The number of western North Pacific common minke whales (*Balaenoptera acutorostrata*) distributed in JARPN II coastal survey areas

Takashi Hakamada[1], Koji Matsuoka[1] and Tomio Miyashita[2]

[1] *The Institute of Cetacean Research, 4-5, Toyomi-cho, Chuo-Ku, Tokyo, 104-0055, Japan.*
[2] *National Research Institute of Far Seas Fisheries (Yokohama), 2-12-4, Fukuura, Kanagawa, Yokohama, 236-8648, Japan.*
Contact e-mail: hakamada@cetacenan.jp

ABSTRACT

In order to examine an impact of whales on Japanese fisheries in Kushiro and Sanriku regions through estimating the amount of prey consumed by minke whales or using an ecosystem model, it was required to estimate the number of the whales distributed in each of the survey areas during the JARPNII survey periods. The estimated number off Kushiro was 601, 968, 368, 316, 241 and 142 in 2002, 2003, 2004, 2005, 2006 and 2007, respectively. The estimated number off Sanriku was 247 in 2005 and 123 in 2006. Note is that these numbers are not abundance estimates of the minke whale stock in the areas because the sighting data we used for the estimation covered only a part of the stock distribution.

INTRODUCTION

Feeding ecology and ecosystem studies are one of the main objectives of the JARPN II. The common minke whales consume some of the main Japanese fishery resources off Kushiro and off Sanriku. An impact of whales on Japanese fisheries in the JARPNII survey area can be assessed from estimating the amount of prey consumed by the whales in survey areas (Tamura *et al*., 2009) or using an ecosystem model developed for the survey area (e.g. Okamura *et al*., 2009). For either way, it is required to estimate the number of the whales distributed in the survey areas.

MATERIALS AND METHODS

Dedicated sighting survey was conducted off Kushiro in September and October every year from 2002 to 2007 and off Sanriku in April and May from 2003 to 2006. The survey area off Kushiro was stratified, except for the 2003 survey, as Offshore (O), coastal-East (E), coastal-Central (C),

coastal-West (W), and off Hidaka sub-prefecture (H) (Fig. 1). Distribution of primary sightings of the common minke whales and searching effort off Sanriku during the 2005 and 2006 JARPN II costal component were shown in Fig. 2. Survey area and design off Sanriku in 2003 were different from those in 2005 and 2006. Although the survey periods were similar in 2003 (8 - 28 April), 2005 (20 April – 2 May), and 2006 (21 April – 3 May), the research area covered by the sighting survey in 2003 was quite different from that in 2005 and 2006. Baceause we thought that the number of whales obtained from the sighting data in 2003 was not comparable to that in 2005 and 2006, we didn't estimate the number of distributed whales from the 2003 data. Survey area off Sanriku was divided at 141°30'E longitudinal line as coastal area (west) and offshore area (east). The coastal area was surveyed twice per year in both 2005 and 2006. The first period was 24 - 30 April in 2005 and 25 – 29 April in 2006, and the second period was 30 Apr. – 2 May in 2005 and 29 April – 3 May in 2006. We used the data only from the second survey because this period was thought to be closer to peak migration period of the minke whales in the area, likely providing relatively a better estimate of the whale numbers for estimation of prey consumption by the whales. More details of the sighting surveys in general are explained in Kiwada *et al.*, (2009), while the details of the 2004 sighting survey in Sendai Bay in Appendix of this paper.. Distribution of trackline surveyed and primary sightings of the minke whales off Kushiro and off Sanriku by strata were shown in Fig. 1 and 2, respectively.

The number of minke whales distributed in the area was estimated using the computer program DISTANCE ver 3.5. The estimated numbers (N) and their CVs (CV(N)) were obtained from the following formulae:

$$N = \frac{AnE(s)}{2wL} \qquad (1)$$

$$CV(N) = \sqrt{\left\{CV\left(\frac{n}{l}\right)\right\}^2 + \left\{CV(w)\right\}^2 + \left\{CV(E(s))\right\}^2} \qquad (2)$$

We applied $g(0)$=0.732 (CV=0.309) for Top barrel and Upper bridge (Okamura *et al*., 2008).

RESULTS

Table 1 shows the estimated number of the minke whales off Kushiro by strata and by year. Table 2 shows the total number of whales off Kushiro assuming $g(0)$=0.732 for each of the survey years. The estimated numbers are 601, 968, 368, 316, 241 and 142 in 2002, 2003, 2004, 2005, 2006 and 2007, respectively. Table 3 shows the estimated number of the minke whales off Sanriku by strata and by year. The estimated number for coastal stratum of 247 in 2005 and 123 in 2006 was used for estimating amount of prey consumed by the common minke whales in the survey area. Table 4 shows the total number of whales off Sanriku assuming $g(0)$=0.732 in each year. The estimated

number in the whole surveyed area of Sanriku region was 437 in 2005 and 236 in 2006. These estimates in the whole survey area were not different substantially compared to the estimate in Appendix. Fig. 3 shows plots of detection functions for each of the survey years off Kushiro and off Sanriku. The fitting of the detection function seemed to be good.

DISUSSIONS

It is important to note that the numbers of the minke whales we estimated in this paper do not represent the number of the whale in a whole stock because the sighting data we used covered only a limited area of the stock distribution.

The estimated numbers of the whales in this study decreased year by year. We think this is because the number of minke whales migrated to the area differed year by year probably due to some environmental factors. It was suggested the number of the minke whales distributed off Kushiro was influenced by the environmental factors such as sea water temperature or Oyashio extension (Watanabe *et al*., 2009). In fact, according to Murase *et al*. (2007), during our surveys in 2002-2006, the stretch of optimal temperature zone for the minke whales was reduced and this reduction caused low influx of the common minke whales..

ACKNOWLEDGEMENT

Authors would like to express gratitude for all the researchers and crew involved the JARPN II coastal component. We also thank Ms. Saeko Kumagai, Mr. Hiroshi Kiwada and Ms. Tomoko Hasegawa (Institute of Cetacean Research) for their assistance in this study. We also thank Hiroshi Hatanaka and Naohisa Kanda (Institute of Cetacean Research) for their valuable comments and suggestions on this study .

REFERENCE

Kiwada, H., Kumagai, S. and Matsuoka, K. Methodology and procedure of the dedicated sighting surveys in JARPN II –Offshore and coastal component of Sanriku and Kushiro-. Paper SC/J09/JR2 presented to the JARPN II Review Workshop, Tokyo, January 2009 (unpublished) 16pp.

Murase, H., Kiwada, H., Matsuoka, K. and Nishiwaki, S. 2007. High sea surface temperature caused low influx of common minke whales to the Kushiro water in September 2006. Appendix 4 of paper SC/59/O7 presented to IWC Scientific Committee, May 2007 (unpublished) [Available from IWC Secretariat]. 14pp.

Okamura, H., Miyashita, T. and Kitakado, T. 2008. Abundance estimation on common minke whales in the Russian waters of sub-area 10 using the IO sighting data in 2006. Paper SC/60/NMP7 presented to IWC Scientific Committee, May 2008 (unpublished). [Available from IWC

Secretariat]. 7pp.

Okamura, H., Nagashima, H. and Yonezaki, S. 2009. Preliminary assessment of impacts on the sandlance population by consumption of minke whales off Sanriku region. Paper SC/J09/JR14 presented to the JARPN II Review Workshop, Tokyo, January 2009 (unpublished). 20pp

Tamura, T., Konishi, K., Goto, M., Bando, T., Kishiro, T., Yoshida, H., Okamoto, R. and Kato, H. 2009. Prey consumption and feeding habits of common minke whales in coastal areas off Sanriku and Kushiro. Paper SC/J09/JR9 presented to the JARPN II Review Workshop, Tokyo, January 2009 (unpublished) 18pp.

Watanabe, H., Yonezaki, S., Kiwada, H., Kumagai, S., Kishiro, T., Yoshida, H. and Kawahara, S. 2009. Distribution and abundance of prey species and prey preference of common minke whale *Balaenoptera acutorostrata* in the coastal component of JARPN II off Kushiro from 2002 to 2007. Paper SC/J09/JR11 presented to the JARPN II Review Workshop, Tokyo, January 2009 (unpublished) 37pp.

Table 1. The number of the minke whales distributed off Kushiro during the survey period for each stratum in 2002-2007. O: Offshore, E: coastal-East, C: coastal-Central, W: coastal-West, and H: off Hidaka sub-prefecture.

year	straum	Area	n	L	n/L	CV	ESW	CV	E(s)	CV	D	P	CV
2002	E	1,864.6	5.0	73.5	0.068	1.043	0.570	0.118	1.05	0.035	0.063	117	1.050
	C	2,912.7	32.7	272.6	0.120	0.185	0.570	0.118	1.05	0.035	0.111	323	0.222
	W	2,403.9	0.0	48.2	0.000	0.000	0.570	0.118	1.05	0.035	0.000	0	0.000
	O	5,931.1	0.0	287.2	0.000	0.000	0.570	0.118	1.05	0.035	0.000	0	0.000
2003		9,471.5	52.5	533.9	0.098	0.359	0.846	0.122	1.29	0.054	0.075	709	0.383
2004	O	5,931.1	1.0	265.2	0.004	0.989	0.443	0.232	1.06	0.056	0.005	27	1.017
	E	1,864.6	1.0	140.6	0.007	1.093	0.443	0.232	1.06	0.056	0.008	16	1.118
	C	2,912.7	12.0	238.7	0.050	0.380	0.443	0.232	1.06	0.056	0.060	175	0.448
	W	2,403.9	3.0	164.9	0.018	0.349	0.443	0.232	1.06	0.056	0.022	52	0.422
2005	H	2,148.5	0.0	112.1	0.000	0.000	0.513	0.318	1.05	0.048	0.000	0	0.000
	W	2,527.8	1.0	169.6	0.006	1.010	0.513	0.318	1.05	0.048	0.006	15	1.060
	C	2,912.7	10.0	365.3	0.027	0.633	0.513	0.318	1.05	0.048	0.028	81	0.710
	E	1,864.6	9.0	127.7	0.070	0.077	0.513	0.318	1.05	0.048	0.072	135	0.331
	O	5,821.7	0.0	41.7	0.000	0.000	0.513	0.318	1.05	0.048	0.000	0	0.322
2006	H	2,148.5	1.0	154.4	0.006	1.021	0.394	0.239	1.00	0.000	0.008	18	1.048
	W	2,403.9	1.0	161.9	0.006	0.897	0.394	0.239	1.00	0.000	0.008	19	0.929
	O	5,931.1	0.0	285.3	0.000	0.000	0.394	0.239	1.00	0.000	0.000	0	0.239
	E	1,864.6	4.0	145.0	0.028	0.623	0.394	0.239	1.00	0.000	0.035	65	0.667
	C	2,912.7	5.0	247.4	0.020	0.274	0.394	0.239	1.00	0.000	0.026	75	0.363
2007	H	2,148.5	0.0	105.8	0.000	0.000	0.394	0.239	1.00	0.000	0.000	0	0.239
	W	2,403.9	2.0	144.5	0.014	0.805	0.394	0.239	1.00	0.000	0.018	42	0.839
	O	8,164.7	0.0	226.3	0.000	0.000	0.394	0.239	1.00	0.000	0.000	0	0.239
	E	1,864.6	1.0	158.6	0.006	1.393	0.394	0.239	1.00	0.000	0.008	15	1.413
	C	2,912.7	4.0	314.4	0.013	0.764	0.394	0.239	1.00	0.000	0.016	47	0.800

Table 2. Total number of the minke whales distributed off Kushiro during the survey period assuming $g(0)=0.732$ for each year.

year	P	CV
2002	601	0.447
2003	968	0.492
2004	368	0.449
2005	316	0.447
2006	241	0.448
2007	142	0.619

Table 3. The number of the minke whales distributed off Sanriku during the survey period assuming $g(0)$=0.732 for each stratum in 2005 and 2006.

	straum	Area	n	L	n/L	CV	ESW	CV	E(s)	CV	D	P	CV
2005	offshore	2,777.7	9.0	282.7	0.032	0.364	0.318	0.237	1.00	0.000	0.068	190	0.533
	coastal	772.2	24.9	167.1	0.149	0.315	0.318	0.237	1.00	0.000	0.320	247	0.501
2006	offshore	2,777.7	6.0	260.7	0.023	0.508	0.388	0.341	1.00	0.000	0.040	112	0.685
	coastal	2,172.4	11.0	341.1	0.032	0.333	0.388	0.341	1.00	0.000	0.057	123	0.568

Table 4. Total number of the minke whales distributed off Sanriku during the survey period assuming $g(0)$=0.732 for each year. More details of the estimate in 2004 is provided in Appendix..

year	P	CV	ref.
2004	283	0.623	2
2005	437	0.425	1
2006	236	0.493	1

ref. 1: This paper, 2: Appendix

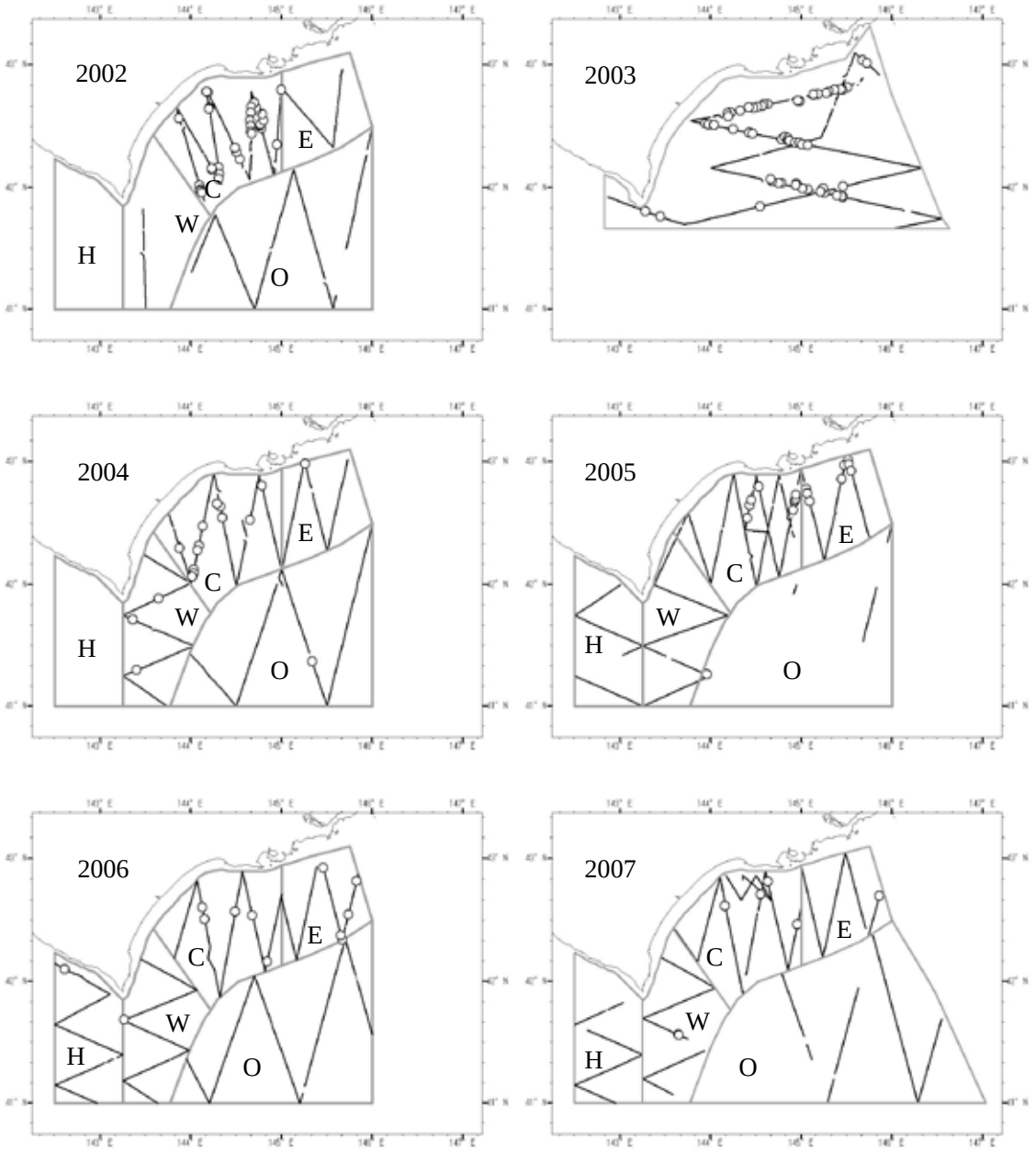

Fig. 1. Distribution of primary sightings of the common minke whales and searching effort off Kushiro in the survey of JARPN II costal component. There are five survey strata:; O: Offshore, E: coastal-East, C: coastal-Central, W: coastal-West, and H: off Hidaka sub-prefecture.

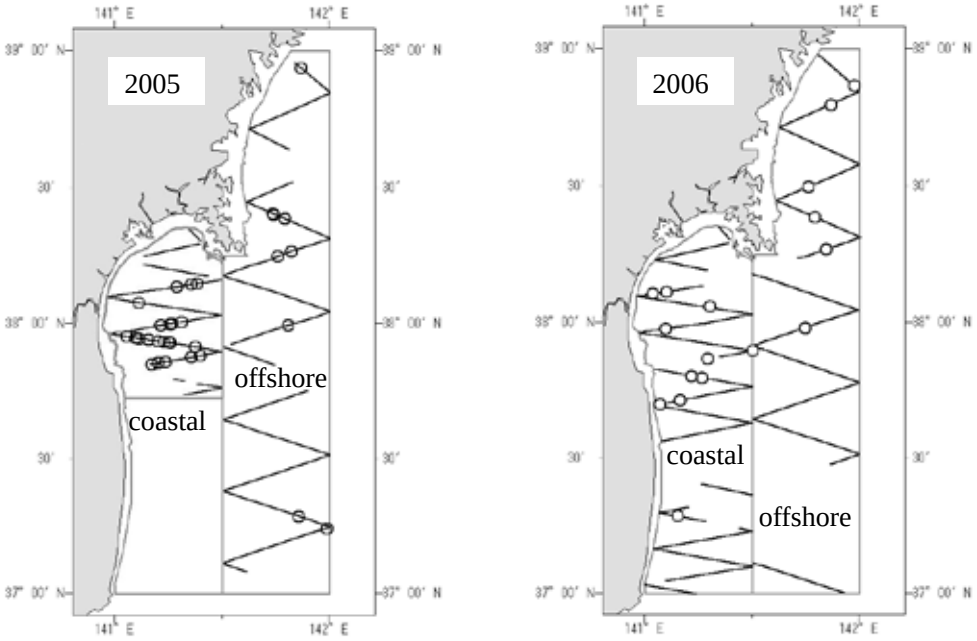

Fig. 2. Distribution of primary sightings of the common minke whales and searching effort off Sanriku during JARPN II costal component.

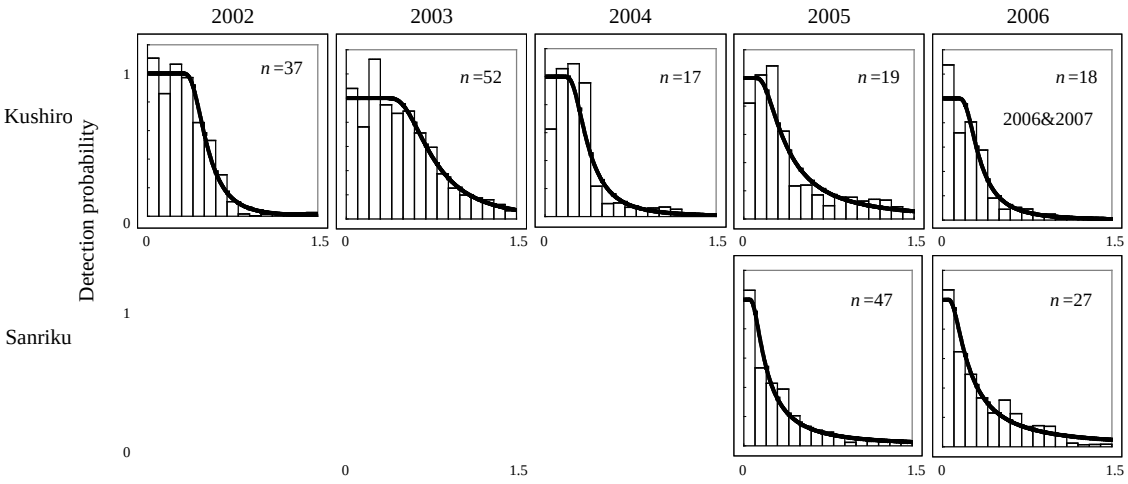

Fig. 3. Plot of detection probability functions for the common minke whales during the sighting survey off Kushiro in 2002-2007 and off Sanriku in 2005 and 2006. *n* is the number of the primary sightings to estimate the detection probability functions.

Appendix.

Abundance estimate of common minke whales in the Sendai Bay, estimated from 2004 sighting survey

Tomio Miyashita
National Research Institute of Far Seas Fisheries
2-12-4 Fukuura, Kanazawa-ku, Yokohama-shi, Kanagawa 236-8648, Japan
Contact e-mail: miyachan@fra.affrc.go.jp

Survey outline

Period: 12 April – 11 May, 2004
Area : Block and pre-determined track line (Fig. 1)
Research vessel: *Kurosaki*
Scientists onboard: T. Ebusui and S. Yonezaki
Whale observers onboard: T. Okumura, T. Okumura and Y. Tanaka
Research method: Closing mode (the first half), Passing mode (the second half)
Research distance: 694.3nmi (closing mode), 607.0nmi (passing mode)
Track line traversed with sighting effort: (Fig. 2).
Common minke whale sighting results :

	Primary sighting		Secondary sighting	
	school	animal	school	animal
Closing mode	6	7	1	1
Passing mode	22	22	-	-

Sighting positions of common minke whale: (Fig. 2)

Abundance estimate

Method: Traditional line transect method using the program DISTANCE 4.1 (Thomas *et al.*, 2003).

Detection curve fitting: Because secondary sightings was very small number and the school size was not different between two research methods, all primary sighting are used for fitting ted and the detection curve was fitted (Fig. 3).

Abundance: 273 (CV 0.57, 95%C.I. 96 – 774) assuming g(0)= 0.756（CV 0.179）which was provisionally estimated from the IO sighting survey in the Sea of Okhotsk (Miyashita, 2004).

References.

Miyashita, T. 2004. Report of the common minke whale sighting surveys in the sea of Okhotsk in 2003. Document SC/56/MP1. 10pp.

Thomas, L., Laake, J.L., Strindberg, S., Marques, F.F.C., Buckland, S.T., Borchers, D.L., Anderson, D.R., Burnham, K.P., Hedley, S.L., Pollard, J.H. and Bishop, J.R.B. 2003. Distance 4.1. Release 2. Research Unit for Wildlife Population Assessment, University of St. Andrews, UK. http://www.ruwpa.stand.ac.uk/distance/

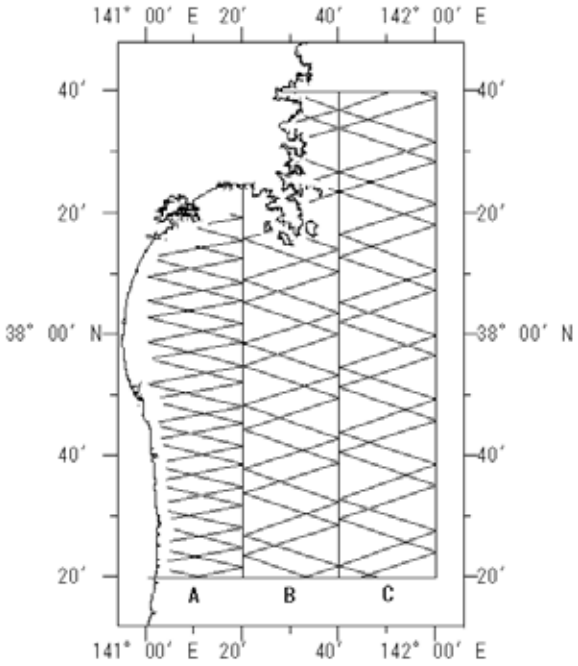

Fig. 1. Block and pre-determined track line for 2004 survey.

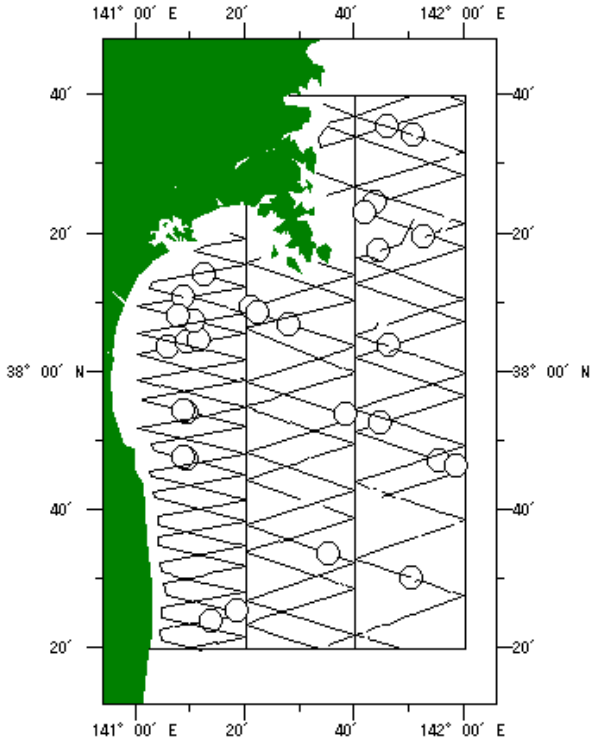

Fig. 2. Track line traversed with sighting effort
and sighting positions of common minke whale school (white circle).

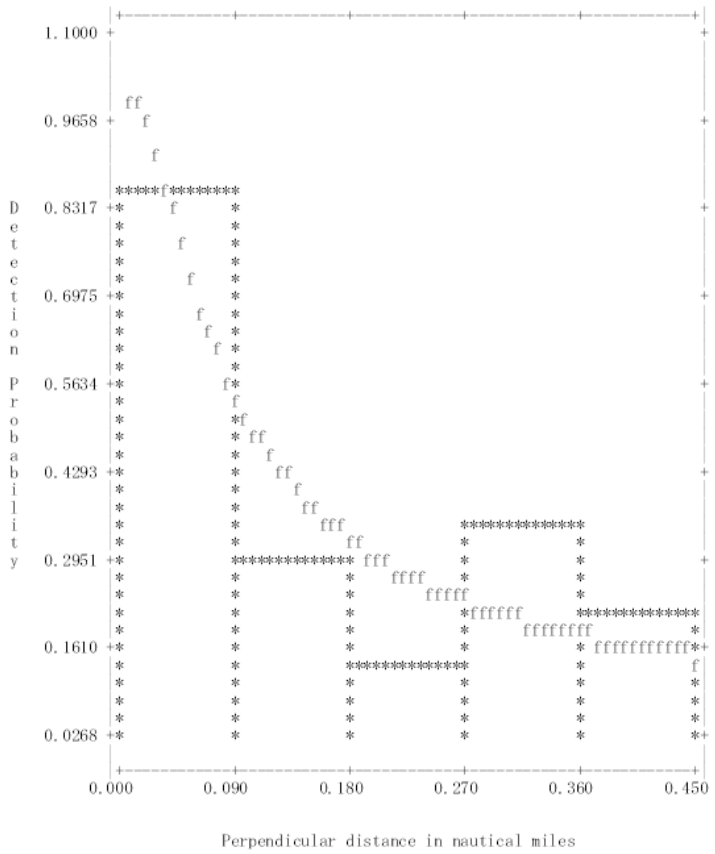

Fig. 3. Detection curve fitted to the sighting data of *Kurosaki* in the Sendai Bay sighting survey in 2004.