Report of February 2012 NTF-2 meeting

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REPORT OF THE NOISE TASK FORCE AT ITS 2ND MEETING

9-10 FEBRUARY 2012
GENEVA, SWITZERLAND

CONVENED BY THE INTERNATIONAL UNION FOR CONSERVATION OF NATURE

Report of the 2nd Meeting of the Noise Task Force

Hotel Royal, Geneva, Switzerland, 9-10 February 2012

CONTENT

ACRONYMS

AIS	Automated Information System
ANSI	American National Standards Institute
CAR	Conditional Autoregressive
cSEL	cumulative Sound Exposure Level
DPV	Dynamic Positioned Vessel
GAM	General Additive Model
GBS	Gravity-Based Structure
GIS	Geographical Information System
GLMM	Generalized Linear Mixed Model
IUCN	International Union for Conservation of Nature
LNG	Liquid Natural Gas
MMO	Marine Mammal Observer
MVA	Multivariate Analysis
NOAA	National Oceanic and Atmospheric Administration
NTF	Noise Task Force
ONR	Office of Naval Research
PA	Piltun Area
PCoD	Population Consequences of Disturbance
POI	Pacific Oceanological Institute
PML	Perimeter Monitoring Line
SEIC	Sakhalin Energy Investment Company
SEL	Sound Exposure Level
SL	Source Level
SPL	Sound Pressure Level
SNR	Signal to Noise Ratio
SSTF	Seismic Survey Task Force
TECOP	Technical, Economic, Commercial, Organisational and Political
WGW	Western Gray Whale
WGWAP	Western Gray Whale Advisory Panel

1 INTRODUCTORY ITEMS

The 2nd meeting of the Noise Task Force (hereafter NTF) was held at the Hotel Royal, Geneva, Switzerland, from 9-10 February 2012 under the chairmanship of Greg Donovan.

The list of participants is given as Annex A. Bernal introduced and welcomed Tatiana Saksina who is the new Science Officer for the WGWAP and Olivier Hasinger who is providing a communications and liaison role for the WGWAP during Béatrice Riché's absence. The NTF welcomed Tatiana and Olivier and passed on its best wishes to Béatrice who will soon begin maternity leave.

A list of acronyms is given at the beginning of the report.

1.1 Chairman's opening remarks

The overall objectives of this meeting are to:

- review results of analyses from the 2010 4D seismic survey (and any implications this may have for the postponed 2D survey now planned for summer 2012);
- prepare advice and a timetable for continuation and completion of the 4D analyses;
- review and comment on the Noise section of the 'Issues Document' prepared by SEIC in response to the Panel's recommendations WGWAP-9/019 and 020;
- review updated SEIC plans for a 2D (geo-technical) seismic survey in summer 2012.

The NTF will also receive information in initiatives relevant to the question of cumulative impacts.

1.2 Available documents

Previous WGWAP and NTF reports are available on the IUCN WGWAP website (http://www.iucn.org/wgwap/). Documents specific to this meeting are listed in Annex C.

1.3 Adoption of Agenda

The adopted agenda is given as Annex B.

2 4-D ANALYSES

2.1 Presentation by SEIC of results to date

2.1.1 Noise Cases

Gailey presented a selection of examples from the now complete set of "case files." Each of these consists of a whale track built from theodolite sightings by the behaviour teams, resolved in 1-minute steps and associated point-wise with estimated sound exposure levels from the seismic source where applicable. At the beginning of that presentation Racca provided a brief overview of the modelling of the estimated levels on the whale tracks, focusing on a few key points:

- The sound levels at each 1-minute interval are estimated on the basis of the geometric relation between source and receiver (from AIS records and theodolite tracking respectively) at the sample time. A single model estimate is computed for each 1-minute interval.
- At each position, sound levels are estimated at a number of water depths from near surface to sea floor in 2m increments; the maximum value over depth is used as nominal exposure level at the track position.
- For tracks that include in full or in part a "ramp-up" period where the airgun array is being brought gradually to its full volume over an interval of about 40 minutes, the received levels from the ramp-up pulses are computed by assuming that the source has the same directivity as the fully operational array and a source level (SL) given by a linear increase of the acoustic energy from zero at the beginning of the start-up period to the full array SL at the beginning of the seismic line.

- For the point along a track that experienced the highest exposure level, the 167 dB SEL isopleth for the corresponding source position (again expressed as maximum over depth along the entire contour) was modelled to enable the visualization of the effective boundary of behavioural disturbance relative to the animal's location at that time.

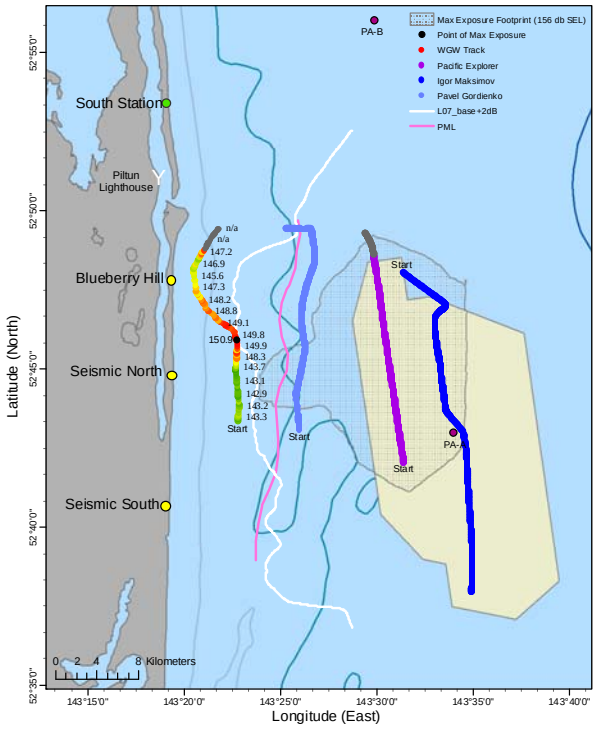

Fig. a. An example of a particularly long tracking that began while the airgun array was already at full volume along a seismic line (thus showing no ramp-up)

Gailey went on to present and discuss a few of the case files rendered in a GIS package as maps that included the animal's track annotated with exposure levels, the track of the source vessel and those of two support vessels: the Pavel Gordyenko and the Igor Maksimov. Each case file map included a single whale track, even though in some cases more than one animal might have been tracked over the same or overlapping periods. An example of a particularly long tracking that began while the airgun array was already at full volume along a seismic line (thus showing no ramp-up) is shown in Fig a below. The track of the animal is coloured according to a thematic mapping of exposure levels from green for minimum, through yellow midrange, to red for maximum; the colour scheme is auto-scaled to a track's dynamic range of exposure levels and is not therefore consistent from case file to case file.

Gailey presented a few case file examples that showed different relative motions of the source, animal and ancillary vessels and ventured some thoughts on how certain dynamics could have resulted in a more likely avoidance reaction. He indicated quite strongly, however, that without formal consideration of the non-acoustic covariates it would have been unjustifiable to assume causality as a certain fact. This led to the next presentation on the behavioural MVA.

2.1.2 Behaviour MVA

Gailey presented preliminary modelling efforts of 5 of the 16 behavioural response variables being analysed. The multivariate analyses consist of significant changes to previous approaches, namely including relative orientations between the whale being observed and the closest vessel of approach as well as the seismic vessel. In addition to relative orientation of the whales to these vessels, these analyses include the relative orientation of the vessel to the whale. It is believe this approach would provide a better indication of the context of sound and vessel activity in the area in relation to the whale.

Pre-modelling procedures were presented with correlations among the response, explanatory, and impact variables along with representative frequency distributions. Several high correlations (Pearson correlations > 0.70) were found among the response variables which reduced the number of models needed to be conducted for movement. Relatively few correlations were found in "natural" explanatory variables, which resulted in the remove of only one variable (temperature). Few vessels were found within 3 km which resulted in increasing the distance of closest approach parameter to a 5 km distance criteria in order to increase sample sizes. To date, several of recommended sound variables (i.e. kurtosis, signal-to-noise ration, peak sound pressure level, etc.) were not included in the analyses. However, Gailey proceeded analysing the three available sound variables (Max Sound Energy, Mean Sound Energy, and Cumulative sound energy).

Gailey illustrated five modelling results of western gray whale movement parameters. These response variables were speed, acceleration, linearity, reorientation rate, and distance from shore. These results were compared to previous multivariate results conducted in 2005 and 2006. The task force noted that some of the coefficients, such as behavioural state, have been relatively consistent despite different analytical approaches and variable inclusion procedures. Other variables came into the models in the current analysis that have not previously been identified, which required further examination. For example, distance from station entered into the distance from shore results while the past two analyses depth included. Gailey suggested this may be due to limited bathymetry data which have large (and in some areas unrealistic) interpolations. Out of these initial 5 models, none of the impact variables, with the exception of seismic vessel distance, were found to be significantly associated with the response variables analysed. The seismic vessel distance was found to be significantly associated with the distance from shore variable indicating that whales observed further from shore were, in general, closer to the seismic vessel.

Gailey further illustrated how the data fit the five model predictions by presenting the residual plots. While several plots suggested reasonable fits to the predicted models, others tended to have over/under-predictions as well as potential outliers. It was recognized that more data exploration of the potential outliers and overall model behaviour was needed which could provide additional insights or alternative explanatory components that could produce better models and more robust results. Gailey recognized these issues in the preliminary models and provided additional details in relation to limitations in the some of the explanatory variables, such as bathymetry.

Table 1

Summary of the variables being considered in the various MVA analyses

Type	Variable name	Description	Behavior	Dive Time	Distance Shore
Natural	Station	Name of observation station where whale was observed			x
	Date	Day of the season	x	x	x
	Time of day	Time of the observation	x	x	x
	Behavior	Animal's behavioral state during observation bin	x	x	x
	Subject	Type of Individual(s) being observed	x	x	x
	Beaufort	Sea state measured on Beaufort scale			x
	Visibility	Visibility conditions estimated at the time			x
	Distance to Station	Distance from whale location to the onshore observation station (km)	x		
	Depth	Water depth at whale location (m)		x	
	Tide	Predicted tide height at time of observation (m)			x
	Humidity	Relative humidity at time of observation			
	Swell	Field estimated swell height (m) during observation	x	x	x
Impact Sound	Cumulative SEL	Cumulative sound exposure level for the entire track of observation	x	x	x
	per-Pulse SEL	Mean sound exposure level for each pulse of pile driving during the 10.5 minutes of observation.	x	x	x
	Peak SPL	Peak sound pressure level during each 10.5 minute observation interval.	x	x	x
	Kurtosis	Sharpness of the pulse distribution with respect to normal (Gaussian) distribution.	x	x	x
	SNR	Ratio between a signal and the background noise observed during each 10.5 minute bin.	x	x	x
Impact - Other	Closest vessel	Distance from whale to closest vessel (km)	x	x	x
	Number of vessels	Total number of vessels within 3 km of the whale	x	x	x
	Vessel Type	Type of vessel closest to animal's location	x	x	x
	Time Since	Number of weeks since the onset of construction.	x	x	x
	Relative Orientation of whales to closest Vessel	Orientation of whale being observed to the closest vessel approach with the distance between the whale and vessel as an interaction term	x	x	x

Relative Orientation of closest vessel to whale	Orientation of the vessel to the whale being observed with the distance between the whale and vessel as an interaction term	x	x	x
Relative Orientation of whales to Pile driving site	Orientation of whale being observed to the ongoing pile driving activity with the distance between the whale and sound source as an interaction term	x	x	x
Distance to Closest/Seismic Vessel	Linear distance of whale being observed to seismic activity	x	x	x

2.1.3 Distribution MVA

Muir presented an update on progress in analysis of the distribution data (including count and location data collected during behaviour scans by Gailey's group). Statisticians L. Ainsworth and R. Joy are assisting with the analysis for the distribution MVAs.

Since the NTF 1 meeting in November preliminary analyses of the data had been conducted to get a sense of their potential to answer questions regarding impact of seismic sound on WGW distribution: Four different types of analysis were conducted:

(a) On/off WGW counts: changes in WGW counts at a station among pairs of successive surveys; i.e., during the shooting of a seismic line, followed by a scan at that station during the subsequent line turn by the seismic vessel.

(b) Average daily WGW counts: changes in average daily WGW counts at the individual observation stations with respect to seismic sound.

(c) WGW density surfaces: used surfaces of average estimated densities at a 1km x 1 km resolution to assess effects of seismic sound.

(d) Distance from shore: assessed changes in mean distance of WGW sightings from shore in regards to seismic sound.

The seismic covariates used for the above analyses included both maximum and median cumulative SEL (cSEL) over depth. Sound accumulations were calculated at the midpoint time of every scan survey at an observation station over the preceding 8 hours, 16 hours, 1 day, 2 days, 3 days, 7 days and since the start of the seismic survey. The cSEL covariates were calculated at both "virtual whale" points located 500m, 1500m, 5000m and 10000m offshore each observation station (Fig. 1) and at the centroids of the grid cells used for the density estimates (Fig. 2).

On/off pairs

This analysis used a Bivariate poisson regression model based on Karlis and Ntzoufras (2005) that takes into account the correlation between whale counts for the on/off pairs so that the parameters that help describe both the on and off counts reflect this correlation. This model also addresses diagonal inflation (large number of ties in paired counts) and can be extended to address zero inflated diagonal inflation (large number of zero ties in paired counts). The pairing of the on/off pairs assumes that the "on" survey is the control, with an effect of seismic, if there is one, occurring during the "off" survey. The analysis also assumes that any effect of seismic on WGW counts at a station decays between "off" and next "on" survey or that there is an additional effect.

Average daily WGW counts

All historical (pre-2010) and 2010 distribution and some behaviour scan data were tested in the preliminary model. Only Behaviour stations that were surveyed both historically and during the seismic period were included, and their data poled with co-located distribution stations.

Any assessment of changes in daily WGW counts during the early season when whales are migrating into the Piltun Feeding Area needs to account for the increasing numbers of whales over time. Population trends are modelled as a logistic growth function (3 parameters). A hierarchical modelling approach that combines two sub-models was used in the analysis (Royle and Dorazio 2006). The abundance sub-model describes the ecological process that estimates local whale abundance at a station $N_{i,j,t}$ while accounting for sources of spatial variation, where i is the station number, j is the year and t is the day since ice melt for the j^{th} year. The observation sub-model models the detection probability. Preliminary analyses will be conducted to ascertain

whether the logistic growth model adequately describes the increase in abundance over the season for all stations. Initially the model will be applied to test for the effect of the start of the 2010 seismic survey. The model will then extended to explicitly test effects of seismic covariates that have been calculated at virtual whale points. In addition, it is planned to include continuous sound covariates for 2005, 2006 and 2007 when construction activity close to shore occurred that may have affected whale distribution.

WGW density surfaces

Numerous issues need to be considered in the development of this model including the large number of zero density cells, spatial correlation among grid cell density estimates, increasing numbers of whales over time, trends in movement of whales over time, use of a continuous response variable rather than counts and varying survey effort.

A Generalized Linear Mixed Model (GLMM) with covariates, spatial random effects and time effects was developed to provide flexible way to explore relationships in the density data. Conditional Autoregressive Random (CAR) effects were used to model spatial correlation. This approach allows density estimates for cells with little effort to be stabilized by "borrowing strength" from neighbouring cells. It is planned to use cubic b-splines to provide a flexible fit for time trends and easting.

Historical (2004-2009) data for the southern distribution stations (9 to 13) were used to investigate spatial and seasonal trends in densities that are then used as the basis for creating informed spatio-temporal autocorrelation structures for the 2010 data. The survey effort for each year of 2004-2010 data is calibrated to the ice-free date, and then average densities are calculated for a set of six time intervals that spanned the first four ice-free weeks of each year. Two types of zero inflated models were tested: a hurdle model and a mixture model.

Simulated data showed good model performance for both hurdle and mixture models with spatial random effects. There was good model performance with the addition of the 2010 average densities and non-seismic covariates. It is planned to continue model development by adding the seismic covariates and spatio-temporal trends. Further work will include densities for the northern distribution stations (1-8) and behaviour scan data.

Distance from shore:

Preliminary model development was conducted for this MVA using a generalized linear mixed effects model with station as a random effect. Distance to whale sightings was used as the response variable. It is planned to extend the analysis to also use distance to each individual whale as the response. Other covariates such as visibility in km, Beaufort sea state, date, time of day, tide height and seismic covariates were also included in the model.

Exploratory analysis was first conducted on 2010 distribution data for all 13 stations to investigate the non-linear relationship between time and distance from shore. Additional preliminary analyses then focused only on southern distribution stations (9-13) which had greater effort. Future work includes further testing of model covariates, inclusion of the behaviour scan data and consideration of how to use the model to do some limited testing on the north distribution station data. Historical data will be used to further investigate the relationship between time and distance from shore. We also plan to apply the distance correction factor to the sightings data that has been developed in response to the NTF-1 report recommendation, and rerun the model to assess the sensitivity of results to distance estimation errors.

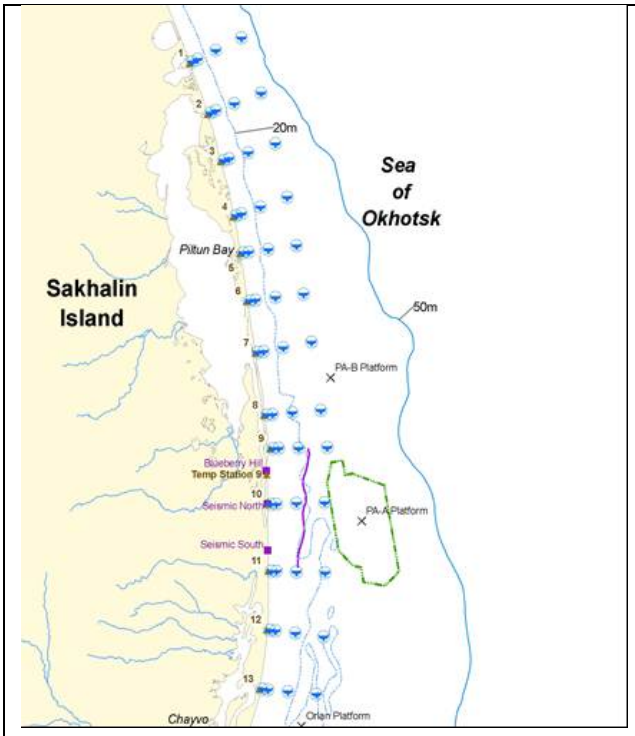

Fig. 1. "Virtual whale" locations used to calculate seismic covariates.

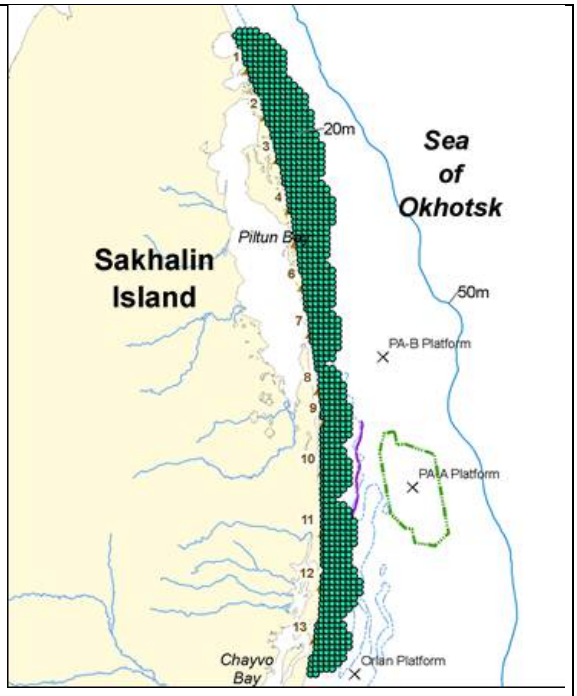

Fig. 2. Centroids of the 1km x 1km grid cells used in the estimated WGW density calculations.

2.2 Discussion

2.2.1 Noise cases

The NTF **appreciated** the considerable work undertaken to generate these depictions of individual whale movement in relation to seismic airgun operations that take into account previous discussions and recommendations of the SSTF (Seismic Survey Task Force), NTF and the WGWAP. Observations on individual behaviour and potential responses to real operations at a variety of received sound levels has been part of the long-term goal to improve the scientific basis for assessing risk and improving mitigation measures for industrial events involving noise. Considerable effort has been expended in collecting and analysing the information on environmental and contextual co-variates (e.g. behavioural state, vessels in the area in addition to seismic airguns). However, as was recognised by the presenters, there are limitations in quantitatively using the data.

The primary limitations is that a significant number of the behavioural observations and tracks of whales were quite short or began after the animal had already been exposed to seismic noise, making it difficult to determine whether behaviour had or had not already been affected. This is not a criticism of how the data were collected, nor an indication that the effort was not worthwhile or the results useful. Rather, this was an expected result of obtaining such data in a non-controlled setting at a time of low densities of animals. Careful consideration of which data are included in an analysis of the individual noise cases is required; simple pooling of all cases into a common analysis irrespective of sampling duration and exposure phase is not appropriate. The NTF **suggested** that those cases that include ramp-up and the start of full scale exposures be considered as the primary subset of the cases while all of the tracks occurring during exposure (including those in the first subset minus the baseline and warm-up phases) be analysed as a secondary subset.

A further complication in interpreting these data is the fact that in some cases animals were relatively near vessels involved in the operation and at times, including in between shots, the vessel noise will have contributed to the overall sound exposure potentially affecting the track of the whales. This factor should be incorporated in the analysis to the extent possible, given the inclusion of contextual variables such as the proximity and orientation to nearby ships. The NTF **acknowledged** the challenges in statistically

disentangling potentially interacting reactions to loud impulse noise and nearby continuous noise from vessel presence and **welcomes** the inclusion of these data in the final analysis.

The NTF **agreed** with the general modelling approach being taken in representing the approximate received impulse signals for whales. These data will be informed for some of the tracks by the inclusion of measured data from the PML monitoring buoys. The inclusion of a linear ramp-up of energy assumed for animals for which sound transmissions had already begun is a more realistic manner of depicting and assessing these individual exposures (but note the above suggestion regarding segregation of analysis). The level of error in the modelling (acknowledged as ~3 dB) for the points provided is probably similar to or less than other forms of uncertainty inherent within the process, including the precise location in space derived from reticle binoculars and position of animal within the water column relative to the modelling estimates. With regard to the latter point, further consideration needs to be given regarding whether to use the maximum sound level at any point in the water at a whale's observed or an interpolated position for the 1-min average SELs. In this case, using the maximum over depth, normally a conservative measure when estimating safety radii, might not be precautionary and could lead to estimates of responses occurring at higher received levels than they may in fact have. An initial estimate of the difference of the maximum over depth values versus a median value of the water column suggested there was a relatively small difference in these values. The NTF **recommended** that this is assessed explicitly at least for a subset of the tracks and if this difference is greater than several dB, suggests that at least the maximum over depth and the median value are examined.

The NTF also **suggested** a number of improvements regarding the depiction of the geospatial relations between whale, seismic vessel, and other ships. For example, highlighting the position of each at specific points during the observations would allow better visualization of the tracks in relation to the operations. Indications of the actual positions of surfacings along the interpolated tracks and an indication of the speed of whale movement would also be valuable. Consideration should be given to developing simple animations for selected tracks. While these improvements will assist in a better understanding of the cases and provide important background for the MVAs, incorporating them should not take away from those ongoing analyses.

In summary, the NTF **believed** that the case studies provided valuable detailed observations from the 4D survey. As suggested by the presenters, further careful consideration is needed to determine the appropriate metrics for exposure. When data are collected in a non-controlled situation such as this, the results should be interpreted cautiously. This is particularly true given the small number of tracks that cover the ramp-up and start of operations as well as long periods of exposure. This small number reflects the fact that the key mitigation measure (completing the survey as early in the season as possible before most whales have arrived in the region) was successful. It also notes that this approach is only likely to detect relatively large scale effects and small changes in behaviour, even with these detailed observations, may not be detected.

2.2.2 Behaviour MVA

The NTF noted that better bathymetric data has been collected by POI and **recommended** that these be used in the final behavioural as well as distribution analyses.

The NTF also discussed the use of previous data collected during 'non-high anthropogenic activity' years such as 2002-2004 to develop more appropriate natural models given that the 2010 data have limited pre-survey sample sizes. For example, the more extensive research effort in 2006 had three behavioural teams operating over a longer duration where analyses identified more associations than those in other multivariate analyses and these associations could have been largely due to increased sample sizes which increased the power to detect a pattern. The same rationale could be applied towards assessing impacts of pulse and continuous noise where a single year's activity may not yield adequate sample sizes to detect more subtle reactions that maybe particularly important for mitigation and monitoring of future activities. For example, a multi-year analyses of the continuous noise activity from 2005-2007 for the installation of a concrete gravity based structure, dredging and pipeline installation, and top-side installation should yield additional insights in relation to western gray whale behavioural responses to continuous noise which would ultimately provided better sound mitigation criteria.

The NTF **welcomed** the presentation by Gailey, **endorsed** the proposed way forward and **encouraged** him to take into account the above discussion of using data from other years to investigate more appropriate natural models.

Finally, the NTF discussed and recognised the emerging use of state-space models to better assess behavioural responses in relation to anthropogenic activity. Development of a new framework would take considerable amount of time for the current analyses, but **encouraged** this framework to be developed in the future.

2.2.3 Distribution MVA

The NTF **thanked** Muir for her progress report, recognizing the considerable amount of work that had been undertaken. Discussions focused on the three most promising types of analysis.

Analysis of scan counts

In this analysis the raw scan counts at each station are the dependent variable. The direction of possible effects cannot be stated *a priori*. If the effect of the seismic survey is to drive whales inshore, it could tend to increase the counts. If the effect is to drive whales out of the area altogether, it could tend to reduce counts.

After some consideration, the NTF **agreed** that the use of "Survey on vs. Survey off" as an explanatory variable is not appropriate. The on/off status had originally been proposed as a proxy for the time since last exposure. However, taking into account the typical lengths of time to shoot a line (on period) and to effect a turnaround (off period), and the variable timing of the scan within an on or off period, the NTF now considers that the on/off status is better subsumed into an explanatory variable that is the accumulated sound exposure (SEL) over the previous *x* hours before the mid-point of the scan. Values of *x* ranging from 1 hour to the time since start of the survey can be examined. The absolute time of the scan can be a smoothed independent variable (for example in a GAM), as can the northing position of the station. The sound dose is calculated at the four fixed distances from the shore, regardless of where whales are seen.

The count data show a substantial excess of zeroes, as is usual for data of this kind. Zero-inflated models are regularly used to analyse such data. Because it can be important to allow for both process-related zeroes (no whales present) and effort-related zeroes (no whales seen, when whales present), the NTF prefers the mixture model for zero inflation, which allows for both kinds of zero counts. The frequency of the former should be independent of sighting effort while the frequency of the latter will depend on effective sighting effort (which itself depends on nominal sighting effort as qualified by sighting conditions). Therefore the observation and abundance models could be combined into a single model in which effects of sighting conditions on detection rate are accounted for by including appropriate covariates in the model: visibility, Beaufort, etc.

Analysis of distance from shore

The proposed analysis is similar to that for the scan counts, except that in this case the dependent variable is the distance from shore of each whale or group seen on a scan. Most of the same considerations apply as for the analysis of counts, except that zero-inflation is not an issue.

Analysis of densities

In principle, the density of whales as a function of position and time is modeled as a smooth surface, but there are alternative ways of doing this and the final choice and implementation approach has not yet been decided. If the method requires the calculation of average densities in a spatial grid over time intervals, then the NTF **recommended** that if possible, the time resolution be to the individual scan level, to maximize the chance of detecting effects of the seismic survey. This will result in most observations being zero: the extent to which this may be a problem depends on the details of the model, fitting method and software to be used. In principle the aim is similar to the analysis of scan counts, but the spatial aspect is on a finer resolution and the spatial overlap of adjacent scans is taken into account.

Sound level covariates

Racca raised with the issue of how to approach the merging of multiple seismic sound level covariates (cumulative SEL for a given accumulation period) in cases where distribution survey counts are being averaged over a daily or multi-day period. He proposed using the arithmetic mean of the dB values, which is not an averaging of the sound energy exposures for the individual instances. The argument supporting this approach is the fact that since the dB levels (not the energy values) are used as covariates in the statistical analysis of individual scans, they should be averaged in their own right as instances of an input variable. Conventional averaging in energy space would invariably over-represent the largest instance in the set of dB covariates; for example a single case of high cumulative SEL in a day of scans with otherwise low sound

exposures would yield a high daily seismic covariate, biasing the interpretation of the average density count. The NTF suggested possible alternatives such as using the median dB value over the set of observations, but this too would be a questionable choice for a skewed distribution of instances and could lead to bias. The NTF **concluded** that while the averaging of dB values was a defensible approach for preliminary statistical analyses involving merged multiple scans, it **recommended** that the distribution MVA team move away from temporal averaging and use density counts and sound level covariates for individual scans.

General

As for the behaviour MVAs, the NTF **emphasised** the importance of using data both from seismic and non-seismic years, and from all periods in the seismic year. The combination of data from the non-seismic years and data from the pre-seismic, between-seismic and post-seismic periods of the seismic year may together provide a sufficient control to enable estimation of seismic effects, depending on the levels of natural variability. The NTF **recognised** that data from non-seismic years or periods may to some extent to be 'contaminated' in the sense that non-SEIC seismic surveys, or other noisy activities for which no specific data are available, may have been occurring that may have affected the animals. The NTF appreciated the plans to include the effects of other noise sources, such as construction work during 2005-07, where possible.

2.3 Way forward (methods, timetable, publication plans etc.) for resolution of outstanding issues

The NTF **recognised** both the complexity of the analyses that are required and their importance in adding to our understanding of the effects of seismic surveys on whales and in developing improved mitigation measures. As has been stated several times before, considerable effort and resources were expended by the Company and the Panel to design a comprehensive monitoring and mitigation programme for the 2010 4D survey. Similarly considerable effort and resources were expended in successfully implementing the programme in the field – an effort perhaps unparalleled in the world. It would be false economy not to complete full analyses of the resultant data. While progress may not have been as fast as the NTF would have liked, this is not a criticism of the analysts but a reflection of the complexity of validating and preparing the data, determining appropriate metrics for key parameters and developing new integrative analytical methods. The discussions above show that considerable progress has been made and the NTF **recommended** that the work continues and **looks forward** to receiving the results. It also **recommended** that the analysts seek input from Task Force members by email and conference calls in the event that unforeseen issues arise with any of the analyses.

3 NOISE COMPONENT OF 'ISSUES DOCUMENT'

This item relates to two previous (WGWAP-9) recommendations that Sakhalin Energy provide:

(a) a document summarising progress made since 2004 towards resolving uncertainties and filling data gaps highlighted in past western gray whale panel reports (WGWAP-9/019); and

(b) a comprehensive overview of the issues and risks that need to be addressed for a new development such as South Piltun, including a risk matrix that makes clear how it would prioritise the various elements, as well as how the company assesses each issue in terms of potential short-, medium- and long-term effects on the western gray whale population (WGWAP-9/020).

3.1 Presentation by SEIC

Sakhalin Energy provided an overview of the "noise issues", looking at this in the context of "what were issues at the start of Sakhalin-2 project" and "what are remaining likely issues for a new development".

The review covered:

- Potential Sources of Noise
- Pipeline Construction Noise
- Gravity Based Structure Construction Noise
- Noise from the Installation and Commissioning of Topsides
- Noise from Drilling Operations
- Noise from Seismic Surveys
- Noise from Piling Operations

Highlights from the presentation indicated that, whilst there is significant "natural" noise in the environment, there is additional anthropogenic noise associated with the Oil and Gas developments.

Key to managing this noise is the establishment of "fit-for-purpose" monitoring and mitigation protocols, as were established for the 4D Astokh seismic survey. The protocols established for that should serve as the basis for ALL future seismic acquisitions. These protocols can be modified and tailored to meet requirements.

Lessons learned from the installation of the platforms indicated the need for:

- Extensive up-front planning
- Reviewing daily operational activities
- Managing the noise impacts from the simultaneous operations
- Avoiding concentrated noise footprints
- Choice of vessels to minimise noise impact
- Avoiding the areas occupied by whales

For both the installation of GBS structures and topsides it was recognised that acoustic modelling together with calibration from similar operations was a key to designing mitigation plans. Certain types of structure design were better suited to noise mitigation than others. Developing access corridors were important to reducing the noise impact. That in both cases the duration of the activities was not sustained for long periods. The most impactful aspects of this work probably relates to the "station keeping" during the positioning by vessels and particularly Dynamic Positoned Vessels (DPV).

Drilling operations from a production platform were less noisy than originally perceived. Equipment choice decisions such as using top-drives rather than rotary drives in the drill floor, reduced noise. Drilling through platform legs effectively decoupled the sound from propagating through the water and consequently, noise from the drilling may be nearly indistinguishable in the overall noise signature.

Limiting the disturbance of the whales during the feeding season was (and still is) seen as being the most effective comprehensive mitigation measure implemented by Sakhalin Energy. The Company's view is that noise mitigation efforts have significantly reduced the impact, compared with non-mitigation. The protocols established e.g. vessel corridors, shutdown criteria. Seasonal activity and focused mitigation are all beneficial to reducing that impact. Focused activity based acoustic modelling, extensive source level measurement, the development of mitigation protocols have all helped to minimise impact. Finally, there is an opportunity to capture the benefits of this approach for others.

3.2 Discussion

The NTF **welcomed** the report that had been produced in response to its recommendations. It recognised that it was not practical for it to undertake a detailed review at the level which would enable it to fully endorse all of its contents. However, it noted that the review broadly covered all of the appropriate areas and provided a valuable background document and summary for its future discussions of noise issues related to future operations and developments, including the broad strategies to be followed in terms of evaluating risks and developing effective mitigation measures.

4 PROGRESS REPORT ON THE CONSIDERATION OF THE SOUTH PILTUN PROJECT INCLUDING PLANS FOR THE 2D SEISMIC (GEOTECHNICAL) SURVEY 2012

4.1 Presentation by SEIC on any changes in plans since previous meeting, including update on monitoring and mitigation plan

4.1.1 General South Piltun

Work on the South Piltun Development has confirmed that the development is currently marginal requiring a step change in value and robustness through innovative solutions.

The project is currently in the Concept Select Phase which focuses on evaluating the best development option. However, a number of concepts - including those requested to be investigated by NTF-1, still on the table having a lower level of definition. In selecting the optimum concept five aspects are considered with

the balance naturally depend on the nature of the opportunity. These are Technical, Economic (and Finance), Commercial, Organisational and Political (TECOP).

For South Piltun this process is challenging for a variety of reasons including the significant subsurface uncertainties (driving a wide range of development concepts), major environmental challenges and the marginal project economics.

With the Project Team currently in the mid Select phase, no decisions have been taken about the size, scope or even feasibility of the Project. However, based on the analysis completed to date the emerging view of costs and volumes support an integrated oil and gas development. If this logic is confirmed this probably favours the full processing facilities. The timing for a combined oil and gas development is driven by when the gas sales opportunities. A key, but not exclusive, driver for this is driven by spare capacity ('ullage') in the LNG plant.

Additionally the Project Team is re-checking previously discarded technologies to ensure that alternatives have been fully considered as requested by the NTF panel.

4.1.2 2D survey in 2012

Operations originally planned for summer 2011 were postponed to summer 2012 consequent of the delay of obtaining Russian Federation approvals for the critical Geophysical part of the work.

The Project Team confirms that the current location remains valid. However, the Project is investigating alternative locations further outboard for the following reasons:

(a) Lower well complexity (risk) and better target access;
(b) The location is further away from Gray Whales feeding grounds and closer to existing pipelines.

However, the possibility of shallow gas at this location requires the data from the planned site survey to assess. To this end consideration is being given to modifying the proposed survey area to cover the outboard location. As currently envisioned any new area will result in no material changes with respect to environmental impact.

In addition, as reported at the NTF-1 in Vancouver, geoacoustic surveys will be taken to cover relief well locations on the PA-A, PA-B and Lun-A platform locations (for further details see insert ref).

Noise modeling shows that with the array guns being considered the 180 dB "safe zone" is less than 200m.

4.2 Discussion and conclusions

4.2.1 General South Piltun

The NTF **thanked** the Company for the updated information.

The new emphasis on gas production produced some discussion within the NTF. Sakhalin Energy indicated that producing the gas phase would require an additional pipeline, but this would run either along the existing pipeline route to the existing pipeline landfall to the north of Chaivo or offshore to Lunskoye. Furthermore, the question was raised as to whether changes the 'gas emphasis' would impact drilling operations, specifically if it would result in anything being released into the water. Sakhalin Energy confirmed that the gas option would not change anything and that no materials from their drilling operations are ever released into the water column. At least three options remain open for the choice of a platform type, and if the decision is taken to proceed with the project, the choice of the platform type will be driven by the capabilities necessary on that platform, e.g., if gas compression must be done at the site, a particular type of platform will be required. Sakhalin Energy indicated that their current investigations show that the amount of 'brown field' work related to some of the options (particularly retrofitting gas compression onto existing platforms) are so significant that they are unlikely to be practicable. This would suggest that the options using smaller minimal facilities for South Piltun are less likely to be a commercial solution than the Piltun B type facilities.

4.2.2 2D surveys in 2012

4.2.2.1 General statement

Recognising that the mitigation and monitoring programmes developed by the Panel and Sakhalin Energy may be considered by others as precedents, the NTF **emphasised** the following:

(1) The mitigation and monitoring strategies developed for the 2010 and (proposed) 2012 seismic airgun surveys were based on:

(a) careful analysis of the specific airgun array being used (**2620** in^3 in 2010 and **160** in^3 in 2012) and associated modelled footprint;

(b) the position and extent of the surveyed area with respect to the WGW feeding areas[1];

(c) the seismic survey strategy, especially the timing of the survey;

(2) thus while the development processes and analytical methods used to determine mitigation measures for seismic surveys involving airgun arrays of different sizes are generally applicable, several aspects are case-specific and must be seen in the context of the total mitigation strategy.

(3) The primary mitigation measure for any seismic airgun survey in Sakhalin waters where gray whales are concentrated must be to complete the survey before the majority of whales have arrived in the area; without this, the other measures alone established for the 2010 or 2012 surveys would not have been considered sufficient.

The sizes of the recommended exclusion zones[2] around vessels operating seismic airguns for gray whales are primarily dependent on the power of the sound source and not the location or spatial extent of the survey. The NTF **recommended** that exclusion zones must be at least the modelled 180dB_{RMS} re:1µPa distance from the specific array to be used plus an appropriate additional safety margin that may change with circumstances. Generalising from the analyses undertaken for the 2010 and 2012 surveys, the NTF **recommended** that for seismic surveys in areas off Sakhalin where gray whales are concentrated:

(1) for sound sources of 200in^3 or less, the exclusion zone must be at least 500m;

(2) for sound sources of over 200in^3 it must be based on modelling (for 180dB_{RMS} re:1µPa) and verified in the field (or directly measured) and in any case must not be less than 1000m.

The NTF **recommended** that this general statement is clearly displayed on the IUCN website along with the detailed mitigation and monitoring strategies.

4.2.2.2 Specifics of the 2012 2D surveys

The NTF **agreed** that the information provided under Item 4.1.2 did not require changes to the previously agreed monitoring and mitigation approach (ref WGWAP-10) for the 2D surveys. However, it **recommended** that any changes to the seismic airgun survey area be submitted to the Panel for comment immediately, followed as soon as possible with the usual modelled sound footprints. SEIC assured the task force that the surveyed area would not be increased in size, but that it might be moved to an adjacent location and, possibly, reduced in size.

The NTF **noted** Sakhalin Energy's reaffirmed commitment to the previously agreed mitigation and monitoring measures for the 2D surveys. It **reiterated** that the most important mitigation strategy is to complete the survey as early in the season as possible when the fewest whales are present in the study area. Sakhalin Energy confirmed that the surveys are scheduled to begin on 20 June 2012 based on average ice-free conditions. However, in response to the recommendation to start as early in the season as possible (NTF-1), company officials reported that although the current plan was to have the vessel in Korsakov for mobilisation on 15 June and on-site on 20 June, the ice situation would be monitored carefully and mobilisation could be earlier if conditions allow.

[1] The Panel developed a working definition of the 'feeding area' based on an analysis of distribution data collected over a number of years (e.g. see WGWAP-9 report). The area varies by season. The analysis should be updated from time to time as more data become available.

[2] Area around the seismic vessel within which activities must cease immediately if a marine mammal is observed.

With respect to the specific details of the 2012 2D surveys, the NTF **recommended** retention of the precautionary 1km exclusion zone provision agreed at WGWAP-10. However, given that the primary mitigation measure is to complete the survey as early in the season as possible, it also **agreed** that should conditions (e.g. fog) mean that visibility falls below 1km, it was permissible for operations to continue provided that visibility was not less than 500m (i.e. remaining consistent with the recommendation above). This measure, which does still include an additional safety margin beyond exposures predicted to result in direct harm to animals, is to prevent the survey from being extended into periods of high whale abundance.

Recognising the difficulties in estimating distance at sea, especially when no horizon is visible, the NTF **recommended** that a 500m marker is incorporated onto or alongside the towed array such that operations must cease when that marker is not visible to the MMO.

During the session to adopt the report, it was realised that the potential impacts of the sub-bottom profiler (also known as 'boomer' device) to be used during the summer of 2012 and beyond had not been discussed. The Chair established a small group (Racca, Southall, Nowacek, Broker, Vedenev) to consider this issue. If possible, the small group will report back during WGWAP-11. Failing that, a report from the small group should be circulated to the NTF by the end of February 2012.

5 CUMULATIVE IMPACTS PROGRESS

5.1 Presentation by Racca and Southall

Racca and Southall gave a presentation on the activities and progress to date of the Working Group on cumulative effects of underwater noise in which they are involved along with some twenty other scientists.

A multidisciplinary working group of scientists convened by the University of California, Santa Barbara under a grant from BP America Production Company has undertaken a two-year project to develop standardized and practical methods for assessing cumulative effects of anthropogenic underwater sound on marine mammals. While the final goal of the project is to conceptualize and specify widely applicable methodologies, case studies are being used to help formulate and test the feasibility of assessment frameworks. The primary case study undertaken by the group focuses on the hydrocarbon-related industrial activities that took place in the Beaufort Sea during the late part of the open-water season of 2008 and their potential cumulative effects on the population of bowhead whales that inhabit and transit through the region in their annual migration cycle. The methodology developed for the case study includes: (a) the identification and suitable simplification of relevant noise producing activities to abstract the key acoustic source properties from the operational details that could make the problem intractable; (b) the frequency-resolved numerical modelling of the sound field from each source and its long range propagation through the medium, both in the water column and in the stratified seafloor; (c) the merging of the various acoustic fields for each distinct phase of the activities into an aggregate volumetric footprint; and (d) the statistical estimation of instantaneous and cumulative exposure to sound by running animats (programmatic virtual receiver "whale" units) through the modelled field according to realistic motion rules. Both the direct effects from exposure to sound and the indirect effects from communication masking can be characterized using this approach. The process flow is shown in Fig. 3.

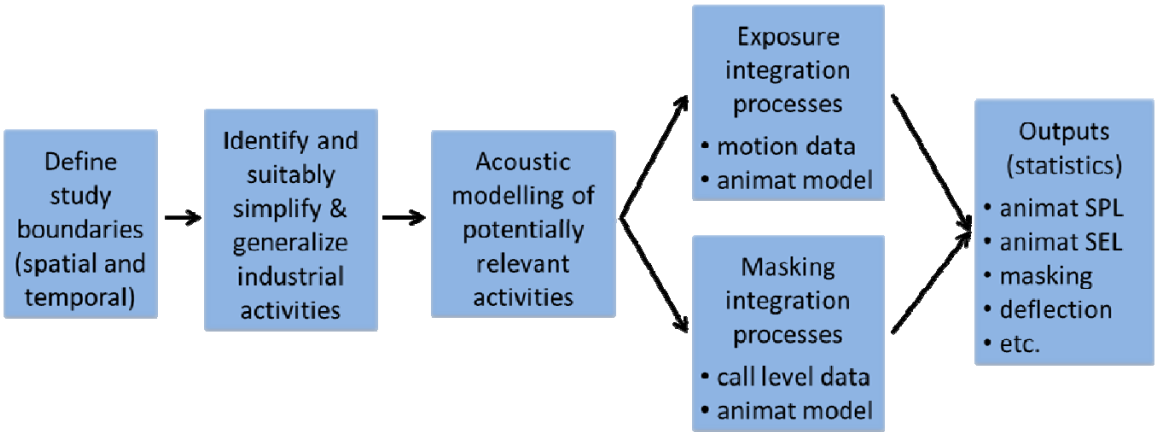

Fig. 3 – Flow diagram of the methodology for estimating quantitatively the potential effects of exposure to multiple noise generating activities on a population.

The presentation included examples of how operations such as seismic surveys of different source sizes and topographic location could be generalized to provide a time-dependent aggregate acoustic footprint in situations, such as the early-stage forecasting of planned activities in a region, where the details of each operation are only partially defined or known. Possible generalizations include the simplification of a seismic survey pattern to a point or a notional "cloud" of source locations and the transformation of the expected directional source pattern from an array into a heading-agnostic omnidirectional source function. The results from sample 'animat' model runs where numerous subjects were made to navigate through a sound field from multiple acoustic sources taking different paths based on behaviour-informed stochastic criteria were presented in the form of dose exposure histograms and time plots of aggregate received levels in the animat's frame of reference. The case study framework presentation was concluded by a brief high-level discussion of how the results from the method can be used in a population disturbance assessment context, including input to the PCoD (Population Consequences of Disturbance) model.

Southall followed the presentation on the work of the cumulative effects working group with an overview of parallel activities in large-scale model based sound mapping currently underway under the aegis of USA government agencies NOAA and ONR and provided reference information.

5.2 Discussion

The NTF noted that this important work is still in its infancy and **agreed** that it would like to be kept informed of future developments in this area. There was some discussion of terminology and whether 'cumulative' or 'aggregate' is appropriate. It was noted that cumulative implies build up over time, but the term is often used to refer to exposure to multiple signals at the same time; 'aggregate' seems more appropriate for the latter. It was also noted that cumulative is generally used in the context of population level effects[3].

6 OTHER ITEMS

6.1 Completion of items discussed at NTF-1

An item carried over from NTF-1 was an issue with the analysis and reporting of acoustic data. NTF-1 had considered a new system for data processing and presentation in order to provide improved, basic overall perspectives or assessments of the data (and thus sound exposure to whales) and limiting the copious quantities of unprocessed data that are difficult to assimilate and interpret. The NTF successfully completed the discussions and developed the following recommendation:

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[3] For example see Wright, A.J. (ed) 2009. Report of the Workshop on Assessing the Cumulative Impacts of Underwater Noise with Other Anthropogenic Stressors on Marine Mammals: From Ideas to Action. Monterey, California, USA, 26-29 August, 2009. Okeanos - Foundation for the Sea, Auf der Marienhöhe 15, D-64297 Darmstadt. 67+iv p. Available from http://www.sound-in-the-sea.org/download/CIA2009_en.pdf

RECOMMENDATION ON THE DESIRED ANALYSIS AND REPORTING OF ACOUSTIC DATA WITHIN SUBSEQUENT SUMMARY REPORTS PROVIDED TO THE WGWAP (AND NTF)

Objective

To provide a more constructive means of initial analysis and reporting of acoustic data, summary data on temporal patterns of noise need to be submitted to the Panel for consideration, while ensuring that the original time series data would be available for more detailed analysis of specific events of interest. The summary data need to be delivered in a consistent manner, and must have an initial level of analysis so as to be useful for review by the Panel and NTF.

Reporting/data requirements

All original time series data should be collected and stored by the Acoustic Monitoring Group at the Pacific Oceanological Institute (POI) as has been done previously to support the additional representations described here and any potential future analyses. This is not a new request but merely a remark on the critical importance of full archival preservation of the original data.

WGWAP recommendation 7/002 remains relevant in terms of the reporting of data on specific acoustic events on relatively fine temporal (1-s for impulse noise; 1-min for continuous noise) and spectral (1-Hz band) scales. Data should be made available upon request on these fine scales for specific events of interest, but such results for all sensors and all sampling periods would be unnecessary. However, to expedite the process of getting these 'event' data released in a timely and efficient manner the NTF recommends that Sakhalin Energy include in their contract with POI a requirement that all raw acoustic data be pre-processed and archived as time-indexed frequency resolved records (e.g., through the computation of simple, non-averaged spectrograms). This operation will minimise the time needed by POI to fulfill subsequent requests for data made under recommendation 7/002.

For each season, beginning with 2012, included in or enclosed in digital format with the reports the following tabular and graphical summary representations of the acoustic data should be included. Specifically, each annual report would include for every recording station and all available data periods:

* Tabular summaries in digital format of 30-min Leq levels in 1/3-octave bands between 10Hz and 10kHz (ANSI standard center frequencies)

* Graphs showing sequential 1-min Leq values for the 20Hz-2 kHz and the 20 Hz-15 kHz passbands (presented chronologically with ~3 days data/graph)

* Distinct spectrograms showing a) 1-minute averages in the range 20Hz-2kHz on a linear frequency scale and b) 1-minute averages in the range 20Hz-15kHz on a logarithmic frequency scale. For completeness and ease of reference the 2-20 Hz frequency range could be shown on a common time axis alongside the 20Hz-15kHz logarithmic spectrograms, but should be segregated and rendered separately with an independent colour scale so as not to restrict the dynamic range of the >20 Hz data.

Responsible persons

SEIC

Timeline

The company should submit a report annually in document and/or digital form that contains the data as described above.

7 ADOPTION OF REPORT

The main components of the report were adopted by the NTF at the end of its discussions. Final editorial matters will be dealt with by the Chair in consultation with relevant members as identified in this draft. The Chair thanked Sarah Humphreys and this involved in drafting sections of the report for their hard working in enabling most of the report to be agreed at the end of the meeting.

Annex A - List of participants

Koen Broker (Sakhalin Energy)
Justin Cooke (WGWAP)
Victor Davey (Sakhalin Energy)
Greg Donovan (WGWAP)
Richard Evans (Sakhalin Energy)
Glenn Gailey (Sakhalin Energy)
Judy Muir (Sakhalin Energy)
Doug Nowacek (WGWAP) (From Day1 pm)
Roberto Racca (Sakhalin Energy)
Randall Reeves (WGWAP)
Brandon Southall (WGWAP Associate scientist)
Grigory Tsidulko (WGWAP)
Dave Weller (WGWAP)
Alexander Vedenev (WGWAP)
Alexey Vladimirov (Sakhalin Energy)

IUCN

Patricio Bernal
Olivier Hasinger
Sarah Humphrey
Tatiana Saksina

Interpreters

Alexander Danilov
Grigory Shkalikov

Annex B - Agenda

1. INTRODUCTORY ITEMS

1.1. Chairman's opening remarks

1.2 Available documents

1.3 Adoption of Agenda

2. 4-D ANALYSES

2.1 Presentation by SEIC of results to date

2.1.1 Cases

2.1.2 Behaviour MVA

2.1.3 Distribution MVA

2.2 Discussion

2.2.1 Evaluation of results and identification of outstanding issues

2.2.2 Way forward (methods, timetable, publication plans etc.) for resolution of outstanding issues

3. NOISE COMPONENT OF "ISSUES DOCUMENT"

3.1 Presentation by SEIC

3.2 Discussion

4. 2D SEISMIC (GEOTECHNICAL) SURVEY 2012

4.1 Presentation by SEIC on any changes in plans since previous meeting, including update on monitoring and mitigation plan

4.2 Discussion and conclusions

5. CUMULATIVE IMPACTS PROGRESS

5.1 Presentation by Racca and Southall

5.2 Discussion

6. OTHER ITEMS

7. ADOPTION OF REPORT