The Joint Program for the Okhotsk-Korean Gray Whale Monitoring off the North-East Coast of Sakhalin, 2013

Photo taken by Y.M. Yakovlev

Prepared for
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and
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EXECUTIVE SUMMARY

The Okhotsk-Korean Gray Whale, also known as the Western Gray Whale (WGW), has been the subject of scientific investigations sponsored by Exxon Neftegas Limited (ENL) and Sakhalin Energy Investment Company Ltd. (Sakhalin Energy) since 1997. The companies combined their efforts in 2002 with the establishment of the Joint Program for monitoring WGW and habitat off northeast Sakhalin. The Joint Program, implemented by scientists from leading Russian institutions, has four primary areas of investigation: WGW photographic-identification, WGW distribution surveys, benthic prey surveys, and acoustic monitoring. The Joint Program efforts have resulted in obtaining information that supports conservation of the WGW and habitat, and helps the companies mitigate potential effect of operations to the WGW population. The 2013 Report of the Joint Program for the Okhotsk-Korean Gray Whale Monitoring off the North-East Coast of Sakhalin provides an overview of the current understanding of WGW and their habitat, and identifies potential threats to WGW, and describes actions taken by the Companies to mitigate potential affects to the WGW and habitat. Additionally, the 2013 results from the implementation of the Joint Program's four primary areas of investigation are included.

WGW spend the period from June-November off NE Sakhalin where two primary feeding areas for WGW are known. The feeding areas are characterized by high biomass of benthic organisms that include amphipods, isopods, sand lance, and sand dollars. The WGW show a high fidelity to the feeding areas with the vast majority of those WGW identified off Sakhalin each year being the same individuals sighted in previous years. For example, 97.5% of WGW sighted in 2013 had been identified off NE Sakhalin at least once in previous years. Since the discovery of ~ 20 gray whales off NE Sakhalin in the early 1980s, WGW numbers have steadily increased. In 2002, the first year of the Joint Program, 47 WGW were identified. As of 2013, a cumulative total of 228 individual WGW have been identified by the Joint Program. Of these whales, 187 individual WGW have been observed in the last four years. During 2013, 128 identified WGW were sighted, including six calves and three first-time sighted non-calf WGW.

The winter habitat and migration route of WGW were unknown until WGW satellite tagging sponsored by the companies established the migration of three WGW to coastal North America in 2010-2012. The overlap of the geographic ranges of the Western and Eastern gray whale stocks established through satellite tracking was further verified by other scientists through comparisons of photo-ID catalogs and genetic matches. To date, at least 26 Sakhalin gray whales have been documented in theranges of both Western and Eastern gray whales. Based on these finding, a reasonable conclusion can be made that all gray whales found in the Pacific are possibly of a single mega-population of North Pacific gray whales. This understanding could be important for the development and implementation of measures protective of all gray whales.

Gray whales are faced with natural threats (e.g., predation, disease and starvation) and anthropogenic threats (e.g., entanglement in fishing gear, vessel strikes, pollution, and noise). ENL's and Sakhalin Energy's commitments to minimizes risks of operations to WGW led each company to develop Marine Mammal Protection Plans (MMPPs) that prescribe criteria for conducting their operations in a manner protective of WGW and other marine mammals. Measures implemented by the companies have successfully mitigated potential risk of operations on WGW, and no incidents involving WGW have occurred. Additionally, noise from natural and anthropogenic sources has been monitored in the WGW feeding areas since 2003. Two primary sources of noise from the Companies' activities have been identified: vessels and offshore production facilities. This information has been used to implement mitigations to minimize noise from company operations. The acoustic monitoring has demonstrated that the mitigations resulted in noise levels believed not to affect the WGW..

1. INTRODUCTION

Exxon Neftegas Limited (ENL), operator of the Sakhalin-1 project, and Sakhalin Energy Investment Company, Ltd. (Sakhalin Energy), operator of the Sakhalin-2 project, are developing oil and gas reserves on the continental shelf off northeast Sakhalin Island, Okhotsk Sea, Russia. These projects are located in proximity to habitat used during ice-free months by the Okhotsk-Korean gray whale (*Eschrichtius robustus*), also known as the Western gray whale (WGW). The WGW population was believed extinct until approximately 20 gray whales were sighted off the northeast coast of Sakhalin in the early 1980s. The occurrence of gray whales within the former range of the Western gray whale, lead to a conclusion that these whales were remnant survivors of the WGW population. Following the discovery of these whales, the population of Okhotsk-Korean gray whale was listed in Category 1 as "threatened to extinction" in the Russian Federation Red Book and as "critically endangered" by the International Union for the Conservation of Nature (IUCN).

The Environmental Impact Assessments (EIAs) and the State Ecological Expert Reviews (SEERs) conducted for the Sakhalin-1 and Sakhalin-2 Projects identified the WGW as being of primary concern for each Company's operations on the northeastern Sakhalin shelf. Based on recommendations of the Project SEERs, monitoring studies of WGW and their habitat were initiated in 1997 by each Company. Since 2002, ENL and Sakhalin Energy (the "Companies") have combined efforts and funding for monitoring of WGW and their habitat under the Joint Monitoring Program for Okhotsk-Korean (Western) Gray Whale off Northeast Sakhalin (i.e., Joint Program). Currently the Joint Program consists of four components: photo-identification of WGW, distribution surveys of WGW, benthic prey studies, and acoustic monitoring.

The Joint Program is one of the few long-term multi-disciplinary research programs with focus on a specific marine mammal and location (Figure 1). Prior to initiating the Joint Program there was relatively little reliable scientific data about WGW, with much of the

Figure 1. The Sea of Okhotsk showing the Joint Program study area off northeast coast of Sakhalin Island, Russia.

understanding of WGW based on unproven information, uncertain historical records, and often unsubstantiated assumptions. The Joint Program established a scientific approach to obtain information needed to understand these whales, their habitat, and potential hazards to the population.

1.1. Objectives of Joint Program

The Companies' objectives for conducting the Joint Program are to:

- Increase scientific understanding of the WGW aggregation and ecology, and factors that affect the gray whale population and habitat; and,
- Assess condition of WGW aggregation (e.g., size, growth rate, etc.) and habitat

The information obtained from the Joint Program is used by the Companies to:

- Ensure that Companies' activities are conducted in a manner that do not adversely affect the WGW and habitat (per Russian requirements); and
- Identify and implement mitigations that minimize risks of Companies' activities to the WGW and habitat.

1.2. Components of Joint Program

The Joint Program is conducted by Russian researchers from leading Russian research institutes in the Far East and Moscow. The components of the Joint Program, the institutes and key researchers involved in the program are:

WGW Photo-Identification Studies. Photo-ID studies have been conducted each year since 2002 to identify individual gray whales. The identification of individual animals provides information on population dynamics and demography, social structure, and individual life histories. In addition, the photo-ID data provides information for long-term assessments of population status and health. Photo-ID studies are implemented by the A. V. Zhirmunsky Institute of Marine Biology of the Far Eastern Branch of the Russian Academy of Science in Vladivostok (IBM) Dr. Yuri M.Yakovlev and Olga Y. Tyurneva, Candidate of Biological Sciences, as scientific leads.

WGW Distribution Studies. Since 2002, the Joint Program has studied WGW distribution and abundance in the Piltun and Offshore feeding areas, as well as in the Piltun-Astokh and Arkuntun-Dagi concession blocks. Each year, WGW distribution surveys have been conducted by shore-based and vessel-based teams. The distribution studies have been implemented by the Sakhalin State University with Dr. V.A. Vladimirov as scientific lead.

Benthic Prey Studies. Gray whale prey studies have been conducted since 2002 to evaluate status of benthic prey in the study areas. Benthic and sediment samples are collected for analysis from within and close to the two primary WGW feeding areas (i.e., Piltun and Offshore feeding areas). The benthic studies are implemented by the A.V. Zhirmunsky Institute of Marine Biology of the Far Eastern Branch of the Russian Academy of Science in Vladivostok (IBM), with Dr. V.I. Fadeev as scientific lead.

Acoustic Studies. Acoustic studies, which document both natural (ambient) and anthropogenic sound levels in the WGW feeding areas, have been a component of the Joint Program since 2003. In addition to measuring sound levels, hydrology data are collected that allows the modeling and understanding of sound propagation in the WGW feeding areas. Acoustic studies are implemented by Pacific Oceanological Institute of the Far Eastern Branch of the Russian Academy of Science in Vladivostok (POI) with Dr. Alexander N. Rutenko as scientific lead.

2. JOINT PROGRAM METHODS

The methods used by each study component of the Joint Program have been developed and refined over the course of >10 years implementation of the program. The methods used for each component of the Joint Program reflect the current state-of-the-science and, as needed, are refined each year to meet the current study objectives, and/or technical and logistical requirements. Importantly, methods that are used by the Joint Program reflect a Best Practice that minimizes disturbance to WGW. The methods used for the 2013 Joint Program are described in the"2012 Methods Report" (WGW Program, 2013). Any revisions to these methods that occurred for the implementation of the 2013 components are described in the Joint Program individual scientific reports provided as Appendices I – IV.

3. JOINT PROGRAM RESULTS

Each year since the 2002 field season, the results of the Joint Program have been presented in the annual reports that are provided to the Russian authorities and other stakeholders. The results for the 2013 Joint Program field work, as well as compilations of results for the entire period of the Joint Program (2002-2013) are provided in the scientific reports prepared for each component in the Appendices of this report as follows:

- **Appendix I.** Photographic Identification of the Gray Whale (*Eschrichtius robustus*) Off the Northeast Coast of Sakhalin Island, 2013 (March 2014)
- **Appendix II**. Distribution and Abundance of Gray Whales In Northeast Waters of Sakhalin Islands in July-November 2013. (March 2014)
- **Appendix III**. Benthos studies in the feeding grounds of gray whales in 2013 (March 2014).
- **Appendix IV**. Acoustic Monitoring on the North East Sakhalin Shelf, 2013 (March 2014)

4. CURRENT UNDERSTANDING OF WGW AND HABITAT

Since the Companies began investigations of WGW in 1997 and initiated their Joint Program collaboration in 2002, a great deal has been learned about the WGW and their habitat, including population parameters, movements, behaviors, and food resources. This section of the report provides a discussion of the current understanding of the Sakhalin gray whale aggregate and its habitat, and includes a discussion of the potential threats to the WGW , and the mitigations implemented by ENL and Sakhalin Energy that reduce potential risks to the WGW and habitat posed by the Companies' operations.

4.1. WGW Population

Historically, gray whales of the north Pacific Ocean have been considered to comprise two populations or stocks: (1) the Okhotsk-Korean or western gray whales (WGW) population that inhabits the north Pacific coastal areas of Asia (e.g., Russia, Japan, China, Korea), and (2) the Chukchi-Californian or eastern gray whale (EGW) population that inhabits the Pacific coastal water of North America (e.g., Canada, USA, Mexico) and Chukotka Peninsula region, Russia (Figure 2). During the 19th and 20th centuries, the numbers of Pacific gray whales were significantly reduced by commercial whaling. In 1938, the US Government set a moratorium on the commercial whaling of the Eastern gray whale; the moratorium was expanded in 1948 by the International Whaling Commission to include all gray whales. These actions resulted in a steady recovery of the gray whale numbers. Based on the latest surveys taken in 2006 / 2007, the population of the Eastern gray whale was estimated to consist of 19,126 (CV=7.1%) whales (Laake et al. 2009) and is not considered threatened. The population of the Okhotsk-Korean gray whales was believed to have been essentially hunted to extinction by the mid-20th century. However, in 1983, approximately 20 gray whales were observed off northeast Sakhalin (Blokhin et al. 1985) and at the time, it was concluded that these whales were the remnants of the Okhotsk-Korean gray whale population.

Since the sighting of the WGW in Sakhalin waters in the 1980s, the cumulative total of individual WGW identified off NE Sakhalin has steadily increased. In 2002, the first year of Joint Program photo-ID studies, there were 47 individual WGW identified. In 2003, with the inclusion of WGW sighted at both the Piltun and Offshore feeding areas, the number of identified WGW increased to 92 individuals. As of 2013, a cumulative total of 228 individual WGW have been identified and are included in the IBM catalog of Sakhalin WGW. A second photo-ID catalog is maintained by the "Russian-American" team, and there are a combined total of 245 individual WGW identified in the two photo-ID catalogs for Sakhalin (i.e. Zhirmunsky Marine Biology Institute (IBM) and the Russia-US Research Team catalogs). As of 2012 (the last year the two photo-ID catalogs were compared), there were 17 WGW found only in the Russia-American catalog and 19 WGW found only in the IBM catalog. During the 2013 field season, nine new WGW (i.e., six calves and three non-calf WGW) were added to the IBM photo-ID catalog.

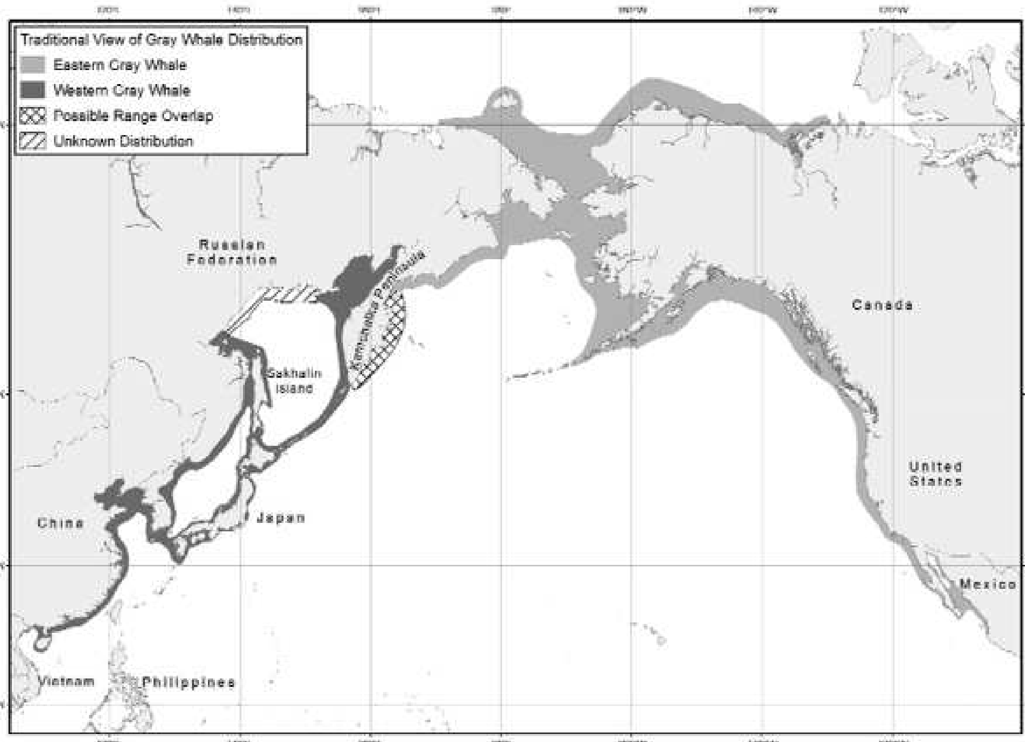

Figure 2. Distribution of the two currently recognized stocks of North Pacific Gray Whales (from Bickham et al., submitted)

4.1.1. Population Growth

The growth and sustainability of any population is dependent upon a multitude of factors including successful reproduction and survival of offspring. Two key issues related to population growth of the Sakhalin WGW are: 1) to obtain an accurate estimate of the annual rate of increase, and 2) estimate the degree to which any observed increase is due to internal recruitment (calves born to females of the population) or external recruitment (immigrants from other populations). Population modeling utilizing the WGW photo-ID data of the Russian-American team collected from the Piltun feeding area was used to estimate an annual population growth rate of 3.3% (±0.5%) (Cook et al., 2013). The accuracy of this growth rate calculation is dependent on several key assumptions of the model (e.g., number of females of reproductive age; calf mortality rate; and a closed system) that are not known, uncertain, and may be inaccurate (e.g., the population may not to be a closed system since new non-calf whales are identified each year).

The WGW population modeling conducted using data (1995 - 2011) from Russian-American photo-ID catalog projected a WGW population of 151 whales (90% CI: 132-166) for 2012, including 32 (90% CI: 18-36) breeding females (WGWAP-11 February, 2012). However, based on the Joint Program data, it is believed that the number of WGW could be at least 20% higher than this estimate and that there could be more than 200 individual Sakhalin WGW. Reasons for believing that the actual numbers of WGW could be greater than the population estimate include: (1) the high number of identified WGW that have been sighted by the Joint Program. Even with the limited size of the geographic area that is included in the monitoring program, there were 187 individual WGW identified in the IBM catalog that have been sighted since 2010. During the 2012 season alone, 150 WGW identified in the IBM catalog were sighted; (2) the model used to develop the population estimate assumes it to be a closed system. However, tracking from the satellite tagging of WGW in 2010 and 2011 and comparison of photo-ID data have demonstrated the overlap of ranges of the western and eastern gray whales. Additionally, each year new non-calf whales are identified which indicates that not all WGW occurring off Sakhalin are seen each year and/or that new whales are coming into the area; and (3) there are routine sightings of gray whales at other locations within the Sea of Okhotsk and off Kamchatka in which the individual whale is not identified within the IBM catalog; these whales are not included in the estimation of population size. When WGW sighted by the Joint Program are combined with whales sighted at Kamchatka, there are a total of 243 individual gray whales that have been sighted since 2010; whether all these whales are members of the Sakhalin gray whale feeding aggregate is unknown.

What is certain is that the number of WGW that have been identified off NE Sakhalin has increased each year since the sighting of ~20 WGW in 1983. For the period 2005 to 2013, the number of identified WGW (both calves and non-calf WGW) added to IBM catalog each year averaged 8.4% (range: 4% - 9.6%). Some of the increases to the IBM catalog in the early years of the study were due to increased effort and/or increased area of coverage. Nonetheless, the consistent addition of whales each year and documentation of calf production over the past decade confirms both a growing population and one that is not solely dependent upon external recruitment for recovery. The 3.3% annual growth rate of the Sakhalin WGW aggregate compares favorably with the Bering-Chukchi-Beaufort Seas (BCB) population of bowhead whales which has grown from approximately 1,000 whales in the early part of the 20th Century to an estimate 16,892 with an estimated annual rate of increase of 3.7% in 2011 (Givens et al., 2013). In short, the current estimate of the growth rate of the Sakhalin WGW, while it may be underestimated, is consistent with the observed growth rate of another species of great whale that has recovered from the devastating effects of commercial whaling.

4.1.2. Cow / Calf Pairs

The Joint Program has recorded cow / calf pairs (i.e., mother with offspring) in Sakhalin and Kamchatka waters through sightings by photo-ID, and shore- and vessel-based distribution teams. Although the number of cow / calf pairs sighted varied from year to year (between 3 and 15 from 2003–2013), it provides information about the health of the population and the reproductive success of female whales. Obtaining an accurate count of the number of new calves each year is challenging, since a calf is often difficult to identify when separated from its mother. Cow / calf separation can happen anytime throughout the summer, but accelerates by late August, with most calves in the Piltun feeding area believed to be independent from their mothers by mid-September. The number of cow / calf pairs derived from photo-ID data is generally considered the most accurate, since observations of cow / calf pair or of single calf can be individually identified only through photographic analyses.

Within the Piltun feeding area, cow / calf pairs were most often observed around the mouth of Piltun Bay. Although cow / calf pairs have also been observed feeding in other parts of the Piltun feeding area and in Olga Bay off SE Kamchatka (this was first observed in 2008), the area near the mouth of Piltun Bay seems to be the preferred area since this is where cow / calf pairs are most often observed. Over the entire monitoring period of the Joint Program, calves have never been observed in the Offshore feeding area. It is hypothesized that calves may require shallow waters (e.g., 10 m or less) to learn to feed and to readily obtain prey, and that at the greater depths (e.g., ~ 40-60 m) of the Offshore feeding area it would be difficult for calves to feed.

During the period from 2002–2013, a total of 87 calves from 24 mothers in the Sakhalin catalog have been identified. During this period, 9 of these cows (37.5%) were only observed with a calf in one year; six cows (25%) were seen with a calf in two separate years; six cows (25%) were seen with a calf in three separate years; and three cows (12.5%) were seen with a calf in four separate years. The average calf interval was 2.9 year for the 15 cows with multiple calves.

Olga Bay off SE Kamchatka may be more important for cow / calf pairs than data from earlier years suggested. Since the first observation in 2008, cow / calf pairs were seen in Olga Bay each year thereafter (i.e., seven in 2009, three in 2010, two in 2011, and three in 2012). No surveys were conducted in Kamchatka in 2013. The majority of mothers (55%) seen in Kamchatka with a calf were also photographed offshore Sakhalin Island, either during the same year or in previous years, and are included in the Sakhalin WGW catalog. Three mothers observed in 2009 in Olga Bay were never seen off Sakhalin, but were observed in Kamchatka before and after 2009.

It is believed that an important reason for cow / calf pairs to concentrate in coastal shallow waters such as the mouth Piltun Bay is that they are more protected here from attacks of transient killer whales, typical for east Sakhalin waters. In cases of such attacks, WGW can escape to coastal shallow waters where the cow can more easily protect the calf. The potential predation of gray whale calves by killer whales could help explain the absence of cow / calf pairs in deep waters of the Offshore feeding area where they would be vulnerable to killer whale attacks. Cases of predatory behavior of killer whales towards gray whales have been observed within the Piltun feeding area, although rarely. It is difficult to assess if predation is an important factor affecting calf survival during the feeding season while in Sakhalin waters.

4.1.3. Whale Body Condition

Based on photographs of WGW, it was observed that some individual WGW appear to be thin or in poor body condition, at least early in the feeding season.

Therefore in 2003, a system for assessing the body condition of WGW was developed by the Joint Program. Body condition classes were assigned to individual whales based upon a visual assessment of their physical condition using specific criteria. Whales with a good body condition were assigned as Class 0 or 1. Whales with clear signs of a poor body condition were assigned as Class 2 to 4, with each higher class number indicating increasingly poor body condition.

The body condition class assigned to individual whales each time that they were photographed over the course of the feeding season showed two main trends: (1) the body conditions of most whales that were assessed as poor at the start of the feeding season improved towards the end of the season, and (2) most whales with a poor body condition were lactating females (i.e., mother observed with a calf). Both trends make sense considering the life history of gray whales. Early spring gray whales migrate from their winter habitat to feed in areas rich in prey resources. It is believed that the whales do not feed or feed very little during their migrations (Nerini M. 1984), thus their body-fat reserves are being depleted during the migrations.

During the past 12 years, the photo-ID data for each year showed 10-20% of WGW with poor body condition, with most of these observations occurring early in the feeding season. Many whales found to have a poor body condition were lactating mothers; however, their calves were observed to be well-nourished. Typically, whales with poor body condition early in the season showed an improved body condition at the end of the feeding season, with a good body condition (Class 0 or 1) in 80-90% of the individuals. The body condition of lactating females generally also showed improvement over the course of the season, since calves become increasingly independent from their mothers during the summer feeding season, thus allowing the mothers to build up fat reserves.

In the Kamchatka area, the percent of gray whales observed with poor physical condition (ranged from 30-60%) was higher than in Sakhalin (i.e.,10-20%). The higher percentage of whales in poor body condition in Kamchatka can be attributed to the timing of the survey (i.e., starting and ending early in the feeding season, from about June/July to late August). WGW traveling from Kamchatka to Sakhalin have had an opportunity to replenish their body-fat reserves by feeding along Kamchatka, thus would be expected to appear in better body condition in Sakhalin as compared to Kamchatka.

Skin sloughing (i.e., the peeling or shedding of dead skin) was observed on some WGW for the first time in 2003. Various severities of skin sloughing were also observed in 2004 to 2007. During 2013, three whales with skin sloughing were observed in the Piltun feeding area. One of these whales (i.e., KOGW056) was later observed in October without signs of skin damage. The cause of skin sloughing is unknown. WGW photographed with skin sloughing were monitored for other obvious changes in external appearance or physical condition. Visual assessments of photographs of these whales did not find any atypical body condition and showed no other effects on health or well-being of the individual.

4.2. WGW Annual Migrations

Prior to 2010, little was known of the winter migrations and habitat of the gray whales observed off NE Sakhalin during ice-free months (e.g., June-November). Each year as the sea ice clears in late May to early June, gray whales begin to appear off the coast of NE Sakhalin. During June and July the number of WGW observed increases, and by August most of the sighted WGW are concentrated in the two primary feeding areas (Figure 3). WGW are observed off NE Sakhalin until they begin their winter migration usually during November, and by early December, essentially all WGW have departed from NE Sakhalin.

Based on historical records of gray whale sightings in the waters of Japan, Korea and China by whalers and seamen, it has been assumed by many scientists that WGW migrate to winter grounds at undetermined locations in the South China Sea. This assumption was bolstered by occasional gray whale sightings and reports of gray whales tangled in fishing nets or stranded on beaches in Japan and China. However, due to the paucity of gray whale sightings in the South China Sea and other areas along their assumed Asian migration route (e.g., Japan, Korea, China), scientists remained uncertain as to where WGW go each winter when they leave the ice-bound waters of Sakhalin.

The sightings of a gray whale in 2010 in the Mediterranean Sea near Spain and Israel (Scheinin et al. 2011) and the sighting of another gray whale in 2013 in the Atlantic Ocean off the coast of Namibia (Africa), provide evidence that gray whales are capable of undergoing long-distance dispersal. Thus the occasional sighting of gray whales off of Japan and other areas south of Sakhalin does not come as a surprise. The Atlantic Ocean sightings hold promise that gray whales have the potential of repopulating areas, such as the North Atlantic Ocean from which they have been extirpated. Such a repopulation may be an explanation for the occurrence of gray whale in the Sea of Okhotsk and off of Sakhalin following a period when the WGW was assumed extinct.

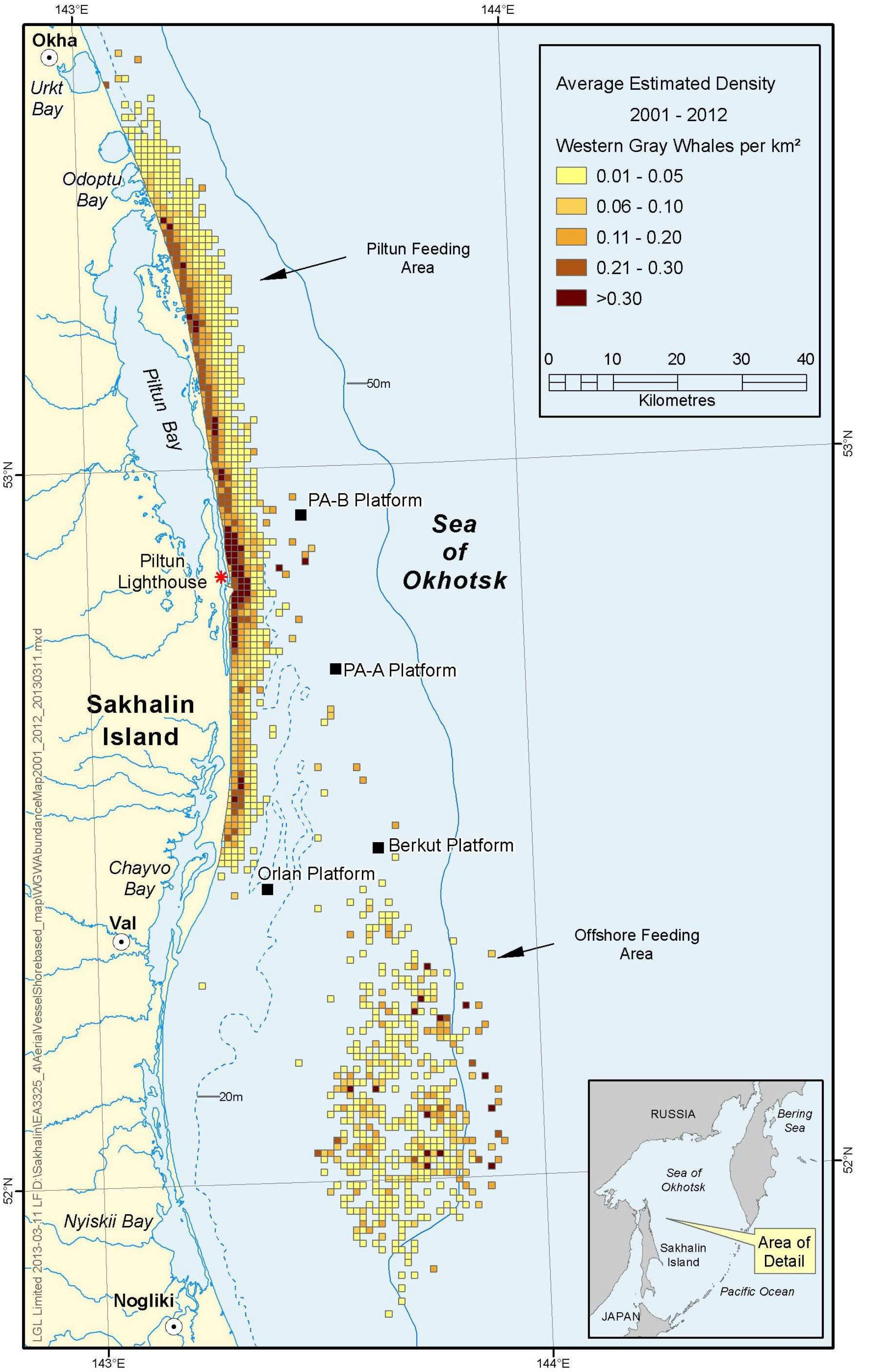

Figure 3. Locations of sightings of WGW in the Piltun and Offshore feeding areas.

4.2.1. Satellite Tagging of WGW

Satellite tagging of WGW off Sakhalin was conducted in 2010 and in 2011 to help resolve the issues as to where WGW spend their winter months and their migration routes, and perhaps identify yet unknown feeding and breeding areas. This research was conducted by A.N. Severtsov Institute of Ecology and Evolution of the Russian Academy of Sciences (IEE RAS) and Oregon State University Marine Mammal Institute in collaboration with the U.S. National Marine Fisheries Service, Kronotsky State Nature Biosphere Reserve and the Kamchatka Branch of the Pacific Institute of Geography. The research was contracted through the International Whaling Commission (IWC) and International Union for Conservation of Nature (IUCN) with funding from Exxon Neftegas Ltd. and Sakhalin Energy Investment Company Ltd. Scientific leadership for satellite tagging was provided by Dr. Valentin Ilyashenko from IEE RAS and Dr. Bruce Mate of Oregon State University's Marine Mammal Institute, a renowned expert in use of satellite telemetry for tracking whales.

The 2010 satellite tagging of a single adult male gray whale (named "Flex") off NE Sakhalin provided the first scientific evidence of a Sakhalin WGW migrating to coastal waters of North America. The satellite tagging efforts were repeated in 2011, when six Gray whales were tagged and resulted in the tracking of two adult female WGW from Sakhalin to coastal North America. The tag transmitted from one female whale, known as "Varvara", for 408 days, and allowed tracking of a complete annual migration route of an individual WGW from Sakhalin to Kamchatka, across the North Pacific Ocean and southern Bering Sea to Alaska, down the west coast of Canada and the U.S., and to the known gray whale breeding lagoons of Baja California, Mexico. A month later Varvara returned by essentially the same migration route and arrived in the Piltun feeding area on 18 May 2012. This was the first tracking of the entire annual migration of a WGW.

The results of satellite tagging prompted examination of other possible records to determine if the gray whales that summer in the Sea of Okhotsk might generally migrate to and from North America rather than, or in addition to, wintering habitats in Asia.

Matches of photographs of whales taken at Sakhalin were made with photographs of whales from British Columbia (n = 6, Weller et al., 2011) and Mexico (n = 17, Urban et al., 2012, Urban et al., 2013), and genetic matches (n = 2, Lang et al., 2011) of whales biopsied at Sakhalin and Southern California have now been reported as well as the whales with satellite tags. To date, more than 30 gray whales identified from the WGW Photo-ID catalogs are known to have migrated from Sakhalin to the North American coastal areas. In addition, 85 WGW in the Sakhalin catalog have also been identified off Kamchatka, which may provide further evidence of the overlap of geographic ranges of whales identified as Western and Eastern gray whales.

4.2.2. Kamchatka

In addition to the northeast Sakhalin feeding grounds, gray whales have been recorded in east Kamchatka waters since their first sightings in Khalaktyrskyi Beach in 2004. Monitoring of gray whales was conducted from 2006 – 2012 at Vestnik Bay or Olga Bay along the SE coast of the Kamchatka Peninsula. All gray whales photographed and identified in the Kamchatka areas have been included in the Kamchatka catalog and provided with a unique identification number. As of 2012, there were 155 gray whales included in the Kamchatka catalog, of which 85 individual whales (55% of Kamchatka catalog) were also included in the IBM catalog of Sakhalin WGW.

In 2006, intra-annual migration between SE Kamchatka and NE Sakhalin was discovered when two whales observed in Olga Bay and Vestnik Bay were later sighted during the same season in the Piltun feeding area. Each year since 2006, a number of the whales observed in Kamchatka were also observed in Sakhalin feeding areas later during the same season. In the period of Kamchatka surveys (2004, 2006-2010) between 15.4% and 37.8% of the whales in Kamchatka were seen later during the same season in Sakhalin waters. An outlier was 2008, when only one whale out of 50 individuals sighted off Kamchatka was also observed at Sakhalin. In 2010, of the six identified early in the season in Vestnik Bay, five (83.3%) were later observed within the same season off Sakhalin.

It is unknown whether or not the 70 gray whales included in the Kamchatka catalog that have not been identified in the IBM Sakhalin catalog also migrate to the Sakhalin feeding areas. The fact that these whales have not been identified off Sakhalin suggests that unidentified feeding areas exist in the Sea of Okhotsk region or that some gray whales arriving in Kamchatka waters do not continue their migration to the Sakhalin area. It is hypothesized that all Kamchatka gray whalesmigrate to Kamchatka from waters of coastal North America, but this has not been confirmed. Since 2009, all gray whales seen migrating along Kamchatka early in the season were moving from north to south.

4.2.3. Population Structure

The observation that Sakhalin WGW migrate to coastal North American waters and share winter habitat with Eastern gray whale (EGW) motivated scientists to examine more closely the relationship between the Sakhalin WGW and the EGW. Evidence from photographic matches and genetic matches confirm additional instances of WGW migrating to North America. The Sakhalin WGW are considered to be the remnant of the once much larger western gray whale stock, or Okhotsk-Korea stock, that was the target of a sustained commercial harvest. In the 1970s scientific papers appeared that concluded that the WGW was extinct. The re-discovery in the 1980's of the WGW summering off NE Sakhalin coincided with the rapid expansion of the EGW which now numbers approximately 19,000.

Genetic comparisons of the WGW to samples taken from the EGW have consistently shown significant Fst (a measure of population subdivision) for both maternally inherited mtDNA and biparentally inherited microsatellite loci (Lang et al., 2011). However, weaknesses to the genetic datasets stem from the fact that although the WGW has been extensively sampled, the EGW has been sampled much less thoroughly. Whether the available EGW samples are an adequate representation of the EGW population is questionable.

The International Whaling Commission Scientific Committee (IWC SC) has formed a study group to review the population or stock status of the WGW. Multiple hypotheses have been generated and are to be discussed at a workshop scheduled for April 2014, and the results are to be reported at the annual meeting of the SC in May 2014. The various stock structure hypotheses consider the possibility that the North Pacific gray whale (EGW and WGW) is a single interbreeding population, or whether there are multiple populations (including WGW and EGW, as well as possible subpopulations of the EGW). Hypotheses that assume multiple populations include those that assume the WGW, i.e. the pre-depletion western gray whale stock, is extinct and those that assume it survives. Hypotheses in the latter group include whether the Sakhalin population is comprised of only WGW or a combination of WGW and EGW. Underlying these hypotheses are two key conservation issues. First, are the Sea of Okhotsk gray whales demographically distinct from the larger Eastern gray whale population? And second, if it is distinct, does it represent the descendants of the historical pre-depletion Western gray whale population, or is it descended post-depletion from Eastern gray whale founders, or is it a mixture of both?

4.2.4. Stock Structure

Genetics data have consistently shown statistically significant measures of population subdivision in both mtDNA and nuclear microsatellite loci in comparisons between WGW, of which a large proportion of the population has been sampled, and various sets of samples from the very large EGW, of which a comparatively much smaller proportion of the population has been sampled. Moreover, mtDNA haplotype diversity is much lower in the WGW compared to the EGW samples. These observations are consistent with the Sakhalin Island gray whales being the descendants of the pre-exploitation WGW stock, but they are also consistent with other stock structure hypotheses. One alternative stock structure hypotheses considers the Sakhalin Island population to have been founded by a small number of EGW which have diverged genetically from other subpopulations of that stock. Another hypothesis is that the Sakhalin Island population is a mixture of EGW and WGW. These and other potentially viable stock structure hypotheses are being considered in a workshop sponsored by the International Whaling Commission Scientific Committee (IWC SC). A better understanding of the population structure of North Pacific gray whales will help to determine conservation priorities and focus research efforts.

Bickham et al. (submitted) present stock structure hypotheses developed from discussions held at the IWC SC annual meeting in 2013 and propose genetic methods to test them. Recommendations include 1) develop a larger genetics dataset of the EGW to insure comparisons to the WGW are meaningful, 2) improve the genetic methods of analysis to include multiple single nucleotide polymorphism (SNP) loci, instead of microsatellites, and greater coverage of the mtDNA molecule to include protein coding genes, and 3) a genetic study of historical samples representing the pre-whaling WGW to establish the genetic profile of this population for comparison to the current Sakhalin WGW.

4.3. WGW Distribution off Northeast Sakhalin

WGW are known to migrate to the Sea of Okhotsk each spring and summer, and spend much of the ice-free months in the two identified feeding areas off NE Sakhalin where they have access to abundant benthic food resources. The data collected by the Joint Program distribution and Photo-ID teams since 2002 has facilitated the understanding of WGW abundance, distribution, and movements off NE Sakhalin. However, the distribution and abundance of the WGW in other areas of the Sea of Okhotsk remains uncertain since monitoring conducted by the Joint Program is limited to the immediate area of NE Sakhalin that includes the Piltun and Offshore feeding areas.

The Joint Program has identified two areas off NE Sakhalin that serve as primary feeding areas for WGW: the Piltun or “near shore” feeding area and the Morskoy or “offshore” feeding area. Each year, most WGW sighted by Joint Program monitoring teams are within these two primary feeding areas. However, in addition to the these feeding areas, WGW have also been observed feeding in other locations near Sakhalin, such as near Chayvo Bay and Severny Bay west of Elizaveta Point (north end of Sakhalin), and in Olga and Vestnik Bays on the SE coast of Kamchatka. There are also reports of frequent sightings of gray whales around the Commander Islands located approximately 200 km east of Kamchatka and along the Kuril Islands. In 2008 a gray whale previously seen in 2007 in Olga Bay off Kamchatka was photographed in Zakatny Bay of Shiashkotan island (Kuril Islands). Later in 2008 this same whale was seen in Olga Bay again, and off Medny Island (Komandor Islands), and off Karaginsky Island (northeast Kamchatka).

Vessel-based surveys of the Arkutun-Dagi and Piltun-Astokh license areas have been conducted since 2006 and 2009, respectively (Figure 4). Generally, the numbers of WGW observed in the Arkutun-Dagi license area were low, except for 2010 when 17 whales were observed during a survey. However, in 2009 and 2010, surveys were conducted during which some whales were sighted in the Piltun-Astokh (7 WGW) and Arkutun-Dagi (17 WGW).

From the Joint Program Photo-ID and distribution studies it is clear that individual WGW move back and forth between the two primary feeding areas within each feeding season and that the distribution of WGW and their relative abundance within each feeding area are variable both across each feeding area (i.e., space) and within each year and among years (i.e., time). The movement of WGW within and between feeding areas was verified with the 2011 satellite tagging when the whales known as Svetlana and Agent were tracked moving between the two primary feeding areas. This satellite tagging data is particularly interesting because it demonstrates that the whales are more-or-less, moving throughout the feeding areas on an on-going basis.

4.3.1. Piltun Feeding Area

The Piltun feeding area, or the “near shore” feeding area, located just east of Piltun Bay extends along the coast from approximate latitudes 52 20’ to 53 20’ with an area of ~1000 km^2 (Figure 3). WGW within the Piltun feeding area are sighted along a 60 km stretch of coast line and typically remain in waters depths of less than 15-20 m and typically no more than 4-5 km away from shore. Based on WGW sighting data, it can be concluded that the boundaries of the area defined as the Piltun feeding area have gradually expanded southwards over the last 30 years (i.e., 1984-2013).

Each year, the WGW begin arriving in the Piltun feeding area in May as the winter ice begins to breakup along the coast of NE Sakhalin. Due to ice and fog conditions in May and early June, WGW are not easily sighted from shore; therefore, the abundance of WGW and their distribution within the Piltun feeding area during the early season are not well documented. In 2012, satellite-tagged whale Varvara was tracked arriving in the Piltun feeding area on May 18 following her migration from Mexico and Kamchatka, which was earlier than complete breakup of the winter ice cover.

Each year, the greatest abundance and concentration of WGW are typically observed congregating in waters adjoining the mouth of the Piltun Bay (Figure 3). Based on the 2002-2013 distribution data it can be concluded that the highest densities of whales are typically near the mouth of the Piltun Bay, and there is considerable variability in WGW use of the northern and southern part of the Piltun feeding area. In late summer, WGW have also been observed congregating in the northern part of the Piltun feeding area (near survey stations No. 4-6) and in some years (e.g., 2004 and 2005) WGW congregated here in large groups that remained, more-or-less, throughout the season. In some years, smaller groups are also sighted southward in the vicinity of Chayvo Bay.

The numbers of WGW sighted within the Piltun feeding area by the on-shore distribution survey teams fluctuates from year to year. Based on shore-based survey data, the number of WGW observed during single-day synchronize counts were highest in the years 2004-2006 (128-138 WGW), then decreased in 2007-2010 (47-73 WGW), and then increased again in 2011-2012 (up to 103-111). In 2013, the maximum number of WGW sighted in the Piltun feeding area for a single day was 64 whales (September 16). The fluctuations of the numbers of WGW observed in Piltun feeding area within a single year and between years are believed to be due to a redistribution of WGWs among the feeding areas (i.e., Piltun, Offshore and Kamchatka).

In 2006, higher numbers of whales were observed southward of survey station 10 than in prior survey years. This coincided with the construction of Sakhalin Energy's offshore pipeline in the southern area and an overall decrease in the biomass of benthic food resources across the entire Piltun area (Fadeev, 2011). In 2008 the number of sighted WGW was low, but increased by more than 50% in 2009, with fewer whales observed north of survey station 3 than in previous years. In 2010, the distribution of whales over the Piltun feeding area was similar to the period 2002 – 2005, with more whales once again observed in the northern portion of the area (i.e., survey stations 1-3).

Distance from Shore

Based on the Joint Program monitoring data, it appears that WGW tend to stay closer to shore during the early months of the feeding season (i.e., June-August) as compared to later during the season (i.e., September). Up to the end of August, approximately 80% (in 2007-2010) of the whales sighted in the Piltun feeding area were within two kilometers from shore, with corresponding water depths of < 10 meters. Cow / calf pairs and single calf were typically observed even closer to shore (< 1 km) than were non-calf individuals.

The greater abundance and distribution of both adults and calves in the near shore areas of the Piltun feeding area during June and July may be due to a combination of the occurrence of high biomass of benthic food resources and the shallow water depths. Cow / calf pairs have only been observed off Sakhalin in the shallow, near shore areas and have not been sighted in deeper areas of the Piltun feeding area or the Offshore feeding area. The young-of-year calves may have limited abilities to dive to depth, thus it would be advantageous for calves to remain in shallow areas to feed. In addition, the calves as well as non-calves would have to exert less effort feeding in shallow water. As benthic biomass is probably easier to harvest at shallower depths, whales are likely to start feeding here upon arrival off Sakhalin. Another factor that could contribute ot why the WGW appear to prefer shallow areas during the early feeding season is that protection of the calves (and adults) from predation would be much easier in the shallow waters where their primary predator the killer whales (Orca) can be more readily fended off by gray whales.

Later in the season (i.e., September), some WGW appear to venture into deeper depths of the Piltun feeding area, and have been observed in the areas that are two to five km from shore where water depths range from approximately 10 to 20 meters. WGW are believed to make the movement to deeper areas of the Piltun feeding area and to the Offshore feeding area in search for the higher biomass of their preferred prey which may be somewhat reduced in near-shore areas by intense feeding. However, the majority of WGW observed in the Piltun feeding area through the entirety of the feeding season were sighted in the near shore zone of less than two km from shore.

4.3.2. Offshore Feeding Area

The Offshore feeding area (OFA) or the Morskoy feeding area, located about 40-50 km South-South-East of the Piltun feeding area and eastward of Chayvo and Nyisky Bays, extends from ~25 to 50 km from shore at approximate latitudes of 51 50' to 52 30' and covers of areas of ~1400 km^2 (Figure 3). Prior to the discovery of the OFA by Joint Program scientists in 2001, it was assumed that the Piltun feeding area was the sole Sakhalin feeding area for WGW. The importance of the OFA to the WGW is now well established. The OFA is characterized by water depths ranging from 35 to 60 m and benthic biomass that has remained high and stable over the years of monitoring. Importantly, the OFA provides a source of preferred benthic food resource (i.e., amphipods) that can supplement the Piltun feeding area. Due to the greater depth of the OFA, WGW feeding is much more energy intensive than is feeding in the shallow Piltun feeding area.

There has been considerably less survey effort in the Offshore feeding area than has been conducted in the Piltun feeding area. Typically, four to six vessel-based distribution surveys of the OFA are done each year during the August-September timeframe (Figure 4). The Offshore feeding area surveys required the use of a vessel, which was not available every day since it is also shared for other work activities. These surveys are dependent upon favorable weather and sea conditions to allow the completion of each day-long survey; due to poor weather and sea conditions surveys are not typically conducted during June, July, or October. Nevertheless, due to the vessel-based surveys conducted in the OFA it is possible to assess both the inter-seasonal and intra-seasonal variability in use of the OFA. Over the course of the feeding season the number of WGW in the OFA gradually increases. This increase typically corresponds with an observed decrease in numbers of WGW in the Piltun feeding area towards the end of the feeding season (i.e., September), suggesting a possible preference for feeding in the OFA at this time.

As with the Piltun feeding area, there is substantial inter-seasonal variation in the distribution and abundance of WGW sighted in the Offshore feeding area. In 2001, when the Offshore feeding area was discovered, the maximum number of whales sighted in the OFA was relatively high (83 WGW). The lowest number of whales (9 WGW) sighted in the OFA occurred in 2004 and coincided with the highest value for the maximum number of whales observed during a single scan in the Piltun feeding area. The year 2008 is notable with its high number of WGW in the OFA. During a single survey on 3 October 2008, 82 individuals were sighted in the OFA, which again, corresponded with lower number of WGW in the Piltun feeding area. The pattern of an increase in number of WGW in the OFA observed between 2004 - 2008 was reversed in 2009 with fewer WGW observed in the OFA.

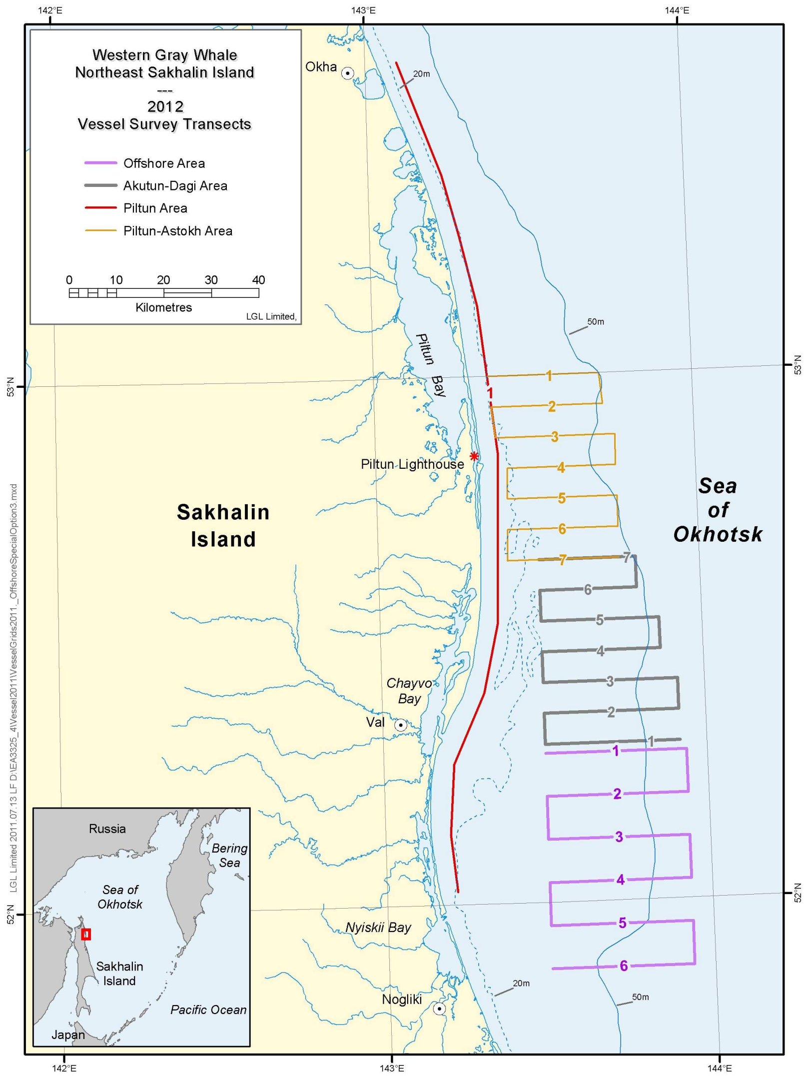

Figure 4. The transects of vessel-based distribution surveys of gray whales.

Since 2004, there has been a gradual expansion of the OFA eastward, with more frequent sightings of WGW along the eastern portion of the survey grid. In 2009, a considerable number of whales (11 WGW) were sighted north-east of the OFA survey grid in an area where WGW had not been previously sighted. This eastward shift towards deeper waters was also observed in 2010. In 2012 the concentration of WGW shifted to the central, most shallow part of the OFA; while in 2013 the WGW shifted to the south-eastern part of the OFA with depths of about 50 m. The sighting of actively feeding WGW at varied locations within the OFA and beyond the eastern boundary of the OFA confirms that suitable feeding areas for WGW are not limited to the boundaries of the OFA as established by the survey grid, but instead extend to a much larger area that has yet to be fully delineated.

The fluctuations of the number of WGWs in the Piltun and Offshore feeding areas in 2003-2010 suggests a "connected vessels" pattern: in the periods with high numbers of WGW in the Piltun feeding area (e.g., 2004, 2005, and 2006), the numbers of whales in the OFA are comparatively lower, and vice versa (Figure 5). This pattern is believed to be due to the Piltun feeding area being preferred when prey biomass is abundant there; in the years when prey biomass is lower in the Piltun feeding area, the WGW increase their use of the OFA, which has high prey abundance but higher energy cost to the WGW due to greater depths. Satellite tagging tracking of WGW in 2010 and 2011 shows that gray whale can swim at >7 km/hr (Mate et al 2011) so the WGW can move among feeding locations off NE Sakhalin in a short period of time. For instance, WGW known to feed in near shore areas of the Piltun feeding area with high biomass of amphipods and are also known to feed in the deeper waters of the Piltun feeding area located 5-7 km away where sand lance are abundant; travel time for WGW between these areas is 1 – 1.5 hrs. (Fadeev, 2011).

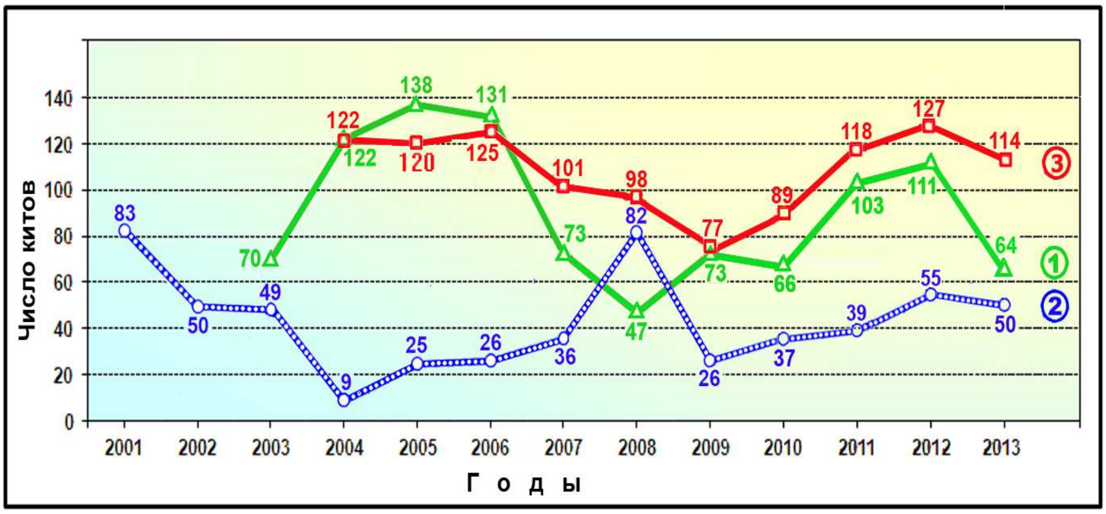

Figure 5. Interannual variations in Gray whale maximum numbers in feeding areas (i.e. Piltun (1), Offshore (2) and in both feeding areas (3) during the simultaneous surveys (not the sum of maximum numbers of Gray whales in Piltun and Offshore feeding areas) the simultaneous surveys (not the sum of maximum numbers of Gray whales in Piltun and Offshore feeding areas)

4.3.3. Other Feeding areas

In addition to the two primary feeding areas located off NE Sakhalin, WGW have been observed feeding in other areas, including the near-shore area off Chayvo Bay (2006-2009), Severny Bay in North Sakhalin (2005), and in regions along the southeast coast of the Kamchatka peninsula (since 2004). In 2013, one WGW was reported feeding offshore of the Vostochney Reserve off eastern Sakhalin. It is likely that other areas are used by WGW for feeding, and the use of other feeding areas could explain why some WGW are not seen every year in the two primary feeding areas off Sakhalin.

4.3.4. WGW Site Fidelity

The WGW identified off Sakhalin show a high site fidelity to the Piltun and Offshore feeding areas. Year after year, the vast majority of those WGW identified in a given year off Sakhalin are the same individual WGW sighted in previous years. For example, of the 122 non-calf WGW identified in 2013 off Sakhalin, 119 or 97.5% had been identified off NE Sakhalin at least once in previous years. Approximately one-third of all identified Sakhalin WGW have been seen every year since the year of their first sighting; while most of the other individual WGW have been re-sighted in some or most of the years following their first sighting. The formation of feeding groups that show high site fidelity is not uncommon among gray whales. A group of Eastern gray whale has been identified that consistently feeds in the area between the coast of Californian and the Alaskan peninsula and is referred to as the Pacific Coast Feeding Group (Calambokidis et al., 2010; Scordino et al., 2011).

Why the WGW have a high fidelity for the Sakhalin feeding areas is not certain but can be reasonably surmised. Each year, cows with calves are observed in the Piltun feeding area (as discussed in Section 4.1.2). It seems probable that a WGW calf travelling with its mother learns the migration route from their winter habitat (which possibly includes lagoons of Baja California, Mexico) to the Sakhalin feeding areas. Once the migration route is known to the WGW as a calf, the individual WGW continues to following the route each year to the location where preferred food is known to the whale to be available. It is also probable that these migrations are conducted with WGW traveling in groups, which would further reinforce the learning the migration routes, feeding areas, and winter habitats.

Not all individual whales identified in the IBM Sakhalin WGW catalog are sighted every year. For example, for the year 2013, 122 individuals or 48.7% of the WGW in the IBM catalog were sighted, and in 2012, 150 individuals or 56.6% of the WGW in the IBM catalog were sighted. However, over the last two years (2012 and 2013) there were 163 individuals in the catalog sighted; over the last three years (2011-2013) there were 182 individual WGW sighted; and over the past four years (2010-2013), 187 individual WGW or 82% of the WGW in the catalog were sighted. On average, 89% of the WGW seen in a given year are seen the next year and 97.6% are seen within two years. Of the 228 individuals identified, 22 individuals have not been sighted off Sakhalin or Kamchatka for more than five years (i.e., after 2009).

There are a number of possible explanations as to why WGW known to Sakhalin are not sighted during a single year or for multiple years. First, the individual WGW may not be using the Sakhalin feeding areas during the period that monitoring occurred, but instead use the feeding areas at times other than during the monitored period (e.g., October-December). Alternatively, it is possible that an individual WGW was present during the monitoring period but was not sighted by the Photo-ID team. Due to the vast size of the Sakhalin feeding areas (~2400 km^2), the Photo-ID team is only able to monitor a limited area on any given day; therefore, it is expected that not all WGW present during the monitoring period will be sighted by the Photo-ID team. In addition, the WGW are frequently moving within the Sakhalin feeding areas, thus may be missed and not photographed for identification. In some cases, an individual WGW is observed, but the Photo-ID team is unable to acquire the photographs necessary for identification of the WGW (these WGW are assigned as "Temporary" in the IBM catalog). From the 2010 and 2011 satellite tagging data, at least two occurrences are known when WGW were in the Sakhalin feeding area during the monitoring period but were not sighted by the Photo-ID team. Another explanation as to why an individual WGW is not sighted is that the WGW did not migrate to the Sakhalin feeding areas during the monitored year and instead the WGW used other feeding areas. An example of this occurred in 2013 when the WGW (IBM catalog #KOW215) was observed feeding near the Vostochney Reserve. It is also possible that WGW are not being sighted because the individual is no longer alive. Fatalities of WGW are known. In 2010, a dead WGW was discovered on the beach south of Chayvo, and an unidentified dead WGW was sighted in 2011 offshore east of Chayvo Bay. Additionally, some WGW fatalities are known as the result of entanglement in fishnets off Japan.

First-Time Sightings

First-time sightings of non-calf (i.e.,subadult and adult) individual WGW off Sakhalin have occurred every year of the Joint Program, with the exception of 2008. Typically, three to five non-calf WGW (average 3.4 for 2007-2013) are sighted each year that had not been identified in previous years. These first-time sightings result in the addition of new whales to the IBM Sakhalin WGW catalog. The number of first-time sightings of non-calf WGW was higher during the first few years of the Joint Program; however, as the catalog grew larger, the number of first-time sightings decreased. In some cases, these new whales are not seen again, while for others, these new whales have been sighted in subsequent years.

It is unknown whether an individual WGW sighted for the first time is new to Sakhalin (i.e., first time) or whether the individual WGW has been off Sakhalin in previous years but just had not been identified by the Photo-ID team. The two existing Sakhalin WGW photo-ID catalogs (i.e., IBM and Russian-American) each contain individual WGW not identified in both catalogs (i.e., as of 2012,19 WGW are found only in the IBM catalog and 17 WGW are only in the Russia-American catalog). The inclusion of WGW in these two Photo-ID catalogs that have not been seen by both teams demonstrates that not all WGW known to Sakhalin are seen by each team, and suggests that there could be other WGW off Sakhalin that have not been identified by either team. Further evidence that not all WGW are seen every year occurred in 2010 when a satellite tag was place on the WGW named Flex; however, Flex was not observed by the hoto-ID team.

4.4. WGW Behavior

WGW behavioral surveys were conducted from 2001 to 2010 during the feeding season to understand the movements and activities of individual WGW and to assess whether anthropogenic activities result in observable changes in WGW behavior. These behavior studies provided important information on WGW feeding, movement, and respiration activities. Three primary observation methods were used: (i) scan sampling to obtain relative abundance estimates, distribution, and group-size information; (ii) theodolite tracking of individuals or groups to describe spatial movements, orientations, speeds, and habitat use; and (iii) focal follow observations to monitor surfacing-respiration-dive parameters and other surface-visible behaviors.

Three behavioral states were predominately observed on the Piltun feeding area: 1) feeding, 2) feeding/traveling, and 3) traveling. Movement and respiration patterns were significantly different when whales engaged in these different modes of activity. Gray whales moved faster, more directional, and covered a larger geographic range while traveling compared to feeding/traveling and feeding. Movement patterns were also different between feeding / traveling and feeding behaviors, which could be representative of the different foraging strategies. Other behavioral states were also observed, such as socializing, resting, and milling, however, there were too few occurrences to provide detailed analyses.

The general movement and respiration patterns were very similar from year to year. WGW speed recorded between 2001 and 2010 was between 1.9 - 2.7 km/hr and the ranging index (a measure of directionality of movement) varied from 31.1 - 41.4 m/min. Blow interval recorded from 2001 to 2010 varied from 0.3 - 0.5 blows per minute and the dive time from 1.8 – 2.7 minutes. The blow interval and dive time were comparable to those of bottom-feeding Eastern gray whales in the northern Bering Sea (Würsig et al. 1986) and off Vancouver Island, Canada (Guerrero 1989). Certain movement and behavior data were found to be significantly different between cow / calf pairs, weaned calves, and other individuals. Cow / calf pairs were found to stay closer to shore than other individuals and speed of mother/calf pairs was lower compared to that of other individuals.

4.4.1. 2001 Odoptu 3-D Seismic Survey

Seismic activity has the potential to affect whale distribution and abundance, as well as affecting certain whale movement parameters, e.g. leg speed, reorientation rate and distance from shore (Gailey et al. 2007, Yazvenko et al. 2007). The analyses from the 2001 Odoptu seismic surveys indicated that at higher received sound energy exposure levels, whales traveled faster, changed directions of movement less, were farther from shore, and stayed under water longer between respirations (Gailey et al. 2007a). Distribution and abundance shifts were also evident recorded by from aerial and shore-based observations (Yazvenko et al. 2007). The results of multivariate analysis suggested that 5 to 10 whales moved away from the seismic exploration area to other parts of the feeding area as a result of increasing cumulative sound over a three-day time scale. These changes were relatively subtle and appeared to have no measurable negative impact on population level parameters as measured to date. The analyses did not find significant changes in feeding intensity of gray whales, which indicated that the whales were receiving adequate nutrition throughout the seismic survey (Yazvenko et al. 2007b). It is noteworthy that a high number of calves (11) was recorded in 2003, two years after this seismic survey (i.e., these calves were conceived during the 2001-02 winter season, immediately following the 2001 seismic survey).

4.4.2. 2005 CGBS installation

The multivariate analyses of gray whale movement and behavior during the CGBS installation found no significant effects. Distance from shore, however, was significantly associated with sound levels, with gray whales predicted to be slightly farther from shore as sound level increased. Sound levels in this study were confounded by near shore research vessel activity and the offshore CGBS related activity and therefore it was not possible to test the effects of one or the other sound source directly. WGW were observed to be particularly sensitive to near shore research vessels that were present close to or within the Piltun feeding area, which could have led to the offshore movement observed in relation to sound levels. Gailey et al. (2007b) argued that some of the highest sound levels were those due to near shore research vessels as opposed to the construction activity.

4.4.3. 2006 Pipeline Installation

In 2006, pipeline construction activity was initiated from Piltun-Astokh-B (PA-B) and Molikpaq (PA-A) platforms, located about 13 to 16 km from shore, respectively. The multivariate analyses, designed to examine potential impact from the pipeline activities on WGW, found that as sound levels associated with dredging activity increased, gray whales responded by shorter respiration intervals (breathing faster), which could be an indicator of stress or at least of a higher energetic state. In these analyses, sound levels were separated for industrial sounds and near shore vessel activity and therefore the results were not confounded by these two different activities (Gailey et al. 2011). It is not known to what extend these changes in behavioral parameters affect the well-being of the population.

4.4.4. 2010 4-D Seismic Survey

Sakhalin Energy conducted a repeat 3-D geophysical seismic survey (4-D) of their Piltun-Astokh-oil-gas field in the summer of 2010. The mitigation measures adopted during the 4-D seismic survey were designed to minimize the duration of the survey, perform it as early in the feeding season as feasibly possible when fewer gray whales were in their feeding grounds, and minimize sound exposure levels to WGW when seismic exploration was being conducted. The study examined the effectiveness of these mitigation and monitoring efforts by examining behavioral changes in WGW movement and respirations to vessel proximities, orientations, and sounds, and the sounds generated by the seismic exploration. The multivariate analyses combined acoustics, environmental, vessel information, and behavioral data to investigate disturbance effects of anthropogenic activity that occurred in the proximity of the nearshore feeding habitat of the WGW. Although individual responses were observed, none of the response variables were found to be significantly associated with the seismic sounds generated. Overall, results suggest there were no large population level impacts on the WGW (Gailey et al., 2013). This outcome could have been due to the reduction in sound exposure to the whales caused by an effective mitigation and monitoring strategy.

4.4.5. 2012 2-D Seismic Survey

Theodolite monitoring of gray whales behaviour in their feeding area near the NE coast of Sakhalin was carried out during the seismic survey at Piltun-Astokh licensed area. The study provides the information about WGW population dynamics in the surveyed area, individual whales' movements (speed, linearity, direction change etc.) and behavior (interval between blows, time of surfacing, time of diving, frequency of blows etc.). Statistical and comparative analysis of the data obtained during the observation in 2012 and the comparison with similar data obtained during the previous years have not revealed any significant negative influence of 2-D seismic survey carried out at the Piltun-Astokhskoye field on the distribution and behavior of WGW (Kryukova and Vladimirov, 2013).

4.5. WGW Food Resources

The WGW feed primarily on benthic (bottom) and epibenthic (near-bottom) invertebrates (Fadeev, 2011, Nerini, 1984; Blokhin and Pavlyuchkov, 1996). Since 2002, the Joint Program has monitored benthic biota off NE Sakhalin, studying the dynamics of benthos and characterizing spatial and temporal differences of the benthic biota believed to serve as prey for WGW (Figure 6). Since WGW migrate each year to coastal waters of Sakhalin to feed, the examination of the benthos that could serve of food resources for the WGW provides important information for understanding WGW ecology, abundance, distribution, movement, and behavior within the Sakhalin feeding areas. The high biomass of benthos that can serve as food resource for WGW in the Piltun and Offshore feeding areas provides a compelling explanation as to why WGW return to Sakhalin year after year (i.e., high site fidelity). The monitoring of the benthic communities has significantly increased knowledge of the WGW food resources, including composition of benthic communities, abundance of individual species, and the influence of environmental parameters (e.g., hydrology, sediment) on these benthic communities.

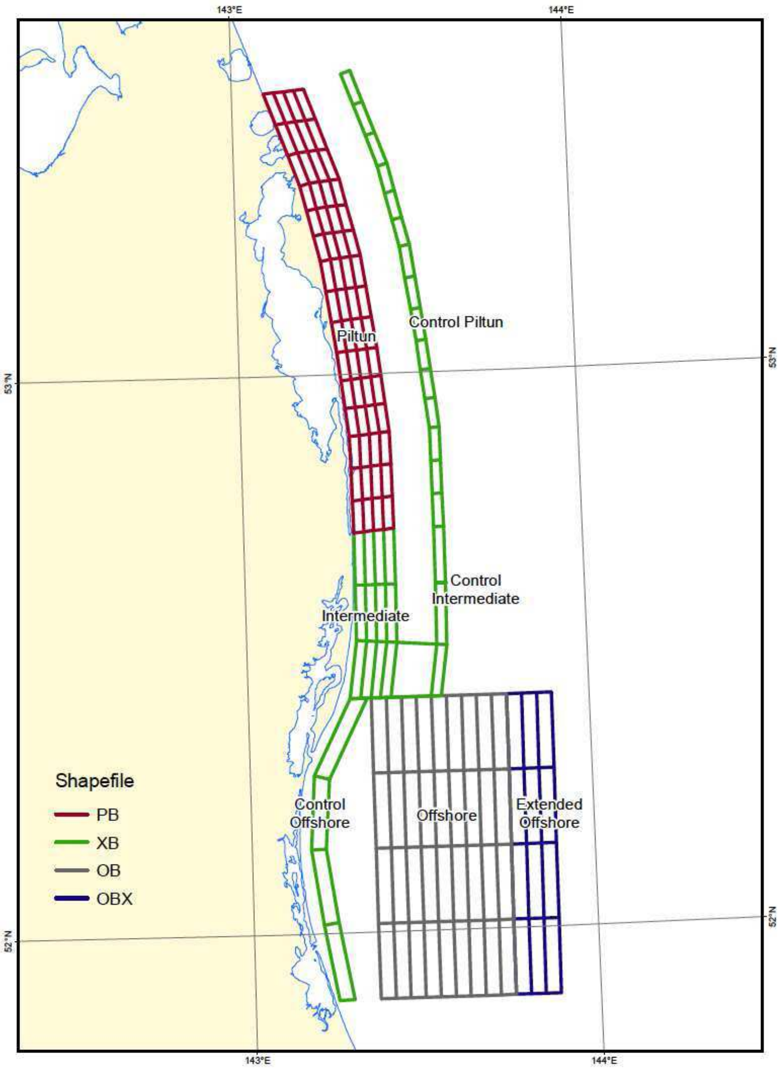

Figure 6. Sampling grid for collection of benthic samples in Piltun and Offshore feeding areas.

4.5.1. Benthos In Piltun Feeding Area

The average total biomass of benthos in the Piltun feeding area measured from 2002-2013 was relatively stable from year to year, ranging from an average of 414 to 556 g/m2. Amphipods and isopods are believed to be the most important food resource for the WGW (Fadeev, 2011). Other benthic organisms, such as sand lance (a fish) and sand dollars were also major contributors to the total benthic biomass. Although sand dollars dominated the overall biomass, they are believed to have little food value for gray whales.

Two complexes of benthic organisms cover most of the Piltun feeding area: a shallow-water, coastal amphipod-dominated complex with a high portion of the biomass consisting of amphipod and isopod species, and a deeper-water, sand dollar complex with a low portion of the biomass consisting of prey organisms of WGW (i.e., amphipods and isopods). The approximate boundary between these two complexes lies at depths of about 20 m. In the Piltun feeding area, WGW do not commonly feed at depths >25 m, probably because amphipods comprise on average < 2% of benthos biomass and sand dollars commonly comprising > 90% of the biomass at these depths.

Three patterns were noticed about the distribution with respect to depth of various crustacean groups in the Piltun feeding area: (1) amphipods and isopods had a maximum biomass at depths of 5–15 m, decreasing sharply at depths >20 m; (2) the biomass of cumacean reflected the opposite pattern, with lower biomass in shallower depths and greater biomass in depths >20 m; and (3) biomass of decapods was low at all depths and varied only slightly. In the Piltun feeding area, the highest prey biomass (amphipods and isopods) was found at depths of <15 m; the proportion of key WGW forage benthos to the total biomass decreased with depth: from 40–59% at 5–15 m to 1–4% at 20–30 m. In all years, the biomass of amphipods and isopods decreased from 50-80 g/m^2 (60-70% of total benthos biomass) at depths of 11-15 m to 25-35 g/m^2 (<5% of total benthos biomass) at >26 m. The steepest changes in benthos biomass were observed between depths of 15 m and 20 m. Based on data from 2002–2012, the overall proportion of amphipods and isopods in the benthos biomass in Piltun feeding area was 40–75% at depths of 5–10 m and only 3–10% at 26–30 m. The total benthic biomass in the Piltun feeding area increased with depth, mainly due to increasing presence of sand dollars, whose biomass increased from 1-10 g/m^2 at depths of 11-15 m to 500-800 g/m^2 at depths over 25m.

Amphipods in Piltun Feeding Area

Over the entire life of the study, 84 amphipod species have been documented in the Piltun feeding area (Fadeev, unpublished data). Of these, six species had frequencies of occurrence of >50%: *Eohaustorius eous eous* (100%), *Monoporeia affinis* (98%), *Grandifoxus longirostris* (86%), *Eogammarus schmidti* (81%), *Anisogammarus pugettensis* (78%), and *Westwoodilla* sp. (65%). In the Piltun feeding area, >50% of the total benthic biomass is comprised of five amphipod species: Mono*poreia affinis, Eogammarus schmidti, Anisogammarus pugettensis, Anonyx nugax,* and *Eohaustorius eous*; these species have relatively large body size (>5mm) and high frequency of occurrence (60-90%) in summer (Fadeev 2011). The maximum biomass of amphipods in the Piltun feeding area ranged from highs of 115.5 +/- 19.6 g/m^2 (2002) to 52.6 +/- 7.4 g/m^2 (2006). The distribution of amphipods across the Piltun feeding area is patchy and distinctly aggregate in nature. In the Piltun feeding area, the amphipod *Monoporeia affinis* is the dominant WGW prey species.

Isopods in Piltun Feeding Area

Isopods were dominant members of the benthos in the Piltun feeding area, although the spatial distribution of isopods was distinctly patchy in all years. The small isopod *Synidotea cinerea* (average body weight 0.02 g) was the most significant component of benthos biomass in the Piltun area. In 2002-2012 it had the highest frequency of occurrence (>80%) of all the macrobenthos species. Maximum biomass of *S. cinerea* was observed in depths < 15 m, with only a few *S. cinerea* encountered in deeper waters. A larger isopod, *Saduria entomon* (body weight up to 5 g, average weight 2.1 g), was encountered much less frequently in the Piltun feeding area. However, this species can form large local accumulations that, together with other crustaceans, can provide a significant food resource for gray whales. In contrast to *S. cinerea*, the biomass of *S. entomon* increased with depth.

Sand Lance in Piltun Feeding Area

The Pacific sand lance (*Ammodytes hexapterus*) is a slender-bodied, eel-like fish that burrows into sandy sediment, and is a known food resources for gray whales (Zimushko and Lenskaya, 1970). The Piltun feeding area is habitat for major spawning concentrations of the bottom-dwelling sand lance. In years when sand lance were abundant in the Piltun feeding area (e.g., 2004, 2005, 2006, 2011 and 2012) they are believed to be an important food source for WGW. In 2004, the relationship between gray whales and sand lance was especially clear: the majority of the sighted whales (up to70%) were concentrated in the northern part of Piltun feeding area where high concentrations of sand lance were also documented (Fadeev, 2005). In 2004 and 2005, high numbers of WGW were sighted at ≥ 6 km from the shore at depths (20-30 m) not usually used by WGW in the Piltun feeding area and coincided with high concentrations of sand lance and other food sources. WGW are typically not sighted feeding in areas dominated by sand dollars (i.e., >20 m deep), except in years when sand lance was also present and abundant at >20 m depths (Fadeev, 2004, 2005, 2006).

There was a high variability in the occurrence and biomass of sand lance in the Piltun feeding area. The sand lance is a temporary component of biota at depths of less than 40 m where it breeds (Fadeev, 2006). The densest accumulations of sand lance in the Piltun feeding area were associated with sandy bottoms and mixed gravel, at depths greater than 20 m. In 2002 and 2003, sand lance occurred in 5-8% of the benthic samples, with an average biomass of 4.6 to 6.2g/m^2. In 2004 and 2005, sand lance occurred in 15% of the benthic samples, with an average biomass of 14.8 to 16.3 g/m^2. The highest accumulations of sand lance were seen in the northern and middle parts of the Piltun feeding area, where the biomass ranged in 2004 from 68 to 166 g/m^2, and in 2005 from 150 to 236 g/m^2, or 25 to 60% of the total macrobenthos biomass In 2006 and 2007, the sand lance biomass decreased to 20-25% of the total benthos biomass; in 2008 and 2009, the land lance biomass was further decrease to 8-12% of the total benthos biomass. However, in 2010 the frequency of occurrence of sand lance in the northern part of the Piltun feeding area increased to 20%. Sand lance biomass in the two WGW feeding areas reached values of 66 and 78 g/m^2.

Sand Dollars in Piltun Feeding Area

The sand dollars (*Echinarachnius parma*) are a dominant component of the benthic community in the Piltun feeding area. The sand dollars, which are an extremely flattened, burrowing sea urchin (i.e., echinoderm) live on top of or just beneath the surface of sandy or muddy sediment. Sand dollars are frequently found together in large numbers. Sand dollars dominated in the benthic biomass over the entire Piltun feeding area with an average of 60-75% of total benthic biomass, which increased with depth from 20% of total biomass at 15 m to 95% at 25–30 m. Most of this biomass is comprised of calcium carbonate skeleton and has no nutritious value. The observation that WGW spend little time foraging in areas with dominance of sand dollar (i.e. beyond the 20 meter isobaths) suggests that sand dollars are not a preferred prey for WGW. WGW in the Piltun feeding ground are not often observed beyond the 20 meter isobaths, which is main habitat for sand dollars.

4.5.2. Benthos in the Offshore Feeding Area

For the Offshore feeding area, 17 taxonomic groups accounted for more than 90% of the average total benthos biomass (Fadeev, 2012). Benthic organisms in the Offshore feeding area with occurrence in >50% of the samples were amphipods, cumaceans, bivalve mollusks, marine worms and sea anemones. The average total biomass of benthos in the Offshore feeding area from 2002-2012 ranged from 489 to 655 g/m^2. Forage benthos biomass in the Offshore feeding area has remained relatively stable over the course of Joint Program monitoring (2002 - 2013) with statistically significant year-to-year variations observed. Benthic groups with lower biomass contributions, such as sand dollars, nevertheless formed localized high concentrations of biomass.

Amphipods in Offshore Feeding Area

The biomass of amphipods, the most important component in the diet of whales in the Offshore feeding area, was 245.8±106.2 g/m^2 (2012), 176.7±78.5 g/m^2 (2011) and 206.2±53.7 g/m^2 (2010). The average amphipod biomass in the Offshore feeding area during 2002-2012 ranged from 174 to 344 g/m^2. The portion of amphipod biomass in the total benthos biomass increased with distance from shore. The year-to-year variations in the average amphipod biomass are statistically insignificant (t-test; $p>0.05$).

The amphipod species *Ampelisca eschrichti* is the most important of prey species in the Offshore feeding area. Colony density and biomass of *A. eschrishti* in the Offshore feeding area were comparable to, and in many cases exceed, those of other highly productive areas of the North Pacific (Kuznetsov, 1964; Koblikov, 1983 a, b, 1986; Makarov, 1937) and eastern gray whale feeding areas (Stoker, 1981; Nerini and Oliver, 1983; Oliver et al., 1983; Dunham and Duffus, 2001, 2002; Moore, 2000; Moore et al., 2007).

4.5.3. Factors Affecting Benthos Abundance and Distribution

The abundance and distribution of benthic biota are affected by a variety of abiotic and biotic factors. As part of the Joint Program, measures of abiotic parameters including temperature, salinity, hydrology parameters, and sediment characterization were conducted to help elucidate factors that influence benthos abundance and distribution in the Sakhalin feeding areas.

Sediment

Sediments at most sampling locations are characterized by predominance of sandy (psammite) fractions. Of the 223 stations analyzed in 2012, 86% were predominantly sands, while 14% consisted of gravel-pebble soils containing some sands of various grain sizes. The proportion of the fine sand fraction exceeded 70% at most locations. For the monitoring period (2002–2012), fine sands predominate at depths up to 10–15 m throughout the Piltun feeding area. With increasing depth, the fine sands are replaced by medium- and coarse-grained sands and areas with gravel–pebble soils containing some sands of varying grain size.

In the Offshore feeding area the portion of silt-clay in the sediment increased with increased water depth. Overall, fine sands predominate at >85% of the stations in the Offshore area. Gravel soils and coarse-grained sands occur in patches mainly in shallower parts along the western part of the Offshore feeding area.

Hydrology

The Piltun feeding area can be characterized as a shallow-water coastal area with a 20-meter isobath at 5-10 km from the shore and the 50-meter isobath at 20-30 km from shore. The Piltun feeding area receives freshened water from the Amurskiy Estuary and water from Piltun and Chayvo Bays. The nature of aperiodic currents is primarily determined by the effects of south and southeast winds (summer monsoon) and by northwest winds (winter monsoon) in autumn. Because the Sakhalin shelf is shallow in the region of the Piltun feeding area, atmospheric circulation that controls the prevailing winds causes typical wind drift that deflects the current to the right of the direction of the wind. These currents have a significant effect on the hydrophysical and hydrodynamic processes in the region and determine their seasonal and year to year variability, which depends on the development of these monsoons.

During upwelling the coastal area is filled with cold and salty water from the Sea of Okhotsk, while relatively warm and freshened-surface water shifts to the offshore deep water area. The Amur River water reaches this area in early June as the ice recedes. For example, on June 12, 2010 during ice flow southwards the water of Piltun area was characterized with a temperature of 5ºC and salinity of 23 psu. In July of some years prevailing southern winds trigger upwelling resulting in freshened water getting to the eastern offshore area from Severny (North) Bay, but in a favorable northwest wind the movement of freshened water may acquire the nature of an “invasion”.

The occurrence of colder surface water observed in the northern part of the Piltun feeding area in 2001–2006 may be due to upwelling of deeper water in the area (Krasavtsev et al., 2000; Rutenko, 2006). Colder sea surface temperatures were also recorded in this area in 2006-2012. It is thought that upwelling plays a significant role in primary productivity of phytoplankton in some parts of the Sea of Okhotsk (Shuntov, 2001). During the summer, upwelling has been observed on the northeastern shelf when winds are from the south (Borisov et al., 2008) and/or southeast. Hydrological observations indicate that durational upwelling can occur over large areas of the northeast Sakhalin shelf, and for prolonged periods in some parts (Krasavtsev et al., 2000).

Ice Cover

Ice-cover dynamics have major influence on phytoplankton growth, and in many ways determines the direction of energy transfer along the food chain. If phytoplankton outbursts happen in cold waters (as usually the case), its low consumption rate at low temperatures affects the food chain status conditional upon availability of resources rather than consumption of such. This scenario ensures more energy is supplied to the benthos community rather than remaining in the pelagic zone. Thus, seasonal and inter-annual variations in phytoplankton blooms may affect the entire food chain. The food chain energy direction surface–bottom and bottom-surface may affect the number and biomass growth of both pelagic and benthic communities.

Considering actual meteorological conditions of northern Sakhalin, it is worth mentioning that winter water temperature variations are insignificant from year to year as the temperature is always below zero and close to the water freezing temperature. This results in initial winter hydrological conditions for phytoplankton spring bloom that are essentially the same every year. If there are variations between the rate of primary production and subsequent variations in benthos biomass, such are conditional upon (for instance) the time of ice breakup.

Wind

Wind and associated summer south-eastern monsoon are another metrological factor which determines the start of coastal upwelling and its duration. On one hand, upwelling creates favorable conditions for phytoplankton growth via additional supply of biogenic substances from the sea bottom. On the other hand, it destroys water stratification and hinders sustainable growth of phytoplankton, because it may move down to the poorly-lit bottom horizons.

Influx From Amur River, and Piltun and Chayvo Bays

Benthos is also influenced by the influx of freshwater and detritus from the Amur River flow and shallow-waters from Piltun and Chayvo Bays. This influx to the shallow waters appears to be a permanent and sustainable factor, which does not vary significantly from year to year. Therefore, ice (breakup time), biogenic and organic substances brought by the Amur River waters and summer upwelling brought in from Piltun and Chayvo Bays during flooding and bringing water from the Sea of Okhotsk full of biogenic substances are variable factors which can affect biological productivity of the area. Apparently, these very processes ensure high biological productivity in this area of the Sea of Okhotsk and make this area a primary feeding area for the WGW in the summer-autumn season. The Piltun Bay may provide nutrients (nitrogen and phosphorous) required for phytoplankton blooms.

Primary Production

Development of the benthos is affected by the material produced on the sea surface. In spring and early summer, the benthos grows rapidly feeding on detritus produced by phytoplankton blooming during the winter-spring period. The primary benthic prey of gray whales in the Piltun and Offshore feeding areas (i.e., amphipods and isopods) feed mainly on diatom phytoplankton, or on other organisms that feed on diatom phytoplankton.

Phytoplankton production during the spring bloom is conditional on surface water salinity. Peak phytoplankton production only occurs if the surface water is freshened to a high degree. Phytoplankton bloom happens not only in spring, but may be triggered by intensive summer showers brought by deep cyclones. Such phytoplankton blooms may occur off NE Sakhalin not only the result of precipitation in the immediate area, but may also be triggered by remote storm rainfall getting into the sea via runoff from the Amur River. Productive capacity of phytoplankton spring bloom depends on a variety of external meteorological factors. For instance, despite sufficiency of biogenic organic matter in spring, phytoplankton bloom may be limited by dynamics of currents (water movements) caused by intensive vertical wind mixing, convection or limitation of light (e.g., light blocked by ice cover). Phytoplankton blooming does not start until sustainable water stratification sets in as a result of summer heat, ice melting or fresh water inflow.

4.6. Risks to Gray Whales

WGW face potential threats throughout their range from both natural and anthropogenic sources. Threats to WGW include entanglement in fishing nets and gear, ship strikes, pollution, habitat damage, oil spills, and disturbance/displacement from key habitats.

4.6.1. Natural Threats

Natural threats to WGW include predation, disease, epizootic mass mortality, climate change followed by the ecosystems degradation, and insufficient food resources. The killer whale (*Orcinus orca*) is the only non-human predator of gray whales. Predation of WGW calves by killer whales is perhaps the greatest threat to the WGW, and is a threat not unique to the Sea of Okhotsk. Although the extent of WGW losses to predation is not known, it is believed that predation may be responsible for losses of >30% of calves in their first two years. Attacks on WGW by pods of killer whales are well known, and was witnessed in 2013 by Joint Program scientists (which fortunately did not result in loss of the WGW).

Threats to WGW from disease are not well understood. However, decrease in Eastern gray whales (EGW) that occurred during the period of 1980-1990s (estimated decrease from ~30,000 to ~20,000 individuals), is believed the result of the EGW numbers exceeding the carrying capacity of the environment, which could have led to disease and/or insufficient food resources to support the large number of whales.

4.6.2. Anthropogenic Threats

Potential anthropogenic threats to gray whale arise from fishing, industrial, and military activities. The primary anthropogenic threats that have potential to adversely impact

WGW include: entanglement in fishing nets and lines, vessel strikes, pollution, oil spills, habitat impairment, and noise. Environmental Impact Assessments (EIAs) conducted by each Company for their respective offshore developments identified three main risk posed to the WGW by the Companies operations: collisions with ships, noise that could affect hearing and cause WGW to leave their feeding areas, and oil spills.

Commercial Fishing

Threats posed to WGW by commercial fishing are considered significant. There have been a number of reports in recent years of gray whale deaths as the result of the whales inadvertently being tangled in fishing nets or lines. At least five female western gray whales are known to have been incidentally caught or entangled in fishing gear near Japan, resulting in their deaths. Mitigation of the fishing threats to WGW can be accomplished with prohibition of use of fishing nets and lines in areas known to be frequented by WGW (e.g., primary feeding areas).

Commercial Fishing in Piltun Feeding Area

In 2013, the placements of fishing nets within the Piltun feeding area heightened concerns of risks to the WGW. On 29 July indigenous people of Sakhalin shared the information about the placement of set fishing nets near the Piltun Bay mouth. On 2 August the Joint Program onshore distribution team checked this information and sighted two set fishing nets and the fishing vessel to the south from Piltun Bay mouth in the area known as constant location of WGW cow/calf pairs. On 7 August the Companies provided this information to RF Federal Authorities. At the same time various specialists and NGOs expressed their concerns regarding the potential threat to WGW from the fishing activity in Piltun feeding area. Considering the situation Sakhalin Oblast Commission on the Regulation of Anadromous Fishing recalled all permits and ban salmon fishing in the north part of Sakhalin. On 26, August all fishing nets were removed from the area.

Entangled Gray Whale

In August 2013, the Companies received a request from both the Secretariat of International Whaling Commission (IWC) and Russian Commissioner in IWC to provide the assistance and support regarding an entangled WGW spotted by US-Russian Team in Piltun feeding area. The WGW named "Ponchik" was photographed with the rope around the peduncle arch. This male is known from 1985 and to be a father of at least two calves. In 2004 he was also sighted near the west cost of USA. The IWC and Russian Commissioner requested Sakhalin Energy and ENL to focus efforts on the re-sighting of this WGW and help the international Marine Mammals Rescue Team with the logistical and technical arrangements in Sakhalin and in the field. Both Companies drew the attention of all Joint Program teams to this issue and agreed to provide the necessary support to Rescue Team. However, the IWC Secretariat decided against further actions since the location of the rope and the body conditions of the whale did not implicate serious threats to the life of the WGW, and due to the difficulties of mobilizing a rescue team within the tight timeline.

Vessel Strikes

In the Sea of Okhotsk, there is overlap of vessel traffic and the habitat used by WGW; therefore, the potential for vessel collisions with WGW poses a threat to these whales. Each Company has implemented mitigation measures through their Marine Mammal Protection Plans (MMPPs) to reduce risk of vessel strikes. The MMPPs have been effective and during the period that the Companies have been working off Sakhalin, neither ENL nor Sakhalin Energy have had any vessel collision or near misses with WGW or other cetaceans.

The MMPPs provide specific vessel operation criteria that minimize potential for vessel collisions with WGW. Key MMPP mitigations include use of Marine Mammal Observers (MMOs) and Watch Standers, vessel speed restrictions, defined navigation corridors, vessel avoidance and minimal operating distance to WGW, and the prohibiting of vessels in feeding areas. Each year, vessel crews and on-board personnel receive training on the MMPP, and during operations the MMO or other delegated personnel provide daily reports to Company supervisors on sighting of WGW and vessel response.

Environmental Contaminants

Sediment contaminant monitoring is conducted as part of the Joint Program benthic studies and separately by each Company as a component of their environmental compliance monitoring programs. Analytical results have consistently shown that contaminant levels (e.g., hydrocarbons, metals) in sediment in monitored areas are not above background level. The first studies of key contaminants in the Piltun Area were conducted in 2001, when sediment samples were collected near locations where WGW were observed feeding. Concentrations of petroleum hydrocarbons and heavy metals (i.e., copper, aluminum, arsenic, barium, cadmium, chromium, iron, mercury, lead and zinc) were found to be low, and no significant effect of contaminants on benthos was observed (Fadeev, 2002).

Detailed assessments of key contaminants (petroleum hydrocarbons, heavy metals, and organochlorine pesticides) were conducted for sediments in 2004, 2005, 2008, 2009 and 2010. In addition, the most common polychaete species were analyzed for heavy metal in 2008; it is known that the heavy metal concentrations in the tissue of polychaete species are proportional to the concentrations in the sediments in which they occur, and therefore these serve as good bioindicators for heavy metal pollution of sediments. Heavy metals in the study area sediment in 2005 and 2009-2012 did not exceed the sediment background levels for NE Sakhalin shelf prior to the beginning of active industrial activities (Status of the Environment, 1996, 1997; Multidisciplinary studies, 1997; Kot, 1998), and were substantially below the values of the Probable Active Concentration of toxic metals (PAC) at which negative influence on benthic organisms is expected. Petroleum hydrocarbons in Piltun feeding area sediment ranged from <0.5 to 5.3 μg/g dry sediment and averaged 2.12±0.11 (m±SE) μg/g dry sediment and were lower than the natural background concentrations of petroleum hydrocarbons in

Sakhalin shelf sediments (Status of the Environment, 1996, 1997; Multidisciplinary Studies, 1997).

The results of the analysis of petroleum hydrocarbons, heavy metals and organochlorine pesticides in the sediments of the Piltun and Offshore feeding areas show that contaminants are at levels that would not have be expected to adversely affect benthos. The active hydrodynamic conditions and the sandy sediment off NE Sakhalin would be expected to contribute to the low accumulation of contaminants in the area.

Oil Spills

Although there is little known concerning impact of oil spills on gray whale, the companies anticipate that oil released into the environment and response to major oil spills could potentially impact WGW and the environment. The potential impact of oil spill to WGW would depend upon a variety of factors including proximity of the spill to WGW and their habitat, the size, location, and timing of the spill, and existing environmental conditions (e.g., wind, rough seas, ice, etc.). Spilled oil could potentially have a direct impact to the whale through contact to skin and other surfaces, which could result in irritation and other responses; potentially indirect impact of oil spill to WGW could result for damage to habitat and food resources.

Results of monitoring of sediment for petroleum hydrocarbons and other contaminants conducted by the Joint Program and separately by each company demonstrate that these environmental contaminants do not exceed background levels and are below levels expected to impact the ecosystem.

Noise

It has long been recognized that anthropogenic sound from oil and gas industry activities, such as seismic exploration and the construction and operation of offshore assets, has the potential to disturb whales. Noise disturbance of whales could possibility result behavioral disruption, displacement from critical habitat and in extreme cases, physiological injury. In recognition of this risk, since 1999 targeted acoustic studies were implemented off NE Sakhalin in preparation for planned oil and gas developments near the Piltun feeding area. With the execution of a seismic survey in 2001, a coordinated acoustic monitoring effort was put in place and related new technology was proven in the field. In 2003, the Joint Program began a standardized annual acoustic monitoring program to further the understanding of the sound levels generated by the Companies' operations (e.g., exploration, construction and production) and where necessary, suggest mitigations including revised planning of activities and/or engineering modifications. Additional goals of the program include the systematic collection of bathymetry and hydrology data required for accurate numerical modeling to estimate the propagation of sound from potential industrial sources into the WGW feeding areas, and the development, field validation and improvement of such numerical models.

The initial contingent of acoustic stations deployed in 2003 consisted of six units, and the longest recording was 12 days. In 2006 the annual monitoring network reached its full configuration of 16 stations, and over 70 days of data were acquired at several of the locations in sequential deployments. The sea floor deployed Autonomous Underwater Acoustic Recorder (AUAR) units developed and manufactured by the Pacific Oceanological Institute (POI FEB RAS, Vladivostok) record acoustic signals in the 2 to 15,000 Hz frequency range; their current autonomy is 52 days of continuous recording per deployment. The layout of the acoustic monitoring framework places particular emphasis on detecting changes in the anthropogenic sound level that could cause a significant increase in the noise exposure for either the Piltun or Offshore feeding areas. The WGW distribution in the Piltun feeding area is roughly defined by coastal bathymetry, with most whales feeding between 8 and 15 m water depth and mother-calf pairs found in 5 to 10 m water depth. Key acoustic monitoring points within the Piltun area were therefore positioned either on the 20 m depth contour, regarded as the eastern limit of the near-shore whale distribution, or on the 10 m contour taken as its midline. For the Offshore feeding area, the station locations (except the OFA station near the center) were placed on the 95% probability contour at the point nearest to a

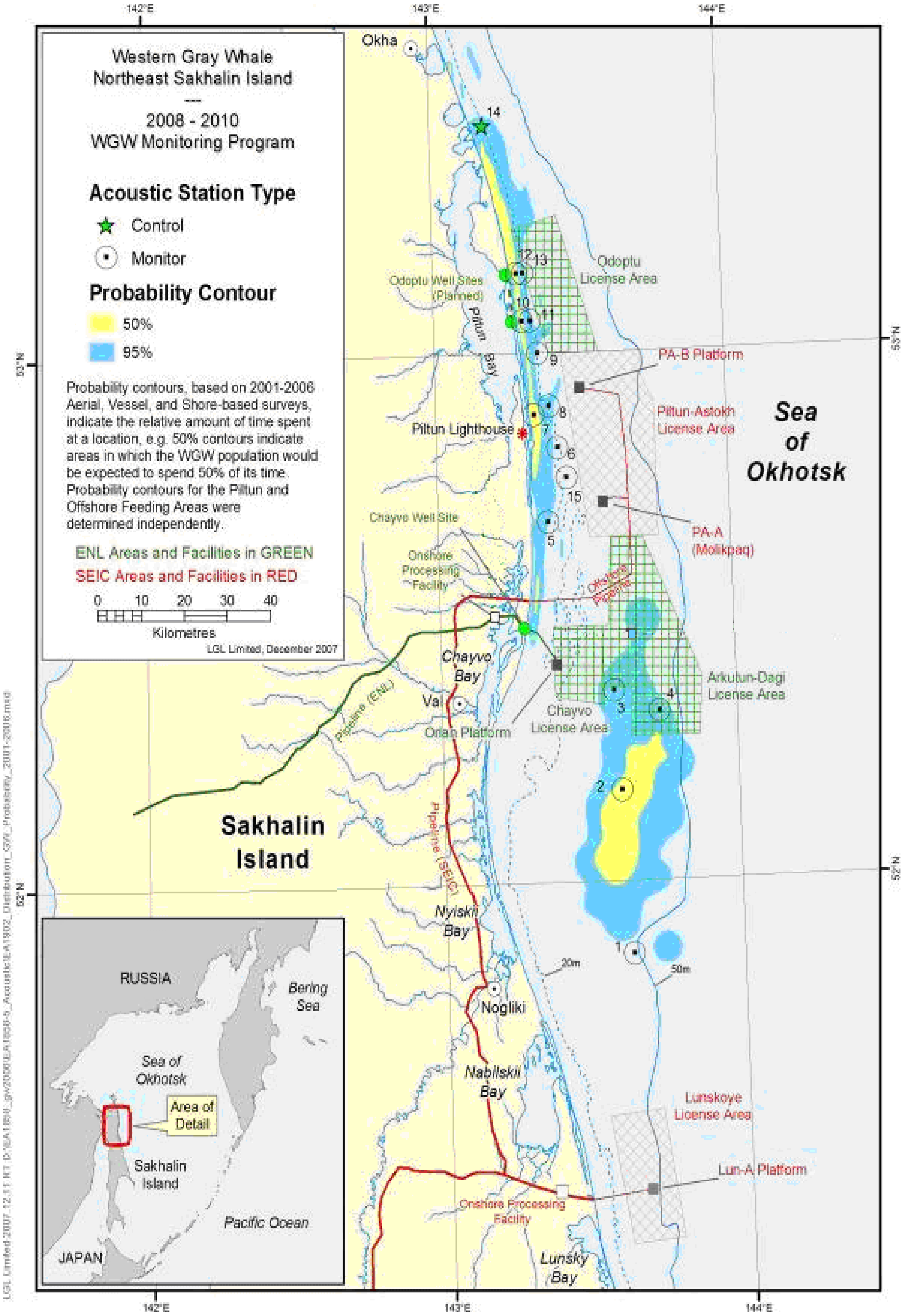

Figure 7. Locations of Joint Program acoustic monitoring stations.

current or planned industrial facility. Aside from some adjustments in the early years, station locations have remained consistent since 2003, thus allowing a systematic analysis of the evolution of the noise over the years. A map of the NE Sakhalin shelf with the sites of acoustic monitoring stations is shown in Figure 7. The network includes a control or background monitoring station situated on the 20 m bathymetry contour, well clear to the north of the Companies' operating sites and with bathymetric and hydrological conditions similar to those observed in the Piltun feeding area.

In addition to the annual program, targeted acoustic monitoring at custom locations and/or on extended schedules has been conducted in certain years by the Companies for evaluation of specific activities, such as construction of offshore production facilities or seismic exploration. Operations for which dedicated monitoring was performed included the pipeline construction and installation of the PA-B platform in 2005-2007 (Sakhalin Energy), the installation of foundation piles at the Odoptu North Well Site in 2009 (ENL), the Astokh 4D geophysical seismic survey in 2010 (Sakhalin Energy), the pipeline construction and placement of the CGBS foundation for the Arkutun-Dagi platform in 2011-2012 (ENL), and the South Piltun high-resolution 2D geotechnical survey in 2012 (Sakhalin Energy). During the 2005-2007 Piltun construction seasons and the 2010 Astokh 4D seismic survey, radio telemetric monitoring from shore of sound levels at acoustic stations was used for real-time assessment of noise exposure and potential triggering of mitigation measures based on preset criteria.

Ambient Noise

In interpreting ambient (i.e., natural background) noise, especially during periods of intensive weather and wave activity, it is important to recognize that especially in the low frequencies (below 20 Hz) the signal received by the acoustic stations is largely driven by the eddy flow of water rushing past the hydrophone and possibly by induced vibrations. This is qualified as "pseudo-noise" because it would not necessarily be heard by a morphologically different receiver such as a marine mammal's ear, and thus would not induce the kind of background masking that might otherwise be assumed. Higher frequency (up to 15 kHz) weather induced noise, e.g. from rainfall and surface churning by wind, is on the other hand an actual acoustic signal and thus can contribute to drowning out other sounds like industrial noise reaching the whales.

Analysis of the acoustic data showed that the natural ambient sound levels are highly variable both from year to year and within a season and are influenced by factors such as wind speed, wave height and precipitation. These factors can alter the background levels by more than 20 dB in some frequency bands. Annual monitoring performed at the control station has enabled the collection of a relatively undisrupted time record of background sound levels, with the exception of periods in 2008, 2009 and 2011 when third-party seismic surveys to the north and east of this station noticeably raised the levels above background for sustained periods of time. Noise from the Companies' construction or exploration projects have usually exceeded the prevailing ambient or background sound levels at points within the WGW feeding areas, but these industrial activities typically lasted only a portion of the ice-free season. In most cases sound levels returned to values within the prior background envelope as soon as the industrial activities ended, although some construction projects leading to the commissioning of a new asset have resulted in a lasting increase of the local background level because of noise from operation and support activities.

Background sound levels as recorded at the control station were statistically lower in 2013 than in the previous two years. This observation gives strength to the argument that the current location of the control station is still suitable as a baseline station for collecting natural ambient noise, countering perceptions that the increasing amount of industrial activity in the region may dictate a removal to a more remote site.

Anthropogenic Noise

An analysis of the evolution of the anthropogenic noise in the region must take into account not only underwater sound generated by industrial activities of the Companies' projects, but also sounds from projects of other operators and fishing vessels active in the area at certain times (generally in the later part of each season). Because of geographical separation of the various license areas and assets, generally the only third-party oil and gas related activities that have been observed to induce sizable levels of anthropogenic noise within the feeding areas have been seismic surveys for neighboring projects. For example, as mentioned earlier, sound levels at the control station in the north (generally unaffected by Companies' project activities) were influenced by 3D seismic surveys from the Sakhalin-5 project license area in 2008, 2009 and 2011.In 2007, an unspecified seismic survey to the east of the Offshore feeding area caused elevated sound levels in that WGW habitat. Fisheries-related vessel activities generally have a limited range of noise exposure at levels significantly above background and tend to be mostly in transit, thus moving around their footprint of influence. There are however sensitive regions such as the Offshore feeding area where multiple fisheries may operate concurrently resulting in a sustained aggregate production of anthropogenic noise. The challenge posed by these third party operations, especially in the case of seismic survey activities, is that neither the scheduling and location nor the specifications of the source may be known in advance, making it virtually impossible to build their potential contribution to the anthropogenic sound levels in the feeding areas into any type of forecasting or planning scenario.

From the evaluation of the acoustic monitoring data over the span of the Joint Program to date, it is possible to derive some key findings about anthropogenic noise levels:

- Offshore construction activities by the Companies generally induced broadband sound pressure levels that did not exceed 120 dB re 1 µPa at the nearest boundary of a feeding area (acoustic monitoring site) except for brief surges in the order of hours. This cap was largely achieved through the planning of activities with the aid of forecasting tools (see section below on numerical models) to avoid scenarios that could lead to unnecessary aggregation of noise sources.

- Mitigation measures implemented by the Companies, primarily through design of development operations to result in the minimum levels of anthropogenic noise and/or the exposure of the least number of whales, have arguably resulted in reduction of potential risk. An example of sound exposure mitigation through adaptive planning comes from the tow-in and placement of the PA-B concrete base (CGBS) in 2005. Acoustic data collected during the installation of a similar structure in Lunskoye a month earlier were analyzed and promptly leveraged to review and improve tug procedures for the operation at the more sensitive PA-B site, resulting in a comparative reduction of sound levels by as much as 5 dB at critical phases.

- The most prominent sources of prevailing anthropogenic noise measured by the monitoring program (with the infrequent exception of seismic surveys conducted within the Companies' license areas) are the vessels operating in the region. Recorded sound levels from vessels moving past a monitoring location are generally transient n time. Vessels associated with a particular operation, however, may remain in place for extended periods and therefore can contribute significantly to sound exposure in a given area.

- The decreasing water depth across the Piltun feeding area moving inshore has the effect of stripping away low-frequency energy from anthropogenic noise propagating into the area from offshore activities, resulting in a reduction in broadband sound level by several dB between the 20m and the 10m bathymetry line (as much as 10 dB at the lower frequencies for sound originating near the platforms). Conversely, the low frequency sound induced by ground vibration from on-shore construction activities is suppressed within the <10m water depth region, forcing as , acoustic energy travels through the sea bottom and couples into the water farther offshore.

- As assets move past the activity-intensive commissioning phase and settle into the long-term production phase, management of lower level but more chronic anthropogenic noise from routine operations becomes the focus of the acoustic monitoring effort. In 2013 dedicated acoustic measurements and analyses were conducted to characterize fully the underwater noise field from the Sakhalin Energy platforms PA-A (Molikpaq) and PA-B, enabling correlation of mechanical noise from on-board equipment with radiated underwater sound and providing information suitable for an engineering review of individual sources.

As the acoustic monitoring continues through successive seasons, observations from individual years contribute to an expanding knowledge about anthropogenic noise that allows broader interpretations to be made. Unlike other environmental quantities such as benthos distribution being monitored by the Joint Program, whose seasonal and annual trends are usually gradual and continuous, noise levels respond directly and abruptly to changes in activities and thus are more likely to exhibit statistical variability. The significant findings are related to a better understanding of sound propagation in the region, of the aggregate and cumulative sound exposure from various operations, and of the effectiveness of mitigation measures.

Numerical Model Development and Application

Starting after the 2004 season that had included a dedicated program of characterization of the noise output from vessels involved in Sakhalin Energy operations in Lunskoye, an effort began to produce a reliable acoustic propagation model that combined with source levels information could be used as a sound exposure forecasting tool for future offshore operations in the NE Sakhalin region. The resulting software, an enhancement of industry standard advanced algorithms, was parametrically tuned to the properties of the region using acoustic transmission loss data and bathymetric and hydrographic profiles collected as part of the annual program. To date the Joint Program has supported a significant effort to characterize the acoustic propagation environment and track its variability. The primary aspects of that effort are as follows:

- Over several program years a set of acoustic transmission loss profiles has been acquired along a range of transects by deploying an active underwater sound source at a number of locations and recording its signal at various frequencies on the deployed acoustic stations. This provides highly accurate characterization of the frequency dependent transmission of sound between points in the region, essential to the calibration and verification of a computational model.

- From 2004 to 2013 about 2,700 vertical hydrologic profiles of the water column have been collected, documenting the spatial (in location and depth) and temporal variability of sea water temperature and salinity plus additional parameters such as turbidity and dissolved gases. This growing base of information provides increased ability to estimate the sound propagation for given periods of a season and to place bounds on its variability. The observations in 2013, for example, showed the most extreme effect of heavy outflow from the Amur River on the local hydrological conditions in the history of the monitoring program.

- Systematic water depth soundings acquired from the acoustics program support vessel from 2003 through 2012 have enabled the synthesis of a highly accurate bathymetry grid of the region that has now replaced for all acoustic modelling work an earlier, coarser grid that ignored finer scale features of the seafloor critical to sound level estimation in shallow waters.

The marine operations noise model thus developed has been an essential part of the environmental impact assessment for the Companies' developments in the region and has enabled considerable insight in the expected noise exposure of operational alternatives. In the case of the 2010 Astokh 4D seismic survey, the model was an integral component of the initial assessment of potential regions of whale disturbance, the definition of the survey area, and the real-time field monitoring and mitigation plan.

Noise Effect on Gray Whale Behavior

Any attempt to assess the effect of noise from industrial activities on gray whale behavior cannot be regarded as valid if other potential inputs have not been considered in a properly designed multivariate analysis (MVA) to either account for or dismiss their hypothetical contribution. Starting with the 2001 seismic survey, every geophysical exploration or significant construction activity by the Companies on the NE Sakhalin shelf has included in its monitoring and mitigation plan some form of visual observation of the gray whales (usually for both distribution and behavior) conducted from land and/or vessel based stations. These visual observations provide the response variables (for example swim speed, changes of direction, diving frequency, respiration patterns) to be explained in terms of predictor variables that include sound levels at the animal location but also proximity of vessels, time of day, environmental conditions and a variety of other possible inputs. MVAs were conducted with behavioral data collected during ENL's Odoptu seismic survey (2001), Sakhalin Energy's PA-B CGBS installation (2005) and pipeline construction activities (2006), ENL's Odoptu pile driving (2009), and Sakhalin Energy's Astokh 4D seismic survey (2010).

The process for estimating the noise explanatory variable(s) involved a hybrid approach combining the hind-casting capability of the model with the ground-truthing of the acoustic monitoring data. Different variants of the basic approach were used for the 2005, 2006 and 2010 MVAs determined in part by the nature of the acoustic source(s) involved and in part by evolving technical capabilities and sophistication in the estimation process. For the 2005 (PA-B CGBS installation) MVA a single acoustic explanatory variable was estimated, namely the broadband sound pressure level received at a whale's location from all anthropogenic sources combined. In this case the anthropogenic noise contribution was assumed to arise from two sources only: a time-evolving conglomerate of all noise producing activities (mostly tug operations) around the PA-B site, and the research vessel that operated in the vicinity of the Piltun feeding area and whose motion was known from GPS records. The modelled aggregate acoustic field from these two sources was then ground-truthed by applying a correction equal to the difference between measured and modelled level at the monitoring station nearest to the animal location. For the 2006 (PA pipeline construction) MVA a similar process was followed for the estimation of the sound field with the difference, that the offshore noise sources were modelled as a time-evolving collection of vessel spread scenarios along the pipeline route whilst the more near shore noise originated from two independently modelled research vessels. After the ground-truthing correction the estimated sound level at the whale location was resolved into its offshore (construction) and near shore (research vessels) components which formed distinct explanatory variables. For the 2010 (Astokh 4D seismic survey) MVAs it was assumed that the received pulse level from the airgun array source would be the sole acoustic input, given its dominating loudness even at considerable distances. For this MVA, however, the cumulative sound exposure levels over a number of accumulation periods from hours to days, rather than instantaneous levels, were considered as explanatory variables.

In 2011 the scientists from Pacific Oceanological Institute responsible for the Acoustic Monitoring under the Joint Program stressed the attention of Sakhalin Energy to the underwater noise exceeding the ambient noise levels in PA-A and PA-B area. In 2012 this information was verified and in 2013 Sakhalin Energy conducted the special measurements of noise on the platforms and around ones in order to identify all potential sources including stand-by and supply vessels. The findings of this study were used as the basis for the development of the certain engineering solutions to address the issue. This is another good example of how the monitoring helps to minimize the impacts and improve mitigation measures.

4.6.3. Mitigation of Threats

ENL and Sakhalin Energy are committed to conducting their operations in a manner that minimizes affects to the WGW and the environment. Each company's facilities are designed, constructed and operated to companies' rigid standards in compliance with international standards and Russian laws intended to prevent and /or mitigate potential impact to the environment and WGW population. Numerous, multi-layered environmental safeguards are part of the design and implementation of the projects. Design solutions include modern environment protection equipment, the use of environmentally safe technologies and additional environmental protection measures. Additionally, specific measures to minimize potential impact on the WGW and habitat have been implemented by the Companies based on the understanding gained from the Joint Program and best accepted practices.

Marine Mammal Protection Plans

Measures to mitigation threats to WGW are included in the Marine Mammal Protection Plan (MMPP) that each Company has developed and implemented specifically for their respective activities. The purpose of the MMPPs is to manage the risks of affect to all marine mammals during the execution of all ENL and Sakhalin Energy activities. The MMPPs focus on reducing potential risks to WGW resulting from whale-vessel collisions, disturbance to feeding and migrating western gray whales, and disturbance of cow / calf pairs.

Protective measures that are included in the Companies' respective MMPPs include controlling vessel routes and speeds, having Marine Mammal Observers (MMOs) and trained personnel on board vessels to ensure prescribed distances from WGW are maintained and corrective action is taken when necessary to maintain such distances, avoidance of areas where WGW feed, prescribed noise standards, and training of all vessel-based personnel on the MMPP.

Vessels operating off northeast Sakhalin are manned with Marine Mammal Observers (MMOs) who are specialist on the MMPP and trained on the identification of marine mammals including WGW. The MMOs provide oversight for full compliance to the MMPP and ensure that WGW are not put at risk by Company operations. Company personnel and contractors that work aboard vessels off NE Sakhalin are provided training on the MMPP and are made aware of Company requirements protective of WGW. Daily stewardship of the MMPP is conducted with the MMOs reporting to an on-shore coordinator the status of work activities and verifying compliance to the MMPP.

Oil Spill Response Plans

ENL and Sakhalin Energy each have Oil Spill Response Plan (OSRP) developed in accordance with the requirements set forth in Russian laws and standards covering oil spill prevention and response, with a view toward ensuring the effectiveness of measures implemented for accomplishing these tasks at their respective facilities and operations. The planning and training for oil spill prevention and response activities are undertaken to ensure utilization of best practices to prevent the occurrence of emergency situations, to maintain response personnel and material in a state of readiness, as well as to reduce damage and losses in case of such emergencies as much as practical. The OSRPs emphasizes the practical actions to be taken for improved response effectiveness and minimization of negative environmental impact.

Facilities Operations and Preventative Maintenance

Operational procedures have been developed to minimize potential for oil spills and other releases into the environment. Regular inspection, maintenance, and repair activities are fundamental to each company's operating philosophy of conducting operations in a manner that minimizes potential for environmental impact. Audit procedures are implemented to verify adherence and effectiveness of operational and maintenance procedures.

5. PUBLICATIONS AND PRESENTATIONS

In support of ENL and Sakhalin Energy efforts to increase the understanding of the WGW, the companies promote the dissemination of Joint Program findings through publications, presentations, participation in scientific conferences and international meetings, and other communications. Additionally, Joint Program scientists and the Companies personnel interact on a regular basis with leading scientists, representatives of regulatory bodies, and other stakeholders, with the goal of communicating and aligning efforts intended to increase the understanding of WGW and their habitat and development and implementation of approaches that contribute to the protection and conservation of entire North Pacific gray whale population and the environment.

A comprehensive list of Joint Program publications and presentations is provided in Appendix V.

Publications, presentations, and meeting participation for 2013 include:

1. IWG:

- 18 April 2013 - meeting No. 9
- 29 November 2013 - meeting No. 10.

2. International Whaling Commission: Jeju, Korea, 3-15 June 2013.

3. Western Gray Whale Advisory Panel (WGWAP): Tokyo, Japan, 15-17 May, 2013.

4. Society for Marine Mammalogy 20th Biennial Meeting: Dunedin, New Zealand, 9-13 December 2013.

Joint Program Presentations and Publications in 2013

Books

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Tombach Wright, C., Tyurneva, O.Yu., Yakovlev, Yu.M. and V.V. Vertyankin. 2013. Interchange of Western Gray Whales Among Three Discrete Feeding Areas Off Sakhalin Island and Southeastern Kamchatka, Russia. 20th Biennial Conference on the Biology of Marine Mammals, Dunedin, New Zealand, 2013

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6. CONCLUSIONS

The implementation of the Joint Program and investigations sponsored by each Company, have resulted in significant increase in the understanding of the WGW and their habitat. The annual reports of the Joint Program (2002-2013) include a record of the progression in the understanding the WGW and help provide the Companies and other interested parties the basis to assess the status of the WGW population and habitat. Below are key conclusions and learnings about the WGW and habitat that have been obtained through the conduct of the Joint Program and other Company-sponsored investigations.

6.1. WGW Population

- Since 1983 when WGW were sighting off NE Sakhalin, the number of known WGWs has steadily increased from ~20 to >200. As of 2013, a cumulative total of 228 individual WGW have been identified in the IBM Sakhalin WGW catalog. During the 2013 field season, nine new WGW (i.e., six calves and three non-calf WGW) were added to the IBM WGW catalog.

- As of 2013, a combined total of 245 WGW have been identified off NE Sakhalin by two photo-ID teams (i.e. Zhirmunsky Marine Biology Institute (IBM) and the Russia-US Research Team). As of 2012, 19 WGW were identified only in the IBM catalog and 17 WGW were only identified in the Russia-American catalog.

- Typically there are three to five non-calf WGW sighted for the first time off NE Sakhalin each year. It is unknown whether these WGW are new to the region or have just not been previously photographed and identified.

- The WGW population has an estimated growth rate of ~ 3.3 %. based on modeling conducted by Cooke et al. 2013 using photo-ID data.

- Typically, 50-60% of the individual WGW identified in the IBM catalog are sighted each year by the Joint Program Photo-ID team. The number of WGW sighted each year is positively correlated to the extent of the Photo-ID effort.

6.2. WGW Migrations

- WGW migrate each spring and summer (~May-July) to the Sea of Okhotsk and some WGW are known to spend the ice-free months in feeding areas off NE Sakhalin.

- Winter migrations and habitat of WGW were unknown until the satellite tagging of WGW in 2010 and 2011 elucidated the timing and route of the winter migration. Three WGW with satellite tags were tracked from Sakhalin to Kamchatka and eastward to North America.

- One satellite-tagged WGW (Varvara) was tracked throughout a complete migratory cycle from Sakhalin to the known wintering habitat of Eastern gray whale in Baja California, Mexico, and subsequently back to Sakhalin, arriving in the Piltun feeding area on May 18, 2012.

- The North American migration for at least 26 Sakhalin WGW has been confirmed by matches between photographic catalogs, genetic matches of biopsied WGW, and satellite tagging. Matching has verified that >30 WGW migrate to North America have (non-published data).

6.3. WGW Distribution and Abundance

- Through all years of monitoring the main feeding period of WGW remains stable and covers summer-fall season; however, WGW distribution and abundance in the Piltun and Offshore feeding areas vary from year to year.

- For all years the peak season of WGW abundance is observed in August-September.

- The near shore area from the mouth of Piltun Lagoon to about 15 km north is the most stable area in terms of whale numbers, i.e., whales have been seen in this area in relatively large numbers every year.

- The most stable WGW aggregation is one near the Piltun Bay mouth which includes approximately the same number of WGW from year to year

- WGW abundance in the Offshore feeding area usually peaks in late summer (i.e., September-October), possibly due to a decrease in prey organisms in the Piltun feeding area towards the end summer.

6.4. WGW Feeding Areas

- Two primary feeding areas for WGW are known off NE Sakhalin: the Piltun or near-shore feeding area and the Morskoy or Offshore feeding area.

- The Piltun feeding area appears to be the preferred area during early feeding months (i.e., June-August), with the Offshore feeding area utilized more in late summer.

- Some WGW are known to move between the two Sakhalin feeding areas during the feeding season, and are hypothesized to feed opportunistically in the entire area.

- Prior to the discovery in 2001 of the Offshore feeding area, it was assumed that the Piltun feeding area was the only feeding area off NE Sakhalin and that WGW only feed at depths of less than 20 m. Non-calf WGW are known to feed in both feeding areas and are not restricted by depths (up to ~50-60m) for feeding.

- WGW observed feeding in water depths of >20 m in the northern part of the Piltun feeding area coincided with high densities of sand lance in that area.

- WGW have been observed feeding in areas outside of the two primary feeding areas including Severny Bay in North Sakhalin, and Olga and Vestik Bays off southeast Kamchatka. In 2013, a single WGW was observed feeding near the Vostochnyy Reserve off the eastern coast of Sakhalin. Additional WGW feeding areas that have not yet been identified seem likely, which may explain why some WGW are not seen every year.

6.5. WGW Body Condition

- Each year, some WGW arriving to the Sakhalin area appear to be in an emaciated ("skinny") or poor body condition. The occurrence of the skinny condition is believed to be the result of the individual WGW having depleted their body fat over the course of their winter migration. About 10 to 20% of WGW off Sakhalin each year have been observed in various levels of poor body condition (i.e., body class 2, 3 or 4).

- Mothers with calves are often in poor body condition upon arrival off Sakhalin (beginning of feeding season); however, the calves appear well nourished.

- It is believe that that there is little to no feeding during the winter period while WGW are away from the Sakhalin feeding areas. WGW spend the ice-free months off NE Sakhalin consuming large quantities of prey and "fattening" themselves. Over the course of the feeding season, the body conditions of most WGW improves, and by the end of the feeding season ~ 80-91% of initially-poor body condition WGW are observed in a normal condition (i.e., body class 0 or 1).

6.6. WGW Food Resources

- WGW are known to feed upon benthic organisms. It is hypothesized that WGW congregate each year in the Sakhalin feeding areas due to the high biomass of preferred prey organisms, especially amphipods and isopods.

- In the Sakhalin feeding areas, amphipods and isopods occur as the highest percentage of the benthic biomass, and therefore serve as the primary food resource for WGW off NE Sakhalin.

- Amphipod biomass within the Piltun feeding area is highest in the near shore zone in water depths of 5 to 15 m and decreases sharply at depths greater than 20 m. The amphipod biomass varies among years; with average biomass at the sampling locations ranging between 28.5-47.4 g/m2.

- The amphipod *Ampelisca eschrichtii* appears to be the main prey species in the Offshore feeding area. Average amphipod biomass in the Offshore feeding area are stable from year to year. WGW in the Offshore feeding area have been observed to feed at depths of 40 to 60 m with amphipod biomass greater than 300 g/m2.

- Sand lance is a temporary component of the benthic community and, when available, appears to be an opportunistic food source for WGW. The highest sand lance biomasses were recorded in northern and middle part of the Piltun area, at depths greater than 20 m. Observed variability in sand lance biomass are believed to influence the distribution of gray whales within their feeding areas.

- The contribution of amphipods and isopods to the total biomass in the feeding areas was more than 50 % and reached values of more than 100 g/m2. When comparing these numbers with the total amphipod biomass of the grid samples, it is clear that WGW target patches with relatively high prey biomass.

- Olga Bay in Kamchatka has amphipod biomass ranging from 35 to 60 g/m2) that was very similar to that found in the Chayvo area.

6.7. Environmental Contaminants in WGW Feeding Areas

- Levels of contaminants in sediments in the monitored areas of NE Sakhalin do not exceed background levels.

- Levels of petroleum hydrocarbons in the sediments of the feeding areas were below background concentrations measured for the Sakhalin shelf sediments.

The lower petroleum hydrocarbon concentrations were found in sediment closer to shore.

- Heavy metals in the sediments did not exceed the background levels for the NE Sakhalin shelf prior to the beginning of active industrial activities and they were substantially below the values of the Probable Active Concentration of toxic metals (PAC) at which negative influence on benthic organisms can be expected. Heavy metal concentrations in polychaetes in the Piltun feeding area confirmed that heavy metals were not above background levels.

6.8. Noise in WGW Feeding Areas

- Since 2003, the Companies have monitored ambient and anthropogenic noise through the Joint Program and with activity-specific monitoring in the feeding areas and offshore work areas to ensure that levels do not exceed prescribed thresholds.

- Ambient noise levels vary significantly because of weather activity (wind, surface waves and rain) which can elevate the background by more than 20 dB; broadband levels can be near 100 dB during storms

- Offshore construction activities by the Companies generally induced broadband sound pressure levels that did not exceed 120 dB re 1 µPa at the nearest boundary of a feeding area except for brief surges in the order of hours. This cap was largely achieved through the planning of activities with the aid of forecasting tools to avoid scenarios that could lead to unnecessary aggregation of noise sources.

- Vessels are the main contributors to the acoustic footprint from Company activities with the exception of seismic surveys or pile driving. Sound levels from moving vessels are generally transient in time and are unlikely to cause sustained disturbance to whales in the area. Vessels associated with a particular operation and remain in place for extended periods could contribute significantly to sound exposure in a given area, and could cause behavioral or distribution changes in whales.

- The systematic monitoring of anthropogenic sound from company activities has allowed the identification of noise, which in turn has led to revision of practices or engineering alterations to minimize acoustic output. A dedicated noise assessment study conducted by Sakhalin Energy on its platforms in 2013 was the outcome of regular comparative profiling of acoustic footprints through the Joint Program.

- Multivariate analyses of behavioral data collected during seismic survey operations have indicated that even at higher received sound exposure levels, any observed changes were relatively subtle.

- When seismic surveys were conducted very early in the season (e.g. the 2010 4D seismic survey by Sakhalin Energy) the number of whales present has been so low that multivariate analyses have insufficient statistical power to detect subtle changes in response variables. These behavioral changes have had no measurable negative impact on population level parameters based on monitoring to date.

- A high number of calves (11) was recorded in 2003, two years after the 2011 ENL seismic survey which took place at a time in the season (August-September) when larger numbers of whales were in the region than in later surveys.

- Multivariate analyses of behavioral data during the 2005 CGBS installation showed that with increasing sound levels whales were observed further from shore. During the 2006 pipeline installation whales appeared to be breathing faster as a result of increasing sound levels. To date it remains difficult to interpret what effect, if any, these statistically significant short-term subtle changes in behavioral parameters could have on the gray whale population.

6.9. Conservation of WGW

- ENL and Sakhalin Energy maintain their commitments to conduct their Sakhalin operations in a manner that does not adversely affect the environment and the Sakhalin gray whales.

- ENL and Sakhalin Energy interact with leading scientists, international organizations, and other stakeholders in public fora through participation in their meetings and scientific publications in order to promote and facilitate efforts to conserve WGW and habitat.

- The Joint Program monitoring from 2002-2013 provides a scientific basis for assessing the gray whales that feed off Sakhalin and demonstrates that the number and distribution of WGW off NE Sakhalin have not been adversely affected by the Companies' activities.

- The Companies' facilities have been designed and constructed to the highest standards in order to minimize risk of environmental impacts. Rigorous operating, services, monitoring, and auditing procedures are adhered to by each Company to mitigation potential risks to the environment and the WGW.

- The Marine Mammal Protection Plans (MMPPs) implemented by each Company have been highly effective at eliminating or mitigating effect of offshore operations on WGW and other marine mammals, with no incidents due to Companies' activities.

7. ACKNOWLEDGEMENTS

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APPENDICES

- Appendix I. Photographic Identification of the Gray Whale (*Eschrichtius robustus*) Off the Northeast Coast of Sakhalin Island, 2013 (March 2014)
- Appendix II. Distribution and Abundance of Gray Whales In Northeast Waters of Sakhalin Islands in July-November 2013. (March 2014)
- Appendix III. Benthos studies in the feeding grounds of gray whales in 2013 (March 2014).
- Appendix IV. Acoustic Monitoring on the North East Sakhalin Shelf, 2013 (March 2014)
- Appendix V. Cumulative List of Joint Program Publications and Presentations (2002-2013).

Appendix V. Cumulative List of Joint Program Publications and Presentations (2002-2013)

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