A note on the spatial distribution of western gray whales (*Eschrichtius robustus*) off Sakhalin Island, Russia in 1998

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ABSTRACT

Three aerial surveys were conducted along a portion of the northeastern coast of Sakhalin Island, Russia between August and September 1998. They were conducted to examine the spatial distribution of western gray whales on their feeding grounds, and in relation to current and planned industrial activity. A total of 32 gray whale groups, consisting of 38 whales, was sighted during the surveys. Group sizes ranged from 1-3 individuals (mean = 1.2, SD = 0.54), with 87.5% (n = 28) composed of single whales. All groups detected were within 5km of the shore and 93.8% (n = 30) were sighted inside 4km. Sighting locations ranged from 0.6-4.8km offshore, with an overall mean distance from shore of 2.5km (SD = 1.11). These data suggest that western gray whales feed primarily in waters less than 20m deep and relatively close to shore. The nutrient-rich effluent from a large coastal lagoon is believed to significantly enrich the near-shore benthic environment of the northeastern Sakhalin Island coast, creating an area of particularly high food availability, and in turn contributing to the near-shore affinity of gray whales observed during this study.

KEYWORDS: GRAY WHALE; PACIFIC OCEAN; NORTHERN HEMISPHERE; FEEDING GROUNDS; DISTRIBUTION; SURVEY-AERIAL

INTRODUCTION

The western (Okhotsk-Korean) North Pacific population of gray whales (*Eschrichtius robustus*) is one of the most endangered and little known populations of large whales in the world (Clapham *et al.*, 1999; Weller *et al.*, 2002). Western gray whales were thought to be extinct as recently as 1972 (Bowen, 1974), but are known to survive today as a small (*ca* 100 animals) remnant population (e.g. Weller *et al.*, 2002). Recent genetic studies show that eastern and western Pacific gray whales should be recognised as geographically and genetically separated at the population level (LeDuc *et al.*, 2002).

Reviews of Russian aerial and ship-based sighting records in the Okhotsk Sea during the late 1960s, 1970s and 1980s (Berzin, 1974; 1990; Vladimirov, 1994) indicated that gray whales were distributed predominantly along the shallow-water shelf off northeastern Sakhalin Island, Russia (Fig. 1) during summer-autumn, with particularly high numbers observed offshore of the southern portion of Piltun Lagoon (see also Blokhin *et al.*, 1985; Blokhin, 1996). Recent photo-identification (1994-1999) and shore-based studies (1997-1999) have also documented the annual occurrence of gray whales off Piltun Lagoon (e.g. Weller *et al.*, 2002). Photo-recognition research identified 88 individuals between 1994-1999, and documented high levels of annual return and seasonal site fidelity for a majority of all known whales (see Weller *et al.*, 2002). Shore-based counts and theodolite-determined sightings suggested that most gray whale groups occurred in coastal waters near the entrance to Piltun Lagoon and that 95% of all observed groups were located within 5km of shore; although feeding gray whales have been observed > 15km from shore in the Piltun area, such sightings are considered to be unusual (Ivashchenko, 1999; Würsig *et al.*, 1999; 2000).

Gray whales aggregate off northeastern Sakhalin Island during summer-autumn to feed on benthic and epibenthic prey. The observed inter- and intra-annual occurrence and distribution patterns of known individuals emphasise the ecological importance of the Piltun region, and suggest that it is likely to be the primary feeding habitat for western gray whales. Activities related to oil and gas exploration and production, including increased vessel and aircraft traffic, geophysical seismic surveys, and well-drilling operations have recently been initiated near or on the feeding grounds. Given the critically endangered status of western gray whales and the potential for increased industry-related disturbance (Weller *et al.*, 2002), a joint USA-Russia research programme was initiated in 1995 to monitor the population (and other marine mammals) off the northeastern Sakhalin Island coast. Results reported here represent findings from three aerial surveys conducted along a portion of northeastern Sakhalin Island during the summer-autumn of 1998. These surveys were designed to examine the distribution of gray whales on their feeding grounds and in relation to current and planned industrial activity.

METHODS

Study area

Zaliv Pil'tun (referred to here as Piltun Lagoon) is located on the northeastern shore of Sakhalin Island, Russia (Fig. 1). It is approximately 80km long and 15km across (at its widest point) with only one entrance to the Okhotsk Sea. The near-shore environment is characterised by waters generally < 20m deep, over a predominantly sand substrate. Although significant inter-annual variability exists, sea surface temperature during the summer varies between approximately 2-15°C, salinity ranges between 28-36ppt, and periods free of sea ice are usually between late May and December.

Survey technique

Systematic flights were conducted on 6 August, 28 August and 29 September 1998. Visibility was excellent to good (> 5km) during each survey and the sea state was always

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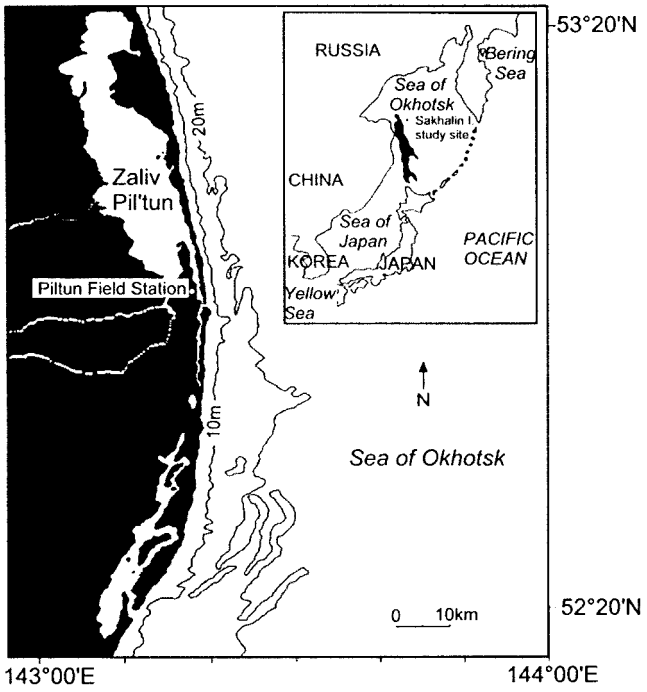

Fig. 1. Northeastern Sakhalin Island.

Beaufort 3 or less. Observations were made from a Russian MI-8 helicopter, travelling at an altitude of 450m and air speed of 150km/h. Four experienced observers, two on each side of the helicopter, were stationed behind the cockpit; a trackline observer and data recorder were in the cockpit. The MI-8 body configuration has poor visibility for aerial surveys; the right side observers could not search between 50-90°, and the left side observers could not search between 60-90°[1]. Fortunately, the trackline observer and data recorder had good below-aircraft visibility through downward-facing landing windows. Given the unacceptable downward visibility of the aircraft (and the track design, see below), no estimates of whale density or abundance have been attempted.

Transects consisted of five 50km north-south lines, with two 2.5km and three 5.0km east-west legs between lines (Fig. 2a). The total area covered by each flight was approximately 1,000km^2. This design allowed both longshore (north-south) and offshore (east-west) distribution to be evaluated, but not abundance estimates. The survey area included waters surrounding an exploratory oil drilling rig (Sakhalinskaya) and an offshore drilling and production platform (Molikpaq), located approximately 13 and 24km from the entrance to Piltun Lagoon, respectively. The Sakhalinskaya was present in the study area during all three surveys, while the Molikpaq was present only for the final survey. Each survey began at the Piltun Lighthouse field station, the helicopter then flew north along the tide line of the eastern seashore, allowing observers to search within approximately 500m of shore. The first two east-west legs were set at 2.5km (one-half of the remainder) to give greater coverage in the near-shore region where gray whales are known to concentrate (e.g. Weller *et al.*, 1999).

Standard survey techniques developed for gray whale aerial surveys were followed (Rice *et al.*, 1981; Rugh, 1984). An on-board Global Positioning System (GPS) was used for navigation and to determine cetacean sighting positions, vessel positions and oil platform locations. Observers followed a standard protocol. Upon first sighting, GPS position and time were recorded. Once the sighting was directly abeam, the angle of declination between the sighting and the helicopter was measured with a hand-held inclinometer (which could be used to calculate sighting distance - Lerczak and Hobbs, 1998). Information on species, number of animals, orientation relative to the aircraft and behaviour was also recorded. Environmental conditions such as visibility, sea state (Beaufort Scale), swell and glare were noted at the start of each transect line and updated as conditions changed.

[1] The horizon is 0° and the line directly below the helicopter is 90°.

RESULTS

A total of 32 gray whale groups (38 whales) were sighted during the surveys (Table 1). The total number of whales sighted on 6 August, 28 August and 29 September was 9, 13 and 15, respectively. Group sizes ranged from 1-3 individuals (mean = 1.2, SD = ±0.54), with 87.5% (n = 28) of the groups sighted composed of single whales. Twenty-three (71.9%) of the groups were seen near the entrance to Piltun Lagoon, or to the north (Figs. 2b-d). All groups detected were within 5km of the shore, with 93.8% (n = 30) located inside 4km of shore (Fig. 3). Sighting locations ranged from 0.6-4.8km offshore, with an overall mean distance from shore of 2.5km (±SD = 1.11). Fig. 4 displays the mean and median group distances from shore for each of the three surveys. An analysis of group distance from shore revealed no significant effect of survey date ($F(2,29) = 0.598$, $p = 0.5563$).

The only other cetacean sighted during the aerial surveys was a pair of killer whales (*Orcinus orca*) approximately 16km from shore during the first survey (Fig. 2b).

DISCUSSION

These data show that western gray whales on their summer-autumn feeding grounds generally remained within 5km of shore and in waters < 20m deep, were distributed mainly offshore of the entrance to Piltun Lagoon, and occurred in small groups. While caution is needed to avoid over-interpretation of the present results due to the limited downward visibility from the helicopter and the fact that only three flights took place, these findings complement the distribution patterns described by recent shore-based theodolite tracking research which also found most groups located within 5km of shore (Würsig *et al.*, 1999; 2000). The mean group size here (mean = 1.2) was lower than those reported from boat-based (mean = 2.0) and shore-based observations (mean = 1.7) during the same period (Weller *et al.*, 1999; Würsig *et al.*, 2000). This finding, in combination with several additional lines of evidence, suggests that the aerial surveys under-counted the number of whales in the study area. Concurrent boat-based research in the same study area in 1998 identified eight mother-calf pairs (Weller *et al.*, 2002), however, none were sighted during the aerial surveys. In addition, the high percentage of single animal groups (87.5%) recorded from the air is substantially higher than the percentage (52.9%) derived from the boat (Würsig *et al.*, 2000). These results are perhaps not unexpected given the poor visibility from the helicopter, and may also explain the absence of sightings of the more difficult to see common minke whales (*Balaenoptera acutorostrata*) and harbour porpoise (*Phocoena phocoena*) that have frequently been recorded from boats or the shore in this area.

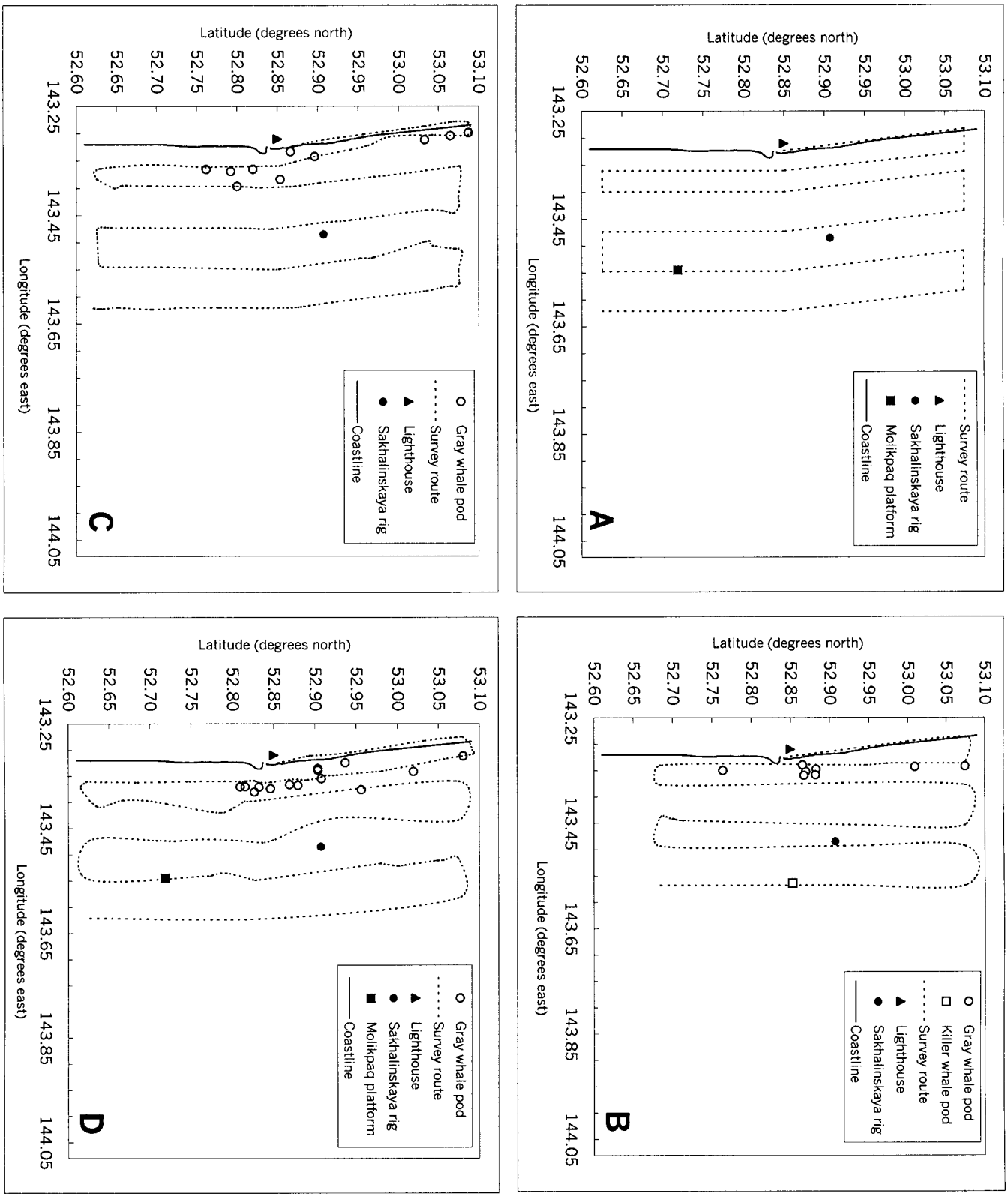

Fig. 2. Aerial survey plots: (a) transect lines; (b) Survey 1 (6 August); (c) Survey 2 (28 August); (d) Survey 3 (29 September). Latitude and Longitude are displayed in decimal degrees.

Since gray whales aggregate off Piltun during summer-autumn to feed, it is assumed that their nearshore distribution mirrors that of their prey. We hypothesise that nutrient-rich effluent from Piltun Lagoon significantly enriches the surrounding near-shore benthic environment, creating an area of particularly high food availability, and in turn contributing to the near-shore affinity of gray whales reported here. This hypothesis is supported by earlier studies that found some of the highest benthic biomass densities (1,000g/m^2) in all of the western Okhotsk Sea occurred near Piltun Lagoon (Koblikov, 1982). This apparent ecological relationship between prey biomass and whale distribution may help to explain why the relatively expansive Russian aerial and ship-based survey programmes during the 1970s and 1980s found the only major concentrations of gray whales in the Okhotsk Sea to be located along the

Table 1

Summary results from Aerial Surveys.

Date	No. whales	Position (Lat.°N/Long.°E)	Distance from shore (km)
6 Aug. 1998	1	53.074, 143.342	3.7
6 Aug. 1998	1	53.009, 143.343	3.0
6 Aug. 1998	1	52.883, 143.348	1.8
6 Aug. 1998	1	52.869, 143.352	2.0
6 Aug. 1998	1	52.865, 143.340	1.1
6 Aug. 1998	1	52.764, 143.350	1.7
6 Aug. 1998	3	52.867, 143.359	2.4
6 Aug. 1998	1	52.882, 143.358	2.5
28 Aug. 1998	1	53.033, 143.311	1.2
28 Aug. 1998	1	53.065, 143.304	1.1
28 Aug. 1998	1	53.087, 143.299	0.8
28 Aug. 1998	2	52.896, 143.342	1.6
28 Aug. 1998	3	52.866, 143.333	0.6
28 Aug. 1998	1	52.853, 143.384	4.0
28 Aug. 1998	1	52.820, 143.365	2.7
28 Aug. 1998	1	52.792, 143.369	3.0
28 Aug. 1998	1	52.762, 143.365	2.7
28 Aug. 1998	1	52.800, 143.396	4.8
29 Sep. 1998	1	52.937, 143.324	0.9
29 Sep. 1998	1	53.080, 143.312	1.7
29 Sep. 1998	1	53.019, 143.341	3.0
29 Sep. 1998	1	52.908, 143.355	2.6
29 Sep. 1998	1	52.903, 143.335	1.3
29 Sep. 1998	1	52.903, 143.339	1.5
29 Sep. 1998	1	52.879, 143.367	3.1
29 Sep. 1998	1	52.869, 143.366	2.9
29 Sep. 1998	1	52.846, 143.374	3.3
29 Sep. 1998	2	52.832, 143.371	3.1
29 Sep. 1998	1	52.827, 143.380	3.7
29 Sep. 1998	1	52.815, 143.370	3.0
29 Sep. 1998	1	52.810, 143.370	3.1
29 Sep. 1998	1	52.956, 143.376	4.6

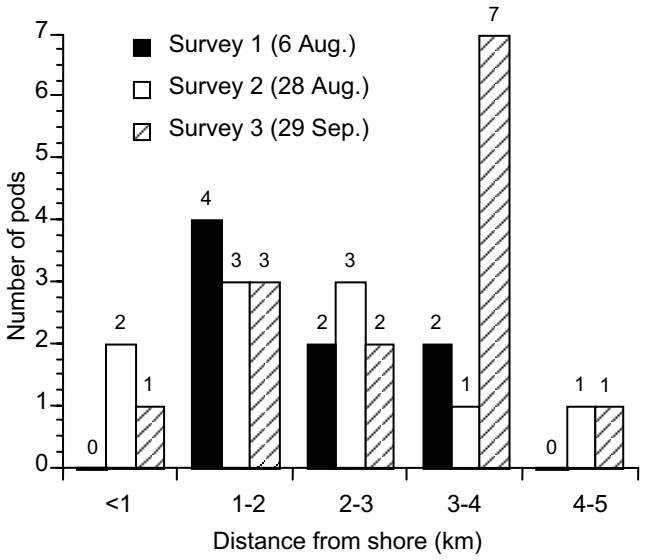

Fig. 3. Number of gray whale groups detected as a function of distance from shore (km). Value labels represent the number of groups sighted.

northeastern shore of Sakhalin Island, particularly off Piltun Lagoon.

In light of the critically endangered status of this remnant population of gray whales, we recommend that the ongoing oil and gas development along the northeastern Sakhalin Island shelf continue to be carefully monitored. In addition to the behavioural, genetic and photo-identification studies currently being conducted, research on the near-shore benthic environment, where whales annually return to feed is essential if the ecological factors that make this region attractive to gray whales are to be better described and the potential impacts of industrial activity further understood.

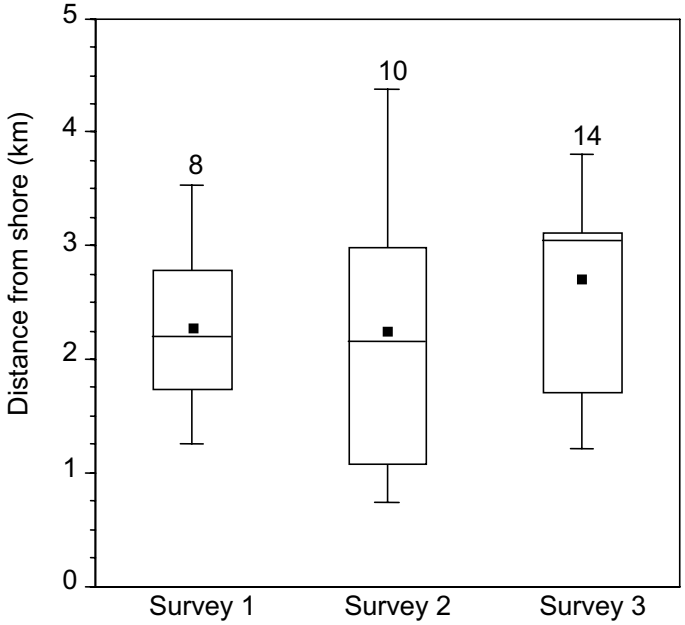

Fig. 4. Mean distance from shore (km) for gray whale groups detected during each survey. The lowest, second lowest, middle, second highest and highest box points represent the 10th, 25th, median, 75th and 95th percentiles, respectively. Means are represented by black squares. Value labels represent the number of groups counted.

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