REPORT OF THE INTERIM INDEPENDENT SCIENTISTS GROUP (IISG) ON MITIGATION MEASURES TO PROTECT WESTERN GRAY WHALES DURING SAKHALIN II CONSTRUCTION OPERATIONS IN 2006

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INTRODUCTION

The Vancouver II workshop was one of a series of reviews and workshops aimed at assessing risks and avoiding potential adverse effects of Sakhalin Energy Investment Company's (SEIC) Phase 2 oil and gas operations on the critically endangered population of western North Pacific gray whales (WGW). Background for those reviews and workshops can be found on the IUCN website. The Vancouver I workshop was convened at the request of potential international lenders for the project, and was held on 17-19 September 2005 in Vancouver, British Columbia. At that time, some of the conservation issues considered were judged to have been resolved or moot, but numerous others were deferred for further consideration and resolution by a planned long-term advisory body, the Western Gray Whale Advisory Panel (WGWAP). Following the lenders' workshop, IUCN received and agreed to a request by SEIC to convene the WGWAP. When it became evident that the WGWAP was not going to be established in time to review SEIC's plans for mitigation during the 2006 construction season, IUCN decided to convene the Interim Independent Scientists Group (IISG) to bridge the gap.

The terms of reference for the IISG workshop can be found on the IUCN website. The workshop was held on 3-5 April 2006 in Vancouver. The IISG developed a list of outstanding key issues and associated questions to which the company was asked to respond several weeks before the workshop. This list was used as a basis for the workshop agenda (see IUCN website). The IISG's deliberations were informed primarily by documents provided by SEIC, as listed at the IUCN website. Not all of the workshop documents were completed in time for full review by the IISG, but the workshop could not be delayed if the IISG's advice was to be available in time to influence operations during the 2006 construction season. The findings of the IISG, as developed and agreed on Day 3 of the workshop, are given below. They are organized and presented following the workshop agenda.

WESTERN GRAY WHALE ADVISORY PANEL (WGWAP)

IUCN described efforts to conclude the terms of reference for the WGWAP. The IISG emphasizes the following points concerning the WGWAP:

1. The principles of independence, objectivity and transparency must be maintained.
2. The participation of other oil and gas developers working on the Sakhalin Shelf, in addition to SEIC, remains a very high priority.
3. Although the principal focus of the WGWAP should be conservation of the WGW and ecologically related biodiversity, its terms of reference should allow IUCN, in consultation with SEIC and the WGWAP, to widen its scope to include other elements of biodiversity on the Sakhalin Shelf.
4. Similarly, the terms of reference should allow extension of the panel's purview to include other parts of the WGW range in addition to the Sakhalin Shelf.

Finally, of utmost importance, the IISG concluded that the modus operandi of the WGWAP needs to shift from the reactive or review approach that has been followed to date (beginning with the initial IUCN Independent Scientific Review Panel and continuing to the present workshop) to a much more proactive approach. This would mean that the deliberations and meetings of the WGWAP are timed and organized to allow it not only to assess, comment upon, and develop recommendations from documents produced by SEIC and other participating companies, but also to prescribe the types of research and monitoring that are needed to provide an adequate basis for gray whale protection. In other words, the WGWAP needs to become directly involved in setting the scientific agenda for oil- and gas-related studies of gray whales and their associated biodiversity on the Sakhalin Shelf. Among the primary concerns of the IISG are to ensure that such work is well focused, prioritized, and directly relevant to WGW conservation, that

redundancy is minimized, and that potentially harmful effects of research activities on the whales (e.g. disturbance from repeated and persistent close approaches by vessels) are kept to a minimum.

POPULATION STATUS AND ASSESSMENT

Russia-U.S. Research Program

Collaborative research of Russian and U.S. scientists has been conducted on western gray whales summering off northeastern Sakhalin Island since 1995. Much of that work has focused on photo-identification research of the animals to characterize population composition and status. In 2005, this work resulted in the identification of 92 whales, including six calves and four previously unidentified non-calves. As in past years, the body condition of whales was documented. Fourteen "skinny" whales (excluding mothers with dependent calves) were observed in 2005, which is a considerably larger number than reported in any year since 2001. The IISG recommends that the Russia-U.S. research program be continued in the future, as it is vital to understanding the status of the WGW population.

Update of the ISRP Assessment

The ISRP population assessment was updated, incorporating two additional years of field data (2004 and 2005) collected by the Russia-U.S. team. Updated projections forward to 2050 were made under various scenarios.

The updated population assessment indicated a substantially more optimistic picture compared with the ISRP assessment. The new data indicated improved calving rates in the last few years, with mean calving intervals shortening from 3 to 2 years. Of the five recorded calving intervals ending in 2005, all were just two years.

The estimate of annual adult survival rate increased from 0.969 to 0.986 (90% confidence interval 0.976-0.995). The estimate of yearling survival rate (i.e. survival from first to second summer season) decreased slightly from 0.73 to 0.71 (90% CI 0.59 -0.82). The estimate of annual population increase rate increased from 3.3% p.a. to 5.2% p.a. (90% CI 3.5% - 6.8%).

The median estimate of non-calf population size in 2006 is 123 animals (90% CI 114 - 133). The estimate for 2004 is 113 non-calves, which compares with the ISRP estimate for the same year of 102 animals. Of About half of the difference in population estimate from the ISRP assessment (from 102 to 113 animals) is due to the additional data, and about half (from 113 to 123 animals) is due to the increase in the population between 2004 and 2006.

The ISRP assessment found that the population was very probably (~90% probability) increasing. On the basis of the updated assessment, it can now be considered virtually certain that the population has increased. The updated median projection forward to 2050 is similar to the upper 90th percentile of the ISRP projection.

The median prediction for calf production in 2006 is 11 calves, on the assumption that construction activities in 2005 had no substantial impact. The median prediction for 2007 is somewhat lower, at 7 calves, because the mothers that calve in 2006 cannot also calve in 2007.

Effects Of Impacts Outside The Sakhalin Area

Three female western gray whales died in fishing gear on the eastern coast of Japan in 2005, during the northward migration. In two separate incidents, one mother with a calf, and one yearling were killed. It is

important to obtain photographs and genetic samples collected by Japanese scientists from these three whales to allow determination of whether they were individuals previously identified and sampled on the Sakhalin feeding ground. This can be done by: (1) comparing photographs of the whales killed off Japan to the existing photo-id catalogues from Sakhalin and (2) comparing DNA from the whales killed off Japan to the DNA database held at the Southwest Fisheries Science Center, California, on behalf of the Russia-U.S. research program. At the time of the IWC Scientific Committee meeting in June 2005, the first of these three whales had been killed and the IWC/SC recommended that efforts be made to see if that whale had been previously identified off Sakhalin. Now that two additional whales have been killed (an adult female and her calf), the need is even greater to determine whether either of these or the first whale, a yearling, is among the known whales photographed or biopsied on the Sakhalin feeding grounds. Therefore, the IISG urges that IUCN request cooperation from the government of Japan and help ensure that these important comparisons are undertaken as soon as possible.

Projections With Additional Impacts

To investigate the consequences of losses continuing at the level occurring off Japan in 2005, projections were made on the assumption of a continuing annual loss of an average of three animals. The median projection still shows an increase, but at a lower rate, and the lower 10^{th} percentile projection declines towards extinction.

The ISRP report estimated that the loss of just one extra female per year would likely reverse the population increase and cause the population to decline towards extinction. Projections from the revised assessment were calculated with this extra loss of one female per year, over and above the net losses reported above. Again, the projection is that the loss of just one additional female per year in the Sakhalin area, if it is additional to other losses, will likely cause the population to decline towards extinction. This confirms the continued importance of avoiding any additional losses in the Sakhalin area.

The good numbers of calves present during 2003-05 presumably reflect conditions during 2002-04. It is not possible to assign a specific cause to the variations in calf production, but the data are consistent with calf production tending to be good in years with little disturbance, because the 2002-04 seasons were apparently relatively quiet with little or no seismic surveying or construction work.

Whatever the explanation for the improved reproduction, the assessment indicates that reproduction can be good when disturbance is low, and suggest that recovery prospects for the population are good provided that construction disturbance can be limited to one season and that threats elsewhere in the range are contained.

The SEIC-Sponsored IBM Photo-Identification Program

The SEIC-sponsored Marine Biology Institute (IBM) photo-identification program on western gray whales off Sakhalin Island has been ongoing since 2002. Photo-identification research conducted in 2005 resulted in the identification of 113 whales, including four calves and a total 17 previously unidentified individuals. When combined with data from 2002-04, a catalog of 138 photo-identified individuals has been compiled. The body condition of whales encountered in 2005 was also recorded. The number of "thin" whales in 2005 was 10 (including mothers with dependent calves) and four whales were observed with sloughing skin.

The IISG questioned the high number of new whales identified by the IBM group in 2005, leading to discussion about how their catalog has been constructed, maintained and validated. Although they identified more whales in 2005 than the Russia-U.S. team, their numbers were still less than the estimated

numbers in the population based on the updated ISRP assessment, and thus may have simply been the result of wider area coverage.

Integration Of Western Gray Whale Photo-Identification Data

Participants at the workshop discussed the costs and benefits of continuing two independent photo-id research programmes with relatively little collaboration to date. Consistency between the two catalogues has not been determined and procedures for identification and inclusion have not been compared. Combining these data sets, after they have passed through appropriate quality control procedures, would enable more precise estimation of the population and hence quicker detection of possible negative developments. Importantly, duplication of field effort potentially exposes the whales to unnecessary disturbance from research.

The IISG recommends that the following steps be taken towards integration of the photo-identification data:

1. Members of IBM and Russia-US teams meet to compare existing catalogs and develop a prototype master catalog.

2. The prototype master catalog be reviewed by external scientists nominated and agreed on by the IISG/WGWAP and stakeholders. An impartial body, such as IUCN or the Marine Mammal Commission, independently selects reviewers and carries the task forward.

3. Adjustments to the prototype catalog be made according to the outcome of independent review and subsequent assignment of a common individual numbering system.

4. A master catalog be created and shared between IBM and Russia-US teams and, potentially, others. Minimum data to be included would be common individual/catalog numbers and information on photographer/team responsible for the photographs.

5. Existing data sets (i.e., sighting information) be adjusted to match the master catalog.

6. Data sharing agreement be developed to protect confidentiality, data use and ownership. This agreement would incorporate interests of all stakeholders (IBM and Russia-US teams, SEIC, ENL). Assistance of the IISG/WGWAP and IUCN in this process would be sought.

7. Data be exchanged on a project-by-project basis using the data sharing agreement above.

Approval by SEIC, ENL, IBM, and the Russia-U.S. team is needed to carry the above collaboration forward.

The IISG recommends this initial step of collaboration to facilitate population assessment, reduce duplication of field efforts, and avoid disturbance of the whales. Such collaboration also could facilitate development of new, more effective approaches to population monitoring.

LONG-TERM ENVIRONMENTAL MONITORING

Long-term monitoring plans (LTMPs) for natural ecosystems are useful for understanding effects of extrinsically generated events on the normal structure and dynamics of a biological community. Events of interest may include natural disturbances such as major storms or mass movement of sediments, or anthropogenic disturbances such as pollution or habitat modification. Use of an LTMP is often the only

option when events of interest cannot be predicted, or occur on a large enough scale that experimental approaches are impractical.

LTMPs are most informative when they incorporate the following attributes:

1. A clearly defined question of interest, explicitly framed *a priori*.

2. Sufficient breadth and flexibility that ecological effects of unexpected events, not related to questions posed at the outset, can be understood and incorporated into functional models of ecosystem dynamics. This capability is particularly important in cases of coincident natural and anthropogenic events, where the latter is of primary interest but where determination of cause and effect may otherwise be impossible.

3. Methods that are clearly defined, consistently applied over time, and readily communicated when changes in project staff occur.

4. A solid basis in existing data on the ecological community of interest, collected *a priori*.

5. Definition of target variables *a priori*.

6. Development of solutions to the following design problems prior to initiation:

    a. Bases of stratification of sampling effort, both pre- and post-sampling;

    b. Choice between sampling repeatedly over time in permanent study sites, or sampling based on a new random selection of sampling sites for each sampling time step.

    c. Choice of desired minimum detectable change (as a percentage of the previously determined mean value) over time for each target variable.

    d. Determination of sampling effort required to allow recognition of a minimum detectable change over time.

Here we suggest attributes of LTMPs for the two known feeding areas (“Piltun” and “Offshore”) for western gray whales off northeastern Sakhalin Island, and for benthic communities within Piltun Lagoon. Lagoon monitoring is strongly encouraged because of the persistent proximity of the primary feeding area for western gray whales to the Piltun Lagoon entrance channel. This pattern is consistent with the hypothesis of a functional ecological linkage between Lagoon biota and gray whale feeding location. Where appropriate, we provide suggestions for LTMP attributes in both spatial and temporal contexts.

Our principal references for information on benthic biota in the feeding areas and Piltun Lagoon were IISG Documents 13-D and 15, with additional guidance from IISG Document 1.

Primary questions

Two primary questions must form the basis for LTMP implementation in the gray whale feeding areas and in Piltun Lagoon:

1. How will pollution events such as oil spills, occurring in association with Sakhalin II activities, influence the structure and dynamics of marine benthic communities of significance to the nutrition of the western gray whale population? How will such effects be distinguished from natural variation in the ecosystems of the Okhotsk Sea region?

2. How will events such as pipeline or platform construction that produce physical alteration of natural habitats, occurring in association with Sakhalin II activities, influence the structure and dynamics of marine benthic communities of significance to the nutrition of the western gray whale population? How will such effects be distinguished from natural variation in the ecosystems of the Okhotsk Sea region?

Existing Studies and Data

Studies of benthic communities in the western gray whale feeding areas have been conducted annually since 2002. A data set of high quality, incorporating a number of relevant and important target variables, has resulted. Collectively, the existing data provide a comprehensive basis for initiation of LTMP work in the feeding areas.

Field survey work was conducted on benthic communities within Piltun Lagoon in September 2002. Document 15 summarizes data collected in 2002, and provides a synthesis of relevant data collected in the Lagoon prior to 2002. Data available on Lagoon benthos are not as comprehensive as those collected in recent years in the feeding areas, but nevertheless are substantial and useful in planning LTMP work in the Lagoon. The historical data sets available on Lagoon biota are valuable in the context of understanding long-term trends in ecosystem structure and function.

Suggestions regarding target variables and species

We suggest that the following variables, or classes of variables, should be the primary target variables for LTMP effort in the whale feeding areas. Selection of variables is based primarily on established data sets described in IISG Document 13-D.

Density and biomass of sampled animal species
Size distributions for dominant animal species
Fecundity patterns in dominant animal species
Sediment grain size distributions
Sediment total organic carbon fraction by mass
Sediment petroleum hydrocarbon residues by mass

Based on data collected to date, we suggest the following, at a minimum, as species of particular interest in whale feeding areas, because of overall abundance and because of likely inclusion in gray whale diet.

Amphipoda
- *Pontoporea affinus*
- *Eogammarus schmidti*
- *Ampelisca spp.*

Isopoda
- *Synidotea cinerea*
- *Saduria entomon*

Cumacea
- *Diastylis spp.*

The above species should be considered for monitoring size distributions and fecundities. All are pericarid crustaceans, in which females have a marsupium bearing relatively large, easily enumerated eggs or recently hatched juveniles, counts of which can provide a fecundity index and information on

seasonality of reproduction. Along with data for density and biomass, information on size distribution and fecundity of dominant species will provide additional insight into population dynamics that may be sensitive to impacts from Sakhalin II, and relevant to the foraging ecology of gray whales.

Suggestions Regarding Methods

Whale feeding areas

Benthic sampling in the feeding areas has been done primarily with grab samples deployed from relatively large support vessels. We recommend that grab sampling be maintained as the primary sampling method in LTMPs. Grab sampling methods have proven effective in water depths exceeding 10 m, but we note that the method has proven problematic in some cases in shallower water because of vessel draft. Sampling from small vessels or with divers has been used in shallow waters, but the comparability of data collected by grab sampler and by divers has not been established. In anticipation of LTMP initiation, the relationship between sampling characteristics of grab samples and diver-obtained samples must be determined to permit standardization of data reporting. This is particularly important in light of frequent use of shallow benthic habitats as foraging locations by gray whales.

Potential LTMP investigators are urged to consider several additional methods for assessment of biological communities in the whale feeding areas:

1. Expanded use of epibenthic sled-type sampling devices to increase sample size for potentially important whale prey known to be highly patchy in distribution, such as the isopod *Saduria entomon*, and for other potentially under-sampled but possibly important taxa such as crangonid decapods.

2. Use of side-scan sonar methods to expand the proportion of whale feeding areas that can be characterized with regard to physical bottom type, and possibly to resident biological communities. This approach may be of particular value in determining boundaries of dense beds of sand dollars (*Echinoarachnius parma*), which are a dominant component of benthic biomass in the feeding areas, and which may define the limits of productive foraging areas for gray whales.

Piltun Lagoon

Lagoon benthic communities are dominated by large stands of plants, such as the seagrass *Zostera spp*. and the pond weed *Potamogeton perfolatus*, and by bivalve mollusks and amphipod crustaceans. Mean water depth in the Lagoon is < 3 m, and sampling must be done from small vessels. Quantitative benthic sampling of high quality will require use of coring devices that can be deployed effectively from small craft such as skiffs, or that can be operated by divers. We suggest that documentation of the extent and dynamics of large plant stands will be most effectively done by application of remote sensing methods, supported by sampling of plant biomass densities in the field, to allow estimation of total plant biomass on larger scales.

Piltun Lagoon Entrance Channel

The transport of organic material from Piltun Lagoon to the adjacent offshore whale feeding areas may have substantial importance in sustaining the productivity of whale prey in the offshore grounds. We encourage the development of methods to monitor rates of transport of organic materials from inside the Lagoon to the adjacent offshore waters. Sampling should focus on phytoplankton, zooplankton, and various categories of detritus transported offshore, recognizing that dominant planktonic and benthic species in the Lagoon are generally different from those occurring offshore. An effort should be made to

sample transport processes among seasons to the extent feasible, as ecologically significant transport periods may be temporally decoupled from whale feeding activity.

Additional information

Recently a considerable amount of data on environmental variables and benthic communities was collected for the northeastern Sakhalin shelf region. The data include temperature, salinity, and tidal current velocities measured at the Molikpaq platform (PA-A), oceanographic data from a number of stations collected by survey vessels, and tidal and weather data during field work by behavioral observation teams. Extensive data on benthic communities have been collected since 2002 as noted above. There is an urgent need for integration of these data sets in a GIS-type data base open for authorized access by external experts. We recommend complementing the GIS data base with relevant satellite images, allowing development of a classification of particular oceanographic situations and their remote sensing indicators.

Suggestions Regarding Sampling Design

The determination of whether to sample repeatedly over time in the same location, or to place samples in newly randomized locations for each sampling effort, requires evaluation of costs and benefits. Newly randomized sample locations for each sample interval maximize the spatial scale of inference when data are interpreted. However, when randomly placed samples encompass multiple habitat patch types, variance in the data is typically increased, and the statistical power to detect trends in the data is reduced. In contrast, sampling at permanent locations repeatedly over time typically reduces variance in patchy habitats and increases the power to detect trends over time, but also reduces the spatial scale of allowable inference in data interpretation. We recommend the latter approach because of the value we see in high power to detect trends. In both approaches, variance and power can be manipulated by stratification. Inferential strength also is improved if the initial selection of permanent sample locations is random.

Determination of minimum detectable change is an arbitrary decision, but it must be tempered by the realities of the variance structure in the data. Assuming that high power for detection of trends over time is a primary goal in LTMP design, desirable qualities of sample data include low variance, high replication, and small sampling interval. The attainable level of minimum detectable change emerges analytically from patterns of variance, replication, and sampling interval. In the case of both the feeding areas and Piltun Lagoon, field conditions likely constrain sampling interval to once per year in general. Logistical considerations also likely influence the number of replicate samples that can be gathered at a given location during a sample time step. We recommend that minimum levels of detectable change be set at 25% for total benthic animal biomass, and at 50% for species that are dominant community members, such as those listed above. With target values for minimum detectable change specified, it is then possible to compute the minimum number of replicate samples per sampled site per year that must be collected. If desirable levels of replication are not feasible and multiple sample series within years are not possible, then minimum detectable changes in data time series are forced to larger values. We strongly encourage LTMP designers to make a maximum effort to attain replication levels necessary for the specified levels of minimum detectable change, ensuring adequate power to detect trends in benthic animal data.

Whale feeding areas

We suggest sample stratification to focus the evaluation of temporal trends on specific community types. We recommend pre-sampling stratification by depth. Samples should be post-stratified by sediment characteristics or by category of animal assemblage. Analyses of individual strata will provide better

insight to processes linking disturbance with ecosystem response, as compared to analyses of unstratified data.

Piltun Lagoon

For Lagoon sampling, we suggest pre-sampling stratification by dominant plant type or by dominant sediment type. Post-sampling stratification can be considered by animal assemblage type.

We do not have recommendations for minimum detectable change levels in assessments of large plant stands based on remote sensing methods, because of lack of availability of indices of variance over time in stand extent in the Lagoon. We suspect that properly implemented remote sensing methods for plant stand size estimation will produce data sets with low variance and high consequent power to detect trends, potentially supporting the ability to establish small values for minimum detectable change.

Hokkaido Sea Bird Die-off

A recent seabird die-off has illustrated the importance of environmental monitoring on a broad scale. Oiled dead sea birds started to appear on the northern coast of Hokkaido in late December 2005 and by 31 March 2006 the estimated total number of dead birds exceeded 5,000. Most of these dead birds were common guillemots, crested auklets, and thick-billed murres. The region where the majority of them have been found is near the base of the Shiretoko Peninsula (designated by the UNESCO as a World Heritage Site in 2005). Some regions of the southern Okhotsk Sea coast of Hokkaido still have sea ice (as of 5 April 2006), but as the ice melts more oiled birds are being discovered. Dead oiled sea birds also have been found on Kunashir Island, Russia, due east of the Shiretoko Peninsula.

The Hokkaido government examined oil from some of the recovered birds and determined that it is Bunker C fuel oil, which is widely used. Therefore, the exact source of the oil spill will be very difficult to identify. The oil could not have come from SEIC's Sakhalin II operations.

In addition to the oiled sea birds, some dead Steller's sea eagles have been discovered in eastern Hokkaido. Some of them had oil in their stomachs that probably came from eating oiled sea birds. The eagles have been of special interest to the WGW panels because of their endangered status, and because their summer range includes the east coast of Sakhalin Island. The 2005 report on Sakhalin II activities by the Independent Scientific Review Panel reflects a strong interest and concern about effects of Sakhalin II activities on regional biodiversity, and the ISRP adopted a broad definition of biodiversity in its 2005 Report.

Recovery and documentation of dead oiled sea birds, dead Steller's sea eagles, and other affected marine wildlife are important for understanding the damage caused by oil spills. These materials also offer unusual and potentially valuable research opportunities to better understand the behavior of spilled oiled in a region known to be a major migration route for western gray whales, and to better understand the effects of spilled oil on other marine resources.

The IISG recommends that IUCN urge UNESCO to make a special effort to ensure that surveys for dead Steller's sea eagles are conducted on both coasts of the Shiretoko Peninsula, and that any carcasses are examined in detail to determine the cause of death. Information from the current spill is of particular interest and value because of the presence of sea ice in the spill area. The IISG also recommends that SEIC work with appropriate Russian and Japanese governments to determine the time, place, and source of the oil spill so that the data and specimens can be used to examine retrospectively the behavior of the spill and its effects. Such information may prove valuable for modeling oil spill and trajectories, and related exercises.

OIL SPILL RISK ASSESSMENT AND MANAGEMENT

Oil spill risk assessment and management are ongoing processes. During the workshop, representatives from SEIC and AEA Technology provided updates on activities related to oil spill response and assessment, particularly with regard to loading and shipping of oil and gas from Prigorodnoye in Aniva Bay, and the risk of platform blowouts.

Prevention measures are viewed as key to avoiding the effects of oil on WGW, their feeding grounds, and their migratory corridors (particularly in the Aniva Bay area). Prevention measures are essential at the platforms (e.g., prevention of blowouts), in the pipelines (e.g., design features, burial, detection of leaks), and in subsequent transport (e.g., loading and vessel accidents). Response measures also are essential to minimize adverse effects should an accident occur. These efforts are compromised by the fact that the marine environment around the platforms is partially or fully covered with ice for about half of the year. The Hokkaido sea bird die-off reported above illustrates the difficulty of detecting and managing spills in the marine environment, and their potential for significant impacts on wildlife.

Past reviews and workshops have evaluated the potential efficacy of both prevention and response measures related to oil spills from Sakhalin II operations. The conclusions from those efforts can be found in reports on the IUCN website. At this workshop, the IISG reviewed certain elements of prevention and response strategies and, consistent with previous recommendations, emphasized the following.

- Continued work is needed to develop response strategies and methods for oil is spilled on or under the ice. The degree to which such oil can be recovered is highly uncertain, but progress has been made by SEIC both independently and in concert with other oil and gas companies. Important studies are underway to assess the costs and benefits of burning oil, retrieving it from under the ice, and retrieving it by various technologies (skimmers and mops) from the ice or open leads in the ice. These studies should be continued to maximize the probability of an effective response.
- The IUCN may wish to consider whether it could play a role in coordinating the efforts of oil and gas companies that are developing oil spill response strategies that can be used on or under ice.
- Response strategies (tiers I, II, and III) must be in place before oil and gas extraction begin and should include training and drills to ensure that all response participants are prepared to carry out their responsibilities effectively if a spill occurs.
- As described in reports from the September lender's workshop, regular (biweekly) flights are needed to detect leaks from pipelines.
- SEIC should continue development of models for predicting the trajectory of oil spilled under ice. The IISG agrees that such models are essential and supports their development.
- Response efforts should include protection of Piltun Lagoon and the Piltun feeding area used by WGWs.
- Dispersants should not be used in areas where they may affect WGWs and, particularly, their habitat.
- The IISG recommends that, should a spill occur, an assessment team be convened to determine the nature and extent of damage caused by the spill. The assessment team should be independent of the response effort.
- SEIC commit to and undertake a long-term environmental monitoring program to determine if undetected leaks and spills are contaminating the environment around or downstream of the platforms and pipelines (see Long-Term Environmental Monitoring above).

SHIP-WHALE COLLISION RISK ASSESSMENT AND AVOIDANCE

Carcass Detection, Salvage, And Necropsy

Previous reviewers have noted the importance of detecting dead (or injured) gray whales on or near the coast of Sakhalin Island and recommended active efforts to find and investigate whales carcasses and to document ship strike injuries or scars through photography. The report of the September 2005 lenders' workshop called specifically for biweekly surveys for stranded, injured, or dead whales (either floating or on the beach) and for plans to evaluate and examine any such animals or carcasses to determine the circumstances surrounding their injury or death and to obtain biological data.

Observers and scientists are limited in their ability to detect whales that are behaving abnormally or are ill or dead. Such animals may not be observed until they strand or wash ashore. Detection of those whales depends in part on whether shoreline surveys are conducted on a regular and frequent basis. Detection is important because examination of the whale may provide evidence of the cause of death – e.g. oil and gas activities, fishery interactions, ship strikes, emaciation, disease. In other words, carcasses provide opportunities to learn about the risks posed to gray whales and factors that affect their health and condition. Such information is highly desirable, especially because a number of western gray whales have been seen in poor condition in recent years.

The IISG reiterated earlier conclusions that reliance solely on Marine Mammal Observers (MMOs), research teams involved in their normal tasks, and other casual observers to detect and report gray whale carcasses is insufficient. A regular surveillance program, employing dedicated (or semi-dedicated, e.g. a helicopter returning from an unrelated crew change, reconnaissance, or supply mission) boats, aircraft, or both, is required.

The IISG offers the following comments on Annex 2 in the Marine Mammal Protection Plan, and specifically the Marine Mammal Mortality-Injury Report. This data sheet is presumably to be filled in by a Marine Mammal Observer (MMO) on a vessel. The form has a box for the observer to complete, simply as a check mark, on whether or not the animal observed had evidence of human interaction, and then whether this was a boat collision, fishery interaction, seismic interaction or "other." It is extremely unlikely that such a determination could be made by an observer from the boat, except in rare cases of obvious entanglement or propeller wounds, and these can often be secondary to some other problem. Most boat strike cases are only determined to be such by flensing the whale and finding broken bones beneath the blubber. Thus, this data sheet in the hands of an observer on a boat will not help determine whether or not a dead gray whale has been struck by a vessel. Instead, the IISG recommends that:

1. Regular surveys be carried out to detect carcasses (see "WGW Stranded Carcass Surveys" below).
2. Any dead animal be towed ashore for complete necropsy, regardless of state of decomposition and the time it will take. Broken bones can be detected in rotting carcasses.
3. A form be developed for thorough examination of the animal (necropsy form available on request from Frances Gulland). The details can then be used to deduce whether or not there was human interaction, and the potential type.
4. Personnel trained in whale necropsies be transported to the necropsy site to assist in examination of the whale. If this is logistically impossible, then extensive photographs and drawings should be prepared during the examination, and results discussed with a veterinarian or pathologist experienced in examining dead whales.

WGW Stranded Carcass Surveys

During the workshop, and in consultation with SEIC scientists, the IISG developed the following plan for carcass surveys.

Survey Areas

Piltun Feeding Area - North Piltun Lagoon to the mouth of Chayvo Bay- 52°25' to 53°25 (~100 km): Land-based WGW observation stations are situated along this stretch of coast and are visited regularly by SEIC ground personnel who could follow-up on any carcasses found in this area.

East Coast of Sakhalin Island - Cape Elizabeth to Aniva Bay ~ 45° to 54° (~1000 km): This area is mostly remote coast with few roads and coastal access points other than in the oil fields and the few coastal settlements.

Survey Platforms

Several possible survey platforms were discussed, including vessel, aircraft, and land vehicle. Aircraft such as twin-engine helicopter MI-8 MTV or twin turbo fixed wing AN-28 were determined to be the most efficient and safe method for coastal surveys. Some additional information could be provided by MMOs working on nearshore research and industry vessels. Local fishermen, hunters, and construction employees could possibly provide other information.

Survey Schedule

Piltun Feeding Area: Every 2 weeks, July-October.

Points for consideration are: (1) If surveys are conducted using an airplane, dedicated only for this survey, there will be cost considerations; (2) If conducted by onshore teams, logistics and safety must be addressed, including concerns related to the possible use of students or local residents searching specific areas of the beach; and (3)The aircraft that is being used to survey the onshore pipeline could fly back along the coastline to search for beached carcasses.

East Coast of Sakhalin Island: Twice per season, May/June and October/November during WGW migration.

Points for consideration are: (1) This survey must be done via aircraft, (2) Full coverage of the coast two times annually could be accomplished at minimal cost.

Response To Carcass Or Stranding

If a WGW carcass is found dead on the beach during the two surveys mentioned above, it should be reported immediately to the SEIC marine mammal coordinator. The SEIC emergency response procedure should then be activated. High priority activities include collection of tissue samples, body measurements and photographs of potential injuries, skin damage, and when possible multiple images for individual identification purposes that span from the head to tail on lateral flanks of both left and right sides as well as top and bottom flukes. This can be done either by the teams already in the field, if available, or a special group of experts (members of such a group must be identified) that will be mobilized. Ideally, full necropsy by experts would be conducted following pre-determined standardized protocols. The foregoing comments concerning the MMO data sheet are relevant here.

If a WGW carcass is found floating in the sea, it should be reported immediately to the SEIC marine mammal coordinator. With this, the SEIC emergency response procedure will be activated. Again, high priority activities include collection of tissue samples and high quality photographs of the entire body. It

may be necessary to place an ARGOS satellite-linked transmitter or other similar relocation beacon on a floating WGW carcass for later sampling or transport of carcass to location for necropsy. One or two vessels, including the SEIC WGW research vessel, could be equipped with these transmitters. The transmitter should be tethered to a 20 m line attached to a large and brightly colored floating buoy. Attachment of the transmitter to the carcass via hand held harpoon or similar device would be sufficient.

The WGW research vessel is considered the best vessel to be equipped with all materials for response to carcasses found floating at sea because it can be mobilized with little delay, has marine mammal experts on board that can conduct first examination and take samples, has high quality photographic equipment on board, and has a zodiac that can be launched to collect pictures and samples and to attach an ARGOS tag. Again, our earlier comments on the MMO data sheet are relevant here.

A live stranding should be reported immediately to the SEIC marine mammal coordinator. With this, the SEIC emergency response procedure will be activated. Again, high priority activities include collection of tissue samples and high quality photographs of the entire body. It may be necessary to place an ARGOS satellite-linked transmitter on the whale to best determine the ultimate fate of the individual.

Traffic rules

With regard to the routes and speed limits specified in the Marine Mammal Protection Plan (MMPP) for the 2005 construction season, SEIC reported generally good compliance based on the control that was in place via Marine Mammal Observers (MMOs) onboard vessels, the SEIC MMO coordinator who reviewed daily and weekly reports, and the company's marine operations department that followed vessel routes and speeds through its own control system for preventing vessel-vessel collisions.

No major changes have been proposed by SEIC in the nature or design of vessel corridors in the draft 2006 MMPP. The IISG noted the company's decision not to reduce the speed limits or routes of vessels in the navigational corridors as they approach the platform areas (PA-A and PA-B). Specifically, SEIC did not accept the recommendation from the lender's workshop that the east-west portions of the navigation corridors should be treated as equivalent to construction corridors (i.e. daylight/good visibility limit of 10 knots; nighttime/poor visiblity limit of 7 knots). While acknowledging that the probability of a vessel's encountering gray whales in these areas offshore of the platform locations is low, the IISG emphasizes that downward adjustment of speed limits as a precaution in these relatively small portions of the navigation corridors deserves further consideration by company management. We further note that the available (albeit inconclusive) evidence on ship strikes on large whales suggests that fatal strikes are less likely to occur when vessels are traveling at speeds less than 14 knots.

The IISG welcomed the decision by SEIC to incorporate the route used by its crew change vessels in the MMPP traffic control scheme. This was a major concern raised at the lender's workshop. SEIC explained the difficulty of adjusting any aspect of the crew change vessel's operations in view of navigational and logistical constraints. This apparently unavoidable lack of flexibility is an ongoing problem that the company acknowledged and promised to continue seeking ways to address. The draft 2006 MMPP commits SEIC to increasing its "awareness training" program for crew-change vessel captains and crews and to placing a MMO onboard at least one of the two vessels "every time it sails." The IISG recommends that, in addition, the company reconsider the adequacy of having a single MMO responsible for maintaining continuous watch during the entire roundtrip to the Molikpaq; there is a clear need for at least two MMOs to ensure consistently adequate vigilance. MMO deployment should be equivalent on both vessels used for crew change trips, not only on the Miss Sybil. Finally, and most importantly, the IISG recommends that the company continue its efforts to minimize the number of trips by the crew change vessels, e.g. by changing the crew rotation schedule, arranging for flexibility in shift management so that crew changes by helicopter can be postponed rather than canceled in favor of boat usage. In this

regard, the IISG welcomed the statement by SEIC that crew rotation schedules would be increased from a 14-day rotation to a 28-day rotation. This change should significantly reduce the frequency of crew change trips and therefore also reduce the risks of collisions with gray whales.

Collision risk assessment

At the lenders' workshop the IISG reviewed the collision risk modeling conducted for SEIC by LGL. The modeling had indicated that the number of potential collisions between project vessels and gray whales, assuming no avoidance of vessels by whales or whales by vessels, was quite high (of the order of 10 whales per annum) but that the number of actual collisions that might be expected was an unknown proportion of this. The IISG noted indirect evidence that the actual expected number of collisions was likely low, based on two considerations: (i) the low reported number of vessel collisions with eastern gray whales, despite the large population (>17,000); and (ii) the low annual total number of adult deaths in the population estimated by the ISRP assessment, despite substantial exposure to shipping traffic along much of the migration route (for example the large amount of traffic passing through La Perouse strait).

The MMO programme may help to reduce the risk of collisions through detection and avoidance of whales, but to date no assessment of the programme's data has been conducted to determine to what extent, if any, close encounters have been avoided as a result of MMO sightings.

The revised modeling work reported to this meeting reached conclusions similar to those presented at the lender's workshop with regard to the potential number of collisions. Again, the actual number of collisions that might be expected cannot be determined, but is thought to be low in the light of the indirect evidence noted above. Nevertheless the modeling work does provide a useful assessment of the relative risk from different parts of the fleet and thus where mitigation efforts should be focused. The crew change vessel was identified as presenting the greatest risk, based on its routing, frequency of trips, and duration of operation (lifetime of the project).

Marine Mammal Observer Program

The purpose of the marine mammal observer (MMO) program is to avoid interactions between gray whales and vessels involved in construction of SEIC platforms and pipelines and their subsequent operation. The MMO program has been initiated and has provided useful information on construction activities and whale distributions. Review of observer reports and data, and questions about their procedures, led to the following recommendations.

Expand the quality assessment and control program

As with any program of this sort, procedures are required to determine whether the observers are functioning as prescribed. Based on the information available, the IISG recommends that steps be taken to assess the efficacy of the observer program and make improvements where necessary. Such steps should include:

1. A review of the training program to ensure that observers are receiving all needed information in a realistic time frame. The current program is two days in duration, and the panel questions whether that is sufficient to provide the necessary instruction and evaluation time to prepare observers for their responsibilities. For example, their duties frequently will require that they estimate distances from vessels to whales, and their ability to do so should be checked or "calibrated" during the training program.
2. Implementation of procedures to check the MMO data for mistakes, make corrections, and ensure that observers are fully informed of correct data collection procedures. Examples of potential

problems include sightings recorded when visibility is close to zero (e.g., at or after the sunset), or at distances beyond the range of view.

3. A broad assessment of MMO operations to ensure that the program is functioning as expected. Examples of questions to be addressed include: Are observers placed on all vessels that may interact with whales/best observation platforms within the vessel group, are observers on station during all daylight operations, whether observers are ineffective because they are required to observe over excessively long periods of time, whether communication procedures are understood by all observers and their SEIC contacts, and whether observer reports are internally consistent.

Clarify observer authority when whales are in the same area as vessels

The IISG understands that a vessel's captain has final authority on all matters involving vessel and human safety. The extent to which an observer can advice or instruct a captain regarding whale protection measures was not clear. The IISG recommends that all recommendations or instructions to the SEIC officer on board and the captain be documented to provide information to assess their compliance with protection measures. The command structure should be clarified and included as part of the training for observers, onboard SEIC officers, and for vessel captains involved in SEIC operations.

Use the collision risk analysis as a basis for making decisions on how observers are deployed

In 2006 vessels involved in much of the construction will be in the direct path of whales migrating to and from the feeding grounds. Those vessels should have an adequate number of observers to ensure that the potential for interaction is detected and suitable avoidance measures are taken. In addition, crew change vessels and supply vessels are likely to be moving over longer distances at greater speeds than many of the construction vessels. Based on their speed, route, and frequency of operation, these vessels likely pose a more significant risk of whale collision. The crew change vessel, in particular, should have observers (2) on board as the route used by this vessel puts it in close proximity to the feeding areas and the area directly between them. Two observers are required to ensure that observation efforts are not compromised by observer fatigue.

Communication among vessels

The IISG recommends that observations of whales from vessels involved in SEIC operations be communicated to all other vessels in the area to ensure they are alerted to the presence of the whales. This should be done routinely, but is especially important when visibility is reduced.

Observer coverage during nearshore pipeline operations

The IISG recommends that daylight observer coverage be continuous during activities associated with construction of the pipelines from offshore to onshore south of the feeding ground.

MONITORING, MITIGATION, AND MANAGEMENT OF NOISE

Design And Scheduling To Avoid Overlap

To reduce potential effects on the WGW population, the ISRP and subsequent panels recommended that SEIC endeavor to design and plan its noise-producing activities to reduce spatial and temporal overlap with gray whales. In response to those recommendations, the company has made a number of potentially meaningful changes to the design and scheduling of the 2006 construction activities (Document 8). These

changes fall into three general categories: timing of pipeline construction, equipment, and various support activities.

Background On Pipeline Route Changes

The route change adopted in response to the ISRP report increased the total length of pipeline required to carry oil from the platforms to the shore in the Chaivo area.

Construction Timing

Consistent with the recommendations of the ISRP to reduce overall disturbance, construction plans now emphasize completing the pipeline in a single year, scheduling loudest activities outside peak periods of WGW presence, and minimizing activities in close proximity to the main feeding areas. As soon as the ice clears in early June 2006, construction will begin with the loudest processes (dredging and pipe laying) at the most northerly construction locations (adjacent to the central part of the feeding area west of PA-B), before whales are expected to become locally abundant. The construction schedule is outlined in Document 8 with many concurrent activities. The installation of the East-West (E-W) pipeline segments from the PA-B east and then south occurs in June, simultaneous with the installation of the more southerly shore-based termination of the E-W pipeline segment. Because the southerly operations may alter whale migration routes into the feeding area, additional shore-based observer efforts will be needed (see "Southern Behavior Team 2006", below in Real-time Monitoring section). Under the most optimistic scenario, the E-W segment from the PA-A platform will be constructed immediately after the PA-B segment from late July to mid-August. Under the worst case scenario, the platform construction at PA-B could extend into early August and the segments for PA-A and E-W to the shore could last until mid-September. Both the E-W and platform segments use the loudest equipment (large hopper dredge and pipe layer). There is some inconsistency between the summary table and graphics, but it appears that dredging in these areas will be completed by July, when whale numbers generally increase in the region. This represents an effort to respond to the ISRP recommendation to conduct the loudest activities in proximity to the feeding areas at times outside the peak whale feeding season (August-September). The pipe laying activities after mid-July concentrate on the E-W segment for PA-A, the E-W segment connecting to shore, and the N-S segment. The latter is far enough from shore to assure meeting noise criteria. The southerly shore connection segment will continue to produce loud sounds during the feeding season which will propagate into the southern-most portion of the nearshore feeding range, an area of traditionally low use compared to the more northerly areas. Due to fabrication and delivery schedules, lifting of modules onto the PA-A platform will generate loud noises during the third week of August, which is the earliest the modules are expected to be available for installation.

Equipment changes

Two new ice breakers are under construction, which will have multiple tasks. Added scrutiny was applied to the size, style and horsepower of equipment needed to accomplish construction activities. Instead of using a self-powered pipe laying vessel with much higher horsepower, a large pipe-laying barge using a four anchor system to stay on station will be used with support of two anchor handling tugs (AHT) to reduce noise. The AHTs will operate one at a time when feasible. Support vessels and hopper dredges have been chosen specifically to minimize horsepower and noise for individual tasks, and selection criteria favor vessels that use indirect (hydraulic or electric) drive systems to reduce transmission noise associated with conventional direct drive vessels. The use of a single dynamic positioning vessel for diver operations instead of barges with AHTs further reduces sound emissions. Vessels on "standby" will move east of the construction zones to reduce noise in feeding areas. Spoil discharge vessels along the southern E-W pipeline will operate on the south side of the pipeline.

The IISG notes that the term “scenario” in Document 8 should be replaced with “phase” when it refers to sequenced activities rather than alternatives.

Results Of 2005 Program

Noise Modeling And Model Validation

SEIC reported consistency of the pre-season modeling footprint data and data measured in the field to within 1 dB accuracy. The IISG believes such consistency is unrealistic, particular in shallow water (see Annex E of the ISRP report).

The sole use of the 90th percentile for comparison of modeling data and real measurements also is inadequate because it does not allow appropriate data averaging. It also smoothes the data and removes information about transient increases in noise, which are of interest because they may elicit responses from the whales.

Instead of hourly averages, useful information would include a larger set of statistical properties of the signal, including:

- The maximum 3-minute L_{eq} during the hour;
- The 90th percentile;
- The hourly L_{eq};
- The 50th percentile; and
- The 10th percentile.

Early model predictions of noise from PA-B construction did not use real power spectra of all vessels involved in Lun-A installation (Lun-A correction). The post season re-calculation was done for model verification. However, it was not used for the implementation of mitigation measures, which is as important as verification.

Data from only one acoustic monitoring site were used to recalculate the acoustic footprint and model verification. The accuracy of both is questionable with data from only one site. Source level and other hydroacoustic parameters important for the calculation of transmission loss would be more accurate with additional reference points.

The acoustic footprints that are presented by JASCO/SEIC and used in the calculations of effect on whales were standardized to 10 meters depth. Such standardization does not represent the effects of the surface and bottom, which is where the whales are most frequently found. Surface and bottom levels should be reflected in the acoustic footprints.

Were There Any Effects on Whales from Noise in 2005?

A major part of the 2005 field season was dedicated to examining potential impacts on western gray whales from construction activities related to the PA-B Concrete Gravity-Based Structure (CGBS). Unfortunately, weather conditions (primarily fog) hampered observational effort during the CGBS tow-in and placement. Despite this, observations were made during other periods, including times before construction began and during construction activities other than the tow-in and placement of the CGBS.

Of the studies conducted during 2005, only the behavioral study by Gailey *et al*. (Document 13c) appears to have taken an analytic approach useful in determining potential effects on whales from the 2005

construction activities (see below). While important information on the distribution of whales in 2005, as reported by Vladimirov *et al*. (Document 13b), was collected from aerial, vessel and vehicle surveys, the analysis of data resulting from those studies was in most cases not directed at determining the possible effects of CGBS construction activities, nor did the analysis include data from acoustic monitoring. Section 4 of Document 13b stated "Poor visibility hampered observations of gray whale distribution during the installation of the PA-B CGBS (end of July and early August). However, when the weather returned to normal (6 August) and regular surveys recommenced, no decrease in the number of whales in the work area (observed from survey stations 7 and 8) was observed compared to the preceding period (Table 8)." With the exception of this statement, there are no other results in that document that the IISG considers useful for determining potential disturbance during the 2005 construction period. Therefore, the IISG finds the results in this report uninformative and deems the statement "No visible signs of a direct or indirect negative impact of industrial activity under the Sakhalin-1 and Sakhalin II projects on the population have been observed" (pp. 46-47) to be unfounded. Further, we note the redundancy between Documents 7 and 13b, which produced a good deal of confusion during the workshop. Finally, the reporting of uncorrected data (e.g., potential double counts) in Document 13b also led to confusion and raised a number of questions regarding the validity of the results in the document as a whole.

The report by Gailey *et al*. (Document 13c) focused on behavior and included data on surface-dive-respiration parameters, movement patterns and overall distribution and numbers. Particular attention was given to behavioural changes that took place before the CGBS construction period, during construction (with except the tow-in and placement period of the CGBS) and after construction. The overall interpretation given in Document 13c is that no detectable effects on whale behavior or distribution occurred during the 2005 construction activities. However, the authors properly acknowledged that their current analyses are univariate in nature and are not in relation to any information on sound levels produced by construction activity (and received at whale positions), nor do the analyses take account of other environmental factors. Therefore, the results are considered by the IISG to be inconclusive until a more detailed multivariate analysis, incorporating data on noise and other environmental parameters, is completed. Such a multivariate analysis is currently underway by Gailey *et al*. and is expected to be near completion in about one month.

A background document by Dyachenko *et al*., which examined the distribution of whales in relation to the number of vessels during the 2005 construction period, was provided to the IISG. While the conceptual approach of that study was to examine potential effects of the CGBS installation, limitations of the univariate statistical analysis resulted in a variety of alternative interpretations, none of which can be regarded as definitive or conclusive.

Document 9 presents initial attempts to integrate whale distribution data collected from a variety of platforms into a single data set that could, in time, be examined quantitatively and linked to noise data. However, in itsform at the time of the IISG meeting no relevant information was contained in Document 9 with regard to assessment of potential effects during the 2005 construction period.

On the whole, none of the behavior-, distribution- or abundance-related documents provided to the IISG for the April 2006 Vancouver meeting were linked to acoustic data. Although such linking is clearly a goal for at least several of the above studies, no definitive conclusion can be drawn from the presented documents with regard to potential impacts on whales during the 2005 construction season. This is particularly regrettable considering that the most active SEIC construction season to date is slated to begin in just two months, i.e. in early June 2006.

Thresholds And Protocols For Managing Noise Exposure

Malme et al. (1988) provide a dose-effect relationship for the eastern gray whale on the feeding grounds in the Bering Sea. This relationship was based on experimental exposure of a small number of whales to playback of continuous noise and was supported by a similar but larger dataset obtained from migrating gray whales. The stimulus in the Bering Sea experiments was recorded noise from the drillship *Explorer II*, which had the majority of its energy in the range from 10 Hz to 5 kHz and was projected for 60 to 90 min. The authors found that whales changed swim direction at received levels (broadband SPL) ranging from 110 dB re 1 µPa (10% of population) to 130 dB re 1 µPa (100%). The level at which 50% of the population responded, 120 dB re 1 µPa, is frequently used as a criterion for disturbance responses of gray whales. This is the basis for setting 120 dB re 1 µPa as a criterion threshold for response.

In their original reports, Malme et al. (1986, 1988) did not report the level of exposure stimuli in units that account for duration of exposure. Their experiments were of short duration and the data they collected on resident feeding whales were so limited that they based their ultimate dose-exposure relationship on a more extensive dataset from migrating whales. However, the whales feeding off Piltun and in the Offshore feeding ground will be present for long periods and may therefore be exposed repeatedly over the course of the season. Therefore, the IISG felt that cutoff thresholds for exposure should take into account duration of exposure as well as level.

Document 8 sets 120 dB re 1 µPa as the minimum level for triggering actions to investigate and reduce noise. It did not provide a time limit for allowable exposure, thus implying that whales could be exposed continuously over long periods to this level. The IISG accepts the SEIC proposal to control noise exposure on the feeding grounds on the understanding that corrective actions will be triggered using the following procedures, which assume that the 'monitoring buoys' are placed at the edge of the feeding area, i.e., between the whales and the noise sources:

1. Corrective actions will be triggered by continuous received levels at monitoring buoy(s) in excess of 120 dB re 1 µPa for four hours.

2. Above this level, exposures up to 140 dB re 1 µPa will be permitted but must be reduced in duration by one-half for each doubling of duration (Table 1).

3. In Document 8, SEIC specifies an additional triggering criterion of up to three consecutive 30-minute intervals with received average levels at monitoring buoy(s) of 130 dB re 1 µPa or greater; this criterion falls within the 5-dB doubling relation the IISG has recommended.

4. In Document 8, SEIC specifies that any five 3-minute intervals in a 1-hour period with received average levels at the monitoring buoys in excess of 140 dB re 1 µPa will trigger actions; this criterion falls within the 5-dB doubling relation as well.

5. Actions always will be triggered when exposures at buoys or estimated at the whales (as when approaches for photo-identification are conducted) if the average level exceeds 140 dB re 1 µPa for more than 15 minutes, and received noise of 146 dB (RMS) will also trigger immediate action.

Table 1. Example Criterion Levels Based on Equal-SEL

Minutes	Criterion Level
15	140
30	135
60	130
120	125
240	120

The proposed 5 dB doubling relation will restrict exposure at 120 dB re 1 µPa to four hours (Table 1), but it retains triggers for action between 130 and 140 dB re 1 µPa and can be interpreted consistently for levels between 120 and 140 dB re 1 µPa. Research activities such as photo-identification are the most likely to be affected by limits at higher levels because they sometimes involve close approaches to whales. However, the disturbance effects of photo-identification vessels will be reduced when vessels are idling and time spent at close range is intermittent, reducing the potential for exceeding the criterion. The transmission loss models developed by SEIC should be used to determine appropriate exposure distances to keep received levels at the whale within the stated limits when vessels come shoreward of the acoustic monitoring array.

Finally, we continue to encourage SEIC to maintain an efficacious system of communications between the acoustic monitoring team and those with the authority to execute mitigation action. The step-down of activities to reduce noise to acceptable levels is an important protection measure for WGWs, and effective feedback mechanisms between and among relevant persons in the system are essential to this strategy.

Real-time behavioral-acoustic monitoring

Although the IISG recognizes that an ideal system that fully integrates behavioral and acoustic monitoring of WGWs is a significant undertaking and likely not to be implemented for the 2006 season, the IISG nonetheless encourages SEIC to make full use of the behavioral and acoustic capabilities available. Noise exposure criteria, as described above, are an important aspect of the protection of WGWs in feeding areas and should be followed. However, whales will sometimes transit from one area to another and receive levels at the higher end of the permissible range. We strongly encourage SEIC to document the behavior of WGWs in response to such noise whenever the opportunity permits. Rigorous documentation of the behavior of whales in the presence of industrial noise would benefit all parties involved: the whales, SEIC, and the conservation community. To this end, we provide the following recognition of SEIC activities as well as recommendations and guidance based on the best available data and knowledge of SEIC activities during the 2006 Sakhalin industrial season:

1. Efforts to coordinate and analyze whale distribution and density data appear to be on track. Integrating observations from multiple platforms can be complex, but SEIC has made significant strides in this regard.
    a. Distribution data should be analyzed as quickly as possible during the 2006 season so as to detect potential changes in WGW distribution in response to noise from SEIC activities.
    b. Whale distribution in the area south of Piltun Lagoon, specifically in the area of the pipeline landfall, should be monitored continuously throughout the critical construction periods in 2006. This area is south of the behavioral monitoring stations, though the distribution surveys have covered the area for some periods. Northward movement of whales early in the season could be affected by these construction activities, and therefore establishment of monitoring stations in the southern area is advisable, as is the placement of additional trained observers on ships working in the area. A separate section included below outlines our recommended strategy.
2. Shore-based observations of WGW behavior seem well planned and executed.
    a. Whale behavior observed from shore should be monitored in real time and integrated as fully as possible with acoustic monitoring.
    b. Observing only from shore stations may be inadequate to test whether whales are reacting to industrial noise, that is, whales at the eastern margin of the feeding area may be inadequately monitored.

c. A real time behavioral monitoring system such as *Pythagoras* should include the following:
    i. a robust method for gauging the effect of distance from shore, and
    ii. testing behavioral data for heterogeneity.
d. Shore-based behavioral and distribution observations should commence at the same time, or preferably prior to, the start of construction activities.

3. Real time acoustic monitoring could be improved. In general, the IISG recommends improvement of acoustic monitoring equipment and that the SEIC acoustic monitoring program be operational during the entire construction season. Furthermore, based on the noise footprint predicted by the JASCO model, SEIC should focus its monitoring effort on the areas with the greatest amount of noise-generating construction activity.
    a. Acoustic Radio Buoys (ARBs) are limited in their dynamic range and are reported to have transmission difficulties, e.g., radio 'drop outs'. The dynamic range can apparently be adjusted prior to deployment. The acoustic levels expected can be determined using the propagation model, but a wider dynamic range would reduce guesswork. SEIC has a plan to transmit a known waveform before and after data transmissions to limit the effect of drop-outs, but they will not be prevented. The best solution would be to use digital radio transmissions with greater reliability and dynamic range. We offer the following suggestions to improve accuracy while reducing data transmission needs:
        i. Real-time data are so difficult to transmit reliably, store, and process that long-term monitoring typically involves some form of data compression. The acoustic monitoring team has selected a compression strategy that involves collecting 10 3-min RMS sound pressure levels, a half-hour average, and a 1/3-octave averaged power spectrum per half-hour period. The advantages are obvious - information volume of the resulting data, transmitted once per 10- or 30-minute period, is one thousand times smaller than the volume of the raw data and can be transmitted more reliably. The disadvantage is loss of detailed information that could be used to identify sound sources. Also, peak amplitudes of noise are lost, which could be used to evaluate risks of high-amplitude exposures. However, sound sources can be identified by other means (e.g., by tracking boats or by listening in real time to identify sounds), and peak values probably cannot be distinguished from spikes in the signal due to the difficult physical conditions in the study area (physical motion of buoys, electrical noise, etc.).
        ii. AUARs represent an improvement in the acoustic monitoring system, but in the transmit mode they appear to suffer from the same dynamic range limitation as the ARBs. Additionally, the duty cycle used in previous seasons (1 hour on – 2 hours off) is unacceptable as the exposure criteria could easily be violated during the off-period.
    b. It would be very useful if all vessels were tracked acoustically using the array of buoys. If the acoustic recording buoys could be synchronized, they could be used as an array to localize the sources of sounds, which could be used advantageously to understand noise signatures and inform mitigation procedures, e.g., to determine which vessel was producing the highest level.
    c. Measurement of noise data from the inshore areas where whales are actually observed should be considered.

4. SEIC should consider targeted, boat-based real time behavioral and acoustic monitoring. The whales that are most at risk of significant noise exposure and therefore disturbance are the ones farthest from shore and thus from the observation stations. Particularly in the 'worst case' scenarios presented for the construction periods, a small boat launched from the large research vessel could idle slowly behind individual whales from an unobtrusive distance and document

disturbance reactions. Data similar to those collected from the shore stations could be collected from this boat (as well as from larger ships) using reticle binoculars and GPS.

Rutenko (2006, Document 13E) and Kruglov et al. (2006, Document 13G) provided results of acoustic monitoring for the 2005 season. Levels are expressed as 'broadband' (within the frequency limits of the receiving equipment) hourly average sound power levels (dB re 1 μPa^2), which give a good indication of general trends in levels. However, they do not allow investigators to interpret high amplitude spikes in the dataset. In many of the graphs of 2005 data, there were hourly levels at or in excess of 130 dB re 1 μPa^2 (e.g., Figure 2.2[a] in Document 13E), suggesting that short-term exposures were considerably higher than allowed or that levels exceeded 130 dB re 1 μPa^2 for an hour or more. Strategies for differentiating these possibilities are described in the section on acoustic modeling and verification. Based on the 2005 observations, criteria that trigger actions to reduce noise should be enforced more strictly for the 2006 season.

The criterion levels at the buoys are conservative because whales rarely travel offshore of the acoustic monitoring array. Thus, they will nearly always be at greater distances from sound sources than buoys and exposed to lower levels. However, several possible conditions have not been considered, making the data presented in Document 13G somewhat difficult to interpret. Whales may have been exposed at or within the boundaries of the monitoring array during the passage of vessels. For this reason, IISG has recommended continuous real-time monitoring, at least by ear. Compressed data also should be reviewed in real time by use of streaming 3-min and half-hour averages.

We also strongly recommend that identifiable sound sources, such as drilling and pipelaying vessels, support vessels, and photo-identification inflatable skiffs, should be logged with a time-stamp by observers so that the total contribution of SEIC to the local acoustic 'budget' can be reported.

In 2005, vessels traveling close to the acoustic monitoring stations sometimes produced received levels considerably greater than 120 dB re 1 µPa. It is possible that some noise exceeded the dynamic range of the instruments, resulting in an underestimate of the actual level produced by the vessel. The levels at the buoys were usually higher than those received by whales, which were typically inshore of the station. However, the buoy data indicated the presence of high-amplitude sources that were taken into account when estimates of received level were generated for analysis. Construction vessels were strictly monitored by satellite and did not stray into the feeding areas to any extent, so it is unlikely that they would have raised average levels on the feeding grounds above the 120 dB criterion. However, they could have raised hourly averages substantially under quiet ambient conditions, reducing the range of exposure (minimum to maximum), with consequences for the outcome of statistical treatments. In addition, whales transiting in or out of the feeding area would have received high levels close to vessels, possibly in excess of criterion levels, as would whales near project vessels working within the feeding area, such as the photo-identification inflatable skiffs. In such cases, whale exposures would have been dominated by vessel noise, introducing additional error into the analysis of the effects of construction activities. These sources of error should be considered during further analysis.

Finally, due to the extent and duration of the 2006 construction activities, the IISG recognizes the value of independent acoustic monitoring and therefore encourages other research organizations to conduct such monitoring.

Southern Behavior Team 2006

Given the amount of continuous construction occurring near the Piltun area in 2006, especially in the region approaching the southern portion of the nearshore feeding ground, the IISG recommends that (1) an appropriate acoustic monitoring effort be made in the pipeline construction zone south of the Piltun

feeding ground, and (2) an additional (third) behavior/theodolite team, supervised by Glenn Gailey, be on site by late May 2006. This team would monitor the occurrence and behavior of WGWs in the south and contribute to development of the “real time” monitoring program. Observational effort in this area would provide valuable data on migrating and feeding whales in nearest proximity to much of the 2006 construction activity. An important caveat surrounding this recommendation is that the addition of a third team must not compromise, in any manner, the ongoing behavioral observations conducted since 2001 in the more northern portions of the Piltun feeding area by the Gailey team.

To accomplish this objective, the IISG recommends the following: (1) A third team should be established in 2006 to monitor the potential effects of dredging and construction activities (given the proximity and levels of noise) on western gray whales migrating through or staying in the area (based on historical evidence of habitat use). (2) This third team will need at least one more senior person experienced with the relevant methods and equipment (theodolite, focal animal and scan sampling), two research assistants and a full complement of needed equipment (i.e. theodolite, tripod, computer, radios, phone, etc.) and necessary infrastructure support. (3) The initial research at the southern location (near land-shore dredging activity) should be conducted by O. Sycheno or G. Gailey, both of whom have conducted similar observational work for the past five years. (4) The third (new) observation team should be trained in methodology and observation techniques established in the current western gray whale behavior research program. (5) Three observation stations in the southern region should be employed with one near the predicted 120 dB footprint border to the south of the dredging activity, a second near the dredging activity (highest received levels) and a third near the predicted 120dB footprint border to the north of the dredging activities. From early June to mid-July, monitoring effort should be focused on stations 1 and 2, and after mid-July station 3 should be incorporated to evaluate potential avoidance by animals approaching the area. (6) If observations during the northbound migration indicate a complete avoidance (animals either remaining in the area and failing to progress northward to the feeding grounds or reversing to a southbound course), SEIC should consider disruption has occurred and take action to ensure that whales are not being prevented from reaching the primary feeding habitat.

In addition, the IISG encourages other organizations (with the requisite capacity for doing so) to conduct independent programs of behavioral observation, paying particular attention to the need to employ methods of data collection and analysis that will allow comparisons with results obtained by the SEIC/ENL teams.