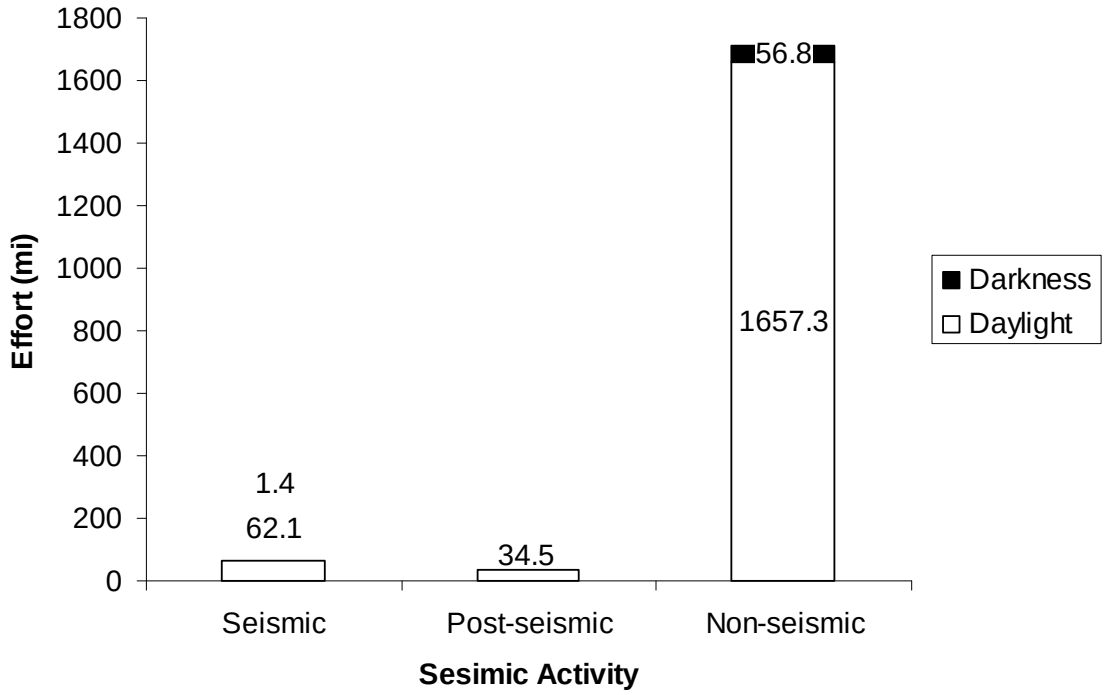


FIGURE D.56. Total marine mammal observer effort (mi) from the *Henry C.* in the Beaufort Sea study area by seismic activity in daylight and darkness. Post-seismic: Period encompassing 3 min to 2 hrs. after all airguns were shut down.

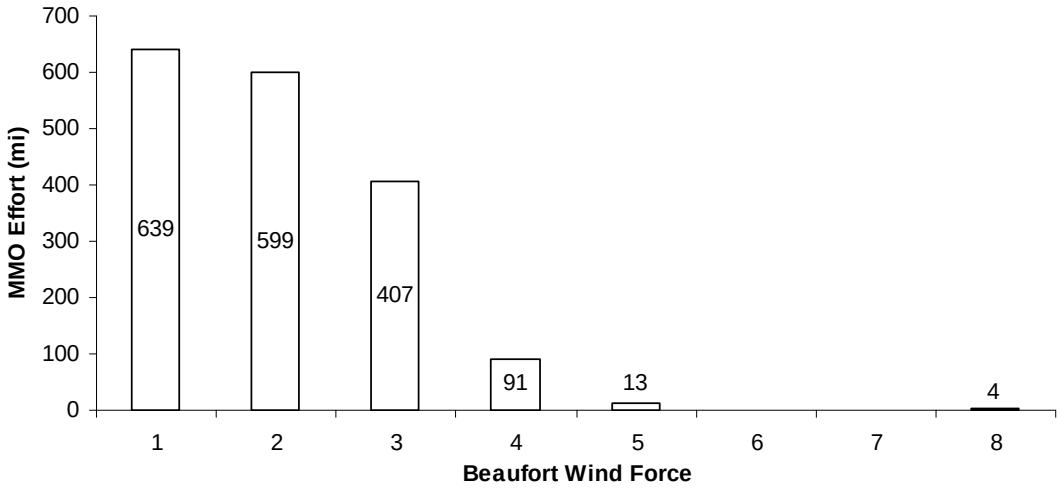


FIGURE D.57. Total daylight marine mammal observer effort (mi) in the Beaufort Sea study area from the *Henry C.* by Beaufort wind force.

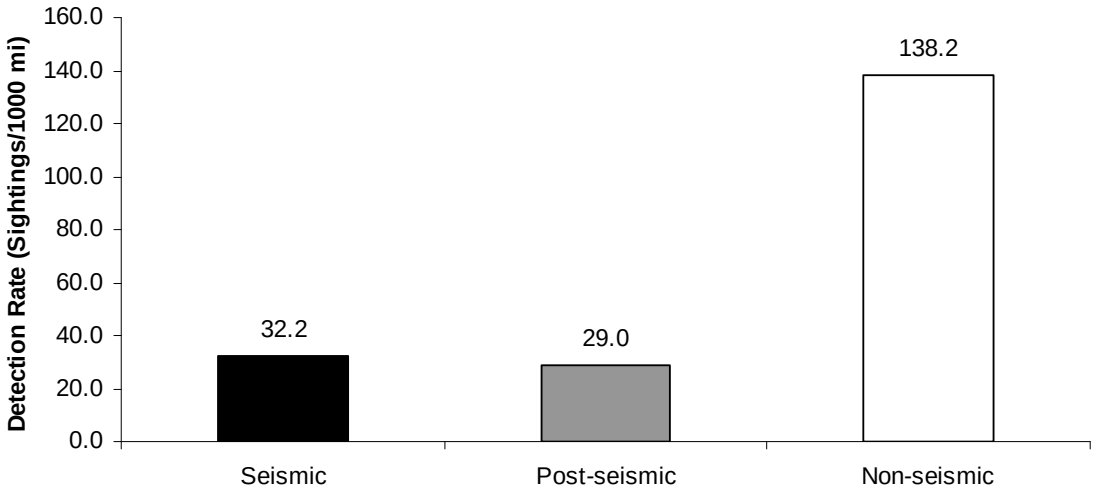


FIGURE D.59. Detection rates from the *Henry C.* in different seismic periods during the shallow hazards survey (16 Aug – 2 Oct 2007).

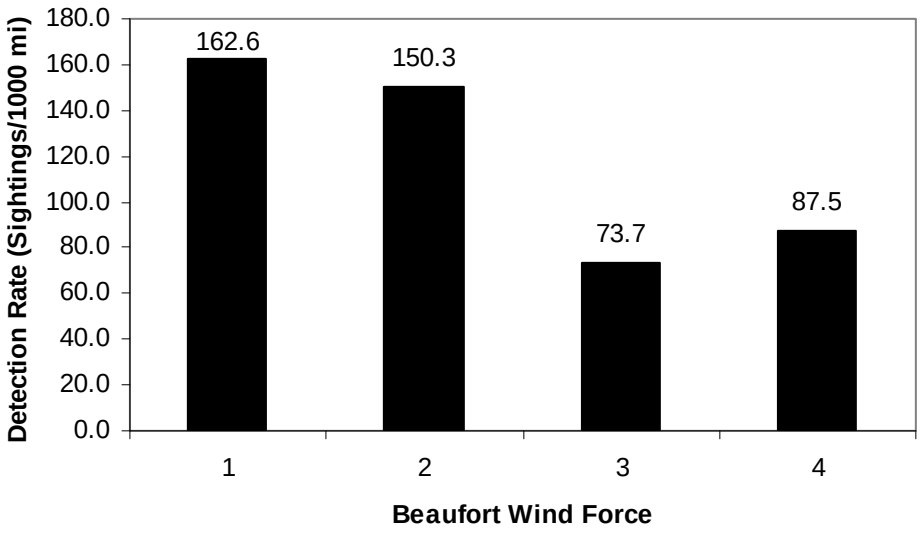


FIGURE D.60. Detection rates from the *Henry C.* in different Beaufort wind force categories during the shallow hazards survey (16 Aug–2 Oct 2007).

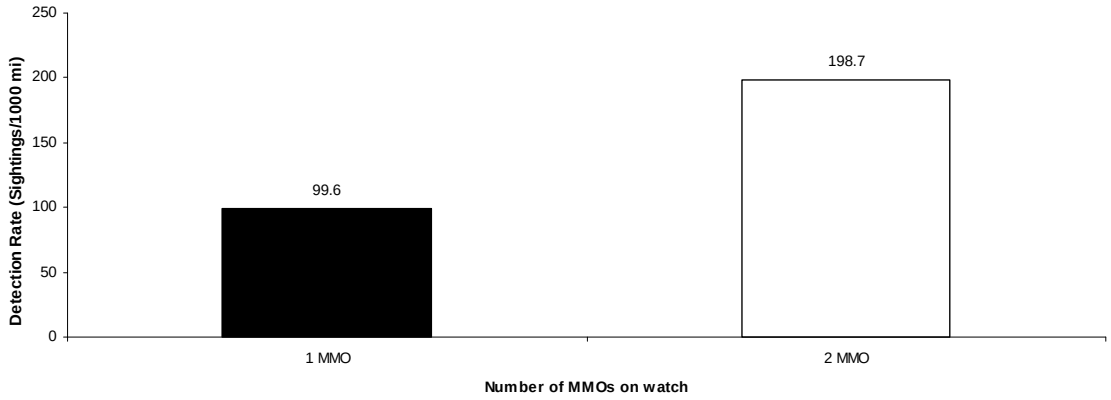


FIGURE D.61. Detection rates for 1 vs. 2 MMOs on watch aboard the *Henry C.* during the shallow hazards survey (16 Aug – 2 Oct 2007).

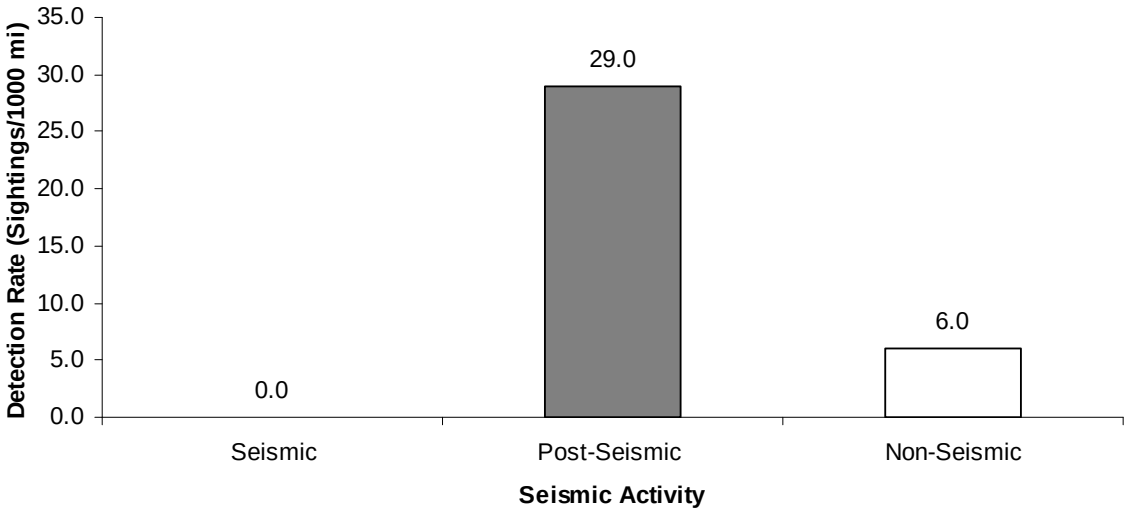


FIGURE D.62. Detection rates for cetaceans during different seismic states from daylight effort aboard the *Henry C.* during the shallow hazards survey (16 Aug – 2 Oct 2007).

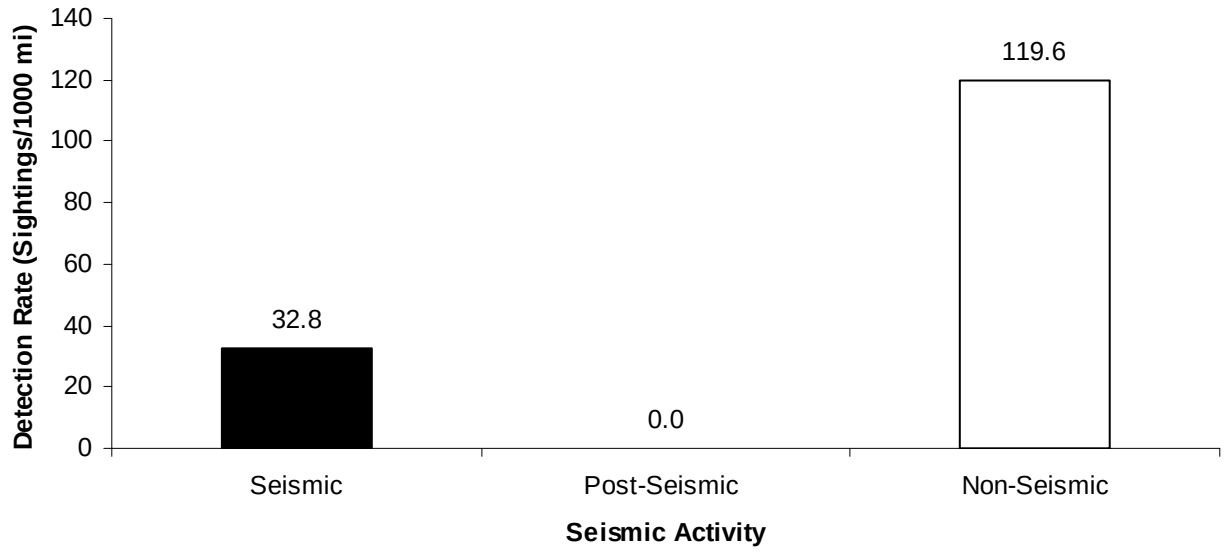


FIGURE D.63. Detection rates for seals during different seismic states from daylight effort aboard the *Henry C.* during the shallow hazards survey (16 Aug – 2 Oct 2007).

TABLE D.45. Closest observed points of approach (CPA) of seals to the airguns of the *Henry C.* during seismic and non-seismic periods of the shallow hazards survey (16 Aug – 2 Oct 2007).

Species and Seismic Status[a]	*n* Sightings	Mean CPA (yd)[b]	s.d.	Range (yd)
Henry C.				
Seals in Water				
Seismic	2	142.7	17.7	129.1-156.4
Non-Seismic	201	184.2	118.3	59.1-1154.9

[a] Seismic Status: *All sightings* is the total of Seismic and *Non-seismic Sightings*. *Seismic sightings* include all sightings while airguns were firing, *Non-seismic sightings* for cetaceans include all sightings after the airguns were off for 1 hour.

[b] CPA = *Closest Point of Approach*. For Henry C.: this value is the marine mammal's closest point of approach to the airgun array.

TABLE D.46. Estimated densities of marine mammals in offshore areas of the Alaskan Beaufort Sea based on all daylight effort and sightings from the *Henry C.* (see Chapter 4 for more details). Densities are corrected for *f*(0) and *g*(0) biases.

Species	Density - Seismic[a] (No. individuals /1000 mi^2)	Density - Non-seismic[a] (No. individuals /1000 mi^2)
Cetaceans		
Bowhead Whale	--	10.45
Unidentified Mysticete Whale	--	0.59
Unidentified Whale	--	0.35
Seals		
Ringed Seal	198.89	775.20
Spotted Seal	--	54.91
Bearded Seal	--	160.34
Unidentified Seal	107.66	287.73
Polar Bears		
Polar Bear	--	14.90

[a] These density estimates are based on daylight sighting and daylight observation effort.

TABLE D.47. The areas (km^2) potentially ensonified to various levels by the *Henry C.* airgun(s) during the shallow hazards survey, (16 Aug.- 2 Oct. 2007). (A) Maximum area ensonified, with overlapping areas counted multiple times. (B) Total area ensonified, with overlapping areas counted only once.

	Level of ensonification dB re 1 µPa (rms)			
Area (mi^2)	**120**	**160**	**180**	**190**
A. Including Overlap Area	5295.09	92.74	4.97	1.18
B. Excluding Overlap Area	1965.17	62.36	4.39	1.13

TABLE D.50. Summary of aerial survey effort and sighting rates in the central Alaskan Beaufort Sea, 22 Aug through 8 Oct 2007. Sighting rates are based on useable sightings and effort. Values in parentheses are based on less than 500 km (311 mi) of effort. Estimates were not calculated when effort was less than 250 km (155 mi).

				Bowhead Whale				Beluga Whale			
Date in 2007	**Survey No.**	**Effort (mi)**	**Percent of Survey Area**	**Sightings**	**Individuals**	**Sightings/ 1000mi**	**Individuals/ 1000mi**	**Sightings**	**Individuals**	**Sightings/ 1000mi**	**Individuals/ 1000mi**
22 Aug	1	540	69	4	5	7.4	9.3	1	13	1.9	24.1
24 Aug	2	180	23	(4)	(4)	(22.2)	(22.2)	(0)	(0)	(0.0)	(0.0)
03 Sep	3	211	27	(5)	(5)	(23.7)	(23.7)	(0)	(0)	(0.0)	(0.0)
10 Sep	4	548	49	16	19	29.2	34.7	0	0	0.0	0.0
11 Sep	4,5	667	59	20	26	30.0	39.0	30	48	45.0	72.0
14 Sep	5	284	25	(8)	(15)	(28.1)	(52.7)	(0)	(0)	(0.0)	(0.0)
18 Sep	6	439	39	14	17	31.9	38.7	0	0	0.0	0.0
19 Sep	6	4	0	(0)	(0)	NC	NC	(0)	(0)	NC	NC
20 Sep	7	303	27	(4)	(4)	(13.2)	(13.2)	(0)	(0)	(0.0)	(0.0)
21 Sep	8	731	65	6	18	8.2	24.6	0	0	0.0	0.0
26 Sep	9	32	3	(0)	(0)	NC	NC	(0)	(0)	NC	NC
30 Sep	10	150	13	(3)	(5)	NC	NC	(0)	(0)	NC	NC
02 Oct	11	57	8	(0)	(0)	NC	NC	(0)	(0)	NC	NC
03 Oct	11,12	343	48	1	1	2.9	2.9	0	0	0.0	0.0
07 Oct	13	83	12	(0)	(0)	NC	NC	(0)	(0)	NC	NC
08 Oct	13	11	2	(0)	(0)	NC	NC	(0)	(0)	NC	NC
Total		**4583**	**27**	**85**	**119**	**19.7**	**26.1**	**31**	**61**	**7.8**	**16.0**

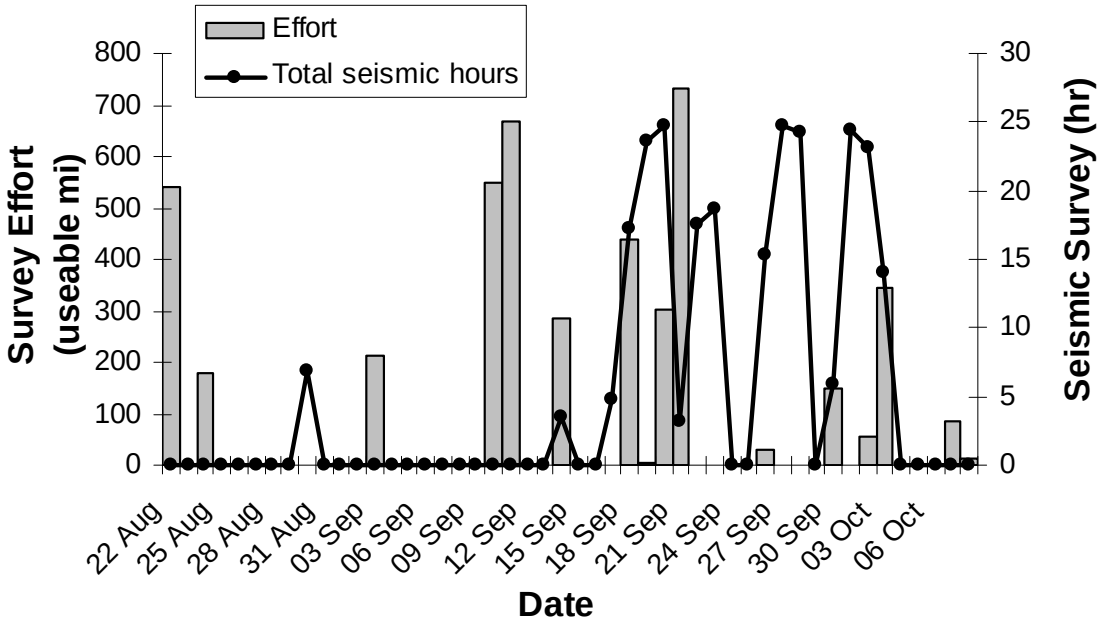


FIGURE D.71. Useable aerial survey effort (mi) and seismic survey effort (hr) in the Alaskan Beaufort Sea from 22 Aug through 8 Oct 2007.

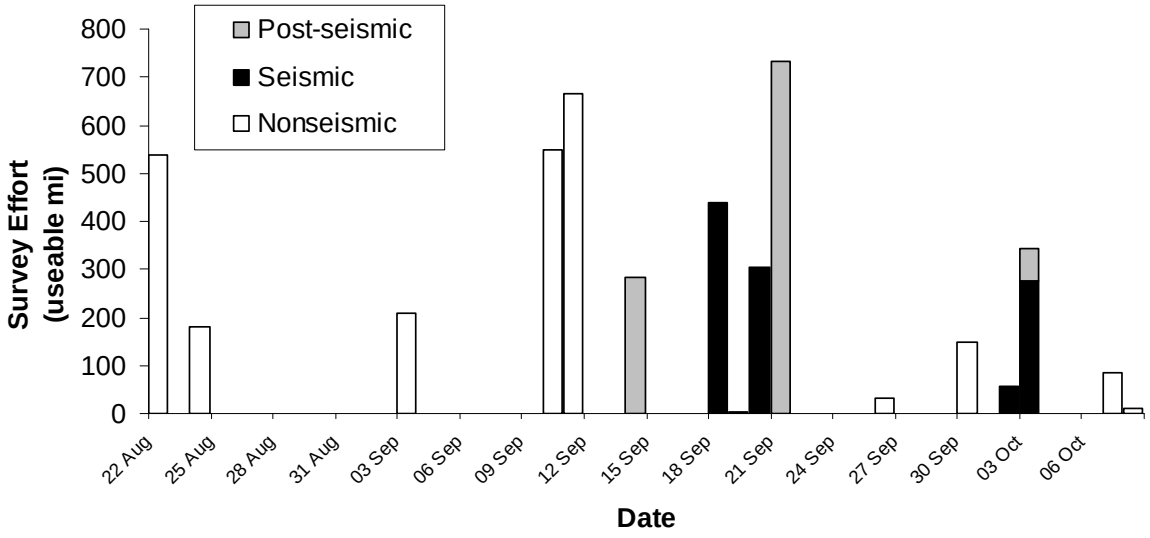


FIGURE D.72. Useable aerial survey effort (mi) by seismic state in the Alaskan Beaufort Sea from 22 Aug through 8 Oct 2007.

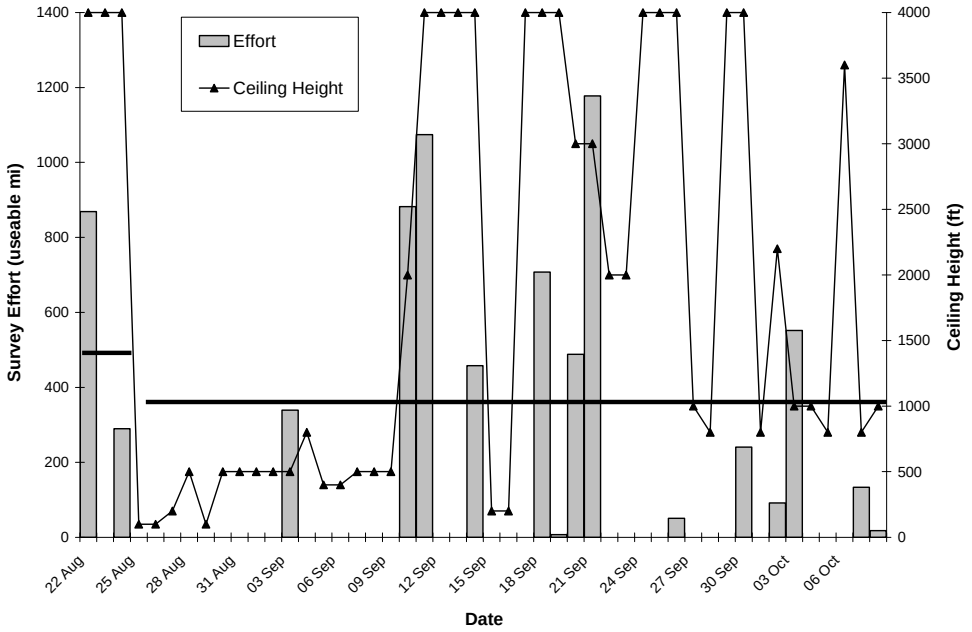


FIGURE D.73. Useable aerial survey effort (mi) and average daily cloud ceiling height (ft) (NWS 2007) from 22 Aug through 8 Oct 2007 in the central Beaufort Sea. Cloud ceiling height is a proxy for useable sighting conditions. Horizontal black bar indicates minimum survey altitude (1500 ft prior to issuance of IHA on 24 Aug and 1000 ft after 24 Aug).

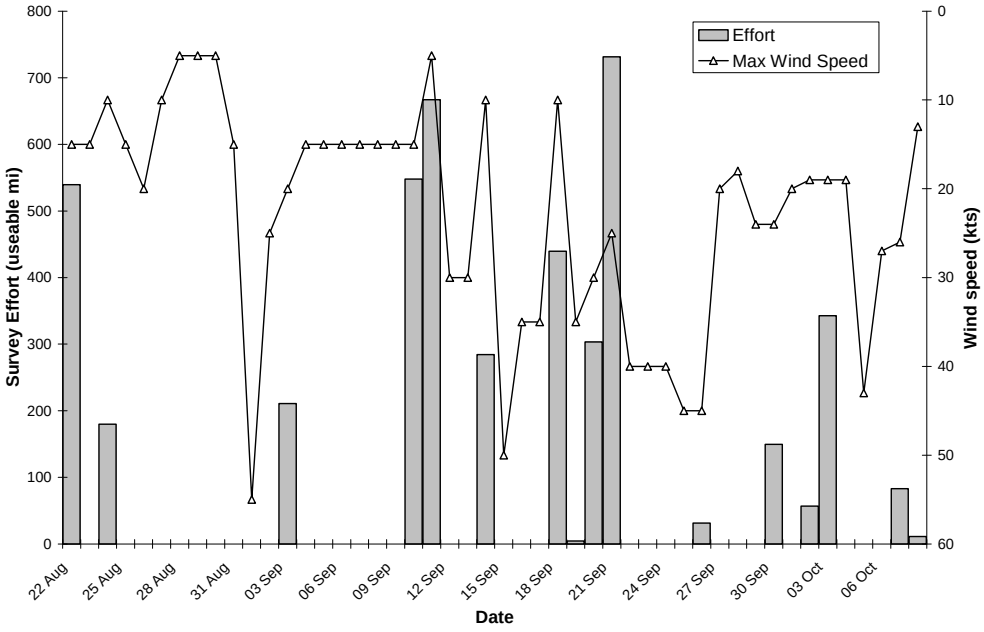


Figure D.74. Useable aerial survey effort (mi) and average daily wind speed (the inverse of wind speed is a proxy for useable sighting conditions) from 22 Aug through 8 Oct 2007 in the central Beaufort Sea.

TABLE D.51. Bowhead sightings and sighting rates in the Beaufort Sea by seismic state, 22 Aug- 8 Oct 2007.

			Seismic	Post-seismic	Non-seismic	Total
All sightings						
	All areas	Sightings	31	18	73	122
		Individuals	35	37	90	162
		Sightings/1000mi	28.7	16.6	30.2	26.6
		Individuals/1000mi	32.5	34.1	37.2	35.3
Useable sightings						
	All areas	Sightings	19	14	52	85
		Individuals	22	33	64	119
		Sightings/1000mi	17.6	12.9	21.5	18.5
		Individuals/1000mi	20.4	30.4	26.4	26.0
	West	Sightings	11	12	15	38
		Individuals	12	31	21	64
		Sightings/1000mi	28.8	29.1	15.4	21.5
		Individuals/1000mi	31.5	75.3	21.6	36.3
	Central	Sightings	5	2	21	28
		Individuals	7	2	23	32
		Sightings/1000mi	10.9	3.0	21.2	13.2
		Individuals/1000mi	15.3	3.0	23.2	15.1
	East	Sightings	3	--	16	19
		Individuals	3	--	20	23
		Sightings/1000mi	12.5	--	35.0	27.3
		Individuals/1000mi	12.5	--	43.8	33.0

TABLE D.52. Estimated numbers of bowhead whales in the Phoenix prospect area. Estimates calculated using DISTANCE software for each individual survey. Numbers in parentheses represent estimates that should be interpreted with caution due to low effort (<311 mi). No estimates were calculated when effort was less than 155 mi. Estimates include allowance for $f(0)$ (as calculated by DISTANCE) and $g(0)$ (value of 0.144 from Thomas et al 2002.).

Survey No.	Date in 2007	Effort (mi)	Sightings	Density (No./1000mi^2)	Est. No. Whales	95% C.I.	
1	22 Aug	540	4	29.7	109	32	365
2	24 Aug	180	4	(178.4)	(653)	163	2617
3	03 Sep	211	5	(152.4)	(916)	325	2582

TABLE D.53. Estimated numbers of bowhead whales in the Sivulliq prospect area. Estimates calculated using DISTANCE software for each individual survey. Numbers in parentheses represent estimates that should be interpreted with caution due to low effort (<311 km). No estimates were calculated when effort was less than 155 mi. Estimates include allowance for *f*(0) (as calculated by DISTANCE) and *g*(0) (value of 0.144 from Thomas et al 2002.).

Survey No.	Date in 2007	Effort (mi)	Sightings	Density (No./1000mi^2)	Est. No. Whales	95% C.I.	
4	10 Sep 11 Sep	1124	33	329.3	3047	1465	6338
5	11 Sep 14 Sep	376	11	463.7	4826	1513	15397
6	18 Sep 19 Sep	444	14	343.3	3176	1651	6109
7	20 Sep	303	4	(35.9)	(332)	(63)	(1755)
8	21 Sep	731	6	223.2	2065	323	13214
9	26 Sep	32		NC	NC	--	--
10	30 Sep	150	3	NC	NC	--	--
11	02 Oct 03 Oct	355	1	30.7	284	59	1364
12	03 Oct	45		NC	NC	--	--
13	07 Oct 08 Oct	94		NC	NC	--	--

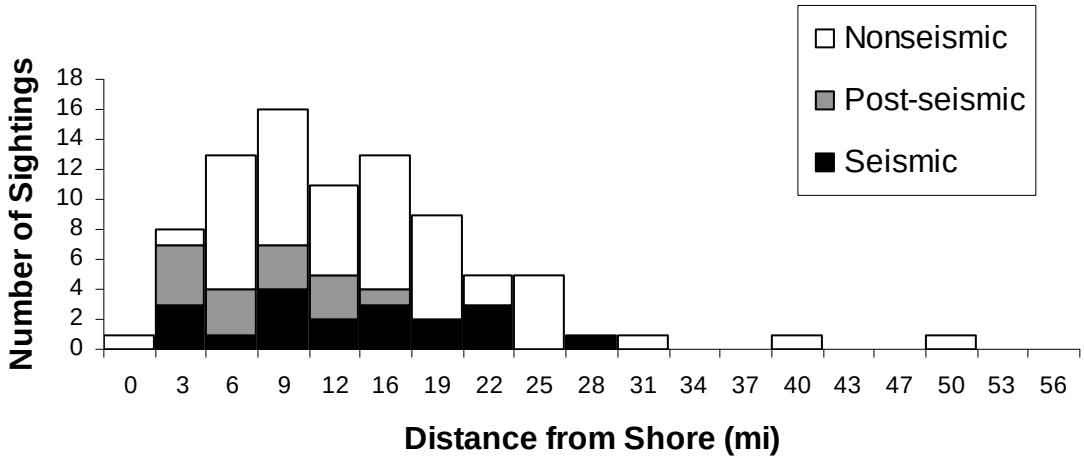
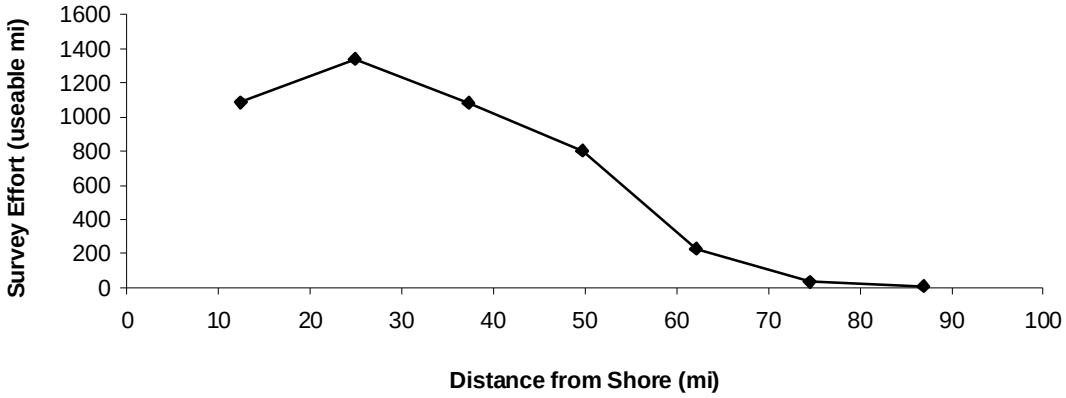


FIGURE D.76. Number of bowhead sightings from 22 Aug through 8 Oct 2007 in the central Beaufort Sea by 3-mi distance from shore intervals. Seismic state at the time of sighting is indicated by color.

(A)



(B)

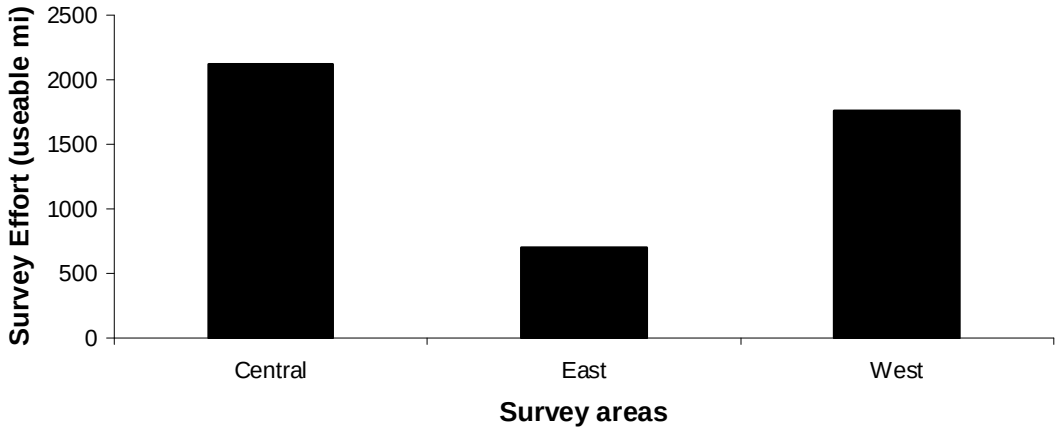


FIGURE D.77. Survey effort within the Beaufort Sea. (A) Total survey effort (mi) in the central Beaufort Sea over the period of 22 Aug through 8 Oct 2007, by 3-mi distance from shore intervals. (B) Total survey effort (mi) within survey areas over the period 22 Aug through 8 Oct 2007.

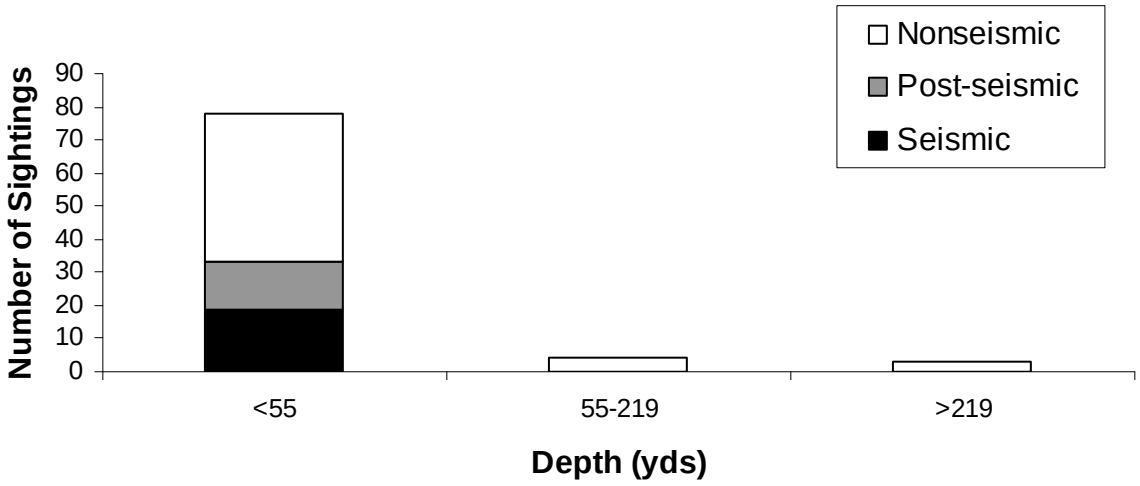


FIGURE D.78. Number of bowhead sightings in the central Beaufort Sea by depth categories with seismic state indicated by color. Data collected from 22 Aug through 8 Oct 2007.

TABLE D.54. Sighting rates (number of sightings/1000mi) of bowhead whales from 22 Aug through 8 Oct 2007 in the central Beaufort Sea by 3-mi distance from shore intervals. Data are presented by area and seismic state. Numbers in bold indicate maximum values. Effort is <311 mi for all bins, so rates should be interpreted with caution.

	West			Central			East			All		
Distance bin	**Seismic**	**Post**	**Non**	**Seismic**	**Post**	**Non**	**Seismic**	**Post**	**Non**	**Seismic**	**Post**	**Non**
3	82.1	84.9	0.0	0.0	0.0	9.9	0.0	--	0.0	42.2	**55.2**	4.8
6	27.3	62.5	**85.1**	0.0	0.0	41.8	0.0	--	0.0	9.6	32.2	48.8
9	**110.9**	41.4	0.0	0.0	21.3	26.0	36.9	--	253.4	**42.4**	31.5	**55.4**
12	35.9	**93.6**	0.0	0.0	0.0	61.2	**49.4**	--	32.0	27.9	42.3	28.0
16	0.0	0.0	35.1	**90.6**	**23.5**	**71.8**	0.0	--	23.6	36.0	14.4	45.6
19	54.9	0.0	74.2	24.0	0.0	37.6	0.0	--	0.0	23.6	0.0	47.0
22	34.0	0.0	0.0	40.4	0.0	33.3	38.9	--	0.0	37.6	0.0	11.5
25	48.2	0.0	0.0	0.0	0.0	0.0	0.0	--	**293.3**	0.0	0.0	37.7
28	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	19.9	0.0	0.0
31	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	36.0	0.0	0.0	7.0
34	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0	0.0	0.0
37	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0	0.0	0.0
40	0.0	0.0	15.8	0.0	0.0	0.0		--	0.0	0.0	0.0	7.4
43	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0	0.0	0.0
47	0.0		0.0	0.0	0.0	0.0		--	0.0	0.0	0.0	0.0
50	0.0		0.0	0.0	0.0	28.8	0.0	--	0.0	0.0	0.0	20.4
53	0.0			0.0	0.0	0.0		--	0.0	0.0	0.0	0.0
56			0.0	0.0	0.0	0.0	0.0	--	0.0	0.0	0.0	0.0
Average	**24.6**	20.2	13.1	9.1	2.6	**18.3**	8.9	--	**37.5**	14.1	10.3	**18.5**

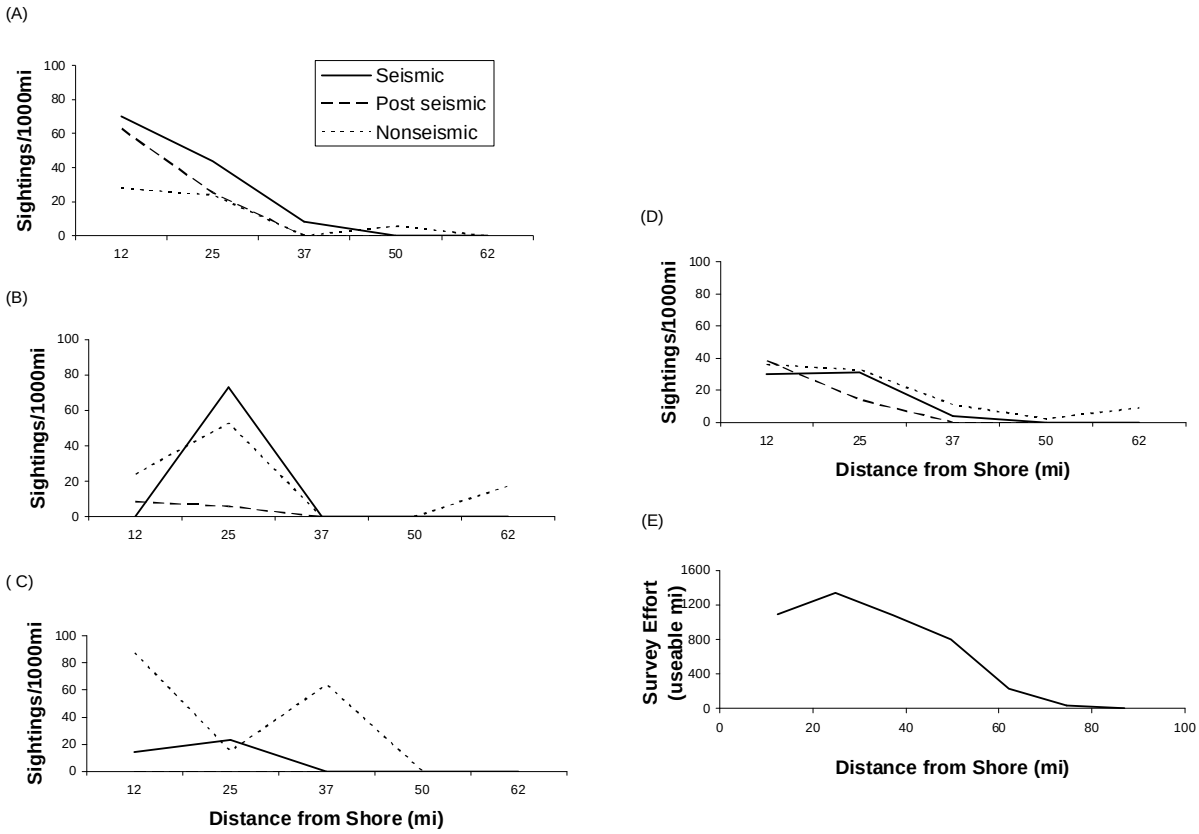


FIGURE 5.79. Bowhead sighting rates from 22 Aug through 8 Oct 2007 in the central Beaufort Sea by 12-mi distance from shore intervals. (A) western area, (B) central area, (C) eastern area, (D) all areas (E) survey effort within 12-mi distance from shore bins.

TABLE 5.56. Minimum, maximum and mean distance (mi) of bowheads in the central Beaufort Sea from center of then-current seismic patch over the period of 22 Aug through 8 Oct 2007.

	Patch locations	Type of sighting	*n*	Minimum Distance	Maximum distance	Mean Distance
A.	***All***	Seismic	19	6.5	50.4	34.8
		Post-seismic	14	18.4	48.0	33.0
		Nonseismic	52	7.6	49.2	28.0
B.	***Phoenix***	Seismic	0			
		Post-seismic	0			
		Nonseismic	13	42.6	7.6	17.6
C.	***Sivulliq***	Seismic	19	6.5	50.4	34.8
		Post-seismic	14	18.4	48.0	33.0
		Nonseismic	39	7.8	49.2	31.4

TABLE D.57. All seismic bowhead sightings in the central Beaufort Sea from 22 Aug through 8 Oct. Sightings in bold are sightings <20 km (12 mi) from the then current seismic patch.

Date in 2007	Time	Number	Array Type	On/Off Transect	Distance (mi) from center of seismic patch	Heading (°T)	Start of seismic	Time elapsed since start of seismic
18 Sep	16:31:21	1	Ramp-up	On	47	60	18-09-07 7:10	9:21:21
18 Sep	16:31:33	1	Ramp-up	On	47	--	18-09-07 7:10	9:21:32
18 Sep	17:02:20	1	Ramp-up	On	46	--	18-09-07 7:10	9:52:19
18 Sep	17:05:47	1	Ramp-up	On	43	90	18-09-07 7:10	9:55:46
18 Sep	17:06:09	1	Ramp-up	On	43	100	18-09-07 7:10	9:56:08
18 Sep	17:21:54	2	Ramp-up	On	37	--	18-09-07 7:10	10:11:53
18 Sep	17:29:57	1	Ramp-up	On	47	--	18-09-07 7:10	10:19:56
18 Sep	17:53:38	1	Ramp-up	Off	35	--	18-09-07 7:10	10:43:38
18 Sep	17:56:05	1	Ramp-up	Off	32	--	18-09-07 7:10	10:46:05
18 Sep	17:57:25	1	Ramp-up	On	32	40	18-09-07 7:10	10:47:25
18 Sep	17:59:09	1	Ramp-up	Off	31	--	18-09-07 7:10	10:49:09
18 Sep	18:01:24	1	Ramp-up	On	30	20	18-09-07 7:10	10:51:24
18 Sep	18:10:30	1	Ramp-up	Off	27	--	18-09-07 7:10	11:00:30
18 Sep	18:16:05	1	Ramp-up	On	33	--	18-09-07 7:10	11:06:05
18 Sep	18:43:40	1	Ramp-up	Off	24	--	18-09-07 7:10	11:33:40
18 Sep	18:43:48	1	Ramp-up	Off	24	--	18-09-07 7:10	11:33:48
18 Sep	18:43:50	1	Ramp-up	Off	24	--	18-09-07 7:10	11:33:50
18 Sep	18:44:15	1	Ramp-up	On	23	--	18-09-07 7:10	11:34:15
18 Sep	18:44:37	1	Ramp-up	On	23	--	18-09-07 7:10	11:34:37
18 Sep	18:44:57	2	Ramp-up	On	23	20	18-09-07 7:10	11:34:57
18 Sep	18:47:03	1	Ramp-up	Off	21	--	18-09-07 7:10	11:37:03
18 Sep	**19:36:43**	**1**	**Full array**	**Off**	**11**	**90**	**18-09-07 7:10**	**12:26:43**
18 Sep	**19:49:45**	**2**	**Full array**	**Off**	**5**	**--**	**18-09-07 7:10**	**12:39:45**
18 Sep	**19:51:48**	**2**	**Full array**	**On**	**7**	**260**	**18-09-07 7:10**	**12:41:48**
18 Sep	20:17:41	1	Full array	Off	34	230	18-09-07 7:10	13:07:41
18 Sep	20:18:18	1	Full array	Off	35	170	18-09-07 7:10	13:08:18
20 Sep	10:56:44	1	Ramp-up	On	50	180	18-09-07 7:10	51:06:44
20 Sep	11:53:03	1	Full array	On	41	68	18-09-07 7:10	52:03:03
20 Sep	12:59:17	1	Full array	On	30	68	18-09-07 7:10	53:09:17
20 Sep	13:39:45	1	Full array	On	25	360	18-09-07 7:10	53:49:45
03 Oct	12:13:51	1	Ramp-up	On	34	315	30-09-07 18:45	65:28:51

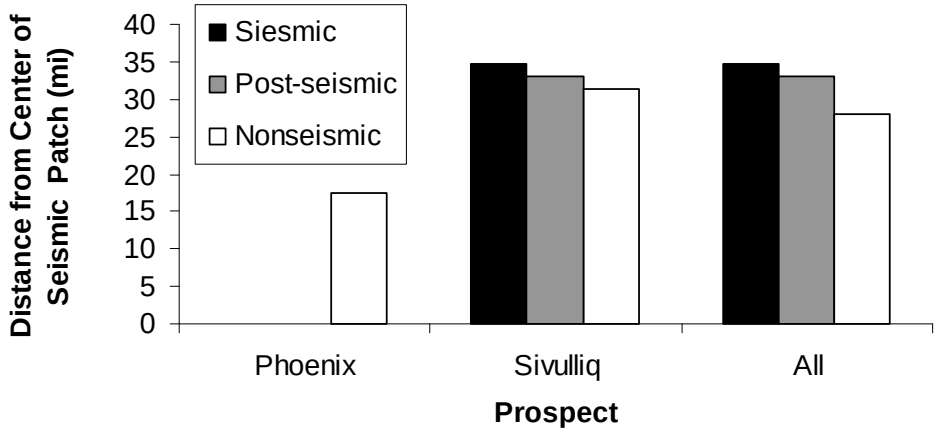


FIGURE D.80. Average distance (km) from the center of the then-current seismic patch of bowhead whales in the central Beaufort Sea from 22 Aug through 8 Oct 2007.

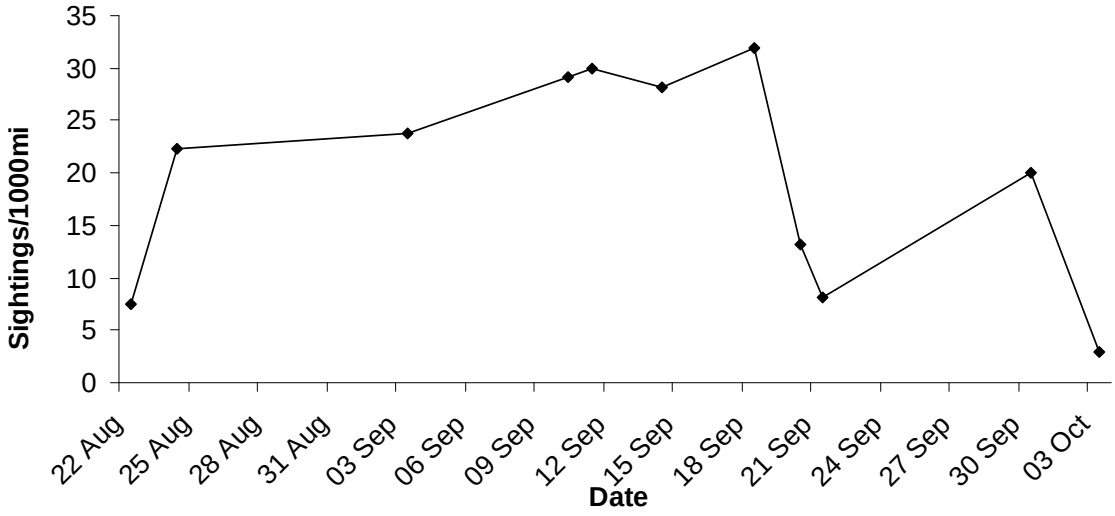


FIGURE 5.82. Daily sighting rates of bowheads in the central Beaufort Sea from 22 Aug through 8 Oct 2007.

APPENDIX E: DETAILS OF MONITORING, MITIGATION, AND ANALYSIS METHODS

This appendix provides details on the standard visual and acoustic monitoring methods and data analysis techniques implemented for this project and previous seismic studies. Four marine mammal observers (MMOs) were aboard the *Gilavar* throughout the cruise. Two MMOs were biologists experienced in marine mammal identification and observation methods. The other two MMOs were Inupiat with various levels of experience identifying arctic marine mammals. In addition to the MMOs onboard the *Gilavar*, SOI placed 2-3 MMOs on each of the chase and support vessels. MMOs generally worked 2-4 hr shifts for up to 12 hrs per day during a 6-week shift before being replaced by other MMOs.

All MMOs participated in safety training and a 1-2 d course, depending on previous MMO experience, designed to familiarize them with the operational and data recording procedures, reporting protocols, and IHA stipulations. The IHA stipulations and requirements were also explained to the Operations Manager and Head Airgun Operator aboard the *Gilavar* during a meeting prior to seismic operations. MMO duties included

- recording environmental and sighting conditions;
- searching for and identifying marine mammals, and recording their numbers, distances from the vessel, and behavior;
- recording possible reactions of marine mammals to the seismic operations; and
- initiating mitigation measures when appropriate.

Visual Monitoring for Marine Mammals

Vessel-based observers monitored marine mammals from the seismic source vessel (*Gilavar*) during all daytime seismic operations, and during any nighttime power ups of the airgun(s), as specified in the IHAs. MMOs onboard the chase vessels also monitored marine mammals during much of the time that seismic operations were occurring. Seismic operations were suspended or amended when marine mammals were observed within, or about to enter, designated safety zones described in the IHAs. In general, vessel-based observations for marine mammals were conducted using the following guidelines:

- Observations during daylight hours were conducted in good and poor visibility whenever the airgun(s) were operating, and by two observers when possible, unless precluded by safety considerations.
- MMOs observed during transit periods without airgun operations, at the discretion of the lead MMO, to obtain baseline data on marine mammal distribution and (in the case of less experienced observers) to become more familiar with observation protocols.
- Two MMOs observed for 30 min prior to the planned start of seismic operations after an extended shut down and the entirety of the ≥180 dB radius was required to be visible for those 30 min.
- When the airgun array was powered up at night, two MMOs watched for marine mammals, using night vision devices, for 30 min prior to start up. (Note that there was 24-hour daylight until late August.)
- At least one MMO was on stand-by during ongoing seismic operations at night, but was not necessarily on watch.
- Bridge personnel watched for marine mammals during seismic operations at night and were required to call for the airgun(s) to be shut down if a marine mammal was observed within or

about to enter the applicable safety zone. Bridge personnel also notified the MMO on stand-by if marine mammals were observed in or about to enter the safety radii.

- MMOs also recorded locations and movements of vessels when on watch; information regarding vessels as well as marine mammals was recorded in a database.

The MMOs used the bridge of the *Gilavar* as an observation platform, where the observer's eye level was ~9 m above sea level (ASL). When two MMOs were on duty on the bridge simultaneously, they worked on opposite sides of the bridge unless safety or weather conditions precluded such observations.

From the duty station, MMO(s) systematically scanned the area around the vessel in a sweeping pattern, usually alternating scan sweeps between reticle binoculars (e.g., Fujinon 7 × 50) and the unaided eye during the daytime. Observations were focused and centered forward and to the sides of the vessel in an arc of ~210º, but MMOs also regularly checked for the presence of marine mammals astern of the vessel. Night vision devices were used during non-daylight hours using a similar sweep search pattern.

MMOs were generally on duty for shifts up to 4 hr, with a 2–4 hr break between shifts, depending on the number of observers available and the number of daylight hours. Each MMO was generally on duty for 8–10 hr per day. The duration of a single visual shift was no longer than 4 hr to minimize observer fatigue. Use of two observers simultaneously was desirable and was scheduled when possible to increase detection of marine mammals near the source vessel. In addition to the dedicated MMOs, bridge personnel were instructed and assisted in detecting marine mammals, implementing mitigation requirements, and collecting data when possible.

While on watch, MMOs kept systematic written records of the vessel's position, activity, and environmental conditions using codes that were entered either onto a datasheet and later transcribed onto an Excel spreadsheet, or entered directly into a database using a hand-held computer. Vessel and environmental data were recorded onto the datasheet every 30 min or whenever conditions changed significantly. Additional data were recorded when marine mammals were observed. For all records, the date and time, vessel position (longitude and latitude), and environmental conditions were recorded. The database was constructed to prevent entry of out-of-range values and codes. Data entries were checked manually by comparing listings of the computerized data with the original handwritten datasheets, both in the field and upon later analyses.

The following information was recorded for each marine mammal sighting: date, time, species, total number of individuals, number of juveniles, bearing relative to vessel's heading, direction of movement relative to the vessel, distance from the vessel, behavior when sighted, whether animal was in the water or hauled out on ice or land, behavioral pace, reaction to the vessel, vessel position, water depth, observer initials, species identification reliability, and the time that mitigation measures were requested (if necessary). On the seismic vessel, distance to marine mammals was measured from the MMO's location on the bridge rather than from the nominal center of the seismic source. The distance of the animal from the airgun array was calculated using a GIS during data error checking and processing at the end of the season. However, for sightings near or within the safety radius in effect at the time, the distance from the marine mammal to the nearest airgun was estimated and recorded for the purposes of implementing power downs or shut downs. The bearing from the vessel to individual or groups of marine mammals was estimated using positions on a clock face, with the bow of the vessel considered to be 12 o'clock and the stern 6 o'clock.

Operational activities that were recorded by MMOs onboard the seismic vessel included the number of airguns in use, total volume of the airguns, and the type of vessel/seismic activity. Intra-ship communication between seismic technicians and MMOs was conducted via radio or telephone and used

to alert MMOs of any changes in operations, and to request power or shut downs by MMOs. The position of the vessel was logged every 60 sec by the ships navigational system and these data were integrated with the marine mammal database to check for data recording errors. Details regarding the seismic activities (start and stop times, number of guns firing, etc.) was collected from the airgun operators log and also used to error check MMO data.

Marine Mammal Mitigation During Operations

The following mitigation measures were adopted for marine mammal sightings during the proposed seismic program, provided that doing so did not compromise operational safety requirements: ramp ups, power ups, shut downs, power downs, and course alterations.

Ramp Up

A ramp up is a process commonly used by seismic vessels with large airgun arrays that involves a gradual increase in the number of airguns firing from none or one airgun until the full array is active. In this report, a ramp up from no airguns firing is simply called a **ramp up**. However, when a ramp up was initiated while the single "mitigation" airgun had been firing it is referred to as a **power up**. The reason for the different terms, as described further below, is that a ramp up can not be initiated during times when the full safety radii are not visible to MMOs for 30 minutes while a power up can be initiated during times when the full safety radius is not visible because the mitigation gun has been firing.

Daylight Procedure.—During daylight hours, a ramp up or power up was required when the full airgun array had not been operating for a period of >10 min. A 30 min watch period performed by at least two MMOs was required prior to a ramp up. The entire ≥180 dB safety radius for the full array must be visible for the entire 30-min pre-ramp up observation period before the ramp-up could commence. However, if the mitigation airgun had been operating during the break in full array activity, then a power up could be initiated at any time provided two MMOs were on active watch during the power up. If the airguns had been shut down or powered down because of the presence of a marine mammal within or near the applicable safety radius, a ramp up or power up could not begin until that safety radius was clear of marine mammals. Following a marine mammal sighting the safety radius was considered clear when the marine mammal was observed to exit safety radius, or if no marine mammals were seen in the safety radii for 15 min (for small odontocetes and pinnipeds) or 30 min (for mysticetes and large odontocetes). If a marine mammal was observed within the applicable safety radius during the 30-min pre-ramp up observation period, the airgun operator was informed and the ramp up was postponed.

Ramp ups of the airgun array began with firing a single airgun. The number of airguns firing was then increased at a rate no greater than an increase of ~6 dB per 5-min period. During a power up the same procedure was applied by increasing the number of operating guns from the single "mitigation" gun to the full array. During a ramp up or power up, the safety zone for the full airgun array was maintained even though fewer airguns were operating.

MMOs informed the airgun operators when ramp up could proceed. If a marine mammal was observed within its applicable safety radius during the 30-min observation period, or during the ramp up, the bridge and airgun operators were informed, as usual, of any necessary mitigation measures (power down, shutdown).

Darkness Procedures.—During hours of darkness, ramp up could commence only if the entire ≥180 dB safety radius for the full array was visible to MMOs for 30 min using either the unaided eye or night-vision devices (unlikely with very large safety radii). However, similar to daylight periods with

poor visibility conditions, a power up could commence at night even if the full array ≥180 dB radius was not visible.

Power Down

A power down is a reduction in the number of operating airguns (usually from all airguns firing to a single mitigation gun firing). If marine mammals were detected outside the applicable safety radius of the full airgun array but were likely to enter the safety radius (i.e., if the mammals were moving towards the vessel or if the vessel was moving in the direction of the mammals), and if the vessel's course or speed could not be changed to avoid having the mammals enter the safety radius, the airgun array was powered down to the single mitigation airgun before the mammals were within the full array safety radius. Likewise, if a mammal was first observed already within the full array safety radius, the airguns were immediately powered down. The single airgun continued firing at a source level of at least 180 dB re 1 μPa-m (rms) during the interruption of full array seismic operations. A shut-down (see below) was implemented only if a marine mammal was detected within or about to enter the smaller safety zone around the mitigation airgun. Full airgun activity did not resume (via a power up) until the marine mammal had cleared the safety zone for the full array.

Shut Down

A shut down is the cessation of all airgun activity, including the single mitigation airgun. If a cetacean or pinniped was detected within or about to enter the applicable safety radius of the mitigation gun, the airgun was shut down. After a shut down, the animal must have cleared the safety zone before start up procedures could begin. If the mitigation airgun was shut down for >10 min and no observer was on duty, then at least 30 min of observation by two MMOs was necessary prior to ramp up. MMOs informed the bridge when ramp up of the airgun(s) could proceed.

Course Alteration

If a marine mammal was detected outside the applicable safety radius and, based on its position and direction of travel, was likely to enter the safety radius, one possible mitigation measure was to adjust the ship track and/or speed to avoid close approach to the mammal. However, given the presence of the streamer(s) and airgun(s) behind the vessel, the turning rate of the vessel while this gear is deployed is limited, and course alteration is generally not a practical mitigation method for a seismic vessel. Instead, the marine mammal's activities and movements relative to the seismic vessel were closely monitored. If the mammal appeared likely to enter the safety radius, further mitigation actions were taken, i.e., power or shut down of the airgun(s).

Analyses

Vessel Based Monitoring

This section describes the analyses of the marine mammal sightings and survey effort recorded during this project. It also describes the methods used to calculate densities and estimate the number of marine mammals potentially exposed to airgun sounds associated with SOI's seismic and shallow-hazards surveys.

The sightings and effort data were grouped into three categories to assess potential effects of seismic sounds on marine mammals. The categories were "seismic" (1 or more airguns operating and up to 3 minutes after airguns stopped firing), "post-seismic" (3 min to 1h for pinnipeds and 2 h for cetaceans

after the airguns were turned off), and "non-seismic" (periods before seismic started or >1 or >2 h after airguns were turned off for pinnipeds and cetaceans, respectively). Unless specifically stated otherwise, comparison of seismic and non-seismic periods excluded the post seismic period. The justification for the selection of these criteria was based on the size of the array in use and is provided below. These criteria were also used and discussed in previous reports to NMFS (see Haley and Koski 2004; Smultea et al. 2004, 2005; MacLean and Koski 2005; Holst et al. 2005a,b):

- Mammal distribution and behavior during the short period up to 3 min after the last seismic shot are assumed to be similar to those while seismic surveying is ongoing.
- It is likely that any marine mammals near the vessel between 3 min and 30 min after the cessation of seismic activities would have been "recently exposed" (i.e., within the past 30 min) to sounds from the seismic survey. During at least a part of that period, the distribution and perhaps behavior of the marine mammals may still be influenced by the (previous) sounds.
- For some unknown part of the period from 30 min to 1 or 2 h post-seismic, it is possible that the distribution of the animals near the ship, and perhaps the behavior of some of those animals, would still be at least slightly affected by the (previous) seismic sounds.
- By 1 or 2 h after the cessation of seismic operations, the distribution and behavior of pinnipeds and cetaceans, respectively, would be expected to be indistinguishable from "normal" because of (a) waning of responses to past seismic activity, (b) re-distribution of mobile animals, and (c) movement of the ship and thus the MMOs. Given those considerations, plus the limited observed responses of most marine mammals to seismic surveys (e.g., Stone 2003; Smultea et al. 2004; Haley and Koski 2004; MacLean and Koski 2005; Holst et al. 2005a,b), it is unlikely that the distribution or behavior of marine mammals near the vessel > 1 or 2 h post-seismic would be appreciably different from "normal" even if they had been exposed to seismic sounds earlier. Therefore, we consider animals seen >1 or 2 h after cessation of seismic operations to be unaffected by the (previous) seismic sounds.

As summarized in Chapter 5, marine mammal density was one of the variables examined to assess differences in the distribution of marine mammals relative to the seismic vessel between seismic and non-seismic periods. Densities were calculated using line-transect procedures for vessel-based surveys. To allow for animals missed during daylight, we corrected our visual observations using correction factors calculated with these procedures.

Corrections for Sightability.— As was standard for line-transect estimation procedures, corrections for the following two parameters were included in the calculation of densities:

- $g(0)$, a measure of detection bias. This factor allows for the fact that less than 100% of the animals present along a transect line are detected.
- $f(0)$, the reduced probability of detecting an animal with increasing distance from a transect line.

Where species-specific values did not exist, values for similar species were used. The $g(0)$ values for gray whales and bowhead whales were taken from previously calculated values for gray whales and right whales respectively. The $g(0)$ values for pinniped species observed during this study were taken from values calculated previously for pinniped species off California. Other correction factors were extracted from species-specific $g(0)$ tables produced for previous studies.

The $f(0)$ factors used in the analysis were calculated from observations made during this study when enough data were available. The sightings from all vessels involved in this study were combined to achieve the largest sample size possible and to minimize the number of $f(0)$s calculated. Only non-

seismic period sightings that were made during useable effort (good sighting conditions) were used for the calculations. These sightings were imported into DISTANCE 4.1 where the *f*(0) values were calculated separately for each species or species group. The default analysis method was conventional distance sampling with a half-normal model and cosine expansion with no stratification. As very few sightings were of large groups of animals, we simply used the ratio of *f*(0)s between group sizes of 1–16, 17–60 and >60 individuals used in previous studies to estimate the appropriate *f*(0)s for the two larger group categories.

Number of Individuals Exposed.—Estimates of the number of individual marine mammals potentially exposed to sound levels ≥160 dB re 1 µPa (rms) were calculated by multiplying the area of water ensonified to that level by the density of marine mammals estimated by line transect methods. The area of water ensonified was calculated using MapInfo Geographic Information System (GIS) software to create a "buffer" that extended around the vessel's trackline to the predicted ≥160 dB distance. The area of water covered by the buffer was calculated two different ways: 1) "Including Overlap Area" is the area of water ensonified to ≥160 dB where areas exposed on more than one occasion (as a result of crossing tracklines or tracklines that were close enough for their ≥160 dB zones to overlap) were counted repeatedly each time they were exposed; and 2) "Excluding Overlap Area" was the area of water that was exposed to airgun sounds ≥160 dB where areas exposed on more than one occasion were counted only once.

Number of Exposures per Individual.—The estimated number of potential exposures per individual is the ratio of the two area calculations described above and represents the average number of times a given area of water was exposed to sound levels ≥160 dB.

Aerial Monitoring—Beaufort Sea

Details of the aerial survey monitoring methods are presented in Chapter 4.

APPENDIX F: BACKGROUND ON MARINE MAMMALS IN THE CHUKCHI AND BEAUFORT SEAS

TABLE F-1. The habitat, abundance and conservation status of marine mammals inhabiting the project areas.

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	I
Narwhal (*Monodon monoceros*)	Offshore, Ice edge	Rare[6]	Not listed	DD	II
Killer whale (*Orcinus orca*)	Widely distributed		Not listed	LR-cd	II
Harbor Porpoise (*Phocoena phocoena*)	Coastal, inland waters	Extralimital	Not listed	VU	II
Mysticetes					
Bowhead whale (*Balaena mysticetus*)	Pack ice & coastal	10,545[7]	Endangered	LR-cd	I
Gray whale (*Eschrichtius robustus*) (eastern Pacific population)	Coastal, lagoons	488[8] 17,500[9]	Not listed	LR-cd	I
Minke whale (*Balaenoptera acutorostrata*)	Shelf, coastal	0	Not listed	LR-cd	I
Humpback whale (*Megaptera novaeangliae*)	Mainly near-shore and banks	2036[10] 4005[11] 2866[12] >6000[13]	Endangered*	VU	I
Fin whale (*Balaenoptera physalus*)	Slope, mostly pelagic	0	Endangered	EN	I
Pinnipeds					
Walrus (*Odobenus rosmarus*)		188,316[14]	Not listed	–	II
Bearded seal (*Erignathus barbatus*)	Pack ice	300,000-450,000[15] 4863[16]	Not listed	–	–
Spotted seal (*Phoca largha*)	Pack ice	1000[17]	Not listed	–	–
Ringed seal (*Pusa hispida*)	Landfast & pack ice	Up to 3.6 million[18] 245,048[19] 326,500[20]	Not listed	–	–
Ribbon seal (*Histriophoca fasciata*)	Ice	100,000[21]	Not listed	N.A.	–
Carnivora					
Polar bear (*Ursus maritimus*)	Coastal, ice	>2500[22] 15,000[23]	Not listed	LR-cd	–

[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] Abundance of bowheads surveyed near Barrow, as of 2001 (George et al. 2004); revised to 10,545 by Zeh and Punt (2005).

[8] Southern Chukchi Sea and northern Bering Sea (Clark and Moore 2002).
[9] North Pacific gray whale population (Rugh 2003 *in* Keller and Gerber 2004) ; see also Rugh et al. (2005).
[10] All feeding aggregations (Angliss and Lodge 2004).
[11] Abundance estimate for the central North Pacific stock (Calambokidis et al. 1997).
[12] Northern GOA and Aleutian Islands (Zerbini et al. 2004).
[13] North Pacific (Calambokidis and Barlow 2004).
[14] Pacific walrus population (USFWS 2000).
[15] Alaska population (USDI/MMS 1996).
[16] Eastern Chukchi Sea population (NMML, unpublished data).
[17] Alaska Beaufort Sea population (USDI/MMS 1996).
[18] Alaska estimate (Frost et al. 1988 *in* Angliss and Lodge 2004).
[19] Bering/Chukchi Sea population (Bengston et al. 2000).
[20] Alaskan Beaufort Sea population estimate (Amstrup 1995).
[21] Estimate for Bering Sea (Burns 1981); current estimate is unavailable.
[22] Amstrup et al. (2001).
[23] NWT Wildlife and Fisheries, http://www.nwtwildlife.rwed.gov.nt.ca/Publications/speciesatriskweb/polarbear.htm
* Listed as a strategic stock under the U.S. Marine Mammal Protection Act

APPENDIX G: CONFLICT AVOIDANCE AGREEMENT

Addendum Between AEWC, Village of Nuiqsut and Shell Offshore, Inc. to the 2007 Open Water Season Programmatic Conflict Avoidance Agreement

July 24, 2007

The parties to this Addendum, AEWC, Village of Nuiqsut and Shell Offshore, Inc. (hereinafter "Parties") agree to the following amendments to the Conflict Avoidance/Mitigation Agreement dated February 27, 2007. The Parties agree to amend section IV.B.2.a. "Drilling Operations – Beaufort-Sea East of Cross Island" as follows:

2. Drilling Operations

   a. Shell Offshore, Inc. agrees to cease drilling operations beginning August 25, 2007, and agrees further to relocate all equipment and related vessels offsite no later than August 27, 2007. However, such equipment and vessels may remain within the Beaufort Sea north of 71.25 N or at the edge of the arctic ice pack whichever is closer to shore, and west of 146.4 W.

The parties agree on the need for a long-term solution to open water season conflicts between oil and gas operators and marine mammal hunters that meets oil and gas exploration and production goals, while preserving the Beaufort Sea marine mammal habitat and hunting areas for Arctic subsistence communities and for the marine resources on which they depend. Given mutual recognition of this need, the Parties agree to engage in formal discussion following the close of the 2007 bowhead whale subsistence hunt and operating season.

SIGNATORIES

Harry Brower Jr. 7/24/07
Chairman, AEWC
Dated:

Executive Vice President
Shell EP Americas
Dated: 7/24/07

Billy Oyagak
President of Whaling Captains Ass'n
of Nuiqsut
Dated: 07-24-07

2007 OPEN WATER SEASON
PROGRAMMATIC CONFLICT AVOIDANCE AGREEMENT

BETWEEN

BPXA
SHELL OFFSHORE, INC
FEX L.P.
GX TECHNOLOGY CORPORATION
PIONEER NATURAL RESOURCES ALASKA, INC.

AND

THE ALASKA ESKIMO WHALING COMMISSION
THE BARROW WHALING CAPTAINS' ASSOCIATION
THE NUIQSUT WHALING CAPTAINS' ASSOCIATION
THE KAKTOVIK WHALING CAPTAINS' ASSOCIATION
THE WAINWRIGHT WHALING CAPTAINS' ASSOCIATION
THE PT. HOPE WHALING CAPTAINS' ASSOCIATION

February 27, 2007

DRAFT ONE

TABLE OF CONTENTS

I. INTRODUCTION

This Conflict Avoidance/Mitigation Agreement is intended to apply to all: Vessel Traffic; Ice Management Traffic; Exploratory Drilling; Well Cellar Operations; Geophysical Operations, including Seismic, Site Clearance, and Bathymetry Surveys; Production Operations; and all related Work to be undertaken by the INDUSTRY PARTICIPANTS (defined below) During the 2007 OPEN WATER SEASON in the BEAUFORT and/or CHUKCHI SEAS.

Vessels and locations covered by this Agreement include those identified in the Agreement, as well as any others that are employed by or for the Industry Participants in the Beaufort and/or Chukchi Seas during the 2007 summer and fall open water season.

All parties identified in the Agreement by name and whose representative(s) has signed the Agreement, including all contractors of such parties, are referred to in this document, jointly, as the "Participants" or where appropriate as the "Industry Participants" or the "Subsistence Participants". Any and all other entities who later become parties to this Agreement or whose activities become subject to this Agreement are referred to in this document as the "Covered Parties". Unless otherwise specified, the term "Industry Participant" shall include such Covered Parties and such Covered Parties shall be subject to all terms and conditions of this Agreement that apply to the Industry Participants.

The Participants agree that the mitigation measures identified in the Agreement, which are intended to mitigate the potential impacts of oil and gas exploration, drilling, seismic, development, or production and related activities on marine mammals, including migrating bowhead whales and the Alaskan Eskimo subsistence hunt of those whales, are designed to apply to all activities of each Participant during the 2007 summer and fall open water season, whether referenced specifically or by category, and to all Vessels and locations covered by this Agreement, whether referenced specifically or by category.

II. GENERAL TERMS AND CONDITIONS

A. STATEMENT OF PURPOSE

The purpose of this Agreement is to provide:

1. Equipment and procedures for communications between Subsistence Participants and the Industry Participants; and

2. Avoidance guidelines and other mitigation measures to be followed by the Industry Participants working in or transiting the vicinity of active

subsistence whaling crews, or in areas where subsistence whaling crews anticipate hunting, or in areas that are in sufficient proximity to areas expected to be used for subsistence hunting that the planned activities could potentially affect the subsistence hunt through effects on migrating bowhead whale behavior.

3. Additional Provisions of the Agreement:

   a. measures to be taken in the event of an emergency occurring during the term of this Agreement; and

   b. dispute resolution procedures.

B. LIMITATIONS OF OBLIGATIONS

1. No cooperation among the Participants, other than that required by this Agreement, is intended or otherwise implied by their adherence to this Agreement. In no event shall the signatures of any representative of the Alaska Eskimo Whaling Commission (AEWC), or of the Barrow, Nuiqsut, Kaktovik, Wainwright and Pt. Hope Whaling Captains' Associations, or of any other Whaling Captains' Association be taken as an endorsement of any Arctic or Beaufort or Chukchi Sea OCS operations by any oil and/or gas operator or contractor.

2. Adherence to the procedures and guidelines set forth in this document does not in any way indicate that any Inupiat or Siberian Yupik whalers or the AEWC agree that industrial activities are not interfering with the bowhead migration or the bowhead subsistence hunt. Such adherence does not represent an admission on the part of the Industry Participants or their contractors that the activities covered by this Agreement will interfere with the bowhead migration or the bowhead subsistence hunt.

3. No member of the oil and gas industry or any contractor has the authority to impose restrictions on the subsistence hunting or any other activities of the AEWC, residents of the Villages of Nuiqsut, Kaktovik or Barrow, or residents of any other village represented by the AEWC.

4. In the event additional parties from the oil and gas industry operate in the Beaufort Sea during the summer or fall of 2007 the Participants shall exercise their good-faith efforts to bring those parties into this Agreement. Should additional parties enter into this Agreement at a date subsequent to the date of the signing of this document and before the termination of the 2007 bowhead subsistence whale hunting season, the Participants will provide to all signatories a supplement to this document containing the added signatures.

5. No Participant is responsible for enlisting additional parties to adhere to the terms and conditions of this Agreement. Similarly, **THE AEWC IS NOT RESPONSIBLE FOR, OR A PARTY TO, ANY AGREEMENT AMONG MEMBERS OF THE OIL AND GAS INDUSTRY** who are Participants in this Agreement or other Covered Parties, concerning the apportionment of expenses necessary for the implementation of this Agreement.

6. In adhering to this Agreement, neither the Participants nor any Covered Party waives any rights existing at law. All Participants agree that the provisions of this document do not establish any precedent as between them or with any regulatory or permitting authority.

7. PARTICIPANTS' OBLIGATIONS SHALL BE SEPARABLE: All Participants to this Agreement understand that each Participant represents a separate entity. The failure of any Participant to adhere to this Agreement or to abide by the terms and conditions of this Agreement shall not affect the obligation of other Participants to adhere to this Agreement and to proceed accordingly with all activities covered by this Agreement. Nor shall any Participant's adherence to this Agreement affect that Participant's duties, liability, or other obligations with respect to any other Participant beyond those stated in this Agreement.

C. OIL AND GAS INDUSTRY VESSELS AND EQUIPMENT

The only vessels or other equipment, including but not limited to boats, barges, aircraft, or similar craft, that are owned and/or operated by, or that are under contract to the Industry Participants, for use in the Beaufort and/or Chukchi Seas during the Term of this Agreement are those:

1. for and in support of each of the Industry Participant's operations as identified, if and only if an IHA (defined below) application has been made, within the Industry Participant's 2007 petition for an Incidental Harassment Authorization pursuant to Section 101 (a)(5)(D) of the Marine Mammal Protection Act (IHA), and as submitted to the U.S. National Marine Fisheries Service (NOAA Fisheries) and as listed in Attachment II of this Agreement; and

2. for and in support of the Monitoring Plans are those identified, if and only if an IHA application has been made, within each Industry Participant's petition for an IHA, submitted to the NOAA Fisheries and listed in Attachment III, III-a and III-b of this Agreement.

The vessels and other equipment identified in 1. and 2. above are referred to in this Agreement as "the Vessels".

NONE OF THE INDUSTRY PARTICIPANTS INTENDS TO OPERATE ANY OTHER VESSEL FOR THESE OR ANY OTHER PURPOSES IN THE BEAUFORT OR CHUKCHI SEAS DURING THE TERM OF THIS AGREEMENT. However, if any Industry Participant decides to use different vessels or equipment or additional vessels or equipment, such vessels and equipment shall be used only for purposes identified in Attachments II or III; and the AEWC and the whaling captains of Nuiqsut, Kaktovik, Barrow, Wainwright and Pt. Hope shall be notified promptly through the appropriate Communications System Coordination Center (Com-Center), as identified in Section III. B. of this Agreement, and in writing, of their identity and their intended use, including location of use.

D. SUBSISTENCE WHALE HUNTING BOATS

1. Boats Owned/Used by Whaling Captains of Nuiqsut (NWCA)

   The subsistence whaling crews of the Village of Nuiqsut plan to use six (6) boats for subsistence whale hunting during the late summer and fall of 2007

2. Boats Owned/Used by Whaling Captains of Kaktovik (KWCA)

   The subsistence whaling crews of the Village of Kaktovik plan to use nine (9) boats for subsistence whale hunting during the late summer and fall of 2007.

3. Boats Owned/Used by Whaling Captains of Barrow (BWCA)

   The subsistence whaling crews of the Village of Barrow plan to use forty (40) boats for subsistence whale hunting during the late summer and fall of 2007.

4. Boats Owned/Used by Whaling Captains of Wainwright (WWCA)

   The subsistence whaling crews of the Village of Wainwright plan to use four (4) boats for subsistence whale hunting during the late summer and fall of 2007.

5. Boats Owned/Used by Whaling Captains of Pt. Hope (Pt. HWCA)

   The subsistence whaling crews of the Village of Pt. Hope plan to use four (4) boats for subsistence whale hunting during the late summer and fall of 2007.

If any additional boats are put in use by subsistence whaling crews, the Industry Participants will be notified promptly through the Com-Center.

E. INDIVIDUALS TO CONTACT

1. Shell Offshore Inc.'s (Shell) Local Representatives

BOB ROSENBLADT and PETER LITTLEWOOD will be Shell's local representatives on the North Slope during the Term of this Agreement and will be stationed at Barrow during Chukchi Sea operations and at Deadhorse during Beaufort Sea operations and will be available by telephone at (907) 770-3700.

WesternGeco's Local Representative-Subcontractor to Shell
And

JOHN DAVIS will be WesternGeco's local representative on the North Slope during the Term of this Agreement and will be stationed at Barrow during Chukchi Sea operations and at Deadhorse during Beaufort Sea operations and will be available by telephone at (907) 360-3518 Cell Phone.

2. BP Exploration (Alaska), Inc.'s (BP) Local Representative

_____will be BP's local representative on the North Slope during the Term of this Agreement and will be stationed at _____and will be available by telephone at (907) _____.

3. GX Technology's Local Representative

Dean Kennedy will be GX Technology's local representative on the North Slope during the Term of this Agreement and will be stationed at _____and will be available by telephone at (907) _____.

4. Pioneer Natural Resources' (Pioneer) Local Representative

Pat Foley will be Pioneer's local representative during the Term of this Agreement and will be stationed in Anchorage and will be available by telephone at (907) 343-2110.

5. FEX L.P's Local Representative

_____will be FEX L.P.'s local representative on the North Slope during the Term of this Agreement and will be stationed at _____and will be available by telephone at (907) _____.

7. Contact Persons for the Village of Kaktovik

For purposes of this Agreement, the individuals to contact for the Village of Kaktovik will be: JOSEPH KALEAK at (907) 640-6213 or 640-6515, and FENTON REXFORD at (907) 640-____ .

8. Contact Persons for the Village of Nuiqsut

For purposes of this Agreement, the individuals to contact for the Village of Nuiqsut will be: ISAAC NUKAPIGAK at (907) 480-6220 (Work), (907) 480-4219 (Home), and ARCHIE AHKIVIANA at (907) 480-6918 (Home) 6220.

9. Contact Persons for the Village of Barrow

For purposes of this Agreement, the individuals to contact for the Village of Barrow will be: HARRY BROWER, JR. at (907) 852-0350 (Work), and EUGENE BROWER at (907) 852-3601.

10. Contact Persons for the Village of Wainwright

For purposes of this Agreement, the individuals to contact for the Village of Wainwright will be: JACK PANIK at (907)763-3845; 763-2915 (W); 763-2171 (Fax), and WALTER NAYAKIK at (907-763-2915) (W).

11. Contact Persons for the Village of Pt. Hope

For purposes of this Agreement, the individuals to contact for the Village of Pt. Hope will be: ELIJAH ROCK SR. at (907) 763-3367

(H); (907) 368-2630; (907) 368- 2618 (FAX); and Ray Koonuk, Sr. at (907) 368-7512 (H); 368-3117 (W); 368-5402 (FAX)

12. Contact Persons for the AEWC

For purposes of this Agreement, the individuals to contact for the AEWC shall be: HARRY BROWER, JR. at (907-852-2910) and (907) 852-0350 (Work), and MAGGIE AHMAOGAK at her Anchorage home/office at (907) 334-9636; in Barrow AEWC office (907) 852-2392; Home in Barrow at (907)852-6843.

F. TERM

The Term of the Agreement shall commence with the signing of this document by the designated signatories and shall terminate upon completion of the Nuiqsut, Kaktovik, Barrow 2007 Fall Bowhead Hunt. A Joint Meeting required under section II.G.1. below or the Chukchi Sea Post-Season Village (Barrow, Wainwright and Pt. Hope) Meetings required under section II.G.2. below, whichever is later.

G. POST-SEASON REVIEW

1. Nuiqsut, Kaktovik, Barrow Joint Meeting

No later than ninety (90) days following the end of the fall 2007 bowhead whale subsistence hunt, the Industry Participants will host a joint meeting with all whaling captains of the Villages of Nuiqust, Kaktovik and Barrow, the Inupiat Communicator(s) (defined below) and with the Chairman and Executive Director of the AEWC at a mutually agreed upon place on the North Slope of Alaska to review the results of the 2007 fall season, unless it is agreed by all designated individuals or their representatives that such a meeting should be held at a different location, should be postponed, or is not necessary.

2. Chukchi Sea Post-Season Village Meetings

If geophysical operations are conducted in the Chukchi Sea by Industry Participants during the Term of this Agreement, no later than ninety (90) days following the completion of such operations, the Industry Participants involved will hold a meeting in each of the following villages: Wainwright, Pt. Hope, and Barrow (or a joint meeting of the whaling captains from all of these villages if the whaling captains agree to a joint meeting) to review the results of the operations and to discuss any concerns residents of those villages might have regarding the operations. The meetings will

include the Inupiat Communicators stationed on the Industry Participants' Vessels in the Chukchi Sea. The Chairman and Executive Director of the AEWC will be invited to attend the meeting(s).

H. PRE-SEASON SOUND SIGNATURE TESTS

For purposes of obtaining a sound signature for Industry Participants' sound sources, Industry Participants shall conduct a test of all geophysical equipment and Vessels identified in the Appendices to this Agreement, before initiating operations in the Beaufort or Chukchi Seas. If more than one sound source will be used on an individual Vessel, a cumulative test of all sound sources used on that Vessel will be conducted.

Each sound signature test shall be conducted at a site mutually agreed upon by the Industry Participant conducting such test and the AEWC. Each Industry Participant conducting such sound signature test(s) and provide one week notice and provide transportation for an appropriate number of representatives from: the whaling captains of the Villages of Barrow, Nuiqsut, Kaktovik, Wainwright and Pt. Hope the AEWC, as well as the AEWC and NSB shall be invited to observe sound signature tests for Vessels to be used in the Chukchi Sea and transportation will be provided by the appropriate Industry Participant(s).

Within five (5) days of completing the test(s), each Industry Participant and/or its contractor conducting such test(s) will make all data collected during the test(s) available upon request to the AEWC and NSBDWM and will provide to the AEWC and NSBDWM the preliminary analysis of that data, as well as any other sound signature data that is available and that the AEWC, the NSB Department of Wildlife Management, and the Industry Participant agree is relevant to understanding the potential noise impacts of the proposed operations to migrating bowhead whales or other affected marine mammals. The final data analysis will be provided to the AEWC and the NSB Department of Wildlife Management as soon as it becomes available to the Industry Participant. Any Industry Participant who prepares a model of the sound signature of its Vessels and operations, whether before or after the Pre-Season Sound Signature Test, will provide copies of those models and any related analysis to the AEWC and the NSB Department of Wildlife Management, except that CPAI will make data available for viewing by AEWC/NSB representatives upon request.

I. MONITORING PLANS AND CUMULATIVE NOISE IMPACTS STUDY

Other than Industry Participants whose operations are limited exclusively to vessel traffic, each Industry Participant agrees to prepare and implement a noise impact study monitoring plan ("Monitoring Plan: Attachment III; III-a and III-b") to collect data designed to determine the effects of its operations on fall migrating bowhead whales and other affected marine mammals. Each Industry Participant further agrees to provide its Monitoring Plan and/or sound signature data for, and to share in the cost of, a cumulative effects analysis of the multiple sound sources and their possible relationship to any observed changes in marine mammal behavior, to be undertaken pursuant to the 2007/2008 Cumulative Noise Impacts Study ("the Cumulative Impacts Study"). Industry Participants whose operations are limited exclusively to vessel traffic will submit sound signature data for each vessel they are using and marine mammal sighting data. The level of funding for the Cumulative Impacts Study provided by each of the Industry Participants is intended to be in proportion to the scale of their respective activities, and shall be mutually agreed by the Industry Participants. The terms of the agreement among the Participants for the Cumulative Impacts Study are not the responsibility of the AEWC.

The Monitoring Plans shall be designed in cooperation with the AEWC, the NSB Department of Wildlife Management, NOAA Fisheries, the U.S. Minerals Management Service, (MMS) and any other entities or individuals designated by one of these organizations and in accordance with stipulation #4 of Oil and Gas Lease Sale 195, Beaufort Sea.

In the Beaufort Sea, the Monitoring Plans shall include an investigation of noise effects on fall migrating bowhead whales as they travel past the noise source, with special attention to changes in calling behavior, deflection from the normal migratory path, where deflection occurs, and the duration of the deflection.

In the Chukchi Sea, the Monitoring Plans should focus on the identity, timing, location, and numbers of marine mammals and their behavioral responses to the noise source.

Prior impact study results shall be incorporated into the Monitoring Plans prepared by each Industry Participant, and into the Cumulative Impacts Study. Each such Monitoring Plan and the study design for the Cumulative Impacts Study shall be subject to stake-holder peer review at the 2007 Open Water Season Peer Review Meeting convened by NOAA Fisheries. Plans will be submitted to the North Slope Borough and AEWC three weeks prior to the Open Water Meeting. Peer review and acceptance of each such Monitoring Plan and the study design for the Cumulative Impacts Study through this process shall be completed prior to

the commencement of each Industry Participants' 2007 operations in the Beaufort or Chukchi Seas. Each completed, peer reviewed, and approved Monitoring Plan and the design for the Cumulative Impacts Study shall be part of the IHA issued by NOAA Fisheries for each Industry Participant who has applied for an IHA, or who is required to engage in monitoring pursuant to a North Slope Borough permit. Draft site-specific and cumulative impacts monitoring reports also shall be submitted to the North Slope Borough and AEWC three weeks prior to the Open Water Meeting for peer review and comment during that meeting.

Each Industry Participant conducting site-specific monitoring will make raw data, including datasheets, field notes, and electronic data, available to the NSB at the end of the season.

Each Industry Participant conducting site-specific monitoring will permit and encourage open communications among their contractors and the AEWC and North Slope Borough.

Each Industry Participant will submit a summary of monitoring plan results and progress to the AEWC and North Slope Borough every two weeks during the operating season.

III. OPEN WATER SEASON COMMUNICATIONS EQUIPMENT AND PROCEDURES

A. COMMUNICATIONS EQUIPMENT

1. Communications Equipment to be Provided to Subsistence Whale Hunting Crews

   The Industry Participants will provide (or participate in the provision of):

   a. All-Channel, Water-Resistant VHF Radios:
      - i) Kaktovik Subsistence Whaling Boats: 9
      - ii) Kaktovik Base and Search and Rescue: 2
      - iii) Nuiqsut Subsistence Whaling Boats: 6
      - iv) Nuiqsut Base and Search and Rescue: 3
      - v) Barrow Subsistence Whaling Boats: 40
      - vi) Barrow Base and Search and Rescue 2
      - vii) Wainwright Base and Search and Rescue: 2
      - viii) Wainwright Subsistence Whaling Boats: 2
      - ix) Pt. Hope Base and Search and Rescue: 2
      - x) Pt. Hope Subsistence Whaling Boats: 4

These VHF radios are specifically designed for marine use and allow monitoring of Channel 16 while using or listening to another channel. The whaling boats from each of the two villages have been assigned individual VHF channels for vessel-to-vessel and vessel-to-Com-Center communications. The Nuiqsut whaling crews will use Channel 68. Channel 69 will be used by the Kaktovik whaling crews. Channel 72 will be used by Barrow whaling crews. The Wainwright Whaling Crews will use Channel 12. The Pt. Hope Whaling Crews will use Channel 68.

b. Global Positioning System (GPS):

i) Kaktovik Subsistence Whaling Boats: 9
ii) Nuiqsut Subsistence Whaling Boats: 6
iii) Unit Reserved for Training and Backup: 1
iv) Wainwright Subsistence Whaling Boats: 2
v) Pt. Hope Subsistence Whaling Boats: 4

Utilizing the GPS Satellite Constellation, these GPSs can indicate to the whaling captains what their current positions are, despite weather conditions. Accurate knowledge of the positions of the whaling vessels will be useful if there is a need for an emergency air-sea or sea-sea rescue.

c. Satellite Telephones:

i) Kaktovik Subsistence Whaling Boats: 2
ii) Nuiqsut Subsistence Whaling Boats: 2
iii) Barrow Subsistence Whaling Boats: 2
iv) Wainwright Subsistence Whaling Boats: 2
v) Pt. Hope Subsistence Whaling Boats: 4

The satellite telephones are to be used as backup for the VHF radios.

d. Distribution and Return of Equipment: The distribution of the VHF radios, GPS units, and satellite telephone equipment to whaling captains for use by whaling crews from Nuiqsut and Kaktovik during the 2007 fall bowhead subsistence whale hunting season shall be completed no later than August 15, 2007. All such units and telephone equipment provided under this Agreement, whether in this section or otherwise, will be returned by the Subsistence Participants from Kaktovik, Nuiqsut, Wainwright and Pt. Hope promptly to the Industry Participant or the person providing such units and equipment at the end of each village's 2007 fall bowhead whale subsistence hunt.

2. Communications Equipment on Vessels Owned or Operated by the Industry Participants and/or their Contractors

   The Inupiat Communicators onboard source vessels owned or operated by the Industry Participants and/or their contractors will also be supplied with all-channel VHF radios. The on-board communicators have been assigned Channel 7 for their exclusive use in communicating with the Com-Center.

3. Radio Installation and User Training

   The Whaling Captains of Nuiqsut, Kaktovik, Wainwright and Pt. Hope with assistance from the Industry Participants, will be responsible for the installation of the VHF radio equipment. The Industry Participants will provide (or participate in the provision of) on-site user training for the VHF and GPS equipment on or before August 15, 2007, as scheduled by the Whaling Captains' Associations of Nuiqsut ,Kaktovik, Barrow, Wainwright, Pt. Hope and the Industry Participant operating the Com-Centers.

B. THE COMMUNICATIONS SYSTEM COORDINATION CENTERS (COM-CENTERS) Note: The communications scheme shall apply in the Chukchi Sea lead system, as identified and excluded from leasing in the current MMS Five-Year Leasing Program, 2002-2007.

1. Set Up and Operation

   Subject to the terms of Section II.B. of this Agreement, the Industry Participants jointly will arrange for the funding of Five Com-Centers, which will be located in Deadhorse, Kaktovik, Barrow, Wainwright and Pt. Hope and will be staffed by Inupiat operators. The Com-Centers will be operated 24 hours per day during the 2007 subsistence bowhead whale hunt. One of the Industry Participants or its contractor will be designated as the operator of the Com-Centers. If the Industry Participants cannot agree on the designated operator of the Com-Centers, then the operator shall be designated by the AEWC. Each Industry Participant shall contribute to the funding of the Com-Centers covering the areas in which it conducts operations. The level of funding for the Com-Centers provided by each of the Industry Participants is intended to be in proportion to the scale of their respective activities, and shall be mutually agreed by the Industry Participants. The procedures to be followed by the Com-Center Operators are set forth below.

2. Staffing

Each Com-Center shall have an operator ("Com-Center Operator") on duty 24 hours per day from the third week of August until the end of the bowhead whale subsistence hunt in Kaktovik for the Kaktovik for the Kaktovik com-Center, Nuiqsut for the Deadhorse Com-Center, Barrow for the Barrow Com-Center, Wainwright for the Wainwright Com-Center and for Pt. Hope for the Pt. Hope Com-Center

3. Duties of the Com-Center Operators

The Com-Center Operators shall be available to receive radio and telephone calls and to call vessels as described below. A record shall be made of all calls from every vessel covered by Sections II. C. and D. of this Agreement. The record of all reporting calls should contain the following information:

a. Industry Vessel:

i. Name of caller/vessel
ii. Vessel location/speed direction
iii. Time of call
iv. Anticipated movements between this call and the next report
v. Reports of any industry/subsistence whale hunter activities

b. Subsistence Whale Hunting Boat:

i. Name of Caller
ii. Location of boat or camp
iii. Time of Call
iv. Plans for travel
v. Any special information such as caught whale, whale to be towed, or industry/whale conflict

c. Report of Industry/Subsistence Whale Hunter Conflict:

In the event an industry/subsistence whale hunter conflict is reported, the appropriate Com-Center Operator shall record:

i. Name of industry vessel
ii. Name of subsistence whaling captain
iii. Location of vessels
iv. Nature of conflict

If all Vessels and boats covered by Sections II C. and D. of this Agreement have not reported to the appropriate Com-Center within one hour of the recommended time, that Com-Center Operator shall attempt to call all non-reporting vessels to determine the information set out above under the Duties of the Com-Center Operator.

As soon as location information is provided by a Vessel or boat covered by Sections II. C. or D. of this Agreement, the appropriate Com-Center Operator shall plot the location and area of probable operations on the large map provided at that Com-Center.

If, in receiving information or plotting it, a Com-Center Operator observes that operations by Industry Participants might conflict with subsistence whaling activities, such Com-Center Operator should attempt to contact the industry Vessel involved and advise the Industry Participant's Local Representative(s) and the Vessel operators of the potential conflict.

C. COM-CENTER GENERAL COMMUNICATIONS SCHEME

1. Reporting Positions for Vessels Owned or Operated by the Industry Participants

All vessels shall report to the appropriate Com-Center at least once every six hours commencing with a call at 0600 hours. Each call shall report the following information:

a. Vessel name/operator of vessel/charterer of vessel/ project;

b. Vessel location/speed direction;

c. Plans for movement between the time of the call and the time of the next call; furthermore, the final call of the day shall include a statement of the vessel's general area of expected operations for the following day if known at that time.

EXAMPLE: This is the Arctic Endeavor, operated by _____ for _____ at the Northstar Prospect. We are currently at ___'___ north, ___'___ west, proceeding SE at ___ knots. We will proceed on this course for ___ hours and will report location and direction at that time.

The appropriate Com-Center also shall be notified if there is any significant change in plans, such as an unannounced start-up of operations or significant deviations from announced course, and such Com-Center shall notify all whalers of such changes. A call to

the appropriate Com-Center shall be made regarding any unsafe or unanticipated ice conditions.

2. Reporting Positions for Subsistence Whale Hunting Crews

a. All subsistence whaling captains shall report to the appropriate Com-Center at the time they launch their boats from shore and again when they return to shore. All subsistence whaling captains shall report to such Com-Center the initial GPS coordinates of their whaling camps. Additional communications shall be made on an as needed basis. Each call shall report the following information:

i) The crew's location and general direction of travel.

EXAMPLE: This is _____. We are just starting out. We will be traveling North-East from _____ to scout for whales. I will call if our plans change.

ii) The presence of any vessels or aircraft owned or operated by any of the Industry Participants, or their contractors that are not observing the specified guidelines set forth below in Section III, Avoiding Conflicts.

iii) The final call of the day shall include a statement of the whaling captain's general area of expected operations for the following day if known at the time.

b. Any subsistence whale hunter preparing to tow a caught whale shall report to the appropriate Com-Center before starting the tow.

EXAMPLE: This is Archie Ahkiviana. I am at ___'___ north, ___'___ west. I have a whale and am towing it into _____.

c. Each time a subsistence whaling camp is moved, it shall be reported promptly to the appropriate Com-Center, including the new GPS coordinates.

d. Subsistence whale hunters shall notify the appropriate Com-Center promptly if, due to weather or any other unforeseen event, whaling is not going to take place that day.

e. Subsistence whaling captains shall contact the appropriate Com-Center promptly and report any unexpected movements of their vessel.

D. OBTAINING INFORMATION

1. Monitoring VHF Channel 16

All vessels covered by parts II C. and D. of this Agreement should monitor marine VHF Channel 16 at all times.

2. Avoidance of Whale Hunting Crews and Areas

It is the responsibility of each Vessel owned or operated by any of the Industry Participants and covered by Section II C. of this Agreement to determine the positions of all of their vessels and to exercise due care in avoiding any areas where subsistence whale hunting is active.

3. Vessel-to-Vessel Communication

After any Vessel owned or operated by any of the Industry Participants and covered by Section II C. of this Agreement has been informed of or has determined the location of subsistence whale hunting vessels in its vicinity, the on-board communicator is encouraged to contact those vessels in order to coordinate movement and take necessary avoidance precautions.

E. THE ON-BOARD INUPIAT COMMUNICATOR

1. Employment and Duties of the Communicator

Each Vessel owned or operated by each of the Industry Participants shall employ an On-Board Inupiat Communicator ("Communicator"). Each Communicator is to be employed as a Marine Mammal Monitor for the duration of the 2007 operating season on the source Vessel on which he or she is stationed.

As a member of the crew, the Communicator will be subject to the regular code of employee conduct on board the Vessel and will be subject to discipline, termination, suspension, layoff, or firing under the same conditions as other employees of the Vessel operator or appropriate contractor.

Once the source Vessel on which the Communicator is employed is in the vicinity of a whaling area and the whalers have launched their

boats, the Communicator's primary duty will be to carry out the communications responsibilities set out in these guidelines. At all other times, the Communicator will be responsible for keeping a lookout for bowhead whales and/or other marine mammals in the vicinity of the Vessel to assist the Vessel captain in avoiding harm to the whales and other marine mammals.

2. Communications

It is the Communicator's responsibility to call the appropriate Com-Center as set out in Section III.C. above. The Communicator will be responsible for all radio contacts between Vessels owned or operated by each of the Industry Participants and whaling boats covered under Section D. of this Agreement and shall interpret communications as needed to allow the Vessel operator to take such action as may be necessary pursuant to this Agreement.

The Communicator is encouraged to contact directly subsistence whaling boats that may be in the vicinity to ensure that conflicts are avoided to the greatest possible extent.

The Communicator will maintain a record of his or her communications with each Com-Center and the subsistence whaling boats.

F. STANDARDIZED LOG BOOKS

The Industry Participants will provide the Com-Centers and Communicators with identical log books to assist in the standardization of record keeping associated with communications procedures required pursuant to this Agreement.

IV. AVOIDING CONFLICTS DURING THE 2007 OPEN WATER SEASON

The following Operating Guidelines apply throughout the bowhead whale migration in the Beaufort and Chukchi Seas, except as otherwise specified and in all cases with due regard to environmental conditions and operational safety. These Operating Guidelines are in addition to any permit restrictions or stipulations imposed by the applicable governmental agencies.

A. GENERAL PROVISIONS FOR AVOIDING INTERFERENCE WITH BOWHEAD WHALES OR SUBSISTENCE WHALE HUNTING ACTIVITIES

1. Routing Vessels and Aircraft

All Vessel and aircraft routes shall be planned so as to minimize any potential conflict with bowhead whales or subsistence whaling activities. All Vessels shall avoid areas of active or anticipated (as reported pursuant to section III. C. 2. above) whaling activity.

2. Aircraft Altitude Floor

AIRCRAFT SHALL NOT OPERATE BELOW 1500 FEET unless approaching, landing or taking off, or unless engaged in providing assistance to a whaler or in poor weather (low ceilings) or other emergency situations.

3. Vessel Speeds

Vessels shall be operated at speeds necessary to ensure no physical contact with whales occurs, and to make any other potential conflicts with bowhead whales or whalers unlikely.

4. Vessels Operating in Proximity to Migrating Bowhead Whales

If any Vessel inadvertently approaches within 1.6 kilometers (1 mile) of observed bowhead whales, except when providing emergency assistance to whalers or in other emergency situations, the Vessel operator will take reasonable precautions to avoid potential interaction with the bowhead whales by taking one or more of the following actions, as appropriate:

a. reducing vessel speed within 900 feet of the whale(s);

b. steering around the whale(s) if possible;

c. operating the Vessel(s) in such a way as to avoid separating members of a group of whales from other members of the group;

d. operating the Vessel(s) to avoid causing a whale to make multiple changes in direction; and

e. checking the waters immediately adjacent to the Vessel(s) to ensure that no whales will be injured when the propellers are engaged.

5. Good Faith Understanding of Vessel Traffic after August 15, 2007

After August 15, 2007 an Industry Participant conducting Vessel traffic within the bowhead migration route shall first consult with the AEWC and affected village whaling captains when the bowhead whale migration is in motion. It is understood that any supply vessels that are caught in the ice or the circulating ice pack will stay close to the ice edge or 35 miles offshore, whichever distance is closer to shore, throughout the migration route and during the subsistence whaling activities. As used in this paragraph, "migration route" means the fall bowhead whale migration beginning in the Canadian Beaufort Sea and extending to St. Lawrence Island, Alaska. If any operator requires emergency vessel movement, the Operating Guidelines set forth in this Section IV. of this Agreement will dictate the procedures to be followed.

B. OPERATING LIMITATIONS

1. Geophysical Operations

The AEWC agrees to this 2007 CAA with **only** the two (2) Industry Participants; Shell and GXT, for geophysical surveys in the Beaufort and Chukchi Seas. The two Industry Participants agree to coordinate the timing and location of such operations so as to reduce, by the greatest extent reasonably possible, the level of noise energy entering the water from such operations at any given time and at any given location. The following operating limitations are to be observed and the operations are to be accompanied by a Monitoring Plan as set forth in Section II.I and Attachment III; III-a and III-b of this Agreement.

a. Beaufort Sea

All geophysical activity in the Beaufort Sea shall be confined as set forth below.

(i) Kaktovik: No geophysical activity from the Canadian border to the Canning River (~146 deg. 4 min. W) from 25 August to close of fall bowhead whale hunt in Kaktovik and Nuiqsut[1].

[1] Marine mammal subsistence hunting in any village shall be considered closed when the hunt in that village has ended or, in the case of the bowhead whale subsistence, the village quota has been exhausted (as announced by the village Whaling Captains' Association or the AEWC).

(ii) Nuiqsut: No geophysical activity from the Canning River (~146 deg. 4 min. W) to Point Storkersen (~148 deg. 45 min. W) from 25 August to close of fall bowhead whale hunt in Nuiqsut.

(iii) Barrow: No geophysical activity from Pitt Point on the east side of Smith Bay (~152 deg. 15 min. W) to a location about half way between Barrow and Peard Bay (~157 deg. 20 min. W) from 10 September to close of fall bowhead whale hunt in Barrow.

[b. Chukchi Sea

(i) Geophysical activity may not commence in the Chukchi Sea prior to July 20, 2007.

(ii) Geophysical exploration may occur beginning July 20 and ending September 10, 2007, unless otherwise specifically authorized by the Whaling Captains' Associations of Wainwright and Pt. Hope, and the AEWC, but in any case no closer than 60 miles from the Chukchi Sea coast at any point.

(iii) Geophysical exploration may resume following the close of the fall 2007 bowhead whale subsistence hunt in Barrow, Wainwright, and Pt. Hope, unless specifically authorized by the Whaling Captains' Associations of Barrow, Wainwright, and Pt. Hope, and the AEWC.

(iii) Safe harbor will not be taken within 50 miles of any village, except when human life is in danger, and then ships shall be moved to a distance of at least 50 miles from the village at the earliest possible opportunity, and shall be moved out to sea as soon as weather permits.

(iv) Any vessel operating within 60 miles of the Chukchi Sea coast will follow the communications procedures set forth in Section III of this Agreement. All vessels will adhere to the conflict avoidance measures set forth in Section IV.A of this Agreement.

(v) If a dispute should arise, the dispute resolution process set forth in Article VI of this Agreement shall apply

2. Drilling Operations

a. Beaufort Sea East of Cross Island

No drilling equipment or related vessels shall be onsite at any offshore drilling location east of Cross Island from 25 August until the close of the bowhead whale hunt in Nuiqsut. However, such equipment may remain within the Beaufort Sea **north of 71.25 N or at the edge of the arctic ice pack whichever is closer to shore, and west of 146.4W.**

b. Beaufort Sea West of Cross Island

No drilling equipment or related vessels shall be moved onsite at any location outside the barrier islands west of Cross Island until the close of the bowhead whale hunt in Barrow.

C. SHORE-BASED SERVICE AND SUPPLY AREAS

Shore-based service and supply areas used by Industry Participants shall be located and operated so as to ensure compliance with the terms of this Agreement.

V. REGULATORY COMPLIANCE

A. UNITED STATES COAST GUARD REQUIREMENTS

The Industry Participants shall comply with all applicable United States Coast Guard (USCG) requirements for safety, navigation and notice.

B. ENVIRONMENTAL REGULATIONS AND STATUTES

The Industry Participants shall comply with all applicable environmental regulations and statutes.

C. OTHER REGULATORY REQUIREMENTS

The Industry Participants shall comply with all applicable federal, state and local government requirements.

VI. DISPUTE RESOLUTION

Subject to the terms of Section II. B. 7. of this Agreement, all disputes arising between any Industry Participants and any Subsistence Participants shall be addressed as follows:

First between the affected Participant(s) in consultation with the affected village Whaling Captains' Association and the Industry Participant(s)' Local Representative.

If the dispute cannot be resolved to the satisfaction of all affected Participants, it shall be addressed by the affected Participants in consultation with the AEWC.

If the dispute cannot be satisfactorily resolved in this manner, it shall be addressed with the AEWC and the Participants in consultation with representatives of NOAA Fisheries.

VII. EMERGENCY AND OTHER NECESSARY ASSISTANCE

A. EMERGENCY COMMUNICATIONS

ALL VESSELS SHOULD NOTIFY THE APPROPRIATE COM-CENTER IMMEDIATELY IN THE EVENT OF AN EMERGENCY. The appropriate Com-Center Operator will notify the nearest Vessels and appropriate search and rescue authorities of the problem and advise them regarding necessary assistance. (See attached listing of local search and rescue organizations in Attachment I.)

B. EMERGENCY ASSISTANCE FOR SUBSISTENCE WHALE HUNTERS.

33 U.S.C. 916c provides for the use of a vessel to tow a whale taken in a traditional subsistence whale hunt permitted by Federal law and conducted in waters off the coast of Alaska is authorized, if such towing is performed upon a request for emergency assistance made by a subsistence whale hunting organization formally recognized by an agency of the United States Government, or made by a member of such an organization, to prevent the loss of a whale.

X. OIL SPILL MITIGATION

Unless otherwise agreed with the AEWC, Industry Operators engaged in oil production or in drilling operations in or near known or suspected oil reservoirs will agree to adhere to the AEWC/NSB/Inupiat Community of the Arctic Slope oil spill mitigation agreement. **(GNP) This must be completed by Shell for this 2007 CAA for their drilling operations in Camden Bay.**

SIGNATORIES

Harry Brower Jr.
Chairman, AEWC
Dated: 5/29/07

Harry Brower Jr.
AEWC Commissioner for Barrow
Dated: 5/27/07

AEWC Commissioner for Nuiqsut
Dated: 5-14-07

Enoch Kelly
AEWC Comm. For Kaktovik
Dated: 5/30/07

AEWC Commissioner for Wainwright
Dated: 5-22-07

AEWC Commissioner Pt. Hope
Date:

Shell Offshore Inc.
Dated: 7-24-07
Executive Vice President
Shell EP Americas,
as Attorney-in-fact

GX Technology Corporation
Dated:

BP Exploration Alaska
Dated:

Dated:

Pioneer Natural Resources Alaska	FEX L.P.
Dated:_____	Dated: _____

ATTACHMENT I

LOCAL SEARCH AND RESCUE ORGANIZATIONS - CONTACT PERSONS

North Slope Borough
Search and Rescue (Pilots)

Director: Randy Crosby	852-2822 WK		852-2495 HOME
Deputy Director:	852-2822 WK	852-	HOME
Hugh Patkotak	852-2822 WK		852-4844 HOME

Barrow Volunteer
Search and Rescue Station 852-2808 OFS

President	Simmik Kanayurak	852- 7032 WK	852-7032 HOME
Vice-Pres.	Oliver Leavitt	852-8633 WK	852-7848 HOME
Secretary	Lucille Adams	852-0250 WK	852-7200 HOME
Treasurer	Eli Solomon	852-2808 WK	852-6261 HOME
Coordinator	Patrick Suvlu	852-0290 WK	852-5060 HOME
Director	Arnold Brower	852-0200 WK	852-JENS HOME
Director	Bud Stevens	852-0250 WK	852-7724 HOME

Nuiqsut Volunteer
Search and Rescue Station 480-6613 (Fire Hall)

President	Cyrus Ahtuangaruak	480-6626 WK	480-8384 HOME
Vice-Pres.	Archie Ahkiviana	480-6626 WK	480-6918 HOME
Sec/Treas.	Gordon Matumeak	480-6518 WK	480-6428 HOME
Coordinator	Gordon Brown	480-6223 WK	480-
Director	Leonard Tukle	480-6529 WK	480-6018 HOME
Director	Isaac Nukapigak	480-6613 WK	480-6134 HOME

Kaktovik Volunteer
Search and Rescue Station 640-6212 (Fire Hall)

President	Charlie Nageak	640-	640-6213 HOME
Vice-Pres.	George T. Kaleak	640-6514/6515	
2nd V-Pres.	Sheldon Brower		640-6399 HOME
Secretary	Charles Brower	640-6516	
Treasurer	Mary M. Brower	640-6314	640-6399 HOME
Coordinator	Archie Brower	None	640-6211 HOME
Fire Chief	George T. Tagarook	640-6212	640-6728 HOME

Wainwright Volunteer Search and Rescue

President	Ben Ahmaogak Jr.	763-3030 (H)	
Coordinator	Max Akpik, Sr	763-2179 (H)	351-0396 (Cell)
Coordinator 2nd in Comm.	Joe Ahmaogak	763-2826 (H)	

Pt. Hope Volunteer Search and Rescue

Coordinator	Andrew Tooyak Jr.	368-2071 (H)	
Fire Chief	Andrew Tooyak Jr.	368-2774 (W)	(Note: Only contact for Pt. Hope)

North Slope Borough Disaster Relief Coordinator

Mr. Patterson	852-0284 OFS

ATTACHMENT II

VESSELS TO BE USED FOR AND IN SUPPORT OF INDUSTRY PARTICIPANTS' OPERATIONS AS IDENTIFIED IN SECTION II. C. 1.

[ALL VESSELS TO BE IDENTIFIED BY COMPANY]

NOTE:

COPY OF PRESENTATION ATTACHED TO THE ORIGINAL FOR SIGNATURE
CAA IDENTIFYING THE VESSELS TO BE USED FOR AND IN SUPPORT OF INDUSTRY PARTICIPANTS' OPERATIONS.

ATTACHMENT III

VESSELS TO BE USED FOR AND IN SUPPORT OF THE INDUSTRY PARTICIPANTS MONITORING PLANS AS IDENTIFIED IN SECTION II. C. 2.

[ALL VESSELS TO BE IDENTIFIED BY COMPANY]

NOTE:

COPY OF PRESENTATION OF THE INDUSTRY PARTICIPANT ATTACHED IDENTIFYING VESSELS TO BE USED FOR AND IN SUPPORT OF THE INDUSTRY PARTICIPANTS MONITORING PLAN.

APPENDIX H: DESCRIPTION OF VESSELS AND EQUIPMENT

Vessels

MV Gilavar

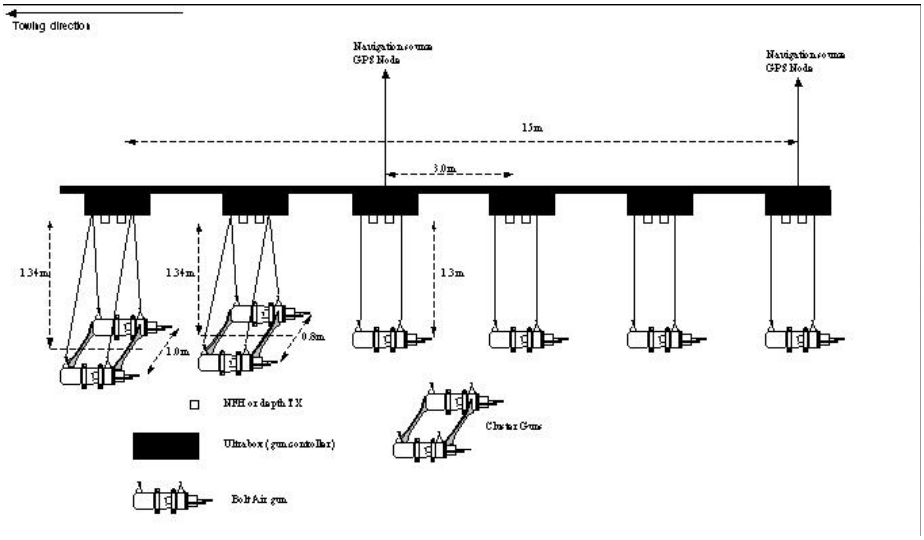
SOI's seismic source vessel, the *Gilavar*, was built in Norway in 1981. The *Gilavar* is owned by Caspian Geophysical Ltd., of Baku, Azerbaijan, and its current port of registry is Panama. The overall length of the *Gilavar* is 84.9 m (279 ft) and its gross tonnage is 3779 metric tons with a mean draft of 5.9 m (19 ft). The total fuel capacity of the *Gilavar* is 916 m^3 with a fuel consumption rate ranging from 24 to 35 m^3 per day. The *Gilavar* has a helicopter deck rated for a Bell 214 or Super Puma. The *Gilavar* is equipped with fresh water making capabilities, and a sludge and waste oil incinerator.

Airgun Description and Safety Radii: Gilavar

Aboard the Gilavar, SOI used WesternGeco's 3147 in^3 Bolt-Gun Array for its 3–D seismic survey operations in the Chukchi Sea. WesternGeco's source arrays were composed of three identically tuned Bolt-Gun sub-arrays operated at an air pressure of 2000 psi. Each sub-array was 15 m in length, and was 8 m from the adjacent array(s). The individual airguns ranged in volume from 30 to 235 in^3, and each sub-array included two 235 in^3 and two 125 in^3 airguns in two-gun clusters. A 30 in^3 airgun was used for mitigation when marine mammals were observed within or about to enter the applicable safety radius. The airgun arrays were towed at a depth of 6 m. The system also included four to six hydrophone streamers with hydrophones distributed over a length of 4200 m and spaced 100 m apart, which recorded reflected sound energy. Air compressors aboard the Gilavar were the source of high pressure air used to operate the airgun arrays. Seismic pulses were emitted at intervals of 25 m (~10 sec) while the *Gilavar* traveled at a speed of 4 to 5 knots (7.4–9.3 km/h). In general, the *Gilavar* towed this system along a predetermined survey track, although adjustments were occasionally made during the field season to avoid obstacles or during repairs to the equipment.

In general, the signature produced by an array composed of multiple sub-arrays has the same shape as that produced by a single sub-array while the overall acoustic output of the array is determined by the number of sub-arrays employed. The gun arrangement for each of the three 1049-in^3 sub-arrays was detailed in SOI's IHA application. As indicated in the application's diagram, each sub-array was composed of six tuning elements; two 2–gun clusters and four single guns. The standard configuration of a source array for 3–D surveys consists of one or more 1049 in^3 sub-arrays. When more than one sub-array is used, as here, the arrays are lined up parallel to each other with 8 m (26 ft) cross-line separation between them. This separation was chosen to minimize the dimensions of the array in order to approximate point source radiation characteristics for frequencies in the nominal seismic processing band. For the 3147 in^3 array the overall dimensions were 15 m (49 ft) long by 16 m (52.5 ft) wide.

Standard 1049 in^3 sub-array - 3 subarrays comprise each 3147 in^3 Source



Information on WesternGeco's source arrays was taken from the IHA application.

As noted above, the sub-array was composed of six tuning elements; two 2-gun clusters and four single guns. The clusters had their component guns arranged in a fixed side-by-side fashion with the distance between the gun ports set to maximize the bubble suppression effects of clustered guns. A near-field hydrophone was mounted about 1 m above each gun station (one phone was used per cluster). One depth transducer per position was mounted on the gun's ultrabox, and a high pressure transducer was mounted at the aft end of the sub-array to monitor high pressure air supply. All the data from these sensors were transmitted to the vessel for input into the onboard systems and recording to tape.

MV Henry Christoffersen

The *Henry Christoffersen* was built in Victoria, B.C., Canada, and is owned by Northern Transportation Company, Ltd. Its port of registry is Edmonton, Alberta, Canada. The overall length of the *Henry Christoffersen* is 47 m (153 ft) and the gross tonnage is 783 metric tons. The *Henry Christoffersen* is powered by four Caterpillar V16 D399 diesel engines and can travel at a speed of 14 knots. The fuel capacity of the *Henry Christoffersen* is 313 m^3 and the fuel consumption rate is ~13.2 m^3 per day. The *Henry Christoffersen* conducted shallow hazards and site clearance surveys in the Beaufort Sea during the 2007 open-water season.

High-Resolution Seismic Profiling.—Reflected sound energy, often called acoustic or seismic energy, can produce graphic images of seafloor and sub-seafloor features. High-resolution profiling systems transmit the acoustic energy from various sources called transducers that are attached to the hull of the vessel or towed astern. Part of this energy is reflected from the seafloor and from geologic strata below the seafloor. This reflected energy is received by one or more hydrophones or a streamer, and the signals are recorded to produce seismic records or profiles. Seismic profiles often take the form of geologic cross-sections along the course traveled by the survey vessel.

The *Henry Christoffersen* operated several high-resolution profiling systems simultaneously in the Beaufort Sea to obtain detailed records of seafloor and near seafloor conditions. A typical survey included

- a dual-frequency sub-bottom profiler (Datasonics CAP6000 Chirp II; 2–7 or 8–23 kHz) as a shallow penetration or sub-bottom profiler; transducer depth ~1 m; pulse interval 0.25–5 sec;
- a Datasonics SPR-1200 Bubble Pulser as a medium penetration system, nominally operating at 400 Hz and pulse interval 0.5–5 sec (but see Chapter 3 for empirical data on measured frequency output);
- a high resolution multi-channel seismic system comprised of a two 10 in^3 airgun array with a total volume of 20 in^3 with predominant output at 0–150 Hz. This small airgun system should not be confused with the much larger system deployed from the *Gilavar* for deep-penetration seismic exploration for hydrocarbons.

These profiling systems complement each other since each system achieves different degrees of resolution and depths of sub-seafloor penetrations.

Side Scan Sonar.—SOI used a Datasonics SIS-1500 side scan sonar system to collect data on seafloor topography. Unlike seismic profiling systems, which produce a vertical profile along the vessel's path, side

scan sonar systems provide graphic records that show two-dimensional (map) views of seafloor topography and of objects on the seafloor. The sonar images provide a swath display/record covering an area on the seafloor up to several hundred feet on both sides of the survey trackline. The side scan sonar transmits very high-frequency acoustic signals (190–210 kHz) and records the reflected energy from the seafloor. Signals reflected from the seafloor are displayed on a continuous record produced by a two-channel recorder. Reflected signals normally appear as dark areas on the record whereas shadows behind objects appear as light or white areas. The intensity and distribution of reflections displayed on the sonar image depend on the composition and surface texture of the reflecting features, on their size, and on their orientation with respect to the transducers. Line spacing and display range are designed to ensure 100 percent coverage of the proposed survey area in the prime survey line direction, with additional tie-lines acquired in an orthogonal direction. Side scan sonar data are useful for mapping areas of boulders, rock outcrops, and other areas of rough seafloor, and for determining the location and trends of seafloor scarps and ice gouges. These data are also used to locate shipwrecks, pipelines, and other objects on the seafloor.

Multi-beam Bathymetry.—A Seabat 8101 multi-beam bathymetric sonar was used to determine water depths in the surveyed area. Multi-beam bathymetric systems are either hull mounted or towed astern of the survey vessel. The system transmits acoustic signals (200–500 kHz; 240 kHz in this project) from multiple projectors propagating to either side of the vessel at angles that vary from vertical to near horizontal. The locations of the soundings cover a swath whose width may be equal to many times the water depth. By adjusting the spacing of the survey tracklines such that adjacent swaths overlap, SOI obtained depth information for 100 percent of the bottom in the survey area. The time required to receive the signals as well as signal intensity, position, and other characteristics for echoes received across the swath were used to calculate the depth where each individual beam in the swath reached the bottom. Acoustic systems similar to the ones used by SOI have been described in detail by NMFS previously (see 66 FR 40996, 6 Aug 2001; 70 FR 13466, 21 Mar 2005).

MV Gulf Provider

The *Gulf Provider* was the Gilavar's primary chase/monitoring vessel during the 2007 Chuckhi and Beaufort sea seismic surveys. The *Gulf Provider* was built in Jennings, Louisiana, in 1979 and was re-built in 2001. The current port of registry is Panama. The overall length of the *Gulf Provider* is 57.8 m (190 ft) and the gross tonnage is 926 metric tons. The fuel capacity of the *Gulf Provider* is 530 m^3 and the fuel consumption rate is 6-10 m^3 per day. The *Gulf Provider* is powered by two Caterpillar D-399 diesel engines and is equipped with a waste oil and sludge incinerator.

MV Norseman II

The *Norseman II* was built in Seattle at the Marco Shipyard in 1979. In 2007 the *Norseman II* underwent major modification adding the new dinning, work area and lounge along with 4 staterooms and bathrooms. The vessel measures 115 ft in length, 27 ft wide and draws 13 ft when loaded. The main engine is a Caterpillar 398 operating at 850 hp. The gross tonnage is 199 tons. Fuel capacity is 44,000 gallons and cruising speed is 10.5 knots. The *Norseman II* operated as a chase/monitoring vessel for the *Gilavar*, and was involved in the deployment and retrieval of acoustic equipment in both the Chukchi and Beaufort seas in 2007.

MV Kilabuk

The *Kilabuk* is a vessel with ice-breaking capabilities and was used as the chase/monitoring vessel for the *Gilavar* during a portion of the seismic operations in the Beaufort Sea in 2007. The *Kilabuk* was built in Victoria, B.C., Canada, and was commissioned in 1975. The *Kilabuk* is owned by Northern Transportation Company Ltd. (NTCL) of Canada and its port of registry is Vancouver, B.C. The overall length of the *Kilabuk* is 62.5 m (205 ft) and its gross tonnage is 1190 tons. The vessel is powered by two General Motors EMD 20-645-E7 turbocharged diesel engines clutched to reduction gears driving open KaMeWa propellers. The maximum speed of the *Kilabuk* is 15.5 knots with a cruising speed of 12.5 knots. The fuel capacity of the *Kilabuk* is 570 m^3 and the fuel consumption rate is 16 m^3 per day at cruising speed.

MV Nanuq

The *Nanuq* is a spill response vessel operated by Edison Chouest Offshore that was used as a chase/monitoring vessel in the Chukchi Sea for a portionof the 2007 season. The total length of the *Nanuq* is 91.9 m (301 ft) with a width of 18.3 m (60 ft). It is powered by two Caterpillar diesel engines and is equipped with a stern thruster and two bow thrusters. The *Nanuq* is capable of sailing at 13.5 kt at full cargo capacity and has bunk space for 41 plus a hospital room. There are two 910 kw generators and one 166 kw emergency generator. Clear cargo deck space is 8535 ft^2, and mission support equipment includes various skimmers, booms, bladders, winches, and pumps.

MV American Islander

The *American Islander*, owned by American Marine Corporation, was built in 1970 and underwent a complete rebuild in 1994. The *American Islander* has a length of 30.5 m (100 ft) and is 7 m (24 ft) at the beam. The gross weight is 98 tons. The vessel is powered by two GM Detroit diesels, Model V-16-71 and can travel at 12 knots. The *American Islander* is equipped with a 15 ton hydraulic crane, deck and bow winches, potable water system, and a clear deck space of 1100 ft^2. It can accommodate 40 passengers plus four crew members, and can sleep 20. The *Ameircan Islander* was a chase/monitoring vessel for the *Gilavar* for a short period during the fall seismic activities in the Chukchi Sea.

RV Peregrine Falcon

The RV *Peregrine Falcon* is a small (94 ft length by 24 ft beam), jet- and prop-driven, aluminum landing craft with a 0.76 m (30 in) draft. The Peregrine Falcon is 29 m (94 ft) in length with a 7 m (24 ft) beam. The *Peregrine Falcon* was powered by three 300 hp Cummins diesels, driving two Kodiak model 403 water jets, and a single four-bladed propeller mounted within a 0.76 m (30 in) recess at the stern. The *Peregrine Falcon* was used to transfer personnel and equipment from shore to other vessels involved in the seismic survey activities.

APPENDIX I: ENGLISH UNIT TABLES FROM CHAPTER 3

Table I.7. Forward-endfire Sound level threshold radii in miles for the full 3147 cubic inch airgun array during the Chukchi seismic survey program.

rms SPL (dB re µPa)	Endfire Range (mi)			
	Flat Weighted	Mid Frequency Cetaceans	High Frequency Cetaceans	Underwater Pinnipeds
190	0.28 (1476 ft)	0.11 (561 ft)	0.09 (479 ft)	0.14 (735 ft)
180	0.71	0.30 (1568 ft)	0.25 (1322 ft)	0.42 (2192 ft)
170	1.80	0.81	0.68	1.18
160	4.44	2.08	1.75	3.00
120	36.29	24.86	21.99	31.16

Table I.8. Broadside Sound level threshold radii in miles for the full 3147 cubic inch airgun array.

rms SPL (dB re µPa)	Broadside Range (mi)			
	Flat Weighted	Mid Frequency Cetaceans	High Frequency Cetaceans	Underwater Pinnipeds
190	0.34 (1788 ft)	0.14 (755 ft)	0.11 (600 ft)	0.21 (1135 ft)
180	1.53	0.42 (2215 ft)	0.33 (1745 ft)	0.64
170	2.80	1.20	0.94	1.82
160	5.03	3.23	2.57	4.72
120	41.01	40.54	37.32	45.37

Table I.9. Sound level threshold radii in miles for the mitigation airgun.

rms SPL (dB re µPa)	Endfire Range (mi)
190	<0.01 (33 ft)*
180	<0.01 (33 ft)*
170	0.05 (249 ft)*
160	0.85
120	25.54

* Extrapolated from minimum measurement range 262 ft.

Table I.10. Forward-endfire sound level threshold radii in miles for the full 3147 cubic inch airgun array at Sivilluq Prospect in Camden Bay.

rms SPL (dB re µPa)	Endfire Range (mi)			
	Flat Weighted	Mid Frequency Cetaceans	High Frequency Cetaceans	Underwater Pinnipeds
190	0.47 (2484 ft)	0.04 (197 ft)	0.02 (121 ft)	0.11 (577 ft)
180	1.39	0.18 (935 ft)	0.11 (594 ft)	0.48 (2520 ft)
170	3.72	0.80	0.53 (2776 ft)	1.86
160	8.33	3.03	2.13	5.58
120	46.49*	36.59*	32.46	41.98*

* Extrapolated from maximum measurement range of 58.7 km (36.5 mi).

Table I.11. Broadside sound level threshold radii in miles for the full 3147 cubic inch airgun array at Sivulliq Prospect in Camden Bay.

rms SPL (dB re µPa)	Broadside Range (mi)			
	Flat Weighted	Mid Frequency Cetaceans	High Frequency Cetaceans	Underwater Pinnipeds
190	0.53 (2812 ft)	0.32 (1703 ft)	0.26 (1358 ft)	0.44 (2333 ft)
180	1.30	0.88	0.72	1.15
170	2.99	2.24	1.89	2.81
160	6.27	5.05	4.42	6.05
120	38.45	33.02	31.14	36.01

Table I.12. Sound level threshold radii in miles for the 30 cubic inch mitigation airgun at Sivulliq Prospect in Camden Bay.

rms SPL (dB re µPa)	Best fit range (mi)	90th percentile range(mi)
190	<0.01 (33 ft)*	<0.01 (33 ft)*
180	0.01 (49 ft)*	0.01 (79 ft)*
170	0.23 (1198 ft)	0.29 (1526 ft)
160	0.78	0.89
120	14.24	15.29

* Extrapolated from minimum measurement range of 656 ft.

Table I.13. Sound threshold level radii in miles for 190, 180, 160 and 120 dB re µPa (*rms*) from 2 x 10 in^3 airgun array.

rms SPL	90th percentile fit (mi)
120 dB	6.65
160 dB	0.37 (1959 ft)
180 dB	0.03 (167 ft)
190 dB	0.01 (39 ft)

Table I.14. Sound threshold level radii in miles for 190, 180, 160 and 120 dB re μPa (*rms*) from single 10 in^3 airgun.

rms SPL	90th percentile fit (mi)
120 dB	5.05
160 dB	0.21 (1093 ft)
180 dB	0.01 (66 ft)
190 dB	0.00 (16 ft)

Table I.15. Sound threshold level radii in feet for 160, 150, 140, 130 and 120 dB re μPa (*rms*) from Datasonics SPR-1200 bubble pulser *sub-bottom* profiler.

rms SPL	Best fit range (ft)	90th percentile fit (ft)
120 dB	3104	4108
130 dB	928	1293
140 dB	249	351
150 dB	66	92
160 dB	16	23

Table I.16. Sound threshold level radii in feet for 160, 150, 140, 130 and 120 dB re μPa (*rms*) from the Datasonics CAP6000 Chirp II *sub-bottom* profiler.

rms SPL	Best fit range (ft)	90th percentile fit (ft)
120 dB	689	853
130 dB	187	233
140 dB	49	59
150 dB	13	16
160 dB	3	3

Table I.17. Sound threshold level distances in miles for 190, 180, 160 and 120 dB re μPa (*rms*) from 2 x 10 in^3 airgun array.

rms SPL	90th percentile fit (mi)
190 dB	0.00 (3 ft)*
180 dB	0.00 (23 ft)*
160 dB	0.62
120 dB	15.66

* Extrapolated from minimum measurement range of 656 ft.

Table I.18. Sound threshold level radii in feet for 120-170 dB re μPa (*rms*) for the *MV Henry Christofferson* cruising at 7.4 km/h (4 kt) during operation of the Chirp profiler.

rms SPL	Best fit range (ft)	90th percentile fit (ft)
120 dB	3540	4390
130 dB	866	1047
140 dB	226	276
150 dB	62	72
160 dB	16	20
170 dB	3	7

Table I.19. Sound threshold level radii in feet for 120-180 dB re μPa (*rms*) for the *MV Henry Christofferson* cruising at full speed (22 km/h or 12 kt).

rms SPL	Best fit range (ft)	90th percentile fit (ft)
120 dB	5479 (1.04 mi)	8199 (1.55 mi)
130 dB	1588	2356
140 dB	466	689
150 dB	138	203
160 dB	39	59
170 dB	13	16
180 dB	3	7

Table I.20. Sound threshold level distances in feet for 140, 130 and 120 dB re μPa (*rms*) for the *MV Henry Christofferson* sailing at 6.7 km/h (3.6 kt) with swells.

rms SPL	Best fit range (ft)	90th percentile fit (ft)
140 dB	72*	89*
130 dB	627*	755
120 dB	4101	4724

* Extrapolated from minimum measurement range of 656 ft.

Table I.21. Sound level threshold radii in miles for the *MV Gilavar* at 8.5 km/h (4.6 kt).

rms SPL (dB re μPa)	Best fit range (mi)
150	0.03 (174 ft)*
140	0.19 (984 ft)*
130	0.93**
120	3.91**

* Extrapolated from minimum measurement range of 1148 ft.

** These ranges may be overestimated due to inclusion of reverberation noise from simultaneous and nearby mitigation airgun shooting.

Table I.22. Sound level threshold radii in feet for the support vessel *MV American Islander* cruising at 14 km/h (7.8 kt).

rms SPL (dB re µPa)	Range (ft)
140	82*
130	427*
120	2133

* Extrapolated from minimum measurement range of 1640 ft.

Table I.23. Sound level threshold radii in feet for the G*ulf Provider* in Camden Bay.

rms SPL (dB re µPa)	Best fit range (ft)
140	112*
130	394
120	1312

* Extrapolated from minimum measurement range of 1640 ft.

Table I.26-1. Sound level threshold radii in feet for the airgun array and mitigation gun from seismic vessel Gilavar in the Chukchi Sea.

rms SPL (dB re µPa)		190	180	170	160	120
Airgun Endfire Range (ft)	Flat Weighted	1476	3740	9514	23458	191601
	Mid Frequency Cetaceans	561	1568	4278	10994	131240
	High Frequency Cetaceans	479	1322	3579	9236	116109
	Underwater Pinnipeds	735	2192	6211	6211	15860
Airgun Broadside Range (ft)	Flat Weighted	1788	8104	14764	26575	216535
	Mid Frequency Cetaceans	755	2215	6342	17073	214029
	High Frequency Cetaceans	600	1745	4984	13563	197057
	Underwater Pinnipeds	1135	3369	9590	24905	239573
Mitigation Gun Range (ft)	Best Fit	<33*	<33*	180*	3678	120791
	90th Percentile	<33*	<33*	249*	4462	134843

* Extrapolated from minimum measurement range 262 ft.

Table I.26-2. Sound level threshold radii in miles for the airgun array and mitigation gun from seismic vessel Gilavar in the Chukchi Sea.

rms SPL (dB re µPa)		190	180	170	160	120
Airgun Endfire Range (mi)	Flat Weighted	0.28	0.71	1.80	4.44	36.29
	Mid Frequency Cetaceans	0.11	0.30	0.81	2.08	24.86
	High Frequency Cetaceans	0.09	0.25	0.68	1.75	21.99
	Underwater Pinnipeds	0.14	0.42	1.18	1.18	3.00
Airgun Broadside Range (mi)	Flat Weighted	0.34	1.53	2.80	5.03	41.01
	Mid Frequency Cetaceans	0.14	0.42	1.20	3.23	40.54
	High Frequency Cetaceans	0.11	0.33	0.94	2.57	37.32
	Underwater Pinnipeds	0.21	0.64	1.82	4.72	45.37
Mitigation Gun Range (mi)	Best Fit	<0.01*	<0.01*	0.03*	0.70	22.88
	90th Percentile	<0.01*	<0.01*	0.05*	0.85	25.54

* Extrapolated from minimum measurement range 0.05 mi.

Table I.27-1. Sound level threshold radii in feet for the airgun array and mitigation gun from seismic vessel *Gilavar* in Camden Bay.

rms SPL (dB re µPa)		190	180	170	160	120
Airgun Endfire Range (ft)	Flat Weighted	2484	7365	19639	43980	245449*
	Mid Frequency Cetaceans	197	935	4236	15981	193196*
	High Frequency Cetaceans	121	594	2776	11270	171385
	Underwater Pinnipeds	577	2520	9806	29462	221677*
Airgun Broadside Range (ft)	Flat Weighted	2812	6850	15787	33084	203041
	Mid Frequency Cetaceans	1703	4636	11808	26667	174367
	High Frequency Cetaceans	1358	3796	9977	23317	164432
	Underwater Pinnipeds	2333	6093	14820	31942	190131
Mitigation Gun Range (ft)	Best Fit	<33**	49**	1198	4137	75167
	90th Percentile	<33**	79**	1526	4721	80709

* Extrapolated from maximum measurement range of 58.7 km (36.5 mi).

** Extrapolated from minimum measurement range of 656 ft.

Table I.27-2. Sound level threshold radii in miles for the airgun array and mitigation gun from seismic vessel *Gilavar* in Camden Bay.

rms SPL (dB re µPa)		190	180	170	160	120
Airgun Endfire Range (mi)	Flat Weighted	0.47	1.39	3.72	8.33	46.49*
	Mid Frequency Cetaceans	0.04	0.18	0.80	3.03	36.59*
	High Frequency Cetaceans	0.02	0.11	0.53	2.13	32.46
	Underwater Pinnipeds	0.11	0.48	1.86	5.58	41.98*
Airgun Broadside Range (mi)	Flat Weighted	0.53	1.30	2.99	6.27	38.45
	Mid Frequency Cetaceans	0.32	0.88	2.24	5.05	33.02
	High Frequency Cetaceans	0.26	0.72	1.89	4.42	31.14
	Underwater Pinnipeds	0.44	1.15	2.81	6.05	36.01
Mitigation Gun Range (mi)	Best Fit	<0.01**	0.01**	0.23	0.78	14.24
	90th Percentile	<0.01**	0.01**	0.29	0.89	15.29

* Extrapolated from maximum measurement range of 58.7 km (36.5 mi).

** Extrapolated from minimum measurement range of 656 ft.

Table I.28. Maxima of Broadside and Forward-endfire direction flat weighted sound level radii in miles for the full 3147 cubic inch airgun array in Camden Bay.

rms SPL (dB re µPa)	Maximum distance (mi)
190	0.53 (2798 ft)
180	1.39
170	3.72
160	8.33
120	46.49*

*Extrapolated from maximum measurement range of 58.7 km (36.5 mi).

Table I.29. Sound level threshold radii in feet for airgun(s) and *sub-bottom* profilers from seismic vessel *Henry Chistofferson* at Beechey Point.

rms SPL (dB re µPa)		190	180	170	160	120
2 × 10 in3 Airgun Array Range (ft)	90th Percentile	39	167		1959	35105 (6.65 mi)
Single 10 in3 Airgun Range (ft)	90th Percentile	16	66		1093	26673 (5.05 mi)
Bubble Pulser Range (ft)	Best Fit	16	66	249	928	3104 (0.59 mi)
	90th Percentile	23	92	351	1293	4108 (0.78 mi)
Chirp II Range (ft)	Best Fit	3	13	49	187	689
	90th Percentile	3	16	59	233	853

Table I.30. Sound level threshold radii in miles for airgun array from seismic vessel *Henry Christofferson* in Camden Bay.

rms SPL (dB re µPa)		190	180	160	120
2 × 10 in^3 Airgun Array Range (mi)	90th Percentile	0.00 (3 ft)*	0.00 (23 ft)*	0.62	15.66

* Extrapolated from minimum measurement range of 656 ft.

Table I.31. Sound threshold level radii in feet for 180-120 dB re µPa (*rms*) for the vessels used in SOI's 2007 Seismic Survey and Shallow Hazards programs.

rms SPL (dB re µPa)		180	170	160	150	140	130	120
Henry C in Beechey Point at 7.4 km/h (4 kt) Range (ft)*	Best Fit		3	16	62	226	866	3540
	90th Percentile		7	20	72	276	1047	4390 (0.83 mi)
Henry C in Beechey Point at 22 km/h (12 kt) Range (ft)	Best Fit	3	13	39	138	466	1588	5479 (1.04 mi)
	90th Percentile	7	16	59	203	689	2356	8199 (1.55 mi)
Henry C in Camden Bay at 6.7 km/h (3.6 kt) Range (ft)	Best Fit					72**	627	4101 (0.78 mi)
	90th Percentile					89**	755	4724 (0.89 mi)
Gilavar at 8.5 km/h (4.6 kt) in Camden Bay Range (ft)	Best Fit				174†	984†	4921††	20669 (3.91 mi)††
American Islander at 14 km/h (7.8 kt) in Camden Bay Range (ft)	Best Fit					82†††	427†††	2133
Gulf Provider at 18 km/h (9.7 kt) in Camden Bay Range (ft)	Best Fit					112†††	394	1312
Maxime at 12 km/h (6.5 kt) in Prudhoe Bay Range (ft)	Best Fit						82	381
Mikkelsen Bay at 10 km/h (5.5 kt) in Prudhoe Bay Range (ft)	Best Fit							554
Jim Kilabuk at 8.3 km/h (4.5 kt) in Prudhoe Bay Range (ft)	Best Fit						1148	4839 (0.92 mi)
Norseman II at 19 km/h (10 kt) in Prudhoe Bay Range (ft)	Best Fit						397	1969

* The Chirp II profiler was operating during this pass due to miscommunication with the ship crew.

** Extrapolated from minimum measurement range of 656 ft.

† Extrapolated from minimum measurement range of 1148 ft.

†† These ranges may be overestimated due to inclusion of reverberation noise from simultaneous and nearby mitigation airgun shooting.

††† Extrapolated from minimum measurement range of 1640 ft.

APPENDIX J: DEFINITIONS OF BEAUFORT WIND FORCES

WIND SPEED		BEAUFORT WIND FORCE	WORLD METEOROLOGICAL ORGANIZATION TERMS	WAVE HEIGHT (M)	DESCRIPTION
KNOTS	M/S				
<1	<0.5	0	Calm	0	Glassy like a mirror
1-3	0.5-1.5	1	Light air	<0.1	Ripples with the appearance of scales but no whitecaps or foam crests
4-6	2.1-3.1	2	Light breeze	0-0.1	Small wavelets, crests have a glassy appearance but do not break (no whitecaps)
7-10	3.6-5.1	3	Gentle breeze	0.1-0.5	Smooth large wavelets, crests begin to break, occasional/scattered whitecaps
11-16	5.7-8.2	4	Moderate breeze	0.5-1.2	Slight; small fairly frequent whitecaps
17-21	8.7-10.8	5	Fresh breeze	1.2-2.4	Moderate waves becoming longer, some spray, frequent moderate whitecaps
22-27	11.3-13.9	6	Strong breeze	2.4-4	Rough, larger waves, longer-formed waves, many large whitecaps
28-33	14.4-17.0	7	Near gale	4-6	Very rough, large waves forming, white foam crests everywhere, spray is present
34-40	17.5-20.6	8	Gale		
41-47	21.1-24.2	9	Strong gale		
48-55	24.7-28.3	10	Storm	6-9	High
56-63	28.8-32.4	11	Violent storm	9-14	Very high