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DISTRIBUTION AND ABUNDANCE OF WESTERN GRAY WHALES OFF THE NORTHEAST COAST OF SAKHALIN ISLAND, RUSSIA, 2008

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Abstract

Data from systematic shore- and vessel based distribution surveys conducted offshore northeast Sakhalin in the summer-to-fall seasons of 2004-2008 indicate the presence of two primary gray-whale feeding areas. The first, nearshore Piltun feeding area is located adjacent to Piltun Bay and extends from Ekhabi Bay in the north to Chayvo Bay in the south over a coastline stretch of about 120-km length; whales predominantly feed in this area at a distance <5 km from shore and in water depths <20 m. The second, deeper Offshore feeding area is located at a distance of about 35-50 km from shore to the southeast of Chayvo Bay; the water depth in this area is about 35-60 m.

Comparison of whale distribution data collected in 2004-2008 shows significant variations between years. These variations include a shift in whale distribution from the northern to the southern Piltun feeding area that occurred from about 2004-2006 and possibly extended into 2007, and increased use of the Offshore feeding area from 2005-2008. In 2008, the maximum number of whales per survey recorded in the Piltun area decreased by 36% compared to 2007. At the same time, the maximum number of whales per survey recorded in the Offshore area increased by more than a factor of two in 2008 compared to 2007. Whale densities decreased in the northern and southern parts of the Piltun feeding area (i.e., north and south of the mouth of Piltun Bay, respectively) in 2008 compared to 2004-2007, but stayed comparable to the 2004-2007 results in the central part of the Piltun feeding area (i.e., within about 10-15 km distance from the mouth of the Bay).

INTRODUCTION

Vessel-and shore-based distribution surveys were performed in the summer and fall of 2008 in the shelf waters of northeast Sakhalin Island as part of an industry-sponsored monitoring program jointly funded by the Sakhalin-1 (ENL) and Sakhalin II (SEIC) oil and gas development projects. Two primary gray whale feeding areas have been identified in this area during past years. The first, Piltun feeding area extends along an approximately 120-km long stretch of coastline adjacent

to Piltun Bay from Ekhabi Bay in the north to Chayvo Bay in the south; whales predominantly feed in this area in water depths <20 m and at distances <5 km from shore. The second, deeper Offshore feeding area is located at a distance of about 35-50 km from shore to the southeast of Chayvo Bay; the water depth in this area is about 35-60 m. In 2007 we reported that whale density seemed to decrease in the Piltun feeding area, whereas whale density in the Offshore feeding area increased. In addition, more western gray whales sightings were observed in Eastern Kamchatka (Vladimirov et al., 2008). In 2008 this apparent change in whale distribution was studied in more detail.

METHODOLOGY

Vessel-based distribution surveys: Systematic vessel-based distribution surveys were conducted between June 30 and October 6, 2008 from board of the research vessel *Akademik Oparin*. A total of eight surveys were performed during that time: three in the Piltun feeding area, three in the Offshore area and two in the Arkutun-Dagi license area located immediately to the north of the Offshore area. The number of systematic vessel-based surveys was low compared to previous years (e.g., 14 surveys in 2007: three in the Piltun area, five in the Offshore area and six in the Arkutun-Dagi area), because fog and rough seas frequently imposed limitations on the surveys during the 2008 field season.

Vessel-based surveys in the Piltun feeding area were conducted on a single transect of approximately 180-km length that followed the Sakhalin coastline along the 20-m isobath at a distance of about 4 km from shore (Figure 1). In the Offshore feeding area, surveys were carried out along a total of eight east-west transects spaced at 6.5-km distance (north-south) apart. Similar transects were run in the Arkutun-Dagi license area (Sakhalin-1) along seven east-west lines.

Shore-based distribution surveys: Shore-based distribution surveys were performed from 13 observation stations located on elevated vantage points along the coast and spaced at approximately 8-10 km distance from each other (Figure 2). The surveys were carried out simultaneously by two teams: the northern team, which covered the Odoptu-Piltun section north of the mouth of Piltun Bay, and the southern team, which covered the near-shore waters south of the mouth of Piltun Bay. Four-wheel-drive, all-terrain vehicles were used for transport between the shore-based survey points. Because weather conditions were unfavorable during large parts of the 2008 field season (fog, rough seas), only eleven synchronous (i.e., simultaneously completed by the northern and southern teams) surveys could be completed in 2008 out of a total of 48 complete and partial surveys combined. Out of these eleven complete surveys, only two were performed in August (August 9 and 20, 2008). An additional six surveys were completed by either the northern (two) or southern (four) teams over the course of the 2008 field season.

Survey equipment: The vessel- and vehicle-based distribution teams used Fujinon 7x50 binoculars with range scale and built-in compass to determine whale sightings. Estimation of distance to the sightings followed the method outlined by Lerzak and Hobbs (1998), with a correction for light refraction (Leaper and Gordon, 2001).

Data analysis: Data on the gray whale distribution from the systematic vessel and shore-based surveys were analyzed to produce estimates of whale densities at a 1-sq. km resolution. Results

were summarized in form of density maps. These maps were also used for comparison with similar maps from previous years (i.e., 2004-2007).

RESULTS AND DISCUSSION

The overall distribution survey effort in 2008 was limited by severe weather conditions, particularly, during the month of August. For example, only eight systematic vessel-based distribution surveys were performed in 2008 in the Piltun ,Offshore and Arkutun-Dagi license areas combined, compared to 14 in 2007. Similarly, only two systematic shore-based distribution surveys could be completed in August 2008, compared to 10 in August 2007.

A total of 628 individual whale sightings were recorded by the vessel-based distribution team in 2008; 196 of these sightings were made during the systematic distribution surveys along transects in the Piltun area (39 sightings), Offshore area (150 sightings) and Arkutun-Dagi license area (7 sightings).

During the shore-based surveys a total of 553 individual sightings were recorded during all (i.e., complete and partial) on-shore surveys combined.

The main results of the 2008 distribution surveys, put into perspective with results from previous (2004-2007) years, are as follows:

1. ***General results:*** Similar to previous years, the 2008 distribution surveys showed that two main areas were used by the gray whales to feed offshore Sakhalin: the Piltun feeding area close to shore, and the Offshore feeding area located about 35-50 km from shore (Figure 3).

Also similar to previous years, the majority of whales in the Piltun area (98.6%) were distributed at a distance less than 5 km from the coast. 19% of the whales stayed within 1 -km distance from shore, 52.7% stayed within 1-2-km distance from shore, 18.4% stayed within 2-3-km distance from shore and 8.5% stayed between 3-5-km distance from shore. Expressed in terms of water depth, most of the whales in the Piltun area (97.7%) were observed feeding in waters <20 m deep. The densest distribution of whales (77.3%) was recorded in depths of 6-15 m: 48.4% were observed within the 6-10-m depth range and 28.9% within the 11-15-m depth range.

In the Offshore area, the whales stayed within a distance of 35-50 km from shore in waters 35-60 m deep.

2. ***Piltun area:*** In 2008, the maximum number of whales recorded in the Piltun area during shore-based surveys was 47, compared to 73 in 2007. The average number of whales over the entire survey period observed on either side of the mouth of Piltun Bay dropped from 13.4 (2007) to 6.5 (2008) north of survey point 7, and from 10.2 (2007) to 4.7 (2008) south of survey point 10. These observations were accompanied by an overall decrease in whale density in the northern and southern parts of the Piltun feeding area between 2007 and 2008 (Figure 4). Particularly, the area along the northern periphery of the feeding area, i.e., around survey points 1 and 2, was nearly abandoned by the whales in 2008. Although some on- and offshore industrial activities occurred in and immediately to the north of the Piltun area in 2008, it is not clear if, or how, these activities

affected the whale distribution in this region. Variations in whale distribution were also observed in 2008 depending on month: the average density (i.e., number of whales over 1 sq. km of scanned waters) in the northern Piltun area changed from 0.03 in August to 0.015 in September (including surveys in early October). In the southern part of the Piltun area, month-to-month variations were less pronounced (0.05 in August versus 0.03 in September, including surveys in early October).

In the central part of the Piltun feeding area, i.e., between survey points 7 and 10 (about 15 km to the north and 10 km to the south of the mouth of Piltun Bay), the density and number of whales observed were similar to those from previous years. The average number of whales that were sighted in this area over all 2008 surveys was 20.6, compared to 19.9 averaged over all surveys in 2004-2007. About 60% of the whales in the Piltun feeding area were distributed around the mouth of the Bay between survey points 7-10; the average density of whales over 1 sq. km of scanned waters in this area was 0.34 in August and 0.23 in September (including surveys in early October).

Seasonal dynamics in whale distribution over the 2008 survey period show a gradual decline in the number of gray whale recorded by synchronous (complete) shore-based surveys between August and September for the entire Piltun feeding area (Figure 5). The maximum number of whales was recorded at the beginning of the field season on August 9, 2008 (47 individuals). Over the course of August, the number of whales declined, but remained relatively stable at about 30-40 individuals per complete survey from mid-August to about mid-September. By early October, the number of whales per survey had dropped to about 15. Reductions in gray-whale numbers in the Piltun area in the late September time frame also were observed in other years, for example, in 2007 (Vladimirov et al., 2008).

3. *Offshore area:* The decreasing number of gray whales in the Piltun area from August to October coincided with a concurrent increase in recorded whales in the Offshore area. The maximum number of individual whales recorded in the Offshore area during vessel-based surveys was 82 in 2008 compared to 36 in 2007; it was the largest number of individual whales reported in the Offshore area since 2001, when 83 whales were observed during the September 17th survey. Increased use of the Offshore area by the whales in 2008 was accompanied by a growing spatial extent of the area both in width (east-west) and toward the south.

Similar to observations in 2004-2007, the number of individual whales observed in the Offshore area in 2008 steadily rose throughout the season: from 5 animals in early July to 63 in early September and 82 in early October.

4. *Whale relative abundance estimates:* The accuracy of whale relative abundance estimates from vessel- and shore-based distribution surveys is limited by several factors: first, shore-based whale counts in the Piltun area can only be used for whale abundance estimates when a complete survey was performed, i.e., when the northern and southern distribution teams synchronously covered all northern and southern observation stations, respectively. Second, accurate estimates require that whale counts be made in both feeding areas, the Piltun area (shore-based) and Offshore area (vessel-based), either on the same day or within a time period short enough (preferably 1 day) to eliminate large errors caused by the dynamic exchange of whales between the two areas.

In 2008, the minimum time interval between a complete shore-based and vessel-based survey was two days on October 1 (Piltun area) and October 3 (Offshore area). Whale counts during these two days were 16 (Piltun) and 82 (Offshore), amounting to a total of 98 whales, assuming there was no exchange between the two feeding grounds.

Even though the accuracy of these estimates is limited due to the time interval between the shore- and vessel-based surveys, they provide an indication that the number of whales offshore northeast Sakhalin Island in 2008 was on the order of about 100 individuals. This value is similar to the estimated whale abundance from survey data in 2007, which amounted to 101 individuals based on survey results from the Piltun and Offshore feeding areas made within one day of each other.

5. *Comparative analysis with photo-ID data:* Comparative analysis of whale relative abundance estimates from systematic vessel- and shore based distribution surveys with the number of photo-identified whales offshore Sakhalin shows good agreement in 2008, 2006 and 2005 (Table 1). In 2007, the number of photo-identified whales offshore Sakhalin (125) exceeded the estimated number of whales from survey data (101) by 24. Photo-identification studies performed in 2007 offshore southeast Kamchatka (Olga Bay, Vestnik Bay) revealed the presence of gray whales in that area during the summer-to-fall feeding season. Altogether, 37 gray whales were photographed offshore southeast Kamchatka in 2007; 20 of these whales were known from the western gray whale catalogue (i.e., had been sighted offshore Sakhalin in previous years), and 13 had been sighted offshore Sakhalin during the same (2007) feeding season (Tyurneva et al., 2009). It is thus possible that part of the difference between the whale abundance estimates from distribution surveys and the number of photo-identified whales in 2007 was the result of whales leaving the Sakhalin area to travel to Kamchatka throughout the feeding season.

Both the photo-identification and distribution survey efforts offshore Sakhalin were lower in 2008 than in 2007, partly due to unfavorable weather conditions during the 2008 field season especially during the month of August (only two on-shore distribution surveys were completed in August 2008, compared to 10 in August 2007, and no systematic vessel-based distribution survey was performed in August 2008). Hence, it is difficult to draw accurate estimates of whale abundance offshore Sakhalin from either distribution or photo-identification data for the 2008 field season. Similar to 2007, gray whales were also encountered offshore southeast Kamchatka in 2008 (Tyurneva et al., 2009): 50 gray whales were photo-identified in Olga Bay; 25 of these whales were known from the Sakhalin catalogue. The timing of arrival/departure of these whales in/from Kamchatka waters and their migration route are unknown. One whale was observed both offshore Sakhalin and southeast Kamchatka during the 2008 feeding season; the remaining 24 western gray whales observed offshore southeast Kamchatka were not recorded offshore Sakhalin in 2008. Whether or not some of the 24 western gray whales observed only in Olga Bay in 2008 also spent a limited amount of time in Sakhalin waters during the same season, but were not encountered there by the photo-identification team, is unknown.

6. *Cow-calf pairs:* The on-shore based distribution teams reported sightings of two cow-calf pairs in the shallow Piltun feeding area in 2008. In comparison, the 2008 photo-identification effort identified three cow-calf pairs in the Piltun area during the 2008 field season (Tyurneva et al., 2009). For the first time in 2008, one (additional) cow-calf pair was sighted offshore southeast

Kamchatka (Olga Bay) by the photo-identification team and identified as belonging to the western gray whale population.

7. *Inter-annual (2004-2008) variations in whale distribution offshore Sakhalin:* Comparison of results from on-shore and vessel-based distribution surveys for 2004-2008 averaged over each individual (i.e., 2004-2008) summer-to-fall season show inter-annual variations in whale distribution over the northeast Sakhalin shelf (Figure 4). Most noticeably, the density of whales in the northern Piltun feeding area began to show lower numbers in 2007 compared to earlier years, although a starting decline in density in this (northern) region already may have been observed in 2006. In 2008, the northern part of the Piltun feeding area had particularly low whale distribution densities and was practically abandoned by the whales near the northern periphery of the feeding area around survey points 1 and 2. Declining whale distributions in the northern Piltun feeding area were partially compensated by an increase in whale numbers in the southern part of the Piltun area, which was particularly obvious from 2004-2006. In the Offshore area, the observed number of gray whales showed an overall increase since 2005; in 2008, the number of gray whales recorded in the Offshore feeding area (82 individuals) almost reached the previous maximum over all survey years recorded in 2001 (83 individuals).

CONCLUSIONS

Results from the systematic vessel- and shore based distribution surveys performed in 2008 show lower distribution densities of whales in the northern and southern part of the Piltun feeding area compared to 2007 and earlier years. Distribution densities in the central Piltun area (i.e., near the mouth of Piltun Bay), were comparable to those in previous years.

The maximum number of whales recorded during a single complete survey in the Piltun feeding area dropped by about 36% in 2008 compared to 2007 (73 whales in 2007 versus 47 whales in 2008). At the same time, the maximum number of whales recorded in the Offshore feeding area increased by more than a factor of two from 36 whales 2007 to 82 whales in 2008; this was the largest number of individual whale sightings in the Offshore area since 2001 (83).

Inter-annual variations in whale distribution in the Piltun feeding area can now be detected as reliable relative density data has been calculated. Data seem to indicate a southward shift in whale distribution from the northern to the southern Piltun feeding area from 2004-2006 that possibly may have continued into 2007. Data also indicate that whales increasingly used the Offshore area from 2005-2008.

The reasons for the observed inter- and intra-annual changes in whale distribution in the northeast Sakhalin region, and the questions of how these changes relate to increasing numbers of western gray whales offshore southeast Kamchatka, remain to be investigated. One possible explanation are variations in the biomass and distribution of available food benthos associated with natural variability of the atmosphere and ocean climate. Analysis of benthic data, particularly, in regard to inter-annual variations in the biomass of diverse amphipod species (preferred food for gray whales), is currently underway by benthos experts (Fadeev, 2009). Also, current data sets cannot exclude delayed or indirect anthropogenic effects on whale distribution.

The field work and data analysis performed as part of the Western Gray Whale Monitoring Program provides valuable information on the status of the western gray whale population and their feeding habitat and for this reason should be continued. Data gathered as part of this program also serve the purpose to develop scientifically sound mitigation measures that minimize potential anthropogenic effects on gray whales as a result of ongoing oil and gas developments offshore Sakhalin.

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Year	Survey results*					Number of gray whales based on the photo-ID data
	Piltun area		Offshore area		Total	
	Shore-based survey		Vessel-based survey			
	date	n	date	n		
2005	6.IX	114	6.IX	6	120	117
2006	6.X	99	7.X	26	125	121
2007	31.VIII	73	1.IX	28	101	125
2008	1.X	16	3.X	82	98	98

∗ based on the data of two surveys carried out in both feeding areas in the closest dates and provided the maximum total numbers.

Table 1: Maximum number of gray whales recorded during systematic onshore (Piltun area) and vessel-based (Offshore area) distribution surveys and from onshore and vessel-based surveys combined (total), and number of photo-identified individuals from 2005-2008. Data in the last column are from Tyurneva et al. (2009).

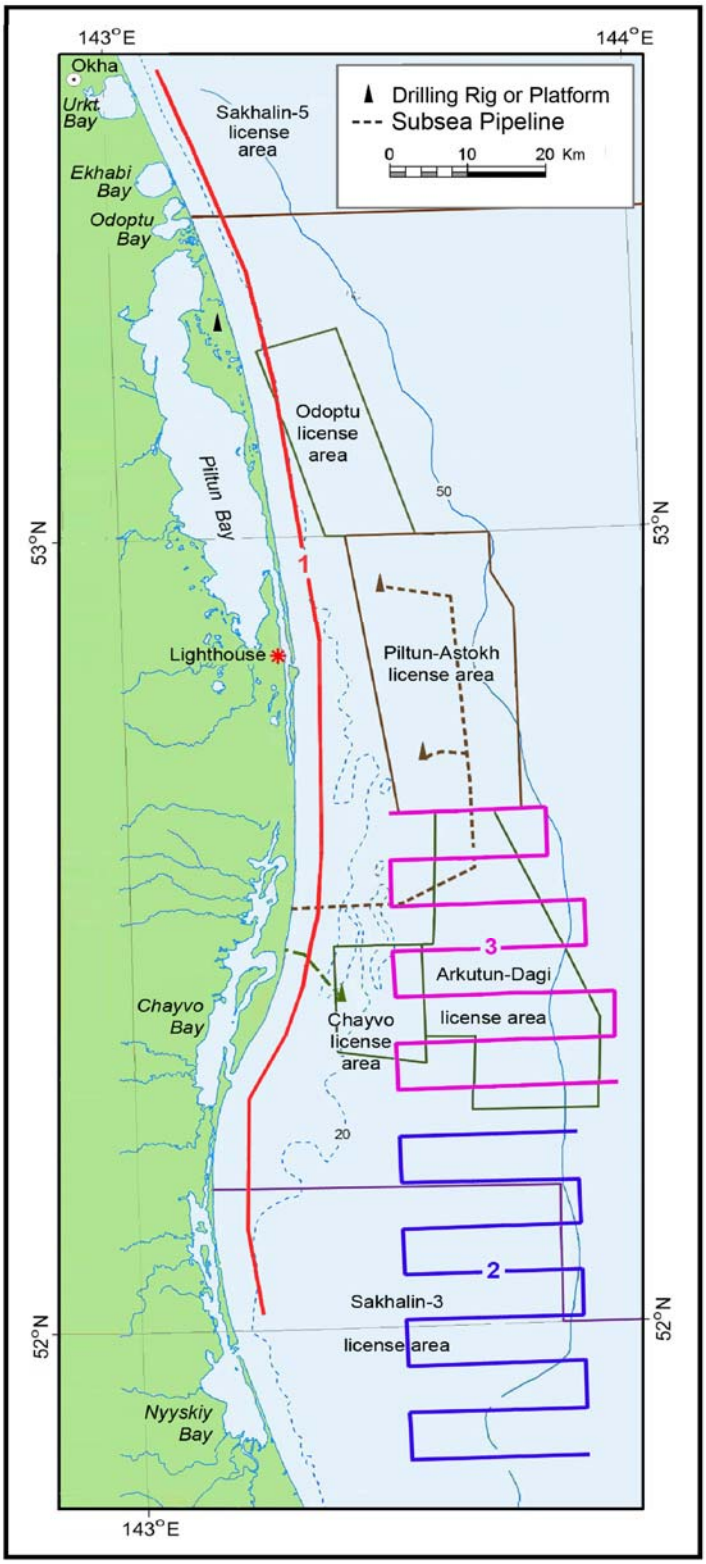

Figure 1: Systematic vessel-based gray whale survey transects in the Piltun and Offshore feeding areas and in the Arkutun-Dagi license area in July-October 2008.

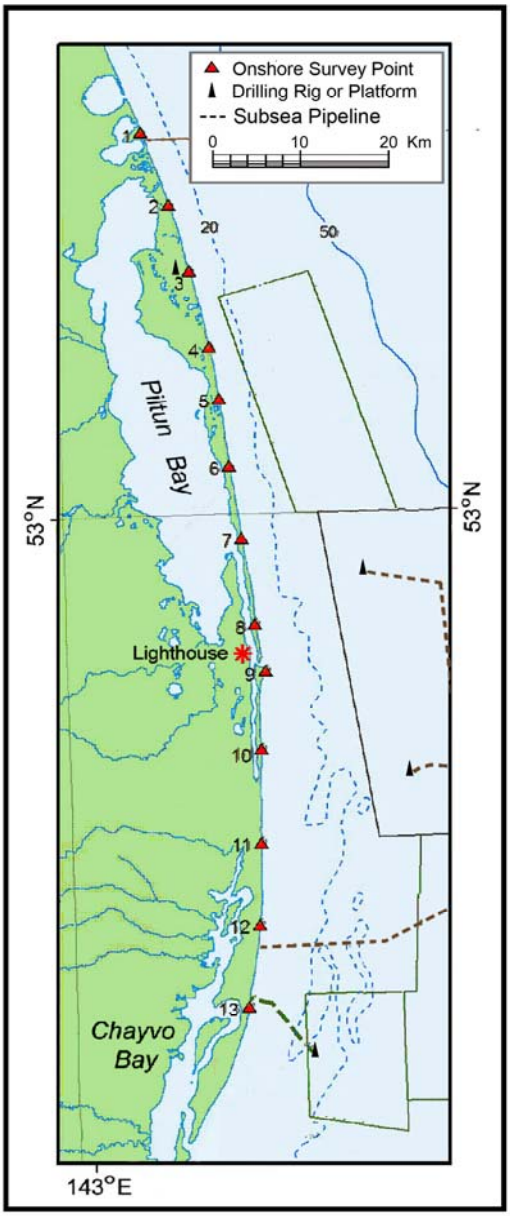

Figure 2: Location of survey stations for shore-based surveys of gray whales in the Piltun feeding area in August-October 2008.

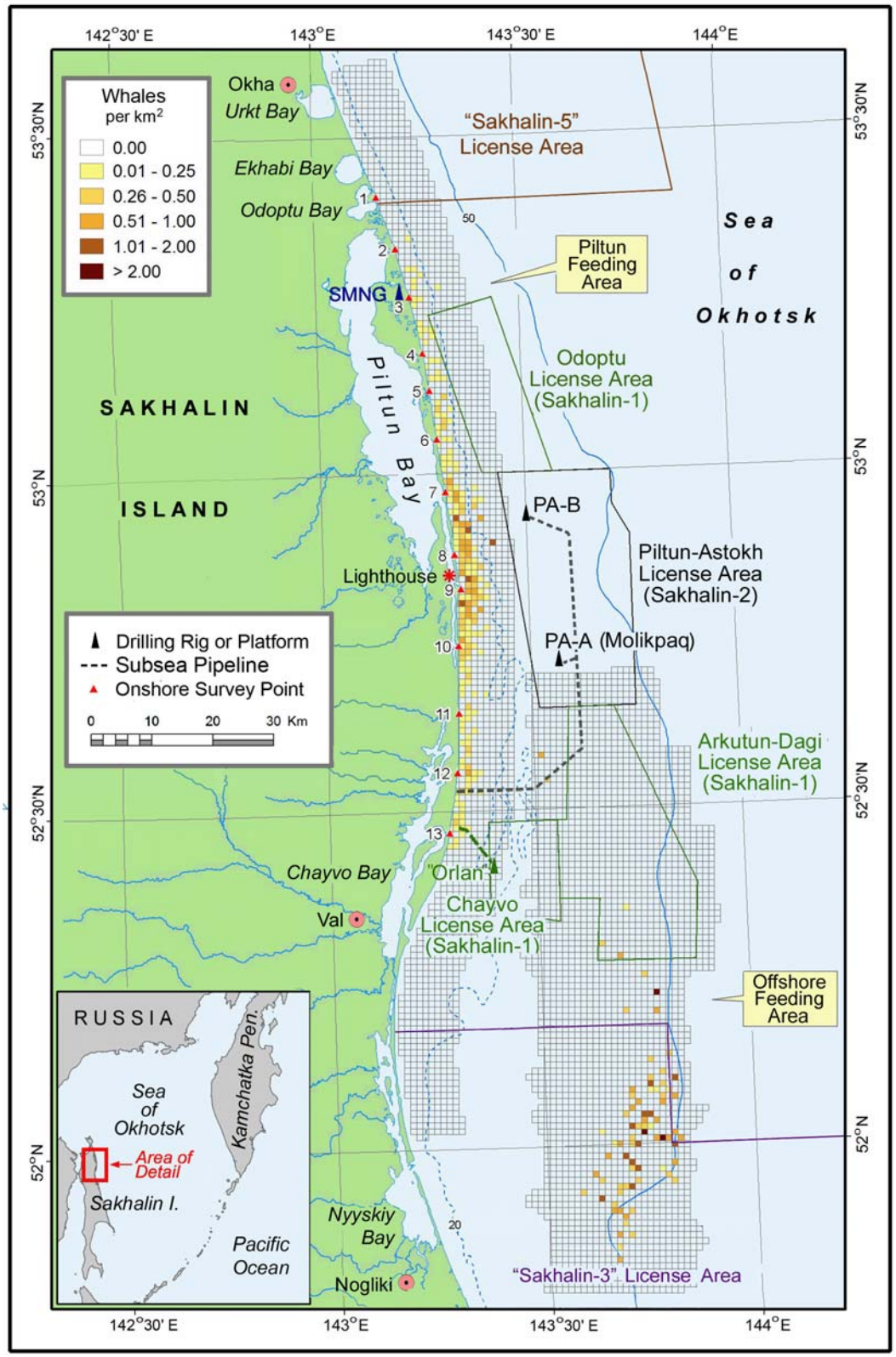

Figure 3: Gray whale distribution in the Piltun and Offshore feeding areas in July-October of 2008 based on combined data of vessel-based and onshore surveys (average whale population per km^2)

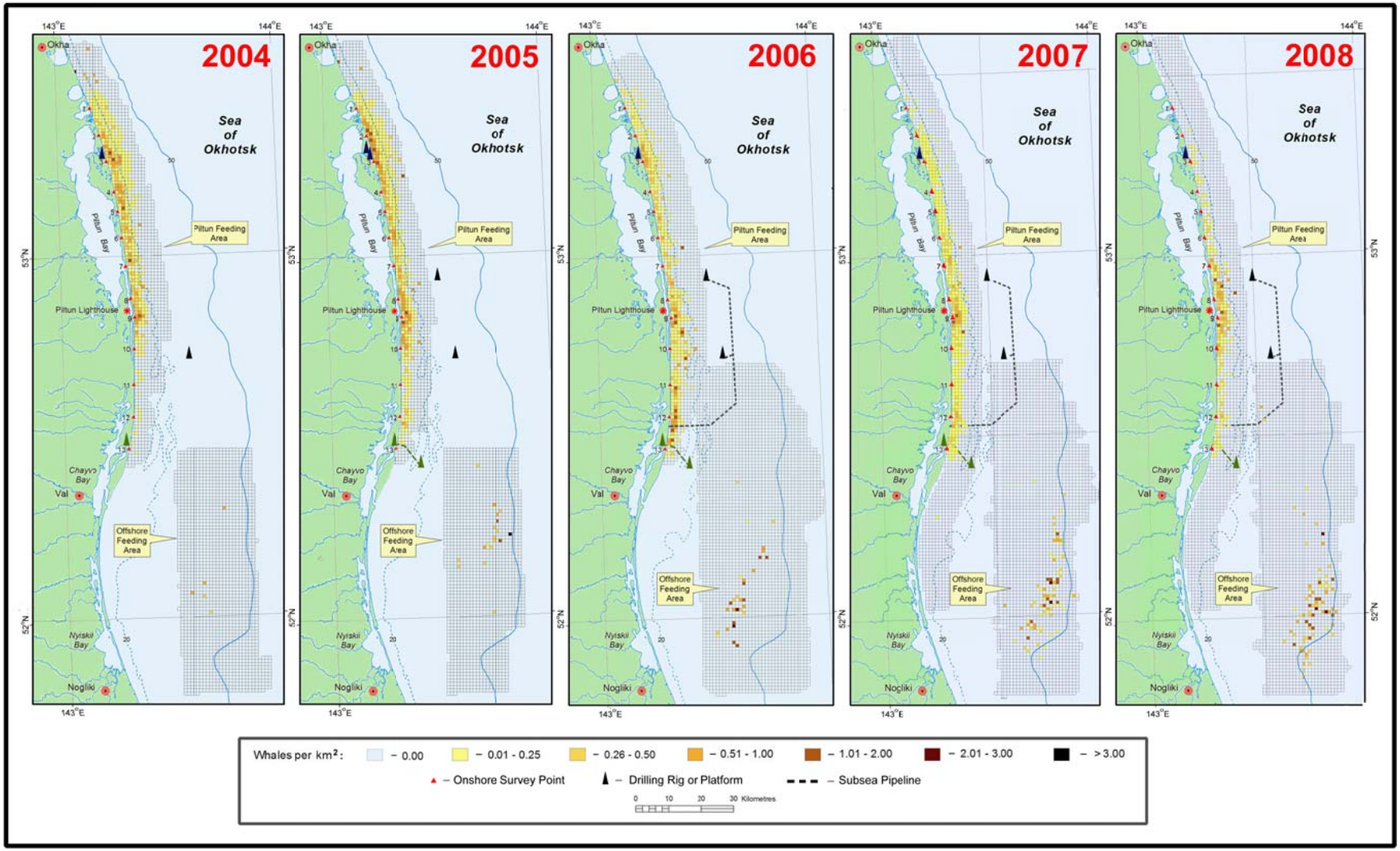

Figure 4. Changes in gray whale distribution in the Piltun and Offshore feeding areas, 2004 – 2008 based on data from combined onshore and vessel-based surveys (whale population seasonal density per km^2)

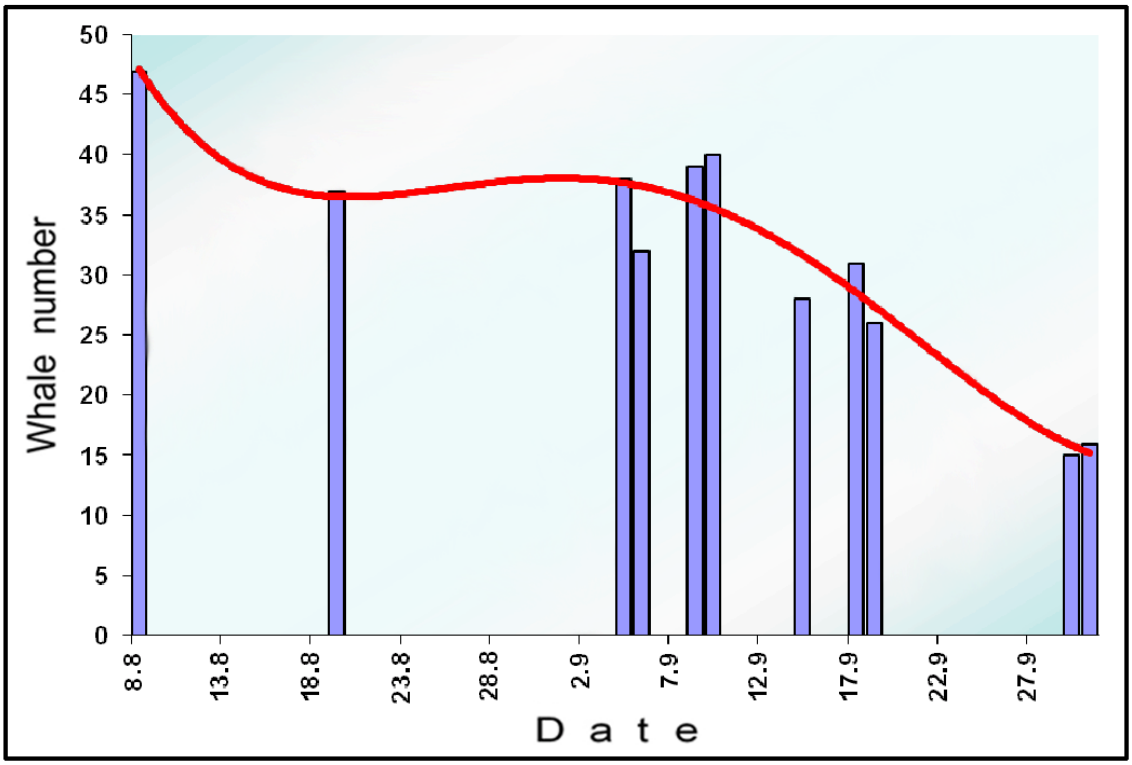

Figure 5: Recorded numbers of western gray whales per shore-based survey in the Piltun feeding area, August 9 – October 1, 2008.

Only complete surveys are shown.
The red curve is a polynomial trend.