WESTERN GRAY WHALE ADVISORY PANEL **NTF-8**

NOISE TASK FORCE

REPORT OF THE NOISE TASK FORCE AT ITS 8TH MEETING

17-18 NOVEMBER 2014

WASHINGTON, D.C., USA

CONVENED BY THE INTERNATIONAL UNION FOR CONSERVATION OF NATURE

Report of the 8th Meeting of the Noise Task Force

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ACRONYMS

AASM	Airgun Array Source Model
AUAR	Automated Underwater Acoustic Recorder
Company	Sakhalin Energy Investment Company
dB	Decibel
D-TAG	Digital Acoustic Recording Tag
ENL	Exxon Neftegas Limited
GIS	Geographical Information System
IUCN	International Union for Conservation of Nature
IWG	Interdepartmental Working Group on Western Gray Whale Conservation of Russian Federation, under Ministry of Natural Resources and Ecology
MC	Mother-Calf
MMO	Marine Mammal Observer
MMP	Monitoring and Mitigation Programme
MMPP	Marine Mammal Protection Plan
MNR	Ministry of Natural Resources and Ecology of Russia Federation
NTF	Noise Task Force
OBN	Ocean Bottom Node
Photo-ID	Photo Identification
POI	V.I. Il'ichev Pacific Oceanological Institute, Far Eastern Branch of the Russian Academy of Sciences
PML	Perimeter Monitoring Line
RMS	Root-Mean-Square
SEIC	Sakhalin Energy Investment Company
SEL	Sound Exposure Level
SPL	Sound Pressure Level
SSTF	Seismic Survey Task Force
VADAR	Visual & Acoustic Detection and Ranging at Sea
WGWAP	Western Gray Whale Advisory Panel

1 INTRODUCTORY ITEMS

1.1 Chairman's opening remarks

The 8th meeting of the Noise Task Force (hereafter NTF) was held at the IUCN-US office in Washington, D.C., USA, from 17-18 November 2014 under the chairmanship of Greg Donovan, with some members from both Sakhalin Energy (the Company) and the Panel remaining for two additional days to finalise the report by 22 November 2014. The list of participants is given as Annex A.

Donovan welcomed participants and stressed the considerable work that needed to be accomplished at this meeting in order to complete the report and provide advice to the Panel on time. He reminded the group that the Panel planned to meet 'virtually' on 8 December to consider the results and recommendations from NTF-8. The Company expects to receive final advice from the Panel on the Monitoring and Mitigation Plan (MMP) for the 2015 seismic survey no later than 12 December (this advice will be contained in the WGWAP-15 report). Given the severe time constraints, it was agreed that the sole focus of discussion at this meeting (NTF-8) would be the 2015 MMP.

1.2 Adoption of agenda

The agenda was adopted and is given as Annex B.

1.3 Available documents/materials

The list of documents and presentations is given as Annex C, along with information on their availability.

2 UPDATE ON SURVEY LOGISTICS

2.1 Details of the accepted tender including technical parameters

2.1.1 Presentation

Van der Veen reported that the tender exercise for streamer seismic had been closed out. The winning bidder had commenced the required Russian Federation permitting procedures and an official announcement was pending approval of the proposed award by the Sakhalin Energy board.

The scope of work consists of Piltun-Astokh 4D and Lunskoye 4D surveys, measuring 350 km^2 and 290 km^2 respectively.

Ocean Bottom Node (OBN) work (as discussed on previous occasions) has not been awarded and options for future deployment of OBNs are currently being considered.

VESSEL

A vessel in 8-streamer configuration will be deployed for the time-lapse geophysical survey. Streamer separation will be 100m, leading to a 700m wide tow, which is deployed to a 6 x 100 m (500m wide) pre-plot from 1997/2010, thus reducing the eventual need for infill shooting.

Cable length will be 4,500m as per specifications announced previously.

ACOUSTIC SOURCE

The source will be an airgun array operating with two sub-arrays spaced 9m apart. The output of this airgun array was modelled by the '*Nucleus*' package, which is the industry standard. This modelled 'signature' will also be used in seismic data processing for 'de-signature' – which is the step that reduces the imprint from the source wavelet in a deterministic fashion. The source array will be towed at 6m depth (± 1m), which is an important parameter for eventual output 'signature'. Source volume is 3,255 in^3 with larger guns in the assembly than was the case in 2010. This change will reduce 'wobble' (peaks and troughs) and improve the peak-to-bubble ratio in the output spectrum.

Nucleus modelling shows that the total power output of the source is in-between the power output from the 2,620 in^3 source (used during the 2010 Astokh 4D survey) and the 2,200 in^3 source (used during the 1997 Lunskoye 3D survey), despite having a larger overall volume. Across the seismic bandwidth, the output is some 3dB lower than that of the 2,620 in^3 source used in 2010.

2.1.2 Discussion

In discussion, it was explained that the horizontal (and "broad-side") energy release, which is of primary concern from the standpoint of potential impacts on the whales, is projected to be somewhat less than in 2010. This should be reflected in the modelled sound "footprints" (see Item 3.1).

Given the initial rationale that use of OBN would reduce the need for seismic surveys of the present kind in the future, some task force members raised concerns about the possibility that Sakhalin Energy would consider it necessary to conduct a "baseline" OBN seismic survey in 2016 rather than "waiting" for the regular cycle of reservoir monitoring every 3-5 years to conduct the OBN survey. Those members urged that Sakhalin Energy (and other companies) give more consideration to long-range planning with a primary objective of reducing the aggregate exposure of the Sakhalin whales to seismic noise.

2.2 Progress on time-sharing options

WGWAP-14 and NTF-7 had discussed the news that Exxon Neftegas Limited (ENL) was intending to carry out extensive seismic survey work in 2015 adjacent and to the north of that being undertaken by Sakhalin Energy; the Panel had expressed serious concern that the combined surveys would introduce considerable acoustic energy into the feeding areas.

2.2.1 Presentation

Van der Veen reported that Sakhalin Energy had proposed the principle of time sharing to ENL, in October 2014 and again in November 2014, as a responsible way of sharing the seismic acquisition season between operators. Sakhalin Energy has stressed that time sharing would allow both companies to manage overall exposure of the environment to seismic noise. It would avoid simultaneous airgun shooting from two vessels, which not only increases the amount of instantaneous noise emitted into the environment, but also inevitably leads to re-shoots (repeated attempts at line acquisition) because of interference. Such need for re-shoots would ultimately lead to longer-duration seismic surveys.

Sakhalin Energy has invited ENL to propose details for time sharing. Failing this, Sakhalin Energy will propose the scheme discussed as part of the simulations (50:50 share, based on 6-hour "blocks" of time) (see Item 3.2).

2.2.2 Discussion

In discussion, Van der Veen indicated that there was no point in planning 'contingencies' in the event that a time-sharing agreement with ENL is not reached. Such an agreement is in both companies' interests and is simply essential if both programmes are to go forward in 2015.

3 ANALYSES FOR THE 2015 SEISMIC SURVEY

3.1 Final acoustic modelling

3.1.1 Presentation

Racca began his presentation of new acoustic modelling results by referring to the information about airgun arrays presented earlier by Van der Veen. He showed the pressure time series output traces modelled using the *Nucleus* software for both the original 2620in^3 source from the 2010 4D survey and the proposed 3255in^3 source for the 2015 survey, overlaid with the same results generated by the Airgun Array Source Model (AASM) software used by JASCO in the footprint modelling process. The traces showed good agreement of key features (primary pulse acoustic pressure, timing of bubble oscillations), indicating that the two modelling programs produce mutually consistent estimates. Racca then showed, for each array, polar plots of the directional source-level far-field equivalent (the sound level pattern in azimuth that the array would have at a 1m radius if it were a point source) resolved in 1/3 octave frequency bands between 10 Hz and 2 kHz, which are used individually for the propagation modelling. By alternating between the plots for the two airgun array sources (2010 and 2015), he pointed out how the pattern in individual frequency bands differed, especially in the shape and magnitude of the lateral lobes.

Racca explained that it would be impossible to estimate, from the source modelling alone, the relative footprint of each array at range, as site-dependent propagation effects would alter the relative received levels in each frequency band that would constitute the total (broadband) received level. He thus introduced maps of the 156 dB per-pulse sound exposure level (SEL) shoreward front and the shoreward sound level fronts between 140 and 160 dB SEL in 5 dB increments for (a) the most near-shore boundary of the 2015 seismic survey footprint, (b) the 14th line from the most near-shore edge of the survey area – i.e. the first line to be acquired North to South according to the survey plan and (c) the 25th line from the most near-shore edge – i.e. the estimated last of the lines expected to expose any part of the feeding area to sound levels above 156 dB per-pulse SEL. All of these results had been modelled using a set of acoustic environment parameters known as the "base + 1 dB" case, which had been the most commonly encountered propagation condition in the 2010 4D survey.

Finally, Racca presented sound footprint maps of individual pulses along the three line profiles mentioned above, modelled using both the 'base + 1 dB' case and a higher-propagation condition 'base +3dB'. These maps gave an understanding of the actual extent, not only shoreward but also laterally in all directions from the source, of the region within the feeding area estimated to be exposed to various sound levels including the agreed 156 dB per-pulse SEL threshold.

3.1.2 NTF conclusions

The group thanked Racca for this update and agreed that this aspect of the task force's work is now completed.

3.2 Review of the simulations modelling work

In order to consider the implications of various strategies for conducting the survey, the task force had agreed at NTF-6 that a simple simulation approach should be developed. Initial work undertaken using an Excel spreadsheet approach was reported and discussed at NTF-7. That meeting had identified some additional performance statistics and scenarios for consideration using the same basic 'spreadsheet approach'. An additional aspect to the work had been identified at NTF-7 i.e. to develop an approach to quantify the relative cumulative exposure resulting from various strategies; this task was expected to require considerable new simulation development work. The simulations can provide insights into the trade-off between the objective of protecting individual whales from exposure to the agreed thresholds and the objective of protecting the maximum number of whales by completing the survey early.

To progress the work in a timely fashion, a steering group had been established at NTF-7 and this group 'met' via teleconference between NTF-7 and NTF-8. A report (NTF-8/6) was circulated to the task force on 12 November showing results thus far and identifying work that remained to be completed. As expected, by the time of this meeting (NTF-8) the work of updating and expanding the existing spreadsheet approach had advanced further than the developmental work to examine relative cumulative exposure.

3.2.1 'Spreadsheet approach'

PRESENTATION

A summary of the work undertaken by the Steering Group, including additional work undertaken since the summary report (NTF8-6), is provided below.

A variety of scenarios were considered.

(1) Companies

Two cases were considered: 'One Company' in which only Sakhalin Energy operates and 'Two Companies' in which Sakhalin Energy and ENL both operate using a 50:50 timeshare. It is important to note that the summary statistics presented for such a scenario related only to the effects from the Sakhalin Energy survey.

(2) Mitigation strategies

Three cases were considered: 'P27' in which additional protection (against exposure to levels at or above 156dB SEL) is given to all 27 projected A-lines; 'P13' in which additional protection is given only to the first 13 A-lines (i.e. those closest to shore); and 'IA' in which no additional protection is given to A-lines.

(3) Start of survey

Three cases were considered: 'Early' with the survey starting on 15 June; 'Middle' with the survey starting on 29 June; and 'Late' with the survey starting on 15 July. The last case was included to represent a scenario whereby Sakhalin Energy starts its survey after ENL has finished operating in the area.

(4) Whales

In the base case, a linear increase in animals present was assumed from Day 1 until the plateau (of 90 animals) is reached by 1 August. In addition, a more extreme case was considered where the plateau was reached as early as 15 June (see discussion below). Distribution was considered uniform throughout the area, except for the mouth of Piltun Lagoon where it was always assumed that one animal would be present. This is an arbitrary number, which allows comparison across scenarios, but is not intended to represent 'reality'.

(5) Number of replicates

For each of the scenarios, 50 replicates were run and the performance statistics (see (6) below) were computed. The choice of 50 replicates was made after running 500 replicates for some cases and noting that the results were similar.

(6) Performance statistics

The concept of 'hits' is introduced in the performance statistics below. A hit represents the exposure of an animal above a certain noise threshold. In the simulations, each exposure of an animal to per-pulse levels above 156dB SEL was counted as one hit. The whales always present off the mouth of Piltun Lagoon attracted one hit per *one* pass of the vessel for the 1st block of 13 survey lines (those sailed nearest to shore) and one hit per *two* passes for the 2nd block of 13 lines (from the 14th line and seaward) in recognition that these lines would cause less frequent exposure to sound levels above 156dB SEL in the feeding area. No hit was counted for the last 14 lines (from the 28th line and seaward), which were assumed to cause no feeding area exposure above 156dB SEL.

It was assumed that hits of > 180dB rms sound pressure level (SPL) would not occur due to source suspension (shutdown) when any gray whale is observed within a range from the source at which such exposure would be expected.

Thus the following performance statistics were tracked:

- Number of hits at per-pulse levels above 156 dB SEL;
- Number of suspensions (shutdowns) due to a whale being exposed to per-pulse levels above 156 dB SEL;
- Number of suspensions (shutdowns) due to a whale being exposed to levels above180 dB rms SPL;
- Days to complete survey;
- Number of lines completed by Day 30.

A summary of the results for the various scenarios is given as Table 1.

DISCUSSION AND CONCLUSIONS

The NTF acknowledged that the purpose of the simulations was to allow a broad comparison of the implications of different mitigation strategies, rather than quantitative predictions on the outcome of a particular case. For this reason it was decided not to factor in many different scenarios related to poor weather or other logistical reasons for shutdowns.

In terms of input, much of the discussion centred around the information available on arrival of the whales into the area and the date by which numbers would be expected to plateau. As noted in previous NTF reports, relatively little recent information is available for the early part of the open-water season when whale are generally thought to arrive at Sakhalin (late May through June), and this has led to recommendations for an earlier start to observation effort. An analysis of pre-2010 SEIC/ENL Joint Programme data (Vladimirov, 2007) was at least in part responsible for the decisions by the companies (SEIC and ENL) to focus their monitoring and mitigation efforts on the 'peak' period, i.e. July onwards. The work of the Seismic Survey Task Force (SSTF)[1] prior to the 2010 survey, primarily with regard to defining the boundary of the whale

[1] In 2011, the name of the Seismic Survey Task Force was changed to Noise Task Force to acknowledge that its remit should include all aspects of the noise issue.

feeding area for the June-July and August-September periods relied upon Joint Programme data along with other available data on distribution (primarily from the Russia-US programme). A simple initial examination by Cooke of the distribution data from 2010 (when observation effort began earlier in the season than usual due to implementation of the MMP for the Astokh 4D seismic survey that year) suggested that the plateau ('peak density') of whales was reached by mid-June. Vladimirov recalled that the data from 2012, when effort also began early due to MMP for the 2D seismic survey at South Piltun, showed an increase from around 5 animals present in mid-June to 20 in mid-July. However, the NTF recognised the difficulties of analysing the available data given the very different observation start dates in the different years and the problems associated with correction for effort.

Despite the difficulties, the NTF agreed that the available data suggest the whales usually begin to arrive in the region in late May or early June and do not reach a plateau in numbers or density until mid- to late July. It therefore agreed that the base-case scenario with the plateau being reached on 1 August was appropriate as a baseline assumption, and the 'early plateau' scenario (15 June) should only be considered in the context of a sensitivity test.

The NTF concurred that this **reiterates** previous conclusions by the NTF and the Panel of the importance of collecting good information on whale distribution and abundance early in the season, given that completing a seismic survey as early as possible when fewer whales are expected to be present is considered a key component of the mitigation strategy. If whale numbers did not ramp up from early June to mid or late July, then it could be argued that (a) starting the survey as early as possible is unnecessary and (b) the trade-off between allowing a few whales to be affected early in the survey in exchange for ensuring that many whales are unaffected later in the survey does not apply, thus putting the emphasis on the protection of individual whales. In terms of the results presented in Table 1, the following broad conclusions can be drawn:

(1) the advice to start as early as possible is shown to be the most important mitigation measure (with the obvious exception of the scenario in which all animals have already arrived by 15 June, the earliest start date contemplated) as this leads to the smallest number of hits and shortest survey duration for the P27 and P13 simulations;

(2) in terms of the predicted number of hits at per-pulse levels above 156 dB SEL, there is relatively little difference regardless of whether the P27, P13 or IA option is considered in the cases of early and mid-season starts, but for the case of a late start, the IA option results in significantly fewer total hits, due to the comparatively large number of times that the vessel would pass Piltun Lagoon mouth in the P27 and P13 simulations;

(3) in terms of days to complete the survey for the One Company scenario, the IA case is always the shortest, taking some 16-17 days increasing to around 24 days for the P27 and P13 options for the early start, around 35 days for the medium start and 45-51 for the late start;

(4) in terms of the time sharing (Two Companies) options and survey completion, the IA option increases to around 22 days with the P27 nad P13 options taking some 30 days for the early start and some 45 days for the medium start;

(5) in terms of time sharing versus One Company, the predicted number of hits at per-pulse levels above 156 dB SEL is similar.

The NTF **agreed** that these conclusions needed to be considered in the light of the cumulative exposure work being undertaken, which should provide more quantitative information on the trade-off between protecting individuals versus the broader population.

Table 1. Summary of results (mean/SD assuming normal distribution)

S1: Only one survey which starts on 15 June (n=21 whales on that day). No false positives. 1 whale near Piltun receives >163dB hit each pass 1st 13, each 2nd pass next 14
S1E: Early start (in this table this is simply a different 50 run –iteration of S1 showing the results are essentially the same as one would expect); S1M – mid start; S1L – late start
S1P: This sensitivity run shows the case where all whales have arrived by 15 June and the survey starts on that day (in practice this scenario incorporates any start date that occurs in the peak season.
S2: 50:50 time sharing. Otherwise as S1
S3: As S2 but with false positives due to Marine Mammal Observer (MMO) failings or night vision problems
S4: As S2 but with late start (29 June)
S5: As S2 but with an early start
S6: As S1P but for two companies
P27 means additional protection for all 27 A-lines; P13 means for only first 13 A-lines; IA means ignore all A-lines

	One Company														
	S1P27	**S1P13**	**S1IA**	**S1EP27**	**S1EP13**	**S1EIA**	**S1MP27**	**S1MP13**	**S1MIA**	**S1LP27**	**S1LP13**	**S1LIA**	**S1PP27**	**S1PP13**	**S1PIA**
Hits at Piltun 27 A	39/8	37/7	24/2	38/9	36/8	24/2	60/19	54/14	25/3	86/23	78/21	25/2	99/23	93/26	25/2
Hits at P-Bay 13	29/8	28/7	16/2	28/8	28/8	15/2	48/18	45/14	16/2	72/22	69/21	16/2	83/24	85/26	16/2
Hits at P-Bay next 14	10/1	9/1	9/1	10/2	9/1	8/1	12/2	9/1	9/1	15/4	9/1	9/1	16/4	9/1	9/1
Total Hits > 156dB	39/8	**40/7**	**35/4**	38/9	39/9	33/4	60/19	59/14	42/6	86/23	85/22	51/6	99/23	103/26	58/8
Total Hits > 156dB outside Piltun	0	3	**9**	0	18	9	0	5	17	0	7	26	0	10	33
Suspensions > 156dB in FA	19/9	19/10	0/0	19/10	19/10	0/0	59/31	51/23	0/0	117/44	105/42	0/0	146/43	140/50	0/0
Suspensions > 180dB	2/1	1/1	1/1	2/1	1/1	1/1	4/2	4/2	2/1	7/4	6/3	2/2	8/3	8/4	3/1
Days to complete survey	24/4	23/4	**16/1**	24/5	23/5	16/1	36/11	33/8	17/1	51/14	45/12	17/1	55/15	52/17	17/2
Lines Complete on day 30	40/2	40/1	40/0	39/2	40/1	40/0	34/5	35/5	40/0	28/4	29/4	40/0	25/4	26/4	40/0
	Two Companies 50:50 timeshare														
	S2P27	**S2P13**	**S2IA**	**S3P27**	**S3P13**	**S3IA**	**S4P27**	**S4P13**	**S4IA**	**S5P27**	**S5P13**	**S5IA**	S6P27	S6P13	S6IA
Hits at Piltun 27 A	38/8	36/8	23/2	41/9	38/8	23/2	65/18	62/16	22/2	26/3	26/3	23/1	96/20	87/20	23/2
Hits at P-Bay 13	28/8	28/8	15/2	31/8	30/8	15/2	53/17	54/16	14/1	18/3	18/3	15/1	81/21	79/20	15/1
Hits at P-Bay next 14	10/2	8/1	8/1	10/2	8/1	8/1	12/3	8/1	8/1	8/1	8/1	8/1	16/3	8/1	8/1
Total Hits > 156dB	38/8	**39/8**	**33/4**	**41/9**	**41/8**	**33/4**	65/18	**67/17**	**39/5**	**26/3**	**26/3**	**26/3**	96/20	96/19	54/5
Total Hits > 156dB outside Piltun	0	3	**10**	0	3	**10**	0	5	**17**	**0**	**0**	**3**	0	9	31
Suspensions > 156dB in FA	21/11	21/11	0/1	25/12	22/10	0/0	71/31	68/29	0/0	4/3	4/3	0/0	142/38	130/38	0/0
Suspensions > 180dB	2/2	2/1	1/1	5/3	4/3	3/2	5/3	5/3	2/2	0/1	0/1	0/1	9/3	8/3	3/2
Days to complete survey	30/5	30/5	**22/1**	32/5	31/4	**22/1**	45/10	45/9	**22/1**	23/1	23/1	**22/1**	61/15	55/15	22/1
Lines Complete on day 30	**38/4**	**38/3**	40/0	**36/4**	**37/3**	40/0	**30/4**	**29/4**	40/0	40/0	40/0	40/0	23/4	25/2	40/0

3.2.2 Cumulative exposure

PRESENTATION

In order to assess the total exposure of the whales, Cooke developed the following simplified model of the survey. The sound field from the survey lines was simulated using a simple function of distance and angle from the source, with parameters supplied by Racca. The shore-based density data by 1km square from the years 2005-2009 were averaged to produce a relative density distribution.

The distribution of whales was generated anew at the start of each survey line, and whales were assumed to remain stationary while the line was surveyed. Each time the distribution was recalculated, each whale was randomly allocated to a square in proportion to the relative density for that square. The position of the whale within the square was chosen randomly and uniformly. The total population in the area was assumed to increase linearly from zero on 1 June to a maximum of 150 whales on 31 July (for the base case); for comparison, simulations were also conducted with the maximum density reached already on 15 June (as appeared to have been the case in 2010).

Whales were assumed to be sighted with a detection probability chosen to be reasonable for two MMOs searching for medium-sized single baleen whales under good conditions. If a whale was detected within the shutdown radius, the line was aborted and started anew. As a sensitivity test, the detection probability at night was set to half the daytime value for some scenarios.

Lines were spaced 300m apart and were mainly about 40km in length but some were shorter because of the shape of the survey area. The survey speed was 2.57 m/s with shots every 18.75m, making about 85,000 shots in total. Turn time between lines was assumed to be 4.5 hours, and each 6-hour period had a 10% chance of being unusable due to bad weather.

For each whale, the maximum and cumulative sound exposure was recorded. The cumulative exposure was calculated by converting each shot exposure to an energy value, summing up the energies across shots, and converting back to dB. Cumulative distributions were computed across whales and replicates, so that the sound levels that had a given probability (such as 5% or 50%) of being exceeded per whale were shown.

Initially, 50 replicates of each of eight scenarios were run involving combinations of the following options: peak density reached by July 31 (base case) or June 15 (alternative); night vision relative efficiency 100% (base case) or 50% (alternative); shutdown radius 2km (base case) or 0km (= no shutdown), 4km or 8km. The latter value was chosen to correspond to approximately the 156 dB per-pulse SEL behavioural threshold.

NTF CONCLUSIONS AND RECOMMENDATIONS

The NTF thanked Cooke for his hard work in presenting initial runs to the NTF. Although the work had only arrived late in the meeting, Donovan noted that the task that had been set by the Steering Group was more complex than for the 'Spreadsheet' simulations since it required the development of new software as well as a more complex and innovative conceptual framework than has previously been attempted.

Given (a) the potential importance of the results to survey strategy; (b) the somewhat counter-intuitive lack of sensitivity of the outcome to parametric changes in the initial scenarios examined; (c) the relative lack of data for the early season (see above) to model distribution and abundance; and (d) the need to fully understand the behaviour of the model in the light of the various assumptions being made, the NTF **agreed** that it was important for Cooke to provide additional documentation of the approach, data and assumptions. It also **agreed** on the following changes and additional runs (not all necessarily realistic) to *inter alia* investigate the behaviour of the model and ensure that this was reasonable:

(i) the number of replicates should be increased to 500 per scenario;

(ii) the cumulative distribution of exposure should be expressed relative to a constant total absolute population, so that the benefits of starting the survey early, before the peak whale density (plateau), can be seen (in the results presented, the cumulative distributions related only to whales actually exposed);

(iii) runs should be conducted with whale densities extending further offshore, so that more whales are ensonified by the survey (for example shift the whale densities 2km east);

(iv) runs should be conducted with varying source levels and/or shot rates, to check that the results accord with expectation regarding the dependence on sound levels;

(v) information should be provided on the frequency of shutdowns (line aborts) in each scenario.

The NTF recognised that the results of this work would not be available for the present meeting but should, when completed, be made available as supplementary material to the Panel and the Company. The NTF requests that Cooke circulates the results by 26 November 2014. It was further recognised that the code of new software developed to inform critical decisions should be validated.

3.3 Review of behavioural criteria for shutdowns

At NTF-7 it was agreed to review any new information that would allow refinement of aberrant behaviour triggers. It was also agreed that mother-calf separations of > 5 body lengths are considered aberrant in June and July but may represent natural behaviour later in the season. The expectation at NTF-7 was that the presence of mother-calf pairs within the 156 dB per-pulse SEL exposure zone would trigger a shutdown.

3.3.1 Aberrant behaviour

PRESENTATION

Nowacek reported that he had searched the literature for new information on aberrant, abnormal or unusual behaviour of gray whales, as well as all other cetaceans for comparison, in response to seismic noise. Nothing was found other than a published paper documenting an event off West Africa in which a pantropical spotted dolphin, *Stenella attenuata*, was observed swimming with its head out of the water while in close proximity to an active seismic survey (Gray and Van Waerebeek, 2011). He had also reviewed the Canadian, US and New Zealand guidelines for conducting seismic surveys and none include a definition of aberrant behaviour, probably due to the difficulties of generalising when considering a wide variety of species. Nowacek's review produced no new information that would suggest any changes to the aberrant behaviours defined for the 2010 MMP.

3.3.2 Mother-calf pairs

PRESENTATION

Tsidulko presented the requested data on occurrence of mother-calf pairs observed from the Piltun lighthouse by the Russia-US team in June and July. He indicated that Geographical Information System (GIS)-type spatial mapping of those data had not proved feasible in the required time frame for practical reasons. He emphasized that the data presented were of first *sighting* in a given year, which does not necessarily mean the first day when a mother-calf pair was *present* in the feeding area. The data should be regarded only as indicative and not definitive. The first-sighting (and first-effort) dates have varied widely from year to year and suggest that mother-calf pairs can first arrive as early as 3 June or as late as 29 July. However in most years the first sighting occurred within the first two or three weeks of July (Table 2).

Year	Date of first effort	Date of first MC sighting from the lighthouse	Date of first MC sighting from the photo ID boat
1997	15/07/97	20/07/97	24/07/97
1998	23/05/98	**03/06/98**	06/07/98
1999	10/06/99	05/07/99	29/06/99
2000	21/06/00	19/07/00	19/07/00
2001	08/07/01	01/08/01	04/07/01
2002	23/05/02	11/08/02	01/07/02
2003	15/07/03	22/07/03	15/07/03
2004	15/06/04	07/08/04	**29/07/04**
2005	07/07/05	13/07/05	14/07/05
2006	25/06/06	25/06/06	23/07/06
2007	26/07/07	28/07/07	26/07/07
2008	09/07/08	09/07/08	09/07/08
2009	07/06/09	10/07/09	22/07/09

Table 2. Dates for the first sighting of Mother-Calf (MC) pairs from 1997-2009.

During systematic observations of whales from the lighthouse in 1998, 1999, 2000, 2002, 2004, 2006 and 2009 mother-calf pairs were seen in June only in 1998 and 2006. The data over the entire period 1998-2009 suggest that the average number of mother-calf pairs increases through July. Therefore as the season progresses, there is probably a growing likelihood of at least one mother-calf pair being within 10 km to the north or the south of the lighthouse at any given time. Throughout July, the likelihood is that the number of mother-calf pairs in the area will grow.

Average distances from shore of mother-calf sightings ranged from 1.16 km to 2 km (in some years) indicating that although the mothers and calves tend to stay close to shore, they can also be found several kilometres offshore and this must be considered in thinking about and planning the 2015 MMP. Tsidulko also commented, based on his personal observations, that although early in the feeding season mother-calf pairs tend to concentrate around the mouth of Piltun Lagoon (e.g. 3-4 km north or south from the lagoon channel/mouth), they range along the shore to increasing distances as the season progresses, up to 35 km north and 10-15 km south of the lagoon channel/mouth. Tsidulko assumes the distribution is influenced by (a) the availability of preferred prey, (b) avoidance of killer whales and (c) energetic limits on the calves related to water depth and/or temperature. The relative importance of these factors may change through the feeding season.

DISCUSSION

There was a brief discussion of ENL's proposed approach with respect to mother-calf sightings during its planned 2015 seismic survey. According to Tsidulko, at the August 2014 meeting of the Interdepartmental Working Group on Western Gray Whale Conservation of Russian Federation, under Ministry of Natural Resources and Ecology (IWG/MNR), ENL had included in its preliminary MMP a requirement for shutdown if a mother-calf pair was sighted within the zone of ensonification to 163 dB rms SPL or higher. Tsidulko recalled that if visibility was poor and 4-5 hours had passed since the sighting, the survey would be allowed to continue. At WGWAP-14 (see meeting report), ENL reported that one of its specific goals would be to ensure 'that mother-calf pairs are not exposed to sound levels affecting feeding.'

3.3.3 NTF conclusions and recommendations

Tsidulko referred to a number of instances when a mother-calf pair appeared to remain essentially stationary or semi-stationary i.e. not leaving their feeding locations for hours or even several days. The NTF noted that, although the data are limited, the possibility cannot be ruled out that the locations of mother-calf pairs in relation to areas exposed to per-pulse levels above 156 dB SEL are such that it is never possible to survey all of the lines closest to the feeding ground.

The NTF **agreed** that sightings of one or more mother-calf pairs within the zone of exposure to sound levels of 156 dB per-pulse SEL or higher must always trigger a shutdown; this mitigation measure must be adhered to strictly and consistently even if this means that seismic acquisition is incomplete as a result. The Company accepted this condition and noted that it would seek to complete whatever portions of 'interrupted lines' prove feasible without risk of exposing mother-calf pairs to unacceptable levels of seismic noise.

4 MITIGATION AND MONITORING PLAN FOR 2015 SEISMIC SURVEY

The NTF had agreed that the rationale for any proposed changes to the 2010 MMP must be fully documented. Given the scale of the planned 2015 survey it is likely that any effects, should they occur, will be more detectable than in 2010, even if the survey is completed quickly (see NTF-7, Item 7).

4.1 Mapping tool

4.1.1 Presentation

Vladimirov presented a comprehensive set of maps of Sakhalin Energy's 2015 seismic survey theatre and explained that it had been prepared under his supervision according to the specifications laid out at NTF-7. The theatre maps included the following information:

- Piltun-Astokh Licensed Area with Sakhalin-2 project infrastructure;
- 2015 4D seismic area;
- Perimeter Monitoring Line (PML) of 95% gray whale distribution;
- Behaviour response 156 dB SEL contour;
- Locations of real-time and archival underwater acoustic stations;

- Positions of regular Joint Programme autonomous underwater acoustic stations;
- Locations of regular Joint Programme onshore observation stations;
- Theodolite and binocular observation ranges for onshore stations (up to sea state 3);
- Gray whale sightings from 15 June to 31 July, split by 15-day periods, from 2004-2007.

4.1.2 NTF conclusions

The NTF thanked Vladimirov for his comprehensive response to the NTF-7 recommendations. The implications of this for the MMP are discussed under the relevant items below.

4.2 Modified A- and B- line concept

At NTF-7, the task force had endorsed the 'sliding A-zone approach' in principle but had requested that practical details be reported to the task force (e.g. in the context of real-time communication between the various components of the mitigation and monitoring schemes and the command centre, including the ability to identify whales within the moving 'swath').

The Company reported that, as noted elsewhere, the importance of communications was recognised and that work was continuing to ensure that all necessary elements are in place including personnel. Observers will report all sightings (not just mother-calf pairs) within the A-zone to the command centre in real time.

4.2.1 NTF conclusions and recommendations

Text describing the modified A- and B- line concept has been incorporated into the 2015 MMP given as Annex D, as has text related to the Command Centre.

The NTF **recommends** that the Panel be informed of progress with communications, stressing that the MMP will not function properly without a reliable communications and reporting system.

4.3 Real-time and acoustic monitoring/mitigation

At NTF-7 the task force had agreed to the proposed design for the PML instrumentation and the specifications for new automated underwater acoustic recorder (AUAR) stations. It had also requested an update on testing the new equipment.

4.3.1 Discussion

Discussion focussed upon finalising the details of the acoustic component of the MMP. Issues raised included the need to ensure sufficient backup equipment was available in the event of failure, timely replacement of dysfunctional or lost equipment and the positioning of the stations. Racca informed the meeting that he was travelling to Vladivostok next month to work on the testing with Rutenko at V.I. Il'ichev Pacific Oceanological Institute, Far Eastern Branch of the Russian Academy of Sciences (POI). The NTF recognised that the details of how the equipment is to be installed and replaced is the responsibility of the Company. The MMP should specify under what circumstances acoustic equipment problems would result in shutdowns, taking into account the mitigation need to complete the survey as quickly as possible.

4.3.2 NTF conclusion and recommendations

The task force **recommends** that ten telemetric AUAR stations are deployed (some used in line of sight radio mode, others in Iridium satellite mode, others potentially in redundant dual mode) along the PML with three-station clusters at each end and the remaining four stations optimally spaced in the intervening length (see Figure 1). With respect to the continuity of monitoring, the Company commits to maintaining functional integrity of the real-time monitoring infrastructure of the PML by reactivating any failed node as soon as feasible. Subject to this underlying guideline, the following rules apply:

(a) If the failed station is a non-clustered one, normal acquisition can continue for a 48 hour period following the failure, after which only 'safe' B lines (i.e. any line that is offshore of the boundary between A and B lines identified by the most recent model case plus a 3dB buffer) can be acquired until the failed node is restored;
(b) If the failed station is part of a three-unit cluster, normal acquisition can continue as long as no other station fails anywhere along the PML. If any second station fails, normal acquisition can continue for a 48 hour period following the failure, after which only 'safe' B lines can be acquired until both failed nodes are restored;

(c) Any partial A line can be acquired as if the PML was fully operational if the failed node(s) are behind the starting point of the partial line.

The precise wording for the MMP can be found in Annex D.

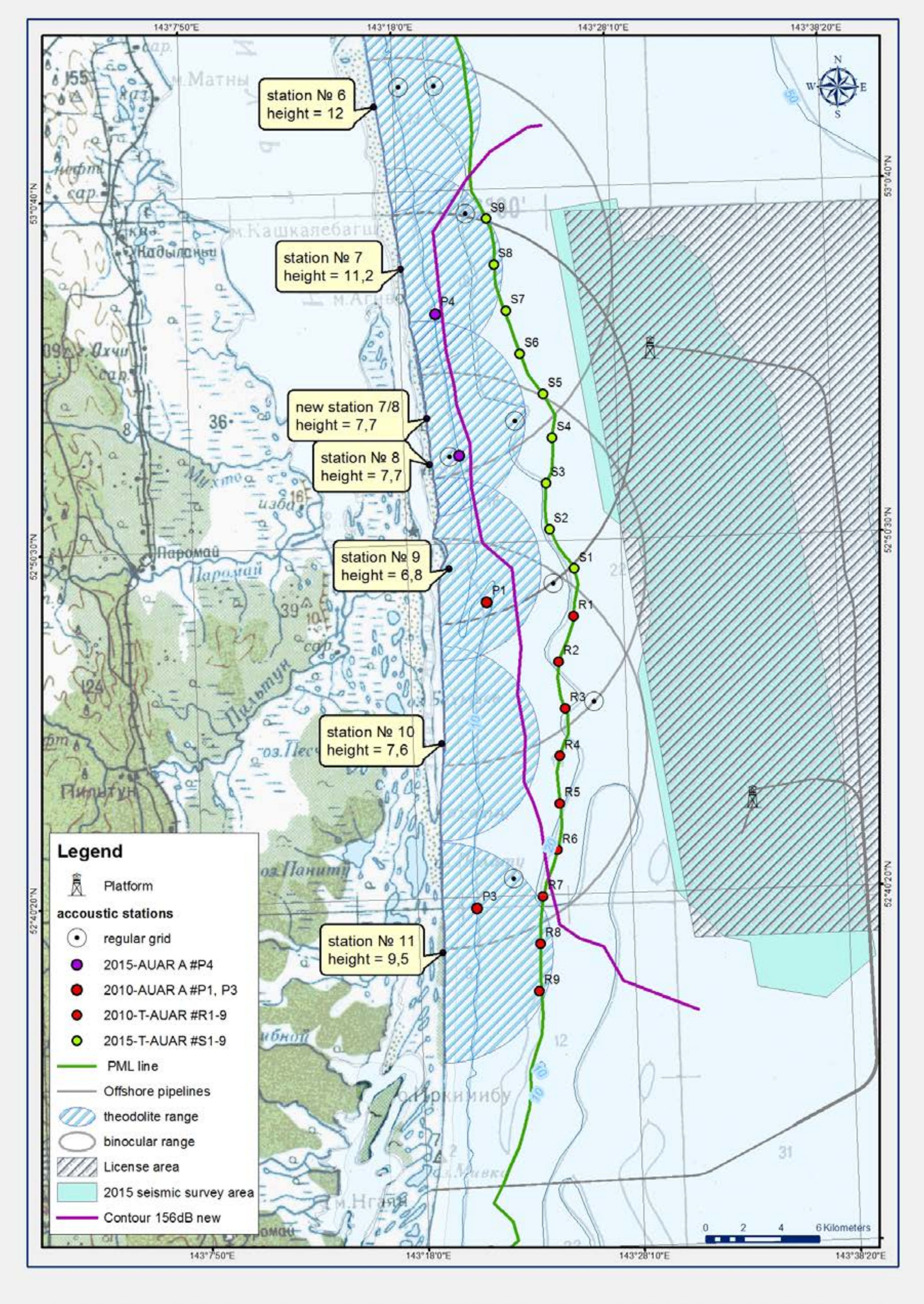

Figure 1. Planned 2015 4D seismic survey area and locations of shore-based visual observation and offshore acoustic stations

4.4 Need for distribution monitoring

Although consensus was not reached at NTF-7 on the necessity or otherwise of distribution monitoring, the Company proposed at the start of NTF-8 that shore-based distribution monitoring would occur and the proposed details are discussed under Item 4.5.

Under this item, the focus was on the question of vessel-based distribution monitoring.

At NTF-7, the Company explained its view that the vessel-based distribution and behavioural monitoring had not been successful and that it therefore had decided that this component of the 2010 MMP would be removed from the 2015 MMP.

Discussion focussed on problems that could arise if, for example, coastal fog prevented monitoring of the A zone from shore. After considerable discussion, the NTF **recommends** that in addition to the four MMOs on the seismic vessel whose primary task is to scan for whales within the exclusion zone, the Company will arrange for Big Eye binoculars to be mounted upon the seismic vessel and for two additional MMOs to be accommodated to enable monitoring of the A zone from the vessel. Reeves noted that another additional MMO would need to be accommodated to monitor detections by the blended remote sensing equipment (see point (2) under Item 5 and point 10.3.2 of Annex D). Although the Company would need final confirmation that the seismic vessel could accommodate the extra observers and equipment, van der Veen believed that this would not be a problem and **agreed** to provide final confirmation through IUCN as soon as possible and certainly before WGWAP-15.

The question of shift logistics for the MMOs on shore is discussed under Item 4.5. Shift logistics for the MMOs onboard the seismic vessel were left for the Company to develop and report to the Panel (see point (2) under Item 5).

4.5 Behavioural and distribution monitoring/mitigation associated with the 2015 survey

The task force had agreed at NTF-7 that the Company should provide detailed protocols for the field teams including:

(a) number of observers on each team and their roles; (b) sampling schedule e.g. timing of scans vs behavioural data/focal follows; and (c) communications strategy between the teams and the Command Centre.

In addition, the Company had been asked to provide more information concerning the use of a scout boat including how many times information from the scout boat had been used in 2010 to allow lines to be shot under ‘poor’ visibility.

4.5.1 Presentation

Vladimirov described the proposed approach by the Company for distribution and behavioural monitoring. He noted that the maps developed under Item 4.1 demonstrate that the number of teams should be increased from the original three to four – with two teams on each spit. Full-day monitoring should be conducted from stations 7, 7/8 (new station between old 7 and 8), 9 and 10 (see Figure 1). Each Observation Team will be provided with its own car and driver and will consist of four specialists: theodolite tracker, computer operator and two observers with binoculars. The team will start and end its observations at the station with scans to determine the occurrence, distribution and number of gray whales. The scans will be conducted by the two observers with binoculars on an hourly basis except when theodolite tracking is underway. Once the individual whale selected for theodolite tracking has been identified by both binocular observers, they will switch to assisting the theodolite and computer operators with the focal follows. When an episode of theodolite tracking/focal follow has been completed, the binocular observers should proceed immediately with another scan. VADAR software will be used by the four teams. The detailed protocols were described in a Technical Note submitted to NTF-7 and are appended as Annex E.

Vladimirov also stated that the Company believed that for a proper assessment of potential impacts on whales, and especially any possible residual effects, it is important to know which individual whale or whales were affected (or exposed to per-pulse levels above 156 dB SEL) during the seismic survey. Therefore the Company has added shore-based photo-ID studies as an important component of its 2015 4D Seismic MMP. The Company considers it very unlikely that Observation Teams will be able to take photographs of an individual whale before or after it has been tracked and it would be contrary to the agreed protocols for a team to drop its primary objective and to take photographs during the tracking or to suspend observations and leave the tower. Therefore two vehicle-based Photo-ID Teams will be mobilized – one on each spit. These teams will be in addition to, and independent of, the four Observation Teams.

The Company also recognised that good communication among the teams, the Command Centre and the seismic vessel is an essential component of the MMP. While details are still being finalised, they reported that communications will be via VHF, Irridium, GlobalStar or mobile phone.

4.5.2 Conclusions and recommendations

The NTF welcomed this information from the Company.

The NTF referred to the discussions and **recommendation** for the use of Big Eye binoculars on the seismic vessel under Item 4.4.

The NTF emphasised the need for observers at each shore station and on the seismic vessel to be capable of determining whale locations with sufficient precision and to communicate these to the Command Centre in a sufficiently timely manner to support the mitigation response protocols. The Company gave assurance that it would ensure both of these requirements are met.

In discussion, the Company explained that the final contracts had not been agreed with the Australian team (see NTF-7 report). It also referred to potential difficulties arising from the current geopolitical situation, indicating that it was considering a number of contractual options and would also confer with IUCN.

The NTF **stressed** the importance of experienced and well-trained personnel for monitoring; its acceptance of that component of the MMP is based upon the presence of appropriate experts. It **recommends** that the Company provide the Panel with regular updates on progress via IUCN.

The NTF also identified the importance of distribution monitoring to the north and south of the areas directly onshore of the survey area, given the possibility that whales change their distribution due to noise. The Company noted that in the event of time-sharing with ENL, that company would undertake distribution monitoring from station 6 and north and station 11 and south. While the raw data collected by ENL would not be made available to the Panel, the companies would undertake joint analyses of the data and these analyses, and the ability to comment upon them, would be shared with the Panel.

In addition, the Company **agreed** that the two mobile Photo-ID teams would be tasked with undertaking occasional distribution scans at stations 6 in the north and 11 in the south. The NTF **stressed** that positive information on the absence of whales in was an area is as valuable as information on the presence of whales.

Finally, the NTF considered briefly the issue of what action would be appropriate if whales are present shoreward of the seismic survey area at the start of the survey but move away during the survey, with the possibility that they are being kept away from their primary habitat for an extended period. There was insufficient time to consider this in depth and to reach a conclusion at the present meeting.

The recommended text regarding distributional and behavioural monitoring for the MMP is given in Annex D.

5 TEXT FOR THE PROPOSED MMP FOR 2015

The NTF took as its starting point the wording of the 2010 MMP. It spent considerable time reviewing this and modifying it for 2015 in the light of the above discussions and analyses (see Annex D). In addition, the NTF focussed on the following issues.

(1) Effectiveness of the use of new technology to allow the survey to continue in ‘poor visibility’.

As noted at NTF-7, several NTF members considered the available evidence insufficient to assess the effectiveness of the proposed new technologies to detect whales in fog or at night. The NTF’s agreement to allow relaxation of the 2010 provision that lines could only be shot at night if the line had been scanned and no whales had been seen for up to six hours beforehand was not based upon a judgment that the new technology is effective (although its use was welcomed) but upon the fact that the Company had given assurance that the 13 lines closest to the coast would only be shot in conditions of daylight and good visibility. Examination of the estimated footprint for line 14 (see Figure 2) showed that only a small portion of the feeding area is likely to be ensonified at per-pulse levels above 156 dB SEL for that line and offshore.

The NTF noted that the new technology would be kept running at all times i.e. in good conditions as well as poor conditions. This provides an excellent opportunity for the effectiveness of the equipment to be tested under field conditions (i.e. in good conditions, 'whales' detected by the technology can be confirmed or otherwise by the visual observations of MMOs). The NTF **recommends** that the Company develop a protocol for this evaluation to be undertaken. This will require an extra MMO or equivalent to use the equipment.

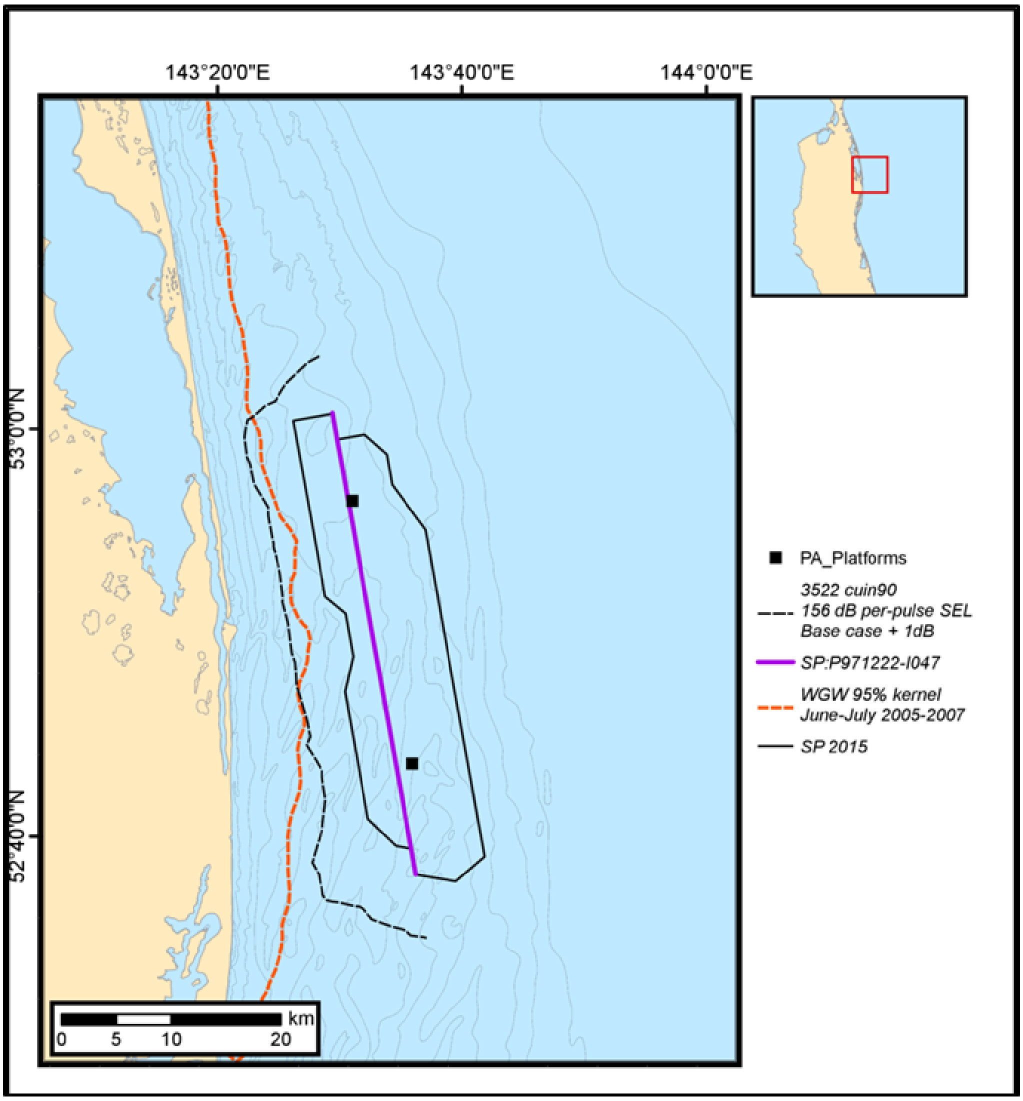

Figure 2. Estimated 156 dB per-pulse contour (Base case +1 dB) for line 14 (about 12km from shore).

(2) The 2010 MMP has a condition for the survey to be shut down if any whales are seen within the behavioural threshold exposure zone. For the 2015 MMP, this condition will be modified and the survey shut down applied only to the presence of mother-calf pairs within the behavioural threshold exposure zone.

The NTF noted that this was a result of a consideration of the trade-off between protecting individual whales versus the overall exposure of the population. Such a balance is difficult to determine but the available 'spreadsheet' analyses (see Item 3.2.1), whilst not conclusive, suggested that this compromise would allow the survey to be completed as quickly as possible (i.e. potentially affecting fewer whales) but still protecting what are probably the most vulnerable animals i.e. mother-calf pairs, and not result in a significantly greater number of 'hits' of other animals (i.e. exposures to per-pulse levels above 156 dB SEL). Without the additional work on cumulative exposure modelling recommended under Item 3.2.2, however, it is not possible to properly quantify the proposed trade-off. The NTF also recognised that given the developmental nature of the work, it could not be guaranteed that results to quantify the trade-off would be available prior to WGWAP-15.

At this stage and given the above discussion, the NTF **agreed** that the MMP as given in Annex D represented its best compromise on the appropriate trade-off between protection of individuals versus the overall exposure of the population. However, some members of the task force reserved the right to maintain their support at the upcoming Panel meeting for a conclusion that all animals within the feeding ground should be protected from exposure above 156 dB per-pulse SEL, including taking into account any results that may arise from the exposure modelling exercise. In any event, it was agreed that any relaxation of the behavioural threshold protection for all animals in 2015 survey should not be seen as a precedent and that it should be reviewed again in the light of results obtained in 2015 and further consideration of modelling approaches examining cumulative exposure discussed under Item 3.2.

6 INDEPENDENT OBSERVER

At NTF-7 it was agreed that the issue of contracting an independent observer for the Sakhalin Energy 2015 seismic survey should be discussed further with IUCN. It was agreed at this meeting that an independent observer is a potentially valuable element of the overall MMP and that IUCN should proceed to facilitate the identification and contracting of a suitable individual, working in close collaboration with the chairmen of the Panel and NTF and in coordination and consultation with the Company. Vladimirov stressed his view that engagement of the independent observer with 'stakeholders' was a missed opportunity in 2010 and that such engagement should be considered thoughtfully this time.

7 CHAIR'S SUMMARY AND CONCLUSIONS

Donovan thanked all of the participants for their diligent work over several meetings under extreme pressure of time. He also referred to the comments on the other proposed major seismic survey plans for 2015 discussed at NTF-7 and WGWAP-14. He concluded that at the time of the close of the meeting, the MMP as given in Annex D represents the NTF's best efforts to determine an appropriate trade-off between protection of individuals against overall exposure to the population, along with a suitable monitoring programme to evaluate the effectiveness of the measures and to improve the knowledge base for future seismic surveys. He noted that the determination of this balance was considerably more difficult for the 2015 survey given its much greater scope and he noted the comments of some members with respect to relaxation of the behavioural threshold protection for all animals (Item 5). The Panel will provide its final advice to the Company at WGWAP-15 by the middle of December 2014.

8 OTHER BUSINESS

At NTF-7, the task force reiterated its view that digital acoustic recording tag (D-TAG) information could prove valuable in the Sakhalin area, especially in the context of seismic surveys. Several NTF members are developing a proposal for a D-TAG study at Sakhalin, including a complete budget and appropriate safety considerations. The NTF requests IUCN and others to investigate funding options for this work and notes that it would be valuable if the proposal can be submitted to the IWG meeting in early December 2014.

9 ADOPTION OF REPORT

Several NTF members remained behind after the close of the meeting to complete the report and others participated by remote methods. A final draft was circulated to the NTF for comment on 21 November. The report was adopted by email on 24 November 2014. Donovan thanked the NTF members, rapporteurs and interpreters for their hard work during difficult discussions. He particularly thanked Anete Berzina and the IUCN Washington office for excellent support.

10 REFERENCES

Gray, H., and Van Waerebeek, K. 2011. Postural instability and akinesia in a pantropical spotted dolphin, Stenella attenuata, in proximity to operating airguns of a geophysical seismic vessel. *J. Nat. Cons*. 19 (6): 363-367. doi:10.1016/j.jnc.2011.06.

Vladimirov, A. 2007. The results of the correlation methods use in analysis of the spatiotemporal features of the Western Gray Whale distribution off the North-eastern coast of Sakhalin Island. *Problems of fisheries* 2(30), vol. 8: 264-273.

Annex A
List of Participants

Justin Cooke (WGWAP, remotely)
Mike Donaghy (Sakhalin Energy)
Greg Donovan (WGWAP)
Douglas Nowacek (WGWAP)
Roberto Racca (Sakhalin Energy)
Randall Reeves (WGWAP)
Andrey Samatov (Sakhalin Energy)
Brandon Southall (Associate Scientist, remotely)
Grigory Tsidulko (WGWAP)
Marko van der Veen (Sakhalin Energy)
Alexander Vedenev (WGWAP)
Alexey Vladimirov (Sakhalin Energy)
David Weller (WGWAP, remotely)

IUCN

Anete Berzina
Andrea Oliver (Rapporteur)

Interpreters

Alexander Danilov
Grigory Shkalikov

Annex B
Agenda

1 INTRODUCTORY ITEMS (CHAIR, IUCN)
- **1.1 Introductions and logistics**
- **1.2 Adoption of agenda**
- **1.3 Available documents/materials**

2 UPDATE ON SURVEY LOGISTICS
- **2.1 Details of the accepted tender including technical parameters (Van der Veen)**
- **2.2 Progress on time-sharing options (Van der Veen)**

3 ANALYSES FOR THE 2015 SEISMIC SURVEY
- **3.1 Final acoustic modelling**
  - *3.1.1* Presentation (Racca)
  - *3.1.2* NTF conclusions
- **3.2 Review of the simulation modelling work**
  - *3.2.1* Presentation (Van der Veen; Cooke)
  - *3.2.2* Discussion
  - *3.2.3* NTF conclusions and recommendations
- **3.3 Review of behavioural criteria for shutdowns (Nowacek, Tsidulko)**
  - *3.3.1* Presentation of new information
  - *3.3.2* NTF conclusions and recommendations

4 MITIGATION AND MONITORING PLAN FOR 2015 SEISMIC SURVEY
- **4.1 Mapping tool (Vladimirov)**
- **4.2 Modified A- and B- line concept**
  - *4.2.1* Presentation (Racca)
  - *4.2.2* NTF conclusions and recommendations
- **4.3 Real-time and acoustic monitoring/mitigation**
  - *4.3.1* Discussion
  - *4.3.2* NTF conclusion and recommendations
- **4.4 Need for distribution monitoring**
  - *4.4.1* Discussion
  - *4.4.2* NTF conclusion and recommendations
- **4.5 Behavioural [and distribution, depending on outcome of discussions under Item 4.4] monitoring/mitigation associated with the 2015 survey**
  - *4.5.1* Presentation
  - *4.5.2* Discussion taking 2010 as the starting point
  - *4.5.3* NTF conclusions and recommendations

5 TEXT FOR THE PROPOSED MMP FOR 2015

6 INDEPENDENT OBSERVER

7 SUMMARY AND CONCLUSIONS

Annex C
List of Documents

DOCUMENT #	TITLE	LANGUAGE	STATUS
NTF-8/1	Provisional agenda	English	Public
NTF-8/2	List of documents distributed in connection with the 8th meeting of the WGWAP Noise Task Force	English	Public
NTF-8/3	Sakhalin Energy Line register of 2010 4D Astokh survey	English	Confidential
NTF-8/4 (Revised, version 2)	Comprehensive map of 2015 seismic survey theatre and information on onshore behavioural sampling protocols to be conducted during 2015 4D seismic survey, submitted ahead of NTF-8 with updates made during NTF-8 meeting (A.Vladimirov)	English	Confidential
NTF-8/5	Set of modelling output maps for 2015 P-A 4D seismic, based on the latest airgun array source design with the annotation, submitted ahead of NTF-8 (R.Racca)	English	Confidential
NTF-8/6 (Revised) -1,2	Summary report to NTF-8 of the NTF simulations steering group, including updated versions of two detailed simulation spreadsheets for 2015 4D seismic survey	English	Confidential
NTF-8/7	Presentation: Update on 2015 4D Survey (M.van der Veen)	English	Confidential
NTF-8/8	Presentation: Modelling 2620 and 3255 in3 airgun arrays: Horizontal directivity patterns and comparison between Nucleus and AASM vertical signatures (R.Racca)	English	Confidential
NTF-8/9	Presentation: Updated acoustic footprint modelling of planned 2015 Piltun-Astokh 4D seismic survey (R.Racca & A.Schlesinger)	English	Confidential
NTF-8/10	Presentation: Early season Western whale counts of Russia-US team, 1998-2004 (G.Tsidulko)	English	Confidential
NTF-8/11	Presentation: Gray whale sightings of Western gray whales by IBM team, 2004-2012 and cross-correlation table 2004-2006 (A.Vladimirov)	English	Confidential
NTF-8/12	Presentation: Modelling cumulative exposure of Western gray whales to 2015 Sakhalin Energy seismic survey (J.Cooke)	English	Confidential
NTF-8/13	Average density maps, as submitted for SSTF-2, March 2008, including SSTF-2 report	English	Confidential
NTF-8/14	R.Racca’s acoustic approximation formula for estimating the empirical broadband source levels and propagation loss, used for Cooke model	English	Confidential
NTF-8/15	Submission on Mother-calf pair sightings of Western gray whales by Russia-US team, 1997-2009 (G.Tsidulko)	English	Confidential
NTF-8/16 -1,2	Two versions of MMO shifts for 2015 4D seismic survey	English	Confidential
NTF-8/Inf.1	Minutes of intersessional NTF conference calls ahead of NTF-8	English	For NTF internal use only
NTF-8/Inf.2	Summary of intersessional progress report and conference calls of simulations steering group ahead of NTF-8	English	For NTF internal use only

Annex D
Monitoring and Mitigation Plan for the 2015 Piltun-Astokh 4D Seismic Survey Developed at NTF-8

1. INTRODUCTION

The planning for the 2010 Astokh and 2015 Piltun-Astokh 4D seismic surveys represented a major investment of time by the Western Gray Whale Advisory Panel (WGWAP), Sakhalin Energy and the Seismic Survey Task Force (SSTF) and Noise Task Force (NTF) of the WGWAP. The 2010 MMP continues to be one of the most complete whale-focused Monitoring and Mitigation Plans (MMPs) developed for a seismic survey anywhere in the world[2]. The 2015 MMP is based on the 2010 MMP.

The fundamental rationale behind the mitigation component in 2010 was:

(1) design ahead of the survey:

(a) minimise the area surveyed.

(b) minimise the sound levels reaching the expected areas of highest density of whales.

(2) measures during the survey:

(a) carry out the survey as early as possible in the season, i.e. when fewest whales are present;

(b) incorporate measures to stop the survey when needed to protect whales present.

During the early stages of development of the 2010 MMP it became apparent that there were very few data available on the effects of noise on gray whales, especially when feeding. It also became apparent that much of what is considered as 'best practice' mitigation has rarely, if ever, been properly evaluated. Monitoring was quickly recognised to be an essential component of the planning for the 2010 survey, both to evaluate the effectiveness of the mitigation component of the plan to see if practical changes were required and to ensure that future MMPs could be based on stronger scientific information than was available to the Seismic Survey Task Force (SSTF) in drawing up the 2010 MMP.

This document incorporates changes to the 2010 MMP that are applicable to the planned 2015 seismic survey. The 2015 Sakhalin Energy survey will be conducted offshore Sakhalin, covering an area of some 350km^2 around Piltun and Astokh platforms beginning in early June 2015. The 2015 seismic survey will consist of longer survey lines than the 2010 survey, which covered only the Astokh field which was 145km^2.

The 2015 survey is predicted to last some 30 days (±10), including uncertainty in timing due to weather, fog, mitigation for whales, and other oil field activities that may be ongoing in the area.

The MMP developed for the 2010 Astokh 4D survey forms the basis for the MMP for the 2015 survey, with modifications based on advances in both knowledge and technology in the intervening years. The mitigation components of the 2015 MMP focus on survey design (e.g. the Company has minimized the survey area and the sound levels expected to reach areas of highest whale density) and on measures to be implemented during the survey. In terms of the latter, as for 2010 the primary mitigating principle remains starting as early as possible in the season and finishing the survey as quickly as possible , such that the survey occurs when fewest whales are present while still ensuring key protective measures.

The present document is an overall outline of the 2015 MMP as developed by the end of NTF-8. For further details, refinements and the rationale for changes from 2010, the reader should consult the full series of SSTF

[2] Nowacek *et al.*, 2013, Responsible Practices for Minimizing and Monitoring Environmental Impacts of Marine Seismic Surveys with an Emphasis on Marine Mammals, *Aquatic Mammals* 39(4): 356-77. http://www.iucn.org/wgwap/best_practices/

and NTF reports which are available on the IUCN website[3]. The changes relate to aspects of the distributional and behavioural monitoring, the addition of information on the command centre, the refinement of the concept of A- and B-zones, and a change in protection afforded to whales within the behavioural threshold from all whales to only mother-calf pairs (NTF-8, Item 5).

2. MONITORING (NUMBER, DISTRIBUTION, BEHAVIOUR)

The monitoring measures proposed here are *integrally related* to the mitigation measures proposed or likely to be proposed for future surveys. Moreover, most of the monitoring measures are essential for implementation of the mitigation measures for the 2015 seismic survey.

The monitoring measures fall into two categories:

(1) real-time (or near real-time) monitoring required to trigger appropriate action where sound levels approach or exceed defined thresholds at locations where whales are observed (i.e. ***essential*** for mitigation);

(2) additional monitoring (involving the collection of some data that do not need to be analysed in real time) to obtain data on the effects of the seismic survey on whales, especially gray whales, to add to the existing knowledge base, and to contribute to the design of mitigation strategies for future seismic surveys.

2.1 Shore-Based Command Centre

It is essential for the efficient and successful implementation of the 2015 MMP that the key information from all sources is assembled in one place in near real-time to allow informed management decisions to be taken in a timely manner. A key component of the 2015 MMP is therefore a Command Centre that fulfils this consolidation role.

(1) The Command Centre will be established on shore to coordinate implementation of the MMP and to ensure efficient communications among all teams at the various observation platforms and outposts.

(2) The Command Centre will be equipped to enable it to receive all real-time data and other appropriate information that is considered essential for overseeing MMP implementation including fact-based decision making.

(3) The Company will appoint a qualified MMP Coordinator who will be accorded single-point responsibility for implementation of the MMP. The MMP Coordinator will be able to maintain 24-hour contact with the seismic vessel and all monitoring teams on active duty as part of the MMP.

(4) The MMP Coordinator will be based at the shore-based Command Centre.

(5) An Independent Observer will be appointed and contracted by IUCN prior to the seismic survey and he or she will be deployed in the field and report on the implementation of the MMP. The Independent Observer will be housed at and will also operate from the Command Centre when not on inspection visits and will be granted full access to information in accordance with the terms of reference (e.g. to observation platforms).

2.2 Acoustic monitoring (perimeter and within area)

2.2.1 Along the perimeter of the feeding area (the perimeter monitoring line, PML)

(1) Real-time monitoring of acoustic levels using sea-bottom receivers (automated underwater acoustic recorder (AUAR) stations) deployed on the PML will be undertaken during all periods of seismic source activity.

(2) There will be ten telemetric AUAR stations (some used in line of sight radio mode, others in Iridium satellite mode, others potentially in redundant dual mode) along the PML, with three-station clusters at each end and the remaining four optimally spaced in the intervening length.

[3] http://www.iucn.org/wgwap/wgwap/

(3) Functional integrity of the real-time monitoring infrastructure will be maintained by reactivating any failed node as soon as feasible. Subject to this underlying guideline, the following rules apply (for a definition of A and B lines please see a later section).

   (a) If the failed station is a non-clustered one, normal acquisition can continue for a 48 hour period following the failure, after which only 'safe' B lines (i.e. any line that is offshore of the boundary between A and B lines identified by the most recent model case plus a 3dB buffer) can be acquired until the failed node is restored.
   (b) If the failed station is part of a three-unit cluster, normal acquisition can continue as long as no other station fails anywhere along the PML. If any second station fails, normal acquisition can continue for a 48 hour period following the failure, after which only 'safe' B lines can be acquired until both failed nodes are restored.
   (c) Any partial A line can be acquired as if the PML was fully operational if the failed node(s) are behind the starting point of the partial line.

(4) Receivers will be in place and verified to be functioning properly before activity starts and for the duration of the survey.

(5) There will be a direct radio link between the real-time acoustic monitoring acoustician outpost, which receives and processes the telemetry from the PML, and the MMP Coordinator.

2.2.2 On the coastal side of the perimeter monitoring line

(1) All necessary efforts will be made to obtain archival acoustic data within the feeding area using bottom-mounted receivers.

(2) During the seismic survey, at least three recording acoustic monitoring buoys will be deployed in the feeding area on or near the 10m isobaths and near the centre of the field of view of the shore stations. Verification that these buoys are operational during the survey should be undertaken, at least at the start of the survey.

2.3 General visual monitoring (shore-based and vessel-based)

Behavioural and distribution and monitoring will be conducted in the entire area inshore of the seismic survey area, supplemented by at least occasional observations to the north and south. Monitoring will commence at least one week before the start of the seismic survey and will continue during the survey and for at least one week after its completion. This is important for analysing and interpreting the data with respect to actual or potential effects of seismic surveys on the whales, and for maintaining the longer-term monitoring data series that will be a valuable resource when future seismic operations occur.

2.3.1 On the coastal side of the perimeter monitoring line (shore-based)

(1) Behavioural and distribution monitoring will be conducted from the fixed shore-based platforms located along the area of coastline facing the seismic survey area. The entire potentially affected area shoreward of the PML must be covered. Monitoring will be conducted by four teams, each comprising four visual survey experienced specialists with directly relevant experience. Each team will consist of one a theodolite operator, one computer operator and two observers using reticle binoculars. The distribution of the whales in the areas to the north and to the south of the seismic survey region (see the NTF-8 report) will be monitored occasionally by the photo-ID teams (see (2) below).
(2) Onshore photo-ID efforts will be made opportunistically in order to collect information about individual whales. As the coastal area is divided into two spits by the mouth of Piltun Lagoon, two vehicle-based photo-ID teams will be mobilised who will also carry out the occasional distribution monitoring (see (1) above).
(3) All onshore teams must report to the Command Centre in a timely manner i.e., at least daily but immediately if they have information to report that is of potential relevance to real-time mitigation.

2.3.2 On the coastal side of the perimeter monitoring line (vessel-based)

(1) Gray whale distribution will also be monitored from the seismic vessel. Two Marine Mammal Observers (MMOs) are required for the task of 'distant' distribution monitoring (i.e. to detect whales near or shoreward of the PML) in addition to four MMOs who are responsible for monitoring the exclusion zone in close proximity to the seismic vessel. To ensure adequate coverage shoreward of the PML area, a pair of Big-Eye binoculars (one unit) will be mounted on the deck of the seismic vessel for use by MMOs trained in their use. These big-eye binoculars should be mounted such that they have an unobstructed view of the area near or shoreward of the PML whether the survey vessel is sailing in a northward or southward direction.
(2) Vessel-based MMOs must report to the Command Centre in a timely manner i.e. at least daily but immediately if they have information to report that is of potential relevance to real-time mitigation.
(3) Experienced MMOs will be stationed on the seismic vessel for the duration of the survey.

  (a) MMOs will be limited to a maximum 2-hour continuous shift with a minimum of 1 hour between shifts.
  (b) Single-point authority for operational shutdown related to marine mammal protection will lie with the on-shift Senior MMO on the seismic vessel.
  (c) The Command Centre will have direct radio access to the on-shift Senior MMO.
  (d) The MMOs will be located on the bridge or at the highest elevation available on the seismic vessel with the maximum viewable range from the bow to 90˚ port/starboard of the vessel.
  (e) An extended visual search (20 minutes) will be conducted prior to start-up of the seismic source.
  (f) There will be a minimum of two MMOs on watch on the seismic vessel for 20 minutes before start of ramp-up, at any given time during ramp-up, and shooting and throughout line acquisition for the 20 minutes before the start of ramp-up.
  (g) Occurrence and behaviour of whales will be documented in accordance with existing Marine Mammal Protection Plan (MMPP) and MMO procedures.

3. MITIGATION MEASURES

3.1 Timing of surveys

(1) The seismic survey will commence and be completed as early in the season as logistically possible. Logistics include ensuring that all mitigation and monitoring procedures are in place.
(2) The duration of the seismic survey will be as short as technically and logistically feasible. Logistics includes ensuring that all mitigation and monitoring procedures are implemented fully.
(3) Lines in Zone A (see definition below) should be acquired at the earliest possible opportunity given visibility, mitigation and monitoring requirements.

3.2 General design and conduct of surveys

The most stringent mitigation measures in relation to whales (other than those observed in the exclusion zone near the seismic vessel) should be applied in the A zone as defined below. The monitoring measures defined above **must** be in place and operational for the acquisition of lines.

3.2.1 Definition and updating of A and B zones

(1) The area for which the additional mitigation measures are in effect (A zone) is defined by the overlap of the region inshore of the PML and the maximum shoreward extent of the 156 dB per-pulse SEL isopleths for the current acquisition line, bounded by the perpendiculars to said line tangent to the projection on the PML of the 156 dB per-pulse SEL isopleth for the current acquisition point.
(2) Before any lines are shot within the range currently predicted to exceed 156 dB per-pulse SEL at the perimeter monitoring line, received sound levels at the line will be compared with model predictions. If received sound levels differ from model predictions by more than 3 dB, then the model shall be re-tuned to match the observed levels. Based on the updated model predictions, shot lines for which an

overlap is predicted between the 156 dB per-pulse SEL contour and the monitoring line will be reclassified as A lines, for which the additional mitigation measures specified below apply.

(3) The comparison between observed and expected sound levels at the PML, and, where indicated, retuning of the acoustic model, shall be repeated at regular intervals during the survey.

(4) In the event that the 156 dB per-pulse SEL threshold is exceeded at any receiver on the edge of the feeding ground while shooting a B line, the line shall be reclassified as an A line immediately.

3.2.2 Measures within the proximity of the seismic vessel – entire survey

(1) After more than 20 minutes of inactive source, ramp-up procedures will be followed such that the individual air guns will be activated in a progressively larger combination over a period of several minutes (6 dB increments every 5 minutes over 20 minutes).

(2) The Senior MMO will initiate source shutdown if a gray whale is observed within the exclusion zone of the source i.e. the circular area that encompasses the region ensonified above 180 dB RMS SPL.

(3) The Senior MMO will initiate a precautionary shutdown if a gray whale is observed to be on a course that is likely to result in its entering the exclusion zone radius.

(4) Various types of remote-sensing equipment4 will be installed onboard the seismic vessel to try to detect marine mammals during periods of 'poor visibility' 5 (e.g. night, fog).

(5) Low level single (smallest) gun operations will be conducted during line changes. Ramp-up procedures will furthermore be implemented 20 minutes prior to the sequential line acquisition.

3.2.3 Additional considerations for Zone A

A considered trade-off is thus required between avoiding the potential disturbance of a smaller number of animals present early in the season against a larger number of whales that present later in the season if operations are still ongoing due to temporary stoppages early in the season. Based on the available information and simulations (NTF-8, Items 3.2 and 5), the following conditions will apply for 2015[6]:

(1) A number of the survey lines (13 lines) positioned closest to shore, sailed from south to north in the 1997/2010 baseline surveys, will be acquired during daylight hours in 'good visibility', i.e. the PML must be within the effective sighting distance of a shore station or a distance monitoring team.

(2) No acquisition will occur if mother-calf pairs are observed in Zone A.

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[4] Including technology that blends images from different type of sensors e.g. thermal, low-light and day light,

[5] "Poor visibility" means any conditions under which the estimated distance at which a gray whale can be reliably sighted is less than the defined exclusion zone.

[6] This is a compromise necessitated by the fact that in 2015 survey lines are extending further north than in 2010, getting closer to Piltun Bay. If a future survey is restricted to Astokh again, the restrictions imposed on the A-zone may be reviewed once more.

Annex E
Behavioural Monitoring Protocol for 2015 4D Seismic Survey

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Background

This document provides a brief summary of the current data collection and anticipated analytical approach for the proposed behavioural monitoring of 4D seismic survey that will be conducted near the western gray whale feeding grounds during the summer of 2015. The objective of this study aims to 1) record potential subtle indicators of response of western gray whales in relation to vessel activity and sound levels associated with the survey, 2) identify obvious aberrant behaviour of western gray whales and communicate these observations to the senior Marine Mammal Observer (MMO) on the seismic ship, and 3) identify both inshore and offshore sightings of western gray whales to minimize their proximity to the seismic activity.

Observation Platforms

Behavioural monitoring will be conducted by the separate teams. Two or three teams consisting of a minimum of three people per team will conduct shore-based observations directly inshore of the seismic activity in areas that are expected to have the highest exposure levels.

Shore-Based Behavioural Monitoring

Shore-based behavioural monitoring will be consistent with previous (2002-2010) behavioural data collection protocols (see Gailey *et al.* 2008 for more details). Four separate methodological techniques will be employed: 1) Scan Sampling, 2) Focal-Animal Follow, 3) Theodolite Tracking, and 4) Shore-Based Photo-Identification.

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 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, and estimated distance from the station will be recorded.
- The special software, 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.

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

- Focal behaviour sessions 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 would not be missed;
- At least one behavioural observer would follow individuals with the aid of the hand-held binoculars (7x50);

- Behavioural observers verbally states each behavioural event (blow, peduncle arch, dive, breaching, etc), and a computer operator records the event into a laptop computer;
- Observers are limited to 30 minute sessions before another observer takes their place in order to minimize observer fatigue;
- Most focal follow sessions are conducted simultaneous with theodolite tracking information thereby providing positional information associated with focal observation data.

Theodolite Tracking **-** The spatial and temporal movement patterns of gray whales will be monitored with a 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.

- Theodolite tracking sessions will be initiated when a single or an individually recognizable gray whale in a group could be identified;
- Individuals will be continually tracked until the animal is lost, moved beyond 5 km distance from the station, or when environmental conditions hampered further tracking;
- 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 and tracking session.

Shore-Based Photo-Identification **-** A digital camera with a lens will be used to photographically capture individual gray whales from shore. The typical distance of successful captures range up to 1-2 km depending on environmental conditions.

- Photographs are 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.

Environmental Data **-** Environmental conditions will be recorded several times per day to ensure consistent and reliable results for all methodological techniques employed by the shore-based monitoring teams.

- The relative visibility, glare concentration and horizontal angles, swell heights, cloud cover and sea state (Beaufort scale values 0-4, with 3 being small whitecaps and > 3 generally unacceptable for most analyses except for movement patterns and when whales are < 2 km from the observation point) will be recorded;
- Hand-held weather stations will be used at each station to automatically record temperature, barometric pressure, wind speed, wind direction, humidity, and several other environmental parameters at 10-min intervals throughout each day of effort at each observation station;
- Temperature and barometric pressure information are used to estimate a refraction correction for calculations of distance approximation.

Explanatory and Response Variables

Both explanatory and potential response variables derived from the scan, focal, and theodolite tracking data are currently being proposed to be similar to the multivariate analyses conducted previously (Gailey et al. 2013). Table 1 and 2 provides a brief overview of the proposed variables for analysis.

Table 1. Response variables derived from scan, focal follow, and theodolite tracking observations.

	Variable	Definition
Movement Parameters	Leg Speed	Distance travelled between two sequential fixed points within a trackline divided by the time interval between the two points
	Acceleration	Changes within leg speed to determine if an animal is generally increasing or decreasing speeds within a trackline
	Linearity	An index of deviation from a straight line, calculated by dividing the net geographic distance between the first and last fix of a trackline by the cumulative distances along the track
	Mean Vector Length	A directionality index r (Cain 1989) dependent on angular changes - range from 0 (great scatter) to 1 (all movements in the same direction)
	Reorientation Rate	Magnitude of bearing changes, calculated by the summation of absolute values of all bearing changes along a trackline divided by the entire duration of the trackline in minutes
	Distance-from-Shore	Distance of animal from the closest perpendicular distance from the nearby coastline
	Ranging Index	Measure the minimal diagonal area of the whale's track incorporating its course and track duration (Jahoda *et al.* 2003)
Respiration Parameters	Blow Interval	Times less than 60 s between subsequent exhalations per surfacing
	Dive Time	Any interval where exhalation period is greater than 60 s
	Surface Time	Duration the animal remains at or near the surface
	Percent Surface time	Percent of time an individual remained at or near the surface per observation bin
	Number Blows/Surfacing	Total number of exhalations per surfacing
	Surface Blow Rate	Mean number of exhalations per minute during a surfacing
	Dive-Surface Blow rate	Number of exhalations per minute averaged over the duration of a surfacing-dive cycle, using the dive previous to the surfacing
Scan Parameters	Number of Whales	Number of whales observed during a scan session
	Number of Pods	Number of pods observed during a scan session
	Distance-from-Shore	Distance of an animal from the closest perpendicular distance from the coastline.

Table 2. Environmental and impact explanatory variables proposed to examine potential disturbance effects of western gray whales in relation to the 4D seismic activity in 2009.

	Variable	**Definition**
Environmental	Station	Name of observation station where effort was conducted
	Date	Day of the season
	Time of day	Time of the observation
	Behaviour	Animal's behavioural state during observation bin (feeding, travelling, feeding/travelling, mixed)
	Subject	Individual composition of focal group (mom-calf, calf, yearling, unknown)
	Beaufort	Sea state measured on the Beaufort scale
	Visibility	Visibility conditions estimated at the time of observation.
	Distance-from- Station	Distance of whale from the observation platform
	Depth	Water depth during observation
	Tide Height	Tide level (m) during observation
	Wind Direction	Categorical wind direction (N, E, S, W)
	Wind Speed	Speed of the wind (m/s) during observation
	Swell Height	Swell height (m) in vicinity of station
Impact	Energy2h	Total amount of received sound energy 2 hours preceding scan at a location 2 km from station
	Energy8h	Total amount of received sound energy 8 hours preceding scan at a location 2 km from station
	Energy 1d	Total amount of received sound energy 24 hours (1 day) preceding scan at a location 2 km from station
	Energy 3d	Total amount of received sound energy 72 hours (3 days) preceding scan at a location 2 km from station
	Sound Level (nearshore vessels)	Predicted underwater sound level (db re 1µPa) from nearshore vessels at the mid-point location of the observation bin.
	Sound Level (Seismic)	Predicted underwater sound level (db re 1µPa) from seismic vessel at the mid-point location of the observation bin.
	Number of Vessels	Total number of operational vessels within 5 km of the mid-point location of the observation bin.
	Closest Vessel	Distance of the closest approach vessel to the mid-point location of each observation bin.
	Vessel Type	Type of vessel closest (within 5 km) to the mid-point location of the observation bin