

Cruise Report of the Japanese Whale Research Program under Special Permit in the Antarctic (JARPA) Area V and Western Part of Area VI in 2002/2003

SHIGETOSHI NISHIWAKI¹⁾, DAISUKE TOHYAMA²⁾, TOSHIHIRO MOGOE¹⁾, HIROTO MURASE¹⁾, GENTA YASUNAGA¹⁾, MASAKATSU MORI²⁾, TAKASI YOSHIDA²⁾, KAZUKI FUKUTOME²⁾, SUMITO MACHIDA¹⁾, RYUSUKE OGAWA¹⁾, RYUJI OKA¹⁾, SHIN ITO¹⁾, TAKAHIRO KONAGAI²⁾, TATSUYA ISODA¹⁾, YOHSUKE MORI¹⁾, HIROSHI IWAYAMA³⁾ AND NAOTO HORII⁴⁾,

Contact e-mail: nisiwaki@cetacean.jp

1) *The Institute of Cetacean Research, 4 – 5 Toyomi-cho, Chuo-ku, Tokyo 104-0055 Japan.*

2) *Kyodo Senpaku Kaisya, Ltd., 4-5 Toyomi-cho, Chuo-ku, Tokyo 103-0004 Japan.*

3) *Department of Animal Science, Obihiro University of Agriculture and Veterinary Medicine, Inada-cho, Obihiro-city, Hokkaido, 080-0833 Japan.*

4) *Department of Fisheries, Faculty of Fisheries, University of Hokkaido, 3-1-1 Minato-cho, Hakodate-city, Hokkaido, 041-8611 Japan.*

ABSTRACT

The sixteenth Japanese Whale Research Program under Special Permit in the Antarctic (JARPA) was conducted in Area V and western part of Area VI (VIW) from 2 December 2002 to 8 March 2003. One sighting vessel (SV), three sighting/sampling vessels (SSVs) and one research base ship were engaged in the research. Searching distance of the SV and the average of three SSVs were 5,413.5 and 4,237.6n.miles, respectively. The total sightings of the Antarctic minke whales by the four research vessels were 7290 individuals of 2677 schools. Antarctic minke whales were the most dominant species and widely distributed in the entire research area. The sightings of dwarf form minke whales were the only primary sightings of six schools/ 6 individuals by SSVs in this cruise. These accounted for only 0.3% of the primary sighting of Antarctic minke whales by SSVs. The sightings of like-minke accounted for only 2.0% and 1.1% of the primary sighting of Antarctic minke whales of SV and SSVs, respectively. Out of 1,582 schools/ 4,506 individuals in the primary sightings of Antarctic minke whales by SSVs, 479 schools and 928 individuals were targeted for sampling. A total of 440 individuals were sampled (110 from Area VIW, 330 from Area V). Technical sampling efficiency was 92%. Mature females were dominant in the East-South stratum of Area V, whereas mature males were dominant in the North strata in Area V and Area VIW. In the West-South stratum in Area V, mature animals dominated and immature male were not collected. Pregnant females were 128 individuals in the entire research areas and they had 131 fetuses including three pairs of twins. Fifteen species of whales include one subspecies were conformed in this cruise. A total of 23 skin samples were collected from Antarctic minke, southern right, fin, sei, humpback, sperm, killer whales and a carcass of unidentified cetacean by using compound-crossbows. CTD and XCTD castings were conducted at 66 and 101 locations respectively in all research areas. Sea surface environmental data recording using EPCS was conducted for 96 days by YS2 and 89 days by KS2 in the entire research areas. Hydro-acoustic survey was conducted for 96 days in the all research areas. Recording for whale song by the sonobuoy was attempted at five stations in the western part of Area VI and the eastern part of Area V. In this cruise, Antarctic minke whales were remarkably high in number and widely distributed over the whole strata except in the East-North stratum in V and VIW. The density in west strata in area V was the highest record of JARPA surveys in past 14 years. A high surface water temperature (the range from 1°C to 4°C) was locally recorded north of the West-North stratum in the Area V. Results in 2000/2001 cruise suggested that Antarctic minke whales could avoid a high surface water temperature. The distribution pattern of the Antarctic minke whales in the West-North stratum in Area V in 2000/2001 JARPA was different from previous JARPA survey because of high water temperature. It was also indicated that results in this cruise was consistent with the past cruises except 2000/2001 cruise. It was suggested that yearly fluctuation of existence of high water temperature affect the distribution and density of Antarctic minke whales.

KEYWORDS: ANTARCTIC MINKE WHALE; SOUTHERN HEMISPHERE; SCIENTIFIC PERMITS

INTRODUCTION

The Japanese Whale Research Program under Special Permit in the Antarctic (JARPA) has been conducted every year since the 1987/88 in compliance with Article VIII of the International Convention for the Regulation of Whaling (ICRW). After two seasons of feasibility research in 1987/88 and 1988/89, the full-scale research started in 1989/90. The program was designed to repeat surveys in the Antarctic Areas IV and V alternatively in each of sixteen years of the research period. From 1995/96, the survey area was expanded into a part of Areas III and VI to improve the stock structure study of Antarctic minke whales (*Balaenoptera bonaerensis*), (Government of Japan, 1987, 1989, 1995). The original objective of expansion to the eastern part of Area III and western part of Area VI was a feasibility study on stock identity to examine the hypothesis of the occurrence of more than one stock in Areas IV and V (Government of Japan, 1995; 1996) and to clarify the distribution pattern of hypothesized Core Stock. The result of the mtDNA RFLP analysis of the samples collected in Area V and western part of Area VI in the 1996/97 survey showed no genetic heterogeneity among sampled Antarctic minke whales in that survey. However, Antarctic minke whales sampled in the western part of Area IV in the early period in the surveys of 1989/90 and 1991/92 showed that another stock was possibly exist (Pastene and Goto, 1998). No heterogeneity was found after the analysis of the samples taken in Area V and western part of Area VI in the 1998/99, although it should be emphasized that only 'late' samples were taken in that survey (Pastene and Goto, 2000).

This finding was not in conformity with the initial expectation that a putative Eastern Stock could be distributed in the western part of Area VI as it has been suggested by morphological analysis (Doroshenko, 1979; Kato, 1982). Further work on this matter is required.

The research plan of the 2002/2003 JARPA was submitted to the 54th Annual Meeting of the International Whaling Commission and the Scientific Committee (IWC/SC) meeting (Government of Japan, 2002). The objectives of the research were as follows;

- 1) Elucidation of the stock structure of the Southern Hemisphere minke whales to improve the stock management,
- 2) Estimation of biological parameters of the Southern Hemisphere minke whales to improve the stock management,
- 3) Elucidation of the role of whales in the Antarctic marine ecosystem through studies of whale feeding ecology,
- 4) Elucidation of the effect of environmental changes on cetaceans.

Although these objectives were the same as for previous JARPA survey, the research was planned with special reference to elucidation of eastern stock distribution pattern.

This paper reports the sixteenth cruise of JARPA, which was conducted from 2 December 2002 to 8 March 2003 in the Antarctic Area V and VIW.

RESEARCH METHODS

Research area

The research area for the present survey was composed of the western part of Area VI (Area VIW, 170W–145W) and the entire Area V (130E–170W) in the area between south of 60S and the ice edge line (Fig.1).

Area V was divided into the east and west sectors by longitudinal line of 165E and then farther divided into north and south strata. The west sector was separated into north and south by a line of 45 n.miles northward from the ice edge line. For the east sector, the area between 60S and 69S was designed as the north stratum, and Ross sea region south of 69S as the south stratum. Consequently, the entire research area was divided into four strata.

Research vessels

Kyoshin Maru No.2 (KS2; 372GT) was dedicated to sighting survey and most of all experiments were conducted by this ship (sighting vessel; SV). Three vessels, Yushin Maru (YS1; 720GT), Yushin Maru No.2 (YS2; 747GT) and Kyo Maru No.1 (K01; 812.08GT) were engaged in sighting and sampling surveys (sighting / sampling vessels; SSVs). Toshi Maru No.25 was retired and YS2 joined as the new vessel from this cruise. YS1 and YS2 are the same ship type. These are called the Shohnan-Marun type that has a topmast on the top of the upper bridge. Nisshin Maru (NM; 7,575GT) served as a

research base on which all biological examinations of collected samples were conducted.

Cruise track line, sighting and sampling method

Fig. 2 shows the track line of the main course. The method for establishment of the cruise track line in Area V was same as the previous JARPA survey (Nishiwaki *et al.* 1997 and 1999). A zigzag line was used both the western part of Area VI and all strata in entire Area V. The sighting information was collected during steaming on the set track lines as well as during transit and experiment.

Sighting and sampling procedures were same as in the previous JARPA surveys (Nishiwaki *et al.* 1999, Ishikawa *et al.* 2000) with some minor modification. The sighting survey using SSVs was conducted under limited closing mode (when a sighting of Antarctic minke whale was made on the predetermined track line, the vessel approached the whale and species and school size were confirmed). One Antarctic minke whale was sampled randomly from each primary sighted school within 3 n.miles of the track line. The dwarf form minke whale was not a target for sampling. Three SSVs advanced along parallel track lines 7 n.miles apart, at a standard speed of 11.5 knots.

The sighting survey using SV was conducted under limited closing mode and passing mode (even if sighting was made on the predetermined track line, the vessel did not approach the whale directly and searching from the barrel was uninterrupted).

The survey was operated under optimal research conditions (when the wind speed was below 25 knot in the south strata and 20 knot in the north strata and visibility was over 2 n.miles). In addition to the sighting of Antarctic minke whales or whales suspected to be Antarctic minke whales, the SV approached blue (*B. musculus*), humpback (*Megaptera novaeangliae*), southern right (*Eubalaena australis*), pigmy right (*Caperea marginata*), fin (*B. physalus*), sei (*B. borealis*), sperm (*Physeter macrocephalus*), killer (*Orcinus orca*), long-finned pilot (*Globicephala melas*) and southern bottlenose (*Hyperoodon planifrons*) whales for conducting some experiments. The SSVs also approached the same whale species as experiments in SV while they engaged in sighting survey.

Low and middle latitudinal sighting survey

During transit cruises, sighting surveys were conducted in the area between south of 30S and north of 60S except for Areas within national EEZs. The results of these surveys are not shown in this report.

Experiments

Sighting distance and angle experiment

This experiment was conducted in order to evaluate the accuracy of the information on sighting distance and sighting angle given by observers of the SV and SSVs.

Photo-identification experiment

The following species were targeted for photographic record of natural markings by SV: blue, humpback and southern right whales. Photographic records of blue whales and other species were also taken from the SSVs.

Biopsy sampling

In addition to the species targeted for the photo-identification experiment, pigmy right whales, fin whales, sei whales, sperm whales, southern bottlenose whales, killer whales, long-finned pilot whales were targeted for biopsy skin sampling by the SV and SSVs using compound-crossbow. All collected sample were preserved at -80°C .

Satellite tagging experiment

Attempts to attach satellite tags to large baleen whales were made by YS1 and YS2 in order to elucidate migration routes.

Oceanographic and acoustic survey

SV conducted the following oceanographic survey.

- 1) Hydro-acoustic survey using a scientific echosounder (EK500 with operating frequencies at 38kHz, 120kHz, 200kHz, SIMRAD, Norway) to elucidate distribution and abundance of prey species of Antarctic whales
- 2) Consecutive measuring of water surface temperature, conductivity, surface chlorophyll, dissolved oxygen, surface particle and surface flow by Electric Particle Counting and Sizing System (EPCS)
- 3) XCTD and CTD survey
- 4) Marine debris recording in the research area.

YS2 also conducted EPCS survey. All marine debris found in the stomach of Antarctic minke whales was recorded and collected on NM.

Biological research

Biological research on all sampled whales was conducted on the research base ship (NM).

RESULTS

Outline of the research activities

Table 1 showed an outline of the research activities. The research period in the Antarctic Area V and VIW was 96 days between 2 December 2002 and 8 March 2003. SOWER cruise was carried out at the same times in Area V. The research periods in SOWER cruise was 65 days between 23 December 2002 and 25 February 2003.

Searching effort

Table 2 showed the searching distance (n.miles) by each stratum. The SV covered 5,413.5n.miles and each of three SSVs covered 4,237.6 n.miles on average. Total searching distance of one SV and three SSVs was 18,126.2n.miles (Area VIW; 5,950.2 n.miles, Area V; 12,176.0 n.miles). Searching effort in this cruise was similar to the past JARPA cruises.

Whale species sighted

Table 3a to 3c showed the summary of the sightings. Antarctic minke whale was the most dominant species in both Areas VIW and V and these accounted for 71.7% of the schools and 68.6% of the individuals of all the sightings. In terms of sightings of the Antarctic minke whales, one SV made the primary sightings of 879 schools/ 2077 individuals and the secondary sightings of 63 schools/ 230 individuals, and three SSVs made the primary sightings of 1582 schools/ 4506 individuals and the secondary sightings of 153 schools/ 477 individuals. In the 2000/01 JARPA survey, the sighting of dwarf form minke whales was the primary sightings of 26 schools/ 26 individuals and the secondary sightings of one individual. These results were the largest sightings among the past JARPA surveys. The sighting of dwarf form minke whales was the only primary sightings of six schools/ 6 individuals by SSVs in 2002/2003 cruise. These accounted for only 0.3% of the primary sighting of Antarctic minke whales by SSVs. Total sightings of like-minke in this cruise were only the primary sightings (19 schools/ 22 individuals). These accounted for only 2.0% in SV and 1.1% in SSVs of total the primary sighting of Antarctic minke whales by SV and SSVs.

Fifteen species of whales include one subspecies form were conformed in this cruise. Following seven baleen whales species confirmed; Antarctic minke, dwarf form minke, blue, fin, sei, humpback and southern right whales. Following eight toothed whales species were confirmed; sperm, killer, southern bottlenose, and arnoux's beaked (*Berardius arnuxii*), gray beaked (*Mesoplodon grayi*) and strap toothed (*M. layardii*), long finned pilot whales and hourglass dolphins (*Lagenorhynchus cruciger*).

Frequently confirmed species were humpback whales (6.0%) and fin (2.1%) for the baleen whales, sperm (5.0%), killer (2.7%) and southern bottlenose whales (3.8%). The percentages in the brackets showed the ratio of these species to the primary sighting of Antarctic minke whale. All of sightings of these species corresponded 30% of the sightings of Antarctic minke whale. The baleen whales sighted except Antarctic minke whales were blue (3.1%), fin (35.1%), sei (2.2%), humpback (59.0%) and right whales (0.6%). The percentage in the brackets shows the composition within five species.

Distributions of confirmed whale species in the research areas

Fig. 3 shows distribution of primary sightings of Antarctic and dwarf form minke whales in VIW and V areas. Antarctic

minke whales widely distributed in the research areas throughout the research periods. High concentrated areas were conformed in the southern part of Area V. Antarctic minke whales highly concentrated in the western part of Area V as in the previous cruises. Sightings of dwarf form minke whales were limited in the northern portion of north strata in Area V.

Fig. 4 showed distribution of sightings of fin, sei and humpback whales in research areas. Fin whales widely dispersed northward in Areas VIW and V. Humpback whales widely distributed in the entire research area except south block in East-South stratum of Area V. These sightings overlapped to those of Antarctic minke whale in northern strata in the entire research areas but were very few in the East-South stratum of Area V where Antarctic minke whales highly concentrated.

Fig. 5 showed distribution of sightings of blue and southern right whales. Sightings of blue whales were limited at the eastern edge of the East-North stratum and the center of the East-South stratum in Area V. These sightings were consistent with sightings in 2000/01 cruise. Southern right whales were sighted in the limited area in west of the West-South stratum in Area V.

Fig. 6 showed distribution of sightings of sperm, killer, southern bottlenose, arnou's beaked, gray's beaked, strap toothed and long finned pilot whales and hourglass dolphins. Three kinds of toothed whales, sperm, killer and southern bottlenose whales, were widely distributed in the entire research areas except the south block of the East-North stratum. Sightings of these species were generally overlapped. Five species of other toothed whales widely dispersed northward in the entire research areas.

Mean school size and density index of Antarctic minke whale

Table 4 showed density indices (DI; schools sighted / 100 n.miles searching distance) and mean school size (MSS) of Antarctic minke whales in each stratum. MSS of SV and SSVs in Area IV was comparable to the past surveys but the DI was low in comparison with the past results. The DI in the Area V showed highest value among the previous JARPA surveys except in the East-North stratum. The East-North stratum was similar to the results of previous JARPA surveys. The MSS was also similar to the trend in the DI.

Sampling of Antarctic minke whale

Out of 1,582 schools/ 4,506 individuals in the primary sightings of Antarctic minke whales by SSVs, 479 schools/ 928 individuals were targeted for sampling. A total of 440 individuals were collected (110 from Area VIW, 330 from Area V). Technical sampling efficiency (the rate of succeeded sampling for targeted individuals) was 92%. The value was highest among the previous JARPA surveys.

Of target individuals, 39 individuals could not be sampled. Among those, eighteen individuals were missed because of their swimming activity (fast speed, long diving or quick mobility). Thirteen individuals were canceled to sample because of bad chasing condition (foggy or sunset). Sampling was abandoned for seven individuals because they escaped into the pack ice. One individual was the cases of struck and lost.

Experiments

A sighting distance and angle experiment was preformed on 31 December 2002 by SV and 2 January 2003 by the SSVs. The results of this experiment will be used in calculation of abundance estimates.

Table 5a summarized the results of photo-ID and biopsy sampling. The photo-ID experiment was conducted in the entire research area except in the east-south stratum in Area V. A total of 20 target individuals were photographed (3 blue, 14 humpback and 3 right whales). A total of 23 skin samples were collected by biopsy from Antarctic minke, southern right, fin, sei, humpback, sperm, killer whales and carcass of unidentified cetacean. The numbers of samples by species were 10 individuals for humpback, 6 individuals for fin, 2 individuals for southern right whales and one for other species each.

Table 5b summarized the results of the oceanographic and acoustic surveys. CTD and XCTD castings were conducted at 66 and 101 locations in total, respectively. EPCS survey was conducted for 96 days by YS2 and 89 days by KS2 in total. Hydroacoustic survey was conducted for 96 days in total. Recording for whale song by the sonobuoy was attempted for 5 days between the western part of Area VI and the eastern part of Area V. These tape recordings were conducted for 183 minutes in the high-density area of Antarctic minke whales, 105 minutes for 3 individuals and 87 minutes for 2 individuals

of blue whales.

The marine debris survey was carried out concomitant with the sighting survey of the SV in all research areas. A total of seven debris (five buoys and two steel cans) were confirmed. Two feathers from the second stomach and palatal baleen, a small mineral matter such as coal and a small piece of plastics from the second and the third stomachs were found in 4 individuals of sampled Antarctic minke whales.

Trial of the satellite tagging experiment was performed toward 30 individuals/1 school of Antarctic minke whales in the south block of the east south stratum in Area V. This trial was unsuccessful because of leaking air from the air gun.

Biological research

Biological research was conducted on the research base ship for all whales sampled (235 males, 205 females). Table 5 summarized data and samples collected.

Products

All the whales collected were processed on NM after biological survey was completed, according to the provisions of Article VIII of the Convention. A total of 1,848 tons of meat, blubber, viscera, etc. was produced.

Preliminary analyses of biological information

Sex ratio and reproductive status

Table 7 and Fig. 7 showed the reproductive status of all samples by each stratum. Because histological examination has not been done yet, maturity of males was tentatively determined by testis weight according to Kato (1986), i.e., testis over than 400g were determined to be mature while others were classified as immature. Maturity of female was determined by existence of corpus luteum or albicans in ovaries.

Mature females were dominant in the East-South stratum (68.6%), whereas mature males were dominant in the North strata (52.8% in East and 61.3% in West) in Area V and Area VIW (40.9%). Pregnant females were most dominant in the south block of the East-South stratum (86.9%) and immature individual of both sexes was not sampled in this block. In the West-South stratum in Area V, mature animals dominated and immature male were not collected. Pregnant females were 128 individuals in the whole research areas and they had 131 fetuses including three pairs of twins (55 males and 60 females, unidentified 16 individuals).

Length composition

Table 8 showed mean body length of Antarctic minke whales collected in each stratum. Maximum length of the sample was 9.61m for male and 10.17m for female, minimum length was 4.94m and 5.03m, respectively.

DISCUSSION

Total sightings of Antarctic minke whales in this cruise were 2,677 schools and 7,290 individuals. This exceeded the recorded of 2,079 schools and 5,393 individuals in 2000/2001. This cruise recorded highest sightings among the previous JARPA cruises.

The characteristics of 2000/2001 cruise are as followings (Nishiwaki *et al.* 2001): 1) Antarctic minke whales were widely distributed in the strata in the western part of Area VI and the eastern part of Area V and 2) A high surface water temperature ranged from 1°C to 4°C was recorded in the western part of Area V. Total sightings of Antarctic minke whales in the Area VIW and the eastern part of Area V accounted for 80% of total sightings. The density in the north stratum was the highest among previous JARPA surveys. The surface water temperature from 1°C to 4°C was widely distributed over the west strata in Area V. Also, 1°C in the surface water temperature was confirmed near the ice edge. Many sightings were unevenly distributed in the southern side of the strata. Antarctic minke whales in these strata were most dominant species. However, density of these sighting was remarkably low compared with other strata. On the contrary, the density of the dwarf form minke whales excelled that of the Antarctic minke whales in the northern part of the West-North stratum. It was highest sightings among the past JARPA surveys. These sightings concentrated in the West-North stratum in the Area V.

The sea surface temperature in the northern part of the West-North stratum of Area V was remarkably high compared with the other strata. In this area, the sightings of the Antarctic minke whale were very few. In addition, humpback and fin whales and hourglass dolphin, southern bottlenose and long-finned pilot whales of toothed whales were widely distributed near the ice edge in the western strata of Area V.

In this cruise, total sightings of Antarctic minke whales in the East-South stratum and the West strata in Area V accounted for 83% of all sightings. The density of Antarctic minke whales was remarkably high and they were widely distributed in entire strata except East-North stratum in V and VIW areas. Especially, density of the west strata in area V was the highest among the past JARPA cruises. A high surface water temperature (the range from 1°C to 4°C) was locally distributed north of the West-North stratum in the Area V.

Results in 2000/2001 cruise suggest that Antarctic minke whales could avoid a high surface water temperature. The distribution pattern of the Antarctic minke whales in the West-North stratum in 2000/2001 cruise was different from previous JARPA cruises because of high water temperature. It was indicated that results in 2002/2003 cruise was consistent with the past cruises except 2000/2001 cruise. It might be suggested that yearly fluctuation of existence of high water temperature affect the distribution and density of Antarctic minke whales.

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Table1. Outline of the research activities

Event	Date	Vessels
Departure from Japan	8 November 2002	NM, SV and SSVs
Low and middle latitudinal sighting survey in transit area	26 November-2 December 2002	SV
	25 November-1 December 2002	SSVs
Sighting and sampling survey in Area VIW	3 December-30 December 2002	SV
	2 December 2002-1 January 2003	SSVs
Sighting and sampling survey in the East-north stratum in Area V	5 January-25 January 2003	SV
	4 January-26 January 2003	SSVs
Sighting and sampling survey in the East-south stratum in Area V	27 January-9 February 2003	SV and SSVs
	27 January-7 February 2003	SV
Sighting and sampling survey in the West-north stratum in Area V	11 February-20 February 2003	SV
	11 February-21 February 2003	SSVs
	5 March-7 March 2003	SV
Sighting and sampling survey in the West-south stratum in Area V	21 February-5 March 2003	SV
	5 March-8 March 2003	SSVs
Low and middle latitudinal sighting survey in transit area	9 March-16 March 2003	SV
	10 March-16 March 2003	SSVs
Arrive in Japan	3 April 2003	NM, SV and SSVs

Table2. Searching distances (n.miles) of one sighting vessel (SV) and three sighting / sampling vessels (SSVs) in each stratum.

Area	Stratum	Block	SV			SSVs			Grand Total	
			Closing	Passing	Sub Total	Closing	Passing	Sub Total		
VI	West	North	52.1	347.5	399.6	1260.3	0.0	1260.3	1659.9	
		South	302.6	792.7	1095.3	3138.0	57.0	3195.0	4290.3	
Sub Total			354.7	1140.2	1494.9	4398.3	57.0	4455.3	5950.2	
V	East-North	North	268.2	719.4	987.6	2880.5	30.1	2910.6	3898.2	
		South	140.1	346.3	486.4	692.5	0.0	692.5	1178.9	
	Sub Total			408.3	1065.7	1474.0	3573.0	30.1	3603.1	5077.1
	East-South	North	113.6	410.1	523.7	513.7	524.7	1038.4	1562.1	
		South	34.7	293.9	328.6	221.2	0.0	221.2	549.8	
	Sub Total			148.3	704.0	852.3	734.9	524.7	1259.6	2111.9
West-North			183.3	714.8	898.1	1837.6	41.5	1879.1	2772.2	
West-South			203.0	491.2	694.2	764.1	751.5	1515.6	2209.8	
Sub Total			942.9	2975.7	3918.6	6909.6	1347.8	8257.4	12176.0	
Grand Total			1297.6	4115.9	5413.5	11307.9	1404.8	12712.7	18126.2	

Table 3-a. Summary of whale sightings conducted by SV and SSVs in western part of Area VI.

Species	SV						SSVs					
	North block		South block		Total		North block		South block		Total	
	Prim.	Sec.	Prim.	Sec.	Prim.	Sec.	Prim.	Sec.	Prim.	Sec.	Prim.	Sec.
Antarctic minke whale	8/15		28/49	3/4	36/64	3/4	30/43		100/113	5/5	130/156	5/5
Like minke whale	2/2		4/4		6/6				4/4		4/4	
Blue whale			1/3		1/3					1/1		1/1
Fin whale	2/3				2/3		4/7		3/3		7/10	
Sei whale	1/1				1/1							
Humpback whale	9/13		4/8		13/21		20/28	3/6	19/28	2/3	39/56	5/9
Unidentified baleen whale	3/5		5/23		8/28		2/2		9/13	1/1	11/15	1/1
Sperm whale	5/6		7/7		12/13		1/1	1/1	8/8		9/9	1/1
Killer whale	1/5		1/5	1/6	2/10	1/6	1/20		5/66		6/86	
Gray's beaked whale							3/8		1/3		4/11	
Mesoplodon sp.							1/1	1/3			1/1	1/3
Southern bottlenose whale	1/3		5/9		6/12		8/17		21/36	2/3	29/53	2/3
Ziphiid	1/1				1/1		14/21		23/27	1/1	37/48	1/1
Unidentified cetaceans	2/2		7/8		9/10		12/12		33/33		45/45	

Table 3-b. Summary of whale sightings conducted by SV and SSVs in east part of Area V.

Area V East-North stratum												
Species	SV						SSV					
	North block		South block		Total		North block		South block		Total	
	Prim.	Sec.	Prim.	Sec.	Prim.	Sec.	Prim.	Sec.	Prim.	Sec.	Prim.	Sec.
Antarctic minke whale	36/55	1/1	25/34	6/6	61/89	7/7	104/200	2/4	42/80		146/280	2/4
Dwarf minke whale							3/3				3/3	
Like minke whale	1/1		1/1		2/2		3/3		1/1		4/4	
Blue whale			2/5		2/5				2/2		2/2	
Fin whale							3/4		1/1		4/5	
Humpback whale	8/13		10/21	1/3	18/34	1/3	27/40	2/6	14/25		41/65	2/6
Unidentified baleen whale	1/1		1/2	1/2	2/3	1/2	11/13	1/1	6/8		17/21	1/1
Sperm whale	5/5	1/1	5/5		10/10	1/1	13/13	1/1	18/18		31/31	1/1
Hourglass dolphin	3/8				3/8		4/13				4/13	
Killer whale	2/10		4/91		6/101		7/119		8/74		15/193	
Long-finned pilot whale	1/8				1/8		8/290	1/25			8/290	1/25
Unidentified dolphin							1/3				1/3	
Arnoux's beaked whale	1/15				1/15		1/10				1/10	
Strap-toothed beaked whale							1/2				1/2	
Gray's beaked whale							1/3				1/3	
Southern bottlenose whale	4/8		1/1		5/9		15/18		8/13	1/3	23/31	1/3
Ziphiid	1/1		1/1		2/2		32/44		7/9		39/53	
Unidentified cetaceans	3/7		1/2		4/9		40/40		13/13		53/53	

Area V East-South stratum												
Species	SV						SSV					
	North block		South block		Total		North block		South block		Total	
	Prim.	Sec.	Prim.	Sec.	Prim.	Sec.	Prim.	Sec.	Prim.	Sec.	Prim.	Sec.
Antarctic minke whale	150/310	13/102	261/598	20/61	411/908	33/163	181/384	14/17	441/1230	62/225	622/1614	76/242
Like minke whale	2/2		1/1		3/3		2/2				2/2	
Blue whale		2/4			2/4			1/1			1/1	
Humpback whale	1/1				1/1		2/3	1/1			2/3	1/1
Unidentified baleen whale	4/6		5/22		9/28			1/1			1/1	
Sperm whale	16/16				16/16		40/40	1/1			40/40	1/1
Killer whale	6/235	1/20			6/235	1/20	10/107	1/30		2/26	10/107	3/56
Southern bottlenose whale	3/8				3/8		1/1				1/1	
Ziphiid							1/2				1/2	
Unidentified cetaceans	4/4	1/1			4/4	1/1	2/2				2/2	

Table 3-c. Summary of whale sightings conducted by SV and SSVs in western part of Area V.

Species	Area V West-North stratum				Area V West-South stratum			
	SV		SSVs		SV		SSVs	
	Prim.	Sec.	Prim.	Sec.	Prim.	Sec.	Prim.	Sec.
Antarctic minke whale	108/255	3/7	117/253	18/27	258/751	12/40	531/2161	52/199
Dwarf minke whale			3/3					
Like minke whale	8/11		4/5				4/6	
Southern right whale								3/3
Fin whale	9/49		16/33	3/8	12/113	1/5	2/3	
Sei whale	1/1		4/7				2/5	
Humpback whale	6/10	1/4	6/7	1/2	4/6	1/2	15/25	
Unidentified baleen whale	10/27		19/32	6/8	16/69		14/36	
Sperm whale	1/1		1/1		2/2		6/6	1/1
Hourglass dolphin	5/55		11/68	3/27	2/28		3/16	
Killer whale	1/3		7/36	2/19	1/16	1/30	9/166	1/15
Long-finned pilot whale	1/50	1/3	2/70					
Unidentified dolphin					2/6			
Arnoux's beaked whale								1/7
Mesoplodon sp.			1/2				1/2	
Southern bottlenose whale	3/7		16/25				11/22	
Ziphiid	2/3		16/23		4/6	1/4	11/16	
Unidentified cetaceans	5/5		28/29		3/6		13/13	

Table 4. Density indices (DI), schools per 100 n.miles) and mean school size (MSS) of Antarctic minke whale primary sightings by SV and SSVs.

Stratum	Block	Ser. Dist. (n.mile)	SV				SSV				
			Sch	Ind.	DI	MSS	Ser. Dist. (n.mile)	Sch	Ind.	DI	MSS
West	North	399.6	8	15	2.00	1.88	1260.3	30	43	2.38	1.43
	South	1095.3	28	49	2.56	1.75	3195.0	100	113	3.13	1.13
		1494.9	36	64	2.41	1.78	4455.3	130	156	2.92	1.20
East-North	North	987.6	36	55	3.65	1.53	2910.6	104	200	3.57	1.92
	South	486.4	25	34	5.14	1.36	692.5	42	80	6.06	1.90
Sub Total		1474.0	61	89	4.14	1.46	3603.1	146	280	4.05	1.92
East-South	North	523.7	150	310	28.64	2.07	1038.4	181	384	17.43	2.12
	South	328.6	261	598	79.43	2.29	221.2	441	1230	199.37	2.79
Sub Total		852.3	411	908	48.22	2.21	1259.6	622	1614	49.38	2.59
West-North		898.1	108	255	12.03	2.36	1879.1	117	253	6.23	2.16
West-South		694.2	258	751	37.17	2.91	1515.6	531	2161	35.04	4.07

Table 5a. Summary of photo-ID and biopsy sampling. B, FIN, HPR represent blue, fin, humpback, right whales respectively.

Photo ID						
Species	Area VI West	Stratum				Total
		Area V				
		East-North	West-North	East-South	West-South	
Southern right whale					3	3
Blue whale	1	2				3
Humpback whale		3	6		5	14

Biopsy samples						
Species	Area VI West	Stratum				Total
		Area V				
		East-North	West-North	East-South	West-South	
Antarctic minke whale					1	1
Southern right whale					2	2
Fin whale			6			6
Sei whale					1	1
Humpback whale		1	5		4	10
Sperm whale				1		1
Killer whale					1	1
Carcass of unidentified cetacean					1	1

Table 5b. Summary of oceanographic and acoustic survey.

Stratum	CTD	XCTD	EPCS		Quantitative echo sounder	Sonobouy recording
	KS2	KS2	YS2	KS2	KS2	KS2
	Stations	Stations	Days	Days	Days	Stations
Area IV West	22	-	33	30	30	3
Area V						
East-North	18	37	22	22	22	1
East-South	8	24	15	14	13	1
West-North	10	20	11	13	13	
West-South	8	20	15	10	10	
Total	66	101	96	89	88	5

Table 6. Summary of biological data and samples collected

Samples and data	Number of whales		
	Male	Female	Total
-Data-			
Photographic record of external character	235	205	440
Body length and sex identification	235	205	440
Measurement of external body proportion	235	205	440
Body weight	235	205	440
Body weight by total weight of parts	35	35	70
Skull measurement (length and breadth)	226	200	426
Standard measurement of blubber thickness (five points)	235	205	440
Detailed measurement of blubber thickness (fourteen points)	35	34	69
Mammary gland; lactation status and measurement	-	205	205
Breadth measurement of uterine horn	-	205	205
Testis and epididymis weight	235	-	235
Weight of stomach content in each compartment	235	205	440
Photographic record of fetus	55	60	131*
Fetal length and weight	55	56	123*
External measurements of fetus	54**	57**	111
Number of ribs	235	205	440
-Sample-			
Diatom film record and sampling	235	205	440
Serum sample for physiological study	235		235
Earplug for age determination	235	205	440
Earplug for chemical analysis (one of the pair)	9	9	18
Tympanic bone for age determination	235	205	440
Largest baleen plate for age determination	42	55	97
Largest baleen plate for morphologic study	234	205	439
Vertebral epiphyses sample	235	205	440
Ovary	-	205	205
Histological sample of endometrium	-	205	205
Histological sample of mammary gland	-	205	205
Milk sample for chemical analysis	-	1	1
Histological sample of testis	235	-	235
Histological sample of epididymis	235	-	235
Testis and epididymis stamp smear for sperm detection	235	-	235
Skin, blubber, muscle, liver, kidney and heart tissues for genetic study	235	205	440
Muscle, liver and kidney tissues for heavy metal analysis	235	205	440
Blubber and liver tissues for organochlorine analysis	235	205	440
Muscle, liver and blubber tissues for lipid analysis	35	33	68
Stomach contents for food and feeding study	55	39	94
Stomach contents for heavy metal analysis	12	14	26
Stomach contents for organochlorine analysis	9	11	20
Stomach contents for lipid analysis	13	15	28
External parasites	51	41	92
Internal parasites	45	25	70
Fetus	-	-	9
Fetal skin, blubber, muscle, liver, kidney and heart tissues for genetic study	57***	58	115
Oocyte for in-vitro fertilization (IVF)		118	118
Fetal serum for culture	10	9	19
Fetal skin for cell culture	4	10	14
Follicular fluid for culture	10	14	24
Placenta for immunohistochemical study	42	48	90
Fetal Humerus for histological study	12	12	24
Fetal liver, kidney and spleen for histological study	9	7	16
Liver, kidney and spleen for histological study	1	2	3
Marine debris	3	1	4

* : including a fetus of sex unidentified.

** : Since a fetus was broken by harpoon, external measurement was partly done.

*** : including a partly broken fetus whose skin, blubber, muscle, kidney and heart.

Table 7. Reproductive status of Antarctic minke whales collected. Numbers in parenthesis represent ratio of samples in each stratum (%). Maturity of males was tentatively defined by testis weight according to Kato (1986). "Resting" represents non-pregnant mature female without corpus luteum. "Preg+Lac" represents pregnant and lactating female and "Ovulating" represents female, which had corpus luteum, but fetus was not observed.

Areas	Stratum	Blocks	Male			Female				Total	
			Immature	Mature	Total	Immature	Mature				
							Pregnant	Resting	Preg.+Lac		Ovulating
Area VI	West	North	9 (33.3)	11 (40.7)	20 (74.1)	5 (18.5)	2 (7.4)	0 (0.0)	0 (0.0)	0 (0.0)	7 (25.9)
		South	13 (15.7)	34 (41)	47 (56.6)	27 (32.5)	8 (9.6)	0 (0.0)	1 (1.2)	0 (0.0)	36 (43.4)
		Combined	22 (20.0)	45 (40.9)	67 (60.9)	32 (29.1)	10 (9.1)	0 (0.0)	1 (0.9)	0 (0.0)	43 (39.1)
Area V	East-North	North	19 (19.4)	53 (54.1)	72 (73.5)	17 (17.3)	9 (9.2)	0 (0.0)	0 (0.0)	0 (0.0)	26 (26.5)
		South	6 (22.2)	13 (48.1)	19 (70.4)	5 (18.5)	3 (11.1)	0 (0.0)	0 (0.0)	0 (0.0)	8 (29.6)
		Combined	25 (20.0)	66 (52.8)	91 (72.8)	22 (17.6)	12 (9.6)	0 (0.0)	0 (0.0)	0 (0.0)	34 (27.2)
	East-South	North	6 (13.6)	12 (27.3)	18 (40.9)	10 (22.7)	16 (36.4)	0 (0.0)	0 (0.0)	0 (0.0)	26 (59.1)
		South	0 (0.0)	5 (8.2)	5 (8.2)	0 (0.0)	53 (86.9)	3 (4.9)	0 (0.0)	0 (0.0)	56 (91.8)
		Combined	6 (5.7)	17 (16.2)	23 (21.9)	10 (9.5)	69 (65.7)	3 (2.9)	0 (0.0)	0 (0.0)	82 (78.1)
	West-North	North	6 (19.4)	19 (61.3)	25 (80.6)	3 (9.7)	3 (9.7)	0 (0.0)	0 (0.0)	0 (0.0)	6 (19.4)
		South	0 (0.0)	29 (42.0)	29 (42.0)	7 (10.1)	33 (47.8)	0 (0.0)	0 (0.0)	0 (0.0)	40 (58.0)
	West-South	North	6 (11.2)	19 (39.7)	25 (50.9)	3 (12.7)	3 (35.5)	0 (0.9)	0 (0.0)	0 (0.0)	6 (49.1)
		South	0 (0.0)	29 (42.0)	29 (42.0)	7 (10.1)	33 (47.8)	0 (0.0)	0 (0.0)	0 (0.0)	40 (58.0)
	Combined	North	37 (11.2)	131 (39.7)	168 (50.9)	42 (12.7)	117 (35.5)	3 (0.9)	0 (0.0)	0 (0.0)	162 (49.1)
		South	0 (0.0)	29 (42.0)	29 (42.0)	7 (10.1)	33 (47.8)	0 (0.0)	0 (0.0)	0 (0.0)	40 (58.0)
Grand total		59 (13.4)	176 (40.0)	235 (53.4)	74 (16.8)	127 (28.9)	3 (0.7)	1 (0.2)	0 (0.0)	205 (46.6)	

Table 8. Mean body length (m) with standard deviation and body length range of Antarctic minke whales collected in each stratum. Maturity of males was defined as Table 7.

Areas	Stratum	Male			Female		
		Immature	Mature	Total	Immature	Mature	Total
Area VIW		6.22 ± 0.82 (5.05 - 7.56)	8.24 ± 0.44 (7.47 - 9.61)	7.58 ± 1.12 (5.05 - 9.61)	6.29 ± 0.82 (5.12 - 7.85)	8.80 ± 0.38 (8.13 - 9.28)	6.93 ± 1.32 (5.12 - 9.28)
Area V							
	East-North	6.65 ± 0.87 (4.94 - 8.37)	8.34 ± 0.39 (7.42 - 9.49)	7.88 ± 0.94 (4.94 - 9.49)	6.25 ± 0.96 (5.03 - 8.21)	8.73 ± 0.38 (8.14 - 9.63)	7.13 ± 1.43 (5.03 - 9.63)
	East-South	6.94 ± 0.87 (5.15 - 7.69)	8.28 ± 0.33 (7.84 - 8.95)	7.93 ± 0.79 (5.15 - 8.95)	7.25 ± 0.62 (5.66 - 8.15)	8.77 ± 0.40 (7.57 - 10.17)	8.59 ± 0.66 (5.66 - 10.17)
	West-North	6.33 ± 0.82 (5.51 - 7.92)	8.39 ± 0.30 (7.67 - 8.94)	7.90 ± 1.00 (5.51 - 8.94)	7.05 ± 0.50 (6.61 - 7.75)	9.24 ± 0.08 (9.15 - 9.34)	8.15 ± 1.15 (6.61 - 9.34)
	West-South	-	8.40 ± 0.43 (7.48 - 9.20)	8.40 ± 0.43 (7.48 - 9.20)	7.22 ± 0.77 (5.81 - 8.10)	8.94 ± 0.38 (8.02 - 9.54)	8.64 ± 0.81 (5.81 - 9.54)
	Combined	6.65 ± 0.88 (4.94 - 8.37)	8.36 ± 0.38 (7.42 - 9.49)	7.98 ± 0.89 (4.94 - 9.49)	6.71 ± 0.96 (5.03 - 8.21)	8.83 ± 0.40 (7.57 - 10.17)	8.28 ± 1.10 (5.03 - 10.17)
Grand total		6.52 ± 0.88 (4.94 - 8.37)	8.31 ± 0.39 (7.42 - 9.61)	7.81 ± 0.99 (4.94 - 9.61)	6.45 ± 0.92 (5.03 - 8.21)	8.78 ± 0.40 (7.57 - 10.17)	7.84 ± 1.32 (5.03 - 10.17)

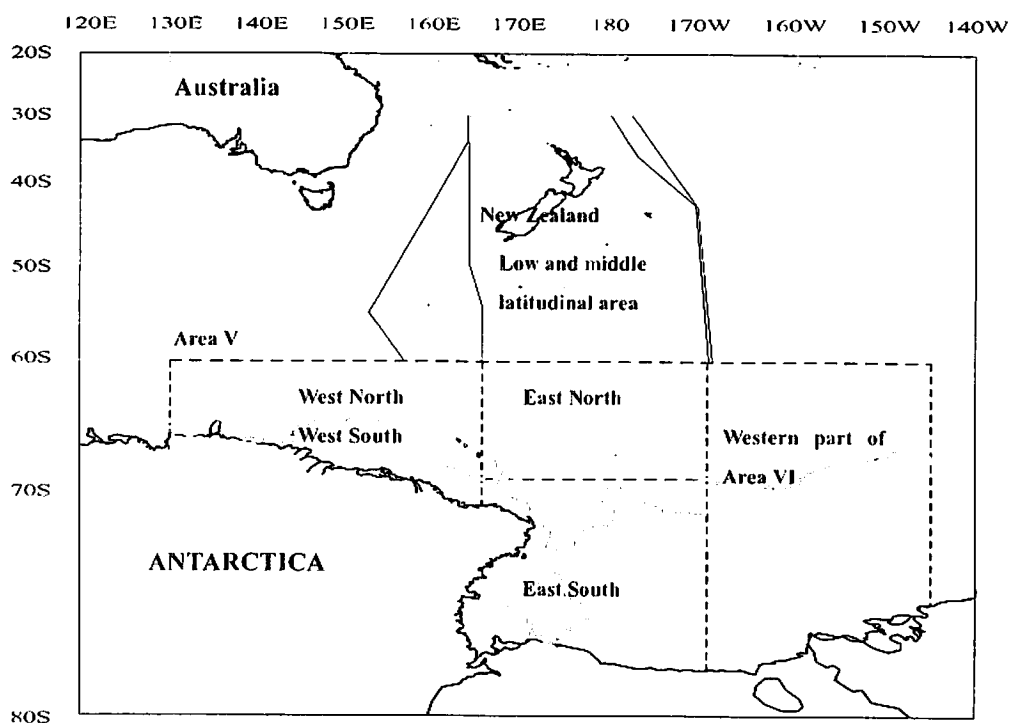


Fig. 1. Geographic location of research area of the 2002/2003 JARPA surveys.

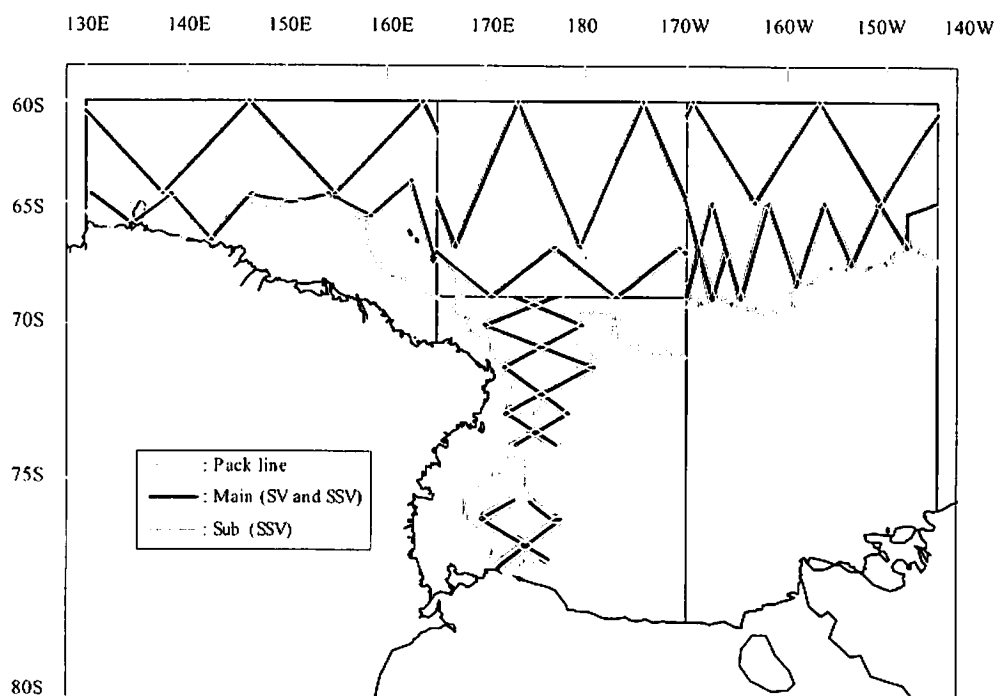


Fig. 2. Cruise track line of sighting vessel and sighting / sampling vessels in 2002/2003 JARPA. Pack ice lines are estimated by observation of research vessels and the information from Near real-time DMSP SSM / I daily polar gridded sea ice concentrations data set available from the National Snow and Ice Center (NSIDC, Cavalieri *et al.* 1999), US.

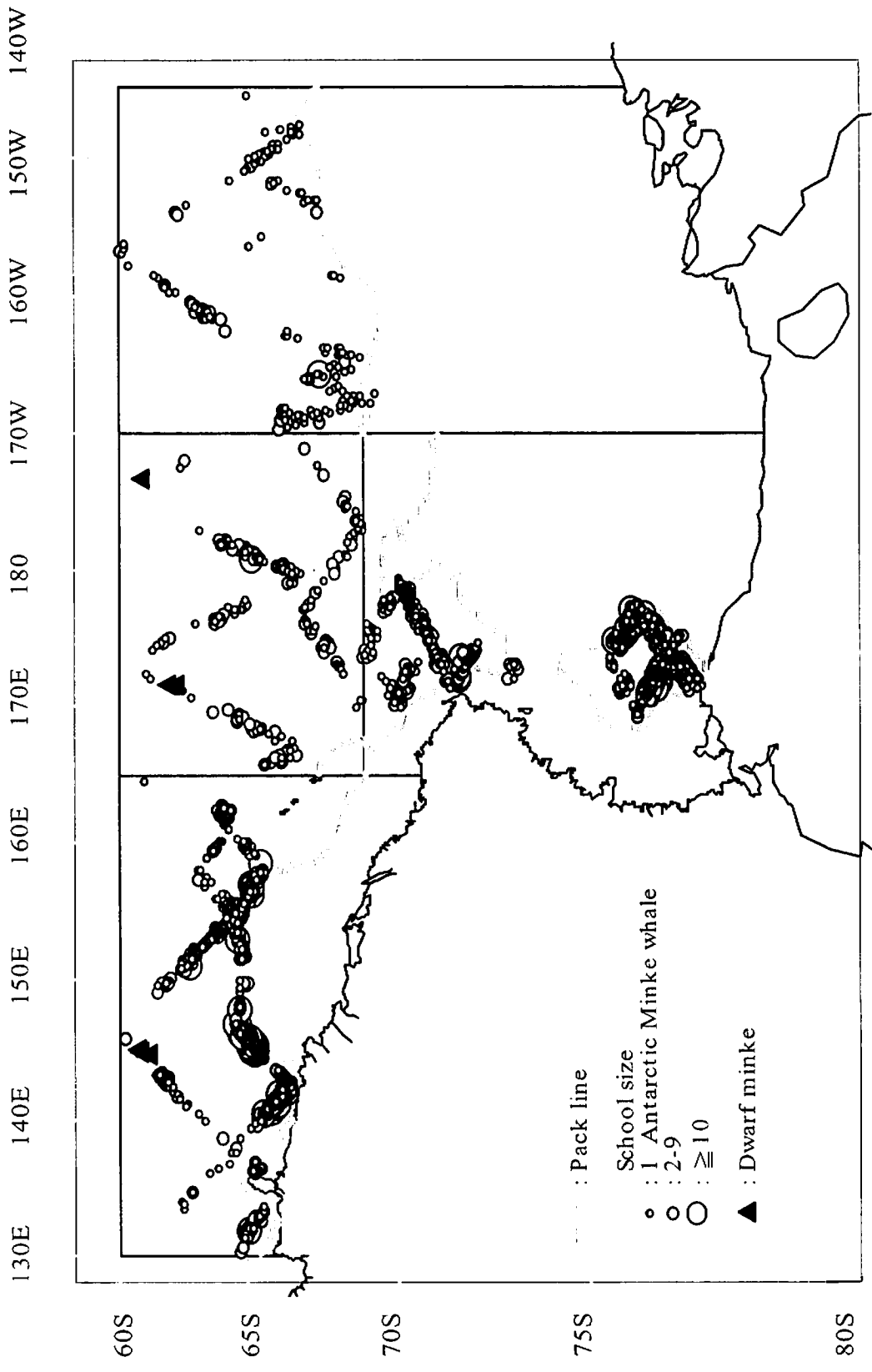


Fig. 3. Distribution of primary sightings of Antarctic minke whales sighted by SV and SSVs in 2002 / 2003 JARPA.

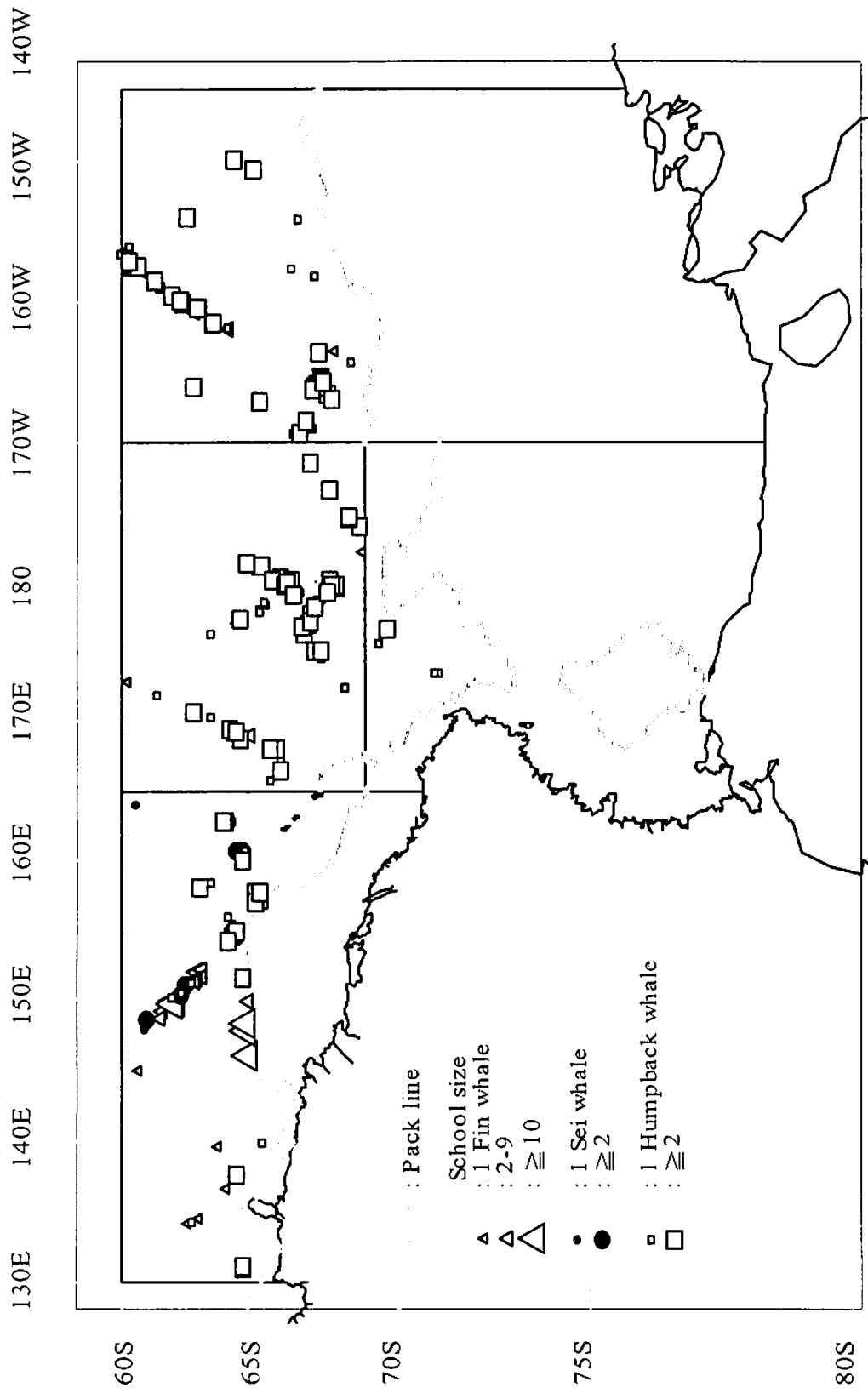


Fig. 4. Distribution of primary sightings of fin and humpback whales sighted by SV and SSVs in 2000/2001 JARPA.

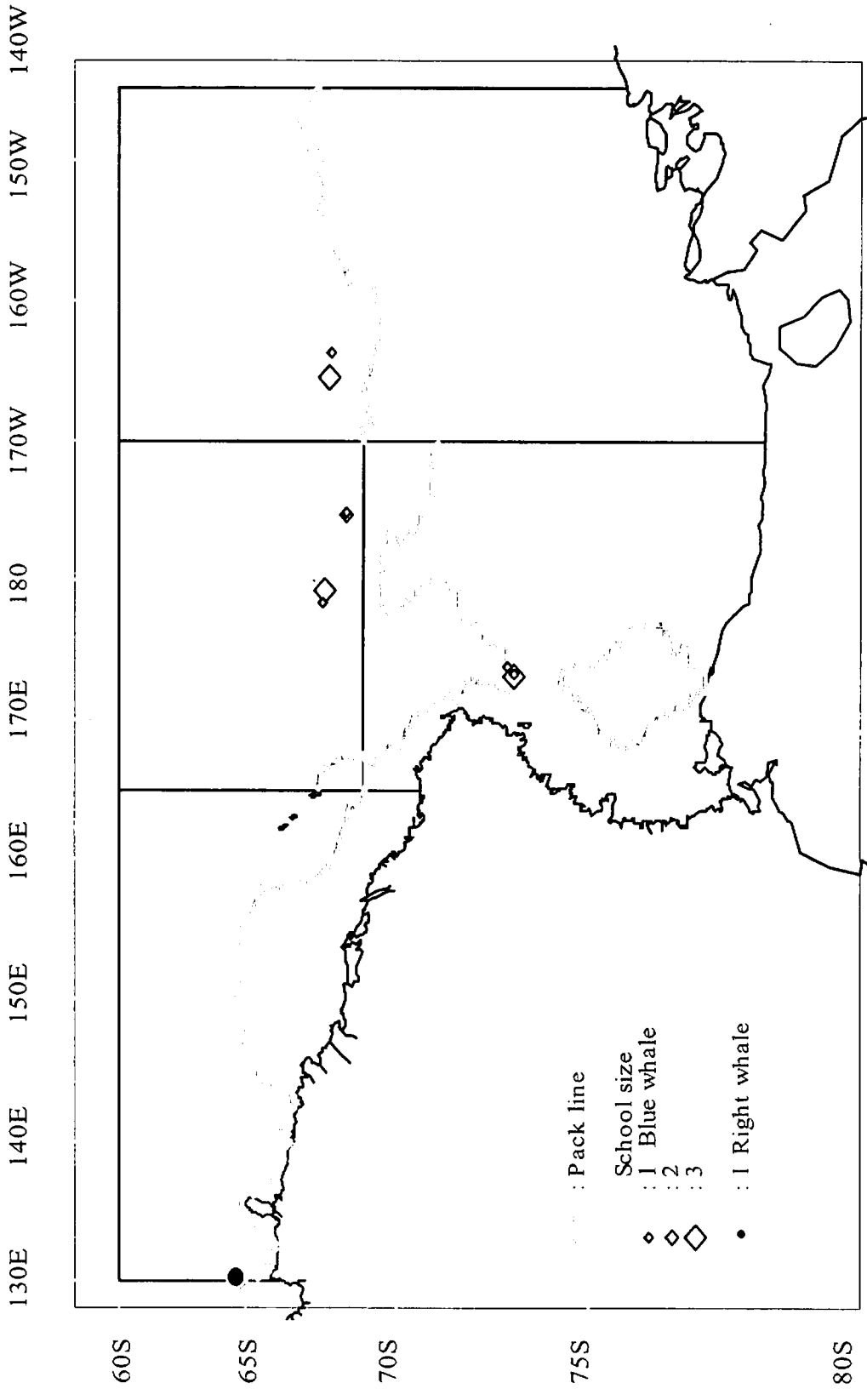


Fig. 5. Distribution of primary sighting of blue and southern right whales sighted by SV and SSVs in 2000/2001 JARPA.

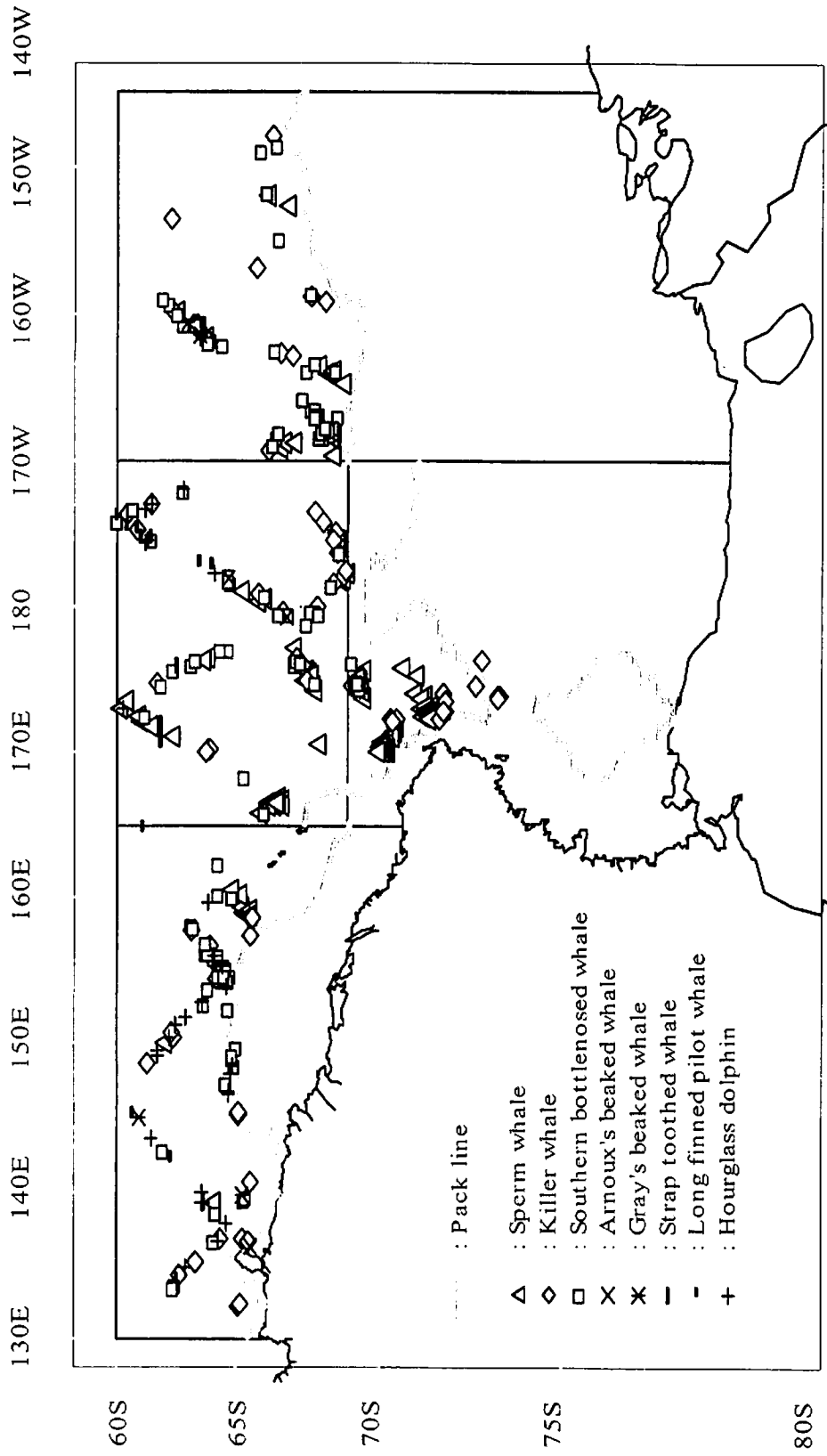


Fig. 6. Distribution of primary sightings of toothed whales sighted by SV and SSVs in 1999/2000 JARPA.

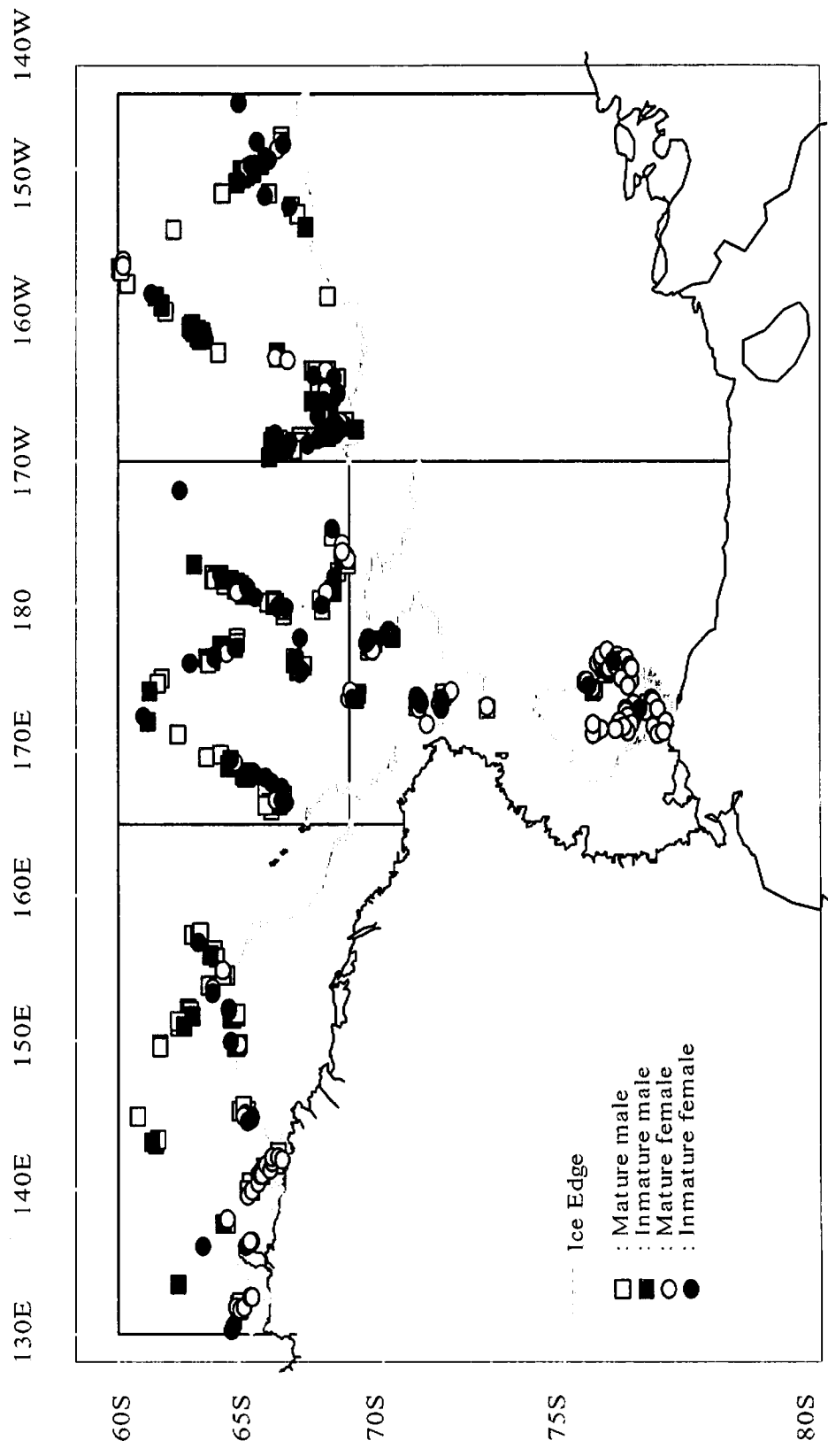


Fig. 7. Sighted position of sampled Antarctic minke whales by sex and reproductive status in 2000/2001 JARPA.