



INTERNATIONAL WHALING COMMISSION

64th ANNUAL MEETING

Panama City, Panama 2012

SC/64/BRG19

DISTRIBUTION AND ABUNDANCE OF WESTERN GRAY WHALES AND THEIR PREY OFF NORTHEAST SAKHALIN ISLAND, RUSSIA, 2011 (WITH RETROSPECTIVE COMPARISONS)

V.A. Vladimirov¹, S.P. Starodymov¹ and M.S. Kornienko²

1 – All-Russian Research Institute for Fisheries and Oceanography (VNIRO) – 17, V. Krasnosel'skaya ul., Moscow, 107140, Russia (contact e-mail: vladimirov.vniro@gmail.com).

2 – Institute of Marine Biology, Far East Division of the Russian Academy of Sciences (IBM FEB RAS) – 17, ul. Pal'chevskogo, Vladivostok, 690041, Russia (contact e-mail: kornbear@mail.ru).

ABSTRACT

The results of the shore-based and vessel-based surveys conducted in August-September 2011 under the Exxon Neftegas Limited - Sakhalin Energy Investment Company Joint Western Gray Whale Monitoring Program showed that the one-time maximum observed number of animals in the coastal Piltun area increased vs. 2010 by 56 % (from 66 to 103 whales). In the Offshore area, the numbers did not clearly increase in 2011 (39 individuals in 2011 vs. 37 in 2010). The total number of gray whales in the Sakhalin feeding habitats, based on the one-time results of the synchronized shore-based and vessel-based surveys in both areas, has increased by 33% to at least 118 animals (compared with 89 individuals in 2010), excluding possible double sightings.

In the Piltun area, most whales (59%) stayed in the central part of the strip along the coast with a high concentration (18% of all whales) at the mouth of Piltun Bay. Another localized group (approximately 17%) concentrated at the southern periphery of the area. In the Offshore area, the majority of whales were sighted in the eastern, deeper part of the feeding ground, mostly beyond the 50-meter isobath. An unusual feature of the distribution of gray whales in the waters of the NE Sakhalin in 2011 was the shift of the majority of animals in the Piltun area (71%) into the shallowest coastal zone <1 km offshore but the reasons of this shift remain unclear.

Qualitative comparison of the current distribution of gray whales in the Piltun area with that in the 1980s - 1990s showed close similarities in the main feeding period (August-September); along with it, the animal's contemporary foraging range appears to have expanded to the south.

KEY WORDS: WESTERN GRAY WHALE, SAKHALIN, PILTUN, DISTRIBUTION, NUMBER.

Introduction

In 2011, the distribution of western gray whales in the shelf waters of NE Sakhalin was monitored in August-September (the main foraging period of the whales in this region) as part of a Joint Monitoring Program funded by Exxon Neftegas Limited (ENL) and Sakhalin Energy Investment Company (SEIC), the operators of the Sakhalin-1 and Sakhalin 2 projects. Studies were conducted in two gray whale primary feeding areas existing in this region known as the near-shore Piltun area and the deeper-water Offshore area, where the whales are sighted during the ice-free season from late May / early June to late November / early December. These surveys continued the series of the long-term effort to monitor the

abundance and distribution of this group of whales in the Sakhalin feeding range initiated under a different Russian program about 30 years ago, in 1984.

Field Efforts and Methodology

In 2011, vessel-based surveys were conducted onboard the *RV Igor Maximov*. The vessel operated in the NE Sakhalin region from August 4 to October 5, however, due to satellite tagging program of the Western gray whales under the IWC (8/22-9/21), and other monitoring studies running from the same vessel, as well as adverse weather conditions in the first half of August, only one full survey of whales (9/23) and one partial survey (8/20) interrupted due to reduced visibility, were conducted in the Offshore area over the two months of the expedition. The survey grid in the Offshore area was modified and extended further east in 2011 compared to previous years in order to increase coverage of the deep-water portion of the area where feeding gray whales had been sighted in the two preceding years (Figure 1).

Shore-based vehicle-supported route surveys of gray whales in the Piltun area in 2011 were performed over a period from August 1 to September 28 (59 days). During this time 15 complete surveys were made over the entire Piltun area (i.e., covered all survey points in both the northern and southern sections – at points 1-8 and 9-13, respectively) were conducted. Eleven complete surveys were carried out at one of the sections (2 in the north and 9 in the south), when the weather conditions at the other section made it impossible to conduct complete surveys. In another 19 cases, surveys that had begun at the sections were interrupted at different stages because of the worsened weather (reduced visibility or heightened sea state).

Both the vessel-based and shore-based field surveying methodology has remained unchanged since 2004 and has been described in earlier reports submitted to the IWC meetings (Vladimirov et al., 2005-2011). Detailed description of all survey, analytic and mapping methods is available in a special annual report submitted to Russian regulators (Vladimirov et al., 2012a).

2011 Results

1. General Results:

Vessel-based surveys in 2011 resulted in the sighting of a total of 800 gray whales, 54 of which were sighted during dedicated surveys in the Offshore area (39 during the complete survey on September 23 and 15 during the incomplete survey on August 20). Shore-based surveys in the Piltun area produced 1316 sightings of groups and lone gray whales, for a total of 1644 individuals.

Overall, the distribution of gray whales in waters off northeast Sakhalin remained unchanged in 2011. Throughout August and September, whales were concentrated in two traditional feeding areas: the nearshore Piltun and the Offshore ones (Figure 1).

2. Abundance and Distribution of Gray Whales in the Piltun Feeding Area

The maximum number of gray whales in the Piltun area reported in the 2011 shore-based surveys was 103 individuals (8/20). The highest number of animals was observed from 15 to 20 August, then their number gradually began to decline and by the end of September fell to 38 individuals (Figure 2).

The decline in the abundance of gray whales in the Piltun area by the end of September is common seasonal event associated with their movement to the Offshore feeding area but it was impossible to document this movement in 2011 due to poor weather which prevented conducting vessel-based surveys and photo-identification work there.

Overall, in August-September 2011, gray whales fed along virtually the entire coastal Piltun area, although most of them (59.4%) were registered in the central portion of the area from observation points 5 to 10, with the highest local concentration (18.1%) near the mouth of Piltun Bay, in the area of observation point 9 (Figure 1). Another discernible group of whales (> 17%) was localized on the southern periphery of the area in the zone of observation points 11-13. During the season, with the decline of the total number of animals in the area, the areas of the central and southern aggregations gradually shrank due to the outmigration of whales and by the end of September only one group of whales remained near the mouth of Piltun Bay (Figure 3).

The distribution of whales by distance offshore in 2011 was different from all earlier years as the majority of animals (70.7%) was sighted in the most shallow coastal belt of the Piltun area <1 km offshore (Figure 1); 34.7% of these whales were recorded < 0.5 km offshore. Corresponding depth distribution indicates that 89.4% of whales were sighted in depths <10 m, including 44.5% which stayed at depths <5 m.

3. Abundance and Distribution of Gray Whales in the Offshore Feeding Area

In the Offshore feeding area, based on the results of one complete and one partial survey, the majority of whales was sighted beyond the 50-m isobath (Figure 1). Their highest recorded number was 39 individuals (9/23).

4. Estimate of the Total Abundance of Gray Whales off the Northeastern Coast of Sakhalin Island

The total number of gray whales in the NE Sakhalin feeding range (i.e. in the Piltun and Offshore feeding areas) can only be calculated when they are surveyed there on the same day or on two consecutive days in order to diminish likelihood of double

counting or undercounting whales due to their movements between the two areas during the interval between surveys.

In 2011, such synchronized surveys in the Piltun and Offshore feeding areas that provided the maximum overall gray whale number were made on August 20 (103 individuals in the Piltun and 15 ones in the Offshore area). Assuming there was no double counting of animals, the total number of gray whales in the waters of northeast Sakhalin was 118 in 2011. This estimate may be somewhat low, since the August 20 survey of the Offshore area covered only about half of the grid area, and a number of whales may have been present in the uninvestigated part of the area. Results from the IBM RAN photo-ID team confirm this finding, providing an estimate of 124 whales in the Sakhalin region sighted in 2011.

Discussion

The 2011 survey data show that in the coastal Piltun area there was an increase in the number of gray whales feeding in the summer-autumn period. Compared with 2010, the maximum recorded number of animals increased in 2011 by 1.5 times - from 66 to 103 individuals. It is difficult to assess inter-annual population dynamics of whales in the Offshore feeding area because of insufficient number of surveys conducted there in 2011. The total instantaneous maximum number of gray whales registered in 2011 in the waters of northeastern Sakhalin (i.e. the total in the two feeding areas), increased vs. the previous year by at least 32.6% (from 89 to 118 individuals).

In terms of long-term population dynamics of gray whales, the total number of animals in the waters of Sakhalin increased to the levels of 2004-2006 (120-125 heads) after a period of low numbers in 2007-2010 (77-101 individuals). In comparison, estimates of the population of gray whales in coastal waters of eastern Sakhalin were about 70-75 individuals in the 1980s and between 90-100 individuals at the end of the 1990s¹ (Vladimirov et al., 2012b).

The distribution of gray whales along the shore in the Piltun area in August and September 2011 was, in large part, similar to previous years. It is characterized by, first, concentration of the majority of whales in the central coastal area (near the mouth of Piltun Bay and to the north of it); second, by the permanent presence of high concentration of whales directly in the zone near the mouth of Piltun Bay; and third, by the low number of animals in the northern and southern peripheral areas of the Piltun area. A similar distribution pattern was observed in the Piltun area in August and September in all recent years (2007-2010, - Figure 4).

Analysis of aerial survey data of 1980s – 1990s showed that, as far as one can gather from rare overflights (i.e., survey methodology not comparable to current robust sampling effort), a similar center-aggregated type of distribution of gray whales in this area in August

¹ the estimates for the 1980s - 1990s were made with the correction for the difference in survey methods.

and September was observed in most years during that early period, i.e. in 1984, 1985, 1989, 1990, 1997, 1998, 1999 and 2000 (Appendix: Figures A-1 - A-4).

However, in some years (or periods of several years) deviations from the usual pattern described above may occur, when the majority of whales concentrated in the northern part of the Piltun area (e.g., in 1986, 2002 and 2004-2005) or when two centers of high concentration of whales formed, one adjacent to the mouth of Piltun Bay, and another in the northern area (this occurred in 1987, 2003 and 2006; - Figure 4 and Appendix: Figures A-1, A-5). The emergence of concentrations of gray whales in the northern coastal feeding area in these years is likely associated with high biomass of prey there. In particular, in 2004-2005, and partly in 2006 concentrations of sand lance *Ammodytes hexapterus* in the north (Fadeev, 2011) could have attracted whales. This fish is known as a prey item of gray whales (Zimushko and Lenskaya, 1970). It has also been documented as prey for humpback whales feeding on the bottom accumulations of sand lance (Tackaberry and Robbins, 2011).

The above patterns of distribution of gray whales in the waters of the Piltun area are an average over the main feeding period (August-September). On a finer temporal scale, the distribution varies from month to month. The center-aggregated type usually shows decrease in the presence of animals on the northern periphery of the central cluster between August to September and the increase in their concentration near the mouth of the Piltun Bay (which took place in 2011). In cases of the north-aggregated or two-centered types (described in the preceding paragraph), a decrease in the number of whales in the central part of the area and increase of their concentration in the north usually occur from August to September.

The distribution of gray whales by depth/distance offshore observed in the Piltun area was different in 2011 from all previous years, marked by very close distance of animals to shore (Figure 4). Thus, the proportion of whales recorded in 2011 in the Piltun area at a distance of <0.5 km from the shoreline (34.7%) increased by a factor of 4.5 compared to the average level in August-September 2004-2010 (7.9%), and by a factor of 1.6 (from 21.9 to 36.0%, - Figure 5-a) in the zone between 0.5 and 1 km from the shore. The number of whales further offshore decreased in 2011 compared with the average in 2004-2010. The magnitude of this reduction has increased from 1.8 times in the area of 1-2 km (24.1% vs. 42.9%, respectively) to almost 10 times in the area of 3-5 km and more (1.3% vs. 12.6%). A similar pattern was observed in 2011 in the distribution of whales along the depth profile – the proportion of animals in the zone of 0-5-meter isobaths increased by almost a factor of 4 compared to the average level in August-September 2004-2010 (44.5% vs. 11.9%) and considerably decreased in the zone beyond the 11-meter isobath (Figure 5-b).

The causes for the observed in 2011 shift of gray whales in the Piltun area towards the coast are unclear. The shift occurred in the entire Piltun area and was observed throughout the season; therefore, its forcing may have been of regional scale.

A small group of whales (17%) stayed on the southern periphery of the Piltun area. This southern group was not documented in 2010. In the summer of 2011 an underwater pipeline was laid in this area, and the sound and activities were expected to cause

avoidance of the area by whales (Richardson et al., 1995). However, the increased sound levels due to the operations did not seem to have caused a measurable avoidance reaction of gray whales.

In the Offshore area, a trend of gradual shift of the main feeding area of gray whales towards the eastern, deeper portion of the area has been observed during the last 5 years (2007-2011, - Figure 4 and Appendix: Figure A-6) that may be a result of natural changes in prey base of the whales in these waters.

Benthic Data

(contributed by Valeriy I. Fadeev,
IBM FEB RAS)

Technical issues related to benthos sampling using the Van Veen grab affected the quality and comparability of the 2011 benthic data, and they are therefore presented in this report as opposed to previous stand-alone reports. The Van Veen grab deployment was not the same as previous years (i.e., slower winch deployment leading to less sediment penetration). Fewer samples than in most other years were obtained in the Offshore feeding area, at depths >15 m in the Piltun area, and at feeding points. Adequate number of samples was obtained at depths <15 m in the Piltun area; therefore, they are directly comparable to previous years.

In 2011, the average biomass of amphipods was 82.3 ± 11.7 g/m² in the Piltun feeding area at depths <15 m. More than 90% of the abundance of amphipods was accounted for by two species: *Monoporeia affinis* (> 60% of the total amphipod biomass) and *Eogammarus schmidtii* (> 30% of the biomass). In 2010-2011 amphipods occurred in the coastal zone of the entire Piltun area; the biomasses were higher in the northern and southern parts of the area than in the middle.

Multi-year changes in amphipod biomass in the shallow waters of the Piltun area represent a statistically significant biomass decrease in 2006 compared to 2002-2005. Increases in amphipod biomass observed in 2007-2011 have not yet reached the maximum values of 2002-2003 (statistically significant differences still remain). In 2009-2011, amphipod biomass, the main feeding component for gray whales in the Piltun area, reached the level of 2004-2005.

In the northern part of the Piltun area at depths > 20 m, a substantial decrease in sand lance frequency of occurrence was observed in recent years, from 40-60% in 2005 to 20-25% in 2006-2007, and 8-12% in 2008-2009. In 2011 the frequency of occurrence of sand lance in the northern part of the Piltun area increased to 45% versus 20% in 2010, which may indicate an increase of sand lance concentrations, which began in 2010. Unfortunately, due to methodological issues outlined above, biomass of sand lance was not possible to assess in 2011.

The average benthos biomass in the Offshore area 2011 was 435 ± 178 g/m² (n=38). The biomass of amphipods was 176.7 ± 78.5 g/m² in 2011 compared to 206.2 ± 53.7 g/m² in 2010. Year-to-year differences in average amphipod biomass were not statistically

significant. The proportion of amphipod biomass in total benthos biomass of the Offshore feeding area increased with distance from shore toward deeper waters.

Analysis of the 2009-2010 benthic data from gray whale feeding points in the Eastern Kamchatka region (Olga Bay) showed that the whales feed in areas dominated by the same species of amphipods - *Monoporeia affinis* - as in the Piltun feeding area. Average total biomass of benthos at whale feeding points in 2009 and 2010 had similar values, i.e., 71.8 ± 9.0 g/m² (n = 21) and 71.2 ± 8.7 g/m² (n = 27), respectively. More than 95% of the biomass at whale feeding points was comprised of amphipods (61%) and cumaceans (36%). The biomass of amphipods and the size of the feeding area of gray whales in Olga Bay are similar to the area near Chayvo Bay in Sakhalin. However, there are usually no more than 5-7 whales sighted feeding in the Chayvo subarea, while in Olga Bay over 40-50 whales were recorded feeding in 2010-2011. Therefore, it can be expected that there are other, yet unknown gray whale feeding areas along the coast of Kamchatka.

Conclusion

Survey data obtained in 2011 indicate that the status of feeding western gray whales in the waters of the north-eastern Sakhalin is stable. The total number of whales documented by distribution and photo-ID programs indicated that levels are relatively steady over the monitoring period, and their distribution is broadly consistent with the usual pattern recorded over the years of the study. A specific feature of 2011 distribution is the shift of whales in the Piltun area closer to the shore over the entire season of observation.

The close similarity of the current distribution of gray whales in the Piltun feeding area and its seasonal dynamics with those in the 1980s - 1990s, indicates that intensification of industrial activity on the continental shelf of northeastern Sakhalin in the 2000s, associated with the exploration and development oil and gas fields, has not led to discernible adverse changes in the number and distribution of gray whales in their key feeding areas. From a qualitative analysis of the historical and current data, it appears that the feeding range has expanded over the years, and the number of registered whales has increased.

Acknowledgements

We wish to convey our sincere gratitude to the Russian whale scientists D.S. Kovshov, V.R. Kuznetsov, D.S. Samarin, A.A. Samarina, R.E. Sidorenko, A.S. Tishchuk and O.V. Tomilov for their active assistance in gathering field data, S.B. Yazvenko, J.E. Muir, Yu.A. Bychkov, L. Ferreira and R. Tamasi (LGL Limited, Canada) for their assistance in conducting the density analysis of gray whale distribution, plotting the relevant maps and preparing the report, J.M. Dupont and M.R. Jenkerson («ExxonMobil Upstream Research Company», US), E.N. Kalinin («Exxon Neftegas Limited», Russia), A.V. Vladimirov and P. van der Wolf («Sakhalin Energy Investment Company, Ltd», Russia), for their assistance in organizing all the work.

References

- Blokhin, S.A., N.V. Doroshenko, and I.P. Marchenko. 2003. The Abundance, Distribution, and Movement Patterns of Gray Whales (*Eschrichtius robustus*) in Coastal Waters off the Northeast Sakhalin Island Coast in 2002 Based on the Aerial Survey Data // Report by Pacific Research Fisheries Center (TINRO-Center), Vladivostok, Russia to Exxon Neftegaz Limited (ENL) and Sakhalin Energy Investment Company, Ltd., Yuzhno-Sakhalinsk, Russia - 67 pp. [available on the Sakhalin Energy Investment Company website <<http://www.sakhalinenergy.ru>>]
- Blokhin, S.A., N.V. Doroshenko, and S.B. Yazvenko. 2004. Distribution, Abundance, and Movement Patterns of Western Gray Whales (*Eschrichtius robustus*) off the coast of Northeastern Sakhalin Island in June-December 2003 Based on Aerial Survey Data // Report by Pacific Research Fisheries Center (TINRO-Center), Vladivostok, Russia to All-Russian Research Institute of Fisheries and Oceanography (VNIRO), Moscow, Russia, Exxon Neftegaz Limited (ENL) and Sakhalin Energy Investment Company, Ltd., Yuzhno-Sakhalinsk, Russia - 151 pp. [available on the Sakhalin Energy Investment Company website <<http://www.sakhalinenergy.ru>>]
- Fadeev, V.I. 2011. Benthos studies in feeding grounds of western gray whales off the northeast coast of Sakhalin Island (Russia), 2002-2010 // Int'l Whaling Com., 63rd meeting, doc. SC/63/BRG15 - 13 pp.
- Richardson, W.J., C.R. Greene, C.I. Malme and D.H. Thomson. 1995. Marine Mammals and Noise // Academic Press, San Diego, CA - 576 p.
- Sobolevsky, E.I. 2000. Marine Mammals Studies Offshore North East Sakhalin. // Report by the Institute of Marine Biology, Far East Branch of Russian Academy of Sciences, Vladivostok, Russia, to Exxon Neftegaz Limited and Sakhalin Energy Investment Company, Yuzhno-Sakhalinsk, Russia. 160 pp. [available on the Sakhalin Energy Investment Company website <<http://www.sakhalinenergy.ru>>].
- Sobolevsky, Ye.I. 2001. Marine Mammals Studies Offshore North East Sakhalin in 2000. // Report by the Institute of Marine Biology, Far East Branch of Russian Academy of Sciences, Vladivostok, Russia, to Exxon Neftegaz Limited and Sakhalin Energy Investment Company, Yuzhno-Sakhalinsk, Russia. 144 pp. [available on the Sakhalin Energy Investment Company website <<http://www.sakhalinenergy.ru>>].
- Tackaberry, J., and J. Robbins. 2011. Bottom feeding by humpback whales in the Gulf of Maine: prevalence, demography and entanglement risk // Abstracts of the 19th Bien. Conf. on the Biol. of Marine Mammals (Tampa, Florida, Nov. 27 – Dec. 2, 2011) - p. 287.
- Vladimirov, V.A., S.A. Blokhin, A.V. Vladimirov, V.L. Vladimirov, N.V. Doroshenko and M.K. Maminov. 2005. Distribution and abundance of western gray whales off the northeast coast of Sakhalin Island (Russia), 2004 (summary information report) // Int'l Whaling Com., 57th meeting, doc. SC/57/BRG23 - 6 pp.
- Vladimirov, V.A., S.A. Blokhin, A.V. Vladimirov, M.K. Maminov, S.P. Starodymov and E.P. Shvetsov. 2006. Distribution and abundance of western gray whales off the northeast coast of Sakhalin Island (Russia), 2005 // Int'l Whaling Com., 58th meeting, doc. SC/58/BRG29 - 12 pp.
- Vladimirov, V.A., S.P. Starodymov, A.G. Afanasyev-Grigoryev, A.V. Vladimirov and A.T. Ashchepkov, 2007. Distribution and abundance of western gray whales off the northeast coast of Sakhalin Island, Russia, in 2006 // Int'l Whaling Com., 59th meeting, doc. SC/59/WP5 – 10 pp.
- Vladimirov, V.A., S.P. Starodymov, A.G. Afanasiev-Grigoriev, J.E. Muir, O.Yu. Tyurneva, Yu.M. Yakovlev, V.I. Fadeev and V.V. Vertyankin. 2008. Distribution and abundance of gray whales off the northeast coast of Sakhalin Island (Russia), 2007 // Int'l Whaling Com., 60th meeting, doc. SC/60/BRG9 - 9 pp.
- Vladimirov, V.A., S.P. Starodymov, A.G. Afanasiev-Grigoriev and V.V. Vertyankin. 2009. Distribution and abundance of western gray whales off the northeast coast of Sakhalin Island, Russia, 2008 // Int'l Whaling Com., 61st meeting, doc. SC/61/BRG25 - 12 pp.
- Vladimirov, V.A., S.P. Starodymov, M.S. Kornienko and J.E. Muir. 2010. Distribution and abundance of western gray whales in the waters off northeast Sakhalin Island, Russia, 2004-2009 // Int'l Whaling Com., 62nd meeting, doc. SC/62/BRG4 - 15 pp.
- Vladimirov, V.A., S.P. Starodymov and A.V. Kalachev. 2011a. Distribution and abundance of western gray whales off northeast Sakhalin Island, 2004-2010 // Int'l Whaling Com., 63rd meeting, doc. SC/63/BRG21 - 11 pp.

- Vladimirov, V.A., S.P. Starodymov and A.V. Kalachev. 2011b. Distribution and abundance of western gray whales off northeast Sakhalin Island, August-September 2010 (based on data from onshore and vessel-based surveys) // In: Western Gray Whale Research and Monitoring Program in 2010, Sakhalin Island, Russia. Volume II: Results and Discussion, Chapter 1. Prepared for Exxon Neftegas Limited and Sakhalin Energy Investment Company, Ltd – p. 1-1 – 1-96. [available on the Sakhalin Energy Investment Company website <<http://www.sakhalinenergy.ru>>]
- Vladimirov, V.A., S.P. Starodymov, J.E. Muir, and Yu. Bychkov. 2012a. Western gray whale distribution surveys (vessel-based and onshore): Introduction and methods // In: Western Gray Whale Research and Monitoring Program in 2011, Sakhalin Island, Russia, Volume 1 - Background and methods, Chapter 2. Prepared for Exxon Neftegas Limited and Sakhalin Energy Investment Company, Ltd – p. 31-63 [available on the Sakhalin Energy Investment Company website <<http://www.sakhalinenergy.ru>>]
- Vladimirov, V.A., S.P. Starodymov, and M.S. Kornienko. 2012b. Distribution and abundance of western gray whales off northeast Sakhalin Island, August-September 2011 (based on data from onshore and vessel-based surveys) // In: Western Gray Whale Research and Monitoring Program in 2011, Sakhalin Island, Russia. Volume II: Results and Discussion, Chapter 1. Prepared for Exxon Neftegas Limited and Sakhalin Energy Investment Company, Ltd - 96 pp. [available on the Sakhalin Energy Investment Company website <<http://www.sakhalinenergy.ru>>]
- Würsig, B., D.W. Weller, A.M. Burdin, S.A. Blokhin, S.Y. Reeve, A.L. Bradford and R.L. Brownell, Jr. 1999. Gray whales summering off Sakhalin Island, Far East Russia: July-October 1997. A Joint U.S. - Russian Scientific Investigation // Final Contract Report by Texas A&M University and Kamchatka Institute of Ecology and Nature Management, for Sakhalin Energy Investment Company and Exxon Neftegas Limited, Yuzhno-Sakhalinsk, Russia - 101 pp. [available on the Sakhalin Energy Investment Company website <<http://www.sakhalinenergy.ru>>]
- Würsig, B., D.W. Weller, A.M. Burdin, S.Y. Reeve, A.L. Bradford, S.A. Blokhin and R.L. Brownell, Jr. 2000. Gray whales summering off Sakhalin Island, Far East Russia: June-September 1988. A Joint US-Russia scientific investigation // Final Contract Report by Texas A&M University and the Kamchatka Institute of Ecology and Nature Management for Sakhalin Energy Investment Company and Exxon Neftegas Limited, Yuzhno-Sakhalinsk, Russia - 133 pp. [available on the Sakhalin Energy Investment Company website <<http://www.sakhalinenergy.ru>>]
- Zimushko, V.V., and S.A. Lenskaya. 1970. On feeding of gray whales (*Eschrichtius gibbosus* Erxl.) in summer feeding grounds // *Ekologiya*, v. 3 - p. 26-35 (*in Rus*).

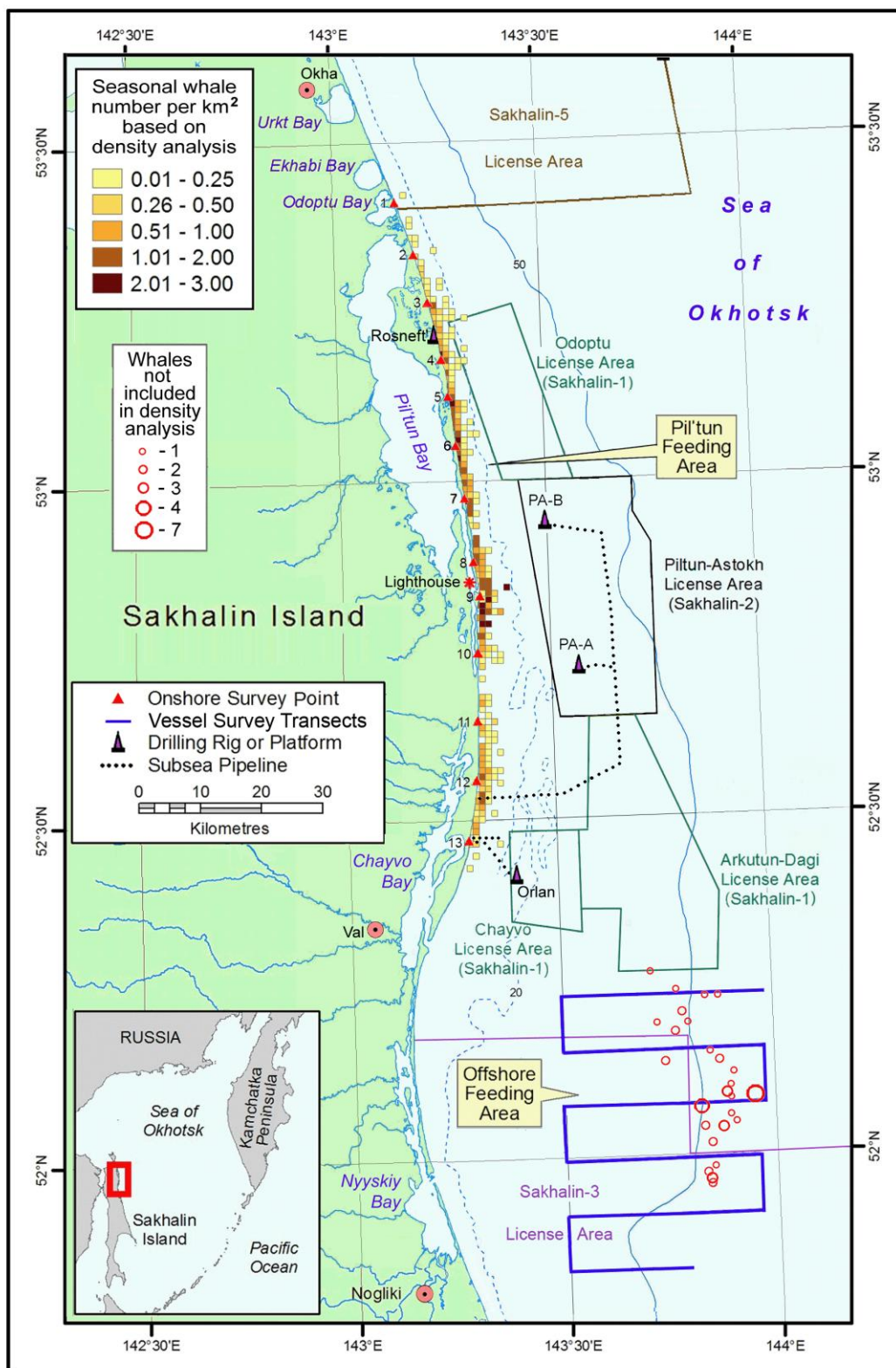


Figure 1. Gray whale distribution in the Piltun and Offshore feeding areas, August–September 2011 (from onshore and vessel-based surveys). Resolution of density cells is 1 km².

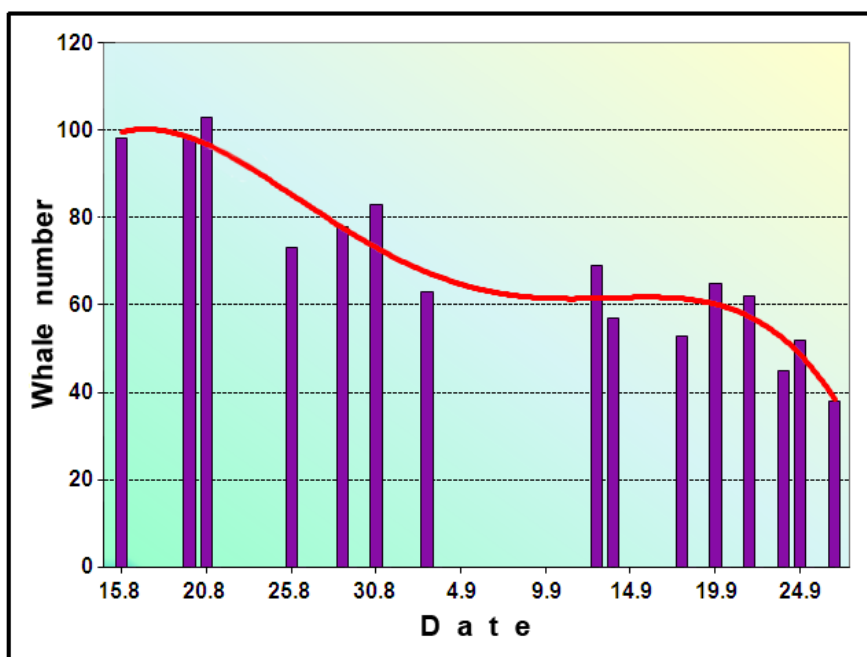


Figure 2. Seasonal dynamics of gray whale numbers in the Piltun feeding area, August-September 2011
(based on the data of complete shore-based surveys)
Red curve – polynomial trend.

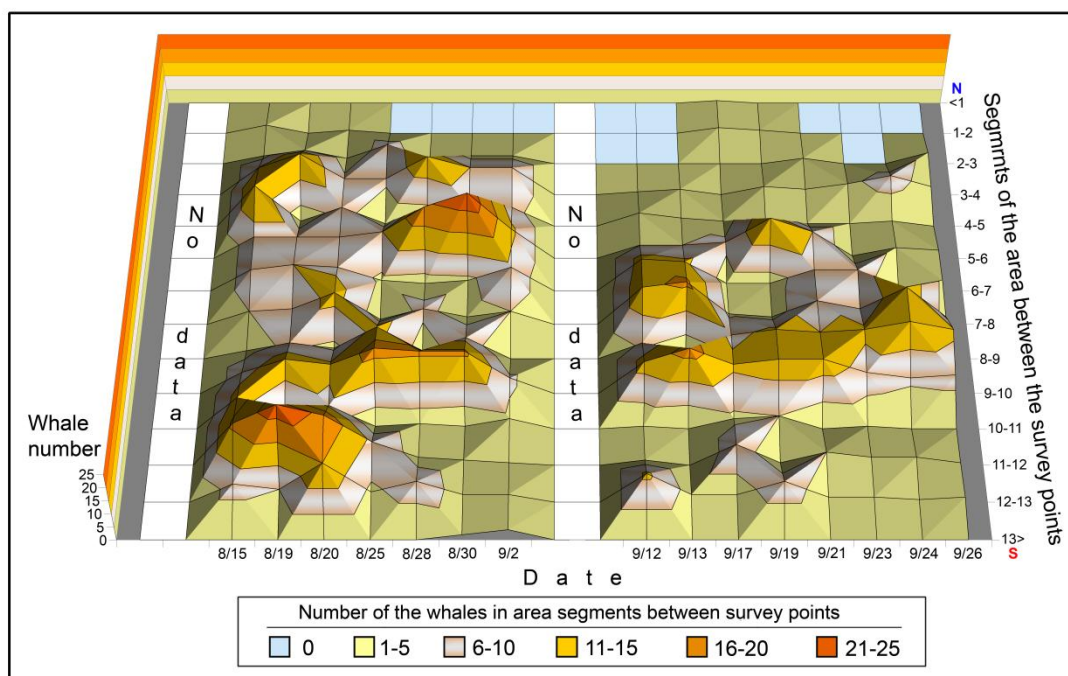


Figure 3. Spatiotemporal changes in the gray whale distribution in the Piltun feeding area, August–September 2011
(based on the data of complete shore-based surveys)

Figure 4.
Annual changes
in the gray whale
distribution
in the northeast
Sakhalin feeding range,
August-September
2004-2011
based on combined
results of onshore
and vessel-based
surveys
(whale average seasonal
density per km²).

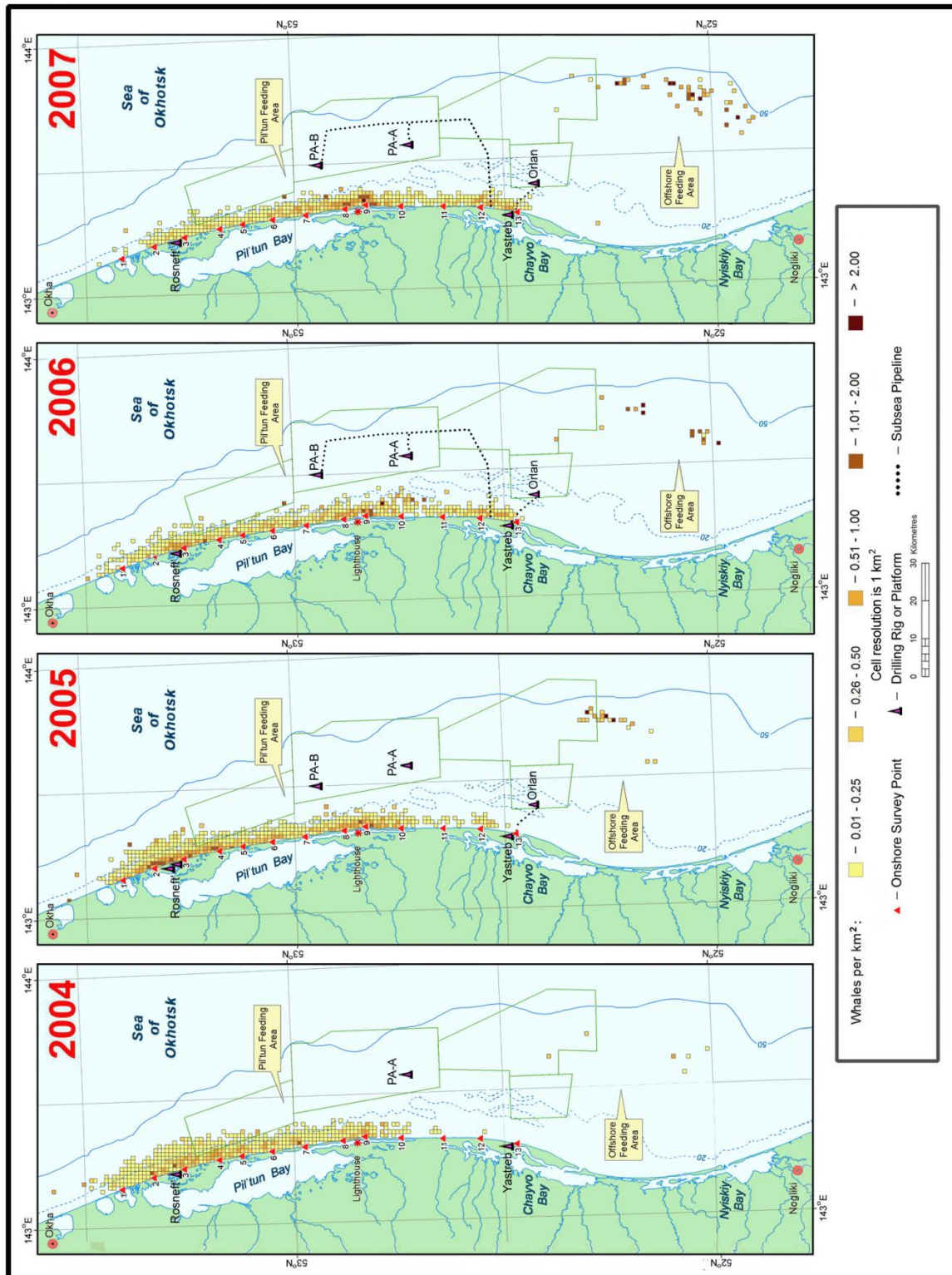
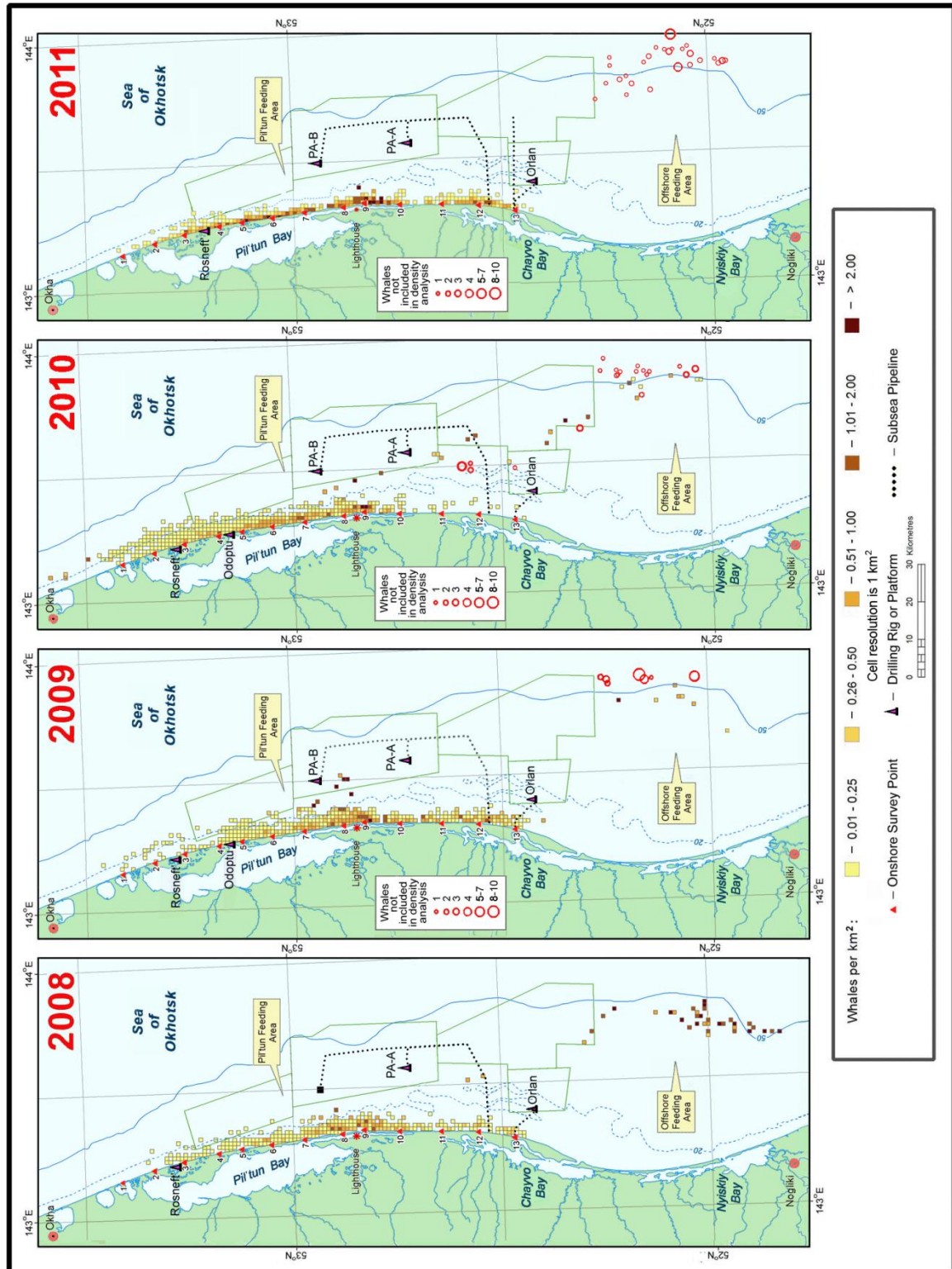


Figure 4.
Continuation



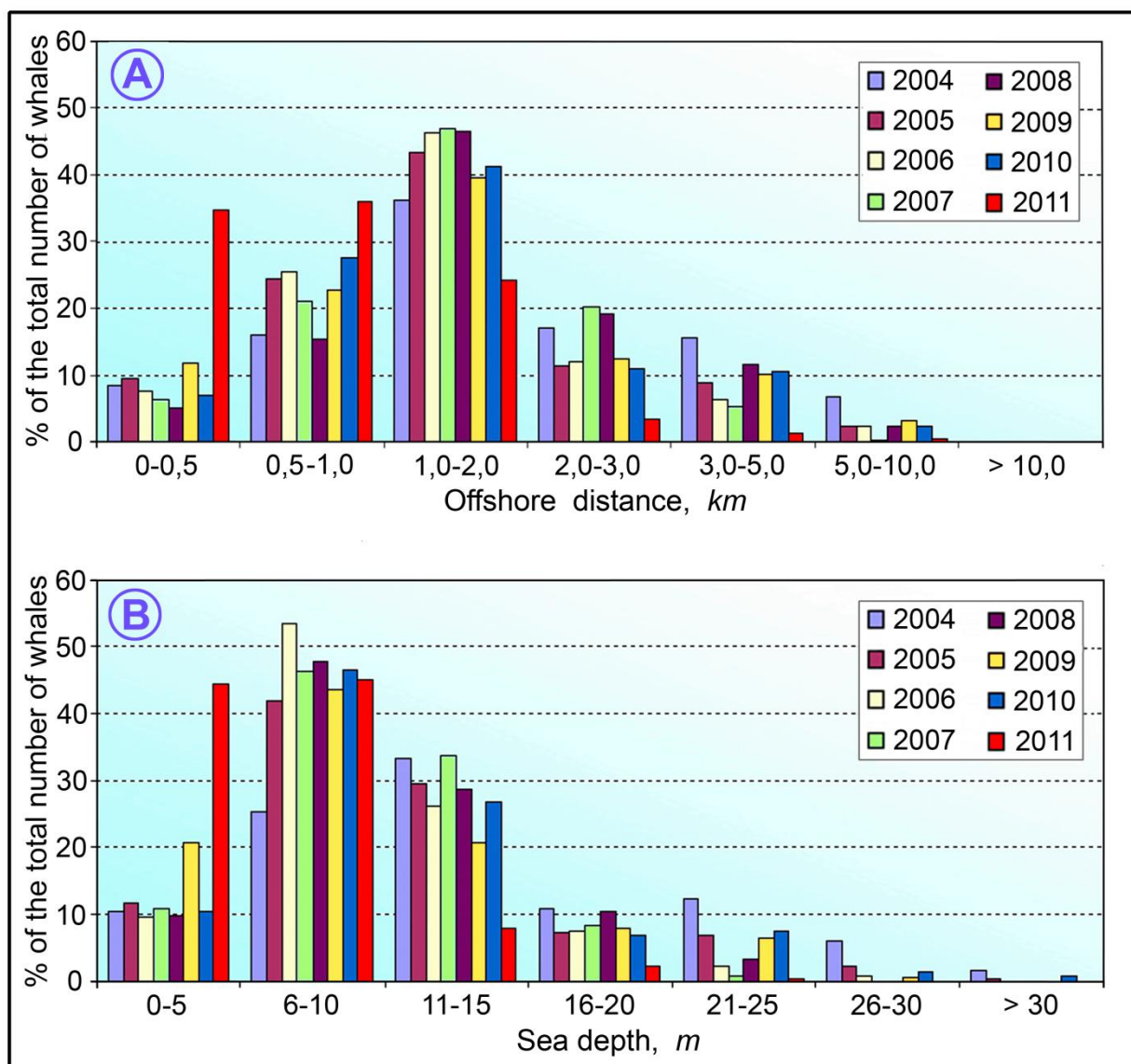


Figure 5. Distribution of gray whales in the Piltun feeding area by offshore distance (A) and the sea depth (B), August-September 2004-2011 (based on the data of shore-based surveys)

A p p e n d i x

**Maps of gray whale distribution in the feeding areas
off Northeastern Sakhalin Island,
based on the results of distribution surveys
of 1984–2003**

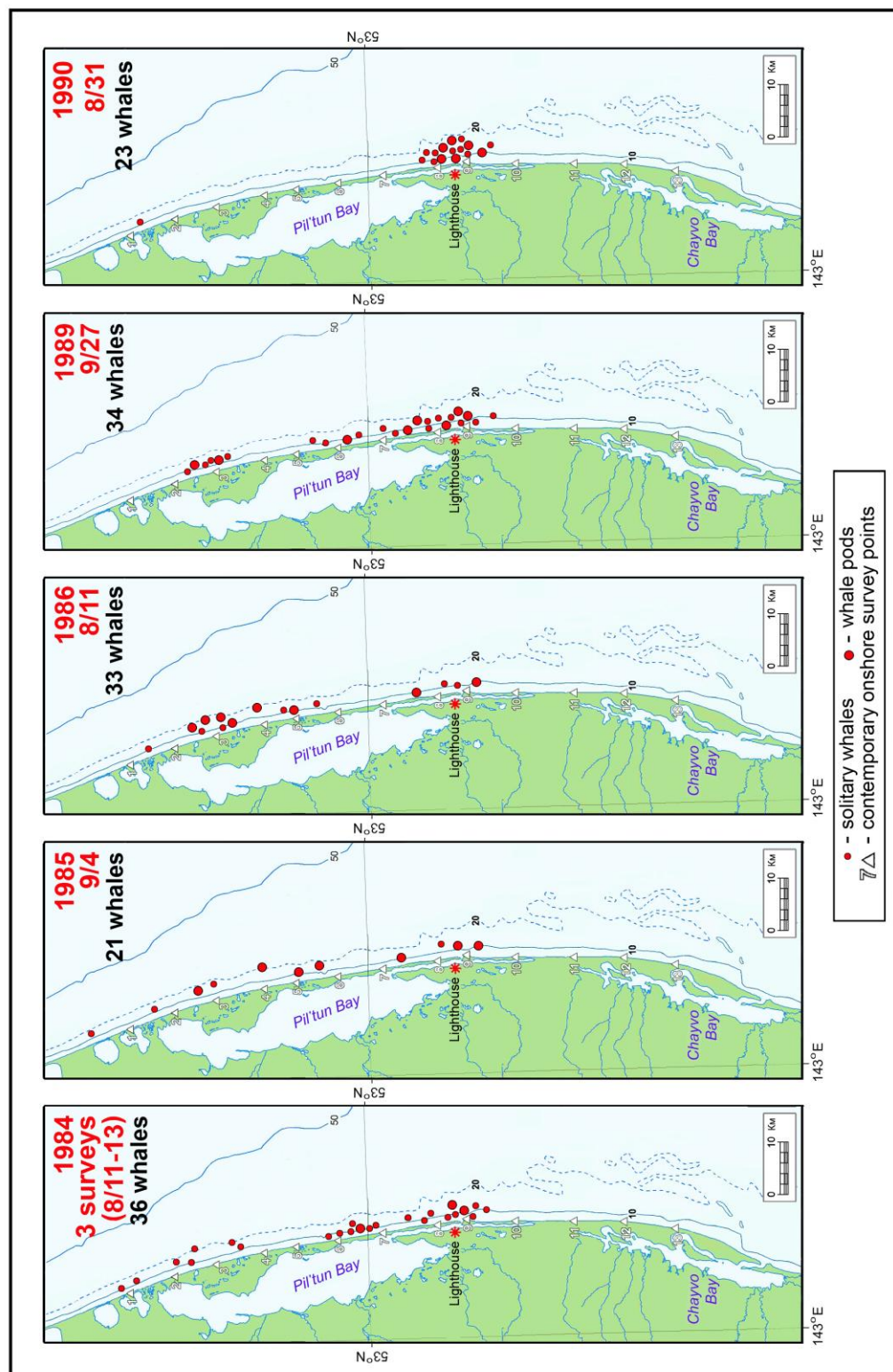


Figure A-1. Distribution of gray whales in the Piltun area, August-September 1984-1990 based on the data of aerial surveys carried out by TINRO, Vladivostok (information for mapping provided by N.V. Doroshenko)

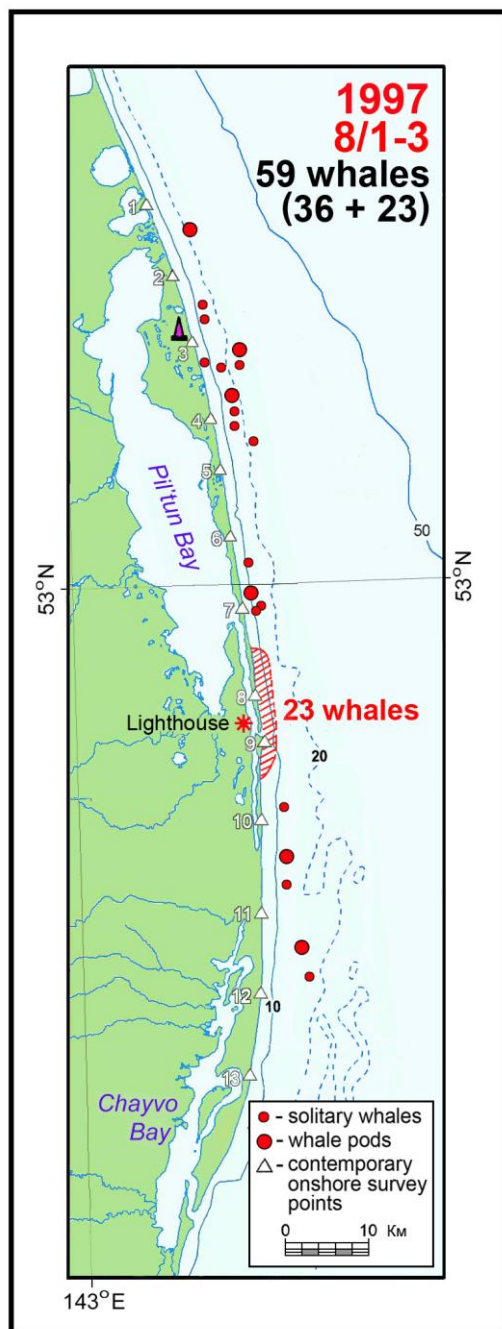


Figure A-2. Distribution of gray whales in the Piltun area, August 1997. Combined results of a vessel-based survey and simultaneous onshore observations from the Piltun lighthouse (the data for mapping from Würsig et al., 1999)

Hatched part of the area – approximate zone of location of 23 whales counted from the lighthouse

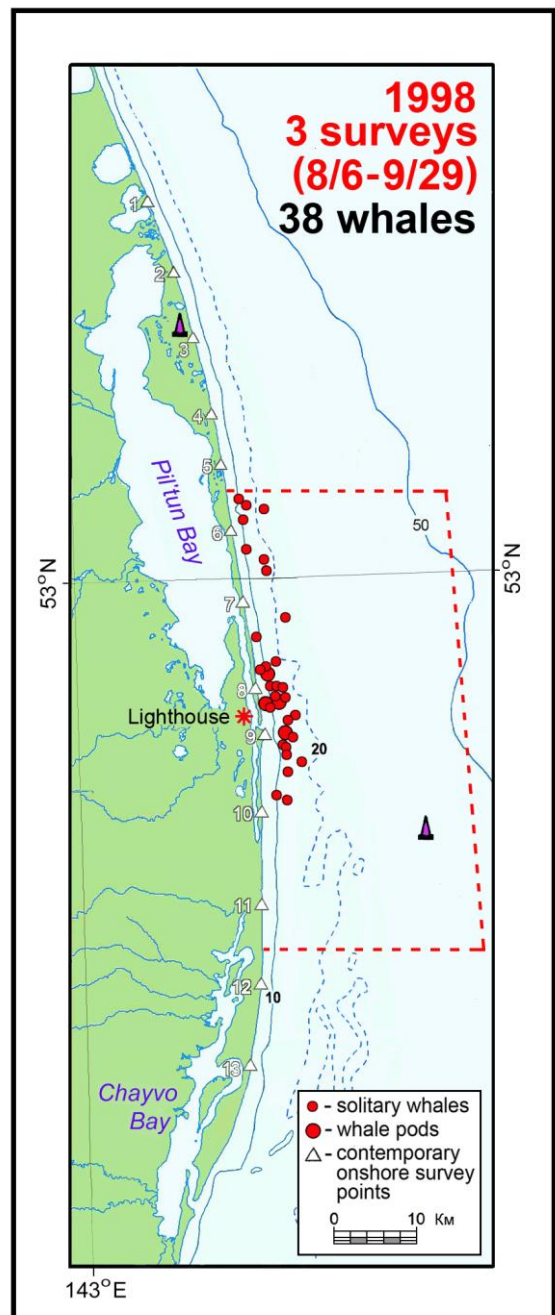


Figure A-3. Distribution of gray whales in the Piltun area, August-September 1998 based on results of aerial surveys (the data for mapping from Würsig et al., 2000)

Red dashed line indicates the surveyed part of the area.

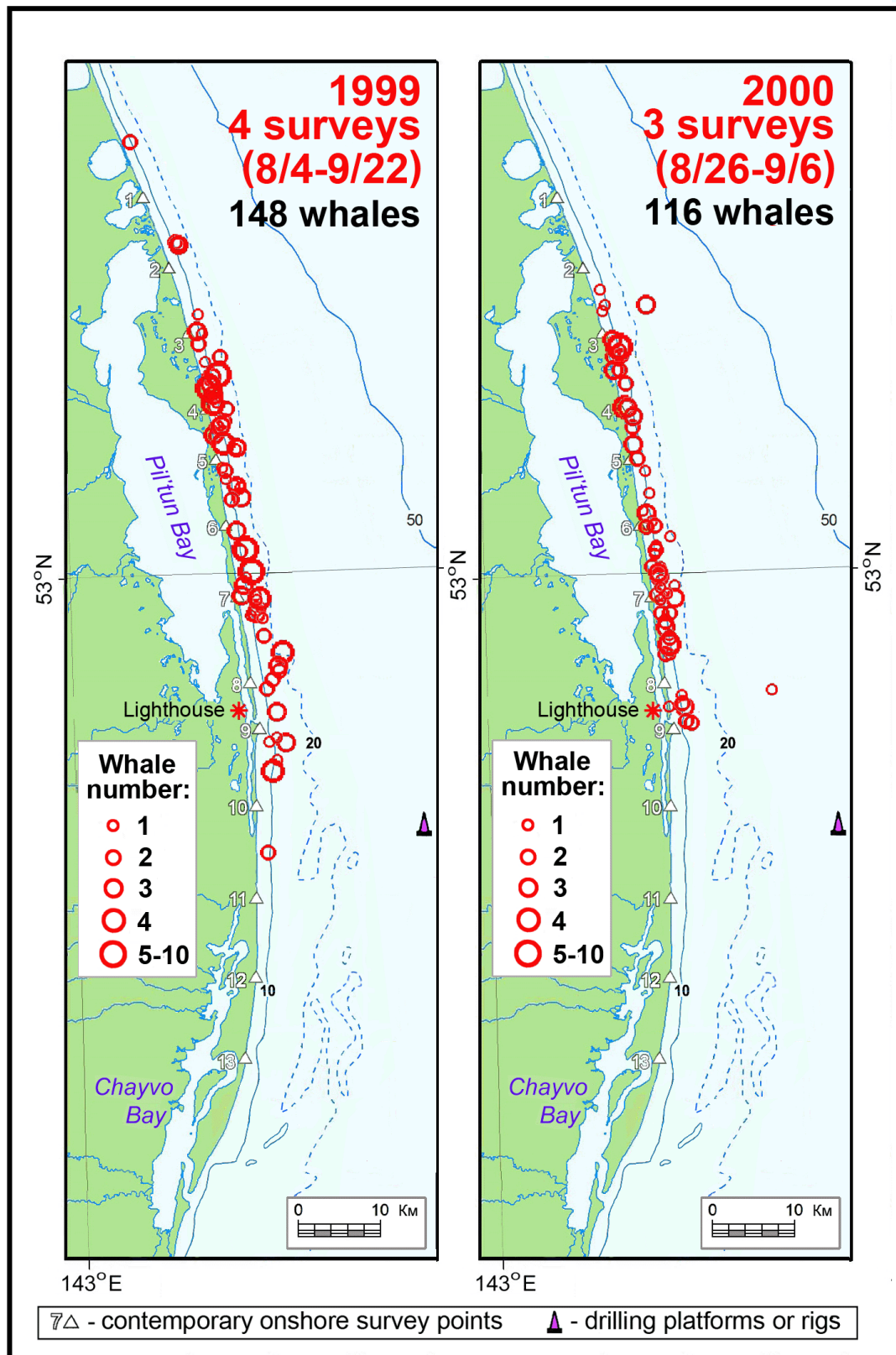


Figure A-4. Distribution of gray whales
in the Piltun area, August-September 1999-2000
based on results of aerial surveys
(the data for mapping from Sobolevsky, 2000, 2001)

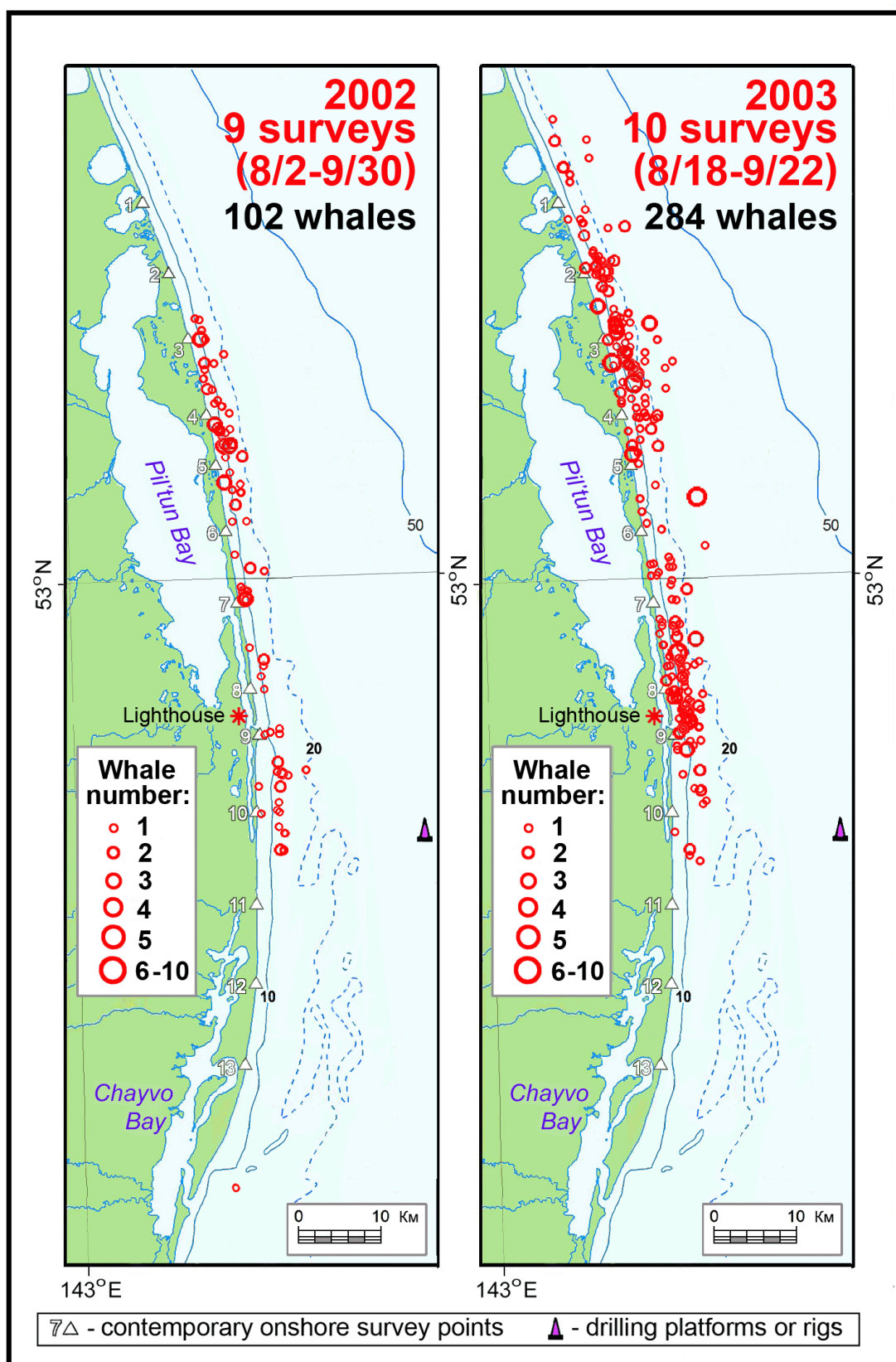


Figure A-5. Distribution of gray whales in the Piltun area, August-September 2002-2003 based on results of aerial surveys (the data for mapping from Blokhin, 2003, 2004)

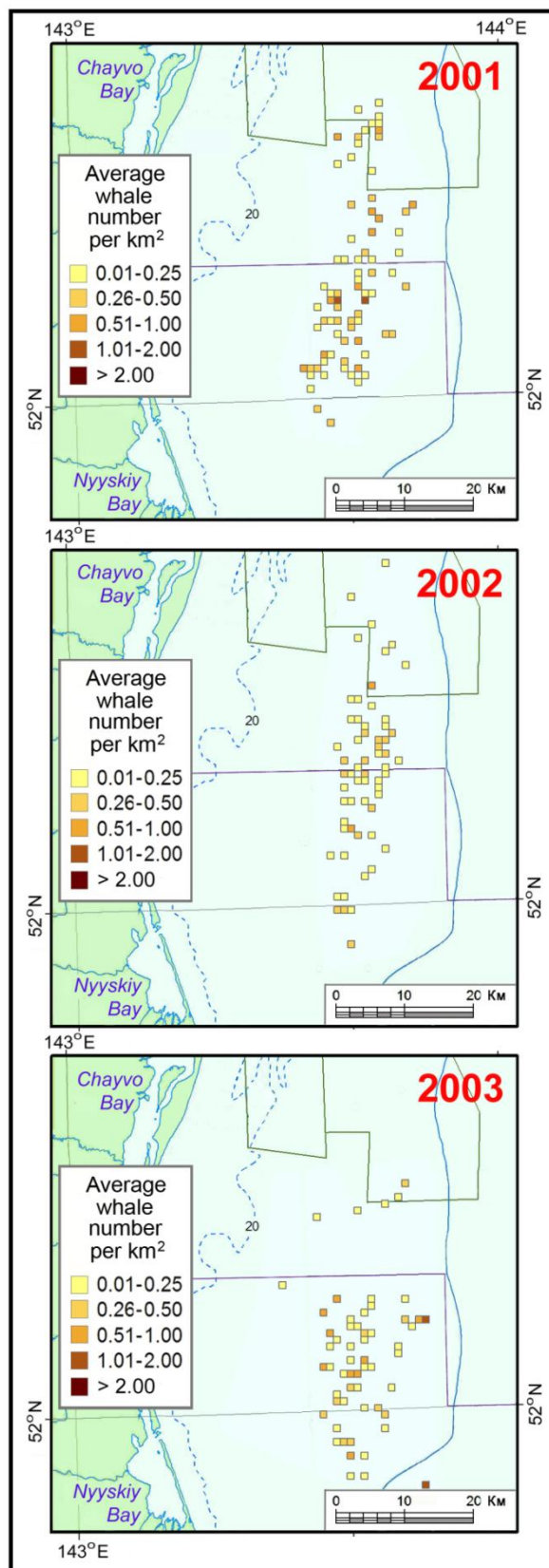


Figure A-6. Distribution of gray whales
in the Offshore area, 2001-2003
based on results of aerial surveys
(the data for mapping from Blokhin, 2003, 2004)
Density cell resolution is 1 km²