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Sakhalin Energy Investment Company Ltd.

Summary of the Joint Okhotsk-Korean Gray Whale Monitoring Program Findings, Sakhalin,Russian Federation, 2002 – 2010

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APPROVED:

Zeljko Runje
Vice-president
«Exxon Neftegas Limited»
27 December 2011 г.

APPROVED:

Richard Evans
General Manager HSE
«Sakhalin Energy Investment Company Ltd.»
27 December 2011 г.

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2011

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EXECUTIVE SUMMARY

The Joint Exxon Neftegas-Sakhalin Energy Okhotsk-Korean Gray Whale Research and Monitoring Program is primarily focused on the northeast Sakhalin shelf, utilizing leading Russian research institutes to monitor the Okhotsk-Korean or Western North Pacific gray whales (*Eschrichtius robustus*), hereafter referred to as the Okhotsk-Korean gray whale population. Since 2002, data have been collected in 5 programs: 1) Acoustic Monitoring, 2) Benthic and Prey Studies, 3) Gray Whale Behavior Studies, 4) Gray Whale Distribution and Abundance Studies, and 5) Gray Whale Photo-Identification Studies. Each year, detailed reports on the results of the previous field season have been submitted by the Companies to the Russian Federation Ministry of Natural Resources, Federal Oversight Service for Natural Resource Use (ROSPRIRODNADZOR), the Russian Federal Fishery Agency, and the local Sakhalin department of ROSPRIRODNADZOR. This summary report provides a high-level synopsis of each of the program components including: 1) Study Components and Objectives, 2) Study Methods, and 3) Summary of Results. The last section, titled "What Have We Learned?" provides answers to frequently asked questions and highlights the major conclusions that can be drawn from the 2002-2010 studies. Overall, the Joint Monitoring Program has provided insights into the status of the Okhotsk-Korean gray whale population, including providing an increased estimate of whale numbers (between 131-165 catalogued individuals), increasing population growth rate, and evidence that the body condition of individuals improves over the course of the feeding season off Sakhalin (80-91% of individuals are considered in "good condition" by the end of a survey season). A number of feeding areas (Piltun, Offshore, and eastern Kamchatka) have been identified and characterized, and studies on preferred prey species (amphipods and isopods) and opportunistic food sources (sand lance) have been conducted. Industrial sound levels from a variety of activities (e.g., seismic surveys, pipeline construction, and offshore platform construction) were monitored, with slightly elevated levels observed at monitoring stations in the Piltun and Offshore areas (maximum levels at 90% level of one-third octave power spectral density plot between 100-120 dB re 1 μPa^2 in low-frequency bands compared to background levels that were generally <100 re 1 μPa^2). Distribution and abundance of whales did not appear to correspond with specific industry activities and seemed to be more linked to availability of prey. An integrated statistical analysis has been initiated, led by Lomonosov Moscow State University, to quantify these linkages and understand more subtle changes that may be imparted by elevated sound levels from individual and cumulative industry activities in the Sakhalin region.

1. INTRODUCTION

Exxon Neftegas Limited (ENL), operator of the Sakhalin-1 project, and Sakhalin Energy Investment Company (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 by the Okhotsk-Korean or Western North Pacific gray whales (*Eschrichtius robustus*), hereafter referred to as the Okhotsk-Korean gray whale. This gray whale population is listed as endangered in the Russian Red Book and as critically endangered by the International Union for the Conservation of Nature (IUCN, Hilton-Taylor 2000). The Environmental Impact Assessments for the Sakhalin-1 and Sakhalin-2 projects were subjected to the State Ecological Expert Reviews (SEER), which required (in 2004 for the Sakhalin-1 and in 1998 and 2003 for the Sakhalin-2) studies to be conducted to understand and monitor the individual and cumulative impact of oil and gas developments on the western gray whale population. ENL and Sakhalin Energy (hereafter referred to as the Companies) initiated preliminary Okhotsk-Korean gray whale studies in 1997. In 2002, the Companies decided to combine efforts and jointly fund a multi-disciplinary research and monitoring program that is now known as the Joint ENL-Sakhalin Energy Okhotsk-Korean Gray Whale Research and Monitoring Program or, in short, the Joint Monitoring Program.

The Joint Monitoring Program is primarily focused on monitoring the Okhotsk-Korean gray whale population and its environment on the northeast Sakhalin shelf, utilizing leading Russian research institutes to monitor the western gray whale population. In 2004, the study area was expanded to include Kamchatka, and other areas were visited on an opportunistic basis. The ENL-Sakhalin Energy Joint Monitoring Program has provided critical information about the Okhotsk-Korean gray whales that can be used to assess the status of the population and mitigate potential impacts associated with the industial activities of the Sakhalin-1 and Sakhalin-2 projects.

1.1. JOINT MONITORING PROGRAM RESEARCH COMPONENTS

The Joint Monitoring Program consists of five main components to collect the data needed to answer the above questions. These study components are:

1. Underwater sound propagation and monitoring studies to understand the variation in ambient noises and sound levels generated by seismic surveys and industrial activities in the sea and onshore.
2. Benthic studies to understand prey distribution and Okhotsk-Korean gray whale feeding activity.
3. Distribution and relative abundance studies of the Okhotsk-Korean gray whale in their feeding areas from a research vessel and from shore.
4. Photo-identification studies to understand population status, reproduction rates and body condition.

5. Shore-based behavioral studies monitoring individual whale behavior parameters.

In addition to these annual studies, ENL and Sakhalin Energy conducted monitoring studies jointly or independently related to specific exploration or development activities. Considerable monitoring effort was put in place by ENL in 2001 in relation to the 3D seismic survey of the Odoptu license area (Gailey et al. 2007a; Johnson et al. 2007; Meier et al. 2007; Rutenko et al. 2007; Yazvenko et al. 2007a,b). Additional monitoring was conducted by ENL during 2003 to 2006 related to the installation of the Orlan drilling/production platform, the construction of the pipeline across Nevelskoy Strait and the marine terminal at DeKastri. Similarly, Sakhalin Energy conducted independent studies related to their 3D seismic survey of the Lunskoye license area in 2003 (Sakhalin Energy 2003), the construction of their offshore pipeline through the Piltun-Astokh license area in 2004 and 2005, installation of the PA-B drilling/production platform in 2005-2007 (Gailey et al. 2007b, Rutenko& Racca 2006), and the 4D seismic survey of the Piltun-Astokh field in 2010. ENL and Sakhalin Energy jointly sponsored satellite tagging studies of eastern North Pacific gray whales in North America in 2005 (Mate and Urban 2005) and in Russia in 2005 and 2006 (Heide-Jørgensen et al. 2006) as pilot studies to test tags and procedures that could be potentially used on Okhotsk-Korean gray whales. In 2010, the Companies provided funding to the International Whaling Commission (IWC) which coordinated a Okhotsk-Korean gray whale satellite tagging program. The program was led by scientists from the A.N. Severtsov Institute of Ecology and Evolution of the Russian Academy of Sciences (IEE RAS) and Oregon State University Marine Mammal Institute (Mate et al. 2011). In 2010, the Okhotsk-Korean gray whale later named “Flex” (or “Whitefluke”) was tagged in October off northeast Sakhalin and by February 2011, Flex had migrated to North American coastal waters of Oregon. In 2011, the satellite tagging effort was again co-funded by the Companies and led by Russian and US scientists. In 2011 6 whales were tagged. Currently 2 tags are still active and the remaining 4 stopped transmitting. The main purpose of the tagging studies is to determine migration routes and over-wintering areas, which are currently unknown for the Okhotsk-Korean gray whale population, to enable development of site specific conservation initiatives.

Figure 1.1. Overview of Sakhalin Island and Kamchatka Peninsula. Research components of the Joint Monitoring Program take place in northeastern Sakhalin (red rectangle), with some monitoring effort along the eastern side of Kamchatka Peninsula (mainly Olga Bay).

1.2. JOINT MONITORING PROGRAM RESEARCH INSTITUTES

ENL and Sakhalin Energy have always strived to utilize Russian researchers from leading Russian Research Institutes in the Far East and Moscow. The institutes and key researchers that have been involved in the program are:

- Acoustic studies: Pacific Oceanological Institute of the Far Eastern Branch of the Russian Academy of Science in Vladivostok (POI FEB RAS). Scientific lead: Dr. A.N. Rutenko
- Benthic studies: A.V. Zhirmunsky Institute of Marine Biology of the Far Eastern Branch of the Russian Academy of Science in Vladivostok (IBM FEB RAS). Scientific lead: Dr. V.I. Fadeev
- Behavior studies: Texas A&M University in Galveston (TAMU) and Institute of Marine Biology of the Far Eastern Branch of the Russian Academy of Science (IBM). Scientific leads: G. Gailey and O. Sychenko.
- Distribution studies: Russian Fisheries Research Institute in Moscow (VNIRO). Scientific lead: Dr. V.A. Vladimirov.
- Photo-identification studies: A.V. Zhirmunsky Institute of Marine Biology of the Far Eastern Branch of the Russian Academy of Science in Vladivostok (IBM FEB RAS) Scientific leads: Dr. Yu. M. Yakovlev and O. Yu. Tyurneva.

Collaboration between the Sakhalin-1 and Sakhalin-2 operators and Russian research institutes has resulted in the development of new equipment and new methods of study. The program has also resulted in the production and submission of annual reports to Russian regulators; abstracts, posters and presentations for national and international symposia; publications in peer-reviewed international scientific journals; and the production of a book containing the Okhotsk-Korean gray whale catalogue of unique individuals photographed over the period 2002-2005and a brief summary of their ecology (Tyurneva et al. 2007). Appendix A provides a summary of these reports. At the same time, study participants keep pace with the increasing volume of scientific literature, and adhere to national and international standards for conducting scientific research on marine mammals and their habitat.

1.3. SUMMARY REPORT PURPOSE

This summary report has been prepared in line with the recommendations of the Federal Oversight Service for Natural Resource Use (ROSPRIRODNADZOR letter № BC-04-01-32/228, dated 18.01.2011), the Russian Federal Fishery Agency (letter № У04-58, dated 20.01.2011) and the Interagency Work Group for the Okhotsk-Korean Gray Whale Preservation (minutes of the meeting with ENL and Sakhalin Energy on 20 December 2010). The purpose is to provide an overview of the research that has been conducted in 2002-2010 under the ENL-Sakhalin Energy Joint Okhotsk-Korean Gray Whale Research and Monitoring Program and of the knowledge that we have gained from this program. The information of most interest to the Russian Federation Regulatory

Agencies, the Companies, and international scientific community is to what extent industrial activities impact Okhotsk-Korean gray whale behavior, distribution and abundance, and population health. Multivariate statistical analyses using behavioral data have been conducted specific to certain industrial activities for some of the years and these results are summarized in this document. In 2011, efforts were initiated to analyze the 2002 – 2010 Joint Monitoring Program datasets in an integrated manner to determine the quantitative connections between different components of the program and the impact of operations on whale distribution and abundance. This work is still in progress and its results are therefore not included in this report.

This summary report is not intended to document detailed methodologies or analyses of the separate research components. This information can be found in the reports and papers listed in Appendix A. Each of the sections should be considered as a "refresher", meaning that they convey specific program component highlights including methodology and basic summary of results. The first section of the report, titled "What Have We Learned" includes a few of the most asked questions about the Okhotsk-Korean gray whales and the Joint Monitoring Program.

1.4. SUMMARY REPORT STRUCTURE

Since 2002 a lot of information on Okhotsk-Korean gray whale ecology has been gathered through the Joint Monitoring Program. Chapter 2 summarizes what we have learned from the results of the Joint Research Program through answering specific questions that are of interest to the Companies, Russian government, and other stakeholders. Chapters 3 to 7 of this summary report provide an overview for each of the five monitoring components including objectives, sampling methodology, and a brief summary of results. Currently, the scientists involved in the Okhotsk-Korean gray whale research and monitoring program, together with the Companies, are focusing on integrating the results from the various monitoring components, with help from statisticians and expert scientists from the Lomonosov Moscow State University. The Companies are also continuing to analyze impacts on gray whale behavior, distribution, and abundance from specific activities that took place in 2009 and 2010. A summary of the objectives and status of these analyses is presented in Chapter 8.

2. WHAT HAVE WE LEARNED?

The Joint Monitoring Program is one of the few long-term multi-disciplinary research programs that focus on a specific area and a single marine mammal species. As is apparent from the more detailed information about each monitoring component described in Chapters 3 to 7, we have gathered a lot of data about various aspects of the Okhotsk-Korean gray whales while on their feeding grounds. This chapter takes these results together and summarizes what knowledge has been gained over the past nine years of the Joint Monitoring Program.

WHAT IS THE STATUS OF THE POPULATION?

- In the early 2000's it was believed that the population of Okhotsk-Korean gray whales consisted of not more than 100 animals.
- Population assessments based on the photo-identification databases of the joint US-Russian and IBM Photo-ID teams, estimate the 2009 non-calf population at 131 animals (Cooke et al. 2010). This is 10 animals more than the estimated population size in 2007 (121 animals: Cooke et al. 2007).
- From the IBM photo-ID catalogue, we have identified a total of 187 OKGWs. Of these, 22 have not recently (<3 yrs) been re-sighted; their status is unknown.
- Combined photo ID data from Kamchatka and Sakhalin shows that the OKGW identified each year is relatively stable (126 in 2006, 132 in 2007, 122 in 2008, 138 in 2009, and 128 in 2010).
- The number of calves varies from year to year. The lowest observed number was 3 in 2004 and highest number was 10 in 2003.
- The results indicate that the population is generally stable, growing and successfully breeding.

WHERE DO OKGWS FEED?

- In the 1990s available data supported the hypothesis that whales were only feeding nearshore in the Piltun area in water depths of less than 20 m.
- Data collected since 2000 show Okhotsk-Korean gray whales also feeding offshore off Chayvo Bay (the Offshore feeding area; since 2001), nearshore off Chayvo Bay (2006-2009), in areas of >20 m water depth in the northern part of Piltun Bay (2004-2005), Severny Bay in North Sakhalin (2005), offshore Lunsky Bay (2003) and in regions southeast of the Kamchatka peninsula (since 2004). Additional feeding grounds utilized by OKGWs may likely exist, which may help explain why some whales are not seen every year within the monitored area.

- Mothers with calves were originally thought to be feeding only in the Piltun feeding area around the mouth of Piltun lagoon. Data collected since 2002 has revealed that mother/calf pairs have been observed feeding in other parts of the Piltun feeding area and in Olga Bay off east Kamchatka coast (first calf was observed there in 2008). However, the mouth of Piltun Bay seems still the most preferred area for mother/calf pairs.
- PhotoID studies revealed that individual whales move between feeding areas within years and between years. This is between the Offshore and Piltun areas and the nearshore Chayvo area, and between Kamchatka and Sakhalin (including calves; in 2009).

WHAT IS THE HEALTH OF THE POPULATION?

- In the early 2000s observations of emaciated whales were considered to be an issue that required attention as it was believed to be related to suboptimal feeding conditions, either through insufficient prey resources or to stress of animals resulting in a reduced uptake of food. What we have learned about emaciated whales is:
  - There are different levels of emaciation, categorized in 5 different body class conditions (0 to 4).
  - From 2002 to 2010 about 10 to 20% of whales have been observed in an emaciated state (body class 2, 3 or 4) in the Sakhalin feeding grounds.
  - A number of the emaciated whales are mothers of new calves observed at the beginning of the feeding season.
  - During the feeding season the body conditions of most whales improves, and by the end of the feeding season approximately 80-91% of whales are observed in a normal condition (= body class 0 or 1).
- Abnormal skin conditions (e.g. sloughing) are observed each year but this does not seem to affect the behavior or feeding habits of the gray whales.
- It is unclear what the causes of these abnormal skin conditions are.

WHAT DO WGWS EAT AND HOW STABLE IS THEIR FOOD SUPPLY?

- Amphipods and isopods are the primary food source and sand lance (*Ammodytes hexapterus*) is an opportunistic food source for OKGWs. It is not yet clear to what extent mysids and porcelain crab larvae are important as food resources for the OKGW (they are for the group of eastern gray whales feeding off Vancouver Island)
- 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 biomass varies between years, some of these variations are statistically significant. Average biomass ranges between 28.5-47.4 g/m^2.

- Main prey species in the offshore feeding area is believed to be the amphipod *Ampelisca eschrichtii*. Average amphipod (p.Ampelisca) biomass in the Offshore feeding area does not vary over the years at a statistically significant level. Whales in the Offshore feeding area are observed to feed in spots with an amphipod biomass of more than 200g/m^2.
- Sand lance are a temporary component of the benthic community and an opportunistic food source for gray whales, when available. Densest accumulations were recorded in northern and middle part of the Piltun area, at depths greater than 20 m (68-236 g/m^2 in 2004 and 2005).

WHAT DO WE KNOW ABOUT THE DISTRIBUTION AND ABUNDANCE OF GRAY WHALES

- Whale distribution and abundance in the Piltun and Offshore feeding areas vary from year to year.
    - The near-shore area from the mouth of Piltun Lagoon to about 15 km north is the most stable in terms of whale density, i.e., whales were seen there in relatively large numbers each year.
- Whale abundance in the Offshore area usually peaks in September-October, likely because the availability of prey organisms in the Piltun area decreases towards the end of the feeding season.
- The observation of whales in water depths of >20 m in the northern part of the Piltun feeding area in 2004 and 2005 coincided with high densities of sand lance in that area in those years. At the same time, whale abundance in the Offshore area was low, assuming that whales redistributed according to food supply.

WHAT ARE THE AMBIENT SOUND LEVELS IN THE FEEDING AREAS AND HOW DO THEY VARY?

- Ambient noise levels vary significantly and can be near 100 dB re 1 mPa^2 during storms.

HOW DOES INDUSTRIAL SOUND CONTRIBUTE TO THE OVERALL BACKGROUND LEVELS?

- Sound from industry activities was monitored at a series of points throughout the Piltun and Offshore feeding areas. Activities tended to raise sound levels in low frequency bands (2-630 Hz) to levels that ranged between 100-120 dB re 1 mPa^2 at the points closest to the industrial activities.

- Vessels are the main contributors to the anthropogenic acoustic footprint from construction activities.
- Acoustic data collected to date allowed for the development, calibration and testing of a numerical model that simulates sound propagation caused by diverse sound sources (e.g., seismic, pile driving) throughout the feeding area.

DO ACTIVITIES ASSOCIATED WITH OIL AND GAS DEVELOPMENT NEGATIVELY IMPACT THE WHALES?

- Pollutant levels (e.g., hydrocarbons) are at background level in sediments.
- Multivariate analyses of behavioral data during seismic operations (2001) 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. These changes were relatively subtle and appeared to have no measurable negative impact on population level parameters that have remained stable over the entire study period.
  - Highest number of calves (10) was recorded in 2003, two years after the seismic survey.
  - The population size, as estimated based on photo-identification data increased at a rate of about 3%
- Multivariate analyses of behavioral data during the 2005 CGBS installation for the offshore platform showed that with increasing sound levels whales were observed further from shore. During the 2006 pipeline installation whales appeared to be breathing faster during the periods of increasing sound levels. To date it remains difficult to interpret what these statistically significant short-term subtle changes in behavioral parameters could mean for the gray whale population.
- The fact that changes in behavioral parameters of gray whales on their feeding grounds occur due to the presence of anthropogenic sounds, emphasizes the importance to continue to closely monitor the Okhotsk-Korean gray whale population with the eye on future developments.

HOW HAVE THE COMPANIES APPLIED INCREASED KNOWLEDGE ON OKHOTSK-KOREAN GRAY WHALE ECOLOGY TO THEIR OFFSHORE ACTIVITIES?

- Based on our increased understanding of OKGW ecology and behavior, the Companies have been able to develop and implement Marine Mammal

Protection Plans (MMPP) to prescribe mitigation requirements (e.g. vessel corridors, vessel speed restrictions, etc.) that are protective of OKGW that must be adhered to by all personnel and contractors with work activities in the vicinity of OKGW feeding areas.

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

3. ACOUSTIC MONITORING

Since the 1970s, concerns about the possible effects of man-made noise on marine mammal populations have risen with increased industry activity in environmentally-sensitive regions. ENL and Sakhalin Energy recognized the possibility that anthropogenic sound from industry activities, such as seismic exploration of oil and gas sources, construction and pile-driving, might affect gray whale population during their exploration and development phases. In 1999, targeted acoustic studies were implemented in the Sakhalin area in preparation for planned oil and gas developments near the Piltun feeding area. In 2003, an annual acoustic monitoring program that uses Autonomous Undersea Acoustic Recorders (AUARs) installed at characteristic stations on the NE Sakhalin shelf (including both the Piltun and Offshore feeding areas) was initiated as part of the Joint ENL-Sakhalin Energy Okhotsk-Korean Gray Whale Monitoring Program.

The main goals of the acoustic study were to document natural and man-made sound levels at the boundaries and within the gray whale feeding areas, to collect data on bathymetry and hydrology required for propagation modeling in order to estimate (model) the distribution of sound from potential industrial sources (installation and operation of oil and gas extraction platforms, construction of underwater pipelines, etc.) into the gray whale feeding areas, and to develop numerical models that will allow estimation of sound levels from existing and planned industrial sources at the boundaries and within the Okhotsk-Korean gray whale feeding areas.

3.1. STUDY COMPONENTS AND OBJECTIVES

1. Recording of acoustic noises at 2-15000 Hz frequency range at a number of locations at the edge of and inside the Piltun and Offshore feeding areas and at a control station north of the Piltun feeding area. This started in 2003 and has been repeated annually.
    - Analyze temporal variation (within and between years) of acoustic noises at fixed locations on the Sakhalin shelf. Quantify the variation in ambient acoustic noise level in various weather conditions (including cyclones).
2. Measurements of data on bathymetry and hydrology (sound velocity, temperature, and salinity). These data were collected between 2004 and 2010.
    - Quantify environmental conditions that have an influence on sound propagation and that are necessary for an accurate quantitative modeling of sound propagation in the study area.
3. Specific acoustic data recording at locations identified in relation to Companies' noise-generating activities (i.e., PA-B platform installation, pipeline installation, pile driving, seismic surveys). This was only conducted in years with the corresponding activities.
    - Monitoring of acoustic noise in additional points for control, including real-time control, of the levels of anthropogenic noise in the gray whale feeding

areas, and determination of the areas of potential increased acoustic footprint of specific activities

- Use acoustic data collected during years with activities, together with gray whale behavior data, to increase understanding of the potential impacts from exploration and construction activities on Okhotsk-Korean gray whales (see Chapter 4 for a summary of the results).

3.2. ACOUSTIC MONITORING STATIONS

The acoustic monitoring of the Joint ENL-Sakhalin Energy Okhotsk-Korean Gray Whale Monitoring Program was conducted using Autonomous Underwater Acoustic Recorders (AUARs), developed by the Pacific Oceanological Institute (POI) FEB RAS specifically for the acoustic component of the ENL-Sakhalin Energy Joint Monitoring Program.

In 2003, a plan and methodology was developed to conduct annual acoustic measurements at a series of monitoring stations on the NE Sakhalin shelf. The acoustic monitoring framework was designed to monitor changes in the acoustic field on the NE Sakhalin shelf, with particular emphasis on changes in the anthropogenic sound level that could cause a significant increase in the received level (RL) in either the Piltun or Offshore feeding areas. The Okhotsk-Korean gray whale distribution in the Piltun area varies with bathymetry, with most whales feeding between 8-15 m, and mother-calf pairs predominantly sighted in 5-10 m. Thus, within the Piltun area, the two key acoustic monitoring points are the 20 m and the 10 m contour, which are regarded as the eastern edge and center of whale distribution. Station locations have remained relatively consistent since 2003, and the map of the NE Sakhalin shelf with the acoustic monitoring stations is shown in Figure 3.1. This program was designed to study temporal and spatial variations in the amplitude and frequency characteristics of ambient and anthropogenic sound at the edges of the Piltun and offshore gray whale feeding areas.

In order to accomplish this monitoring program POI developed and manufactured six Autonomous Underwater Acoustic Recorders (AUAR) in 2003 (Borisov et.al. 2004).

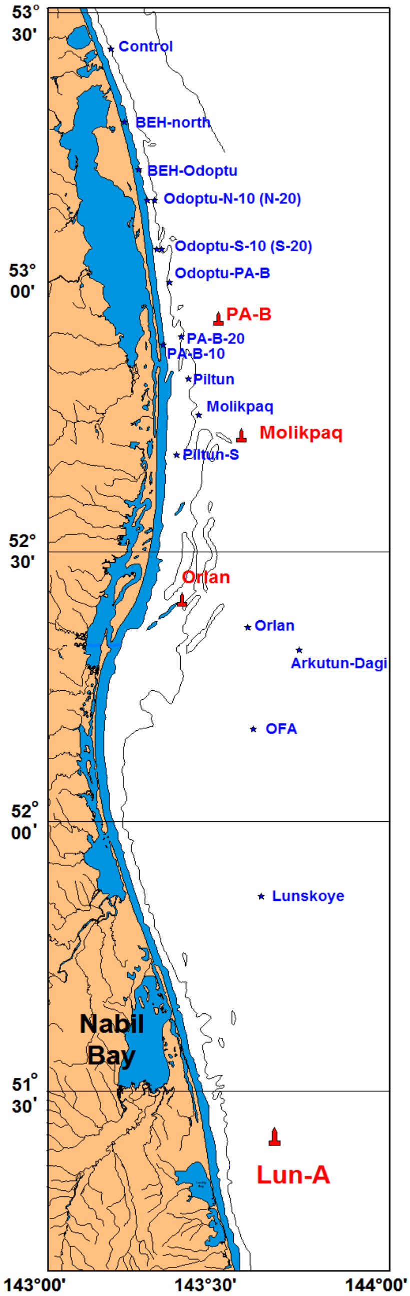

FIGURE 3.1 MAP OF THE NE SAKHALIN SHELF SHOWING THE LOCATIONS OF OIL AND GAS PLATFORMS (RED) AND THE AUAR DEPLOYMENT LOCATIONS 2003-2009.

In subsequent years, the AUARs were upgraded to improve their reliability and increase the duration of their autonomous operation (improving their power supply and hard drive capacity). Since 2006, 16 AUARs have been used for acoustic monitoring on the NE Sakhalin shelf. In 2007, all of the AUARs were equipped with acoustic releases to eliminate vibrating noise from the surface buoy and the possibility of unauthorized lifting of the AUAR. As a result, in 2007-2008 no AUARs were lost. In 2009 and 2011 two AUARs have been lost because they were caught by a bottom trawl fishing vessel. . Additionally, incidents such as a leak in the bottom container or equipment problems could cause the acoustic recording to be interrupted. Not all of the planned data were therefore recorded practically every monitoring station has gaps in its recorded data during certain time periods (see Table 3.1 for the number of deployment days).

TABLE 3.1 NUMBER OF DAYS PER YEAR THAT MEASUREMENTS WERE TAKEN AT THE ACOUSTIC MONITORING STATIONS

Station name	2003	2004	2005	2006	2007	2008	2009	2010
Control	4		13	29	52	51	41	53
BEH-North (A10)			31	10	18	18	36	53
BEH-Odoptu (A9)				26	17	33	63	
Odoptu-N-10	6		32	26	39	53	63	52
Odoptu-N-20			32	43	35	50	73	53
Odoptu-S-20		6	32	50	51	45	83	52
Odoptu-S-10	5	15	17	44	36	29	72	49
Odoptu-PA-B			70	75	39	47	26	33
PA-B-20		12	56	78	63	37	72	50
PA-B-10	12	20	46	71	52	39	72	48
Piltun	5	13	67	65	61	48	58	48
Molikpaq				58	44	48	55	52
Piltun-S		6	67	73	43	59	61	48
Orlan		28	62	58	50	50	29	55
Arkutun-Dagi		36	48	42	53	25	29	56
Lunskoye	3		15	61	54	67	53	51

3.3. SUMMARY OF RESULTS

Analysis of the acoustic data showed that the levels of the ambient (or background) sound field were very variable and mainly influenced by natural factors such as wind speed, wave height, and precipitation. Acoustic data analyses also showed that the levels of anthropogenic noises generated by industrial activities from Sakhalin-1 and Sakhalin-2 projects temporarily increased within and at the edge of the gray whale feeding areas as compared to ambient or background sound levels (Table 3.2).These industrial activities were typically temporary, lasting only a portion of the summer and fall season. In most cases, sound levels returned to pre-construction ambient sound levels as soon as the industrial activities ended. Depending on the weather conditions, these post-construction ambient sound levels were sometimes slightly lower or higher than ambient levels measured during pre-construction.. Results from this monitoring program are being used to evaluate the sound levels generated by the Sakhalin-1 and Sakhalin-2 operations (both construction and production) and where necessary suggest mitigations. In addition to sound generated by industrial activities of the Sakhalin-1 and Sakhalin-2 projects, sounds from projects of other operators (especially 2D and 3D seismic surveys) were also taken into account during the multi-year acoustic analysis. For example, anthropogenic noises generated by Sakhalin-1 and Sakhalin-2 project activities were not detected at the control acoustic monitoring station in the north, but noise and acoustic pulses were recorded generated during 3D seismic surveys and other operations from the Sakhalin-5 project. For full information on annual data from acoustic monitoring stations, please refer to the "Analysis of Acoustic Measurements Conducted in the Piltun and Offshore Gray Whale Feeding Areas on the Northeast Sakhalin Shelf During the 2003-2009 Field Seasons" report submitted by ENL and Sakhalin Energy to the Ministry of Natural Resources (Rutenko et al. 2011).

TABLE 3.2.SOUND LEVELS GENERATED BY SPECIFIC ENL OR SAKHALIN ENERGY PROJECT (OR OTHER INDUSTRY) ACTIVITIES.

Activity (operator)	Year	Station(s) where sounds were measured	Frequency (Hz), Max levels in dB (re 1 μPa^2) at 90% level[1]	Background noise level[2] Frequency (Hz), Max. levels in dB (re 1 μPa^2) at 90% level
Sakhalin-5 3-D seismic surveys (unknown)	2009[3]	Control	25-200,120	
Foundation pile installation at Odoptu North Well Site (ENL)	2009[3]	A9 Odoptu-N-10 Odoptu-N-20	2-200, 110 32-158, 109 13-158, 110	 >20, <95 >20, 95
Installation of PA-B platform and pipeline construction (Sakhalin Energy)	2005-2007	Odoptu-S-20 Odoptu-S-10 Odoptu-PA-B PA-B-20 PA-B-10 Molikpaq Piltun-S Orlan	100-300, 100 200-500, 108 63-600, 100 63-79, 115 >50, 110 60-400, 110 60-400, 105 100-631, 109	>16, <93[4] >20, <90[4]
Seismic exploration near Sakhalin coast (unknown)	2007	Arkutun-Dagi OFA	158, 105 158, 108	>32, <95 >10, <100

[1] Based on statistical plots of one-third octave power spectral density levels
[2] Best approximation based on percentile plots of one-third octave power spectral density at respective station (see Rutenko et al., 2011)

[3] In 2009, pile installation operations occurred from June 15-September 14. The Sakhalin-5 seismic exploration operations were conducted during an overlapping time period (August-September).

4 There was a stable, narrow-band acoustic signal at both stations during 2008 (year used for background noise estimation) which was most likely generated by equipment operating on the PA-B platform.

In 2010, Transmission Loss (TL) profiles were acquired across the region. These experimental measurements are used to estimate propagation losses for different frequencies generated and received at defined locations along the specified profiles. Both bathymetric and hydrological conditions in the region are used to generate plots. The TL plots for the region can be found in the 2011 Acoustics section of the MNR report.

4. BENTHIC AND GRAY WHALE PREY STUDIES

The primary objective of the benthic study is to document potential variation in benthic species distribution and abundance in and close to the two known gray whale feeding areas and at gray whale feeding locations. This information is important in understanding how changes in prey availability affect gray whale distribution and movements. It is also used to determine to what extent industrial oil and gas activities may impact prey availability or access to prey resources. The benthic study consisted of various components to address this primary objective as summarized in section 4.1.

4.1. STUDY COMPONENTS AND OBJECTIVES

1. Benthic and sediment sampling within and close to two known gray whale feeding areas (Piltun and Offshore feeding areas). This started in 2002 and has been repeated annually. Specific objectives are as follows:
    - Quantify benthic species distribution and abundance (density and biomass) of individual taxonomic groups and of the most common species.
    - Quantify sediment composition and distribution and assess the influence of sediment particle size distribution on the production and composition of benthos.
    - Determine annual variation in benthos distribution and abundance within the feeding areas and assess how hydrology parameters influence the production and composition.
2. Quantify concentrations of high-priority pollutants (such as petroleum hydrocarbons, heavy metals and organochlorine pesticides) in sediment samples and polychaete species in gray whale feeding areas.
3. Benthic, epibenthic, plankton and sediment sampling at gray whale feeding locations. This started in 2002 and has been repeated annually. Specific objectives are as follows:
    - Determine what prey species gray whales are targeting and quantify species distribution and abundance (density and biomass) of these species at the gray whale feeding locations.
    - Quantify sediment composition and distribution at the gray whale feeding locations and assess the influence of sediment particle size distribution on the production and composition of gray whale prey species.
    - Determine interannual variation in gray whale prey abundance and assess how hydrology parameters influence the production and composition.
4. Benthic sampling at the start and end of the season at opportunistically selected stations within the gray whale feeding areas (mostly coinciding with deployment

and retrieval of acoustic recorders). This started in 2007 and has been repeated annually. Specific objective is as follow:

- Assess size distributions and growth rates of dominant amphipod and isopod species throughout the season using morphometric analysis.

5. Benthic and plankton sampling at selected locations within Piltun Bay, in near-shore areas of the Piltun feeding area, and in the Offshore feeding area. This was done in 2006-2008 with the following objective:

    - Conduct isotope and molecular biomarker (lipid) analyses to determine the importance of Piltun Bay for benthos productivity in the Piltun feeding area

4.2. SAMPLING STATIONS

The benthic study was designed such that there were two types of benthic and sediment sampling stations: (*i*) stations that were located in pre-defined grid cells designed for three areas (Piltun, Intermediate and Offshore) (Figure 3.1); and (*ii*) stations that were chosen based on where whales have been observed feeding, referred to as feeding points. Grid cell sampling was intended to document changes in sediment composition and benthic species composition and abundance over time. The sampling at gray whale feeding points was intended to determine what prey species the whales were targeting, their size distributions and biomass, and how this changes over time. This section provides a brief overview of the areas in which grid cell sampling and sampling at feeding stations has been taken place over the years. Details on sampling protocol and laboratory analyses are not included in this summary; these can be found in the Annual Report (Fadeev 2011 – Volume I).

4.2.1. Piltun Feeding Area

The Piltun feeding area sampling grid consists of 60 cells of equal area, comprising five blocks of 12 cells each; three cells in the north-south direction and four cells in the east-west direction (Figure 3.1). The total area of the Piltun feeding area sampling grid is approximately 1000 km^2. Every year from 2002 to 2010 benthos and sediment samples were taken from each of these 60 grid cells, either at locations randomly selected within the grid cell or at locations sampled in previous years. Sampling depth in this area ranged from about 5 to 35 m.

4.2.2. Offshore Feeding Area

The sampling grid of the Offshore survey area was initially divided into 36 sectors (four rows of nine cells), each ~50 km^2 in size (Figure 3.1). In 2002 and 2003, one location was randomly selected within each grid cell. In 2003, the sampling grid was extended by three more cells to the east, increasing to a total of 48 sectors (four rows of twelve cells), because feeding gray whales were observed beyond the eastern boundary of the original sampling grid (Maminov 2004). The total area of the Offshore feeding area sampling grid is approximately 2000 km^2. Every year from 2004 to 2010 benthos and sediment samples were taken from each of these 48 grid cells. Samples were collected in water depths ranging from 30-63 m.

4.2.3. Intermediate Area

Stations of the Intermediate area are located south of the Piltun feeding area and cover waters from Chayvo Bay to the western boundary of the Offshore feeding area (Figure 4.1). Benthos and sediment samples were collected in this area in 2002 and again in 2007 to 2010. The number of stations sampled in this area changed from year to year, with 13 stations in 2002, 15 stations in 2007 and 2008, and 12 stations in 2009 and 2010. Samples were collected at water depths ranging from 8 to 25 m.

Since 2006, whales were regularly seen feeding near-shore in a small part of the intermediate area (located between the Piltun and Offshore feeding areas (Figure 4.1)). Sampling at several locations in this small subarea (30 km^2) was therefore initiated in 2006, repeated in 2007–2010. This area, located ~40 km south from the mouth of Piltun lagoon was referred to as the Chayvo subarea. Each year benthos, epibenthos, and plankton was sampled at the same seven locations to analyze any changes in the composition and abundance of gray whale prey species.

4.2.4. Gray Whale Feeding Sites

Benthos, epibenthos, and plankton samples were collected at locations where gray whales were observed feeding in and near the Piltun and Offshore feeding areas. In July of 2009 and 2010 benthic, epibenthos and plankton samples were also taken at 16 locations where gray whales were observed feeding in Olga Bay along the eastern coast of Kamchatka (Figure 1.1). Gray whales feed in Olga Bay at depths ranging from 6 to 13 m. In addition, two locations were sampled in the same area but at locations where gray whales had not been observed feeding.

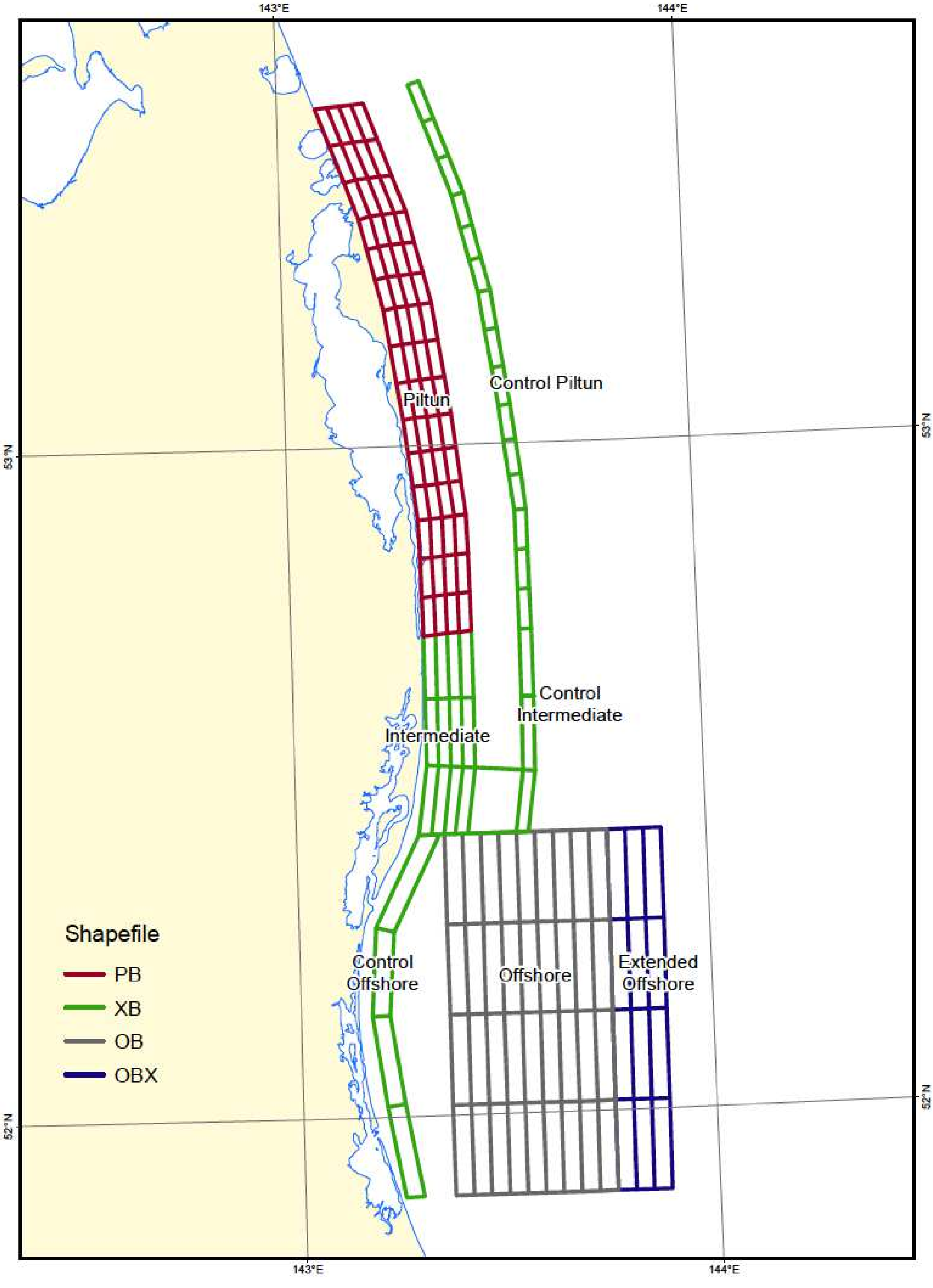

FIGURE 4.1. OVERVIEW OF THE BENTHIC SAMPLING GRIDS. THE YEARS THAT SAMPLES WERE TAKEN IN THESE AREAS ARE INCLUDED IN THE FIGURE.

4.3. SUMMARY OF RESULTS

4.3.1. Benthos composition and abundance within and close to known gray whale feeding areas

Nine year of benthos and sediment sampling has increased our knowledge of the species composition and abundance (density and biomass) of each study area, the differences between the areas, the influence of hydrology and particle size distribution of sediments, and variation over time. This section highlights the general trends that have been observed. Detailed information is available in the annual reports that have been submitted to Russian Federation Ministry of Natural Resources, Federal Oversight Service for Natural Resource Use (ROSPRIRODNADZOR), the Russian Federal Fishery Agency (Fadeev2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011).

Piltun feeding area

- The average total biomass of benthos in the Piltun feeding area as measured from 2002-2010 was relatively stable from year to year, ranging from 414 to 556 g/m^2. Sand dollars were the major contributors to the biomass.
- The average total biomass in the Piltun feeding area increased with depth, mainly due to increasing presence of sand dollars.
- The average prey biomass (amphipods) in the Piltun feeding area in the period 2002-2010 ranged from 28.5 to 54.6 g/m^2.
- The highest prey biomass in the Piltun area was found at depths of <15 m. The distribution of amphipods had a distinctly aggregated nature.
- Multi-year comparisons of amphipod biomass in the shallow waters of the Piltun feeding area show:
    - A statistically significant biomass decrease in 2006 compared to 2002-2005, following with an amphipod biomass increase in 2007-2010. However, these values have not yet reached the maximum biomass values of 2002-2003.
    - Amphipod biomass of 2009-2010 was similar to the values found in 2004-2005.

Offshore feeding area

- The average total biomass of benthos in the Offshore feeding area measured from 2002-2010 ranged from 489 to 655g/m^2.
- The average amphipod biomass in the Offshore feeding area measured from 2002-2010 ranged from 174 to 344 g/m^2. The proportion of amphipod biomass in the total benthos biomass increased with distance from shore.
- Multi-year comparisons of amphipod biomass in the Offshore feeding area showed no statistically significant differences between years.

Intermediate area

- The average benthos biomass in the Intermediate area was 414 g/m^2 over the years 2007-2010. The amphipod species and biomass are very similar to those of the Piltun area. Also similar to the Piltun feeding area, the biomass of amphipods decreased sharply with increasing depth.

4.3.2. Benthos, epibenthos, plankton and sediment sampling at gray whale feeding locations

- The average depth of gray whale feeding sites in the Piltun feeding area was variable, but commonly less than 20 m. The contribution of prey species (amphipods and isopods) to the total biomass in these gray whale feeding areas was more than 50 % and reached values of more than 100 g/m^2. When comparing these numbers with the total amphipod biomass of the grid samples, it is clear that gray whales target patches with relatively high prey biomass.
- There was a high variability in the frequency of occurrence and biomass of sand lance in the Piltun area. Sand lance has been mentioned as a food resource for gray whales (Zimushko and Lenskaya 1970). The sand lance is a temporary component of biota at depths of less than 40 m, where it breeds. The densest accumulations of sand lance in the Piltun 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 samples, with an average biomass of 4.6 to 6.2g/m^2.
  - In 2004 and 2005, sand lance occurred in 15% of the samples, with an average biomass of 14.8 to 16.3 g/m^2. Densest accumulations were recorded in the northern and middle parts of the Piltun area, where the biomass reached values ranging from 68 to 166 g/m^2 in 2004 and 150 to 236 g/m^2 in 2005 (which amounted to 25 to 60% of the total macrobenthos biomass).
  - After 2005 the sand lance frequency of occurrence decreased over the years, with occurrences of 20-25% in 2006 and 2007, and 8-12% in 2008-2009. The cause for this decline is unknown, but possibly related to natural variation.
  - In 2010 the frequency of occurrence of sand lance in the northern part of the Piltun area increased to 20%. Sand lance biomass in two gray whale feeding locations reached values of 66 and 78 g/m^2.
  - Observed variations in sand lance concentrations were believed to influence the distribution of gray whales with their feeding areas (see Chapter 5 and 7).

- In the Offshore feeding area whales were feeding at depths ranging from 40 to 60 m in areas with amphipod biomass greater than 300 g/m^2.
- Olga Bay in Kamchatka is similar to the Chayvo (Intermediate) subarea on Sakhalin in terms of the size of the area and amphipod biomass, which averaged 43.8 and 50.3 g/m^2 in 2009 and 2010, respectively . The prey biomass at the two stations in Olga Bay where gray whales had not been observed feeding was lower than at locations where whales were seen feeding, i.e., 24 and 22 g/m^2 in 2009 and 2010, respectively (Fadeev 2011).

4.3.3. Size Distribution of Common Prey Species

Analysis of the size composition of prey species in the whale feeding areas makes it possible to assess the proportion of amphipods potentially suitable as diet for gray whales. The threshold value is assumed to be 6 – 8 mm (Rice and Wolman 1973, Nerini 1984). In addition, reproduction, growth rates of individuals and, most important, productive potential of gray whale feeding areas can be assessed based on the size composition of prey amphipod species. Data showed that the proportion of individual specimens with a body length greater than 6 mm, i.e., individuals accessible for whale feeding, varied in the different prey species from 58 to 100%.

4.3.4. Concentrations of Pollutants in Bottom Sediments and Polychaete Tissue

The first studies of key pollutants in the Piltun Area were conducted in 2001, when sediment samples were collected in the vicinity of locations where whales were observed to feed intensely. Concentrations of petroleum hydrocarbons and 10 heavy metals (copper, aluminium, arsenic, barium, cadmium, chromium, iron, mercury, lead and zinc) were found to be low, and no significant effect of pollutants on benthos was observed (Fadeev 2002).

More detailed assessments of the same key pollutants (petroleum hydrocarbons and heavy metals) and of organochlorine pesticides were carried out for bottom sediments in 2004, 2005 and 2008-2010. In addition, heavy metal concentrations were analyzed for the most common benthic polychaete species 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 they are therefore very suitable as bio-indicators for heavy metal pollution of bottom sediments. The conclusions from the pollutant analyses are summarized here.

- Concentration of DDT as well as the total concentration of DDT and its metabolites, varied only slightly and did not exceed background values for the northeastern Sakhalin region.
- Concentration values of heavy metals in the sediments did not exceed the background values registered for the northeastern 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.

- Petroleum hydrocarbons values were lower than the natural background concentrations of petroleum hydrocarbons registered for the Sakhalin shelf sediments, with lower concentrations measured closer to shore.
- Of all pollutants in aquatic ecosystems, heavy metal compounds can adversely impact benthos the most. The 2008 analyses of heavy metal concentrations in polychaete species in the Piltun area confirmed that heavy metal pollution was not observed in the littoral waters of the Piltun Area during the study period.

4.3.5. Importance of Piltun Bay for gray whale food resources

Based on this analysis it was concluded that:

- The main prey species of gray whales in the Piltun and Offshore feeding areas (amphipods and isopods) feed mainly on diatom phytoplankton, or on organisms feeding on diatom phytoplankton. Piltun Lagoon is not an important source of diatom plankton species, although it may provide nutrients (nitrogen and phosphorous) required for phytoplankton blooms.
- Bacteria attached to suspended sediment (detritus) exported from Piltun Lagoon into Piltun feeding ground do not provide a significant part of the food resource for amphipods. Other benthic species, for example bivalves, may feed on these bacteria attached to the sediment.

5. GRAY WHALE BEHAVIOR STUDIES

To understand to what extent industrial activities from oil and gas developments offshore Sakhalin Island might result in disturbance to gray whales, onshore behavioral surveys have been conducted from 2001 to 2010 during the feeding season. Behavior studies provide important information on gray whale natural feeding, movement and respiration activities. Observations of behavioral responses to anthropogenic activities provide valuable information about the potential disturbance of whales due to activities that occur near or within their feeding habitat. The main objectives of the behavior studies of Okhotsk-Korean gray whales are as follows:

5.1. STUDY COMPONENTS AND OBJECTIVES

- Gray whale distribution and abundance: evaluate inter and intra daily variation in relative abundance and distribution patterns of Okhotsk-Korean gray whales
- Gray whale movements and behavior: evaluate spatial and temporal movement patterns and ascertain baseline feeding and other behaviors of Okhotsk-Korean gray whales in relation to environmental and demographic factors to better understand how Okhotsk-Korean gray whales utilize their near-shore feeding habitat on a daily, seasonal, and annual basis.
- Impact from anthropogenic activities: analyze the potential impact on Okhotsk-Korean gray whale movements and behavior from anthropogenic activities.

5.2. BEHAVIOR SAMPLING

Behavioral observations of Okhotsk-Korean gray whales were conducted at six geographic locations (stations) covering a 66-km stretch of coastline along the Piltun feeding area (Figure 5.1). Two of these six stations have been sampled for behavioral data since 2001 (2nd Station and Station 07), two additional stations were added in 2002 (1st Station and Odoptu), and the last two stations were added in 2004 (North Station and South Station). The use of onshore locations allows observations of behavioral patterns without disturbing the whales. In some cases, during years where Sakhalin Energy or Exxon Neftegas Limited were conducting specific industrial activities, behavioral stations closer to the activity were added if needed.

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. These methods, along with the study area, are summarized below. More details can be found in the Annual Report (Gaily et al. 2011 – Volume I).

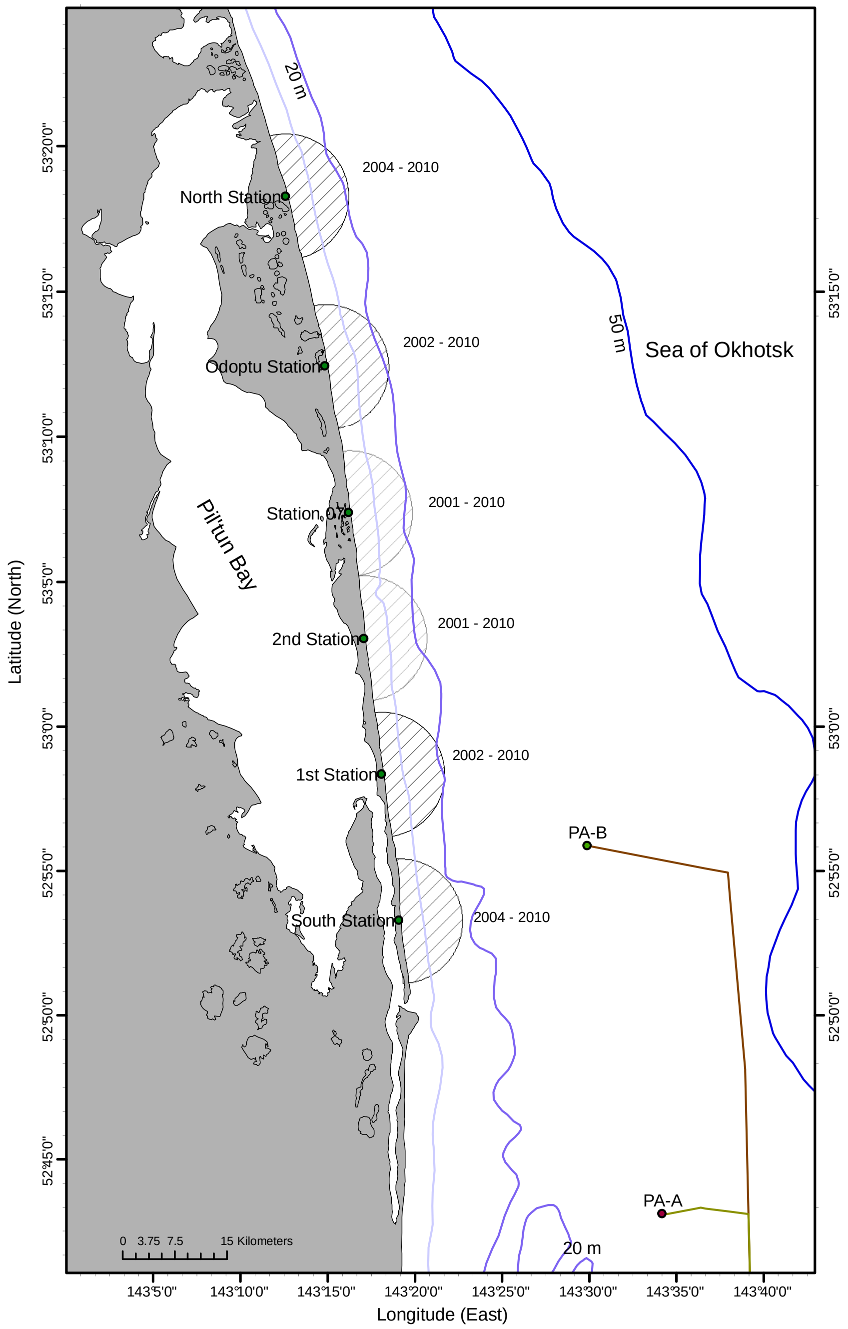

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FIGURE 5.1. LOCATION OF SHORE-BASED STATIONS IN THE NORTHEASTERN COASTAL REGION OF SAKHALIN ISLAND, RUSSIA. SEMI-CIRCULAR GRIDS ILLUSTRATE APPROXIMATE VIEWABLE RANGE (4 KM) FROM EACH STATION. THE 4-KM RANGE IS USED FOR FOCAL FOLLOW AND THEODOLITE TRACKING INFORMATION. DATES INDICATE YEARS WHEN DATA WERE COLLECTED AT EACH STATION.

5.2.1. Scan Sampling: Gray Whale Abundance and Distribution

Scan sampling methods were used to monitor the relative number and distribution of Okhotsk-Korean gray whales in the Piltun feeding area. Every hour two observers scanned a predetermined section of the study area using hand-held binoculars. When an observer sighted a whale or group of whales, the number of whales, angular distance between the whale and the horizon (measured using binocular reticles), magnetic bearing, estimated distance from the station, and the observer who made the initial sighting were recorded. Results of gray whale abundance and distribution gathered by the behavior team are combined into Chapter 6.

5.2.2. Theodolite Tracking: Gray Whale Movements

Theodolites were used to monitor spatial and temporal movement patterns of Okhotsk-Korean gray whales. The theodolite tracking technique converts horizontal and vertical angles into geographic positions of latitude and longitude for each theodolite recording (for more details related to the use of theodolites see Würsig et al. 1991, Gailey 2001, Gailey and Ortega-Ortiz 2002, and Gailey et al. 2004). The tracking of individuals over time provides information about the animals' relative speeds and orientations, which can then be analyzed alone or in relation to anthropogenic activity on the water.

A theodolite tracking session was initiated when a single or a recognizable gray whale in a group could be identified and the individual was within a relatively close distance (4-5 km) from the onshore station. Each individual was continually tracked until the animal was lost from sight, moved beyond the 4-5 km distance, or when environmental conditions hampered further tracking. For each theodolite recording, the date, time, and vertical and horizontal angles were stored in a Microsoft Access database with the relative distance, bearing referenced to true North, and geographic position calculated in real-time by the theodolite computer program Pythagoras (Gailey and Ortega-Ortiz 2002).

5.2.3. Focal Behavior Observations: Gray Whale Behavior

Focal observations of behavior and respiration events were conducted on individual gray whales. At least one observer would follow a reliably identifiable individual with the aid of hand-held binoculars, stating each behavioral event. A computer operator recorded this into a laptop computer with Pythagoras software (Gailey and Ortega-Ortiz 2002). The focal session was terminated if the whale moved out of the study area (~4-5 km distance from the observation station) or when criteria for environmental conditions were exceeded. In most focal follow sessions, behavior and respiration events were recorded simultaneously with spatial and temporal movements provided by theodolite tracking of the focal animal.

5.3. SUMMARY OF RESULTS

The sections below summarize the results of the gray whale behavior study conducted from onshore locations along the coast of NE Sakhalin during July-September

2001 to 2010. It also includes a section that summarizes the findings of various multi-variate statistical analysis that was conducted to determine the impact of Sakhalin Energy's and Exxon Neftegas' industrial activities on gray whale behavior.

5.3.1. Gray Whale Movements and Behavior

Three behavioral states were predominately observed on the feeding grounds: 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 are very similar from year to year. Okhotsk-Korean gray whale speed recorded between 2001 and 2010 was between 1.9 - 2.7 kilometer per hour and the range index varied from 31.1 - 41.4 meters per minute. The general 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 mother/calf pairs, weaned calves, and other individuals. Mother/calf pairs were found to stay closer to shore than other individuals and speed of mother/calf pairs was lower compared to that of others.

5.3.2. Impact on gray whale behavior from anthropogenic activities

Multivariate statistical analysis was conducted with behavioral data collected during Exxon Neftegas' Odoptu seismic survey (2001), and Sakhalin Energy's PA-B CGBS installation (2005) and pipeline installation activities (2006). Multivariate statistical analysis of the behavioral and distribution data collected during Exxon Neftegas' Odoptu pile driving (2009) and Sakhalin Energy's Piltun PA-A seismic survey (2010) is still in progress.

The primary objective of these multivariate analyses was to examine to what extent underwater sound levels generated by the various industrial activities influenced Okhotsk-Korean gray whale movements, behaviors, distribution, and relative abundance. Univariate statistical analysis allows only one response variable to be correlated to one impact variable. Although this can provide useful insights in trends in the data and in determining auto correlation between variables, it may not always provide an adequate representation given that gray whales are impacted by several factors simultaneously (such as natural and environmental conditions, anthropogenic activities, and their own endogenous motivations related to space, time, and/or season). Multivariate statistical techniques provide an advantage in that they allow taking into account multiple variables within one statistical model.

2001 Odoptu seismic survey

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 from aerial and shore-based observations (Yazvenko et al. 2007; Weller et al. 2005). These results 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 3 day time scale.

2005 CGBS installation

The multivariate statistical 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 we were unable to test the effects of one or the other sound source directly. Gray whales 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 whale 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.

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 Okhotsk-Korean gray whales, 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.

5.4. INITIAL CONCLUSIONS:

1. The multivariate statistical analysis shows that with 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, these effects are short-term disturbances.

2. No significant effects were seen in whale movement and behavior as a result of the Concrete Gravity Based Structure.

3. Highest sound levels were those due to near-shore research vessels as opposed to the construction activity.

6. GRAY WHALE DISTRIBUTION AND ABUNDANCE STUDIES

Since 2001 the joint monitoring program has studied whale distribution and abundance in the Piltun and Offshore feeding areas, as well as in the Piltun-Astokh and Arkuntun-Dagi concession blocks. Whale distribution surveys were conducted both from shore as well as from a vessel by teams of experienced observers. Between 2001 and 2005 aerial surveys were conducted by researchers from Pacific Research Institute of Fisheries and Oceanography (TINRO), Vladivostok. The shore-based and vessel-based surveys were coordinated by the Russian Fisheries Research Institute in Moscow (VNIRO) with participation of marine mammal observers from the Institute of Marine Biology (IBM), Far Eastern State University (DVGU) and Far Eastern State Technical Fisheries University (Dalrybvtuz)..

6.1. STUDY COMPONENTS AND OBJECTIVES

The objectives of the distribution surveys of the Joint Monitoring Program are to determine:

- how Okhotsk-Korean gray whales utilize the Piltun and Offshore feeding areas, northeast Sakhalin on a daily, seasonal and annual basis;
- estimate the natural variation in intra- and interseasonal differences in Okhotsk-Korean gray whale habitat use and movements between feeding areas;
- how observed changes in Okhotsk-Korean gray whale distribution and abundance in the feeding areas relate to anthropogenic activities;
- What mitigation measures can be developed based on our knowledge of Okhotsk-Korean gray whale abundance and distribution.

In addition to the Joint Monitoring Program, specific Okhotsk-Korean gray whale distribution and abundance surveys are conducted during Companies' construction or seismic activities. These activity-specific surveys are designed and executed with the following objectives:

- Assess temporal changes in the distribution and abundance of gray whales in relation to specific activities.
- Determine the influence of industrial activities, environmental factors, and other variables on the distribution and abundance of gray whales within their preferred feeding area adjacent to Piltun Bay.

This chapter provides a brief summary of the findings of the shore- and vessel-based distribution and abundance surveys. The data and results described in this chapter are taken from the Joint Monitoring Program distribution reports submitted to the Russian Federation Ministry of Natural Resources, Federal Oversight Service for Natural Resource Use (ROSPRIRODNADZOR) and the Russian Federal Fishery Agency annually (Blokhin et al. 2004, Vladimirov et al. 2005, 2006, 2007, 2011). More detail can be found in these reports, and in papers and presentations summarized in Appendix A.

6.2. SAMPLING STATIONS AND PROTOCOL

6.2.1. Effort

Joint Monitoring Program vessel-based and aerial distribution surveys in the Piltun and Offshore feeding areas were initiated in 2002. In 2003, shore-based monitoring from the northern spit of Piltun lagoon was added as a feasibility study. In 2004, it was decided to continue the onshore monitoring effort, including stations south from the Piltun lagoon mouth to Chayvo Bay (Table 6.1).

Since 2005 the location of these shore-based stations has not changed significantly. In 2006 it was decided to cancel the aerial surveys because they provided limited additional value to the shore- and vessel-based data, were costly and provided a high safety risk. The Piltun vessel-based survey was extended towards the south in 2007, covering the area offshore Chayvo Bay and the the north end of Nyiskii Bay as more whales were observed in this area in 2006 by observers on Sakhalin Energy's pipeline barges. To obtain data on the distribution and abundance of whales in ENL and Sakhalin Energy license blocks, the Arkutun Dagi (ENL) and Piltun Astokh (Sakhalin Energy) vessel-based distribution surveys were added to the annual scope in 2006-2010 and 2009-2010, respectively.

A map of the onshore stations and offshore transects that form the core distribution program is shown in Figure 6.1. The joint program distribution and abundance surveys typically start at the end of July/early August and continue until the end of September. In years with specific industrial activities, distribution surveys were conducted earlier (e.g., end of June), at additional stations, and/or with more field teams.

TABLE 6.1 SUMMARY OF GRAY WHALE DISTRIBUTION AND ABUNDANCE SURVEY TYPES AND AREA

Survey type	Location	Period, years
Aerial	Offshore, Piltun	2002-2005
Shore-based	Piltun feeding area	2003 – 2010
Vessel-based	Offshore feeding area	2002 – 2010
Vessel-based	Piltun feeding area	2002 – 2006 2007 – 2010
Vessel-based	Arkutun Dagi	2006 – 2010
Vessel-based	Piltun – Ashtokh	2009 – 2010

6.2.2. Observation Protocols

During vessel-based line transect surveys two marine mammal observers (MMOs) systematically scan an area of 180 degrees centered on the vessel's trackline for presence of gray whales and other marine mammal species. Surveys were only taking place in conditions of good visibility (at least 1.5 km along the transect line or 50% of the horizon visible) and smooth seas (not more than sea state three on the Beaufort scale).

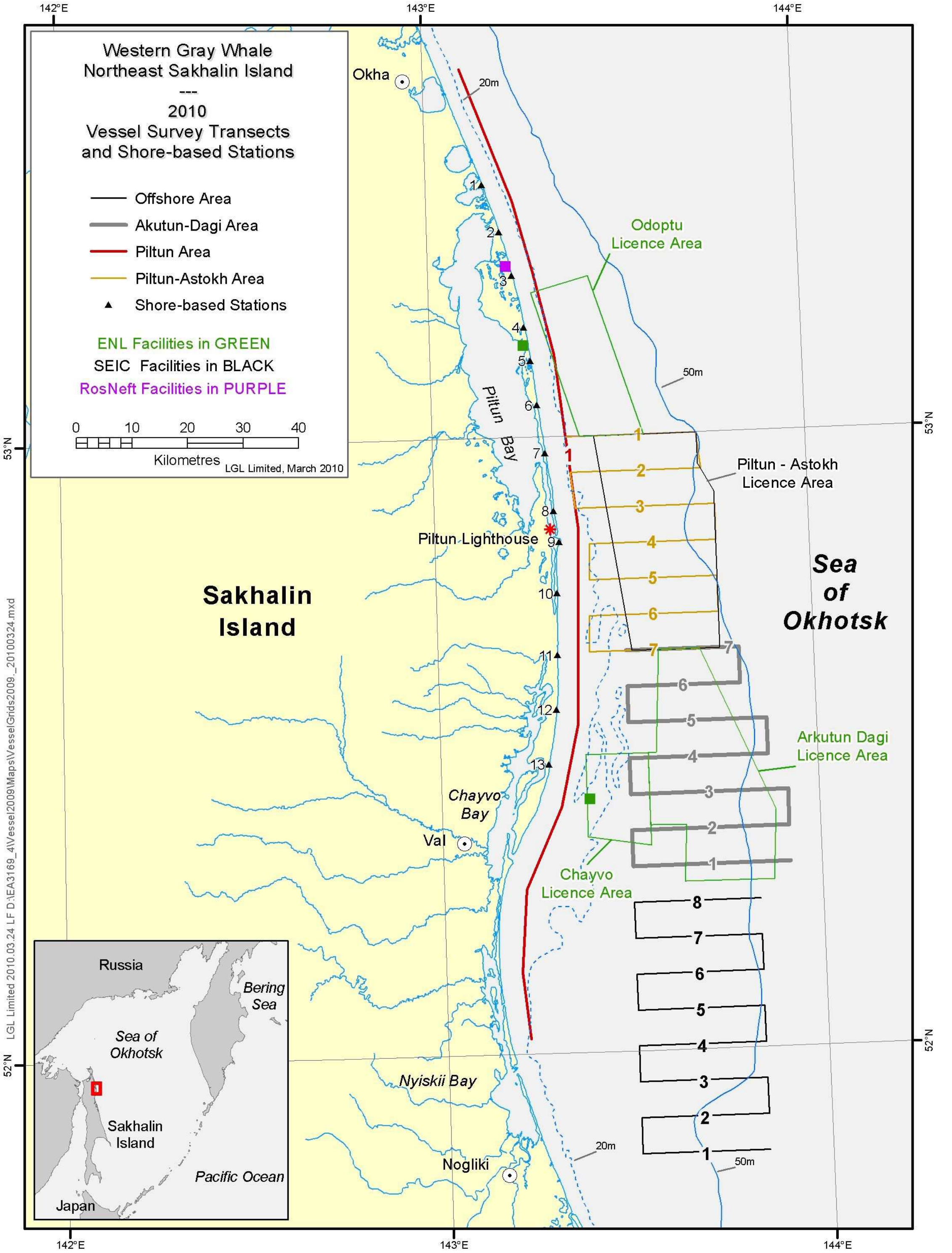


FIGURE 6.1. SYSTEMATIC VESSEL-BASED GRAY WHALE SURVEY TRANSECTS IN THE PILTUN AND OFFSHORE FEEDING AREAS, AND IN THE ARKUTUN-DAGI AND PILTUN-ASTOKH LICENSE AREAS. THE LOCATIONS OF THE 13 SHORE-BASED SURVEY STATIONS ARE ALSO SHOWN.

Shore-based surveys of gray whales and other marine mammal species are performed by two survey teams: eight survey stations to the north and five – to the south of the Piltun lagoon mouth. The shore-based observers simultaneously continuously scan the near shore waters surrounding an observation station with binoculars at the speed of 10 degrees/minute according to the protocol established in 2004. Okhotsk-Korean gray whale abundance and distribution data collected from the vessel-based and shore-based systematic surveys are analyzed to produce estimates of whale densities at a 1 km^2 resolution. This methodology is described in more detail in Vladimirov et al. 2011.

6.3. SUMMARY OF RESULTS

The sections below summarize the results of the gray whale distribution surveys conducted from shore-based and vessel-based stations during July-September 2001 to 2010.

Results from the Joint Monitoring Program distribution and abundance surveys demonstrated that there is considerable intra-annual and interannual variation in the distribution and densities of whales in their feeding grounds. Because the Piltun and Offshore feeding areas have the longest continuous data sets, the main focus of this report is on these areas.

6.3.1. Intra-annual variation in the Piltun feeding area

Seasonal patterns

Okhotsk-Korean gray whales start to arrive in the Piltun feeding area upon melting of the ice. The data available for the period June/July collected during activity-specific distribution surveys showed that the number of whales observed at the beginning of the feeding season is typically low. Over the course of the season the numbers gradual increase with highest counts in the period mid-August – mid-September. From mid-September onwards the number of whales starts to gradually decline. Typically the decrease in number of whales in the Piltun feeding area in the second part of September corresponds with an increase in animals sighted in the Offshore feeding area.

Distance from shore

In the beginning of the feeding season, gray whales tend to stay closer to shore compared to later during the season (Figure 6.2). Up to the end of August approximately 80% (2007-2010 data) of the whales were sighted within 2 kilometers from shore, which corresponds with water depths of approximately 10 meters. Calves and cow-calf pairs are observed closer to shore (< 1 km) than adult individuals (Sychenko et. al. 2011, Vladimirov et al. 2011). During the month of September, the majority of the whales are still found about 1 -2 km from shore, but are also observed further from shore (2 -5 km). Water depths in this zone range from approximately 10 to 20 meters.

The main reasons for the preference of shallower water at the start of the feeding area are likely partly related to the presence of cow-calf pairs in this period, which are usually sighting close to shore. This could be related to avoidance of predators, calm areas (better places for nursing), and/or suitable conditions for calves during the learning process and when begin to feed on solid food (Synchenko et al. 2011). Furthermore it is speculated that at the start of the feeding season the benthic biomass is still high close to shore. As benthic biomass is easier to harvest at shallower depths, whales are likely to start feeding here upon arrival from the breeding grounds.

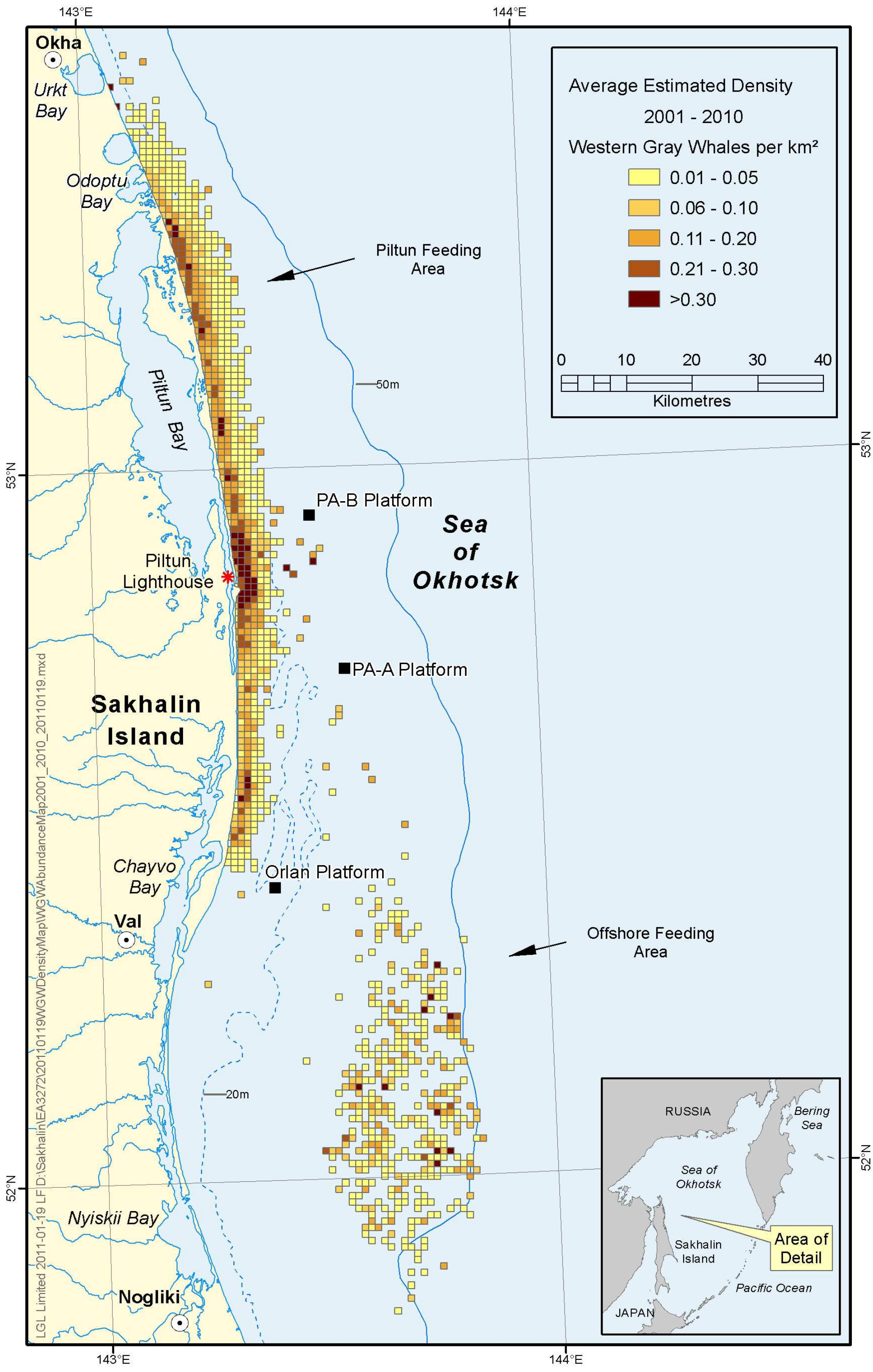
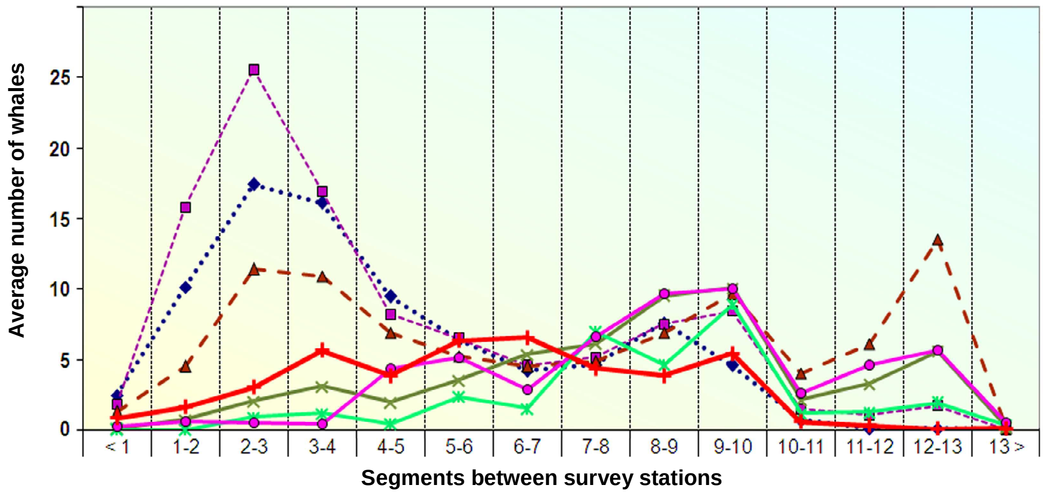


FIGURE 6.2 AVERAGE ESTIMATED OKHOTSK-KOREAN GRAY WHALE DENSITY BASED ON 2001-2010 AERIAL, VESSEL AND SHORE-BASED SYSTEMATIC SURVEY DATA. DENSITIES ARE CORRECTED FOR EFFORT.

6.3.2. Interannual variation in use of the Piltun feeding area.

Whales in the Piltun feeding ground are not often observed beyond the 20 meter isobaths, which is main habitat for sand dollars, a non-prey species. However, in some years, sand lance (*Ammodytes hexapterus*) blooms are observed in the northern part of the feeding ground (Fadeev 2004, 2005). When these blooms occur, more whales are sighted near and beyond the 20 meter isobaths. Figure 6.3 displays interannual trends in gray whale abundance in the Piltun feeding area.



Year	Average number of whales in segments													
2004	2,45	10,14	17,41	16,09	9,45	6,36	4,18	4,64	7,59	4,59	0,68	0,09	0,09	0,00
2005	1,80	15,80	25,56	16,92	8,20	6,52	4,56	5,16	7,52	8,44	1,48	1,04	1,72	0,00
2006	1,25	4,50	11,38	10,88	6,88	5,25	4,50	4,88	6,88	9,63	4,00	6,13	13,50	0,13
2007	0,10	0,75	2,05	3,10	1,95	3,55	5,35	6,10	9,50	10,10	2,15	3,25	5,60	0,20
2008	0,00	0,00	0,91	1,18	0,45	2,36	1,55	7,00	4,64	8,91	1,18	1,27	1,91	0,36
2009	0,23	0,62	0,54	0,38	4,31	5,15	2,85	6,62	9,69	10,00	2,62	4,62	5,62	0,54
2010	0,84	1,63	3,00	5,63	3,84	6,32	6,53	4,37	3,84	5,42	0,58	0,32	0,05	0,11

FIGURE 6.3 YEAR-TO-YEAR VARIATIONS IN SEASONAL GRAY WHALE ABUNDANCE IN THE PILTUN AREA WATERS, 2004–2010 (FROM COMPREHENSIVE SYNCHRONIZED SHORE-BASED SURVEY DATA)

Annual variation in density over the Piltun feeding area can be seen in Figure 6.3 and the figures in Appendix B, which provides a series of annual density maps from the period 2004 - 2010.

- In the period 2002 – 2005 the majority of the whales were observed north of the lagoon mouth, with few sighting south of station 10. High whale densities in the northern part of the survey area in 2004 and 2005 overlapped with the presence of sand lance blooms suggesting that whales were further north to exploiting this resource.
- In 2006 there was a remarkable increase in whale densities between station 11 and 13, which coincided with the construction of Sakhalin

Energy's offshore pipeline in that area. In 2006 and 2007 whales were fairly equally distributed over the entire survey area.

- The year 2008 was characterized by low numbers of sightings, which increased with more than 50% in 2009.
- Similar to the period 2002 – 2005, in 2010 there were very few whales south of the lagoon mouth.
- Based on the 2002-2010 distribution data it can be concluded that there are usually high densities of whales are near the lagoon mouth, and there is extensive variability in use of the northern and southern part of the feeding area.
- As 165 photo-identified individuals have been documented over the past three seasons (2008-2010), the population is higher than the latest abundance assessments, which also do not take into consideration the calves born in the period 2009-2010 (16 calves).

6.3.3. Intra- and inter annual variation use of the Offshore feeding area.

Compared to the onshore distribution surveys of the Piltun feeding area, there has been considerably less survey effort in the Offshore feeding area, due to vessel-based vs. shore based survey, inclement weather, poor visibility, etc.. Nevertheless, due to the annual vessel-based surveys conducted in this area it is possible to analyze both the inter and intra seasonal variation in use of the offshore area.

It is evident that during the course of the feeding season the number of whales in the deeper offshore feeding area gradually increases. This corresponds with an observed decrease in numbers and densities of whales in the Piltun feeding area towards the end of the feeding season, suggesting there is a preference for feeding in the offshore area before the start of the migration to the breeding grounds (Figure 6.4).

As is the case in the Piltun feeding ground there is substantial inter-seasonal variation in the distribution and abundance of whales sighted in the offshore feeding ground.

In 2001, when the offshore feeding ground was discovered (Maminov and Yakovlev 2002), the maximum number of whales sighted in the offshore feeding ground was high. The lowest number of whales sighted in the offshore feeding ground was observed in 2004 and coincided with the highest value for the maximum number of whales observed during a single scan in the Piltun area. Figure 6.4 also demonstrates that there is a gradual increase in whale densities in the period 2004 – 2008. Especially 2008 was characterized by high densities of whales in the offshore feeding grounds. During a single scan on the 3rd of October, 82 individuals were sighted, which, again, corresponded with low whale densities in the Piltun feeding ground. The increase in whales in the offshore feeding ground between 2004 -2008 is reversed in 2009 with fewer observed whales, which are also observed further towards the east of the survey area. This eastward shift towards deeper waters is also observed in 2010.

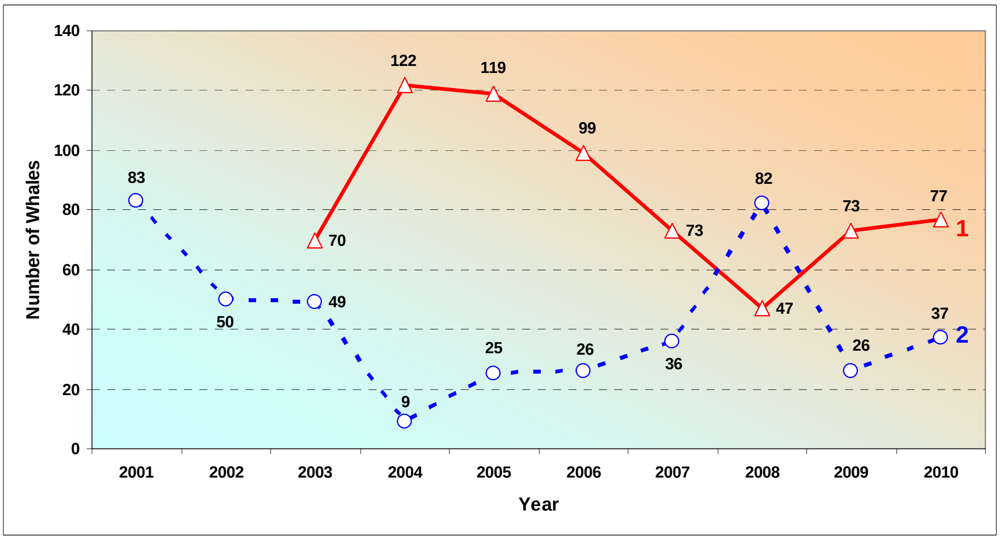


FIGURE 6.4 MAXIMUM NUMBER OF WHALES OBSERVED DURING ONSHORE-BASED SURVEYS (RED LINE) AND DURING VESSEL-BASED SURVEYS (BLUE DOTTED LINE).

6.3.4. Whales in the Arkutun-Dagi and Piltun-Astokh license areas.

Vessel-based surveys of the Arkutun-Dagi and Piltun-Astokh license areas have been conducted since 2006 and 2009, respectively. Generally, the number of whales observed in the Arkutun-Dagi license area was low, except for 2010 when 17 whales were observed during a survey (Table 6.2).

However, in 2009 and 2010 vessel surveys were conducted during which some whales were sighted in the Piltun-Astokh (7) and Arkutun-Dagi (17) respectively, but these figures do not appear to be common.

TABLE 6.2. NUMBER OF ANIMALS OBSERVED IN AKUTUN-DAGI (AD) AND PILTUN-ASTOKH (PA) LICENSE AREAS DURING LINE TRANSECT SURVEYS.

Year	No. of completed surveys in A.D.	No. of observed animals during surveys within A.D.	No. of completed surveys in P.A.	No. of observed animals during surveys within P-A
2007	6	0, 0, 1, 2, 2, 3	N/A	N/A
2008	2	0, 7	N/A	N/A
2009	1	0	1	7
2010	2	0, 17	2	0, 4

7. GRAY WHALE PHOTO-IDENTIFICATION STUDIES

Photo-ID studies have been a valuable component of the Joint Monitoring Program since 2002. Identification of individual animals provides information on population dynamics and demography, social structure, and individual life histories. On the longer term it also provides information on population status and health. This detailed understanding of individual movements and overall population status and trends is used to support management decisions. More detailed objectives of the Joint Monitoring Program photo-ID studies are summarized in the section below.

7.1. STUDY COMPONENTS AND OBJECTIVES

The main objectives of the Okhotsk-Korean gray whale photo-ID study in northeastern Sakhalin were to:

1. Assess abundance and site fidelity (i.e. annual return of the identified whales) of OKGW's visiting the northeastern Sakhalin Shelf and along the east coast of Kamchatka;
2. Investigate intra- and inter- year movements of individual whales within and among the Piltun and Offshore feeding areas, and along the east coast of Kamchatka (since 2006);
3. Assess physical status and health indicators of individual whales; and
4. Assess Okhotsk-Korean gray whale population demographics and structure.

This chapter provides a brief overview of the learning's originating from the photo-ID efforts. The data and results described in this chapter are taken from the Joint Monitoring Program photo identification reports submitted to the Russian Federation Ministry of Natural Resources, Federal Oversight Service for Natural Resource Use (ROSPRIRODNADZOR) and the Russian Federal Fishery Agency annually (Yakovlev et Tyurneva 2003, 2004, 2005, 2006, 2008; Yakovlev et al. 2007, 2009, 2010, 2011). More detail can be found in these reports, and in papers and presentations summarized in Appendix A. (see Appendix A).

7.2. PHOTO ID METHODOLOGY

7.2.1. Field Procedures

The field procedures for the photo-ID work used by the IBM team since 2002 are based on recommendations for photo-ID work of marine mammals, set forth in the International Whaling Commission Special Publication No. 12 (Hammond et al. 1990).

Upon approaching the whales, the following data are recorded on data sheets for each sighting: the position of the zodiac (as determined by GPS), depth (digital depth finder), temperature and the distance and bearing to target animals. Furthermore, the whales' position, time, behavior, number of whales in the area, direction of their movement, the presence of killer whales and passing vessels, airplanes and helicopters in the observation area were also noted. During photographing and video recording, the camera frames and video recording counter numbers were recorded in reference to the sighted whales. Ideally all aspects (head, back flanks, and flukes) of each whale are photographed. Priority is given to photographing the right and left sides of each whale, as fluking frequency varies with individual behavior and foraging depth.

7.2.2. Laboratory Procedures

During laboratory processing of the photographs, each of the photos obtained during that season is studied to determine which specific individual is represented. The procedure for identifying the whales is described in detail in the annual reports. After all the whale images have been identified, they are grouped by individual and the best photographs of each whale are selected that best depict the various aspects. The whales that were sighted for the first time are given a new catalogue number. After this, all the data are entered into the database that stores all available photographs and contains the full sighting history for each individual. Each study year, an annual catalogue of identified whales is created, on the basis of which the master multi-year catalogue is updated annually. Whales recorded on the Sakhalin Island shelf are given the call letters KOGW, while those recorded on the Kamchatka Peninsula shelf are given KamGW.

7.3. SUMMARY OF RESULTS

7.3.1. Gray Whale Catalogues

The photo ID study area of whales near Sakhalin Island covers the entire northeast coast of Sakhalin Island, including the nearshore Piltun feeding area and the Offshore feeding area further away from the coast. Photo-ID effort has been concentrated in these two feeding areas, but whales were also photographed opportunistically if encountered elsewhere (e.g., north of Okha in 2010 and in other areas in earlier years). Photo-ID studies have been conducted on the east coast of Kamchatka in 2004 (Khalaktyrskyi Beach) and 2006 – 2010 (Vestnik and Olga Bay). All animals photographed in these areas are included in the Kamchatka catalogue. In addition to whales seen of Sakhalin and East Kamchatka, frequent sightings of gray whales have been made around the Commander Islands that are located approximately 200 km east of Kamchatka. In 2008 a gray whale previously seen in Olga bay, Kamchatka (in 2007), was photographed in Zakatny bay of Shikotan island (Kuril Islands). Later in 2008 this whale was seen in Olga bay again, off Medny Island (Komandor Islands), and off Karaginsky Island (northeast Kamchatka).

7.3.2. Gray Whale Population Status

Since the start of the photo ID program the number of identified animals off Sakhalin has gradually increased from 47 in 2002 to 187 in 2010 (Table 7.1). Preliminary analysis indicated that 22 of these 187 animals haven’t been seen for more than three years, i.e. not after 2007, near Sakhalin or east Kamchatka. As on average approximately

89% of the whales are seen the next year and 97.6% within two years, it is questionable whether these whales are still alive. If these 22 animals are presumed to be dead, and the remaining animals are considered to be alive, then the total population would come to about 165 animals. This is substantially more than provided in the latest population assessment (Cooke et. al. 2010) which provides a population estimation of 131 excluding calves in 2009.

Up to 2005, the number of individuals new to the catalogue was fairly high due to the identification of adult whales sighted for the first time (Table 7.1). However, since 2005 this figure has reduced substantially, with an average of 3.2 adult whales added to the catalogue each year between 2005 and 2010. Despite the fact that interaction has been identified between animals from the Okhotsk-Korean population with the eastern population (Mate et al. 2011), this figure indicates it are mainly the same individuals coming to feed of the coast of Sakhalin every year.

TABLE 7.1 OVERVIEW OF THE NUMBER OF WHALES IDENTIFIED EACH YEAR OFF SAKHALIN AND KAMCHATKA OVER THE PERIOD 2002-2010

Year	Number of whales (total for year) off Sakhalin	Number of new non-calves per year off Sakhalin	Number of calves off Sakhalin	Number of whales in Sakhalin catalogue	Number of whales (total for year) off Sakh or Kam
2002	47	47	N/A	47	N/A
2003	82	37	10	92	N/A
2004	96	21	3	118	98
2005	117	14	4	136	N/A
2006	121	7	5	148	122
2007	125	4	9	160	132
2008	98	0	5	165	122
2009	117	4	8	177	138
2010	105	2	8	187	128

There is quite some annual variability in the number of whales identified each year, which can be explained by a combination of both the amount of photo-identification survey effort performed as well as the actual number of whales present near Sakhalin.

When the Kamchatka data are included in the estimation of annual abundance of OKGW whales, the total number of sightings of OKGW in Sakhalin and east Kamchatka was 122, 138 and 128 for 2008, 2009 and 2010 respectively. It is clear from this data (Table 7.1) that not all whales included in the OKGW catalogue are seen in Sakhalin waters every year, and at times they are only seen in east Kamchatka.

Of the 140 animals included in the Kamchatka catalogue in 2010, 78 are also included in the Sakhalin catalogue as they were observed in the Sakhalin feeding grounds previously. It is not clear yet to which population the remaining 62 animals belong to. .

The 2002 – 2008 IBM dataset has also been included in the latest population assessment conducted by Cooke et al. (2010). The assessment, concluded that the estimated population size in 2009 (excluding calves) consisted of 131 animals (90% Bayesian confidence interval 120-140), of which 33 (CI 29-38) are estimated to be reproductively mature females. The population assessment from Cooke et al. (2010) also concludes that the population is projected to increase with high probability (>99%), if there are no additional anthropogenic mortalities. In an earlier population assessment (Cooke et al. 2008) Cooke predicts an annual population increase of 2.5%.

. As 165 individuals have been observed over the past three seasons (2008 – 2010), the population is probably higher than current abundance assessments.

In the period 2003 - 2010 a total of 52 calves have been photographed from 31 cows. The majority of the cows (20) were observed with one calve in this period, seven cows gave birth twice and four cows were seen with calves three times. The average calve interval was 2.28 year for the 11 cows with multiple calves.

7.3.3. Gray Whale Habitat Use

Prior to the discovery of the offshore feeding ground in 2001, it was thought that the Piltun area was the main feeding ground of OKGW's. Since then it has become clear that the offshore feeding area is frequented by OKGW as well, especially towards the end of the season. Occasionally whales are also observed to feed in the Chayvo area and near Okha.

Photo ID data has demonstrated that every year a part of the OKGW population moves back and forth between the Piltun and Offshore feeding ground within the same season. In addition to the northeast Sakhalin feeding grounds, gray whales have been recorded in East Kamchatka waters since the beginning of the monitoring program in 2004. In 2006, intra-annual migration between East Kamchatka and the Piltun area was discovered when two whales were observed in Olga and Vestnik Bay and resighted later during the season in the Piltun area. Since 2006, each season a number of the whales observed in Kamchatka are observed in Piltun later during the season. In 2010, 81 of the 140 whales included in the Kamchatka catalogue have been seen near Sakhalin at some point and therefore considered to be Okhotsk-Korean Gray Whales. It is currently unclear to what population the remaining 59 animals belong to, but it is likely they belong to the eastern population.

Kamchatka may also be an important area for cow-calf pairs. In 2008, a cow and a calf were recorded in Olga Bay for the first time, of which the mother was observed both in Piltun and Olga Bay in previous years. In 2009 seven cow-pairs were observed in Olga Bay. Four of the mothers were encountered on the Sakhalin Island shelf in previous years, one of them was also photographed in the Piltun area in 2009 and was encountered there with a calf in 2007. In 2010, three cow/calf pairs were recorded in Olga Bay. All three of the recorded mothers were encountered offshore Sakhalin Island and Kamchatka Peninsula in previous years. One female was photographed as mother with calves in the Piltun area in 2004 and 2007. The two other females had never been recorded as mothers.

7.3.4. Gray Whale Health

Body condition

Starting in 2003, whales were assigned body condition (BC) classes based upon their physical condition using visual assessment. Classes 0-1 indicate a satisfactory BC, while classes 2-4 indicate inadequate physical condition or insufficient body fat.In comparison to other years, more whales with insufficient body conditions were sighted in 2003, 2006, 2008 and 2009 The best body conditions were found in the year 2005. In 2005, the BC of whales sighted more than once in a given season began to be tracked. It became clear that most of the whales improved their physical condition toward the end of the observations (Yakovlev and Tyurneva, 2006; Yakovlev et al., 2007). Based on the last sighting of the season of individual whales, it was determined that the majority of the animals, this is 80% or more, were in good body condition towards the end of the season (class 0 and 1).

Skin sloughing

Skin sloughing of OKGWs was observed for the first time in 2003. In addition, this phenomenon was also observed in various severities in 2004 to 2007, but not in the period 2008 to 2010. The cause of skin sloughing is unknown. Whales that have been photographed with skin sloughing were monitored for other obvious changes in external appearance or physical condition. To date, annual visual assessments of the photographs of these whales did not find any atypical physical condition. Visual assessments have shown that these areas do not appear to have any effect on health.

8. ANALYSES PLANS

There are a number of Company-specific analyses currently underway, as well as one comprehensive analysis which with the objective to integrate results from several Joint Monitoring Program components. A list of analyses and potential timelines for completion are included below.

1. 2010 4D Seismic Survey Behavior and Distribution Multivariate Analysis – Sponsored by Sakhalin Energy. A dedicated monitoring and mitigation plan was implemented during the seismic survey with the purpose of enhancing our understanding of the impacts a seismic survey may have on gray whales. Whale behavior and distribution data were collected before, during, and after seismic activity. Furthermore a set of acoustic buoys recorded sound levels at the edge of the feeding ground. Multivariate analyses are currently conducted to determine if and how the seismic survey affected whale behavior and distribution. The work is expected to be completed by May 2012.
2. 2009 Odoptu Pile Installation Multivariate Analysis – Sponsored by ENL; led by Glenn Gailey (Texas A&M). Glenn is leading a team of behavioral specialists, statisticians, and acousticians to complete this multivariate analysis. The work began in October 2011 and is expected to be completed by July 2012.
3. Integrated Analyses of the multi-year results of the Joint Monitoring Program– Sponsored by both Companies; performed by a group of statisticians and GIS-specialists from the Lomonosov Moscow State University (Acad., Prof. Evgeny Kriksunov) and the lead scientists from each of the program components (VNIRO, IBM, POI).A step-wise approach to integrating 3 of the program component datasets is planned. First, the benthic and distribution sets will be integrated to understand potential correlations between prey biomass/availability and the presences of whales. Second, the acoustic sound field (in the form of cumulative sound levels) will be incorporated as a potential alternative/additional explanatory variable. A kick-off meeting for these integrated analyses was held in September 2011 and an initial work plan was developed. Multi-year data analysis had started.
4. Ongoing statistical analyses – Sponsored by both Companies. Led by the scientists from the Joint Monitoring Program. The goal is to explore datasets (e.g., photo-ID) to their fullest, through simple analytical techniques. Studies on body condition, individual life histories, etc. will be initiated when time is available. Results are expected throughout the continued duration of the Joint Monitoring Program.

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Results and Discussion

APPENDIX A

List of publicly available materials related to ENL-Sakhalin Energy Joint Western Gray Whale Research and Monitoring Program

Acoustic Studies

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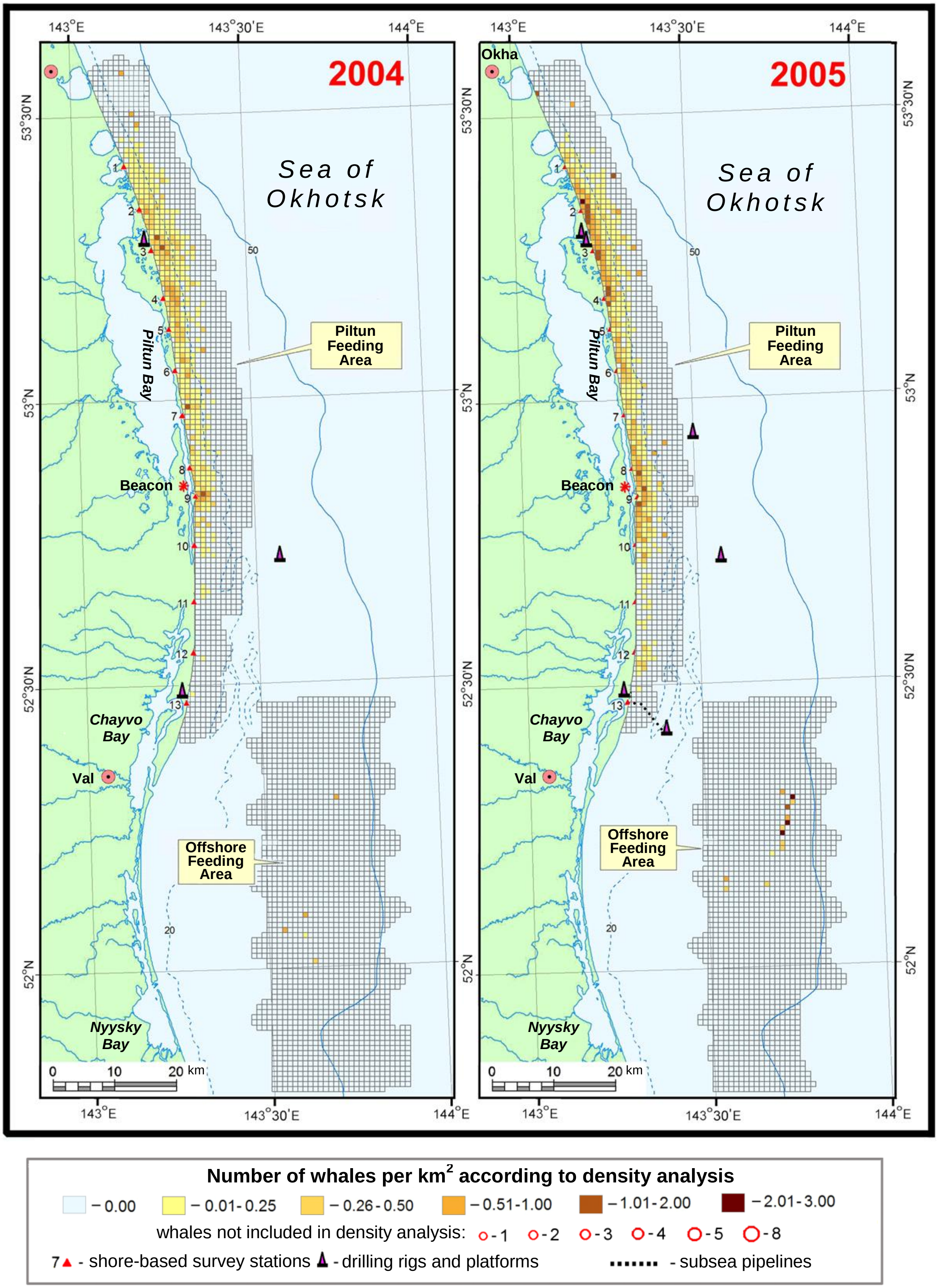
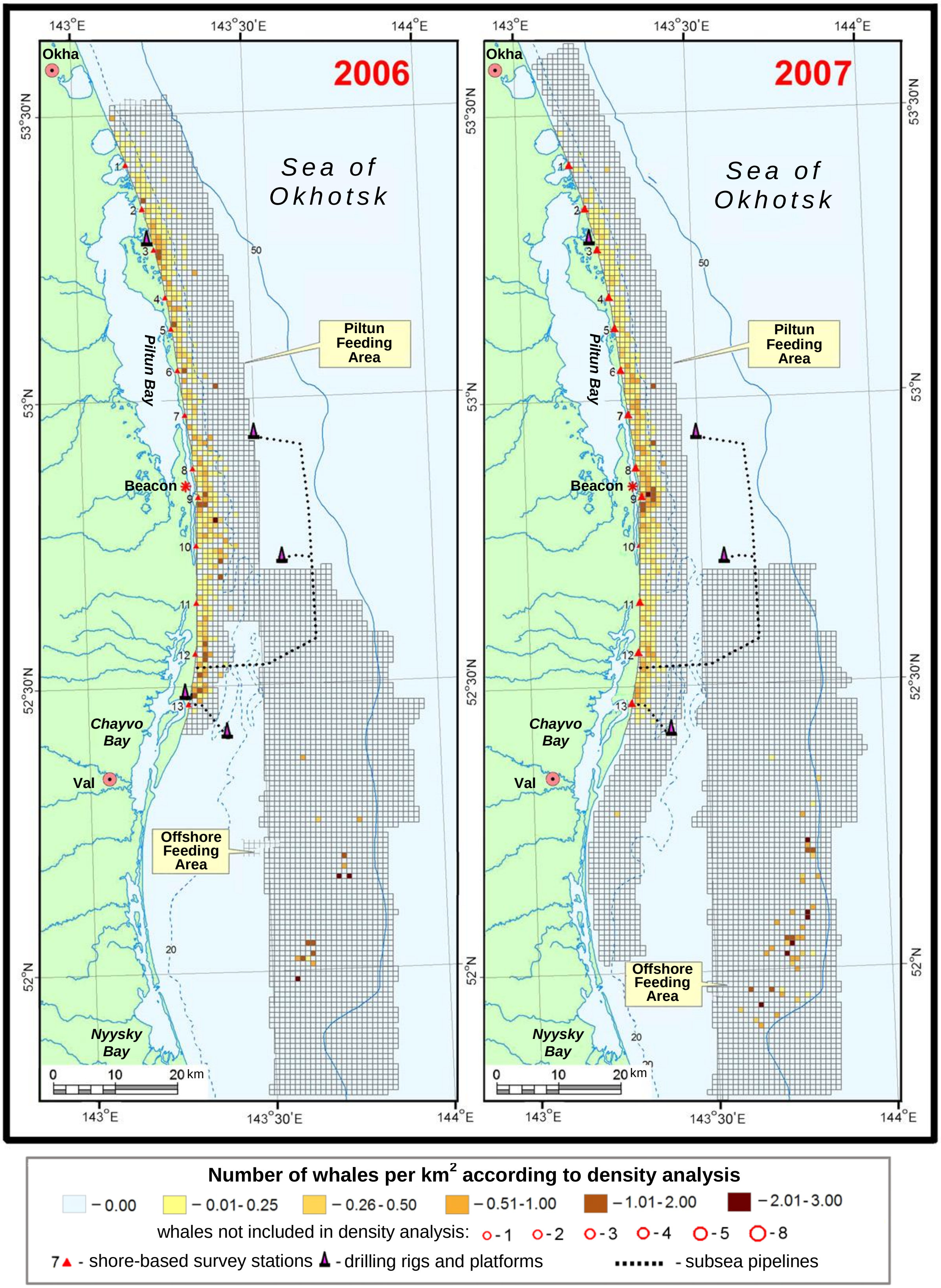
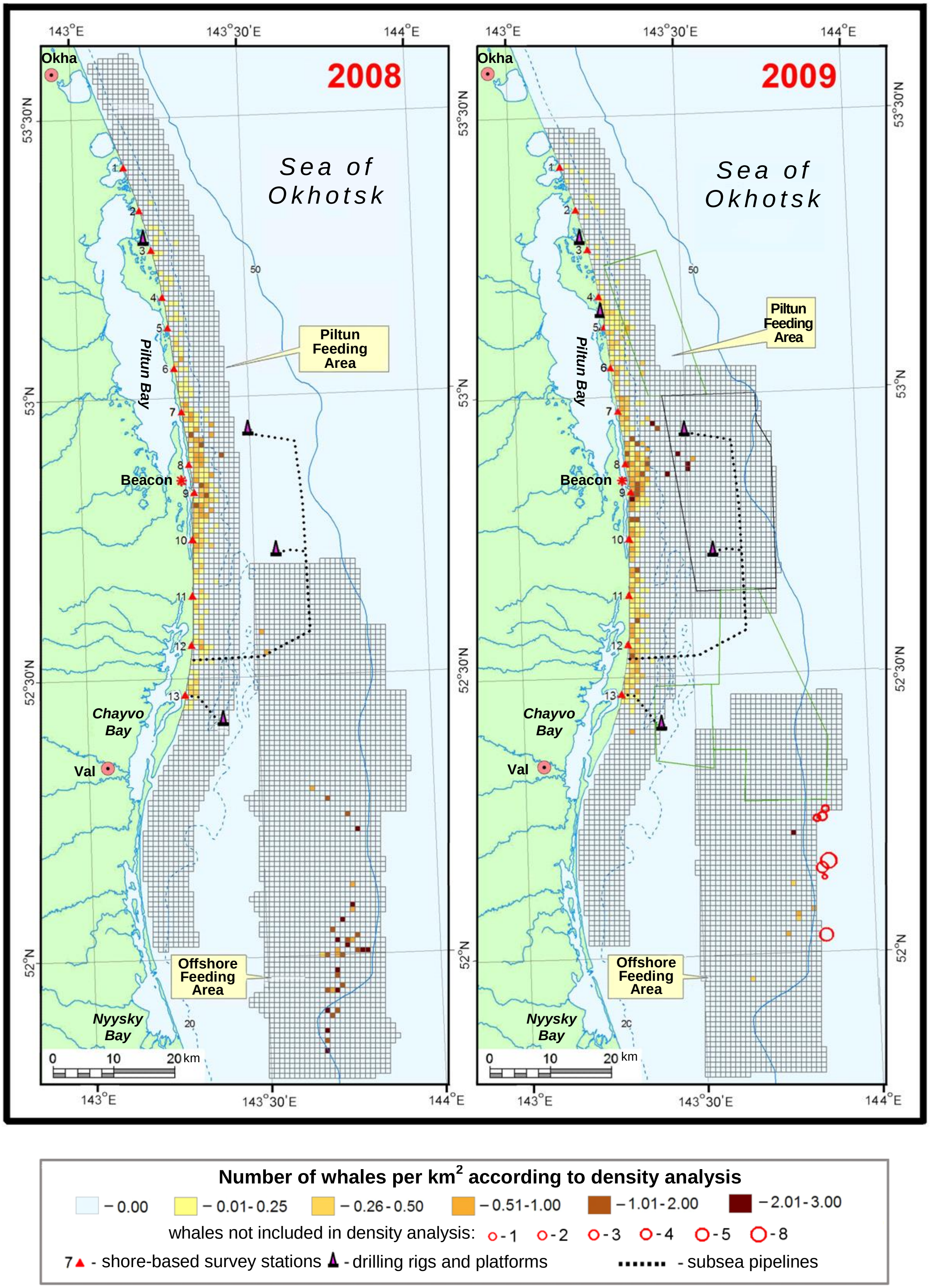
APPENDIX B

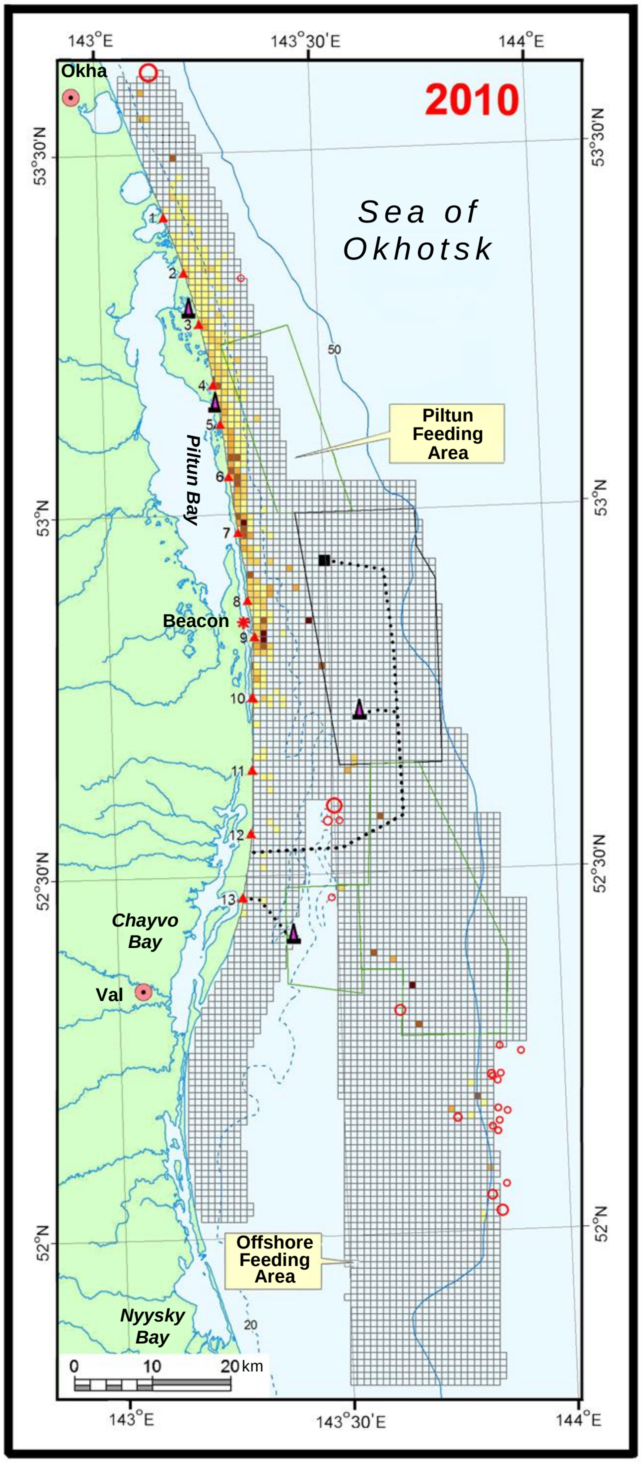
The distribution of gray whales in the waters of Northeast Sakhalin in August-September 2004-2010 (according to combined shore- and vessel-based surveys)


2004
2005
Sea of Okhotsk
Sea of Okhotsk
Okha
Piltun Feeding Area
Piltun Feeding Area
Piltun Bay
Piltun Bay
Beacon
Beacon
Chayvo Bay
Chayvo Bay
Val
Val
Offshore Feeding Area
Offshore Feeding Area
Nyysky Bay
Nyysky Bay
143°E
143°30'E
144°E
53°30'N
53°N
52°30'N
52°N
0 10 20 km
50
20

Number of whales per km² according to density analysis
– 0.00
– 0.01 - 0.25
– 0.26 - 0.50
– 0.51 - 1.00
– 1.01 - 2.00
– 2.01 - 3.00
whales not included in density analysis: - 1 - 2 - 3 - 4 - 5 - 8
7 - shore-based survey stations
- drilling rigs and platforms
- subsea pipelines


2006
2007
Okha
Sea of Okhotsk
Piltun Feeding Area
Piltun Bay
Beacon
Chayvo Bay
Val
Offshore Feeding Area
Nyysky Bay
143°E
143°30'E
144°E
53°30'N
53°N
52°30'N
52°N
0 10 20 km
Number of whales per km2 according to density analysis
– 0.00
– 0.01-0.25
– 0.26-0.50
– 0.51-1.00
– 1.01-2.00
– 2.01-3.00
whales not included in density analysis: - 1 - 2 - 3 - 4 - 5 - 8
7 - shore-based survey stations - drilling rigs and platforms
- subsea pipelines


2008
2009
Sea of Okhotsk
Okha
Piltun Bay
Piltun Feeding Area
Beacon
Chayvo Bay
Val
Offshore Feeding Area
Nyysky Bay
143°E
143°30'E
144°E
53°30'N
53°N
52°30'N
52°N
50
20
0 10 20 km
Number of whales per km2 according to density analysis
– 0.00
– 0.01 - 0.25
– 0.26 - 0.50
– 0.51 - 1.00
– 1.01 - 2.00
– 2.01 - 3.00
whales not included in density analysis: - 1 - 2 - 3 - 4 - 5 - 8
7 - shore-based survey stations
- drilling rigs and platforms
- subsea pipelines


2010
Sea of Okhotsk
Okha
Piltun Feeding Area
Piltun Bay
Beacon
Chayvo Bay
Val
Offshore Feeding Area
Nyysky Bay
143°E
143°30'E
144°E
53°30'N
53°N
52°30'N
52°N
0 10 20 km