WESTERN GRAY WHALE ADVISORY PANEL **SSTF-5**
4-D SEISMIC SURVEY TASK FORCE

REPORT OF THE 4-D SEISMIC SURVEY TASK FORCE AT ITS 5TH MEETING

13–14 APRIL 2010
GENEVA, SWITZERLAND

CONVENED BY INTERNATIONAL UNION FOR CONSERVATION OF NATURE

5th Meeting of the 4-D Seismic Survey Task Force
Hotel Warwick, Geneva, Switzerland, 13-14 April 2010

CONTENTS

LIST OF ACRONYMS USED

AIS	**= Automated Information System**
AUAR	**= Automated Underwater Acoustic Recorder**
CPA	**= Closest Point of Approach**
DMNG	**= DalMorNefteGeophizika**
EIA	**= Environmental Impact Assessment**
ENL	**= Exxon Neftegas Limited**
IUCN	**= International Union for Conservation of Nature**
IWC	**= International Whaling Commission**
IWG	**= Interdepartmental Working Group on Western Gray Whale Conservation of Russian Federation**
MMO	**= Marine Mammal Observer**
MMPP	**= Marine Mammal Protection Plan**
MNR	**= Ministry of Natural Resources of Russian Federation**
NGO	**= Non-Governmental Organization**
OV	**= Observation Vessel**
PML	**= Perimeter Monitoring Line**
RHIB	**= Rigid Hull Inflatable Boat**
SSTF	**= Seismic Survey Task Force**
SSV	**= Seismic Survey Vessel**
WGWAP	**= Western Gray Whale Advisory Panel**

The 5th meeting of the Seismic Survey Task Force (hereafter SSTF with reference to the meeting as SSTF-5) was held at the Hotel Warwick, Geneva, Switzerland on 13-14 April 2010 under the chairmanship of Randall R. Reeves.

1. INTRODUCTORY ITEMS

1.1 Introductions of participants

Reeves welcomed participants (Annex A). After some discussion and a few additions to the draft, a final agenda was adopted (Annex B).

Participants introduced themselves. Béatrice Riché served as meeting rapporteur. Finn Larsen and Riché of IUCN also provided various types of support to the task force. Brandon Southall, acting as an associate scientist for the WGWAP-8 meeting, attended both days of the task force meeting.

1.2 Aims of workshop and expected product

As this was to be the last meeting of the task force before the 2010 Astokh 4-D seismic survey, the primary goal was to ensure that all outstanding issues regarding the monitoring and mitigation plan were considered and resolved to the extent possible. The product of SSTF-5 is this publicly available report as well as the recommendations and discussions regarding the seismic survey in the report of WGWAP-8.

2. DOCUMENTS AND PROGRESS REPORTS

2.1. Review of available documents

2.1.1. Existing documents made available

Previous WGWAP and SSTF reports were available on the IUCN WGWAP website (http://www.iucn.org/wgwap/) and were referred to throughout the meeting.

2.1.2. New documents prepared for this meeting

Several working documents were prepared for the current meeting.

Sakhalin Energy prepared:

i) a 'contingency plan' for the operation of the observation vessel (OV) if the acoustics shore station loses the ability to monitor the remote acoustic buoys;

ii) an 'A-line truncation proposal' to apply B-line criteria to portions of A-lines that are not predicted to result in the 156 dB_{SEL} threshold being exceeded at the PML; and

iii) a draft behaviour sampling protocol.

The Panel provided:

i) the draft Terms of Reference (TOR) for an Independent Observer (IO); and

ii) a draft data management plan prepared by Southall.

Only the TOR and behaviour protocol were intended to end up being stand-alone documents, specifically as appendices to this report. The other items were to be subsumed into the text and annexes of this report.

Additionally, the SSTF was provided with the library of acoustic modelling cases constructed by Sakhalin Energy, as well as some raw acoustic data (electronically) from the acoustic monitoring team.

2.2. Summary of progress since WGWAP-7 and results of tasks requested at WGWAP-7

This part of the agenda was covered item by item; see below.

2.3. Identification of outstanding issues to be resolved

All outstanding issues known to the SSTF were identified in the Agenda for this meeting.

2.4. Other new information (*e.g.* updates to EIA)

Sakhalin Energy reported that the Environmental Impact Assessment (EIA) for the Astokh 4-D seismic survey had been initiated several years ago when it thought that the company would need to apply for permits. In strictly legal terms, no EIA is required, but Sakhalin Energy has nonetheless continued to work on it. Some small changes have been made recently to update the document. The EIA has been available on the IUCN website for the last year. It was concluded that there was no need for the SSTF to discuss the EIA further at this point.

3. OPERATIONAL PLANS AND EXPECTATIONS

3.1. Summary of seismic acquisition plans, preparation status and start date based on ice data

Sakhalin Energy summarized its seismic acquisition preparations (see previous SSTF reports for more details on overall design and planning, all available at IUCN website). All contracts for seismic acquisition, support, and monitoring and mitigation are in place. Approvals for DMNG licensing are ahead of schedule and the monitoring and mitigation programme has been submitted to the Ministry of Natural Resources (MNR). Preparations are proceeding as planned, and a technical kick-off meeting is planned for mid May in Yuzhno-Sakhalinsk. Training and mobilisation of onshore and offshore monitoring teams and equipment are expected to commence in the last week of May. Terwogt advised the task force that the seismic survey vessel, *Pacific Explorer*, has no other jobs scheduled before the Sakhalin Energy survey, which should further ensure that the survey will commence as early as possible.

Although the 2009-10 winter and the sea ice coverage were initially classified as ‘mild’, severe ice build-up occurred in the latter half of March. The maximum ice extent was seen on 31 March and the ice was finally, at the time of the SSTF meeting, melting and moving. The current estimate was that the sea in the Astokh area would become ice-free between 11 and 15 June. It was noted that given the late formation of the ice, it would likely be thinner than if it had formed earlier in the winter and thus could break up, melt or be moved away more quickly by winds and tides. Given this and the desire for the survey to occur as early in the open-water season as possible, the SSTF encouraged Sakhalin Energy to continue monitoring the ice conditions closely. Terwogt explained the incentive scheme designed for the seismic operator’s contract to ensure that acquisition of the survey occurs as early as possible. The PGS/DMNG acquisition vessel is currently planned to mobilise to Sakhalin from its current location on 22 May, and thus should arrive well ahead of the expected ice-free window.

Terwogt also described the results from the 4-D seismic test line conducted in 2009; acoustic results from this line had been presented to the Panel at WGWAP-7 in the context of the performance of the propagation modelling.

3.2. Update on monitoring and mitigation logistics, preparations and platform stability for theodolites

The following information was provided by Sakhalin Energy:

Management of logistics
LGL Sakhalin has been contracted to coordinate the logistics for implementation of the 4-D seismic monitoring and mitigation plan. In addition, an ‘outdoor-specialist’ has been hired to provide advice and assistance in camp design and management, accommodation and safety.

Field teams
All members of the acoustics, distribution and behaviour field teams have been identified and have confirmed their participation. Letters of Invitation for non-Russian residents are being processed and will be available shortly so that visas can be obtained in time.

Accommodation

A temporary camp will be constructed at the southernmost tip of Piltun Lagoon. Several large, high-quality tents ($72m^2$) have been sourced, which will be heated by electrically powered heating units. [Post-meeting note: Sakhalin Energy advised that cabins were to be used instead of tents.] These tents [cabins] will be used for accommodation, office space, clinics and food preparation. Heaters and generators are available and, together with other items (beds, mattresses etc.), will be transported to Nogliki in 24 ft containers. Portable toilets and showers will be installed in the camp with water supplied from either Nogliki or the ENL facilities in Chaivo. A doctor or paramedic will be contracted for permanent presence in the camp with all equipment required for emergency situations. A helicopter pad will be set up in the near vicinity of the camp. Camp construction crew, camp manager and cooks have been contracted.

A mobilisation schedule has been prepared and the final version will depend on the start date of the survey. Camp construction will start 2.5 weeks prior to the start of the seismic survey. Field teams are scheduled to mobilise in order to be in the field 9 days prior to the seismic survey for a week of pre-survey monitoring. A kick-off meeting is scheduled for all field team members prior to mobilisation for training and to discuss safety and monitoring protocols.

Transport

Sufficient light vehicles (4WD) and heavy vehicles (trucks) have been contracted for mobilisation of field teams and transport of monitoring teams.

Towers

During SSTF-4 concern had been expressed about vibration of the observation towers, which could compromise the effective and precise use of the theodolites. To address this issue, an independent structure was designed that could be constructed below the tower. Cut-outs will be made in the deck of the observation tower so the tripod can be placed on the independent structure below. This structure has been designed, constructed and tested. Results were satisfactory and were communicated at the meeting, with detailed photographs. A contract is in place with the Nogliki Forestry Department, who will construct these structures in May 2010.

Communication

Required communication lines have been determined and were included in the SSTF-4 report. Both mobile phones and VHF will be used for communication between teams on shore and on vessels. Use of mobile phones is preferred but all teams will be provided with VHF radios as well. Information on vessel positions will be made available to the base camp on shore – the method was still to be finalised. The communications protocol (*e.g.* specific channels, battery back-up) was still being developed but was planned to be completed by mid-May. The task force **recommended** that a summary checklist be provided to the Panel (via IUCN) for a quick turnaround review at least one week before the seismic survey begins. [Post-meeting note: This did not happen.]

Observation vessel

A contract for the vessel *Pavel Gordienko* is in place. Modifications to the vessel are being made to facilitate the deployment of buoys. A suitable location for installation of the Big-Eyes binoculars had not yet been identified at the time of the meeting. The Big-Eyes stand had been constructed but a method for installation had not been determined. Welding directly onto the deck is not possible because it is made of aluminium-alloy.

The desired model of Big-Eyes binoculars had been identified (Fujinon 25x150 MTM) and ordered.

3.3. Update of acoustic modelling and library of cases to run pre-acquisition

The following information was provided by Sakhalin Energy (via Racca):

To obtain a sufficiently varied sampling of propagation cases to reasonably match the conditions found in the field, the 156 dB SEL shoreward noise envelope front from each shot line is modeled using three sets of parameters:

1. A base case using geo-acoustic profiles optimised against transmission loss (TL) measurements and identical to those used for all prior industrial sound modelling in Piltun-Astokh, and a water sound speed profile representative of early-summer conditions;

2. A lower-loss case using an isovelocity water sound speed profile and an increased compressional speed in the substrate (to a reasonable physically acceptable limit); and
3. A higher-loss case using the same water sound speed profile as the base case but a decreased compressional speed in the substrate (to a reasonable physically acceptable limit).

Comparison of the acoustic footprints generated by the three scenarios for various shot lines shows that the influence of the propagation conditions on the shoreward extent of the noise front is moderate, amounting to a change of about +3dB for the lower-loss case and about -1dB for the higher-loss case relative to the results for the base case. Indeed the shoreward noise fronts obtained by offsetting the base case by the indicated amounts tend to coincide closely with the fronts from the modelling with the modified parameters. The footprints for the three cases, on the other hand, do differ more variably in directions other than broadside. The following strategy for the selection of the most appropriate footprint at the beginning of a line is therefore proposed [note that step (a) will be performed in advance of the field mobilization]:

a) For each of the noise footprints in the library a table of forecast acoustic levels at the seafloor, where the sensors are located, is pre-computed at the first three sensor sites on the PML for a seismic source position at CPA (closest point of approach) relative to the first sensor. For the most inshore lines, which do not extend south of the first sensor, this reference source position will be the start of the line instead. Levels will also be pre-computed for the seismic source at the CPA of all remaining sensors. The definition of “first” and “first three” here is meant relative to the line sail direction.

b) Upon the seismic array reaching the position defined in point a), the pulse levels measured at the first three sensors on the PML will be compared with the pre-computed sensor levels for the base, low-loss and high-loss footprints, and the case that gives the least residuals will be selected.

c) The levels for the selected case will then be adjusted by addition or subtraction of a common integer dB offset to minimize the residuals at the first three sensors. This will identify the footprint to be used as the boundary of the 156 dB SEL ensonified area for the line in question.

d) The selected footprint will be communicated to the behaviour observation teams as a coded identifier (for example “BC+2” for “base case plus 2dB” or “LL-1” for “lower loss minus 1dB”). The teams will already have these footprints available as GIS layers on which whale observations can be superimposed.

e) As the seismic source progresses along a line and reaches the CPA for subsequent PML sensors, the shore team will monitor the measured level and, if necessary, call for a line reclassification based on the criteria stated elsewhere in this document.

Some concern was expressed within the SSTF that this approach relies too heavily on the propagation models. The alternative, however, would be to have additional sensors distributed throughout the area where whales are likely to receive measurable levels of noise. The cost and complexity of adding receivers, as well as the disturbance associated with distributing and servicing them, make such additions inadvisable and/or infeasible.

4. TRUNCATED A-LINE PROPOSAL

At SSTF-4, the concept was introduced of a region within the Astokh 4-D survey shooting area in which individual lines may not be sailed entirely under a single set of mitigation rules (see SSTF-4 report, Section 4.3). Under this scenario, which is intended to follow the established monitoring and mitigation protocols but to facilitate rapid completion of the survey, either the more precautionary “A” regime or the more readily executed “B” regime will be used, but the approach may switch between the two regimes as the slanted heading of a survey line takes the source progressively closer to or farther from the edge of the feeding area. This leads to the concept of a polygonal “A-line region” boundary encompassing the portion of shot lines to be sailed according to the stricter mitigation rules.

At the December 2009 meeting (SSTF-4), the SSTF requested that a pre-season definition of the A-line region be provided by Sakhalin Energy based on model estimations and incorporating the results of field validation studies, for each shot line affected, of the overlap between the sound propagation front (multi-shot envelope contour) at the 156 dB SEL level and the region shoreward of the PML. The SSTF recommended that this definition include sufficient precautionary allowance to avoid any revisions in the field, though the SSTF recognized that real-time monitoring of levels at the PML provides an intrinsic verification of the noise front estimates for a line being sailed. At this (5th) meeting of the SSTF, Sakhalin Energy proposed a modified definition of the A-line region, as requested, and the text below represents this new approach with several minor clarifications and/or additional specifications.

The SSTF-4 report, based on information available at that time, stated that all shot lines on the shoreward side of the survey area would be sailed towards the southeast. However, upon examination of the 1997 acquisition report, it was re-confirmed that the sailing direction is from southeast to northwest. This has marked benefits in terms of a precautionary approach, as sailing a line starting from its “quieter” end presumably provides better options for monitoring and verification of model results with real-time acoustic data.

To generate a well delineated boundary for the A-line region the acoustic propagation model for the Astokh-4D seismic source was used to generate 156 dB SEL sound front estimates for the survey lines in the shoreward part of the survey area (sound front is defined here as the envelope of the individual shot noise contours as the source travels along a line).

Given the large computational time demands, the model was run for every tenth shot point along every second survey line starting with the one closest to shore, switching to single-track spacing as required to pinpoint the line at which the 156 dB SEL acoustic front would no longer affect the feeding area. The model was run with the “base” set of parameters, which have proven to generate intrinsically precautionary overestimates of received levels under the shoreward shallow water propagation conditions characterizing the Astokh 4-D scenario. Two empirical verifications of model results have been performed by JASCO against seismic array pulse measurements in the same geographic region: a comparison to published measurements from the 2001 ENL Odoptu survey and a validation against recordings of a seismic source operated on a single line just inshore of the PA-A platform. Results for both of these have been presented in SSTF and/or WGWAP meetings. The consistent finding is that the JASCO model with the “base” parameters tracks very well the experimentally measured trends of level versus range but generally overestimates measurements by a few dB, the difference depending on the specific scenario. Given that no measurements of seismic levels exist yet for direct shoreward propagation from an Astokh survey source configuration, the aforementioned corollary evidence is the basis for assuming that the model results for the shoreward acoustic front from the 4-D survey lines provide an intrinsic level of precautionary buffering.

On this basis, the notional boundaries of the A-line region were constructed by projecting upon the corresponding shot line the first point of intersection of the 156 dB SEL front with the PML. As a further precautionary measure, given that these predictions are based on model results, a 500m “lead” has been added to the transition points along each line with the exception of the three most shoreward ones which have been designated *ipso facto* as full A-lines because of their greater potential for causing unexpected exposure in their initial segments. Implementing the concept described here does not change the underlying provisions of A-lines vs. B-lines and the corresponding mitigation approach. All 12 lines on the shoreward side of the survey area will still have all A-line preparatory monitoring measures executed as agreed with the SSTF. However, if gray whales are observed inside the 156 dB SEL ensonification boundary of a given line either during the pre-survey scan or while shooting the B section of the line, the source can stay active until the transition point. At this point the source will be shut down as it has the potential to expose whales to sound levels exceeding the agreed threshold. In the interest of establishing a precautionary approach, the defined boundaries of the A-line region including its lead-in buffer will not be altered if the measured levels at the PML for a given line are found to be lower than the model results used in the definition of the zone.

In the case that received sound levels at the PML, as measured by the real-time acoustic buoys at the start of the acquisition of a line, are found to exceed either the model results by >3 dB for 3 or more of any 10 shots at any point along the line or 156 dB_{SEL} at the PML, the line will be immediately reclassified as a regular A-line to which the standard protocol applies. Subsequent to such an event, a revised definition of the A-line region based on the higher modelled levels may be used in the sailing of subsequent lines within that zone. Ultimately this concept of a polygonal A-line region should result in reduced seismic survey duration, thus accomplishing the activity within the shortest time period when there are relatively few gray whales in the area.

The SSTF continues to agree in principle with the rationale and recognises the benefits of the A-line truncation. It therefore supports the proposed definition with the minor modifications integrated into the above summary.

5. BEHAVIOUR MONITORING AND SAMPLING PROTOCOLS

A small group led by Gailey had worked since SSTF-4 to adapt and refine the joint programme (Sakhalin Energy/ENL) behaviour data collection protocol for use during the seismic survey. At SSTF-4 it had been decided that behaviour data during the seismic survey should be collected in such a way that the data would be comparable to Gailey's other behaviour data sets, though care would be needed to ensure that the behaviour team on the OV can use essentially the same protocol. Gailey showed the task force the computer programmes he uses for logging data, and the group was encouraged to learn that these programmes will be used both onboard the OV and at the shore stations. Overall, the SSTF was satisfied with the plans for the collection of behaviour data (see Annex C for the full protocol), though three issues emerged and require attention.

First, the task force discussed the use of a rigid-hulled inflatable boat (RHIB), launched from the OV, as an additional/alternative behaviour observation platform. Sakhalin Energy has indicated that it is willing to support the use of a RHIB, but the original configuration that at least some members of the SSTF and Panel had envisioned is apparently no longer possible. Based on discussions during previous SSTF meetings, some members had been operating on the assumption that a second team would be aboard the OV (*i.e.* two behaviour teams on the water) and that one could be deployed with the RHIB without compromising data collection from the OV itself. However, this was not formalised into a specific Panel recommendation for Sakhalin Energy to consider and possibly implement. Sakhalin Energy consequently developed its operational protocols such that only one team would be aboard the OV. Also, at least some task force members assumed that the RHIB would have an observation tower or elevated platform, as specified in the report from SSTF-3. However, Sakhalin Energy advised the task force that there was no intention of constructing a tower or platform on the RHIB. There was some debate about the efficacy and usefulness of working from a RHIB. Panel members of the SSTF argued that the behaviour data obtainable by observers in small boats near the whales are qualitatively and quantitatively different from data obtained by observers on a large vessel farther away. Additionally, there is value in having acoustic recordings made at the whale's location. Airgun pulses recorded (received level and other signal characteristics) at points very near a whale are likely to be unobtainable except from a small boat. The acoustic recorders deployed by Sakhalin Energy are reliable, but to obtain estimates of RL at the whale requires much interpolation from data recorded at the remote locations. **The SSTF concluded that without an observation tower on the RHIB and a second observation team on the OV, the deployment of the RHIB as initially envisioned is impractical and there is no point in pushing the idea further.**

Next, the SSTF considered operational aspects of the OV platform, *e.g.* communications with shore and information on the vessel's configuration etc. Sakhalin Energy informed the SSTF that negotiations regarding the use of the *Pavel Gordienko* were ongoing and not settled. One point of concern is the location on the ship where the behaviour observers will conduct their work, including the installation of the Big-Eyes binoculars, which must be solidly mounted on the deck of the ship. The ideal location for the observation station is on the flying bridge, which would provide the best vantage point in terms of elevation off the water and offering a panoramic view around the ship. The SSTF was notified that the operators of the *Pavel Gordienko* were balking at the idea of attaching anything to the deck of the ship, and so far had offered only to locate the observation team next to the bridge, which is unacceptable, as the view would be obstructed by the bridge. With regard to the flying bridge, the two impediments appear to be the inability to affix the Big Eyes to the deck and the presence of the radars, around which it is unsafe for people to operate. These issues are being addressed to the extent possible given the short time available before the survey. **The SSTF again stressed the importance of locating the observation team as high as possible on the ship and with an unobstructed view around the ship.** Some members of the SSTF also voiced concern about the experience level of the team slated for the OV. Effective use of the Big Eyes, for example, requires training and experience. Sakhalin Energy described the plans for training this and other teams, but exactly who would conduct the training and the content of the training were not described.

Although questions were raised concerning communications between the shore- and vessel-based behaviour teams, including the actual mode of communication to be used (*e.g.* VHF radio, cellular phone), Sakhalin Energy confirmed that these matters were well in hand and being addressed.

The question arose as to how the vessel-based team would log the vessel's position and other underway data. As the actual vessel to be used was not yet known, the specifics of this data collection remained unclear. Knowing the location and heading of the OV is necessary in real time as the whale sighting data rely on such information for correctly locating the positions of whales. Sakhalin Energy assured the SSTF that the exact position of the seismic survey vessel (SSV) would be known as this information is vital to the survey itself, but the **SSTF again stressed the importance of knowing where all operational assets are located at all times**. Virtually every ship logs its location, and maintaining this stream of data (often referred to as the 'NMEA stream') is standard operating procedure. Moreover, most vessels are equipped with automatic identification systems (AIS) that continually broadcast at least basic information about the navigation of the vessel (*e.g.* its position, heading and speed). These data streams can easily be integrated into Sakhalin Energy's standard data collection system with the appropriate data communication and management systems. Koen Broker, being remotely connected to the task force meeting via phone and internet, related that Sakhalin Energy was investigating the use of AIS for the seismic survey. **The SSTF agreed that positions of all vessels should be logged at least every 30 seconds. Furthermore, the SSTF strongly encouraged Sakhalin Energy to pursue the AIS option** as it will be very important for the shore-based observers to know the location of the OV and for the OV to be readily able to locate whales in time and space, the latter being difficult without real-time GPS information, and both being important for smooth transition of observations of specific whales from shore to ship, and *vice versa*. [Post-meeting note; AIS had been purchased according to Sakhalin Energy.]

Finally, with respect to the behaviour protocol (see Annex C), the SSTF considered the concept of 'aberrant' whale behaviour, specifically as this relates to the monitoring and mitigation programme. Gailey informed the SSTF that during the 2001 ENL seismic survey, a gray whale ~2 km from the SSV began breaching and swimming rapidly away from the SSV. The subject of aberrant behaviour and mitigation had not been discussed previously by the SSTF so a small working group was asked to review the draft behaviour protocol with this concept in mind. Based on what is known or expected to be 'normal' vs. 'aberrant' behaviour of western gray whales off Sakhalin, and applying standards of reasonable confidence and precaution, the small group settled on three specific conditions under which observed behaviour should trigger a precautionary shut down. These are as follows: i) repeated breaching, ii) high-speed swimming, *e.g.* at > 8-10 km/h (only as observed by shore-based teams as the ship-based team will not have sufficient accuracy of positional information to measure swimming speed) and iii) separation of mother-calf pairs by more than 5 body lengths. These three criteria were chosen for the following reasons: the SSTF believes that they i) represent real distress in the particular whale and require immediate attention and ii) are relatively unambiguous. The SSTF clarified that less overt avoidance reactions, while possible or even likely, would not warrant a shut down. Not only would more shut downs prolong the seismic survey and thus cause more whales to be exposed to air gun noise as the season progresses, but also avoidance of high-exposure areas by the whales is desirable. If aberrant behaviour is observed, it should trigger an immediate shut down. The SSTF agreed that the SSV should continue to sail along the same acquisition line and, after its normal turning procedure, it can then restart the air guns (following normal startup procedure) and acquire the next scheduled B-line.

Finally, the SSTF concluded that observations from the OV should be conducted at a distance of ~2 km from the focal whale when the weather is favourable (*i.e.* Beaufort sea state < 2) and ~1 km when the weather is less favourable (Beaufort 2-4). When the sea state is above 4, the seismic acquisition cannot be conducted so observations are less important.

6. CONTINGENCY PLAN

Possible contingency roles for the OV, which is implied in the description of crew duties above with regard to acoustic monitoring, is an essential component of Sakhalin Energy's overall strategy for ensuring timely completion of the survey without compromising the effectiveness of acoustic monitoring. If capability at the shore station for receiving acoustic data from sensors along the PML by telemetry becomes disabled to the extent that it is impossible to comply with the requirement to monitor levels at spacing of no more than 5 km, immediate remedial measures will be needed to ensure that this critical monitoring can function. Specifically, the OV should immediately take over and act as an acoustic telemetry reception node and processing centre that relays information on sound levels to the shore station until the latter can be restored to operational status. Considerable resources have been invested in assembling the equipment and onboard personnel to make this role feasible, if needed. This contingency mode of operation is intended only for situations where all alternative solutions (such as rearranging the working telemetry streams at the land station to cover the most relevant buoys in case of a partial failure) have proven infeasible, and every effort should be made to restore shore processing as soon as possible.

While in this contingency mode, a certain degree of operational restriction will be imposed on the OV. It will not be able to freely fulfil some its visual monitoring duties, primarily those that involve focal follows. **The SSTF understands and accepts those trade-offs, provided that the visual monitoring required for mitigation is maintained at an acceptable level.** The vessel will have to remain within telemetry reception range as a waterborne platform lacking the benefit of directional antennas. In practice, this will require that during acquisition of a line, the OV tracks the progress of the SSV in a general sense, at least to the extent that it stays within radio range of the subset of PML buoys experiencing the highest sound levels (realistically this could be as little as 5-6 km under worst-case conditions). Such a requirement is largely compatible with the OV's 'patrolling' duty during line acquisition as a visual observation platform meant to detect whales inshore of the PML. Such patrolling is most suitably performed if the OV is running along the length of the PML somewhat ahead of the SSV. In this way it should be able to obtain the most up-to-date information on whales entering the region just before the loudest survey noise footprint reaches their location. The only potentially conflicting role for the OV is that of performing behavioural follows on individual whales, especially if they exhibit aberrant movement and/or behaviour and require more extended tracking. When a follow is initiated under this contingency scheme, the OV may have to break off its monitoring parallel to the PML and thus allow the distance between its position and the most highly ensonified area to increase. This should have less impact on the OV's data telemetry reception capacity than on its visual 'patrolling' duty. There will be a considerable period when the loudest noise from the air guns is received by PML buoys that are within radio range, whereas the visual scouting capacity in the most ensonified area will be lost almost immediately. Indeed, depending on where the follow is initiated and proceeds, buoys may be within radio range of the OV all the way to the end of the line.

The acoustics team aboard the OV will therefore monitor the quality of telemetric data and advise the behaviour observers of the approach of signal loss from (or inability to acquire) the subset of buoys covering the region of loudest noise. Upon imminent loss of the required shore-side acoustic coverage, the OV will get underway in order to get within assured radio reception range, and this may result in interruption of the focal follow. Thus, as long as the OV is operating in contingency mode because of compromised acoustic capabilities on shore, important behaviour measurements are likely to be compromised to some extent. However, the highest priority is to ensure the overarching requirement for constant monitoring of noise along the PML in order to prevent whales from being exposed to sound levels that induce significant changes in their behaviour. From this standpoint, it is also important to recognise that the regular duty of the OV is to patrol the region of maximum sound level for the presence of whales inshore of the PML. This duty takes precedence over focal follows in all cases where the shore-based teams have difficulty (due to glare or other factors) making reliable observations all the way to the PML.

The SSTF, while recognising the importance of behaviour observations from the OV, **agreed** that the contingency plan is needed to ensure constant, real-time monitoring along the PML during the seismic survey and it **endorsed** the plan proposed by Sakhalin Energy. It was **emphasised**, however, that maintaining behaviour monitoring and focal follows, even if abbreviated, from the OV is an important element of the monitoring and mitigation plan.

7. INDEPENDENT OBSERVER

Following SSTF-4, a small working group discussed the terms of reference (TOR) for the Independent Observer (IO) via e-mail and teleconference. At this meeting, the SSTF debated two main issues: the specific role of the IO and where this person should be located, either on shore or on one of the vessels.

Although individual views differed on exactly how the IO should function, it was finally **agreed** that this person's primary responsibility was to give the SSTF and WGWAP an empirical basis for i) verifying that the monitoring and mitigation plan was implemented as expected and ii) evaluating the plan's effectiveness retrospectively. Importantly, it was also **agreed** that if the IO identifies a problem or problems while in the field, he or she is encouraged to 'wave a flag' and call attention to the problem(s) both to Sakhalin Energy's senior MMO and to IUCN (and in turn the Panel).

With respect to where the IO is to be located, there was general agreement that it would be most advantageous to have the person located where most of the information about the monitoring and mitigation program is collected, *i.e.* on shore. There was also general agreement, however, that the experience level of the observation team on the OV was likely to be marginal and therefore it could be useful in some ways to have the IO on the OV. A small working group was asked to discuss this issue in depth, and it concluded, and the SSTF **agreed**, that the IO should be on shore but also that a protocol should be put in place to compare the data sets collected by the observers on the OV with those collected by the shore-based teams so that the SSTF and the Panel would have some means to evaluate the quality of the data obtained from the OV. **Sakhalin Energy agreed** to conduct this analysis after the survey has been completed, with advice from Panel members as required.

The TOR were given further attention by Panel members of the task force following SSTF-5 and the final version is given here in Annex D.

8. QUICK REVIEW OF COMMUNICATIONS

As detailed in the SSTF-4 report, the task force again emphasised the need for a communications plan that ensures all necessary information is conveyed between the shore-based and vessel-based teams, including the acoustics teams, distribution teams and behaviour teams. The vessels involved are the observation vessel (OV), seismic survey vessel (SSV) and scout vessel (SCV). The most important element is that the lead individual on any given team must have direct contact with the lead MMO on the SSV, who has sole authority to implement a shut down under the monitoring and mitigation plan.

The behaviour teams (shore- and vessel-based) also need to be in direct communication with each other to coordinate their respective activities. This is especially important for synchronisation of data streams as related to the recommended *post-hoc* analysis comparing sightings data between the shore and OV teams.

The importance of real-time acquisition and permanent archiving of positional data from all vessels involved with the seismic survey was again highlighted by the SSTF. The SSTF **recommended** that an AIS tracking system be used (*i.e.* transmitting) at all times (*i.e.* 24 hours a day) on the SSV, SCV and OV and that AIS receivers be made available to the shore-based acoustics and behaviour teams. It was noted that if for some reason the use of AIS tracking systems is prohibited in the survey area, positional data must be recorded and permanently archived from each vessel via onboard GPS **every 30 seconds, 24 hours a day**. In this case, it is **recommended** that the head MMO on each vessel be assigned responsibility for ensuring that these data are collected and archived onto a dedicated Sakhalin Energy-controlled laptop computer.

9. PLANS FOR POST-SURVEY ANALYSES BY SAKHALIN ENERGY AND ROLE OF PANEL

Discussion of this item was brief. It was noted that the extent, nature and quality of such analyses would hinge on the amount and quality of data obtained. For example, if the seismic survey is carried out early and quickly, it is possible that few observations will be made of gray whales. On the other hand, if because of ice, weather, logistics or other difficulties the survey is prolonged into July, there is a good chance that enough data will be available on whale distribution and behaviour and on underwater acoustics in the study area to support informative analyses.

It was generally agreed that at least a preliminary report on the seismic survey would be available for presentation at WGWAP-9 in early December 2010. Also, it is likely that the SSTF will reconvene and hold at least one further meeting to consider results and analyses.

10. DATA MANAGEMENT PLAN – MANAGEMENT OF, AND ACCESS TO, DATA STREAMS

Southall gave a short presentation summarising previous SSTF recommendations regarding a comprehensive data management plan. Four elements of an idealised data management strategy were identified and discussed. In presenting these, Southall emphasised that he did not mean to imply that any of the elements were currently being ignored or overlooked. Rather, his proposed approach was intended simply to expand on previous SSTF recommendations regarding the optimal and most robust means of obtaining, analysing and delivering the results. It was further noted that the results of the monitoring, mitigation and measurements during the 2010 Asktokh 4-D survey would be of great interest and importance to other industrial and regulatory parties, largely because of the comprehensive and systematic nature of the preparatory work carried out by Sakhalin Energy and the WGWAP (see particularly item 4 in the outline below). The SSTF generally **endorsed** the approach proposed by Southall and **encouraged** Sakhalin Energy to integrate its key concepts while developing its own data management strategy.

1. **Data Collection/Archive (within teams)**
   - ***Robust, comprehensive data collection with sufficient consistency/archive across teams to ensure the following steps***
     - Are correct/robust data being collected?
     - Are protocols in place for quality control/assurance?
     - Are data from different teams in compatible formats?
     - Are sufficient data back-up systems in place?
2. **Data Integration (across teams)**
   - ***Ensure that time and geospatial synchronization of data streams are completed across different teams***
     - Need clear plan for integrating time-synchronised data across visual, acoustic, and operational teams in geospatial (GIS) environment.
     - Importance of integrating information from other relevant:
       1. Biological factors
       2. Environmental factors
       3. Human activities, including vessels (Sakhalin Energy and otherwise)
3. **Data Analysis (within and across teams)**
   - ***Ensure complete and timely analysis of data within teams and comprehensive analysis of integrated temporal/geospatial data***
     - Need *a priori* plan for timing of integration and how data will be available for analysis.
     - Clear understanding and expectation of timing and availability of classified/sensitive information.
     - Importance of analyzing “control” and “exposure” data and also for considering low-level exposures.
4. **Presentation of Results (multiple levels)**
   - ***Public availability of data for transparency about current operation and lessons-learned for other exercises and decision-making***
     - Quick-look reporting to WGWAP and public summaries.
     - White papers to IWC or similar fora?
     - Summary/white papers to industry and/or regulatory groups?

- Scientific presentations and publications (critical).

11. STATUS OF LEBEDENSKOIE SEISMIC SURVEY (AND ANY OTHER RELEVANT OPERATIONS THAT COULD BE CONCURRENT WITH OR ADJACENT TO ASTOKH 4-D SURVEY)

Tsidulko summarised what was known at the time of this meeting concerning Rosneft's planned Lebedenskoie seismic survey in the northern part of the gray whales' near-shore Piltun feeding area in the summer of 2010. It was his understanding that it would not begin any earlier than late June and that it would probably continue until the end of the summer season. Tsidulko stated that he had no details on Rosneft's monitoring and mitigation plans but he understood that some activities would be suspended during non-daylight hours. A number of Russian internal consultations and meetings where the Lebedenskoie survey was to be discussed were expected in the last two weeks of April (immediately following WGWAP-8) and it was hoped that the three Russian members of the Panel – Tsidulko, Vedenev and Yablokov – would be involved in these and thus be able to provide more details in due course.

[Post-meeting note: Lebedenskoie was discussed in more detail at the WGWAP-8 meeting immediately following SSTF-5, and it was also the subject of several Panel letters to Russian governmental representatives after WGWAP-8. Therefore, it was decided not to discuss the matter further here.]

Attention was drawn to the fact that according to the WGWAP-7 and WGWAP-8 reports (prepared after this meeting), a number of other seismic surveys could take place in 2010, *e.g.* in the Ayashskiy, East-Odoptu and Kirinskoye fields. This raises the longstanding question of cumulative impacts of industrial activities. It also brings to mind the caution expressed repeatedly by the Panel that much of the data collected by the joint Sakhalin Energy/ENL programme over the years may not be representative of true 'baseline' (*i.e.* undisturbed) conditions.

Finally, participants pointed out that many other seismic surveys are planned and will take place off north-eastern Sakhalin and elsewhere in the Sea of Okhotsk region in the coming years and decades. This means the western gray whale population will be exposed to high-intensity noise over a prolonged period and in much of its summer feeding range, year after year. This gives cause for great concern about the population's future. There is no understanding of the 'limits of tolerance' for these whales, and we do not know if, or when, such limits will be reached and they will stop coming to this prime feeding area off Sakhalin.

12. SPECIFICATION OF TASKS TO BE COMPLETED AFTER MEETING, WITH TIMELINE AND RESPONSIBILITIES

Because of time constraints, and because most of the responsibilities of various parties and their respective deadlines etc. were either specified already in other parts of this report (or in earlier SSTF or WGWAP reports) or self-evident, the task force dealt with this item in its agenda only superficially.

Reeves assured participants that with help from various other individuals, notably Nowacek and Southall, he would try to produce a complete draft SSTF-5 report in a reasonable timeframe, i.e. well before the end of May 2010, and circulate to the full SSTF for review and approval before publication on the IUCN website.

Annex A
List of participants

Doug Bell (Sakhalin Energy)
Justin Cooke (WGWAP)
Glenn Gailey (Sakhalin Energy)
Judy Muir (Sakhalin Energy)
Doug Nowacek (WGWAP)
Roberto Racca (Sakhalin Energy)
Randall Reeves (WGWAP)
Brandon Southall (Associate Scientist)
Dorine Terwogt (Sakhalin Energy)
Grigory Tsidulko (WGWAP)
Dave Weller (WGWAP)
Alexander Vedenev (WGWAP)

IUCN

Finn Larsen (IUCN)
Béatrice Riché (IUCN)

Interpreters

Alexander Danilov
Grigory Shkalikov

Annex B

Agenda

1. Introductory items
    1.1. Introductions of participants
    1.2. Aims of workshop and expected product
2. Documents and progress reports
    2.1. Review of available documents
        2.1.1. Existing documents made available
        2.1.2. New documents prepared for this meeting
    2.2. Summary of progress since WGWAP-7 and results of tasks requested at WGWAP-7
    2.3. Identification of outstanding issues to be resolved
    2.4. Other new information (*e.g.* updates to EIA)
3. Operational plans and expectations
    3.1. Summary of seismic acquisition plans (highlight any changes), preparation status and start date based on ice data
    3.2. Update on monitoring and mitigation logistics, preparations and platform stability for theodolites.
    3.3. Update of Racca's modelling and library of cases to run pre-acquisition
4. Truncated A-line proposal
5. Behaviour sampling protocols
6. Contingency plan – If problems arise at shore-based acoustic stations, how will *Pavel Gordienko* take over and juggle its other responsibilities?
7. Independent Observer
    7.1. Clarification of role
    7.2. Logistics
    7.3. Means for tracking vessels, communicating with field stations, access to acoustic data
8. Quick review of communications (*e.g.*, who calls whom when thresholds are reached?) (This is not intended as a revisitation of the thresholds and limits but simply as a quick update of exactly what will happen in different scenarios.)
9. Plans for post-survey analyses by Sakhalin Energy and role of Panel
10. Data management plan – management of, and access to, data streams
11. Status of Lebedenskoie survey (and any other relevant operations that could be concurrent or adjacent to Astokh 4-D survey)
12. Next steps
    12.1. Specification of tasks to be completed after meeting, with timeline and responsibilities
    12.2. Arrangements for monitoring progress with tasks

Annex C

Onshore and Offshore Behavioural Protocols for Monitoring the Astokh 4-D Seismic Survey

Background

This document provides information on behavioural sampling protocols to be conducted during the Astokh 4-D seismic survey, currently scheduled for summer 2010. Behavioural monitoring will be conducted from both onshore and offshore platforms to observe and monitor western gray whales near the seismic survey and support effective real-time mitigation of impacts. Both onshore and offshore sampling protocols, data collection, and integration with the conduct of the survey are outlined within this document.

The primary objectives of this study are to: 1) document behavioural responses of western gray whales to vessel activity and sound levels associated with the survey, 2) identify obvious aberrant behaviour (Appendix A) of western gray whales and communicate these observations to the senior MMO on the seismic ship, and 3) document both inshore and offshore sightings of western gray whales and assess their proximity to the seismic activity in real-time to alert the seismic vessel to avoid close approaches.

Study Area and Observation Platforms

Onshore Observation Stations – Behavioural monitoring will be conducted by three separate teams. Two of these teams will conduct observations from onshore stations. Each team will consist of a minimum of three people per team operating in rotations as described below to prevent fatigue. The locations of these onshore platforms have been agreed upon by the SSTF and are illustrated in Figure 1. The rationale for the locations is to monitor portions of the nearshore feeding habitat where the highest sound levels from the seismic survey are predicted to approach the closest to shore. The locations also have an advantage of covering areas that are not being effectively monitored by distribution team monitoring efforts.

Offshore Observation Vessel – Offshore behavioural monitoring will be restricted to those animals that are outside of the defined feeding habitat and that are not being monitored effectively by onshore teams (*e.g.* due to low station heights, onshore fog, etc). The offshore behaviour team, consisting of 3-4 people, will monitor the presence of western gray whales and their behavioural activity from the R/V *Pavel Gordienko* (Figure 1). The primary focus of this effort will be in regions that are expected to have the maximum sounds levels (*i.e.* loudest exposure levels for the whales) from the seismic survey. When no whales have been reported in the seismic region, the vessel will effectively coordinate its movement with the seismic survey vessel to survey for whales to monitor (see survey mode below).

Shore-Based Behavioural Monitoring

Shore-based behavioural monitoring will be consistent with previous (2002-2009) behavioural data collection protocols. Therefore, the protocols are briefly outlined here as more details can be found in annual reports (for example Gailey *et al.* 2010). To summarize, four research methods will be employed:

1) *Theodolite Tracking* - The spatial and temporal movement patterns of gray whales will be monitored with Lietz/Sokkisha Model DT5 theodolite with 30-power monocular magnification and 5-sec precision. The theodolite tracking technique converts horizontal and vertical angles into geographic positions of latitude and longitude for each recording.

- Gray whales in the study area will be initially detected by eye or binoculars (7x50) used during scan sampling surveys (see below).
- Theodolite tracking sessions will be initiated when a single or an individually recognizable gray whale in a group can be identified.
- Individuals will be continually tracked until the animal is lost, moved beyond a 5 km distance from the station, or when environmental conditions hamper further tracking. If the whale moves offshore or towards the second onshore behavioural platform, the whale location will be communicated to that platform so those observers can continue to track/monitor the whale. Unique identifier

information in regards to the track for both platforms will be communicated and recorded on each platform to link the tracks in later analysis.

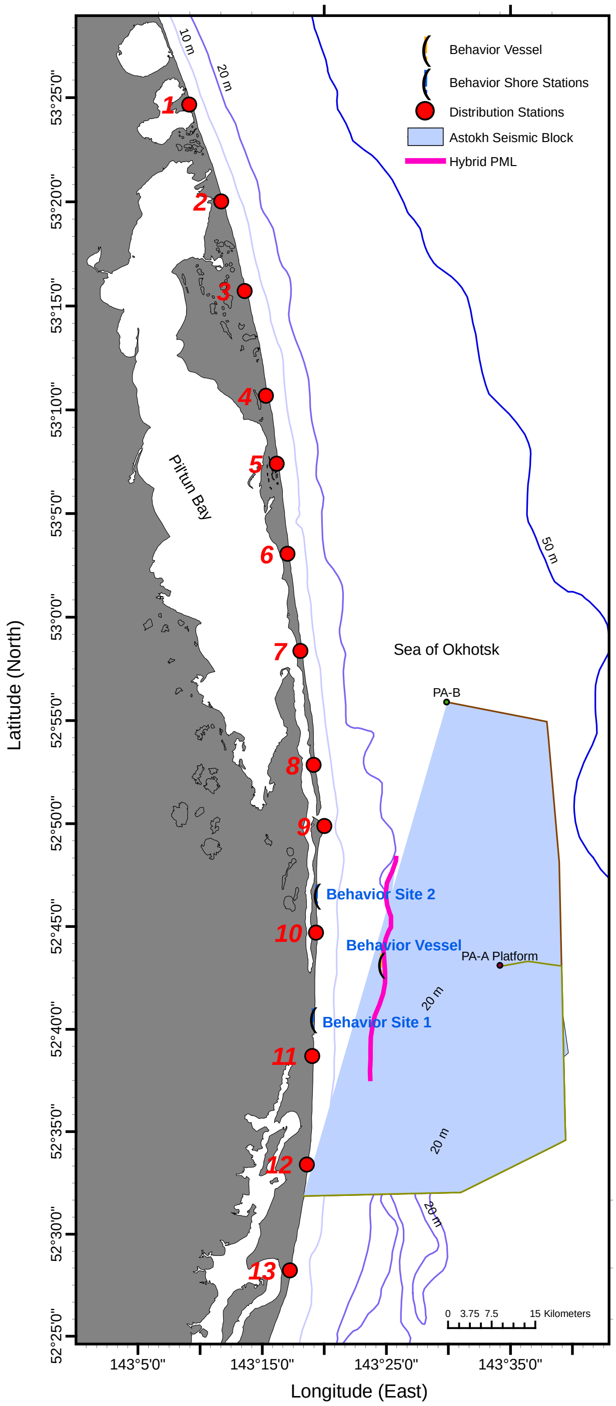

Figure 1. Locations of onshore behaviour monitoring stations and offshore observation vessel (OV) operations. The hybrid Perimeter Monitoring Line (PML, pink) represents the 95% maximum density of western gray whales and the shaded (blue) polygon illustrates the seismic survey area. The OV (orange dot; called "Behavior Vessel" on map) represents a third platform conducting observations at sea. The vessel's location will vary with the seismic survey and whale locations near the survey, but will be located offshore of the PML.

- For each theodolite recording, the date, time, and vertical and horizontal angles are stored in a Microsoft Access database with the relative distance, bearing referenced to true North, and geographic position calculated in real-time.
- Behavioural states (travelling, feeding, feeding/travelling, socializing, etc.) are recorded with each focal follow (see below) and tracking session.

2) Focal-Animal Follow – Focal follow sessions of behaviour and respiration events will be conducted on individual gray whales.

- Focal behaviour sessions (*sensu* Altmann 1974, Martin and Bateson 1993) will be initiated when all observers determine that a single whale could be monitored continuously and reliably enough so that respiration and critical behavioural events will not be missed based on proximity and distinctiveness.
- At least one behavioural observer will follow individuals with the aid of a hand-held binocular (7x50 Fujinon).
- Behavioural observer verbally states each behavioural event (see Table A.2. in Appendix A for detailed descriptions of behavioural events), and a computer operator records the event into a laptop computer operating the *Pythagoras* software.
- Observers are limited to 30 minute sessions before another observer takes their place in order to minimize visual fatigue.
- Most focal follow sessions are conducted simultaneous with theodolite tracking information thereby providing positional information associated with each focal follow.

3) Scan Sampling - To monitor the relative number and distribution of gray whales in the near-shore waters, scan sampling methods will be conducted hourly when focal behaviour sessions are not being conducted.

- Two observers use hand-held binoculars (7x50 Fujinon FMTRC-SX with reticle and compass) to progressively scan the study area from North to South.
- Scan duration will be approximately 19.3 minutes with a rate of 9.33 °/min.
- Once an observer sights a whale or whales, then the number of whales, angular distance between the whale and the horizon (based on binocular reticles), magnetic bearing, whale(s) heading, and estimated distance from the station will be recorded.
- *Pythagoras* software (Gailey and Ortega-Ortiz 2002), will be used to 1) inform the observers of the approximate region they should be scanning for every 10° magnetic North, 2) provide a data entry form to record sighting information, and 3) calculate geographic position and visually display sightings in real-time.

4) Shore-Based Photo-Identification - While observers are tracking or following a whale, the whale may approach the platform at a distance that allows an opportunity to identify the individual by photographic means. Photographs will be taken at the closest approach. For example, a whale travelling south to north parallel to the shoreline is closest directly perpendicular of the onshore platform. A Nikon D1x or D2x digital camera with a Sigma 300-800 mm APO F5.6 EX DG lens will be used to photographically capture these individual gray whales from shore. A 2x extender may be employed to extend the range when individuals are further from shore. The typical distance of successful captures range up to 1-2 km depending on environmental conditions.

- Photographs will be taken opportunistically from the station where behavioural observations are being conducted that day or in route to the station.
- Photo-identification can be conducted simultaneously with theodolite tracking and/or focal behavioural work.
- For each photographic session, the date, time, group number, corresponding number of behavioural track/focal observation, behaviour, group size, geographic location, card and frame numbers will be recorded.

All photographs will be processed with the WGW Photo-ID software system (developed by G. Gailey). This database contains all individuals identified by shore-based methods since 2004 as well as cross-matched identification to other existing photo-identification catalogs (Yakovlev and Tyurneva 2002-2010, Weller *et* *al.* 1995-2008). This system provides a platform that seamlessly integrates existing information from a variety of sources.

Data Collection Priorities - Due to the number of methodologies conducted and limitations of the number of observers per monitoring team, the behavioural program designates priorities in the data to be collected. The priorities are listed in sequence above from 1 to 4 with theodolite tracking having the highest priority and shore-based photo-identification having the lowest priority for data collection. However, there are certain times and/or spatial considerations for allocating a higher priority towards other methodologies, some exceptions to the general priority rule are:

- Initial and end observation times – By way of this protocol, a scan will be conducted prior to the onset of observations. This scan provides a relative understanding of the number of whales in the area and gives the theodolite operator time to setup and find a whale to track. Prior to ending the observation day, a final scan should override other priorities (such as extending a focal follow session) in order to record the number of whales in the area at the end of the observation day.
- Nearby Individuals – When an individual is particularly close or at certain angles from the observer, shore-based photo-identification takes priority. Usually these sessions take priority over theodolite tracking (but not focal animal follows).

Preferential Tracking/Focal Follow Animals - When multiple animals are observable from a shore-based station, researchers can choose which whale to monitor. Observers will be instructed to preferentially choose those whales that are at greater distances from shore (*i.e.* closer to the seismic survey area). If the whale(s) is/are too far away to reliably conduct observations, shore teams will communicate this information via radio to the vessel-based behaviour platform. Any observations of aberrant behaviour (Appendix A) or the presence of mother-calf pairs should be reported to all behavioural teams and priority should be taken to observe these whales.

Vessel-Based Behavioural Operations

Behavioural observations will be conducted from a large (> 25 m) vessel to monitor gray whales that are not effectively being monitored by onshore behavioural teams. The primary objectives of the vessel-based behaviour team are to:

- Survey the offshore region near the perimeter monitoring line for the presence of gray whales and other marine mammals.
- Conduct focal follow observations on whale(s) identified to be closest to the seismic operations.
- Conduct extended focal follows on whale(s) displaying aberrant movements and/or behaviours (Appendix A) to document the extent of the potential response.
- Monitor gray whale distribution near the perimeter monitoring line in the event that inclement weather (*e.g.* onshore fog) prevents onshore monitoring, but does not restrict offshore efforts.
- Communicate observations of gray whales and aberrant behaviour (Appendix A) to the Senior MMO on the active seismic vessel.

Vessel Platform - The R/V *Pavel Gordienko* (45.6 m length) research vessel will be used to conduct behavioural observations (Figure 2). This vessel offers increased observation height and more powerful (25x150) binocular ('Big Eyes') equipment that are likely to operate at further distances from the focal animal. For example, shore-based operations conduct focal follows at approximately 10 m elevations with whales being monitored several kilometres from the observation platform. The eye height from a smaller vessel, such as a Zodiac, is no greater than the observer's own height (2m, maximum) and environmental conditions (lighting, swells, etc.) in combination with the less stable platform make the effective observation distance much less and binocular use very difficult. In addition, when transitioning from survey mode (see below), which is conducted on the larger vessel, to focal follow mode, it would take valuable time to prepare and launch a smaller vessel while the seismic survey is still underway.

Figure 2. Image of the R/V *Pavel Gordienko* vessel platform used to conduct behavioural observations during the 4-D seismic survey during the summer of 2010.

Vessel Distance and Approach - Unlike onshore monitoring, behavioural observation from a vessel has the potential to be disruptive to the natural behaviour of the animals. The primary sources of potential disturbance from a vessel are likely to be the visual presence and sounds associated with the proximity and operations of vessels themselves (particularly any changes in heading, speed, and/or other operational modifications that have associated acoustic indicators to the animals). As part of these protocols, we have developed a general guideline for different zones of approaches to marine mammals (see Figure 3). The distance to the whale can vary by species and even individuals. Ideally, for behavioural studies, the vessel would be at a distance that is outside of the whale's awareness zone. For this study, this is not likely to be the case. The study animal will likely be aware of vessel presence and general location. Therefore, it is important to avoid rapid speed or changes in movement while maintaining an optimal distance to minimize altering the whale(s) movement and behaviours while still being close enough to make reliable observations. Some potential signs of disturbance include rapid movement away from the vessel, 'surface-active' behaviour (tail slaps, breaches, etc.), abrupt diving, changes in movement (*e.g.* direction, speed, etc.), changes in respiration patterns, and changes in behavioural states (*e.g.* from feeding to travelling). The following guidelines are recommended to minimize disrupting the animal(s) under observation.

- *Distance of Approach*
  - Focal animal observations should take place at a maximum distance that an observer can reliably see the animal's body and respirations. This maximum distance can vary depending on lighting and weather conditions (see Optimal Distance of Approach below).
  - For a relatively large vessel (>25 m) with an observation height of 5 - 10 m, the effective observation range should be at least a 1 km from the whale. This minimum distance should be strictly maintained. Behavioural observers will continually attempt to conduct observations at greater distances (see Optimal Distance of Approach below).
  - Distance ranges can be extended with higher power binoculars, such as 'big eye' (25x150) binoculars. It should be noted, however, that with higher power binoculars, the observer's field of view drastically decreases and it is critical that the observers are experienced in

handling the equipment on a moving vessel to minimize missing critical behavioural events. A second observer will be instructed to use a less powerful (7x50) hand-held binoculars in combination with the 'big eye' binoculars to ensure behavioural events are not missed, particularly in situations where animals may be relatively close to the observation platform(s).

- A smaller vessel (< 5 m observation height) is presumably less likely to acoustically disturb animals, but more likely, given the maneuverability, to disrupt animals if the vessel changes direction and speed often. Larger vessels tend to maintain a consistent speed and direction, while smaller vessels can vary both drastically. However, a smaller vessel will have a decreased observation range and it is recommended that the smaller vessel maintain a separation distance of at least 0.5 km from the focal animal.
- If at any point during the observation, the observers have any indication that their presence has altered the behaviour of the whale; the vessel will remain stationary until the animal has moved to at least 0.5 km from the current observation point. It is important to record these events in detail, especially in regards to the vessel activity, approach, and distance to the focal animal. If disruption continues, focal observations should cease to avoid potential harassment of the animal.

- *Behaviour of Vessels*
    - Vessel speed and manoeuvring will be as consistent and slow as possible. Abrupt changes in speed and direction will be strictly avoided.
    - While approaching the whale, the vessel will not attempt a direct/head-on approach towards the whale. Approaches, even from distances beyond the minimum distance of approach, will attempt to maintain a direction that is slightly less than parallel in order to decrease the distance from the vessel to the whale.
    - Vessels will attempt to maintain a parallel course and speed with the focal whale at the approach distance from the whale to conduct observations. The vessel will not follow the whale from behind. If the vessel is initially behind the whale, the vessel will slowly head diagonally away from the whale(s) in a broad arc until the vessel reaches a parallel course with that of the whale(s). The speed of the vessel will be consistent with the speed of the whale(s) and repeated changes to maintain the speed with the whale should be avoided.
    - Vessel movement will never turn around towards the direction of the whale or cross the whale’s path or turn in front of the whale(s) being monitored.
    - If a whale alters its course to the direction of the vessel, the vessel will switch the engine to neutral and remain stationary until the whale moves beyond the approach distance. Observers will record these events and behavioural responses of animals to the stopping and re-starting of vessel movements.
    - If a whale alters its course in other directions, the vessel will continue in a broad arc that maintains the optimal distance of approach (see below).
    - Behavioural observers will be in contact with the bridge captain to advise appropriate steering of the vessel and correct any inappropriate vessel activity at all times.

Optimal Distance of Approach - As noted above, a closer distance to a whale will likely increase the whale’s awareness and could alter the very behaviour being monitored. Therefore, observers will make all attempts to conduct observations at greater distances while appropriately manoeuvring the vessel (as described above). The optimal distance of approach can vary with weather and lighting conditions. Extreme lighting (low or intense) conditions will require the vessel to be closer to the whale. Larger swells, higher Beaufort Sea states, and/or lower visibility conditions due to fog presence or haze, will result in closer distances of approach. On good weather and lighting days, an optimal distance would be approximately 2 km from the whale's location. As weather and lighting conditions worsen, for example Beaufort sea state 2 or lower lighting in the morning, the distance of approach will vary closer to the whale's location. However, the 1 km minimum distance of approach will be strictly maintained at all times. It should be noted that some environmental conditions (especially during calm (Beaufort 0) days with good reflective lighting) can hinder an observer's ability to see any respirations. If respiration and other behaviours are not reliable seen during these conditions, then focal follow observations will not be conducted.

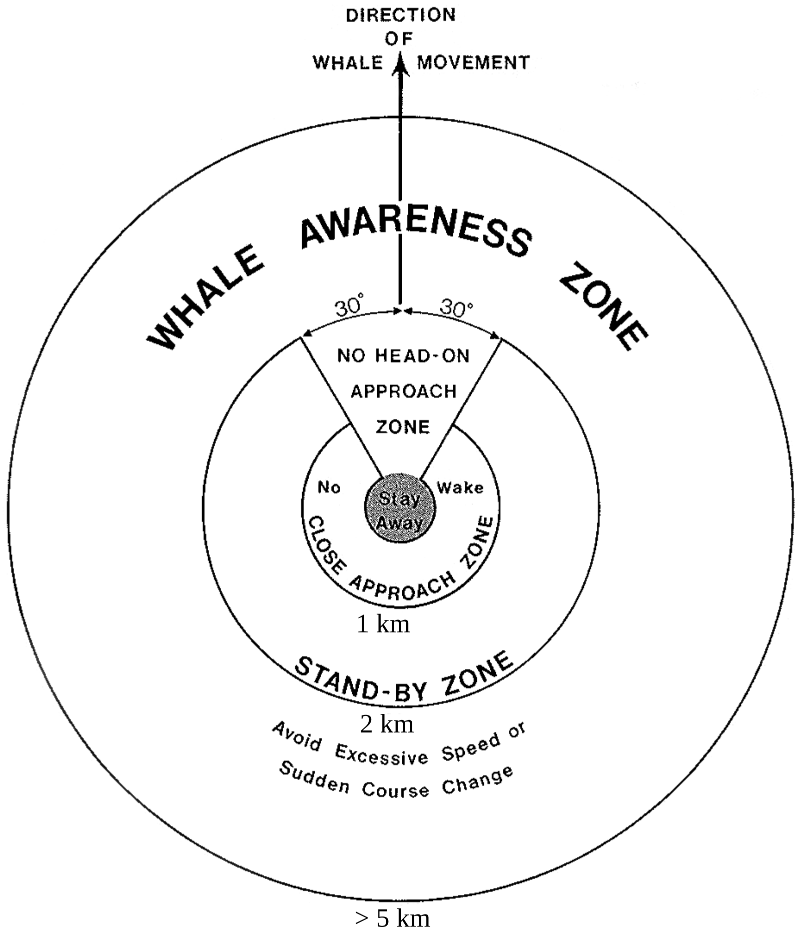

Figure 3. Guidelines indicating different zones for vessels that are approaching whales (taken from Beach and Weinrich 1989).

Software - Due to the needs for data management and processing sighting information in real-time, two software systems (developed by G. Gailey) will be used for data collection and processing: 1) Whaletrack II to record and process sighting information, GPS data, environmental data, and effort data and 2) Pythagoras (Gailey and Ortega-Ortiz 2002) to record focal follow observation data. WhaleTrack II will provide an environment for users to process, record, and display the ships geographic position (based on the ship's or hand-held GPS system) and any sightings entered into the program. The software was originally designed to network passive acoustic monitoring information with visual sighting information on a ship while both operators visually see the sightings of both teams on a geographic information system display. This system could be networked from the flying bridge to the bridge for personnel to monitor or with properly installed Long-Range Wi-Fi capability, multiple vessels. The Pythagoras system is designed to collect scan, focal follow, and theodolite tracking data. It will be used on the vessel to record behavioural events and states (Appendix A) during focal follow sessions.

Effort - Vessel based behavioural monitoring will occur in two modes: 1) *Survey Mode* - to survey for western gray whale presence and 2) *Focal Follow Mode* - to monitor behavioural events and states (Appendix A) of individual gray whales. During each morning in the field, observers will inspect weather conditions as early as possible. In June, sunrise can occur as early as 4:00 while sunset can be as late as 19:00. Depending on the seismic survey, observations may need to occur earlier in the morning. However, it should be noted that continual extended research effort with minimal observers can result in visual fatigue, which should be minimized. While environmental conditions allow (Beaufort Sea states < 4 and Visibility < 5; Appendix B), monitoring effort will be conducted throughout the day. Observers will record periods when they are "on effort" and "off effort" for each field day. Both effort recordings will have associated environmental data. In addition, a comment will be supplied for all "off effort" recordings describing the rationale (weather, equipment failure, etc.) for lack of effort.

Survey Mode - Behavioural observers will start each day in a survey mode. During the survey mode, two observers will be scanning with Fujinon FMTRC (7x50) hand-held binoculars. One scan observer will be positioned on the port side of the ship, while the other observer will be positioned on the starboard side. While in survey mode, the observers will continually scan the area from 270° to 10° for the starboard observer and 350° to 90° for the port observer. This strategy overlaps the bow of the ship, which results in duplicate effort in front of the ship which is an important area to identify close approaches. The rate of scan will be approximately 10°/min., where an observer will cover the entire region in 10 minutes. Both observers will attempt to offset the scans to provide multiple coverage of the bow region at different times (Figure 5).

A third observer will be tasked with monitoring the entire (270° - 90°) area with Fujinon MTM (25x150) 'big eye' binoculars. The use of the 'big eye' binoculars will extend the observation range for sighting western gray whales in the area. A fourth observer will operate as a data recorder, responsible for entering environmental, comment, and sighting information as well as ensuring that GPS data, environmental sampling and other equipment is working properly.

Once an observer has made a sighting, relevant information (geographic bearing, reticle reading, whale heading, and group size information) will be conveyed to the data recorder. Based on the ship's current position, environmental conditions, and sighting information entered, the distance and geographic location of the sighting will be calculated and geographically displayed in real-time. In all cases an attempt will be made to record the sighting with both the 'big eye' binoculars and the hand-held binoculars. At least one hand-held binocular operator and the 'big-eye' binocular operator should continue to monitor the sighting. If the whale is sufficiently close, the 'big-eye' operator may need to switch to hand-held binocular equipment. Both observers will continue to monitor the whale and communicate the sighting to personnel on the bridge. If it is reasonable to attempt to conduct a focal follow on the whale based on the distance and location, the observers will advise the bridge to alter course and speed such that the range is appropriate for conducting the observations. At this point, the behavioural observers will switch from survey mode to focal follow observation mode. Otherwise, one observer will continue to monitor the sighting, while two observers continue on survey mode. While at least three observers are engaged in focal follow mode, the fourth observer will continue in survey mode with hand-held binoculars scanning the entire 270° - 90°.

To minimize visual fatigue, observers will alternate responsibilities at 30-minute intervals. Thereby, every observer would have a visual break for each hour of surveying.

Focal Follow Mode - The primary behavioural data collected by the observation vessel will be focal follow information. These data consist of monitoring the surface-respiration-dive cycle of gray whales as well as identifying and recording behavioural events and states (Appendix A). A focal follow session will be initiated when all observers have determined that a single whale can be monitored continuously and reliably enough so that respiration and critical behavioural events are not missed. At least one behavioural observer will follow individuals with the aid of hand-held (7x50) or 'big eye' (25x150) binoculars. To accurately and rapidly record the respiration data, which are time-sensitive, a computer-based system will be used. An operator will use a computer with the Pythagoras software installed and a programmable keyboard that displays each behavioural event as a button. In addition, the observer monitoring the whale will have a headset to ensure the data are being entered correctly. To collect data, the observer states a behavioural event (*i.e.* "Blow"), the recorder pushes the appropriate button on the programmable keyboard labeled for that behavioural event, the Pythagoras software records the event with the associated date and time and then, via text-to-speech components built into the software, the software repeats the recording back to the initial observer stating the behaviour. This ensures that the data being recorded match to behavioural observations.

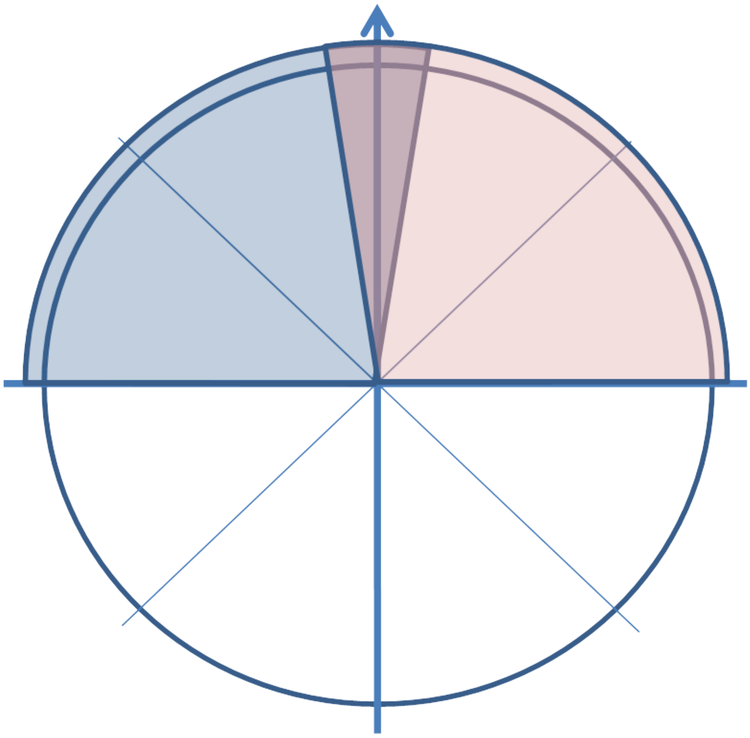

Figure 4. Diagram illustrating range of surveying for two observers with hand-held (7x50) binoculars.

To minimize inter-observer variability, the behavioural observer's observations will be periodically evaluated by other observers and an inter-observer test (Appendix C) should be built into the data collection design to assess the reliability of observers. To minimize observer fatigue, focal follow observers will maintain continuous observations for 30 minutes. Both the recorder and the observer will then switch operations, but ensure events are not missed during this transition.

Since some behavioural events have been associated with the location of the animal, such as dive time and water depth, it is important that sighting information continues to be recorded during a focal follow. Observers will attempt to record a position as frequently as possible, but will have a minimum of one estimated sighting position every 10 minutes of continual observation. Ideally, a position would be recorded each time the animal dives.

In case of equipment failure, behavioural teams will have back-up (datasheets and voice recorders) systems to record behavioural observations.

Vessel Position - To estimate the animal's geographic position and to account for vessel activity in later analyses, it is important to have a real-time GPS stream attached to the computer during observations. A ship GPS feed could be provided for more accurate (*i.e.* differential GPS) estimates or a hand-held GPS system could be attached to the computer. All vessel operations will automatically record the vessel location at 30 second intervals and these vessel tracks will be downloaded to a computer upon each day of operation.

Choosing Focal Animals - The primary purpose of behavioural studies conducted on the vessel platform is to observe whales that are being exposed to higher sound levels from the seismic survey than whales that are near enough to shore for shore-based observation. As such, observers will choose whales that are in the vicinity of the survey or likely to move into the vicinity of the survey. Therefore, if multiple sightings of gray whales are made in the seismic area, observers will choose those whales that will be closest to the survey. If only one whale is observed in the study area, then focal follows will be conducted on that group as opposed to surveying for other whales. Other vessels (scout, seismic, etc.) should report any sightings to the observation vessel to inform them of whale locations which may prove closer to the activity compared to the current animal of study. Pre-exposure, exposure, and post-exposure data are extremely valuable for understanding whale responses to sound exposure levels. As a whale remains in the seismic block area, behavioural observers will continue to follow and observe the animal. Extended focal-follows will be considered on whales that display aberrant behaviour (moving away at high speeds, breaches with rapid movement, etc.). Extended focal-follow will continue beyond the seismic area to evaluate the extent of the response. For the extended focal follow, it is important to understand the duration the whale continues to display aberrant activity. A short-term response may be movement for a couple kilometres, while longer-term responses could last hours. Once the animal has reverted to 'normal' activity and the whale is outside the seismic area, then at least 30 minutes of additional data should be collected.

Data on Vessel Approaches - As previously noted, one potential consequence of collecting behavioural data from a vessel-based platform is that the platform itself may influence the behaviour of the animal. It is possible to examine if such vessel approaches alter the behavioural parameters of the whale being monitored. If opportunities allow, it would be valuable to collect data on the same whale from both a shore platform and the vessel-based platform. In such cases, it would be preferable to conduct a focal follow from shore before, during, and after the behavioural vessel platform conducted their focal follow on the same animal. We believe these data will assist in understanding if the observation vessel itself could be a potential source of disturbance and contribute to a confounding factor in the analyses of potential impact.

Vessel-Based Photo-Identification - Photographic equipment (Nikon D70 and 70-300 lens) will be provided to the behavioural observers on the vessel. Photo-Identification is not a priority for the behavioural team and should only be used if a whale opportunistically approaches the vessel and photographing the animal does not interfere with other priorities, such as focal animal data information.

Communication

It is important to continually track or conduct focal observations on a single animal as long as possible as that animal will be exposed to varying sound levels and changes in its movement and/or respiration may indicate response to certain levels of exposure. As such, behavioural teams need to effectively communicate their observations to other teams that may extend the observation of an individual or group. For the two onshore teams, the teams will be in constant communication and when whales move outside of their observation range and are moving in the direction of the other observation team, the team will communicate the sighting and provide unique identifiers for the other team to record and link these data for later analyses. Whales that are moving offshore of the onshore observation range will be communicated to the behavioural vessel to consider conducting focal observations. Any aberrant behaviour observed by any team will be communicated initially to the senior MMO on the seismic vessel as well as to all other behavioural teams.

The behavioural vessel platform will require constant communication between the behavioural observers conducting observations on whales from the 'flying bridge' of the vessel with the captain that is steering the vessel. Both the captain and behavioural recorder will be in constant communication via hand-held VHF radios to provide information on the whale's location and distance and type of approach the vessel should take to manoeuvre around the whale under observation.

Environmental Data Recording

For both onshore and offshore teams, environmental data will be recorded at least once every hour or when conditions, such as sea state, visibility, wind direction, etc., have significantly changed. Environmental data are derived from several sources: 1) observation, 2) weather devices, and 3) mathematical predictions (*i.e.* tide height). Environmental conditions being recorded include, relative visibility, glare, sea state, wind speed, wind direction, cloud cover and swell height. Hand-held weather stations (Kestrel 4500) will be used at each observation platform to automatically record atmospheric temperature, barometric pressure, wind speed, wind direction, humidity and several other environmental parameters at 10-min intervals throughout each day of effort. Atmospheric temperature and pressure information were used to estimate a refraction correction for calculations of distance approximation (Leaper and Gordon 2001).

After each field day, the environmental data will be downloaded to a computer and stored. If environmental parameters hamper observations, then research effort will be discontinued until conditions are acceptable.

For scan sampling surveys or vessel survey mode, visibility conditions greater than 3 (*i.e.* obscured horizon) and/or Beaufort sea states > 3 are generally unacceptable for data collection/analyses. For focal follows and theodolite tracking, an obscured horizon (visibility code > 3) generally does not interfere with data collection (but does affect observation range) and data can be collected in these conditions. Given the animal's distance from the observation platform, theodolite tracking can be continued until Beaufort 5 conditions and visibility conditions < 5. Appendix B describes the environmental parameters to be recorded for the 4-D Astokh seismic survey.

For vessel-based recordings, wind speed and direction are likely to be affected by vessel movement. All attempts should be made to identify and record any environmental data available from ship-based instruments.

Data Validation and Reporting

Upon completion of each field day, all data (sighting, GPS logs, environmental, focal follow, theodolite tracking, comments, etc.) recorded will be examined for potential data entry errors. The team leader for each platform will be responsible for examining the data each evening to identify any mistakes and expand upon entries that are unclear. All effort, sighting, and focal follow summary data should be collated and reported. Any anomalous behaviour or events will be highlighted in the report. All data will be backed up on a daily basis to two external sources (external hard drives, USB keys, etc.).

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Appendix A: Definitions

Aberrant Behaviour

Aberrant behaviour is defined as a behaviour that is observed to be anomalous or outside of the range of natural parameters. For example, when a western gray whale travels, previous observations indicate "natural" travel speeds to range from 2-6 km/h (Table A.1). An observation of a gray whale consistently travelling at speeds of 8-10 km/h would be considered aberrant as these speeds are on the extremes of natural movement parameters. An animal that is particularly stressed may rapidly ventilate (decreased respiration intervals) or cycle through their surface-respiration-dive cycles more rapidly. Behavioural indicators of response can be subtle and difficult to measure or objectively assess in real-time. The speed of the animal and respiration intervals are monitored in real-time, but also need to be examined in to the context of the behavioural activity of the animal. Constant changes in direction in relation to nearby activity can be interpreted as movements being influenced by a nearby source. Change in behavioural states may also serve as an indicator of influence. For example, if an animal was observed to continually feed in an area, then changes their behavioural activity to travelling as a vessel approaches, this would suggest that the vessel or sound produced by the vessel influenced the animal to leave the area.

Surface-active behaviours may also function as a response or at least annoyance to nearby anthropogenic activity. For example, multiple tail slaps or abrupt diving while a vessel approaches has been suggested as an annoyance response. Breaching behaviour (an intentional jump from the water in which at least 40% of the animal's body emerges) can have multiple purposes but needs to be examined in context. Calves and sub-adults tend to breach more frequently than adults. Adults tend to breach more in a social context when groups are emerging or splitting (Whitehead 2002). There have been further suggestions that breaching behaviour may be related to increased wind speeds. In the context of seismic activity, multiple breaches in combination with rapid movement away from a sound source will be determined as aberrant behaviour. Separation of individuals in a group could be interpreted as a response to nearby activity. However, these events do occur naturally as well and needs to be examined in the context of the activity that is occurring. For mother-calf pairs, separation of the two individuals by five body length in combination with a lack in coordinated movement would be particularly aberrant for the time period of the seismic survey (June-July).

Table A.1. Movement and respiration parameters of western gray whales during feeding, feeding/travelling and travelling behavioural states in 2009.

Variable	Feeding	Feeding/Traveling	Traveling
Speed (km/h)	0.8 ± 0.47 (35)	1.5 ± 0.86 (36)	3.9 ± 1.78 (83)
Reorientation rate (°/min)	33.5 ± 13.82 (35)	21.5 ± 12.53 (36)	9.2 ± 7.01 (83)
Linearity Index	0.6 ± 0.23 (35)	0.8 ± 0.16 (36)	1.0 ± 0.05 (83)
Mean vector length	0.5 ± 0.23 (35)	0.8 ± 0.20 (36)	0.9 ± 0.09 (83)
Ranging index (m/min)	10.1 ± 7.00 (35)	22.5 ± 14.54 (36)	62.6 ± 29.51 (83)
Distance to shore	1.0 ± 0.54 (35)	1.0 ± 0.56 (36)	1.0 ± 0.72 (83)
Acceleration $(km/h)^2$	0.0 ± 0.12 (35)	-0.1 ± 0.15 (36)	0.0 ± 0.30 (83)
Respiration Interval (min)	0.23 ± 0.056 (15)	0.27 ± 0.060 (18)	0.54 ± 0.193 (43)
Blows/Surfacing	3.89 ± 1.063 (15)	4.38 ± 2.146 (18)	4.55 ± 2.912 (40)
Surface Time (min)	0.65 ± 0.226 (15)	0.94 ± 0.757 (18)	1.86 ± 1.772 (40)
Dive Time (min)	2.74 ± 0.842 (15)	2.73 ± 0.863 (18)	1.75 ± 0.511 (40)
Surface Blow Rate	6.40 ± 1.403 (15)	5.28 ± 1.280 (18)	3.21 ± 1.225 (40)
Dive-surface Blow Rate	1.10 ± 0.225 (15)	1.16 ± 0.297 (18)	1.19 ± 0.302 (40)

Groups and Group Structure

Observations usually concentrate on one individual during any given session. With the exception of mother-calf pairs, western gray whales are typically solitary, but aggregations can occur near a particularly favoured area for feeding, travelling companions, short-term interaction, social activity, etc. For behavioural research, *a group is defined as one or more interacting individuals that demonstrate coordinated activity in their* *behaviour*. In some instances, it is possible to identify one individual among a group as a subject of focal observations. This individual can be spatially separate from the other individual(s) or distinguished by an obvious identifiable feature (*e.g.* large white spot, body size, etc.).

It is important to record changes in group composition. Western gray whales have been observed to form short-term associations, where, for example, one individual is feeding alone and another individual travels into the area and *joins* (affiliates with) the other feeding individual. These associations can last for a brief period of 10 minutes or 1 hour. Often such interactions can hinder an observer's ability to record reliable data since it is unclear which whale is surfacing. However, behavioural observers should record such events and the duration of the affiliations despite the inability to collect respiration and other focal animal data. On the other hand, two individuals observed in a group may separate ("*split*"/disaffiliate) from one another. It is important that these *splits and joins* are recorded, particularly if the subjects are a mother-calf pair.

Behavioural States and Events

For behavioural observations, it is important to distinguish between behavioural events and behavioural states. Behavioural events are instantaneous and can have regular or irregular pattern, while behavioural states last longer and indicate the general activity of the animal(s). For example, a whale that breaches (event) several times could be travelling (state) in one direction. For western gray whales, behavioural events, such as dive time, respiration interval, etc. have often been associated with their behavioural state (feeding, feeding/travelling, travelling, etc.). Therefore, it is important to consistently and reliably identify both behavioural events and states of the study animal. Identification of behavioural states takes observational experience and patience to detect behavioural patterns. Given that "*the greatest source of errors in using observations made by others is that no two people who look at the same thing see the same thing*" (Lorenz 1935), it is important to have consistency among behavioural observers. Inter-observer reliability (Appendix C) data should be collected to examine consistency between observers.

Behavioural States - The three primary behavioural states that have been observed on the western gray whale feeding grounds are: 1) Feeding, 2) Feeding/Travelling, and 3) Travelling. Milling behaviour has been observed to some extent and more frequently occurs with mother-calf pairs. Socializing behaviour has been observed each year, but tends to occur in the latter part of the feeding season (late August through early October) when individuals have successfully fed and can engage in more energetic activities. Resting behaviour has not been observed frequently. Table A.2 defines seven behavioural states.

Table A.2. Behavioural states of western gray whales.

Behavioural States	Code	Definition
Feeding	F	Non-directional movement where individual(s) generally remain in one localized area with consistent periods of diving
Feeding/travelling	FT	Individual(s) swimming at relatively slow speeds with consistent periods of diving and having directional persistence in movement
Travelling	T	Individual(s) Swimming in one general direction and often remaining at the surface without consistent dives
Socializing	S	Two or more interacting individuals displaying surface active, chasing, or sexual play behaviour
Milling	M	Individual(s) swimming with no consistent direction (i.e. circling, moving back and forth, playing in swell, etc.)
Resting	R	Individual(s) observed to be relatively stationary at the surface without an observed period of submergence
Unknown	U	Any undetermined/unrecognizable behaviour

Behavioural Events - Any observed activity while the animal can be seen at the surface is recorded as an event. Events can be categorized as respiration, submergence, leaping, pectoral and fluke, social, disturbance, and miscellaneous behaviours (Table A.3). It is important to note that many of the respiration and submergence events are time sensitive as response variables such as dive time, surface time, respiration interval, etc. are derived from them. Event data are also considered time-series data where one event is dependent on the next, therefore it is critical that respiration and submergence events (as well as leaping behaviours) are not missed and are accurately recorded. If the observer or recorder fails to state or record the event at the time of observation, the data should be recorded as missed rather than trying to estimate retroactively. Other events, such as "sea birds", "mud", "chasing", etc. are not as time sensitive. In behavioural event recording, priority should be given to respiration and submergence categories as they are time sensitive.

Table A.3. Behavioural events of western gray whales.

Behavioural Events	Code	Definition	Category
First Surface	FS	First respiration after an observed dive	Respiration
Surface No Blow	SNB	Animal observed at the surface with no apparent respiration	Respiration
Blow	B	Animal observed breathing	Respiration
Missed First Surfacing	MFS	Missed initial respiration after an observed dive	Respiration
Missed Blow	MB	A respiration occurred but observer missed recording the observation	Respiration
Peduncle Arch	PA	Animal observed arching back portion of body, indicator of diving event	Submergence
Missed Dive	MD	Animal remains submerged for > 60 seconds without any indication of diving (Peduncle Arch, fluke up, etc)	Submergence
Fluke Up	FU	Fluke extends out of the water	Submergence
Fluke	F	Fluke observed on the surface or slightly above the water	Submergence
Head-Out	HO	A portion of the animal's head rises out of the water	Leaping
Head Lunge	HL	An angular movement out of the water with forward movement	Leaping
Breach	Br	Vertical movement out of the water with a non-forward direction of movement	Leaping
Unidentified Leap	UL	An individual observed to move a portion of the body out of the water but unable to recognize the type of leaping behaviour	Leaping
Fluke Out	FO	A portion of the animal's fluke is observed above the water line (indicator of feeding)	Pectoral & Fluke
Tail Slap	TS	Animal observed to raise fluke above water line and forcible slash water below with their fluke	Pectoral & Fluke
Pectoral Out	PO	A portion of the animal's pectoral fin is observed above the water line	Pectoral & Fluke
Rolling	R	Alternating portions of the animal's fluke and/or pectoral fins are observed above the water line	Pectoral & Fluke
Sea Birds	SB	Sea bird(s) are observed hovering above or near the focal animal	Other
Mud	M	Observed mud plume observed near the focal animal	Other
Bubbles	B	Air bubbles are observed near the focal animal's position	Other
Object Play	OP	Animal observed interacting with object at the surface	Other

Sexual Social	SS	Interacting individual in a social group with an observed penis above the water	Social
Social Play	SP	Two or more individuals interacting for apparent non-sexual purpose	Social
Nursing	N	An observed adult interacting with one or more calves in apparent nursing behaviour where adult rolls or calf is observed diving under the stationary adult	Social
Chasing	C	One or more individuals observed to continually follow one or more other individuals with intermittent social activity	Social
Avoidance - Whale	AW	Individual(s) are observed changing direction to move away from other individual(s) of the same species	Disturbance
Avoidance - Predator	AP	Individual(s) are observed to be moving away from the direction of another individual(s) of a potential predatory species (*i.e.* Killer whales)	Disturbance
Avoidance - Anthropogenic	AA	Individual(s) are observed to be moving away from the direction of a potential anthopogenic source	Disturbance
Attraction - Predator	AP	Individual(s) are observed to be moving toward the direction of another individual(s)of a potential predatory species (*i.e.* Killer whales)	Disturbance
Attraction - Anthropogenic	AA	Individual(s) are observed to be moving toward the direction of a potential anthropogenic source	Disturbance
Harassment - Predator	HP	Individual(s) are observed in close proximity to a potential predator species with obvious interaction	Disturbance

Appendix B: Environmental Parameters

This appendix summarizes the environmental parameters that will be recorded during the 4-D Seismic Survey in 2010 (Table B.1). Categorical codes for Beaufort and Visibility are described in Tables B.2 and B.3.

Table B.1. Environmental parameters recorded hourly for behavioural observations.

Parameter	Units	Description	Estimation	Example
Station	Textual	Name of Observation Station	Computer	2nd Station
Date	Date	Date of environmental recording	Computer	12-Aug-09
Time	Time	Time of environmental recording	Computer	14:23:33
Beaufort	0-12	Beaufort scale to estimate sea state conditions	Observational	3
Visibility	1-5	Code to estimate visibility conditions	Observational	2
Temperature	° C	Atmospheric temperature at time of environmental recording	Weather Device	12.5
Pressure	mB	Atmospheric pressure at time of environmental recording	Weather Device	1008.5
Swell height	m	Estimated swell height at time of environmental recording	Observational	0.8
Wind Speed	km/h	Speed of wind at time of environmental recording	Weather Device	13.6
Wind Direction	Textual	Direction of the wind (N, E, S, W, NE, SSW, etc) at time of environmental recording	Weather Device	SSE
Glare	%	Percent of the observational area obscured by sun glare	Observational	10
Glare Angles	Numeric Bearings (0-360)	Magnetic bearing range from the beginning of the northern concentration of glare to the southern end of sun glare concentration that obscures observations	Observational	120-145
Cloud Cover	%	Percent of cloud coverage in the atmosphere	Observational	60
Tide	m	Predicted tide heights at time of observations. Not estimated in field.	Predicted	0.1

Table B.2. Beaufort sea state categories for environmental data recording.

Beaufort	Description	Sea conditions	Land conditions
0	Calm	Flat.	Calm. Smoke rises vertically.
1	Light air	Ripples without crests.	Wind motion visible in smoke.
2	Light breeze	Small wavelets. Crests of glassy appearance, not breaking	Wind felt on exposed skin. Leaves rustle.
3	Gentle breeze	Large wavelets. Crests begin to break; scattered whitecaps	Leaves and smaller twigs in constant motion.
4	Moderate breeze	Small waves with breaking crests. Fairly frequent white horses.	Dust and loose paper raised. Small branches begin to move.
5	Fresh breeze	Moderate waves of some length. Many white horses. Small amounts of spray.	Branches of a moderate size move. Small trees begin to sway.

Table B.3. Visibility category codes for environmental data recording.

Visibility Code	Description	Conditions
1	Excellent	Clearly defined horizon line with no obstruction
2	Good	Little to no haze and/or rain with a relatively clear horizon line
3	Fair	Some haze and/or rain but the horizon is still visible for reticle estimation
4	Poor	No visible horizon due to fog and/or rain obstruction
5	No visiblity	No visible horizon due to fog and/or rain obstruction with visibility less than half the distance to the horizon and the observation point

Appendix C: Inter-Observer Reliability

Behavioural observations are subjective and therefore observer-dependent. Although two observers may see the same thing, there may be differences in their ability to identify and classify behavioural states, events, etc. It is reasonable to conduct inter-observer reliability tests as part of the behavioural sampling program, particularly given the number of behavioural teams (two shore and one vessel) and the likely differences in observer experience and thus in ability to understand and classify western gray whale behaviour consistently. Reliability measures can identify potential sources of error in behavioural data collection and interpretation of analyses.

Inter-observer data should be collected whenever possible. This requires two observers to be at the same location and observing the same animal while independently (*i.e.* without the other observer hearing/seeing the recordings) classifying their observations. Future training efforts should include video recordings which can help ensure consistency in behavioural observations. The following analyses can be used to assess inter-observer differences.

Inter-observer reliability analyses - The level of agreement between judges can be evaluated with a standard kappa ($\hat{K}$) statistic (Fleiss 1981, O'Connell and Dobson 1984, Agresti 1990). This agreement statistic is commonly used in the educational, psychological, and medical literature. Kappa statistics estimate the observed pair-wise agreements between two or more judges corrected for chance alone. The kappa statistic can be calculated by

$$\hat{K} = \frac{P_o - P_e}{1 - P_e}$$

where P_o is the observed amount of agreement between two judges and P_e is that expected by chance alone. The null hypothesis of the kappa agreement among judges does not differ from chance alone can be calculated by

$$\hat{K}* = \frac{\hat{K}}{\sqrt{\operatorname{var}_0\left(\hat{K}\right)}}$$

where,

$$\operatorname{var}_o\left(\hat{K}\right) = \frac{\sum_i \sum_j P_i \cdot P_{\cdot j} - P_e^2}{\left(1 - P_e\right)^2 n}$$

Kappa values usually range between one and zero, but can be negative as well due to the chance corrected component of this statistic. A kappa value of one represents a high level of agreement and a kappa value near zero indicates a low level of agreement. This chance-corrected agreement statistic should not be confused with percent agreement values. The resulting kappa value will almost always be less than that of percent agreement due to the chance-corrected component. Landis and Koch (1977) recognized this aspect of kappa values and presented a qualitative basis for evaluating kappa statistics (Table C.1). For ordinal data, such as group size, weighted kappa scores can be used to examine reliability (Agresti 1990).

Table C.1. Qualitative evaluation of kappa statistics (taken from Landis and Koch (1977)).

Kappa	Qualitative Level of Agreement
0.00 - 0.20	Slight Agreement
0.20 - 0.40	Fair Agreement
0.40 - 0.60	Moderate Agreement
0.60 - 0.80	Substantional Agreement
0.80 - 1.00	Perfect Agreement

Annex D

Terms of Reference for Independent Observer for Astokh 4-D Seismic Survey (11 May 2010)

Sakhalin Energy will conduct a 4-D seismic survey of the Astokh lease area during June 2010. Sakhalin Energy and WGWAP, primarily via the Seismic Survey Task Force (SSTF), have jointly developed an integrated monitoring and mitigation program to minimize the effects of the survey on western gray whales and to maximize data collection to assist in the planning of similar programs for future seismic surveys. Inevitably, these programs are complex, particularly in remote areas, and require decisions to be taken in the field in real time based on the guidance provided in the monitoring and mitigation plan. Implementation of the plan will require prompt integration of information of a number of types (*e.g.* acoustic, visual sightings, observed behaviour) from a number of sources (buoys, vessels, shore stations).

In order to evaluate the effectiveness of the monitoring and mitigation program, and also to provide a degree of transparency and public confidence, Sakhalin Energy and the SSTF agreed that an independent observer should be present to develop a firsthand report on the effectiveness and implementation of the plan and to provide any recommendations for improvements. The qualifications and duties of the independent observer (IO) are given below.

Qualifications:

(1) Be able to speak English and communicate on progress with the lead operator offshore.
(2) Be able to communicate effectively in real time with the crew of the observation vessel including the senior MMO.
(3) Have completed the Sakhalin Energy basic safety training program for shore-based personnel or an approved equivalent.
(4) Be in possession of any Russian documentation needed to undertake the duties outlined in these Terms of Reference.
(5) Have experience in cetacean fieldwork.
(6) Have an understanding of the issues surrounding seismic surveys and whales, including knowledge of seismic acquisition operations and procedures.
(7) Have a good understanding of the monitoring and mitigation plans and the reports that led to their development.
(8) Have a good understanding of the acoustic data expected to be received and the ability to interpret such data in the light of the monitoring and mitigation plan.
(9) Be able to monitor the progress of the vessel in the light of A- and B-lines (and any truncation thereof).

Duties and collaboration:

(1) Comply with all Sakhalin Energy safety requirements.
(2) Behave courteously and responsibly at all times.
(3) Arrive on Sakhalin Island in time to complete necessary safety training and then mobilize with the field teams in advance of the start of the survey. Remain on site for at least half of the actual seismic survey (~10 days depending on weather).
(4) Receive and review, in near real time, visual and acoustic data relevant to implementation of the monitoring and mitigation plan and thus to evaluate compliance with the plan and/or any difficulties in its implementation [the IO will be on shore and will be able to view the acoustic data coming from the real time monitoring buoys].
(5) Co-operate with the senior MMO and provide advice where appropriate on the implementation of the plan, whilst recognizing the existing decision-making structure [the IO has no authority to start or stop any operations].
(6) Provide real or near real-time feedback, while in the field during the survey, to IUCN and to Sakhalin Energy about any apparent gross violations of the protocols set forth or other observations of serious concern.
(7) Present a full report to IUCN on the implementation of the plan and document any exceptions or changes to the protocol should they occur. The documentation should be of sufficient detail to

allow for a full analysis and review of the program, including an overall conclusion on the success of the implementation of the plan and recommendations for improvements for future surveys, if appropriate. The report will include:

(a) A general summary of IO schedule, activities and general impressions;

(b) A detailed summary of observations of each on-land team (*e.g.* acoustics, behavioural stations), including an assessment of efficacy and lessons learned;

(c) A detailed assessment of how well communication did/did not work within and between teams during the survey; and

(d) A detailed assessment of the overall efficacy of the protocols established by WGWAP and Sakhalin Energy for the survey.

The report will be authored by the IO and made public by IUCN after acceptance by the Panel. The draft report will be subject to review by Sakhalin Energy to ensure factual accuracy, following a procedure similar to that used for WGWAP reports.

Other:

1. All contractual, travel and financial arrangements will be made by IUCN
2. There are regular scheduled telephone conference calls to shore from the seismic operations in which it is possible that the observer could participate.