NMFS' Questions/Comments/Suggestions on the Shell 2009-2010 IHA Open Water Marine Survey Program Application

1. How far offshore are the project areas for the site clearance and shallow hazards surveys in the Chukchi and Beaufort Seas?

Shell Response:
Shell has cancelled all of the planned Open Water Marine Survey Program (site clearance and shallow hazards, ice gouge, and strudel scour surveys) in the Beaufort Sea for 2009. Shell has also cancelled the ice gouge surveys in the Chukchi Sea. The site clearance and shallow hazards surveys are planned for the 2009 open water season in the Chukchi Sea. These surveys will take place in the Chukchi Sea approximately 60 miles or greater offshore of the Alaska coast.

2. How far offshore are the project areas for the ice gouge surveys in the Chukchi and Beaufort Seas?

Shell Response:
As noted in response to Question 1 (above), Shell has cancelled the ice gouge surveys in both the Chukchi and Beaufort Sea for the 2009 season.

3. The application states that the Beaufort Sea site clearance and shallow hazards surveys will be completed by the end of August. If surveys are not concluded by the end of the month, does Shell have plans to try to acquire the remaining data in September? If the answer to this question is yes, then NMFS will most likely put a provision in the IHA that the surveys must stop after August 25 and not resume until the end of the bowhead subsistence hunts in Kaktovik and Nuiqsut. Additionally, there may or may not be a requirement to conduct aerial survey monitoring if surveys continue into September. This will depend on the size of the 120 dB isopleths.

Shell Response:
Shell has cancelled planned site clearance and shallow hazard surveys in the Beaufort Sea for the 2009 season.

4. Page 34 of the application provides the radii for the 160 dB isopleths for both the one gun and the two guns from three different vessels. Are the *Henry Christoffersen* and the *Cape Flattery* and the guns used on those two vessels the same or very similar to the *Norseman II*, which is proposed for use during the site clearance and shallow hazards surveys in 2009?

Shell Response:
The equipment Shell will use on the *Norseman II* is the same equipment used on the *Cape Flattery* during the 2008 season and referenced at page 34 of the application.

5. Additionally, what are the radii for the 190, 180, and 120 dB isopleths for these sources? I see that a table has been provided on page 12 of the 4MP. Is it Shell's intention that NMFS use these modeled radii in its assessments for the airgun sources, and then new radii will be applied following the sound source verification tests?

Shell Response:
Yes, Shell prefers that NMFS use the modeled radii in Table 1 on page 12 of the 4MP to estimate exposures. These radii are the sound threshold level radii to 190, 180, 170, 160, and 120 dB re µPa (rms) for the 2 X 10^3 inch airgun array. These radii were calculated using similar equipment and vessels from the 2008 Sound Source Verification (SSVs) in the area were the open water surveys will be preformed. Shell currently does not plan on completing SSVs on the vessel conducting the open water marine surveys in the Chukchi Sea during the 2009 season; however, as discussed below, Shell is considering the use of alternative equipment for its surveys, and, if such equipment is used, Shell will complete appropriate SSVs.

Since Shell submitted its 2009 IHA application for an open water marine survey program, it has been considering alternative methods of data collection for site clearance and shallow hazard surveys in the Chukchi Sea. One option Shell is considering is the replacement of the 2 X 10^3 inch airgun array with a sparker survey instrument. A sparker generates an acoustic pressure pulse by discharging a short duration electrical pulse between an electrode and a grounded frame spaced several inches apart in the conducting medium of seawater. The rapid discharge of electrical energy between the frames generates a bubble which generates a positive pulse of acoustic energy.

In most cases, the sparker will result in a somewhat smaller ensonified area than with airguns and therefore fewer "takes." ConocoPhillips measured received sound levels from a 10 kj sparker last year and reported radii of 5, 30, and 1170 m for the 190, 180, and 160 dB rms zones, respectively (available in their 90-d report to NMFS [pg. 23], on the NMFS website). By comparison, the measured received sound levels from the 2 x 10^3 inch airgun array from the Cape Flattery in the Chukchi Sea were: 17 m, 62 m, 830 m, and 25,000 m for the 190, 180, 160, and 120 dB rms levels, respectively.

Should Shell decide on using the sparker system, Shell will perform SSVs on the vessel and its survey equipment before the surveys begin in the Chukchi Sea. Shell would then provide NMFS the sound source radii for the sparker system following conclusion of SSVs.

6. Section 7 (The anticipated impact of the activity on the species or stock) of the application is quite short and does not touch on some other possible effects, such as tolerance, masking, and non-auditory physiological effects. NMFS recommends that in addition to the information on permanent threshold shift that Shell is preparing to submit to NMFS, Shell should also submit a write-up on the possibilities or likelihood of these other effects as a result of the proposed activities.

Shell Response:

Any impacts to marine mammals associated with noise propagation from vessel movements and survey operations would be non-lethal, temporary and, at most, might result in short term displacement of whales and seals from within the ensonified zones produced by such noise sources. Please note that the following discussion of potential behavioral deflection of whales or seals from received sound levels pertains to observations of behavior during relatively large scale seismic programs, such as deep 3D seismic sound sources. Shell's planned 2009 open water marine survey program only includes small-scale sound sources used to perform site clearance and shallow hazards and ice gouge surveys.

Any impacts on the whale and seal populations in the vicinity of Shell's Chukchi Sea operations will be non-lethal, short-term and transitory arising from the temporary displacement of individuals or small groups from locations they may occupy at the time they are exposed to sounds between the 160- to 190-dB received levels. In the case of migrating bowhead whales, that displacement might take the form of deflection from its swim path away from (seaward of) received noise levels lower than 160 dB (Richardson et al., 1999). While it is not presently known at what distance after passing the sound source bowhead whales return to their previous migration route, any deflection is only temporary and does not adversely impact the whales or materially affect the whales' successful completion of the migration to the winter calving grounds. Richardson and Thomson [eds]. (2002) found that bowheads engaged in feeding activities did not appear to avoid seismic survey activities until received sound levels were at or above 160 dB rms.

Results from the 1996-1998 BP and Western Geophysical seismic monitoring programs in the Beaufort Sea indicate that most fall migrating bowheads deflected seaward to avoid an area within about 20 km (12.4 mi) of an active nearshore seismic operation, with the exception of a few closer sightings when there was an island or very shallow water between the seismic operations and the whales (Miller et al., 1998, 1999). The available data do not provide an unequivocal estimate of the distance (and received sound levels) at which approaching bowheads begin to deflect, but this may be on the order of 35 km (21.7 mi). Any deflection as a result of being exposed to seismic operations would be temporary and would not adversely impact the whales or materially affect the whale's successful completion of the migration to the winter calving grounds.

When the received levels of noise exceed some threshold, cetaceans will show behavioral disturbance reactions. The levels, frequencies, and types of noise that will elicit a response vary between and within species, individuals, locations, and seasons. Behavioral changes may be subtle alterations in surface, respiration, and dive cycles. More conspicuous responses include changes in activity or aerial displays, movement away from the sound source, or complete avoidance of the area. The reaction threshold and degree of response also are related to the activity of the animal at the time of the disturbance. Whales engaged in active behaviors, such as feeding, socializing, or mating, appear less likely than resting animals to show overt behavioral reactions, unless the disturbance is perceived as directly threatening.

Masking

Masking effects of pulsed sounds will be limited relative to continuous sound sources. Bowhead whales are known to continue calling in the presence of marine survey sounds, and their calls can be heard between sound pulses, although at reduced rates (Greene et al., 1999, Richardson et al., 1986). Masking effects are expected to be absent in the case of belugas, given that sounds important to them are predominantly at much higher frequencies than are airgun sounds.

Injury and Mortality

There is no evidence that bowheads or other marine mammals exposed to survey sounds in the Arctic have incurred an injury to their auditory mechanisms. Richardson et al. (1995) notes that temporary threshold shift (TTS) is a theoretical possibility for animals within a few hundred meters of the source. More recently, scientists have determined that the received level of a single sound pulse might need to be ~210 dB re 1 [mu]Pa rms (~221-226 dB pk) in order to produce brief, mild TTS. Exposure to several sound pulses at received levels near ~210 dB (rms) might result in slight TTS in a small odontocete, assuming the TTS threshold is a function of the total received pulse energy. Sound pulses with received levels of ~210 dB or more are usually restricted to a radius of no more than 200 m (656 ft) around a survey vessel operating a large array of airguns. Shell's 2009 open water marine survey program of site clearance and shallow hazard and ice gouge surveys with 2 x 10^3 inch airguns or 6kj sparker may generate sound pulses of 190 dB, 20 dB less than ~210 dB, but in neither case would the 190dB sound pulses exceed 20m from the source. Clearly it is extremely unlikely that any whales or seals would be in this close of proximity to the sound sources to incur the onset of TTS. Furthermore , there is a strong likelihood that baleen whales (*i.e.*, bowheads, gray whales and humpback whales) would avoid the approaching sound source (or vessel) before being exposed to levels high enough for there to be any possibility of onset of TTS.

For pinnipeds, information indicates that for single sound impulses, sounds would need to be higher than 190 dB rms for TTS to occur while exposure to several sound pulses indicates that some pinnipeds may incur TTS at somewhat lower received levels than do small odontocetes exposed for similar durations.

Permanent Threshold Shift (PTS)

There is no specific evidence that exposure to pulses of airgun sound can cause PTS in any marine mammal, even with large arrays of airguns. However, given the possibility that mammals close to an airgun array might incur TTS, there has been further speculation about the possibility that some individuals occurring very close to airguns might incur PTS. Single or occasional occurrences of mild TTS are not indicative of permanent auditory damage in terrestrial mammals. Relationships between TTS and PTS thresholds have not been studied in marine mammals, but are only assumed to be similar to those in humans and other terrestrial mammals. PTS might occur at a received sound level 20 dB or more above that inducing mild TTS if the animal were exposed to the strong sound for an extended period, or to a strong sound with very rapid rise time.

Again, Shell's 2009 open water marine survey program of site clearance and shallow hazard and ice gouge surveys with 2 x 10^3 inch airguns or 6kj sparker may generate sound pulses of 190 dB, 20 dB less than ~210 dB, that is thought to potentially cause the onset of TTS. Therefore, it is even more extremely unlikely that any whales or seals would be in this close of proximity to the sound sources to incur PTS. Given the higher level of sound necessary to cause PTS, it is even less likely that PTS could occur. Baleen whales generally avoid the immediate area around operating seismic vessels. The planned monitoring and mitigation measures, including visual monitoring and shut downs of the airguns when mammals are seen within the "safety radii", will essentially eliminate the already-minimal probability of exposure of marine mammals to sounds strong enough to induce PTS.

7. When can NMFS Office of Protected Resources expect to receive a copy of the draft Plan of Cooperation?

Shell Response:
The Chukchi Sea Plan of Cooperation (POC) meetings in Wainwright, Point Hope Point Lay, and Kotzebue were scheduled for February 16-19, 2009, but winter weather conditions postponed these meetings. POC meetings for the Chukchi Sea communities are now scheduled for the fourth week in March 2009. A draft copy of the POC should be complete sometime in mid to late April 2009, Shell will provide NMFS the draft plan on its completion.

8. On page 2 of Attachment A, the 4MP, the following statement is found: "The MMOs will be stationed aboard the survey source vessels and other support vessels throughout the active field season." In the description of the activity (Section 1 of the application), it states that all of the various surveys can be conducted with only one source vessel and that no support vessels are necessary to carry out the surveys. Is it a mistake that the above mentioned sentence includes the mention that MMOs will be placed on support vessels?

Shell Response:
Yes, Shell intends on placing MMOs on the source vessel only. Given that the ensonified radii for > 160 dB rms can be monitored by MMOs stationed on the source vessel, the source vessel will not need a support vessel during site clearance and shallow hazards or ice gouge surveys in the Chukchi Sea during the 2009 season.

9. **NMFS requests that Shell provide some additional information on the ancillary acoustic devices that are proposed to be used during the site clearance and shallow hazards surveys, such as the source levels of the devices and whether or not these devices have the capability to be ramped-up.**

Shell Response:
It is planned that the following acoustic instrumentation, or something similar, will be used for the 2009 site clearance/shallow hazards program in the Chukchi Sea.

- Dual frequency subbottom profiler (2 to 7kHz or 8 to 23 kHz), or similar;
- Single beam Echo Sounder (33-210 kHz), or similar;
- Multi-beam Echo Sounder (200 kHz), or similar;

- High resolution multi-channel 2D system, 2 x 10^3 inch airguns (0 to 150 Hz), or similar;
- Shallow Sub-Bottom Profiler (1-12 kHz), or similar;
- Medium penetration subbottom profiler, (400-800 Hz), or similar; and
- Sparker (6 kj max).

The High resolution multi-channel 2D system, 2 x 10^3 inch airguns or the sparker survey do not have the capability to be ramped-up as classically defined for larger 3D seismic arrays, but do have the capability of a soft startup. In a two gun array, the first gun can be turned on followed by the second, and the sparker dual tip sound source instrument may also be soft started by sequentially turning on the acoustical tips. The other survey devices are instantaneously turned on, or off.

10. On page 10 of the 4MP, bullet number 3 under the Reporting section has the word delectability instead of detectability. NMFS suggests correcting this particular typo.

Shell Response:
Thank you. Shell will correct the typo in the 4MP to read detectability instead of delectability.