Cruise Report of the Japanese Whale Research Program under Special Permit in the Antarctic (JARPA) Area IV and Eastern Part of Area III in 2003/2004

Hajime Ishikawa[1)], Seiji Otani[1)], Hiroshi Kiwada[1)], Tatsuya Isoda[1)], Daisuke Tohyama[2)], Kenji Honjo[1)], Atsushi Hasegawa[1)], Tatsuma Terao[1)], Teppei Kushimoto[1)], Takuro Ohshima[1)], Kazuma Sugiyama[1)], Takashi Sasaki[1)], Shin Itoh[1)], Toru Takamatsu[1)] and Takashi Yoshida[2)].

Contact e-mail: ishikawa@cetacean.jp

ABSTRACT

The seventeenth year of the Japanese Whale Research Program under Special Permit in the Antarctic (JARPA) was conducted in Area IV and eastern part of Area III (Area IIIE) from 30 November 2003 to 3 March 2004. One sighting vessel (SV), three sighting and sampling vessels (SSVs) and one research base ship were engaged in the research. The SV covered 7,000.4 nautical miles of searching distance and made primary sightings of 454 schools / 1,756 individual of Antarctic minke whales *Balaenoptera bonaerensis*. Three SSVs searched a total of 12,287.0 n. miles and sighted 638 schools / 1,494 individual of Antarctic minke whales as primary sightings. The primary sightings of humpback whale *Megaptera novaeangliae* made by the SV and the SSVs were 597 schools / 1,138 individual and 1,093 schools / 1,996 individual, respectively. Antarctic minke whale was the most dominant species in Area IIIE, however, sightings of humpback whales overwhelmed those of Antarctic minke whales in Area IV. Antarctic minke whales occurred in high density near ice edge in Area IIIE and coastal water of the Davis Sea (88°E-95°E) in Area IV where the ice edge retreated widely. On the other hand, they were relatively few in the East-south stratum in Area IV even near the ice edge where dense distribution of them was observed in the previous research. Humpback whales distributed widely off the Area IIIE and 90°E-110°E in Area IV, and highly abundant even near the ice edge of Area IV except for the Davis Sea and Prydz Bay. It has been observed southward expansion of distributions of humpback whales in recent years. The increases of humpback whales may result in inter species competition with Antarctic minke whales. A total of 440 Antarctic minke whales was sampled (110 from Area IIIE and 330 from Area IV). A total of 72 biopsy samples was obtained from humpback, blue, fin and right whales by the SV and SSVs. The SV conducted an oceanographic survey using a passive acoustic system, Electric Particle Counting and Sizing System (EPCS), CTD, XCTD and XBT. One of the SSVs also conducted an oceanographic survey using EPCS.

KEYWORDS: JARPA, CRUISE REPORT, ANTARCTIC MINKE WHALE, HUMPBACK WHALE

---

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

2) Kyodo Senpaku Kaisha, Ltd., 4 -5, Toyomi-cho, Chuo-ku, Tokyo 104-0055, Japan,

INTRODUCTION

The Japanese Whale Research Program under Special Permit in the Antarctic (JARPA) has been conducted every year since the 1987/88 season. In compliance with Article VIII of the International Convention for the Regulation of Whaling, JARPA is authorized by the Government of Japan and planned and conducted by the Institute of Cetacean Research (ICR). After two seasons of feasibility research in 1987/88 and 1988/89, full-scale research started in the 1989/90 season. The program is designed to repeat surveys in the Antarctic Areas IV and V alternatively in each of the sixteen years of the research period. From the 1995/96 season, the survey area was expanded into a part of Areas III and VI to improve the stock structure study (Government of Japan, 1987a, 1987b, 1989, 1995). The original objective of the expansion to the eastern part of Area III (Area IIIE) in 1995/96 season was a feasibility study on stock identification to examine the hypothesis of the occurrence of more than one stock in Areas IV and V (Government of Japan, 1995). Estimation of biological parameters, which is the main objective of the JARPA, should ideally be carried out on the basis of genetically identified stock units. Then for this objective of the JARPA, it is very important to corroborate the hypotheses on stock identity derived from genetic and non-genetic analyses under JARPA (e.g. Pastene *et al.* 1996; Fujise, 1995). The analyses of genetic data suggested a lot of movement of minke whale across the IWC-boundary between Areas IV and V. This result has been corroborated recently by analyses of several independent biological markers. Therefore these analyses provide no biological support for a stock boundary at 130°E. Rather these results are consistent with a main (core) stock occupying Area IV and part of Area V. Different stocks could occur at the lateral sectors of the JARPA research Area as suggested by some degree of heterogeneity in Areas IIIE (at least detected by some of the approaches being used) and Area VIW. Then the additional surveys in Areas IIIE and VIW are important to investigate distribution and boundaries (geographical and temporal) of stocks. The research plan for the 2003/2004 JARPA was submitted to the 55th Annual Meeting of the International Whaling Commission and the Scientific Committee (IWC/ SC) meeting (Government of Japan, 2003). As in the past, the objectives of the research were as follows; 1) estimation of biological parameters of minke whale stock, 2) elucidation of the role of whales in the Antarctic ecosystem, 3) elucidation of the effect of environmental changes on cetaceans, and 4) elucidation of the stock structure of the Southern Hemisphere minke whales (Antarctic minke whales) to improve the stock management.

This paper reports on the seventeenth cruise of the JARPA, which was conducted from 30 November 2003 to 3 March 2004 in the Antarctic Area IV and Area IIIE.

RESEARCH METHODS

Research area

The research area in the present survey was composed of the eastern part of Area III (Area IIIE, 35°E – 70°E) and the entire Area IV (70°E - 130°E) south of 60°S (Fig. 1). Area IV was divided into two sectors, east and west, by the 100°E. They were further divided into two strata, a south stratum extending from the ice edge to a locus 45 n. miles, and a north stratum extending from the northern boundary of the south stratum to the 60°S. As the north strata were surveyed prior to the south strata, the southern boundary of the north strata was set at estimated latitude expecting a retreat of the ice edge at the time of the survey of the south strata. The southern boundary of the West-south stratum between 70°E and 80°E was fixed at 66°S and Prydz Bay was defined as the southern area of this boundary. The survey of each stratum in Area IV was conducted in the order of West-north, East-north, East-south, West-south and Prydz Bay. Area IIIE was surveyed prior to Area IV for the purpose of collecting the W stock samples which may migrate early in the feeding season.

Research vessels

Three vessels, *Kyo Maru No.1* (K01; 812.08 GT), *Yushin Maru No.2* (YS2; 747 GT) and *Yushin Maru* (YS1; 720 GT) were engaged in sighting and sampling surveys (the sighting and sampling vessels; SSVs). *Nisshin Maru* (NM; 7,638GT) served as a research base on which all biological examinations of collected samples were conducted. *Kyoshin Maru No.2* (KS2; 372 GT) was dedicated to sighting survey from which most of oceanographic surveys were conducted (the sighting vessel; SV).

Cruise track line and sighting and sampling method

Fig. 2 shows the track line of the SV and SSVs. The method for establishment of the cruise track line in Area IV was the same as for previous surveys (Nishiwaki *et al.* 1996, Ishikawa *et al.* 1998, Ishikawa *et al.* 2000). In Area IIIE, westbound and eastbound zigzag lines were set in 10 ° longitudinal intervals. The eastbound line was set south of westbound line to cover the area appeared with retreat of ice edge during the westbound survey.

Sighting and sampling procedures were as in the previous JARPA surveys (Ishikawa *et al.* 1998, Ishikawa *et al.* 2000, Ishikawa *et al.* 2002). 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 it and species and school size were confirmed). SSVs followed 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, i.e. 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. In addition to the sightings of Antarctic minke whales or whales suspected to be Antarctic minke whales, the SV and SSVs approached blue whale *Balaenoptera musculus*, right whale *Eubalaena glacialis* for conducting some experiments. They also occasionally approached humpback whales and fin whale *B. physalus* for conducting experiments. 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 species for sampling.

Low and middle latitudinal sighting survey

During transit cruises, sighting surveys were conducted in the area between south of 30°S and north of 60°S except for areas within national exclusive economic zones (Fig. 1). The results of these surveys are not included 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. Observers on each vessel were required to assess eight sets of angles and distance from two platforms (barrel and upper bridge). All trials were conducted under good sighting condition.

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 these species were also taken from the SSVs occasionally.

Biopsy sampling

The species targeted for photo-identification experiments and fin whale *Balaenoptera physalus* were also targeted for biopsy skin sampling using a crossbow. All collected samples were preserved at – 80°C

Satellite telemetry tagging

Satellite telemetry tag was developed from separated type (consisted of mounting part and transmitter) to united type. Two of SSVs conducted this experiment using an air gun developed by ICR (Kasamatsu *et al*, 1991).

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 surface water temperature, conductivity, surface chlorophyll, dissolved oxygen and surface particle by Electric Particle Counting and Sizing System (EPCS), 3) XBT, XCTD and CTD survey and 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 NM.

OUTLINE OF THE RESEARCH ACTIVITIES

An outline of the research activities conducted during the 2003 /2004 JARPA survey is as follows.

Event	Date	Vessels
Departure from Japan	7 November 2003	NM, SV and SSVs
Sighting survey in transit area.	21 November - 29 November 2003	SV and SSVs
Sighting and sampling survey in Area IIIE	30 November - 26 December 2003	SV*
	30 November - 23 December 2003	SSVs
Sighting and sampling survey in the West-north stratum in Area IV	26 December 2003 -10 January 2004	SV
	27 December 2003 -11 January 2004	SSVs
Sighting and sampling survey in the East-north stratum in Area IV	11 January - 24 January 2004	SV
	12 January - 24 January 2004	SSVs
Sighting and sampling survey in the East-south stratum in Area IV	25 January - 7 February 2004	SV
	25 January - 11 February 2004	SSVs
Sighting and sampling survey in the West-south stratum in Area IV	7 February - 25 February 2004	SV
	12 February - 28 February 2004	SSVs
Sighting and sampling survey in the Prydz Bay	26 February - 3 March 2004	SV*
	29 February - 1 March 2004	SSVs
Sighting survey in transit area.	4 March - 11 March 2004	SV and SSVs
Arrival at Japan	28 March 2004	SSVs
	31 March 2004	NM, SV

* SSVs were allocated SV position after completion of sampling survey in each Area IV and Area IIIE.

RESULTS

Searching effort

Table 1 shows the searching distances (n. miles) by each stratum. The SV covered 7,000.4 n. miles and the three SSVs covered an average of 4,095.7 n. miles each. Total searching distance of one SV and three SSVs was 19,287.4 n. miles (Area IIIE; 5,895.4, Area IV; 13,392.0). As SSVs were allocated to the sighting survey of un-surveyed area after the sampling survey in each Area was completed, data obtained in such case was regarded as SV activity. The SV conducted passing mode searching (NSP) for eight hours a day in principle. The ratio of NSP was 75.8 % of total searching distance of the SV. The searching distance of SSVs was divided into searching survey with sampling operation (NSC) and that without sampling operation (ASP). The ratio of ASP was 6.8 % of total searching distance of the SSVs.

Species sighted

Tables 2a and 2b summarize the sightings made. Total primary sightings of Antarctic minke whales involved 1,092 schools / 3,250 individuals. Antarctic minke whale was the most dominant species in Area IIIE, however, sightings of humpback whales overwhelmed those of Antarctic minke whales in Area IV. Antarctic minke whale was abundant in near ice edge in Area IIIE and coastal water of Davis Sea (88°E-95°E) in Area IV where the ice edge retreated widely. On the other hand, they were relatively few in the East-south stratum in Area IV even near the ice edge. In the East-south stratum, they were found to be concentrated only at small ice free area near the Budd coast of Antarctica (112°E) where the research fleet was difficult to enter because of drifting pack ice. In the Prydz Bay, they were abundant in northeast area but sporadic in the bottom of the Bay (Fig. 3). Two dwarf minke whales were sighted in the East-north stratum in Area IV.

Humpback whale was the most dominant species in all strata of Area IV except for the Prydz Bay. Total primary sightings of humpback whales involved 1,690 schools / 3,134 individuals. They distributed widely off the Area IIIE and 90°E-110°E in Area IV, and highly abundant even near the ice edge of Area IV except for the Davis Sea and Prydz Bay (Fig. 4). In Area IIIE and the Davis Sea where abundant Antarctic minke whales were observed, distribution of humpback whales showed clear separation from Antarctic minke whales.

Table 3 shows density indices (DI: schools sighted / 100 n. miles searching distance) and mean school size (MSS) of Antarctic minke whale and humpback whale in each stratum. Compared to Antarctic minke whale, the DI of humpback whale was extremely high in southern strata (11.01-23.04) except for the Prydz Bay and averaged DI in Area IV (10.62) was more than two times higher than that of minke whale (5.25). Although the MSS of minke whale was higher in Area IIIE and southern strata in Area IV than northern strata in Area IV, that of humpback whale was relatively stable in every stratum.

A total of 32 schools / 61 individual blue whales, 109 schools / 446 individual fin whales and 1 school / 2 individual right whales were primarily sighted. Sightings of blue whales occurred mainly in southern area between 55°E - 70°E. Most of fin whales were sighted in Area IIIE (Fig. 5).

Sperm whale, killer whale and beaked whales were dominant toothed whales. Killer whales were frequently observed where sightings of Antarctic minke whales and humpback whales were concentrated. Killer whales were also found at the bottom of the Prydz Bay where other species were few observed except for Antarctic minke whales (no figure).

Sampling of Antarctic minke whale

Out of 638 schools / 1,494 individual Antarctic minke whales sighted by the SSVs, 473 individuals were targeted for sampling. A total of 440 individuals was collected (110 from Area IIIE, 330 from Area IV, see Fig. 6). Technical

sampling efficiency (the rate of sampling for targeted individuals) was 0.93. Out of 33 cases of sampling failure, the most frequent reason was an escape of targeted whale into pack ice (8 cases). Struck and lost also occurred in 3 cases.

Special attention to reduce the time to death was given to all targeted and sampled whales. Explosive harpoons were used for all targeted whales as the primary killing method. A large caliber rifle was used as the secondary killing method when required.

Experiments

A sighting distance and angle experiment was performed on 2 January 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 100 individuals from humpback, blue, and right whales were photographed and 72 biopsy samples were collected from those whales and fin whales.

Table 4b summarizes the results of the oceanographic and hydro-acoustic surveys. XBT, XCTD and CTD surveys were conducted at 41, 122 and 54 locations respectively in all research areas. EPCS surveys 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 steel oil drum was confirmed. An Antarctic minke whale with body length of 5.73m taken in Area IIIE was found to be entangled by longline fishing gears in tale flukes. The animal dragged those gears more than 20m long when it was sighted by the SSV. A small rubber piece was found in the stomach of Antarctic minke whales sampled in West-north stratum in Area IV during the biological research.

Satellite tagging experiment was conducted for three Antarctic minke whales and two humpback whales. Although tagging was succeeded for two Antarctic minke whales and a humpback whale, we failed to track those whales because no radio wave was received. The causes of failure are under investigation.

Biological research

Table 5 summarizes data and samples collected. These data and samples will be analyzed for the purposes of JARPA and some will be used for collaborative studies in various fields such as histology, physiology, embryology, pharmacology, pathology and reproductive physiology.

Preliminary analyses of biological information

Sex ratio and reproductive status

Table 6 and Fig. 6 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 the testis weight according to Kato (1986), i. e., males with either testis over than 400g were determined to be mature while others were classified as immature. Maturity of females was determined by existence of corpus luteum or albicans on ovaries.

Mature females were dominant in the East-south stratum (41.6 %) and the West-south stratum (60.2 %) in Area IV, whereas mature males were dominant in Area IIIE (48.2%) and the West-north stratum (43.2 %) in Area IV. In the Prydz Bay, both mature males and females were dominant. The ratio of immature animals was relatively high in the East-north stratum.

Length composition

Table 7 shows mean body length of Antarctic minke whales collected in each stratum. Maximum length of the sample was 10.05m for female and 9.39m for male. Minimum length was 4.90m and 4.94m, respectively.

Products

All the whales collected were processed on NM after biological sampling was completed according to the provisions of Article VIII of the Convention. A total of 1,926 tons of meat, blubber, viscera, etc. was produced.

DISCUSSION

The most characteristic result of the present survey is a large number of sightings of humpback whales. Total sighting number of humpback whales marked the largest record in the history of JARPA (see Ishikawa *et al.* 2002). Fig. 7 shows yearly change of species composition of sightings and DI of Antarctic minke and humpback whales in Area IV. The composition ratio and DI of humpback whale have been increasing especially from 1995/96 JARPA, while those of Antarctic minke whales changed by research years. The DI of humpback whale increased from 0.63 (1989/90 JARPA) to 10.62 (present survey) during 14 years. Matsuoka *et al.* (2003) estimated population and annual rate for increase of humpback whales in Area IV using the latest JARPA sighting data, and showed 29,856 (CV=0.27) and 12.5% (CV=0.58), respectively. The estimated population was 8.7 times higher than that obtained from 1988/89 IWC/IDCR sighting data (Brown and Butterworth, 1999). These data therefore confirm an increase of humpback whales.

In the past research cruises, humpback whales had been observed abundantly off the ice edge and observed to be separated from Antarctic minke whales that were abundant near the ice edge (Ishikawa *et al.* 1998, 2000,). However, recent observation suggested that distribution of humpback whales expand not only offshore but also near the ice edge. Humpback whales were observed to be either mingled with or clearly separated from Antarctic minke whales near the ice edge (Ishikawa *et al.* 2002, Ishikawa 2003). Compared to last two researches in Area IV, total sightings of Antarctic minke whales in this research were relatively small in the southern strata even near the ice edge. They were found to be concentrated where the ice edge retrieved to coastal area of the Antarctica or small ice free area south of the ice edge (polynya). It seems that when humpback whales distributed along the ice edge abundantly, Antarctic minke whales might gather deep inside of the pack ice as much as they could do so as to avoid humpback whales. Such an inter species competition of two species may result the spatial shift of distribution of Antarctic minke whales and cause difficulty of sighting survey for them because research vessels are hard to enter the deep inside of the pack ice.

It has been recognized that the Antarctic minke whales declined age at sexual maturity from 12-13 years in the mid 1940s to 7-8 years in the early 1970s because of increase of the carrying capacity of Antarctic krill-feeders due to reductions in the populations of the large baleen whales (Kato and Sakuramoto, 1991). Abundance of humpback whales in the Antarctic had depleted during past commercial whaling era and they have been protected from 1963 by IWC. Recent drastic increase of humpback whales may suggest that they have changed reproductive physiology as occurred in Antarctic minke whales after several decades of slow recovery. Therefore it is important to elucidate species interaction between Antarctic minke whales and humpback whales for the object of JARPA, i.e. elucidation of the role of whales in the Antarctic ecosystem. For that purpose, it will be necessary to develop new research including such as improved sighting method for the Antarctic minke whales distributing inside of the pack ice, comparative study of feeding strategy of these two baleen whale species and/ or study of biological parameter of humpback whales.

ACKNOWLEDGEMENTS

The project leader was Dr. Seiji Ohsumi and Dr. Hiroshi Hatanaka, former and new director-general of the ICR. We are indebted to Mr. Joji Morishita, the Government of Japan for implementation of the research. We thank research technicians, Messrs. Yasuhiro Murai, Chinori Asahina and Makoto Nakamura, Kyodo Senpaku Kaisha Ltd., for their contribution. Mr. Masaomi Tsunekawa and Kazuki Fukutome, Kyodo Senpaku Kaisha Ltd., contributed strategy and

logistics of the sighting and sampling survey. Mr. Akira Hachimine from the Government of Japan, served as onboard inspector. We are also indebted to all the crew of the research fleet, colleagues of ICR and other related institutions who participated in the research for their contributions. Financial support for this research was provided by the Government of Japan.

REFERENCES

Brown, R. M. and Butterworth, D. S. 1999. Estimates of abundance for Southern Hemisphere humpback and blue whales from the IWC/IDCR-SOWER sighting survey cruise. Paper SC/51/CAWS35 presented to the IWC Scientific Committee, May 1999 (unpublished).

Fujise, Y. 1995. A preliminary morphometric study in minke whales from Antarctic Area IV using data from the 1989/90 JARPA survey. Paper SC/47/SH7 presented to the IWC Scientific Committee, May 1995 (unpublished).

Government of Japan 1987a. The program 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). 57pp.

Government of Japan 1987b. The research plan for the feasibility study on "the program for research on the Southern Hemisphere minke whale and for preliminary research on the marine ecosystem in the Antarctic" Paper SC/D87/1 presented to the IWC Scientific Committee, December 1987 (unpublished). 36pp.

Government of Japan 1989. The research plan in 1989/90 season in conjunction with note for "the program for the research on the Southern Hemisphere minke whale and for the preliminary research on the marine ecosystem in the Antarctic (SC/39/O4)". Paper SC/41/SHMi13 presented to the IWC Scientific Committee, June 1989 (unpublished). 9pp with Annex.

Government of Japan 1995. The 1995/96 research plan for the Japanese Whale Research Program under Special Permit in the Antarctic. Paper SC/47/SH3 presented to the IWC Scientific Committee, May 1995 (unpublished). 8pp.

Government of Japan 2003. The 2003/2004 research plan for the Japanese whale research program under special permit in the Antarctic (JARPA). Paper SC/55/O1 presented to the IWC Scientific Committee, May 2003 (unpublished). 6pp.

Ishikawa, H. 2003. Relationship between ice condition and number of sightings of Antarctic minke whales – comparison between 1997/98 and 2001/2002 JARPA surveys in Area IIIE and IV. *J. Cetacean Res. Manage.* 5 (Suppl.) 278-282.

Ishikawa, H., Matsuoka, K., Tohyama, D., Yuzu, S., Shimokawa, T., Ohshima, K., Mizushima, Y., Nibe, T., Kido, T., Asada, M., Nakamura, M., Ichinomiya, D. and Kinoshita, T. 1998. Cruise report of the Japanese Whale Research Program under a Special Permit in the Antarctic (JARPA) Area IV and eastern part of Area III in 1997/98. Paper SC/50/CAWS8 presented to the IWC Scientific Committee, September 1998 (unpublished). 26pp.

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, May 2000 (unpublished). 25pp.

Ishikawa H., Otani S., Mogoe, T., Kiwada, H., Tohyama, D., Yoshida, T., Hayashi, T., Nagamine, M., Fukutome, K., Koyanagi, T., Fujihira, T., Sasaki, T., Ishihara, T. and Mori, M. 2002. Cruise Report of the Japanese Whale Research Program under Special Permit in the Antarctic (JARPA) Area IV and Eastern Part of Area III in

2001/2002. Paper SC/54/O18 presented to the IWC Scientific Committee, May 2003 (unpublished). 20pp.

Kasamatsu, F., Iwata, S. and Nishiwaki, S. 1991. Development of biopsy skin sampling system for fast swimming whales in pelagic waters. *Rep. Int. Whal. Commn* 41. 555-557.

Kato, H. 1986. Year to year changes in biological parameters and population dynamics of southern minke whales. Doctoral Thesis, Hokkaido University. 145pp.

Kato, H. and Sakuramoto, K. 1991. Age at sexual maturity of southern minke whales: a review and some additional analyses. *Rep. Int. Whal. Commn* 41. 331-337.

Matsuoka, K., Hakamada, T., Murase, H. and Nishiwaki, S. 2003. Current distribution, abundance and density trend of humpback whales in the Antarctic Areas IV and V. Paper SC/55/SH10 presented to the IWC Scientific Committee, July 2003 (unpublished).15pp.

Nishiwaki, S., Ishikawa, H., Tohyama, D., Kawasaki, M., Shimamoto, K., Yuzu, S., Tamura, T., Mogoe, T., Hishii, T., Yoshida, T., Hidaka, H., Nibe, H., Yamashiro, K., Ono, K. and Taguchi, F. 1996. Report of the 1995/96 Japanese Whale Research Programme Under Special Permit in the Antarctic (JARPA) in Area IV and eastern part of Area III. Paper SC/48/SH12 presented to the IWC Scientific Committee, June 1996 (unpublished). 20pp.

Pastene, L. A., Kishino, H. and Goto, M. 1996. Preliminary RFLP analysis of mitochondrial DNA in the Antarctic minke whale from Areas III and IV. Paper SC/48/SH13 presented to the IWC Scientific Committee, June 1996 (unpublished). 19pp.

Table 1. Searching distances (n. miles) of one sighting vessel (SV) and three sighting/sampling vessels (SSVs) in each stratum.

Stratum	SV			SSVs			Grand Total
	Passing mode (NSP)	Closing mode (ASP)	Total	Sampling survey (NSC)	Sighting survey (ASP)	Total	
Area IIIE	**2,144.5**	**373.2**	**2,517.7**	**3,137.6**	**240.1**	**3,377.7**	**5,895.4**
Area IV	**3,161.1**	**1,321.6**	**4,482.7**	**8,310.9**	**598.4**	**8,909.3**	**13,392.0**
East-North	809.8	329.1	1,138.9	2,599.6	0.0	2,599.6	3,738.5
East-South	791.8	242.9	1,034.7	2,586.2	12.3	2,598.5	3,633.2
West-North	587.2	257.1	844.3	2,330.4	61.9	2,392.3	3,236.6
West-South	729.3	257.0	986.3	772.6	516.3	1,288.9	2,275.2
Prydz Bay	243.0	235.5	478.5	22.1	7.9	30.0	508.5
Grand Total	**5,305.6**	**1,694.8**	**7,000.4**	**11,448.5**	**838.5**	**12,287.0**	**19,287.4**

Table 2a. Summary of sightings (no. schools / no. individual) conducted by SV and SSVs in Area IV.

	SV				SSV			
	West Sector		East Sector		West Sector		East Sector	
Species	Primary Sch. / Ind.	Secondary Sch. / Ind.	Primary Sch. / Ind.	Secondary Sch. / Ind.	Primary Sch. / Ind.	Secondary Sch. / Ind.	Primary Sch. / Ind.	Secondary Sch. / Ind.
Northern Stratum								
Antarctic Minke whale	29 / 33	1 / 1	16 / 28	1 / 1	54 / 73	5 / 5	47 / 74	2 / 2
Like Antarctic Minke whale	2 / 2		3 / 3				1 / 1	
Minke whale (Dwarf form)							2 / 2	
Blue whale			1 / 1					
Fin whale			3 / 10		8 / 14		3 / 19	
Humpback whale	66 / 122	3 / 5	84 / 150		176 / 308	20 / 35	207 / 371	15 / 26
Unidentified Baleen whales	11 / 18		30 / 50		2 / 2		2 / 4	
Sperm whale	10 / 10	1 / 1	11 / 11		23 / 23	1 / 1	4 / 4	
Southern bottlenose whale	2 / 4	1 / 1	7 / 13		20 / 27	1 / 3	24 / 35	
Mesoplodon spp.							1 / 2	
Unidentified Beaked whales	8 / 13		18 / 26	1 / 1	25 / 33	1 / 2	31 / 35	
Killer whale	3 / 4		2 / 6		9 / 45		10 / 57	1 / 20
Long-finned pilot whale	1 / 35				4 / 240		1 / 30	
Hourglass dolphin							1 / 10	
Unidentified whales			1 / 1		21 / 21		23 / 23	
Southern Stratum								
Antarctic Minke whale	94 / 221	2 / 2	31 / 148	2 / 4	247 / 667	41 / 154	102 / 185	25 / 174
Like Antarctic Minke whale	4 / 4		2 / 2		2 / 2		4 / 4	
Blue whale	2 / 3		1 / 1		4 / 5	1 / 1		
Fin whale					1 / 1			
Right whale					1 / 2			
Humpback whale	113 / 228	2 / 4	191 / 373	4 / 11	297 / 581	19 / 42	286 / 508	24 / 52
Unidentified Baleen whales	8 / 14		20 / 39	2 / 3	1 / 2	4 / 48		2 / 5
Sperm whale	9 / 9		12 / 12		13 / 13		21 / 21	2 / 2
Southern bottlenose whale	2 / 2		2 / 2		9 / 25		45 / 93	1 / 2
Unidentified Beaked whales	5 / 9		8 / 12		11 / 29		23 / 51	
Killer whale	19 / 71		12 / 88		20 / 360	4 / 90	22 / 191	1 / 10
Unidentified whales			2 / 2		14 / 14		20 / 20	
Prydz Bay								
Antarctic Minke whale	56 / 139	1 / 1			27 / 55	1 / 1		
Like Antarctic Minke whale	3 / 3							
Humpback whale	2 / 4							
Unidentified Baleen whales	6 / 10							
Arnoux's beaked whale	2 / 28	1 / 3						
Killer whale	10 / 338				2 / 75			

Table 2b. Summary of sightings (no. schools / no. individual) conducted by SV and SSVs in Area IIIE.

	SV		SSV	
	Primary	Secondary	Primary	Secondary
Species	Sch. / Ind.	Sch. / Ind.	Sch. / Ind.	Sch. / Ind.
Antarctic Minke whale	228 / 1,187	12 / 23	161 / 440	10 / 21
Like Antarctic Minke whale	15 / 17		1 / 1	1 / 15
Blue whale	20 / 43		4 / 8	3 / 4
Fin whale	53 / 300	6 / 53	41 / 102	10 / 42
Humpback whale	141 / 261	2 / 4	127 / 228	15 / 26
Unidentified Baleen whales	63 / 181	1 / 1	16 / 27	5 / 11
Sperm whale	43 / 44	4 / 5	76 / 76	9 / 9
Southern bottlenose whale	7 / 14		36 / 59	
Mesoplodon spp.			2 / 3	
Unidentified Beaked whales	29 / 51		50 / 79	4 / 7
Killer whale	4 / 68		7 / 45	
Unidentified whales	3 / 3		19 / 19	

Table 3. Density indices (DI) and mean school size (MSS) of Antarctic minke whale and humpback whale primary sightings by SV and SSVs. *As SSVs searched only 30.0n.miles in the Prydz Bay in total (see Table 1), these value do not represent the whole stratum.

	Antarctic minke whale						Humpback whale					
	SV		SSV		Combined		SV		SSV		Combined	
Stratum	DI	MSS	DI	MSS	DI	MSS	DI	MSS	DI	MSS	DI	MSS
Area III-E	**9.06**	**5.21**	**4.77**	**2.73**	**6.60**	**4.18**	**5.60**	**1.85**	**3.76**	**1.80**	**4.55**	**1.82**
Area IV	**5.04**	**2.52**	**5.35**	**2.21**	**5.25**	**2.31**	**10.17**	**1.92**	**10.84**	**1.83**	**10.62**	**1.86**
East-North	1.40	1.75	1.81	1.57	1.69	1.62	7.38	1.79	7.96	1.79	7.78	1.79
East-South	3.00	4.77	3.93	1.81	3.66	2.50	18.46	1.95	11.01	1.78	13.13	1.85
West-North	3.43	1.14	2.26	1.35	2.56	1.28	7.82	1.85	7.36	1.75	7.48	1.78
West-South	9.53	2.35	19.16	2.70	14.99	2.60	11.46	2.02	23.04	1.96	18.02	1.97
Prydz Bay	11.70	2.48	90.00*	2.04	16.32	2.34	0.42	2.00	0*	-	0.39	2.00
Combined	**6.49**	**3.87**	**5.19**	**2.34**	**5.66**	**2.98**	**8.53**	**1.91**	**8.90**	**1.83**	**8.76**	**1.85**

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

Stratum	SV & SSV Combined						
	Photo-ID			Biopsy			
	number of individuals			number of samples			
	B	HP	R	B	F	HP	R
Area IIIE	**9**	**39**	**0**	**2**	**4**	**26**	**0**
Area IV	**4**	**46**	**2**	**2**	**0**	**36**	**2**
East-North		5				4	
East-South		15				10	
West-North		16				13	
West-South	4	10	2	2		9	2
Prydz Bay							
Grand Total	**13**	**85**	**2**	**4**	**4**	**62**	**2**

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

Stratum	CTD	XCTD	XCTD	EPCS		Scientific Echosounder
	number of stations	number of stations	number of stations	running days		logging days
	KS2	KS2	KS2	KS2	YS2	KS2
Area III-E	**20**	**2**	**16**	**26**	**27**	**24**
Area IV	**34**	**120**	**25**	**65**	**66**	**57**
East-North	12	23		14	13	13
East-South	5	13	21	14	18	12
West-North	11	24		14	16	13
West-South	4	26	4	18	17	15
Prydz Bay	2	34		5	2	4
Grand Total	**54**	**122**	**41**	**91**	**93**	**81**

Table 5. Summary of biological data and samples collected.

Samples and data	Number of whales		
	Male	Female	Total
-Data-			
Photographic record of external character	200	240	440
Body length and sex identification	200	240	440
Measurement of external body proportion	200	240	440
Body weight	200	240	440
Body weight by total weight of parts	29	38	67
Skull measurement (length and breadth)	197	239	436
Craniometric study	1	1	2
Standard measurement of blubber thickness (five points)	171	202	373
Detailed measurement of blubber thickness (fourteen points)	29	38	67
Mammary gland; lactation status and measurement	-	240	240
Breadth measurement of uterine horn	-	240	240
Testis and epididymis weight	200	-	200
Weight of stomach content in each compartment	200	239	439
Photographic record of fetus	78	56	155*
Fetal length and weight	78	56	155*
External measurements of fetus	78**	56	134
Number of ribs	200	240	440
-Sample-			
Diatom film record and sampling	200	239	439
Serum sample for physiological study	200	240	440
Earplug for age determination	200	240	440
Tympanic bone for age determination	66	62	128
Largest baleen plate for age determination	197	238	435
Largest baleen plate for morphological study	197	238	435
Vertebral epiphyses sample	200	240	440
Ovary	-	240	240
Histological sample of endometrium	-	240	240
Histological sample of mammary gland	-	240	240
Milk sample for chemical analysis	-	4	4
Histological sample of testis	200	-	200
Histological sample of epididymis	200	-	200
Testis and epididymis stamp smear for sperm detection	200	-	200
Skin, blubber, muscle, liver, kidney and heart tissues for genetic study	200	240	440
Muscle, liver and kidney tissues for heavy metal analysis	200	240	440
Blubber and liver tissues for organochlorine analysis	200	240	440
Muscle, liver and blubber tissues for lipid analysis	29	38	67
Stomach contents for food and feeding study	47	66	113
Stomach contents for heavy metal analysis	8	14	22
Stomach contents for organochlorine analysis	11	6	17
Stomach contents for lipid analysis	10	13	23
External parasites	38	54	92
Internal parasites	5	15	20
Fetus	0	0	17*
Skin, blubber, muscle, liver, kidney and heart tissues of fetus for genetic study	68	51	119
Oocyte for *in-vitro* fertilization (IVF)	-	168	168
Oviductal fluids for *in-vitro* culture (IVC)	-	13	13
Spermatogenic cell for round spermatid injection (ROSI)	13	-	13
Adult vertebra, rib, sternum, humerus, spleen and liver for histological study	4	0	4
Fetal vertebra, rib, sternum, humerus, spleen and liver for histological study	16	5	21
Fetal pectoral fin for molecular biological study	2	3	5
Fetal kidney and liver for molecular biological study	1	1	2
Adult heart for anatomical study	1	1	2
Fetal heart for anatomical study	2	0	2
Fetal upper part of the body for anatomical study	3	0	3
Skeleton for educational exhibition	2	0	2
Skull for educational exhibition	3	0	3
Baleen plate for educational exhibition		0	0

* : including a fetus of sex unidentified.

** : External measurement of a fetus was partly done when it was broken by harpoon.

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 that had corpus luteum but fetus was not observed.

Stratum	Male			Female						
	Immature	Mature	Total	Immature	Mature					
					Pregnant	Resting	Preg.+Lac	Ovulating	Lactating	Total
Area IIIE										
First-period	9	53	62	21	22	2	3	0	0	48
	(8.2)	(48.2)	(56.4)	(19.1)	(20.0)	(1.8)	(2.7)	(0.0)	(0.0)	(43.6)
Area IV										
East-North	13	14	27	12	2	0	1	1	0	16
	(30.2)	(32.6)	(62.8)	(27.9)	(4.7)	(0.0)	(2.3)	(2.3)	(0.0)	(37.2)
East-South	12	19	31	14	27	4	1	0	0	46
	(15.6)	(24.7)	(40.3)	(18.2)	(35.1)	(5.2)	(1.3)	(0.0)	(0.0)	(59.7)
West-North	6	19	25	8	8	2	1	0	0	19
	(13.6)	(43.2)	(56.8)	(18.2)	(18.2)	(4.5)	(2.3)	(0.0)	(0.0)	(43.2)
West-South	14	27	41	15	77	3	3	0	2	100
	(9.9)	(19.1)	(29.1)	(10.6)	(54.6)	(2.1)	(2.1)	(0.0)	(1.4)	(70.9)
Prydz Bay	1	13	14	1	10	0	0	0	0	11
	(4.0)	(52.0)	(56.0)	(4.0)	(40.0)	(0.0)	(0.0)	(0.0)	(0.0)	(44.0)
Combined	46	92	138	50	124	9	6	1	2	192
	(13.9)	(27.9)	(41.8)	(15.2)	(37.6)	(2.7)	(1.8)	(0.3)	(0.6)	(58.2)
Grand total	55	145	200	71	146	11	9	1	2	240
	(12.5)	(33.0)	(45.5)	(16.1)	(33.2)	(2.5)	(2.0)	(0.2)	(0.5)	(54.5)

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		
	Immature	Mature	Total	Immature	Mature	Total
Area IIIE						
First-period	6.27 ± 0.65	8.33 ± 0.36	8.03 ± 0.83	7.29 ± 0.81	9.04 ± 0.45	8.28 ± 1.08
	(5.14 - 7.19)	(7.64 - 9.03)	(5.14 - 9.03)	(5.38 - 8.42)	(8.14 - 10.05)	(5.38 - 10.05)
Area IV						
East-North	6.23 ± 0.99	8.41 ± 0.52	7.36 ± 1.35	6.53 ± 1.25	9.10 ± 0.37	7.17 ± 1.58
	(4.94 - 7.81)	(7.71 - 9.39)	(4.94 - 9.39)	(5.11 - 9.02)	(8.58 - 9.38)	(5.11 - 9.38)
East-South	5.99 ± 0.74	8.33 ± 0.38	7.43 ± 1.28	6.32 ± 1.13	8.98 ± 0.45	8.17 ± 1.43
	(5.08 - 7.51)	(7.63 - 8.93)	(5.08 - 8.93)	(5.13 - 8.36)	(7.34 - 9.60)	(5.13 - 9.60)
West-North	6.49 ± 1.41	8.49 ± 0.33	8.01 ± 1.12	6.13 ± 1.12	8.90 ± 0.38	7.73 ± 1.59
	(5.31 - 8.82)	(7.86 - 9.29)	(5.31 - 9.29)	(4.90 - 8.40)	(8.31 - 9.48)	(4.90 - 9.48)
West-South	6.23 ± 0.83	8.39 ± 0.32	7.65 ± 1.17	7.11 ± 0.81	9.01 ± 0.40	8.72 ± 0.83
	(5.31 - 7.85)	(7.39 - 8.98)	(5.31 - 8.98)	(5.79 - 8.30)	(8.05 - 9.97)	(5.79 - 9.97)
Prydz Bay	7.51	8.53 ± 0.37	8.46 ± 0.45	7.26	9.13 ± 0.33	8.96 ± 0.64
		(7.85 - 9.16)	(7.51 - 9.16)		(8.64 - 9.74)	(7.26 - 9.74)
Combined	6.23 ± 0.94	8.42 ± 0.38	7.69 ± 1.21	6.60 ± 1.10	9.00 ± 0.40	8.38 ± 1.25
	(4.94 - 8.82)	(7.39 - 9.39)	(4.94 - 9.39)	(4.90 - 9.02)	(7.34 - 9.97)	(4.90 - 9.97)
Grand total	6.24 ± 0.89	8.39 ± 0.37	7.80 ± 1.11	6.80 ± 1.06	9.01 ± 0.41	8.36 ± 1.21
	(4.94 - 8.82)	(7.39 - 9.39)	(4.94 - 9.39)	(4.90 - 9.02)	(7.34 - 10.05)	(4.90 - 10.05)

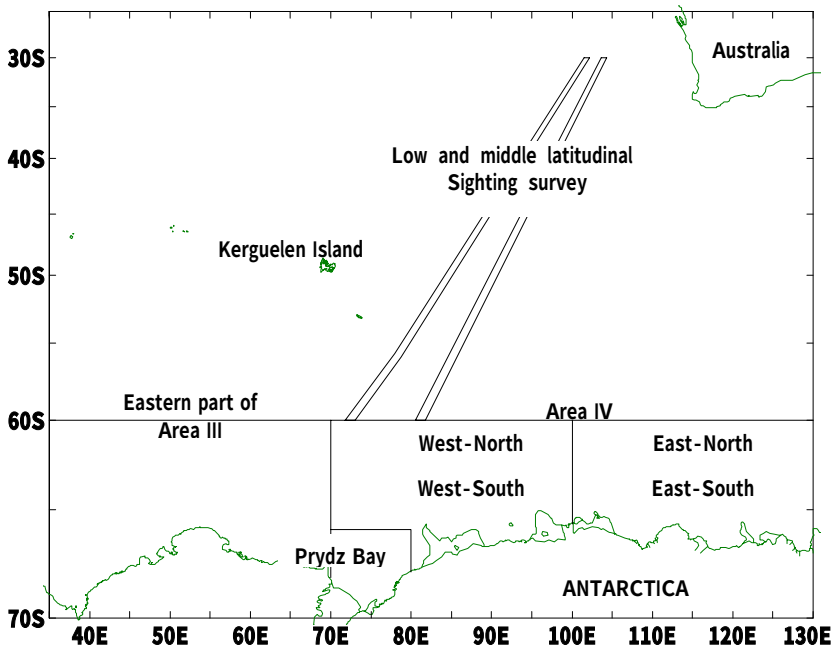

Fig. 1. Geographic location of research area of the 2003/2004 JARPA surveys and cruise tracks of sighting survey between research area and Japan.

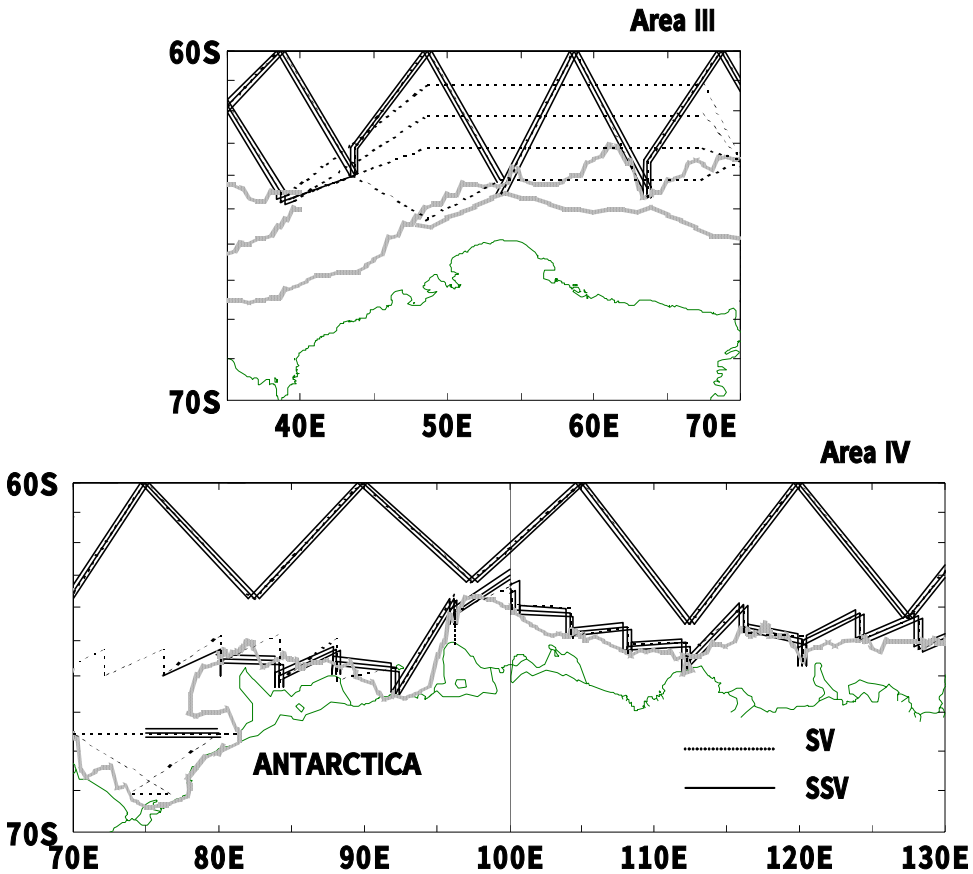

Fig. 2. Cruise track line of sighting vessel (SV, broken line) and sighting/ sampling vessels (SSVs, solid line) in 2003/2004 JARPA. Pack ice lines (bold and solid line) are estimated by observation of research vessels and the information from SSM / I.

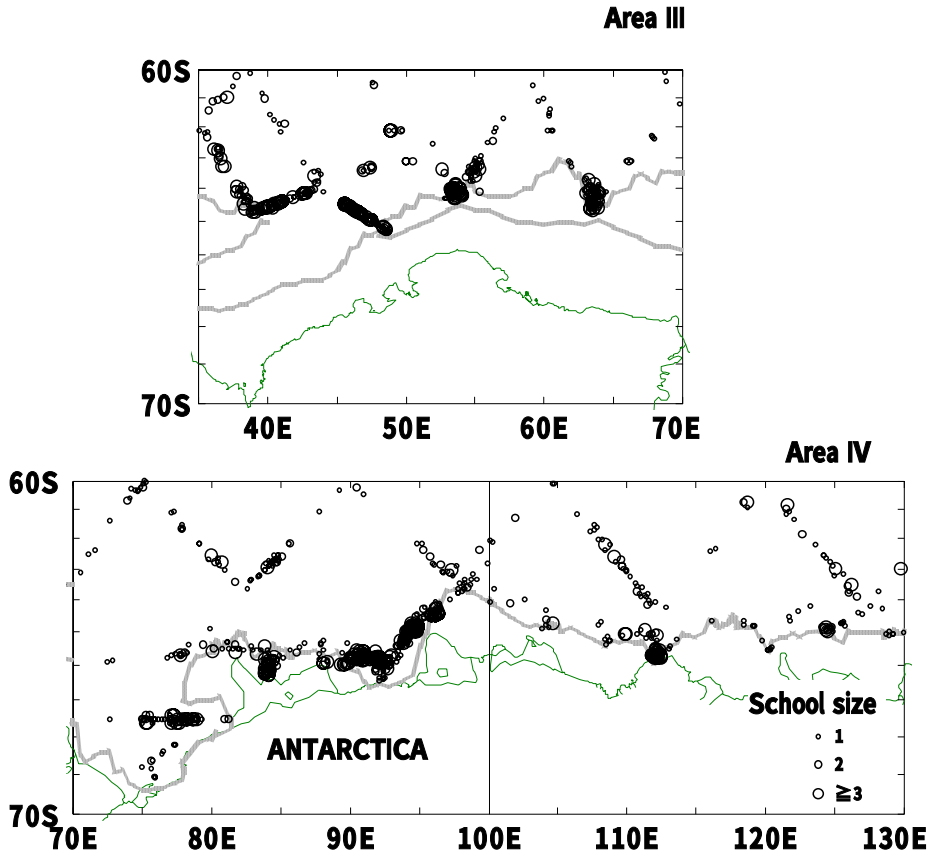

Fig. 3. Distribution of sightings of Antarctic minke whales sighted by SV and SSVs in 2003/2004 JARPA.

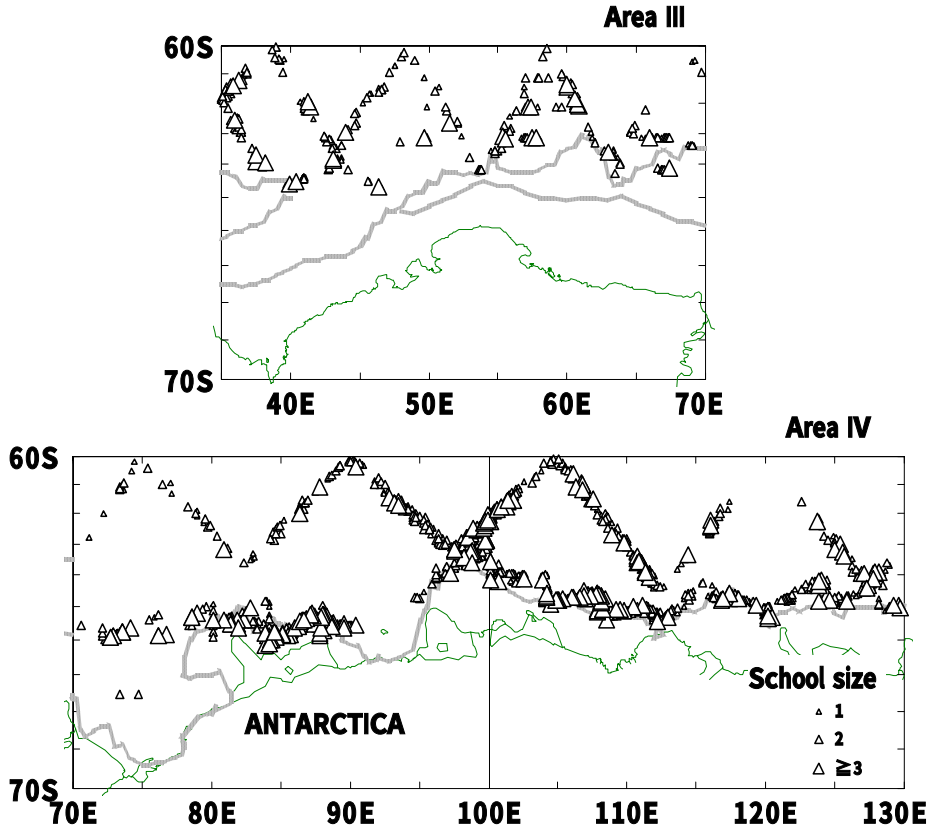

Fig. 4. Distribution of sightings of humpback whales sighted by SV and SSVs in 2003/2004 JARPA.

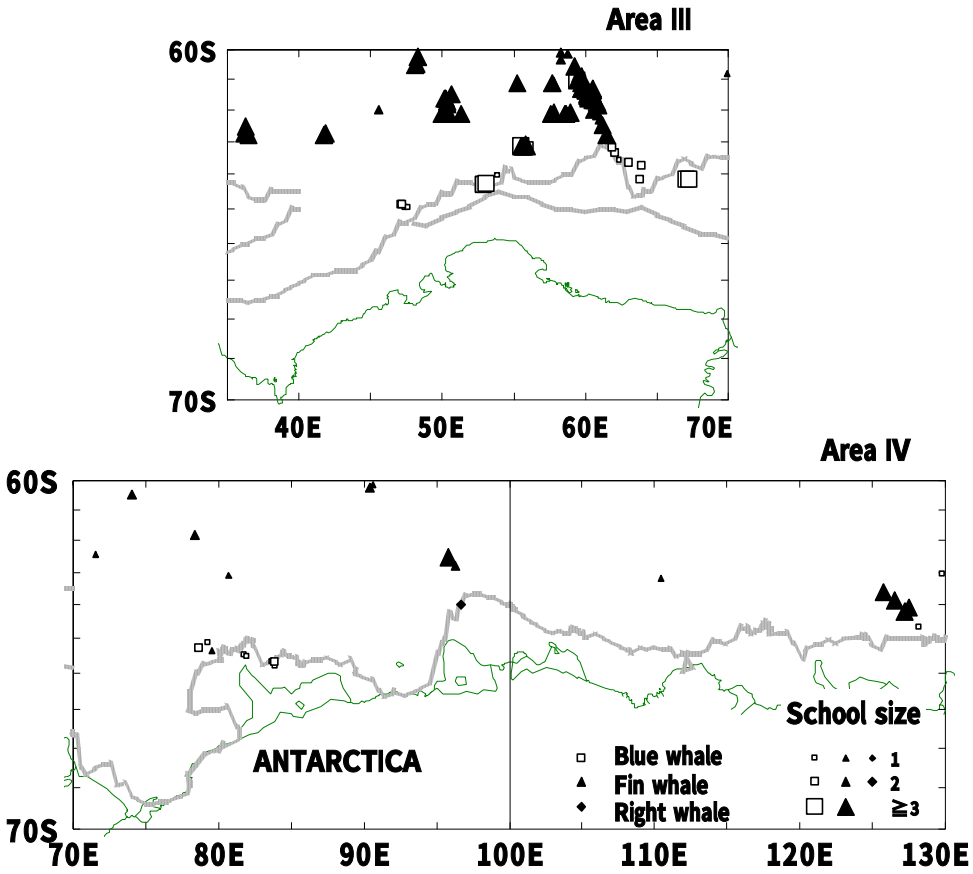

Fig. 5. Distribution of sightings of blue, fin and right whales sighted by SV and SSVs in 2003/2004 JARPA.

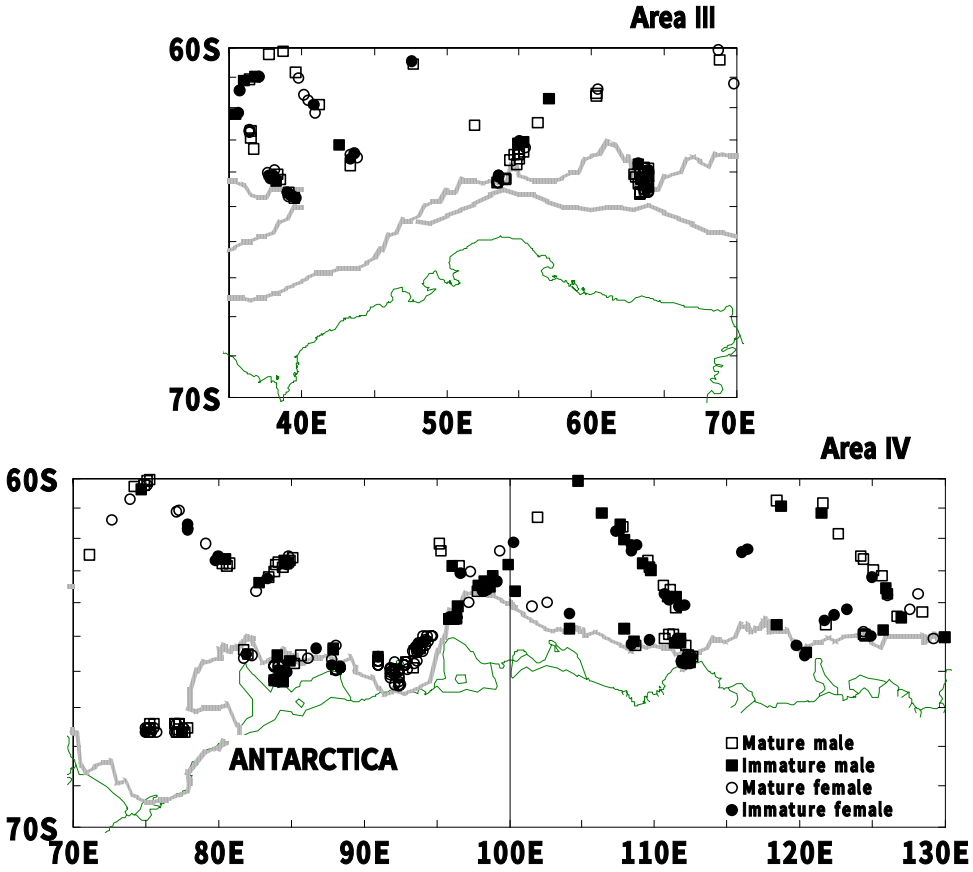

Fig. 6. Sighted position of sampled Antarctic minke whales by sex and reproductive status in 2003/2004 JARPA.

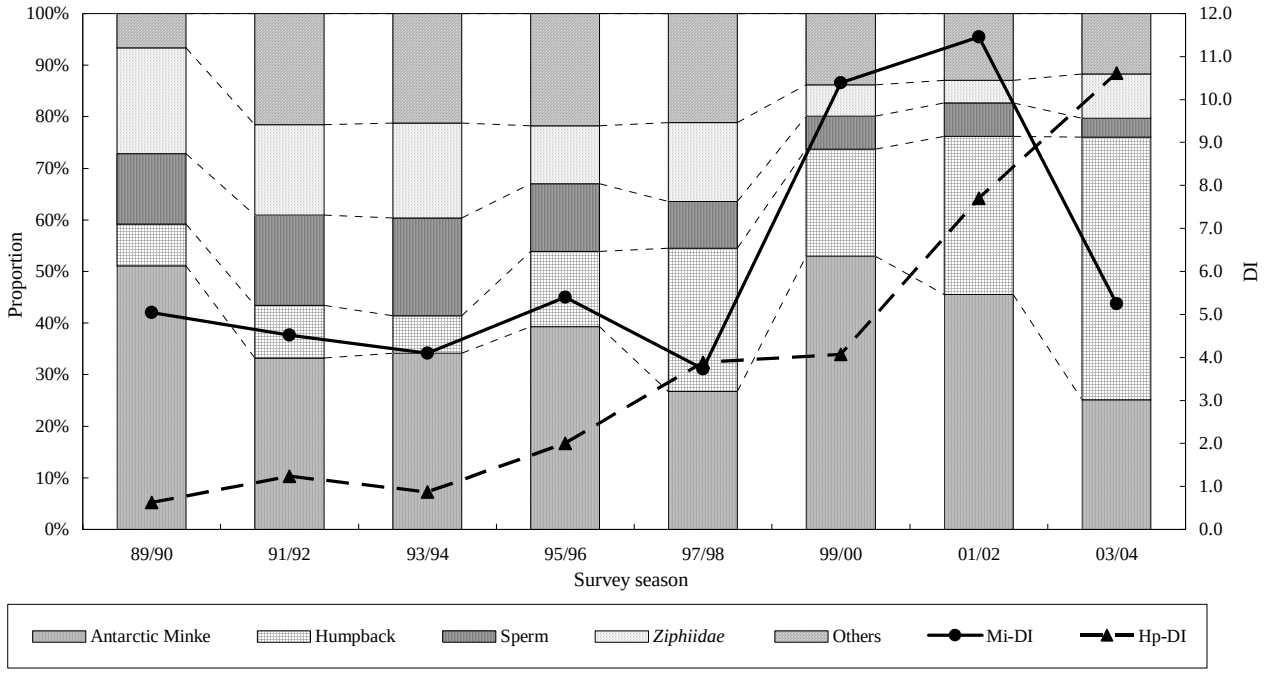

Fig. 7. Yearly change of species composition of sightings and DI of Antarctic minke and humpback whales in Area IV.