Abundance of common minke whales in the Russian EEZ in the Sea of Okhotsk and east of the Kurile archipelago – the Kamchatka, estimated from 2003 and 2005 sighting surveys

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ABSTRACT
Using the sighting survey data in 2003 (the Sea of Okhotsk) and 2005 (east of the Kurile archipelago and the Kamchatka), abundance of common minke whales in the Russian EEZ was estimated by the conventional line transect method assuming g(0)=1. Research vessels, *Shonan-maru* and *Shonan-maru No.2*, were used for both seasons. Independent observer passing mode was basically used for these cruises, but normal closing mode was also used alternately by leg in 2003 to increase identification of the color type of Dall's porpoises. All these data was accumulated because number of sightings was not enough to estimate by each survey. During the research distance of 5,078 n.miles, a total of 91 schools were primarily sighted. Abundance of common minke whales in the Sea of Okhotsk was estimated as 28,438 (CV 0.185; 95%C.I. 19,866 – 40,703) and that in the waters east of the Kurile archipelago and the Kamchatka 972 (CV 0.520; 95%C.I. 372- 2,534).

Introduction

Sea of Okhotsk has high productivity in summer because the reversal mixing between the surface and the bottom water occurs. Therefore many kinds of animals migrate into the waters for feeding in summer. It is well known that common minke whales are not exception and the waters is essential for the abundance estimate of whole population. First sighting survey in the Sea of Okhotsk including the Russian EEZ was conducted in 1989 (Miyashita et al., 1990). Since then several surveys were conducted and abundance estimates were obtained (Buckland *et al*., 1992; Miyashita and Shimada, 1994). Because of some logistical reasons such as the Russian permission (research area restriction), it has been impossible to cover the whole area of the Sea of Okhotsk since mid 1990's. In 2003, we conducted the most recent large scale sighting surveys using two research vessels (Miyashita, 2004). On the other hand, the northern waters in the Russian EEZ east of the Kurile archipelago and the Kamchatka is also assumed to have high productivity and feeding area of many animals including common minke whales, but only a survey was conducted in the waters east of the Kurile archipelago in 1990 (Miyashita *et al*., 1991). The waters east of the Kamchatka peninsula (northern part of the sub-area 9) has never been surveyed by the Japanese research vessel. In 2005, the Russian permission to enter and survey the EEZ east of the Kamchatka Peninsula and the Kurile archipelago was issued firstly, and the two research vessels conducted the sighting surveys (Miyashita, 2006).

In this paper, the abundance of common minke whales in the research area in 2003 and 2005 was estimated using the conventional line transect method assuming g(0)=1.

Materials and method

Survey outline

Both survey designs have been presented to the SC (Miyashita *et. al.* 2002; 2005) and endorsed (IWC 2004, 2006). Oversight for these surveys was left to T. Miyashita.

The survey in the Sea of Okhotsk in 2003 was conducted from 22 July to 19 September (Miyashita, 2004). Two research vessels, *Shonan-maru* (SM1) and *Shonan-maru No.2* (SM2) were used for the survey. Eight blocks were established to cover the research area (Fig. 1). The research area was limited to south of 58ºN and west of 155ºE and without the South Kurile Islands which has been a dispute between Japan and Russia. Pre-determined track line was shown by vessel (Figs. 2 and 3). SM1 covered the eastern blocks, CE, OE, ONW and OSW. SM2 covered the western blocks, SHA, CNW, CNS and 11W. Scientists onboard SM1 were T. Saito, T. Hayashi and E. Chvestov (TINRO-centre, Russia), and onboard SM2 T. Miyashita (NRIFSF), D.Tokuta and A.Vlamidirov

(VNIRO, Russia). Independent observer passing mode and normal closing mode were alternately used by the transect leg. Normal closing mode was applied to increase certainty of color type identification of Dall's porpoises.

The survey east of the Kurile archipelago and the Kamchatka in 2005 was conducted from 29 July to 20 September (Miyashita, 2006). The research vessels were same as in 2003. Research area in the Russian EEZ was divided into three blocks, KUL, KAN and BEN, and high seas four blocks, PAW, PAE, KAS and BES (Fig. 5). SM1 covered the eastern blocks (KAN, BEN, KAS and BES) and SM2 the western blocks (KUL, PAW and PAE) (Figs 6 and 7). Scientists onboard SM1 were T. Miyashita (NRIFSF), H. Hiruda and S. Kornev (Kam TINRO, Russia), onboard SM2 T. Saito, S. Noji and P. Gusakov (VNIRO, Russia). Independent passing mode was used through these surveys.

The surveys were conducted in the good weather when the visibility better than 2 n.miles and the wind force less than three. Naked eyes were used for observation and after first sighting binocular could be used for confirmation of species and estimation of school size. Distance and angle estimation trainings and experiments were conducted during each survey.

Conventional line transect method was applied using the program DISTANCE 4.1 (Thomas *et al.*, 2003). Abundance in the *i*-th block, N_i , was estimated by the following formula;

$$\hat{N}_i = \frac{n_i \cdot \hat{E}[s_i] \cdot A_i}{2 \cdot \hat{w} \cdot L_i},$$

where n_i is number of primary sightings, $\hat{w}$ is the estimate for the effective strip half-width , $\hat{E}[s_i]$ is estimate for the expected mean school size, L_i is research distance and A_i is size of the area.

The estimate of variance $\hat{\mathrm{var}}(N_i)$ in each block is estimated by the following formula.

$$\hat{\mathrm{var}}\left(\hat{N}_i\right) = \hat{N}_i^{\,2} \cdot \left\{ \frac{\mathrm{var}(n_i)}{n_i^{\,2}} + \frac{\mathrm{var}(\hat{w})}{\hat{w}^2} + \frac{\mathrm{var}\left(\hat{E}[s_i]\right)}{\hat{E}[s_i]^2} \right\}$$

The 95% confidence interval of the total abundance is calculated as following formula (Buckland *et al.*, 2001),

$$\left(N/C, N \cdot C\right),$$

where

$$C = \exp\left\{ 1.96 \cdot \sqrt{\ln\left\{ 1 + \frac{\hat{\mathrm{var}}(\hat{N})}{\hat{N}^2} \right\}} \right\}$$

Results and discussion

Research distance in the Sea of Okhotsk in 2003 was 903nmi by SM1, 1,805 nmi by SM2, respectively. The reason of less effort by SM1 is the bad weather and the time loss due to the accident of injury of the crew (Miyashita, 2006). Therefore the coverage of the central blocks (OSW, ONW and OE) was not so good (Fig. 4). The number of sightings of common minke whales is summarized in Table 1. Number of primary sightings during the 2003 Okhotsk surveys was as follows; SM1: 12 schools - 12 animals, SM2: 69 schools - 78 animals. The sighting positions were shown in Fig. 4.

Research distance in the waters east of the Kurile archipelago – Kamchatka was 1,441nmi by SM1, 929nmi by SM2, respectively. Because the Russian EEZ has priority to be surveyed and the bad weather especially dense fog disturbed the survey for a long time, the coverage in the high seas blocks (PAW, PAE, KAS and BES) was low. Number of primary sightings was SM1: 5 schools - 5 animals, SM2: 6 schools - 6 animals. Sighting positions were shown in Fig. 8.

Because of small sample size and the common vessel types through these cruises, all primary sighting are combined and the detection curve was fitted. The information of the distance and angle for the first sighing from

the top barrel and the IO platform was used for the fitting of detection curve. The selected detection curve was the hazard probability model and the fitting was shown in Fig. 9.

In the Sea of Okhotsk, abundance of common minke whales was estimated as 28,436 (CV 0.185, 95%C.I. 19,866 – 40,703) (Table 2). Based on the cookie cutter shark scar observation, the mixing proportion of J stock in the northern Okhotsk Sea was estimated as zero recently (Miyashita et al., 2010). Then the abundance estimate in this study without 11W (about 27,000) was assumed to be O stock animals. In the Russian EEZ east of the Kurile archipelago and the Kamchatka, the abundance was estimated as 972 (CV 0.52, 95%C.I. 373 – 2,534). All animals can be assumed as O-stock.

Because the Russian territorial waters was not covered, there the unsurveyed area remained in the northeastern coastal waters in the Sea of Okhotsk and g(0) was assumed as 1, the present abundance estimate has under bias. Especially it is well known that common minke whales move into the very coastal waters such as bay, the coastal survey is necessary in the future to evaluate the number in these waters.

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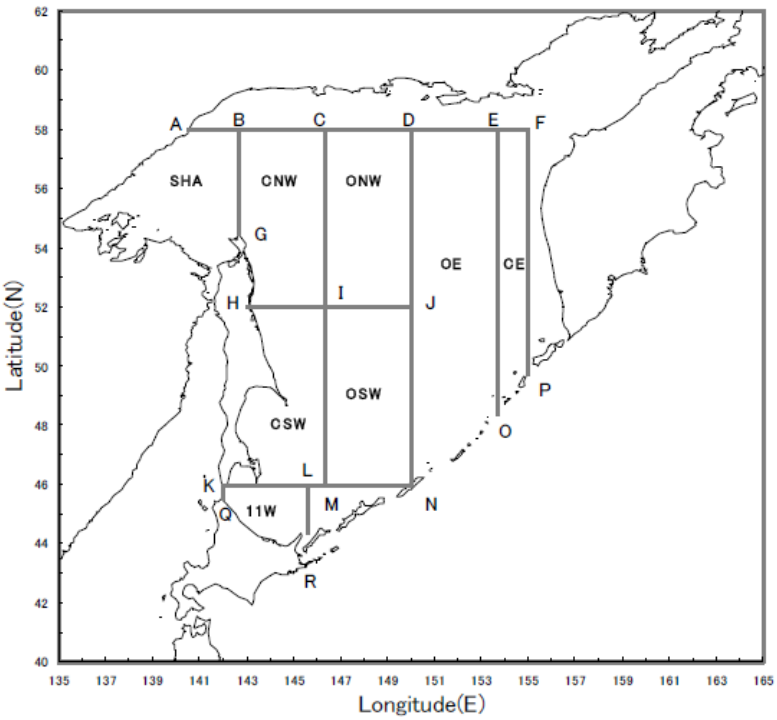

Fig. 1. Block definition of the 2003 sighting surveys in the Sea of Okhotsk. Area north of 58ºN, east of 155ºE was not permitted to enter and survey from the Russian government.

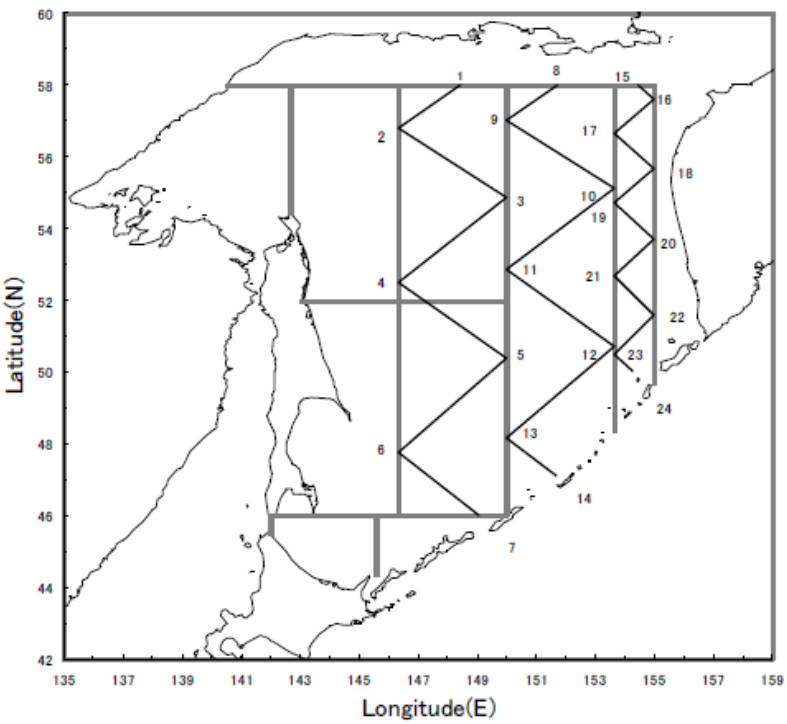

Fig. 2. Pre-determined track line for *Shonan-maru* in 2003.

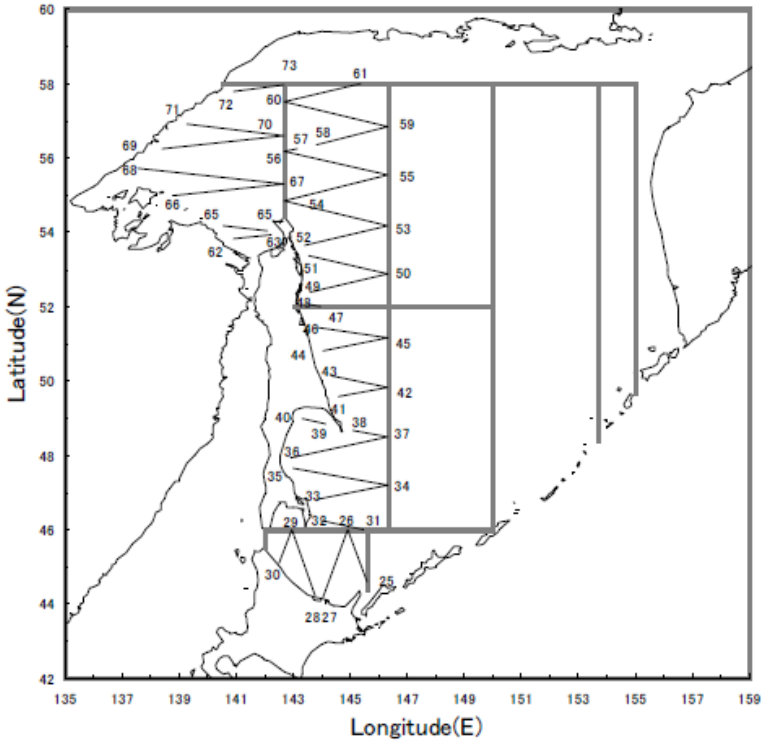

Fig. 3. Pre-determined track line for *Shonan-maru No.2* in 2003.

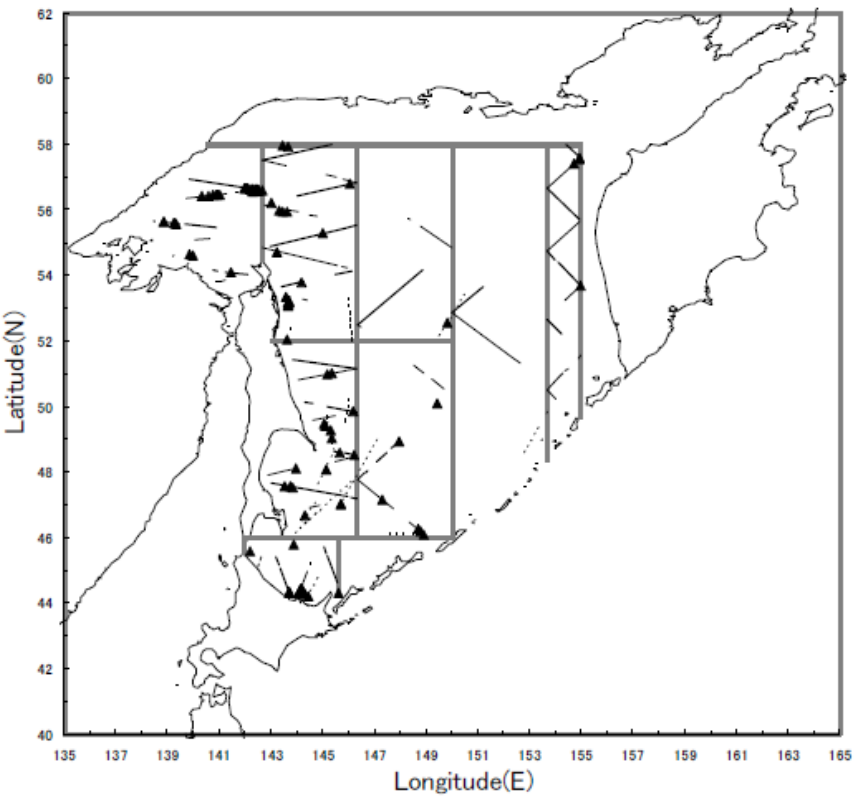

Fig. 4. Track line traversed with sighting effort and sighting position of common minke whale school (black triangle) in 2003.

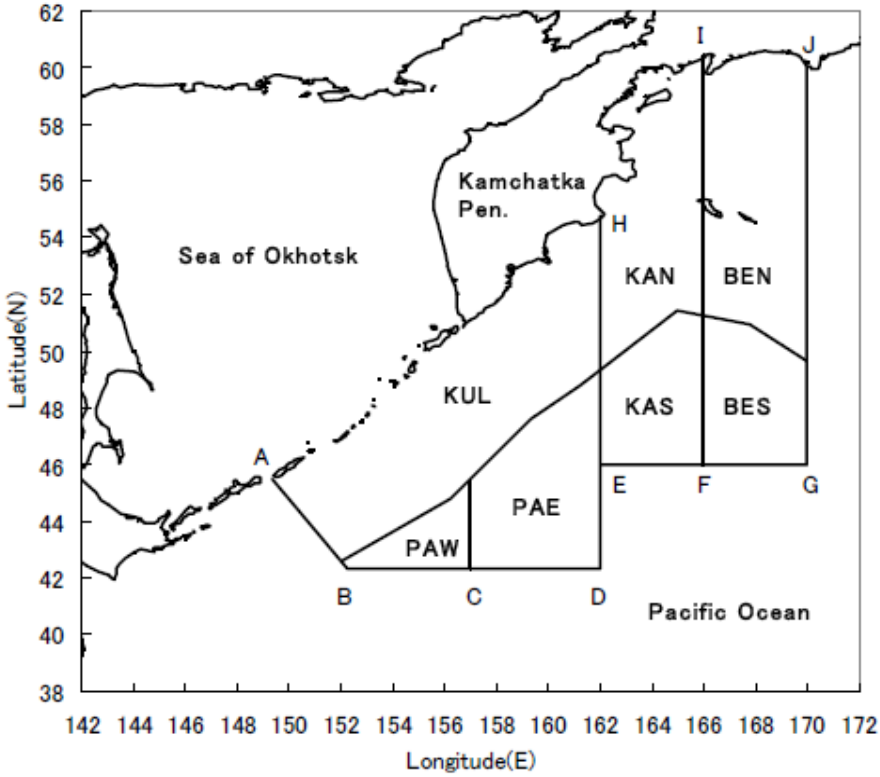

Fig. 5. Definition of blocks for the 2005 sighting survey.

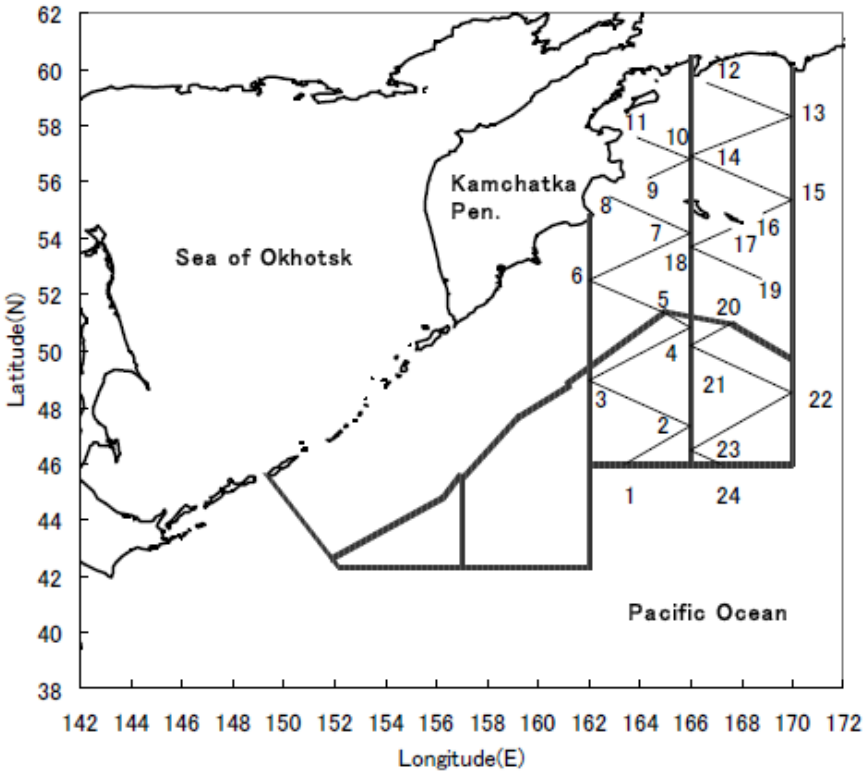

Fig. 6. Pre-determined track line for *Shonan-maru* in 2005.

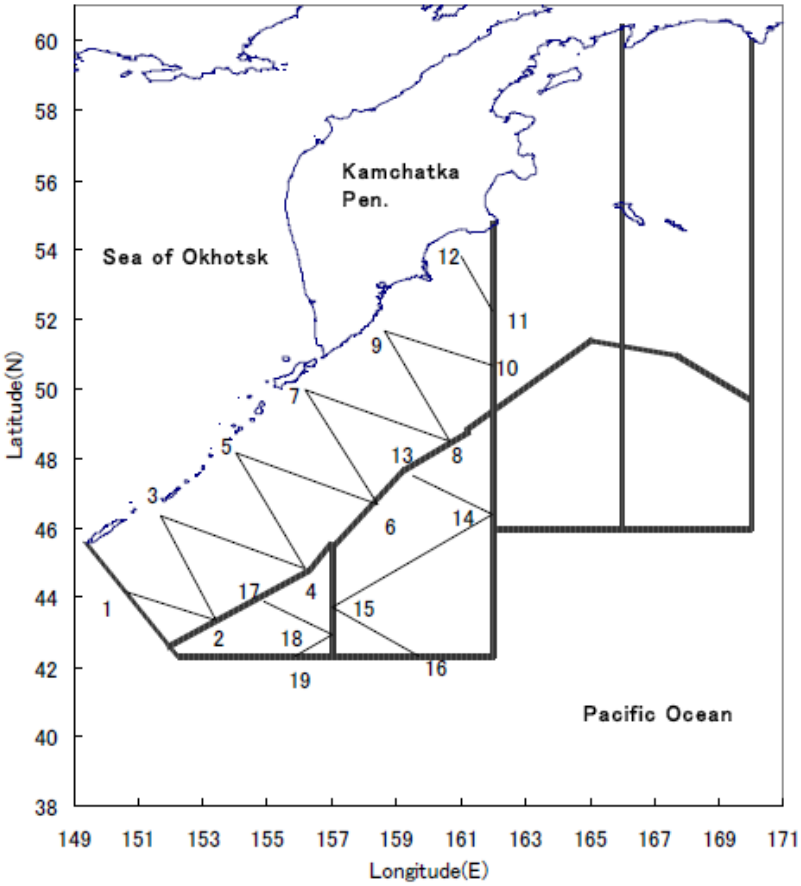

Fig. 7. Pre-determined track line for *Shonan-maru No.2* in 2005.

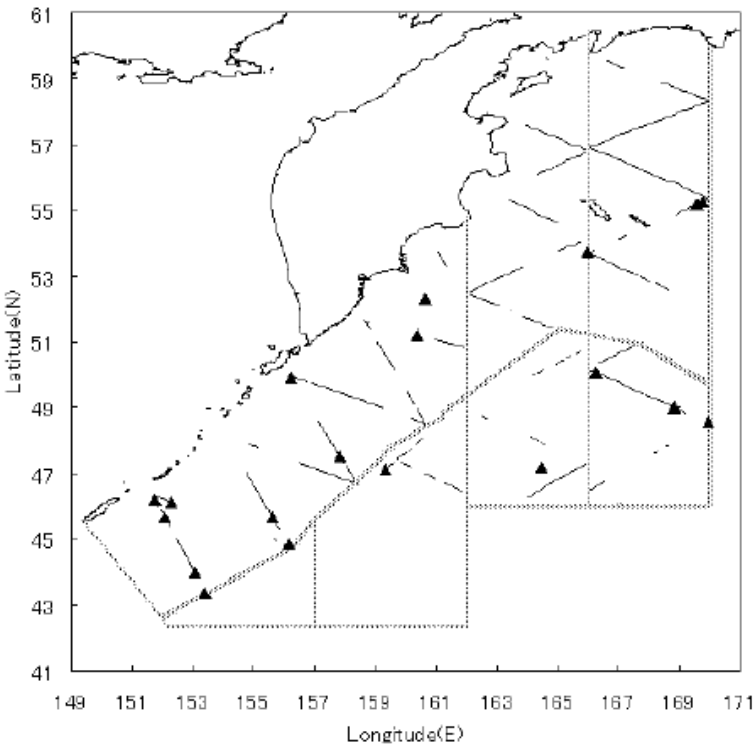

Fig. 8. Track line traversed with sighting effort and sighting positions of common minke whales (black triangle) in the 2005 survey.

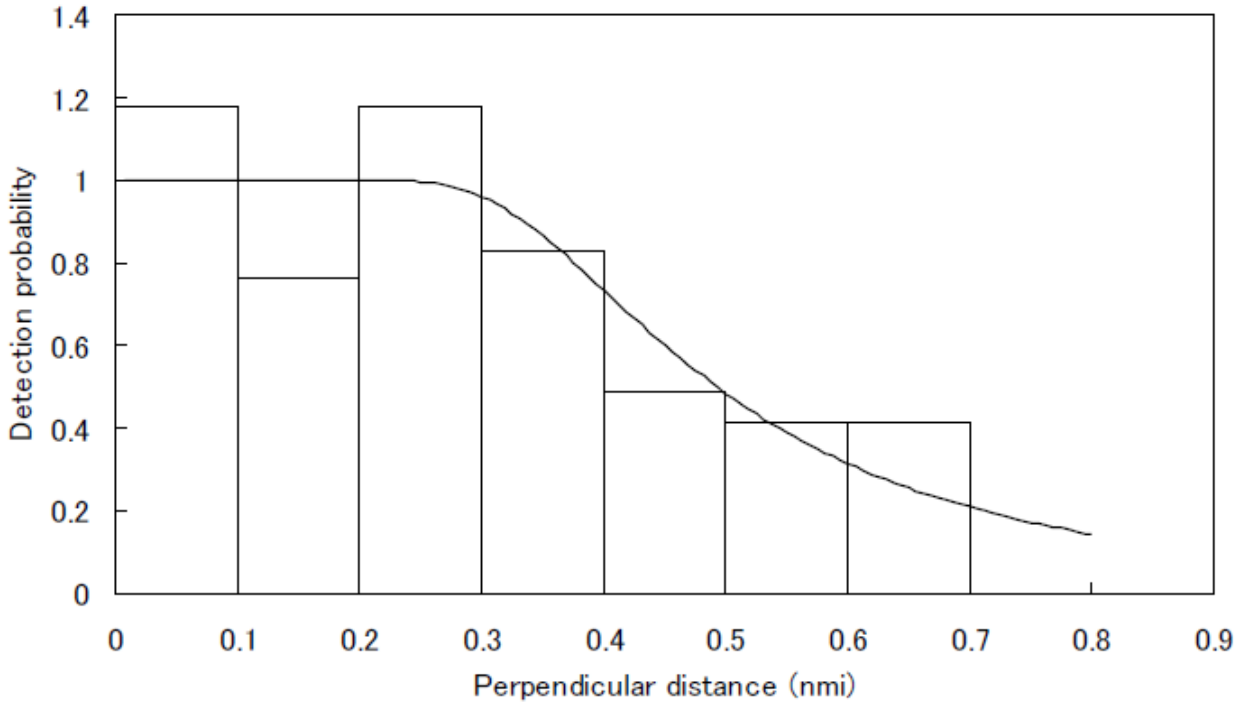

Fig. 9. Perpendicular distribution and detection curve fitted to the 2003 and 2005 sighting survey data.

Table 1. Research distance and number of sightings.

Block	R/V	Research distance (nmi)	No. primary sightings (schools – animals)
Sea of Okhotsk, 2003 survey			
SHA	SM2	304.2	29 – 34
CNW	SM2	575.0	4 – 4
CSW	SM2	536.3	8 – 8
11W	SM2	182.5	19 – 22
CE	SM1	449.2	4 – 4
OE	SM1	138.5	0 – 0
ONW	SM1	136.0	0 – 0
OSW	SM1	180.0	4 – 4
East of Kurile archipelago – Kamchatka, 2005 survey			
KUL	SM2	868.2	6 – 6
PAE	SM2	60.7	0 – 0
PAW	SM2	0	-
BEN	SM1	578.1	2 – 2
BES	SM1	359.5	2 – 2
KAN	SM1	418.4	0 – 0
KAS	SM1	184.9	0 – 0

Table 2. Abundance estimate from the 2003 and 2005 sighting surveys.

Block	N	CV%	95% C.I.		
Sea of Okhotsk (2003)					
11W	1,496	92.6	320	–	6,994
CSW	2,882	34.1	1,506	–	5,516
OSW	4,035	88.9	904	–	18,002
Subtotal(12SW)	6,917	53.8	2,576	–	18,573
CE	935	49.6	373	–	2,342
CNW	772	36	390	–	1,529
ONW	1,335	36.7	666	–	2,678
SHA	16,981	19.8	11,571	–	24,920
Subtotal(12NE)	20,023	17.2	14,333	–	27,972
Total	28,436	18.5	19,866	–	40,703
East of Kuril Islands – Kamchatka pen. (2005)					
KUL	728	47	303	–	1,747
BEN	244	152.3	29	–	2,088
Total	972	52	373	–	2,534