

Cruise Report of the Japanese Whale Research Program under Special Permit in the Antarctic (JARPA) Area V and Western Part of Area VI in 2000/2001

Shigetoshi Nishiwaki¹⁾, Hajime Ishikawa¹⁾, Hidenori Narita²⁾, Seiji Otani³⁾, Hiroshi Kiwada¹⁾, Tatsuya Kariya¹⁾, Isamu Yoshimura¹⁾, Tohru Takamatsu¹⁾, Takuya Teraoka¹⁾, Masataka Shiozaki³⁾, Norihito Abe³⁾, Shinsuke Okamura⁴⁾, Kunihiro Yasui³⁾, Masakatsu Mori³⁾

Contact e-mail: nisiwaki@i-cetacean-r.or.jp

1) *The Institute of Cetacean Research, 4 – 18 Toyomi-cho, Chuo-ku, Tokyo 104-0055 Japan.*

2) *Kyodo Senpaku Kaisya, Ltd., Higasi-Nihonbashi 2-8-3, 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, School of Marine Science and Technology, Tokai University, Shimizu city Shizuoka, 424-0902 Japan.*

ABSTRACT

The fourteenth Japanese Whale Research Program under Special Permit in the Antarctic (JARPA) was conducted in Area V and western part of Area VI (Area VIW) from 11 December 2000 to 20 March 2001. One sighting vessel (SV), three sighting/sampling vessels (SSVs) and one research base ship were engaged in the research. The SV covered 5,941.6 n.miles, and made primary sightings of 583 schools/1,988 individual Antarctic minke whales. Three SSVs searched a total of 14,542.5 n.miles and sighted 1,298 schools/2,915 individual Antarctic minke whales as primary sightings. Minke whale was the most dominant species in both Areas VIW and V. Antarctic minke whales were widely distributed in the whole research area. Sightings were concentrated, however, in the East-South stratum of the Area V and a part of near the pack ice. Dwarf form minke whales of 27 schools/ 27 individuals were sighted. It was the highest number of sightings through the previous JARPA surveys. Sightings of dwarf form minke whales were concentrated on the West-North stratum in the Area V, and the sea surface temperature of this stratum was remarkably compared with the other strata. In this area, the sightings of the Antarctic minke whale were very few and the dwarf form minke whales were abundant. Other baleen whales sighted were blue, fin, sei, humpback and right whales. The greater part of these sighting was for humpback and fin whales. These two species were widely dispersed in the research areas except on the East-South and West-North strata in Area V. Blue whales of 15 schools/25 individuals were sighted in the Area V. The greater part of these sightings was limited in offshore from the ice edge at the eastern edge of the East-North stratum and the center of the East-South stratum (Ross Sea). For toothed whales, sperm and southern bottlenose whales were widely distributed in the whole research area except the East-South stratum. Killer whales were widely distributed in the research areas. The distribution pattern of this species was similar to that of Antarctic minke whales. A total of 477 Antarctic minke whales were targeted for sampling resulting in the catch of 440 individuals (110 from Area VIW, 330 from Area V). A "Feasibility Study of Modification of Sampling Method" was conducted in the West-South stratum and the target schools for sampling were selected according to the predetermined interval for each school size category. A total of 49 biopsy samples were obtained from humpback, fin and blue whales by the SV and SSVs. The SV conducted an oceanographic survey using a passive acoustic system, Electric Particle Counting and Sizing System (EPCS), XCTD and CTD. One of the SSVs also conducted an oceanographic survey using EPCS and CTD.

KEYWORDS: JARPA, CRUISE REPORT, ANTARCTIC MINKE WHALE

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 is 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 (*Balanoptera 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 Antarctic minke whales sampled 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 possible another stock (Pastene and Goto, 1997). 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 2000/2001 JARPA was submitted to the 52nd Annual Meeting of the International Whaling Commission and the Scientific Committee (IWC/SC) meeting (Government of Japan, 2000). 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 research, the research was planned with special reference to elucidation of western stock distribution pattern.

This paper reports on the fourteenth cruise of JARPA, which was conducted from 11 December 2000 to 19 March 2001 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

Three vessels, Yushin Maru (YS1; 720GT), Kyo Maru No.1 (K01; 812.08GT) and Toshi Maru No.25 (T25; 739.92GT) were engaged in sighting and sampling surveys (sighting / sampling vessels; SSVs). Nisshin Maru (NM; 7,575GT) served as a research base on which all biological examinations of collected samples were conducted. Kyoshin Maru No.2 (KS2; 368GT) was dedicated to sighting survey from which most of all experiments were conducted (sighting vessel; SV).

Cruise track line and 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 research (Nishiwaki *et al.* 1997 and 1999). A zigzag line was used both in the western part of Area VI and all strata in entire Area V except for the west-south stratum. In this stratum, the track line was zigzagged from north to south at interval of four degree's longitudes. The sighting information was collected on the set track line during transit and experiment.

Sighting and sampling procedures were 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). Three SSVs advanced along parallel track lines 7n.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, humpback, right, pigmy right, fin, sperm, killer, long-finned pilot and southern bottlenose whales for conducting some experiments. The SSVs also approached blue whales and right whales for experiments. One Antarctic minke whale was sampled randomly from each primary sighted school within 3 n.miles of the track line. This sampling manner was changed during the Feasibility Study of Modification of Sampling Method (see the paragraph of Experiments). The dwarf form minke whale was not a target for sampling.

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

Following experiments were conducted

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 in this cruise.

Photo-identification experiment

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

Biopsy sampling

The species targeted for the photo-identification experiment and pygmy right whales, fin whales, sperm whales, southern bottlenose whales, killer whales, long-finned pilot whales were also targeted for biopsy skin sampling using air guns (ICR guns) by the SV. SSVs also tried biopsy sampling using compound-crossbow. All collected sample were preserved at -80c.

Satellite tagging experiment

Attempts to attach satellite tags to some species were made by SV in order to elucidate migration routes.

Oceanographic survey

SV conducted the following oceanographic survey: 1) hydro-acoustic survey using a passive acoustic system (EK500 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 and 4) marine debris recording in the research area. YS1 conducted CTD and EPCS survey. All marine debris found in the stomach of Antarctic minke whales was recorded and collected on NM.

Feasibility Study of Modification of Sampling Method (S-experiment)

During the 49th IWC/SC meeting, modification of the sighting and sampling method of JARPA was proposed (Schweder, 1998). Japan decided to conduct a limited scale feasibility study on whether the modified method was workable or not (Government of Japan, 1999). The feasibility study (S-experiment) was conducted in the West-south stratum in Area V. During the S-experiment period, all SSVs stayed at the point where the survey of the day was finished until next day. Different from the ordinal research manner, they never moved forward during night or in bad weather condition. Target school for sample was selected according to the predetermined interval for each school size category. One or two individuals were collected from the targeted school. Eighteen days were allocated for the S-experiment.

Biological research

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

OUTLINE OF THE RESEARCH ACTIVITIES

An outline of the research activities conducted during the 2000/2001 JARPA survey is as follows:

Event	Date	Vessels
Departure from Japan	17 November 2000	NM, SV and SSVs
Sighting survey in transit area	3 December-10 December 2000	
Sighting and sampling survey in Area VIW	11 December-31 December 2000	SV
	11 December 2000-1 January 2001	SSVs
Sighting and sampling survey in the East-north stratum in Area V	1 January-23 January 2001	SV
	2 January-23 January 2001	SSVs
Sighting and sampling survey in the East-south stratum in Area V	24 January-9 February 2001	SV and SSVs
Sighting and sampling survey in the West-north stratum in Area V	10 February-23 February 2001	SV
	10 February-25 February 2001	SSVs
Sighting and sampling survey in the West-south stratum in Area V	25 February-19 March 2001	SV
	26 February-20 March 2001	SSVs
Sighting survey in transit area	21 March-27 March 2001	SV and SSVs
Arrival at Japan	9 April 2001	YS1
	11 April 2001	NM, K01 and T25
	12 April 2001	KS2

RESULTS

Searching effort

Table 1 shows the searching distance (n.miles) by each stratum. The SV covered 5,941.6 n.miles and three SSVs covered an average of 4,847.5 n.miles each. In 99 days of research period, total searching distance of one SV and three SSVs was 20,484.1 n.miles (Area VIW; 5,366.0 n.miles, Area V; 15,118.1 n.miles). Total searching distance in Area VIW was less than half of that searched in the previous JARPA in 1996/97. Because of fewer planned research days than previous research, a shorter search effort was planned. In addition to this, the weather condition during the research period was generally better and consequently samplings achieved earlier than planning. Consequently, it is caused by SSVs searching distance also became shorter.

In the entire research of Area V, the searching distance was longest through the previous JARPA in Area V. This is caused by the good weather condition throughout the research period. The SV conducted passing mode searching for six hours a day. The ratio of passing mode was 58.8% of total searching distance of the SV.

Whale species sighted

Table 2a to 2d summarize the sightings made. All sightings of the Antarctic minke whales were shown in Figure 3. Antarctic minke whale was the most dominant species in both Areas VIW and V. The total sightings of the Antarctic minke whales by the four research vessels were the primary sightings of 1881 schools/ 4903 individuals and the secondary sightings of 172 schools/ 443 individuals. Antarctic minke whales accounted for 61.5% of all the sightings. Antarctic minke whales were 111 individuals of 65 schools, merging together the primary and the secondary sightings. It was 3.1% of the sightings of Antarctic minke whale. Antarctic minke whales were widely distributed in the whole research area. The sighting concentrated, however, in the East-South stratum of the Area V and a part of near the pack ice.

Dwarf form minke whales were sighted primary sightings of 26 schools/ 26 individuals and the secondary sightings of one individual. Although it was only 1.3% of the Antarctic minke whale, it was largest sightings throughout the previous JARPA. 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 high in remarkably compared with the other strata. In this area, the sightings of the Antarctic minke whale were very few, but the dwarf form minke whales were abundantly sighted.

Sightings were followed by humpback whales (10.0%) and fin (6.0%) of the baleen whales, sperm (5.2%), killer (3.6%) and southern bottlenose whales (3.8%). The percentage in the brackets shows 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 except Antarctic minke whales sighted were five species, blue (3.1%), fin (35.1%), sei (2.2%), humpback (59.0%) and right whales (0.6%). The percentage in the brackets shows sighting composition of five species. The greater part of them was humpback and fin whales. The humpback and fin whales were widely distributed on the research areas except in the East-South and West-North strata in Area V (Fig 4). Blue whales were sighted 15 schools/25 individuals in the Area V. The most of these sightings was limited in offshore from the ice edge at the eastern edge of the East-North stratum and the center of the East-South stratum (Ross Sea, (Fig5)). For toothed whales, sperm and southern bottlenose whales were widely distributed in the whole research area except on the East-South stratum (Fig.6). Killer whales were widely distributed on the research areas. The distribution pattern of this species was similar to that of Antarctic minke whales (Fig. 6).

Table 3 shows density indices (DI; school sighted / 100 n.miles searching distance) and mean school size (MSS) of Antarctic minke whales in each stratum with the results of previous surveys. As for the Area VIW, there was no

substantial difference in the MSS. For the DI, higher values were shown in this season for both SV and SSVs. In the Area V, the DI in the southern strata is higher than the northern strata that are similar to the previous research. The highest value was observed in the eastern part of Area V throughout the previous surveys. On the other hand, the lowest value was shown in the West-North stratum. As for the MSS, there was no substantial difference among strata.

Sampling of Antarctic minke whale

Out of 1,268 schools/ 2,915 individual Antarctic minke whales sighted by SSVs, 477 schools/ 835 individuals were targeted for sampling. A total of 440 individuals were collected (110 from Area VIW, 330 from Area V, see Fig 7). Technical sampling efficiency (the rate of sampling for targeted individuals) was 0.92. The value was high compared with the previous JARPA surveys.

Of target individuals, 37 could not be taken. Nine individuals were missed because of their swimming activity (fast speed, long diving or quick mobility). Six individuals were canceled to sample because of bad chasing condition (foggy or sunset). Sampling was abandoned for 15 individuals because they escaped into the pack ice. Seven individuals were missed due to technical reasons including four cases of struck and lost.

Experiments

A sighting distance and angle experiment was performed on 8 January 2000 by the SV and SSVs. The results of this experiment will be used in calculating abundance estimates.

Table 4a summarizes the results of photo-ID and biopsy sampling. A total of 64 individuals were photographed from humpback, blue and right whales and 49 skin samples were collected by biopsy from humpback, fin and blue whales.

Table 4b summarizes the results of the oceanographic and hydro-acoustic surveys. CTD and XCTD castings were conducted at 116 and 166 locations in all research areas respectively. EPCS and hydro-acoustic surveys were also conducted in the all research areas.

The marine debris survey was carried out concomitant with the sighting survey of the SV in all research areas. A total of seven debris (three buoys, two plastic bottles, two steel cans and a styrene float) were confirmed. Three wood pieces were found in the stomach of sampled Antarctic minke whales.

Eleven trials of the satellite tagging experiment were performed for humpback, Antarctic minke and right whales. Although the small harpoon for tagging hit the target in eight cases, the connection between the device and the harpoon failed in all cases. These trials were therefore unsuccessful.

S-experiment was conducted from 26 February to 15 March in the West-South stratum in Area V. During the experiment, 172 schools / 272 individual Antarctic minke whales were primary sighted and 80 schools / 142 individuals were selected for the target according to the predetermined interval for each school size. In case of the actual density was substantially different from the assumed density, it was confirmed again as well as from the former experiment that the predetermined effort and securing of samples are very difficult to achieve. It was shown that satisfactory trials could not be obtained from the present procedure of the experiment.

Biological research

Biological research was conducted on the research base ship for all whales sampled (248 males, 182 females). Table 5 summarizes 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 1,869 tons of meat, blubber, viscera, etc. was produced.

Preliminary analyses of biological information

Sex ratio and reproductive status

Table 6 and Fig. 7 show 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 female was determined by existence of corpus luteum or albicans in ovaries.

Mature females were dominant in the East-South stratum (68.2%), whereas mature males were dominant in the north strata (62.7% or 46.9%), West-South stratum (51.9%) in Area V and Area VIW (44.5%).

Length composition

Table 7 shows mean body length of Antarctic minke whales collected in each stratum. Maximum length of the sample was 9.16m for male and 10.12m for female, minimum length was 4.75m and 5.11m, respectively.

DISCUSSION

The characteristics of present survey are followings. 1) Antarctic minke whales were widely distributed over the whole strata in the western part of Area VI and the eastern part of Area. 2) A high surface water temperature of the range from 1°C to 4°C was distributed in the western part of Area V. Total sightings of Antarctic minke whales were 2,079 schools and 5,393 individuals. This was largest sightings throughout the previous research. The Area VIW and the eastern part of Area V accounted for 80% in these sightings. Antarctic minke whales were widely distributed over the whole research strata. Especially, the density on the north stratum was the highest throughout previous researches.

In the western part of Area V, 1°C in the surface water temperature was confirmed near the ice edge. Also, the surface water temperature from 1°C to 4°C was widely distributed over the whole strata. Although Antarctic minke whales were most dominant species in these strata, sighting rate was remarkably low compared with other strata. Many sightings were uneven distributed on the southern side of the stratum. On the contrary, the density of the dwarf form minke whales excelled more than the Antarctic minke whales in the northern part of the West-North stratum (Fig. 3). 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. These results suggest that Antarctic minke whales might avoid a high surface water temperature. The distribution pattern of the Antarctic minke whales in the West-North stratum in this survey is different from previous research because of high water temperature.

ACKNOWLEDGMENTS

We are indebted to Dr. Seiji Ohsumi, director-general of the ICR and Mr. Joji Morishita, the government of Japan for implementation of the research. We thank research technicians, Messrs. Masahiro Yomogihata, Yoshihiko Kitamura and Mitsutomo Hanaya, Kyodo Senpaku Kaisya Ltd., for their contribution. Mr. Masaomi Tsunekawa, Kyodo Senpaku Kaisha Ltd., contributed strategy and logistics of the sighting and sampling survey. Mr. Michitoshi

Nabeshima from the Government of Japan, served as onboard inspector. We are also indebted to all the crew, colleagues of ICR and other related institutions who participated in the research for their contributions. We would like to express the Government of Japan for providing financial support for this research.

REFERENCES

- Doroshenko, N.V. 1979. Populations of minke whales in the Southern Hemisphere. *Rep.int. Whal. Commn* 29: 361-4.
- Government of Japan. 1987. The programme for research on the Southern Hemisphere minke whale and for preliminary research on the marine ecosystem in the Antarctic. Paper SC/39/O4 presented to the IWC Scientific Committee, June 1987 (unpublished). 60pp.
- Government of Japan. 1989. The research plan 1989/90 in conjunction with note for "The programme for research on the Southern Hemisphere minke whale and for preliminary research on the marine ecosystem in the Antarctic (SC/39/O4)". Paper SC/41/SHM13 presented to the IWC Scientific Committee, May 1989 (unpublished). 21pp.
- Government of Japan. 1995. The 1995/96 research plan of Japanese Whale Research Program under Special Permit in the Antarctic (JARPA). Paper SC/47/SH3 presented to the IWC Scientific Committee, May 1995 (unpublished). 9pp.
- Government of Japan. 1996. The 1996/97 research plan of Japanese Whale Research Program under Special Permit in the Antarctic (JARPA). Paper SC/48/SH3 presented to the IWC Scientific Committee, April 1996 (unpublished). 10pp.
- Government of Japan. 1998. The 1998/99 research plan of Japanese Whale Research Program under Special Permit in the Antarctic (JARPA). Paper SC/50/O1 presented to the IWC Scientific, September 1998 (unpublished). 6pp.
- Government of Japan. 2000. The 2000/2001 research plan of Japanese Whale Research Program under Special Permit in the Antarctic (JARPA). Paper SC/52/O2 presented to the IWC Scientific, July 2000 (unpublished). 5pp.
- Ishikawa, H., Murase, H., Tohyama, D., Yuzu, S., Otani, S., Mogoe, T., Masaki, T., Kimura, N., Ohshima, T., Konagai, T., Asada, M., Takeuchi, J., and Kinoshita, T. 2000. Cruise Report of the Japanese Whale Research Program Under Special Permit in the Antarctic (JARPA) Area IV and Eastern Part of Area III in 1999/2000. Paper SC/52/O20 presented to the IWC Scientific Committee, July 2000 (unpublished). 25pp.
- Kato, H. 1982. Some biological parameters for the Antarctic minke whales. *Rep.int. Whal. Commn* 32: 935-45.
- Kato, H. 1986. Year to year changes in biological parameters and population dynamics of southern minke whales. Doctoral Thesis, Hokkaido University. 145pp. 1986
- Nishiwaki, S., Niimi, Y., Itoh, S., Shimamoto, K., Abe, H., Yuzu, S., Shimokawa, T., Miyamoto, S., Taguchi, F., Kasai, H., Kinoshita, T., Iwata, T., Sano, K., and Tanabe, K. 1997. Cruise Report of the Japanese Whale Research Program Under Special Permit in the Antarctic (JARPA) Area V and Western Part of Area VI in 1996/1997. Paper SC/49/SH10 presented to the IWC Scientific Committee, September 1997 (unpublished). 20pp.
- Nishiwaki, S., Tohyama, D., Yuzu, S., Bando, T., Watanabe, M., Kitajima, A., Takeda, S., Murase, H., Ootose, S., OKubo, J., Tsutsui, S., Takatsuki, M. and Kinoshita, T. 1999. Cruise Report of the Japanese Whale Research Program Under Special Permit in the Antarctic (JARPA) Area V and Western Part of Area VI in 1999/2000. Paper SC/52/O20 presented to the IWC Scientific Committee, May 1999 (unpublished). 20pp.
- Pastene and Goto, 1998. Further RFLP analysis of mitochondrial DNA in Antarctic minke whales from Areas III and VI. Paper SC/50/CAWS4 presented to the IWC Scientific Committee, April 1998 (unpublished). 16pp.
- Pastene and Goto, 2000. Mitochondrial DNA analysis in minke whales from Antarctic Areas V and VI. Paper

SC/52/IA3 presented to the IWC Scientific Committee, Jun 2000 (unpublished). 12pp.
 Schweder, T. 1998. A proposed modification for the JARPA sighting and sampling protocol. Report of the Scientific Committee, Annex U. *Rep. Int. Whal. Commn* 48:298.

Table 1. Searching distances (n.miles) of one sighting vessel (SV) and three sighting / sampling vessels (SSVs) in each stratum. Line-transect shows the searching distance on the track-line. Transit/experiment shows the searching distance of sighting activity other than line-transect survey.

Stratum	SV					SSVs					Grand Total
	Line-transect		Transit/experiment		Total	Line-transect		Transit/experiment		Total	
	Closing	Passing	Closing	Passing		Closing	Passing	Closing	Passing		
Area VIW	653.0	821.9	223.5	3.6	1702.0	2968.5		605.6	89.9	3664.0	5366.0
Area V											
East-North	333.9	902.4	56.2	88.9	1381.4	2704.8		381.9	148.6	3235.3	4616.7
East-South	225.0	721.3			946.3	1308.5	1065.4			2373.9	3320.2
West-North	254.9	651.9	29.9	90.0	1026.7	2688.7	156.4	156.5		3001.6	4028.3
West-South	674.4	210.8			885.2	2267.7				2267.7	3152.9
Total	1488.2	2486.4	86.1	178.9	4239.6	8969.7	1221.8	538.4	148.6	10878.5	15118.1
Grand Total	2141.2	3308.3	309.6	182.5	5941.6	11938.2	1221.8	1144.0	238.5	14542.5	20484.1

Table 2a. Summary of large whale sightings conducted by SV and SSVs in area V. Line-transect shows the searching distance on the track-line. Transit/experiment shows the searching distance of sighting activity other than line-transect survey.

Line-transect	SV								SSVs								
	East sector				West sector				East sector				West sector				
	Primary		Secondary		Primary		Secondary		Primary		Secondary		Primary		Secondary		
	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	
Northern stratum																	
Antarctic minke whale	47	203	2	9	20	31			273	556	22	43	71	124	8	13	
Like minke whale	4	4			3	3			1	1	1	4	2	3	1	2	
Dwarf minke whale					1	1			5	5			20	20	1	1	
Blue whale	1	1							5	11	1	2	1	1			
Fin whale	7	14			12	26			1	3	1	4	32	147	3	13	
Sei whale					1	3			1	1			2	3			
Humpback whale	22	61	1	2	14	36			33	58	7	15	31	51	5	10	
Unidentified baleen whales	7	20	1	1	11	24			10	14	9	15	35	58	2	6	
Sperm whale	9	11	1	1	3	4			18	19			6	6			
Killer whale	3	44			2	74			9	55			4	41			
Arnoux's beaked whale													1	12			
Southern bottlenose whale					2	4			15	30	1	2	21	30			
Gray's beaked whale									2	6			5	14			
Unidentified Mesoplodon					1	3											
Unidentified Ziphiidae	15	25			4	8			41	72	1	1	32	44	1	2	
Unidentified whales									35	36			31	31			
Sub total	116	403	5	13	87	509			455	1024	43	86	323	1024	25	197	
Southern stratum																	
Antarctic minke whale	182	686	21	63	47	77	1	3	572	1556	74	186	228	375	15	26	
Like minke whale	1	5			1	1			22	48	3	8	9	9			
Blue whale									2	3	4	5					
Fin whale					8	20			1	2			32	91	1	2	
Humpback whale					19	35	1	4					12	16	4	5	
Right whale					1	1							1	1			
Unidentified baleen whales	1	1			13	27			10	21			29	76			
Sperm whale	1	1	1	1	1	1			4	4	1	1	6	6			
Killer whale	6	382			5	44			15	521			17	182	2	14	
Southern bottlenose whale	1	1			5	10			1	2			12	18			
Unidentified Ziphiidae					5	9			1	1			22	29			
Unidentified whales					1	1			13	13			27	28			
Sub total	192	1076	22	64	113	348	2	7	641	2171	82	200	411	920	23	59	
Grand total	308	1479	27	77	200	857	2	7	1096	3195	125	286	734	1944	48	256	
Transit/experiment																	
Species	SV								SSVs								
	East sector				West sector				East sector				West sector				
	Primary		Secondary		Primary		Secondary		Primary		Secondary		Primary		Secondary		
	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	
Antarctic minke whale	9	14							27	69	5	6	3	11	1	3	
Like minke whale											1	1					
Blue whale									1	2							
Fin whale	3	11							2	26							
Sei whale	1	1			1	4											
Humpback whale									3	6	1	1					
Unidentified baleen whales					1	3			1	1							
Sperm whale	5	5															
Killer whale					2	4											
Southern bottlenose whale					1	1			1	4							
Unidentified Mesoplodon	1	2															
Unidentified Ziphiidae									1	1	1	2	1	3			
Unidentified whales	2	2															
Total	25	115			5	12			36	109	8	10	4	14	1	3	

Table 2b. Summary of large whale sightings conducted by SV and SSVs in Area VTW. Line-transect shows the searching distance on the track-line. Transit/experiment shows the searching distance of sighting activity other than line-transect survey.

Line-transect	SSVs				SV			
	Primary		Secondary		Primary		Secondary	
	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.
Species								
Antarctic minke whale	67	133	6	8	124	224	11	28
Like minke whale	5	7			5	5	4	8
Fin whale	8	17	3	8	7	16	1	2
Sei whale					1	1		
Humpback whale	17	29	1	2	35	53	2	4
Unidentified baleen whales	5	9	4	8	8	17	1	1
Sperm whale	6	6			21	21	1	1
Killer whale	5	51						
Southern bottlenose whale					7	7		
Unidentified Mesoplodon					1	2		
Unidentified Ziphiidae	6	15	1	3	40	61	2	3
Unidentified whales	6	6	1	1	33	41		
Total	125	273	16	30	282	448	23	147

Transit/experiments	SV (Ice edge)				SV (Open water)			
	Primary		Secondary		Primary		Secondary	
	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.
Species								
Antarctic minke whale	191	674	1	1	20	170	5	54
Like minke whale	1	1						
Humpback whale	1	3	1	2	4	8	5	23
Unidentified baleen whale	1	1			1	1	1	4
Sperm whale	7	7			5	5	1	1
Killer whale	1	5			2	50	1	4
Southern bottlenose whale	1	2			4	8		
Unidentified Ziphiidae					2	2		
Total	203	693	2	3	38	244	13	86

Table 3. Density indices (DI, schools per 100 n.miles) and mean school size (MSS) of Antarctic minke whale primary sightings by SV and SSVs. Area VIW in 1998/99 was not conducted the same time.

DI	SSVs			SV		
	2000/2001	1998/99	1996/97	2000/2001	1998/99	1996/97
Area VI West	4.18	ND	3.19	4.54	ND	2.15
Area V						
East-North	10.09	8.01	4.95	3.80	3.37	1.99
East-South	24.10	10.22	13.16	19.23	9.54	14.80
West-North	2.50	5.99	2.94	2.21	5.51	2.31
West-South	10.05	14.65	5.35	5.31	17.61	3.46
MSS						
Area VI West	1.81	ND	2.04	1.99	ND	1.83
Area V						
East-North	2.04	2.65	1.90	4.40	2.05	1.88
East-South	2.72	2.22	3.06	3.77	2.92	6.02
West-North	1.75	1.87	1.67	1.55	5.68	3.56
West-South	1.64	4.38	3.15	1.64	4.18	6.50

Table 4a. Summary of photo-ID and biopsy sampling. B, FIN, HP,R represent blue, fin, humpback, right whales respectively.

Stratum	Photo identification (no. of ind.)			Biopsy sampling (no. of samples)		
	B	HP	R	B	FIN	HP
Area VI West		8				22
Area V						
East-North	2	31		2	1	9
East-South		9		1		1
West-North		9			8	5
West-South		4	1			
Total	2	53	1	3	9	15
Grand total	2	61	1	3	9	37

Table 4b. Summary of oceanographic and hydro-acoustic survey.

Stratum	CTD		XCTD	EPCS		Hydroacoustic
	YS1	KS2	KS2	YS1	KS2	KS2
	(station)	(station)	(station)	(days)	(days)	(n.miles)
Area VI West	17	11	28	22	21	2414.6
Area V						
East-North	15	11	43	20	23	2721.8
East-South	15	11	30	17	16	2874.7
West-North	15	6	24	15	15	1936.5
West-South	9	6	41	22	20	1435.3
Total	54	34	138	74	74	8968.3
Grand total	71	45	166	96	95	11382.9

Table 5. Summary of biological data and samples collected

Samples and data	Number of whales		
	Male	Female	Total
-Data-			
Photographic record of external character	258	182	440
Body length and sex identification	258	182	440
Measurement of external body proportion	258	182	440
Body weight	258	182	440
Body weight by total weight of parts	44	23	67
Skull measurement (length and breadth)	247	165	412
Craniometric study	1	1	2
Standard measurement of blubber thickness (five points)	258	182	440
Detailed measurement of blubber thickness (fourteen points)	44	23	67
Mammary gland; lactation status and measurement	-	182	182
Breadth measurement of uterine horn	-	182	182
Testis and epididymis weight	258	-	258
Weight of stomach content in each compartment	256	182	438
Number of ribs	258	182	440
Photographic record of fetus	-	-	118
Fetal length and weight	-	-	115
External measurements of fetus	-	-	115
-Sample-			
Diatom film record and sampling	258	182	440
Serum sample for physiological study	258	180	438
Earplug for age determination	258	182	440
Earplug for chemical analysis (one of the pair)	12	8	20
Tympanic bone for age determination	258	182	440
Largest baleen plate for age determination	62	48	110
Largest baleen plate for morphologic and chemical study	257	182	439
Vertebral epiphyses sample	258	182	440
Ovary	-	182	182
Oocyte for <i>in-vitro</i> fertilization (IVF)	-	44	44
Histological sample of endometrium	-	182	182
Histological sample of mammary gland	-	182	182
Cord blood for embryo culture	-	37	37
Milk sample for chemical analysis	-	3	3
Histological sample of testis	258	-	258
Histological sample of epididymis	258	-	258
Testis and epididymis stamp smear for sperm detection	258	-	258
Skin, blubber, muscle, liver, kidney and heart tissues for genetic study	258	182	440
Muscle, liver and kidney tissues for heavy metal analysis	258	182	440
Blubber and liver tissues for organochlorine analysis	258	182	440
Muscle, liver and blubber tissues for lipid analysis	44	23	67
Stomach contents for food and feeding study	94	58	152
Stomach contents for heavy metal analysis	11	17	28
Stomach contents for organochlorine analysis	14	12	26
Stomach contents for lipid analysis	16	5	21
Marine debris in stomach content	3	0	3
External parasites	42	42	84
Internal parasites	61	22	83
Fetus	-	-	2
Skin, blubber, muscle, liver, kidney and heart tissues for genetic study (fetus)	-	-	116
Fetal serum for endocrinologic study	-	-	37
Fetal ovary	-	-	49
Fetal tooth germ for embryologic study	-	-	13

Table 6. 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.

Stratum	Male			Female						Total
	Immature	Mature	Total	Immature	Mature					
					Pregnan	Resting	Preg	Preg+L	Ovulati.	
Area VI West	23 (20.9)	49 (44.5)	72 (65.5)	21 (19.1)	13 (11.8)	1 (0.9)	2 (1.8)	1 (0.9)	-	38 (34.5)
Area V										
East-North	15 (18.1)	52 (62.7)	67 (80.7)	7 (8.4)	6 (7.2)	-	1 (1.2)	1 (1.2)	1 (1.2)	16 (19.3)
East-South	5 (4.7)	19 (17.8)	24 (22.4)	8 (7.5)	73 (68.2)	1 (0.9)	-	1 (0.9)	-	83 (77.6)
West-North	9 (28.1)	15 (46.9)	24 (75.0)	5 (15.6)	2 (6.3)	1 (3.1)	-	-	-	8 (25.0)
West-South	15 (13.9)	56 (51.9)	71 (65.7)	14 (13.0)	21 (19.4)	2 (1.9)	-	-	-	37 (34.3)
Combined	44 (13.3)	142 (43.0)	186 (65.7)	34 (10.3)	102 (30.9)	4 (1.2)	1 (0.3)	2 (0.6)	1 (0.3)	144 (43.6)
Grand total	67 (15.2)	191 (43.4)	258 (58.6)	55 (12.5)	115 (26.1)	5 (1.1)	3 (0.7)	3 (0.7)	1 (0.2)	182 (41.4)

Table 7. 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 6.

Stratum	Male			Female		
	Immatur	Mature	Total	Immature	Mature	Total
Area VI West	5.64 ± 0.53 (4.75 – 6.86)	8.31 ± 0.34 (7.61 – 8.93)	7.46 ± 1.32 (4.75 – 8.93)	5.81 ± 0.58 (5.11 – 7.09)	8.77 ± 0.40 (7.88 – 9.47)	7.14 ± 1.57 (5.11 – 9.47)
Area V						
East-North	6.41 ± 0.87 (5.48 – 8.28)	8.35 ± 0.29 (7.74 – 8.87)	7.92 ± 0.94 (5.48 – 8.87)	6.33 ± 0.50 (5.50 – 7.02)	8.92 ± 0.22 (8.46 – 9.15)	7.80 ± 1.39 (5.50 – 9.15)
East-South	7.08 ± 1.43 (5.59 – 8.55)	8.31 ± 0.33 (7.60 – 8.78)	8.05 ± 0.83 (5.59 – 8.78)	7.31 ± 1.09 (5.60 – 8.73)	8.84 ± 0.43 (7.93 – 9.97)	8.69 ± 0.69 (5.60 – 9.97)
West-North	6.69 ± 0.50 (6.05 – 7.46)	8.40 ± 0.43 (7.29 – 8.90)	7.75 ± 0.96 (6.05 – 8.90)	6.82 ± 0.67 (5.79 – 7.51)	9.30 ± 0.29 (9.03 – 9.61)	7.75 ± 1.39 (5.79 – 9.61)
West-South	6.74 ± 1.01 (5.56 – 9.19)	8.54 ± 0.28 (7.83 – 9.16)	8.16 ± 0.90 (5.56 – 9.19)	6.39 ± 0.61 (5.46 – 7.80)	9.04 ± 0.38 (8.40 – 10.12)	8.04 ± 1.38 (5.46 – 10.12)
Combined	6.66 ± 0.93 (5.48 – 9.19)	8.42 ± 0.32 (7.29 – 9.16)	8.01 ± 0.92 (5.48 – 9.19)	6.66 ± 0.81 (5.46 – 8.73)	8.90 ± 0.41 (7.93 – 10.12)	8.37 ± 1.09 (5.46 – 10.12)
Grand total	6.31 ± 0.95 (4.75 – 9.19)	8.39 ± 0.33 (7.29 – 9.16)	7.85 ± 1.07 (4.75 – 9.19)	6.33 ± 0.84 (5.11 – 8.73)	8.88 ± 0.41 (7.88 – 10.12)	8.11 ± 1.31 (5.11 – 10.12)

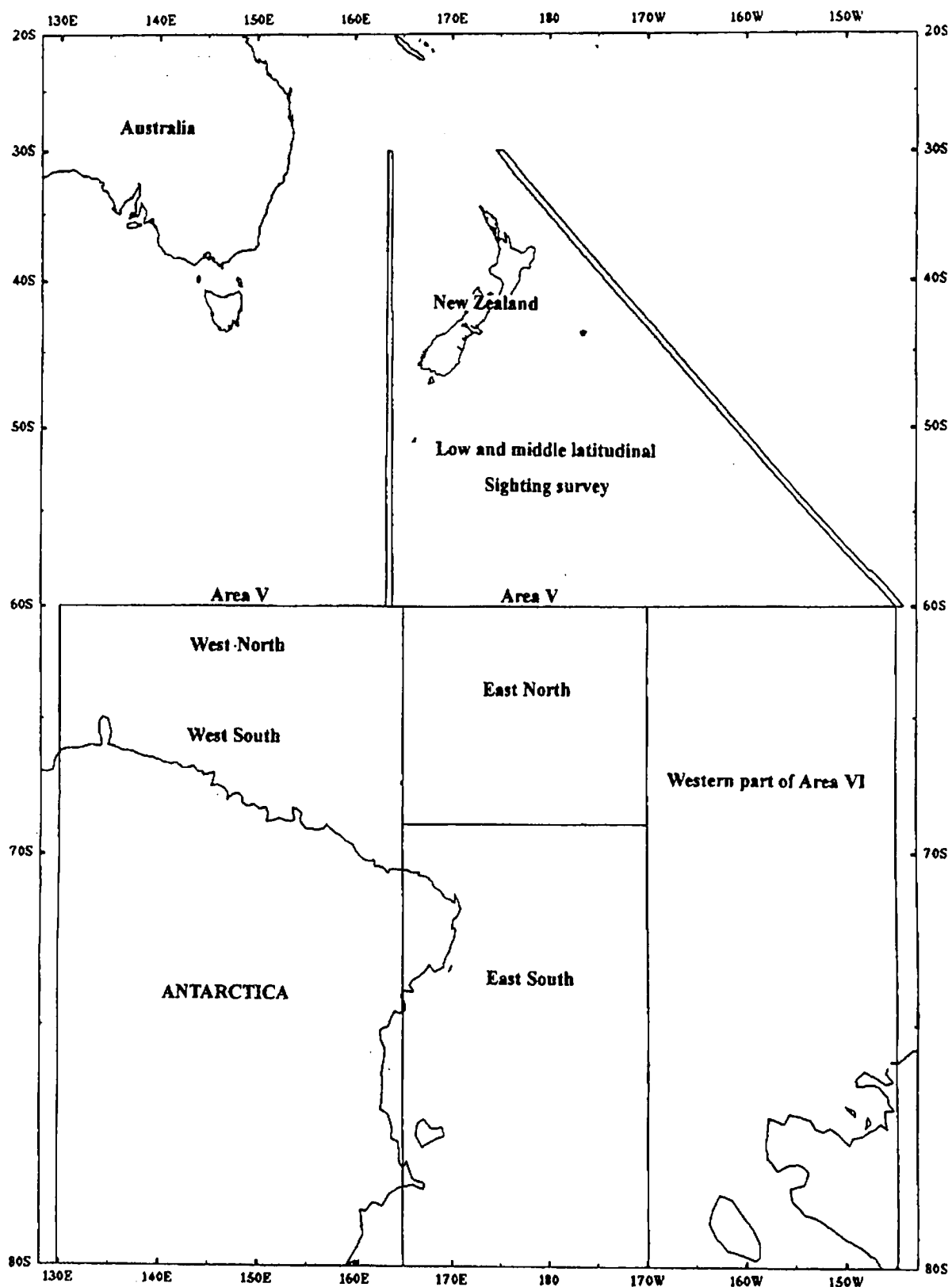


Fig. 1. Geographic location of research area of the 2000/2001 JARPA surveys and cruise tracks of sighting survey between research area and Japan

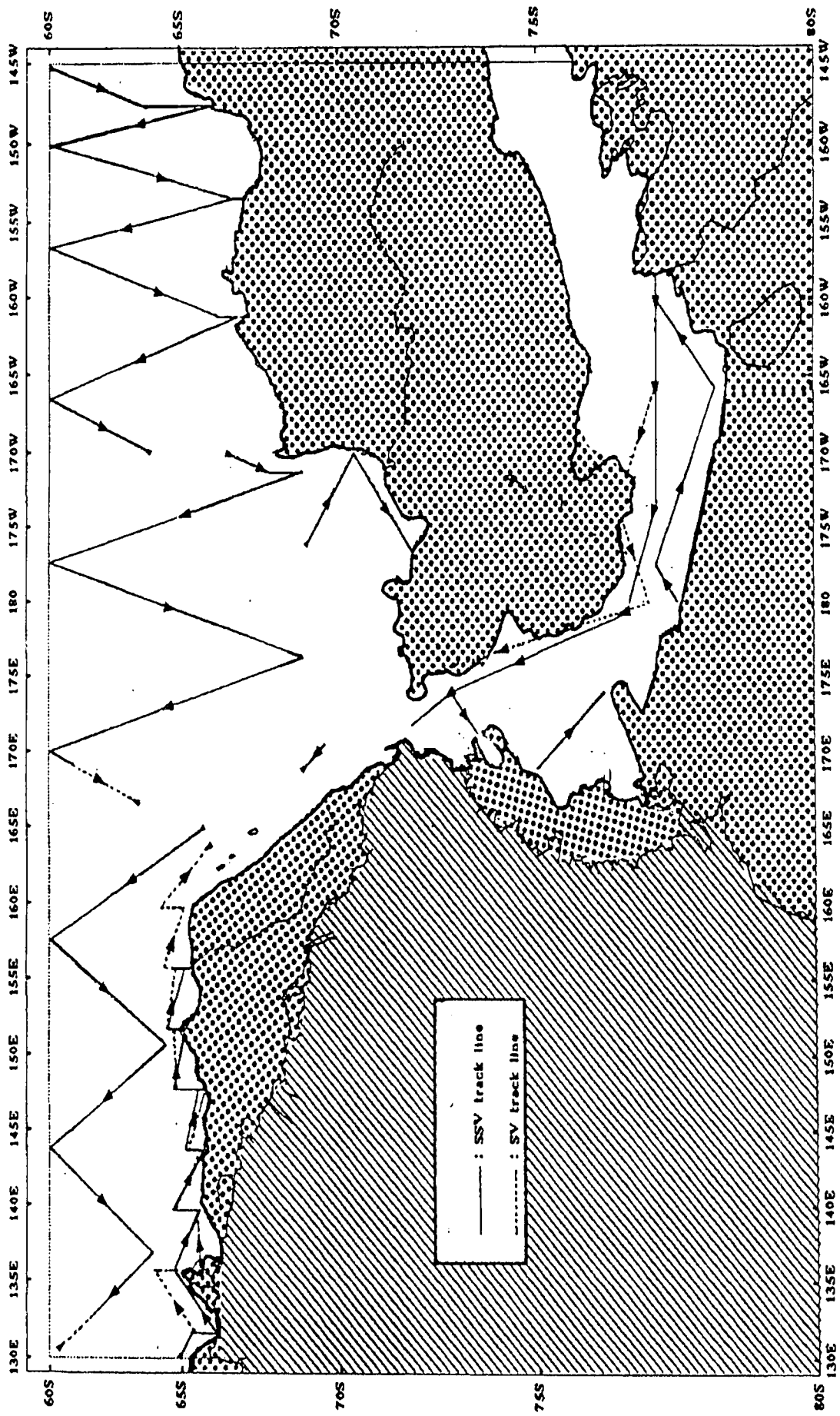


Fig. 2. Cruise track line of sighting vessel (SV, broken line) and sighting / sampling vessels (SSVs, solid line) in 2000/2001 JARPA. Pack ice lines are estimated by observation of research vessels and the information from National Ice Center (NIC).

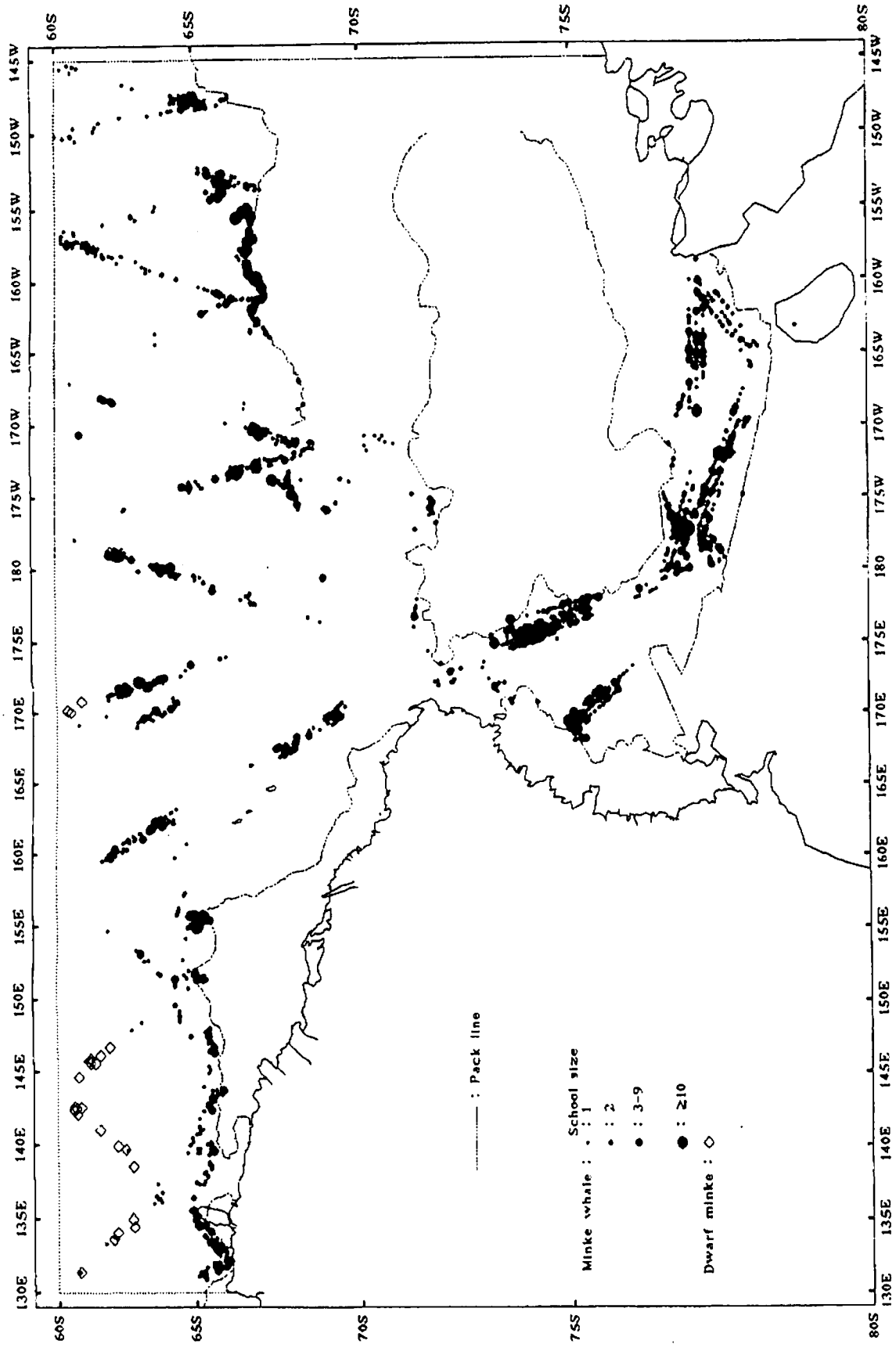


Fig.3. Distribution of primary sightings of Antarctic minke whales sighted by SV and SSVs in 2000/2001 JARPA

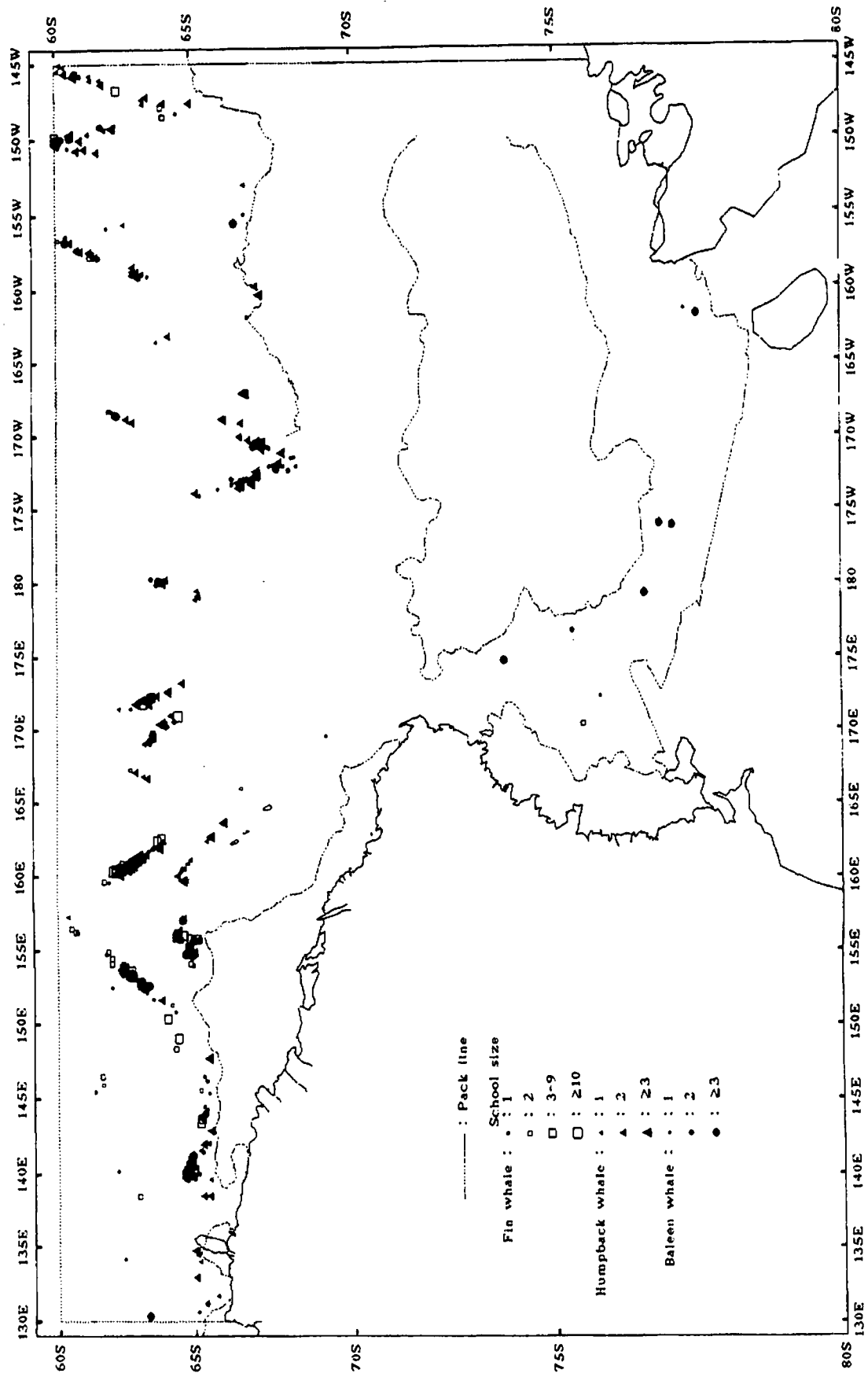


Fig. 4. Distribution of primary sightings of fin and humpback whales sighted by SV and SSVs in 2000/2001 JARPA

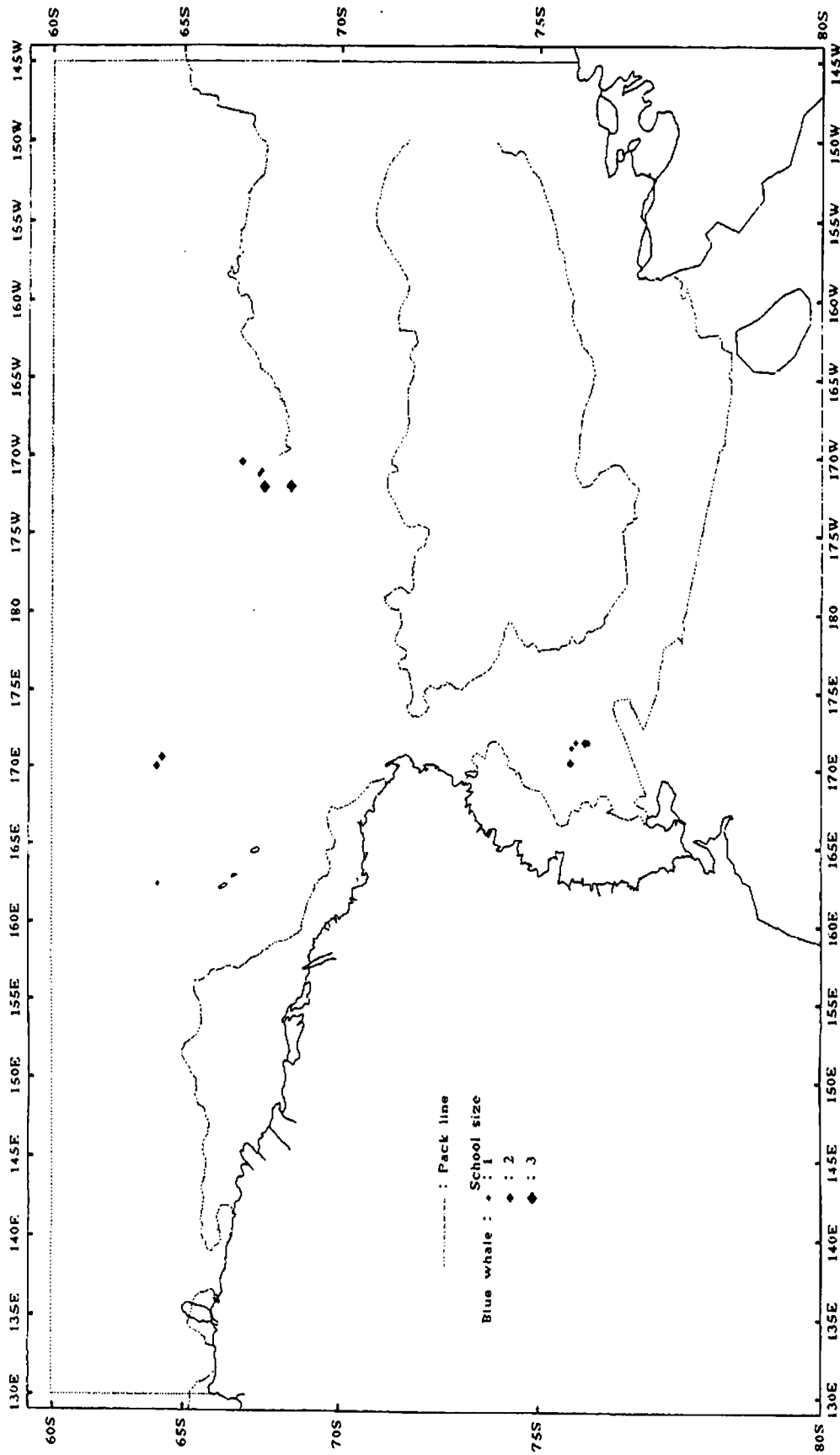


Fig. 5. Distribution of primary sighting of blue whales sighted by SV and SSVs in 2000/2001 JARPA

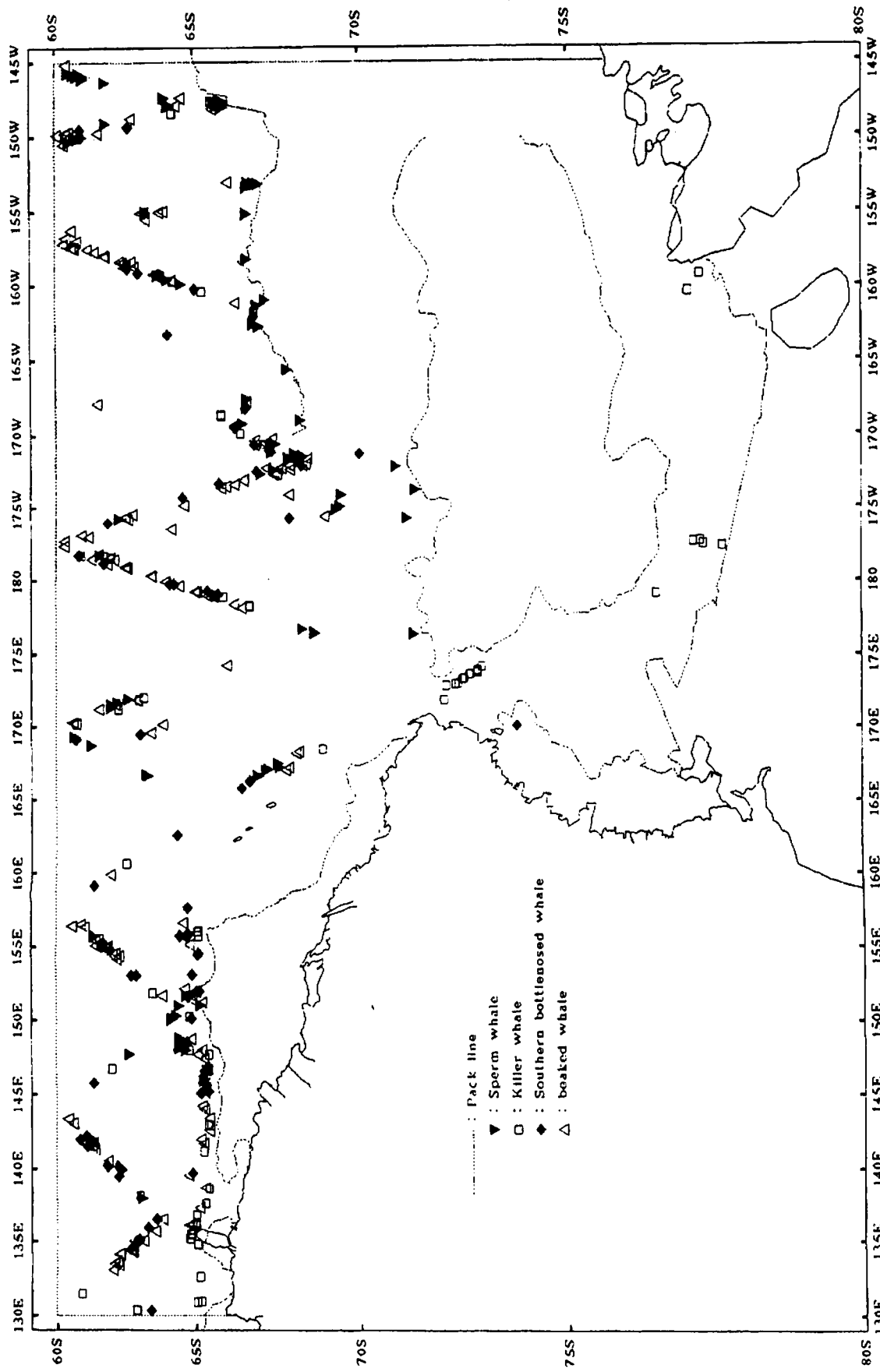


Fig. 6. Distribution of primary sightings of sperm, killer and southern bottlenose whales sighted by SV and SSVs in 1999/2000 JARPA

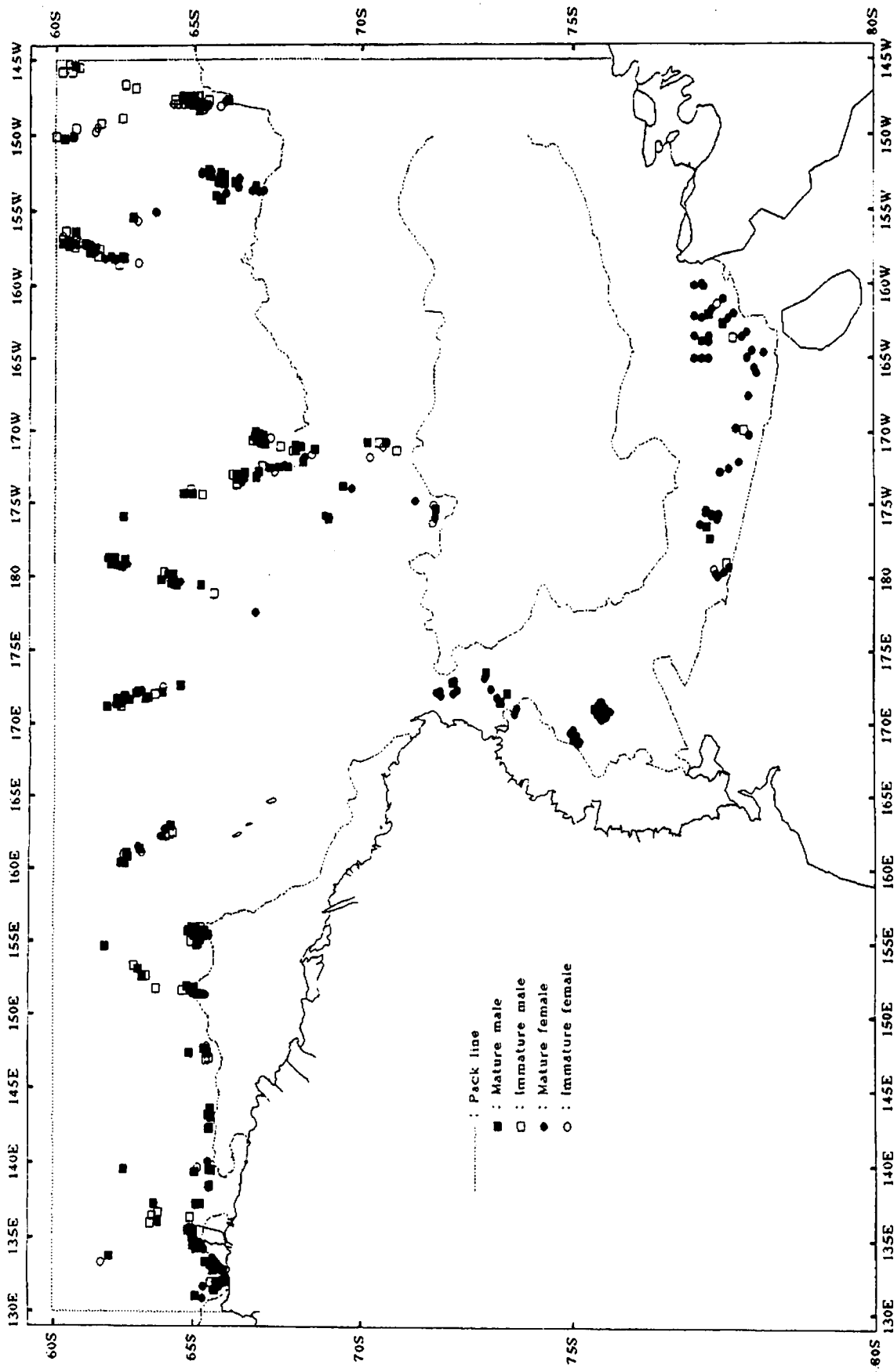


Fig.7. Sighted position of sampled Antarctic minke whales by sex and reproductive status in 2000/2001 JARPA