Cruise Report of the Second Phase of the Japanese Whale Research Program under Special Permit in the Antarctic (JARPAII) in 2007/2008

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ABSTRACT

The 2007/08 Second Phase of the Japanese Whale Research Program under the Special Permit in the Antarctic (JARPA II) was conducted following feasibility research in the 2005/06 and 2006/07 austral summer seasons. Two dedicated sighting vessels (SVs), three sighting and sampling vessels (SSVs) and one research base ship engaged in the research for 101 days from 15 December 2007 to 24 March 2008. The planned research area was Area III East (35°E - 70°E), Area IV (70°E - 130°E), Area V West (130°E - 165°E) and a part of Area V East (165°E - 175°E). The research activity was interrupted several times by violent action by anti-whaling groups. As a result, both sighting and sampling surveys in the Area V East were canceled and sampling survey in the Area IV East and Area V West was not fully completed. The results of the sighting survey showed that the sighting number of humpback whales was far greater than those of Antarctic minke whales in the Areas III and IV. On the other hand, Antarctic minke whale sighting was less than a half of that in the previous survey conducted in the same area in 2005/06. It was suggested that the increase and habitat expansion of humpback whales in those areas may affect the distribution of Antarctic minke whales in the Antarctic. A sighting and sampling survey in a polynya revealed that mature female Antarctic minke whales were concentrated within the polynya and that they were segregated from humpback whales which were distributed outside of the polynya. The results support the hypothesis that many Antarctic minke whales, especially mature females, are distributed in the ice free area beyond the ice edge where research vessels could not enter. For the improvement of the management of whales in the Antarctic, elucidation of the interactions between humpback and Antarctic minke whales related to habitat and prey and elucidation of the behavior of Antarctic minke whales in pack ice are necessary. A combination of lethal and non-lethal methods, such as comparison of results obtained from stomach content analysis and net sampling is important to elucidate the role of whales in the Antarctic ecosystem.

KEYWORDS: JARPAII, ANTARCTIC MINKE WHALES, HUMPBACK WHALES, POLYNYA, SCIENTIFIC PERMITS.

INTRODUCTION

The Japanese Whale Research Program under the Special Permit in the Antarctic (JARPA) was conducted between 1987/88 and 2004/05 austral summer seasons, under Article VIII of the International Convention for the Regulation of Whaling. The IWC Scientific Committee conducted an interim review of JARPA results in 1997 and the final review in 2006. In 2005, another JARPA review meeting called by the Government of Japan was also held. JARPA provided a wide variety of information on biological parameters of Antarctic minke whale (*Balaenoptera bonaerensis*) such as the natural mortality coefficient and changes over time in the age at sexual maturity as well as narrowing down the parameters of relevance for stock management. IWC recognized these results from JARPA have the potential to improve management of minke whales in the Southern Hemisphere (IWC, 1998, 2007). JARPA data also demonstrated that there were at least two Antarctic minke whale stocks in the research area, and that their geographical boundaries were different from those used by the IWC, i.e. 150°E -165°E was suggested (IWC, 2007). The review meeting in 2005 agreed that results from JARPA were consistent with the behavior to be expected for baleen whale populations competing for a dominant single food resource, krill. The meeting also agreed that the JARPA results provided clear support for the need to take species-interaction effects into account in understanding the dynamics of the baleen whale species in the Antarctic ecosystem, and predicting future trends in their abundance and population structure (Government of Japan. 2005).

Based on these considerations, the Government of Japan launched a new comprehensive study, the Second Phase of the Japanese Whale Research Program under Special Permit in the Antarctic (JARPA II), which combined lethal and non-lethal methods, starting from the 2005/06 austral summer season. The first two seasons (2005/06 and 2006/07) were dedicated to feasibility studies. Evaluation of two feasibility studies concluded that the practicability and appropriateness of the planned sighting and sampling methods and design were adequate and could be used to cover the entire research area under normal conditions (Government of Japan, 2007), therefore Japan decided to execute the original plan of JARPA II.

The 2007/08 season was the first full-scale survey of JARPA II. JARPA II is a long-term research program with the following objectives; 1) Monitoring of the Antarctic ecosystem, 2) Modeling interaction among whale species and developing future management objectives, 3) Elucidation of temporal and spatial changes in stock structure and 4) Improving the management procedure for the Antarctic minke whale stocks. JARPA II focuses on Antarctic minke whale, humpback whale (*Megaptera novaeangliae*), fin whale (*B. physalus*) and possibly other species in the Antarctic ecosystem that are major predators of Antarctic krill.

This is a cruise report of the 2007/08 JARPA II. In this season, the survey area could not be covered completely and the number of whale sample was restricted because of violent obstruction from anti-whaling groups. However, most of other research items were completed and valuable data and samples were obtained.

RESEARCH METHODS

Research vessels

The research fleet was composed of two dedicated sighting vessels, three sighting and sampling vessels and one research base ship. Following vessels were used.

Dedicated sighting vessels (SVs)

Kyoshin Maru No. 2 (KS2; 372 tons)
Kaiko Maru (KK1; 860.25 tons)

Sighting and sampling vessels (SSVs)

Yushin Maru No. 1 (YS1; 720 tons)
Yushin Maru No. 2 (YS2; 747 tons)
Yushin Maru No. 3 (YS3; 742 tons)

Research base ship

Nisshin Maru (NM; 8,044 tons)

Two SVs were dedicated to sighting survey, prey species survey, oceanographic survey and most of the various experiments. Three SSVs were engaged in sighting and sampling surveys. NM served as a research base on which all biological examinations of sampled whales were conducted.

Research area

The area to be covered by JARPA II is basically same as JARPA; the eastern part of Area III, Areas IV and V, and the western part of Area VI (35°E - 145°W), south of 60°S. The research area for 2007/08 JARPA II was western side of the whole research area, i.e. Area IIIE (35°E - 70°E), Area IVW (70°E - 100°E), Area IVE (100°E - 130°E), Area VW (130°E - 165°E) and a part of Area VE (165°E - 175°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. The southern boundary of the West-south stratum in Area IV between 70°E and 80°E was fixed at 66°S and the Prydz Bay was defined as the southern area of this boundary. Fig.1 shows geographic location of the research area for the 2007/08 JARPAII survey. The SVs cover south of 60°S, whereas the SSVs cover south of 62°S (Government of Japan. 2005).

Survey track line design

The survey track line for the SVs consisted of two legs in the northern stratum at 5° longitudinal degree intervals and four legs in the southern stratum for 2°30' longitudinal degree intervals (Fig. 2). Two SVs alternately survey the northern and southern strata each crossing the track line at the veering point between two strata.

The survey track line for the SSVs consisted of a zigzag course changing direction at 2°30' or 1°40' longitudinal degree intervals. Three parallel track lines were set at 7 n. miles apart (Fig. 3). The two legs of track line for the northern stratum were set every six legs for southern stratum, in principle. The interval of legs and number of legs for the northern stratum could be changed by sub-area according to progress of the survey.

Sighting method

Sighting procedures followed the previous JARPA surveys (e.g. Nishiwaki *et al*. 1999, Ishikawa *et al*. 2000) in principle. The sighting survey using SSVs was conducted under limited closing mode (when a sighting of target species was made on the predetermined track line, the vessel approached the whales and species and school size were confirmed). Three SSVs advanced along parallel track lines at a standard speed of 11.5 knots.

The sighting survey of SVs 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 whales directly and searching from the barrel was uninterrupted). Two SVs advanced at a standard speed of 10.5 knots.

Both SV and SSV survey were operated under the same optimal research conditions (when the wind speed was below 25 knots in the southern strata and 20 knots in the northern strata and visibility was more than 2.0 n. miles). In addition to the sightings of Antarctic minke whales and fin whales or whales suspected to be these species, the SVs and SSVs approached blue whales (*Balaenoptera musculus*) and southern right whales (*Eubalaena australis*) for conducting experiments. Humpback whales and other whales were also approached for conducting

experiments.

Low and middle latitudinal sighting survey (Non-lethal research)

During transit cruises, sighting surveys were conducted in the area between 30°S and 60°S outside of national EEZs. The results of these surveys are not shown in this report.

Non-lethal research and experiments

Sighting distance and angle experiment

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

The following species were targeted for photographic record of natural markings during the surveys conducted from the SVs; blue whales, humpback whales and southern right whales. Photographic records of these species were also occasionally taken from the SSVs.

Biopsy sampling

In addition to the species targeted for the photo-identification experiment, pygmy right whale (*Caperea marginata*), fin whale, sei whale (*B.borealis*), sperm whale (*Physeter macrocehpalus*) and southern bottlenose whale (*Hyperoodon planifrons*) were targeted for biopsy skin sampling by the SVs and SSVs using a compound-crossbow. All samples collected were preserved at –80°C.

Prey species survey

Two SVs conducted hydro-acoustic surveys using a passive acoustic system (EK500 with operating frequencies at 38kHz, 120kHz, 200kHz, SIMRAD, Norway) to elucidate distribution and abundance of prey species of Antarctic baleen whales. KK1 conducted net sampling for prey species of whales. The IKMT was used for sampling of krill and the NORPAC net was used for amphipods.

Oceanographic survey

Two SVs conducted the following oceanographic survey; 1) consecutive measuring of surface water temperature, conductivity, surface chlorophyll, dissolved oxygen and surface particle by Electric Particle Counting and Sizing System (EPCS), 2) XCTD and CTD survey and 3) marine debris recording in the research area. All marine debris found in the stomach of whales taken was also recorded and collected on the NM. In addition to these surveys, KK1 deployed Argo profiling floats (profiling devices) to collect high quality oceanographic data of upper and middle layers of the world ocean simultaneously with very high space-time resolution. This was a cooperative study with Japan Marine Science and Technology Center (JAMSTEC) (See http://w3.jamstec.go.jp/ARGO/J_ARGOe.html).

Sampling and biological survey for whales (lethal research)

Three SSVs were engaged in the whale sampling survey. 850 Antarctic minke whales (with 10 % allowance) and 50 fin whales were planned to be taken in the research area south of 62°S. Although the original plan included 50 humpback whales (Government of Japan. 2005), Government of Japan decided to suspend the sampling of humpback whales.

One or two Antarctic minke whales were targeted randomly for sampling from each primary sighted school within 3 n. miles of each track line. The dwarf minke whale was not a target for sampling. The fin whale was also targeted randomly from each primary sighted school within 3 n. miles of each track line. However, target of fin whales was restricted to an estimated body length less than 20 m due to a limitation of the research base ship facility for dissection. Biological research on all sampled whales were conducted on the NM

RESULTS

Outline of the research activities

Table 1 shows an outline of the research activities. The research period in the 2007/08 JARPAII was 101 days from 15 December 2007 to 24 March 2008.

On 7 January, NM received GMDSS (Global Maritime Distress and Safety System) emergency call. Responding to the request from the RCC (Rescue Coordinate Center) Australia, NM engaged in rescue activity of injured crew on a fishing vessel. Unfortunately the crew deceased and we were released from the rescue operation on 8 January by the RCC Australia.

Following the rescue operation, the research activity was interrupted several times by violent actions from anti-whaling groups. A Greenpeace (GP) vessel stalked the research base ship (NM) from 11 to 26 January and obstructed refueling of NM on 22 January. A Sea Shepherd (SS) vessel attacked YS2 and two hoodlums intruded the vessel on 15 January. The SS vessel also attacked YS3 on 17 January. Although we continued moving to avoid collision with SS, we encountered SS on 23 February and the SS vessel stalked 7 days and attacked NM twice on 3 and 7 March.

An Australian patrol ship, Oceanic Viking (OV) stalked NM and three SSVs from 22 January to 12 February. Although OV never obstructed research activity directly, it often approached our vessels at abnormally close distance and our crew members were exposed to potential threats of ship collisions all the time.

Research activity was interrupted for a total of 31 days. As this resulted in a reduction of the number of research days, both sighting and sampling surveys in the Area VE were canceled. Furthermore, the sampling surveys in Area IVE and Area VW were restricted.

Developed ice edge covered the Prydz Bay throughout the research period and prevented the research vessels from entering into the Bay. Therefore both SVs and SSVs conducted limited surveys within a small area between 66°S and the ice edge covering the Prydz Bay (data was combined with that for the West-south stratum in the area IV).

Results of non-lethal survey

Sighting survey

The searching distances of the SVs and the SSVs are shown in Table 2. The searching effort on the predetermined track line is shown in Figs. 4 and 5. The total searching distance was 14,575.4 n. miles consisting of 8,029.2 n. miles for the two SVs and 6,546.2 n. miles for the three SSVs. Compared to the 2005/06 survey in the same research area, the searching distance for SVs and SSVs was 807 n. miles and 990.3 n. miles lower, respectively. This is because research activity was interrupted for a prolonged period of time as described above and because the research vessels could not enter the Prydz Bay due to the thick pack ice. Proportions for northern strata in the total searching distance were 54.4 % for SVs and 25.5 % for SSVs. Searching effort by SVs was almost equal in northern and southern strata.

Whale species sighted

Twelve species including six baleen whales and six toothed whales were identified during the research period. Table 3 shows the number of sightings for eight large whale species and Figs 6 and 7 show sighting position of humpback and Antarctic minke whales. Humpback whale was the most abundant species in the research area, followed by Antarctic minke whale. The number of sightings of humpback whales (1,433 schools and 2,753 individuals in total) was about 1.5 times of that of Antarctic minke whales (926 schools and 1,961 individuals) and was considerably higher than that of other species. Many sightings of southern right whales were made, whereas the number of sightings of fin whale was relatively low. Both Antarctic minke whale and humpback whales were widely distributed in the whole research area, but density of the distribution was different among each stratum. Table 4 shows density indices (DI, the number of primary sighted schools per 100 n. miles) and mean school size (MSS) of Antarctic minke, humpback and fin whales for two SVs. The DI of Antarctic minke whale was higher in the southern strata than that in northern strata and the highest in the West-south stratum in the Area V. However, the DI in the Area IV was relatively low in every stratum. On the other hand, the density of humpback whale was high in both the northern and southern strata except for the Area VW. The DI for humpback whale in each stratum of Area IV was 5.8 - 29.5 times of that for Antarctic minke whale.

Fig. 8 shows the sighting position of other large whales. More southern right whales and blue whales were sighted than that reported for previous seasons. Most sightings of southern right whales were made in the southern strata of the Area IV. The sightings of blue whales were concentrated in the Area IIIE. Distribution of fin whale was sparse in the research area and few fin whales were found in the Area IVE.

Photo-ID and biopsy sampling

Table 5 summarizes the results of the photo-identification experiment. A total of 75 individual blue, humpback and southern right whales were photographed. Table 6 summarizes results of biopsy sampling. A total of 32 biopsy samples were collected from blue, fin, humpback and southern right whales. One sample from a carcass of a sperm whale was also collected.

Prey species and oceanographic survey

Table 7 shows the summary of prey species and oceanographic surveys. The CTD casting was conducted at 90 locations at the same point as net sampling by KK1 and once a day by KS2. The XCTD casting was conducted at 98 locations at predetermined positions. EPCS collected data for 87 days by KS2 in total. KS2 and KK1 conducted the quantitative echo sounder survey for 171 days in the whole research area except for the Area VE. KK1 conducted IKMT and NORPAC net sampling 36 and 37 times, respectively. Fig. 9 shows an overview of the prey species and the oceanographic survey in the research area.

Survey for the marine debris

The marine debris survey was carried out concomitant with the sighting survey of the two SVs in the research area. A total of 32 debris items was recorded which consisted of 28 buoys or floats, one rope, one lump of Styrofoam, one drum can and an unidentified box object. Most of these items seemed to be fishing gear related.

Sighting distance and angle experiment

A sighting distance and angle experiment was performed on 30-31 December 2007 by three SSVs and on 2 and 5 January 2008 by KS2 and KK1, respectively. The results of this experiment will be used in calculation of abundance estimates.

Results of lethal survey

Sampling for Antarctic minke whales

Out of 501 schools (979 individuals) in the primary sightings of Antarctic minke whales by three SSVs, 473 schools (912 individuals) were targeted for sampling. A total of 551 individuals were sampled (229 from Area IIIE, 222 from Area IVW, 13 from Area IVE and 87 from Area VW). Sampling efficiency (the rate of successful sampling for targeted individuals) was 86.2 % for solitary schools, 95.6 % for the first targeted individual from multitude schools and 54.0 % for the second targeted individual from the same schools. An explosive harpoon was used as the primary killing method for all whales collected. When the animal was not killed instantaneously, a large caliber rifle and/or the second harpoon was used immediately as the secondary killing method. No struck and lost case occurred.

Sampling for fin whales

Although 50 whales were planned for sampling, three SSVs made only nine primary sightings of fin whales. Sampling for these whales was not conducted due to inappropriate sea condition for safe transferring and flensing and/or practical reasons.

Biological research

Biological research was conducted on the research base ship for all whales sampled. Table 8 summarizes biological data and samples collected from the Antarctic minke whales.

Biological information of sampled whales

Table 9 shows the reproductive status of sampled Antarctic minke whales by stratum. Fig. 10 shows distribution of sighting position of sampled Antarctic minke whales by sex and sexually mature status. Mature females were dominant in the IVW-south and VW-south strata, whereas mature males were dominant in both north and south strata in the Area IIIE. In the IVW-north stratum, both immature males and females were dominant. Pregnancy rate in mature females was 92.3 % (168 individuals) in the whole research area. Two cases of twins were observed. Three lactating females were sampled, though neither suckling calf was sampled nor observed.

Fig. 11 shows body length distribution of Antarctic minke whales sampled during the 2007/08 JARPA II survey. Maximum length of the sample was 10.18 m for females and 9.23 m for males. Minimum length was 5.13 m and 4.82 m for female and male, respectively. Maximum body length of immature animals was 8.82 m and 8.61 m for female and male, whereas minimum body length of mature animals was 7.93 m and 7.05 m for female and male, respectively.

By-products from the research

All whales were processed on NM after biological examination, according to the provisions of Article VIII of the Convention. A total of 1,983.7 tons of meat, blubber, viscera, etc. was produced.

DISCUSSIONS

The third cruise of JARPAII was planned as the first full-scale research after two feasibility research cruises (Government of Japan, 2005). As the Government of Japan decided to suspend sampling of 50 humpback whales, target species and numbers for lethal sampling were 850 ± 85 of Antarctic minke whales and 50 of fin whales.

However, preventing collisions with vessels of violent and obstructive groups and ensuring the safety of crew and vessels, resulted in a suspension of research activity for 31 days. Due to the reduction in the number of research days, sampling activity of SSVs was restricted and could not cover whole research area. As a result, the total number of samples was lower than for the 2005/06 feasibility study in which nearly the same area was surveyed (Nishiwaki *et al*., 2006).

In spite of the restricted survey, the 2007/08 JARPAII cruise obtained many important results summarized as follows:

1) Total number of sightings of humpback whales was far higher than that of Antarctic minke whales in this season. They were found widely distributed in both the southern and northern strata especially in the Areas IIIE and IV. Drastic increases of humpback whale sightings in the Areas IIIE and IV had been repeatedly reported in scientific documents from JARPA (e.g. Ishikawa *et al.*, 2000, 2002, 2004). It was suggested that the population of humpback whales were recovering and expanding their distributions year by year. It was also suggested that the population increase and habitat expansion of humpback whales in the Area IV may lead to interactions with Antarctic minke whales (Ishikawa *et al.*, 2004, Matsuoka *et al.*, 2003, 2005, 2006.). The results of the sighting survey in this season strongly support these findings.

2) On the other hand, the total number of sightings for Antarctic minke whale was less than a half of that in the previous (2005/06) survey. DI for the SV (Table 4) was only 4.1 in the entire area, which was one third of that in the 2005/06 survey (Nishiwaki *et al*., 2006). Antarctic minke whales were more abundant in the southern strata of Areas IIIE, IVW and VW, whereas they were infrequently found in the northern strata of the Area IIIE and whole of the Area IVE. It is likely that the lower sighting number and smaller DI for Antarctic minke whales in this season were caused by complicated pack ice in Area IV. The Prydz Bay in the area IVW, where a large number of Antarctic minke whale sightings was expected, was isolated by thick ice throughout the austral summer in the 2007/08 season. A large ice-free area (polynya) was observed in the Prydz Bay from December to February from satellite photographs and information from the National Snow and Ice Data Center (NSIDC), US. Furthermore, it was observed that a lot of medium and small sized polynya occurred and/or disappeared in the Area IV compared to other seasons. Similar ice conditions were observed in the 1997/98 JARPA when the sightings and estimated population of Antarctic minke whale in Area IV were lower than those in other seasons (Ishikawa *et al*, 1998, Matsuoka *et al.*, 2006). It was suggested that many Antarctic minke whales, especially mature females, were distributed in the ice free area beyond the ice edge where research vessels could not enter (Ishikawa *et al*, 1998, Ishikawa, 2003). It was also suggested that recent drastic expansion of humpback whale distribution may force Antarctic minke whales to move in the pack ice (Ishikawa *et al*., 2004., Fujise *et al*., 2006).

3) To confirm above hypotheses, we conducted a sampling survey in a polynya formed at the Davis Sea, an area of the sea along the coast between West Ice Shelf and the Shackleton Ice Shelf (89ºE - 95ºE). Although concentrated pack ice covered the area north of the Davis Sea, we entered the polynya when a randomly set track line met the thinnest pack ice. Distribution pattern of humpback whales outside (north) of the pack ice was clearly separated from that of Antarctic minke whales inside of the polynya (Fig. 12). Biological survey of sampled whales revealed that most of the Antarctic minke whales distributed inside the polynya were mature females. The result shows the important examples of (1) the species interaction affecting distribution areas of humpback whales and Antarctic minke whales, (2) close relation between ice condition and distribution (sighting number) of Antarctic minke whales, and (3) segregation of Antarctic minke whales by sex and sexual maturity. Many

Antarctic minke whales in this season must have been distributed in the Prydz Bay and polynya formed by complicated pack ice. Fig .13 shows distribution pattern of Antarctic minke whales and humpback whales by latitude and water temperature. Although latitudinal distribution of the two species was overlapped between 64ºS to 65º30´S, humpback whales were apparently distributed in areas with higher sea surface temperature than Antarctic minke whales and Antarctic minke whales tend to distribute in higher latitude areas with lower sea surface temperature. One of the reasons why Antarctic minke whales tend to concentrate in polynya regardless of possibility of mass die offs from being bottled up by thick ice might be that pregnant females need to enter icy water to avoid disturbance from humpback and other larger whales.

4) Fin whales were not collected, although 50 whales were planned for sampling. One of the reasons was interruptions of sampling activity of SSVs, another was low numbers of sightings of this species. Nine sightings of fin whales by SSVs were not targeted for sampling due to inappropriate sea conditions for safe transferring and flensing and/or practical reasons.

However, SVs sighted relatively more fin whales north of 62ºS and a number of fin whales were sighted during the Low and Middle Latitudinal Sighting Survey conducted north of 60ºS (data is not shown). Therefore, it seems that in this season, fin whales were distributed more in northern areas as compared to other seasons.

5) Of 551 samples of Antarctic minke whales, maturity rate for male and female was 71.4 % and 65.5 %, respectively. 92.3 % of mature females were pregnant, which indicated their robust reproductive potential. 174 immature whales were collected and biological examinations revealed that there were no pre-weaning individuals. Both the sighting and biological surveys have been carefully conducted for a long period since 1987/88 when JARPA started in the Antarctic. During this period, neither mother and calf pair of Antarctic minke whales was observed nor pre-weaning individual taken. Kasamatsu *et al.* (1988) reported only two sighting records of calves south of 60ºS from Japanese scouting boat data during twenty years (1965/66-1985/86) and described that mother and calf of Antarctic minke whales did not normally migrate into Antarctic waters. We also conclude that Antarctic minke whales calves weaned before their first migration to the Antarctic and that mother and calf pair do not normally occur in the Antarctic during the austral summer season.

6) Two SVs succeeded in covering almost all of the research area and a full scale prey species survey and several oceanographic surveys as well as the sighting survey were conducted successfully. It is expected that estimation of consumption of prey species by whales in the Antarctic will become more accurate by combining the results of the acoustic and net sampling surveys by the SV and stomach contents study of whales by the NM.

Combination of lethal and non-lethal methods is necessary to elucidate the role of whales in the Antarctic ecosystem. Comparing the stomach contents and net samples is important to understand preference of whales for prey species. Combination of sighting and sampling survey data clearly showed inter and intra species segregated distribution. In this season, we found a concentrated distribution of pregnant females of Antarctic minke whales in the small polynya. Continuous expansion of the humpback whale distribution may increase the number of Antarctic minke whales in polynya. For the improvement of the management of whales in the Antarctic, elucidation of the interactions between humpback whales and Antarctic minke whales related to their habitat and prey and elucidation of the behavior of Antarctic minke whales in pack ice is necessary.

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Table1. Outline of the research activities. SV includes two sighting vessels (KS2 and KK1) and SSV includes three sighting and sampling vessels (YS1, YS2 and YS3). NM was operated with SSV in principle.

EVENT	DATE	SVs	SSVs	REMARK
Departure from Shiogama port, Miyagi	14 Nov. 2007	○		
Departure from Shimonoseki port, Yamaguchi	18 Nov. 2007		○	
Low and middle latitudinal sighting survey in transit	4 Dec. 2007 ~ 15 Dec. 2007	○	○	
Start of the survey in the Antarctic	15 Dec. 2007		○	
	16 Dec. 2007	○		
Survey in the Area III E (35E - 70E)	15 Dec. 2007 ~ 7 Jan. 2008	○		
	16 Dec. 2007 ~ 7 Jan. 2008		○	
Survey in the Area IV W (70E - 100E)	9 Jan. 2008 ~ 11 Jan. 2008		○	*1
	31 Jan. 2008 ~ 23 Feb. 2008			
	7 Jan. 2008 ~ 13 Jan. 2008	○		*1
	25 Feb. 2008 ~ 2 Mar. 2008			
Survey in the Area IV E (100E - 130E)	25 Feb. 2008 ~ 1 Mar. 2008		○	*2
	2 Mar. 2008 ~ 20 Mar. 2008	○		
Survey in the Area V W (130E - 165E)	26 Jan. 2008 ~ 18 Feb. 2008	○		
	11 Mar. 2008 ~ 23 Mar. 2008		○	*2
Survey in the Area V E (165E - 175E)	- - - - - -			*3
Finish of the Survey in the Antarctic	24 Mar. 2008	○	○	
Low and middle latitudinal sighting survey in transit	25 Mar. 2008 ~ 2 Apr. 2008	○	○	
Arrival at Tokyo and Shimonoseki port	14 Apr. 2008 ~ 16 Apr. 2008	KS2	○	
Arrival at Kagoshima port	18 Apr. 2008	KK1		

*1) The survey was interrupted by the obstruction of the violent anti-whaling groups
*2) The survey effort was restricted by the obstruction of the violent anti-whaling groups
*3)The survey was cancelled by the obstruction of the violent anti-whaling groups

Table2. Searching distances (n. miles) of two sighting vessels (SVs) and three sighting / sampling vessels (SSVs) in each stratum.

Area	Sector	Stratum	SVs			SSVs	Total
			Closing	Passing	sub-total	Closing	
III	East	North	322.2	609.2	931.4	397.2	1328.6
		South	241.7	884.4	1126.2	2161.2	3287.4
IV	West	North	281.7	677.2	958.9	956.6	1915.5
		South	193.5	654.1	847.6	1920.9	2768.4
	East	North	503.6	828.8	1332.4	312.5	1644.9
		South	261.8	558.0	819.8	563.9	1383.7
V	West	North	280.9	867.3	1148.2	0.0	1148.2
		South	149.9	715.0	864.9	233.9	1098.8
		Total	2235.3	5793.9	8029.2	6546.2	14575.4

Table 3. Summary of whale sightings conducted by SV and SSVs in whole research areas.

Vessels	Sighting vessels				Sighting and sampling vessels				Total			
Type of the sightings	Primary		Secondly		Primary		Secondly		Primary		Secondly	
Species	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.
Blue whale	29	55	2	2	14	29	4	6	43	84	6	8
Fin whale	39	91	9	23	9	43	3	15	48	134	12	38
Sei whale	2	2	0	0	0	0	0	0	2	2	0	0
Antarctic minke whale	326	727	77	190	501	979	22	65	827	1706	99	255
Like minke whale	21	35	4	9	14	14	0	0	35	49	4	9
Humpback whale	796	1528	107	196	518	1008	12	21	1314	2536	119	217
Southern right whale	54	70	3	5	18	26	0	0	72	96	3	5
Sperm whale	181	181	11	11	99	99	4	4	280	280	15	15
Southern bottlenose whale	53	108	3	4	27	52	1	4	80	160	4	8
Unidentified baleen whales	133	229	16	23	3	15	3	5	136	244	19	28
Unidentified cetacean	21	118	1	20	60	60	0	0	81	178	1	20

Table 4. Density indices (DI, the number of primary sighted schools per 100 n. miles) and mean school size (MSS) of Antarctic minke whale, humpback whale and fin whale by two SVs.

Area	Sector	Stratum	Antarctic minke whale				Humpback whale				Fin whale			
			Sch.	Ind.	DI	MSS	Sch.	Ind.	DI	MSS	Sch.	Ind.	DI	MSS
III	East	North	11	14	1.2	1.3	87	195	9.3	2.2	4	8	0.4	2.0
		South	57	89	5.1	1.6	84	150	7.5	1.8	7	24	0.6	3.4
IV	West	North	26	34	2.7	1.3	159	307	16.6	1.9	10	26	1.0	2.6
		South	33	78	3.9	2.4	244	471	28.8	1.9	1	2	0.1	2.0
	East	North	2	2	0.2	1.0	78	147	5.9	1.9	1	1	0.1	1.0
		South	15	39	1.8	2.6	85	159	10.4	1.9	0	0	0.0	0.0
V	West	North	45	172	3.9	3.8	44	79	3.8	1.8	16	30	1.4	1.9
		South	137	299	15.8	2.2	15	20	1.7	1.3	0	0	0.0	0.0
		Total	326	727	4.1	2.2	796	1528	9.9	1.9	39	91	0.5	2.3

Table 5. Summary of Photo-ID conducted during 2007/08 JARPAII.

	Stratum								Total
	Area III		Area IV				Area V		
	East		East		West		West		
Species	North	South	North	South	North	South	North	South	
Blue whale	1	21	0	0	0	1	0	0	23
Humpback whale	3	0	2	4	0	7	0	0	16
Southern right whale	0	0	4	18	0	11	0	3	36
Total	4	21	6	22	0	19	0	3	75

Table 6. Summary of biopsy conducted during 2007/08 JARPAII.

	Stratum								Total
	Area III		Area IV				Area V		
	East		East		West		West		
Species	North	South	North	South	North	South	North	South	
Blue whale	0	4	0	0	0	1	0	0	5
Fin whale	0	3	0	0	0	0	0	0	3
Humpback whale	1	0	0	0	0	4	0	0	5
Southern right whale	0	0	1	4	0	11	0	2	18
Sperm whale (Carcass)	0	0	1	0	0	0	0	0	1
Total	1	7	2	4	0	16	0	2	32

Table 7. Summary of oceanographic survey, acoustic survey and plankton net sampling conducted during 2007/08 JARPAII.

Vessels				CTD (stations)		XCTD (stations)		EPCS (days)	Quantitive echo sounder (days)		IKMT (stations)	NORPAC-Net (stations)
				KS2	KK1	KS2	KK1	KS2	KS2	KK1	KK1	KK1
Stratum	Area III	East	North	9	7	11	3	14	14	10	7	7
			South	10	5	2	1	11	11	8	5	5
	Area IV	East	North	6	5	6	7	10	10	10	4	5
			South	5	3	2	3	10	10	11	3	3
		West	North	6	2	7	13	10	10	10	2	2
			South	2	4	2	9	6	6	14	4	4
	Area V	West	North	11	7	14	11	14	14	11	7	7
			South	4	4	4	3	12	12	10	4	4
Total				53	37	48	50	87	87	84	36	37

Table 8. Summary of biological data and samples collected from Antarctic minke whales.

Samples and data	Number of whales		
	Male	Female	Total
Photographic record of external character	273	278	551
Body length and sex identification	273	278	551
Measurement of external body proportion	273	278	551
Body weight	63	38	101
Body weight by total weight of parts	19	13	32
Skull measurement (length and breadth)	263	269	532
Standard measurement of blubber thickness (two points)	273	278	551
Observation of lactation status	-	278	278
Measurement of mammary grand	-	278	278
Testis weight	273	-	273
Weight of stomach content	273	278	551
Diatom film observation	273	278	551
Blood plasma for physiological study	272	278	550
Earplug for age determination	273	278	551
Ocular lens for age determination	89	98	187
Tympanic bulla for chemical analysis	33	22	55
Largest baleen plate for chemical analysis	272	278	550
Vertebral epiphyses for biological study	222	223	445
Observation and collection of ovary	-	278	278
Histological sample of endometrium	-	14	14
Histological sample of mammary gland	-	278	278
Milk sample for chemical study	-	1	1
Histological sample of testis	273	-	273
Skin and liver tissues for genetic study	273	278	551
Blubber, muscle and liver tissues for environmental monitoring	273	278	551
Lung and liver tissues for environmental monitoring	21	21	42
Gross pathological observation (thyroid, lung, stomach and gonad	273	278	551
Tissues for histopathological study	34	33	67
Tissues for various study (muscle, blubber)	3	3	6
Tissues for nutrient study (muscle, blubber, ventral groove)	0	1	1
Stomach contents for food and feeding study	24	22	46
Stomach contents for environmental monitoring	10	12	22
External parasites	3	3	6
Internal parasites	2	0	2
Photographic record of fetus	82	85	170*
Fetal length and weight	82	85	170*
Collection of small fetus	-	-	3*
Fetal ocular lens for age determination	28	27	55
Fetal skin for genetic study	82	85	170*
Fetus for embryological study	3	3	6
Cyamid for phylogenetic study	1	2	3

*including fetus of sex unidentified.

Table 9. Reproductive status of Antarctic minke whales sampled in 2007/08 JARPAII. Numbers in percentage 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.

Area	Sector	Stratum	Male			Female							Combined
							Mature						
			Immature	Mature	Total	Immature	No-pregnant		Pregnant		Unknown	Total	
							Lactating	Resting	No-Lactating	Lactating			
III	East	North	7	13	20	6	0	0	1	1	0	8	28
			25.0%	46.4%	71.4%	21.4%	0.0%	0.0%	3.6%	3.6%	0.0%	28.6%	
		South	36	94	130	41	1	1	26	1	1	71	201
			17.9%	46.8%	64.7%	20.4%	0.5%	0.5%	12.9%	0.5%	0.5%	35.3%	
IV	West	North	15	13	28	15	0	0	3	0	0	18	46
			32.6%	28.3%	60.9%	32.6%	0.0%	0.0%	6.5%	0.0%	0.0%	39.1%	
		South	15	41	56	28	0	7	85	0	0	120	176
			8.5%	23.3%	31.8%	15.9%	0.0%	4.0%	48.3%	0.0%	0.0%	68.2%	
	East	North	0	0	0	0	0	0	0	0	0	0	0
			-	-	-	-	-	-	-	-	-		
		South	4	6	10	0	0	0	3	0	0	3	13
			30.8%	46.2%	76.9%	0.0%	0.0%	0.0%	23.1%	0.0%	0.0%	23.1%	
V	West	North	0	0	0	0	0	0	0	0	0	0	0
			-	-	-	-	-	-	-	-	-		
		South	1	28	29	6	0	4	48	0	0	58	87
			1.1%	32.2%	33.3%	6.9%	0.0%	4.6%	55.2%	0.0%	0.0%	66.7%	
Combined			78	195	273	96	1	12	166	2	1	278	551
			14.2%	35.4%	49.5%	17.4%	0.2%	2.2%	30.1%	0.4%	0.2%	50.5%	

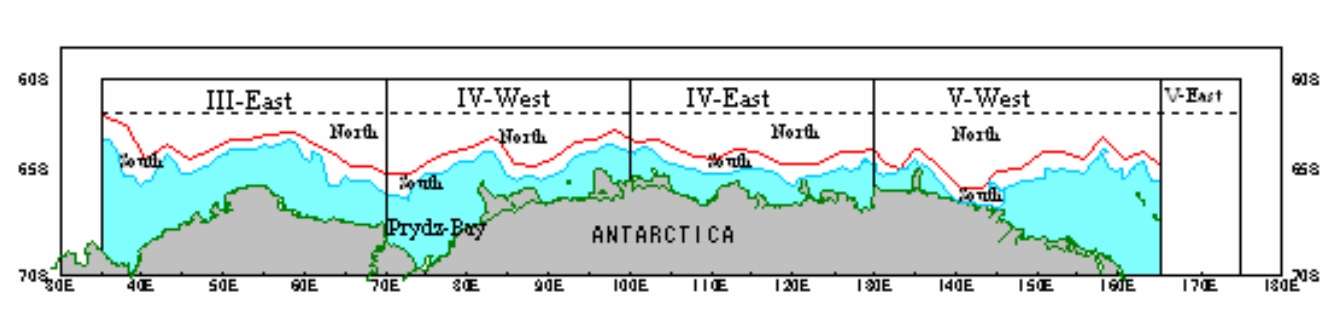

Fig. 1. Geographic location of the research area of 2007/08 JARPAII. A solid line represents a border between northern and southern strata.

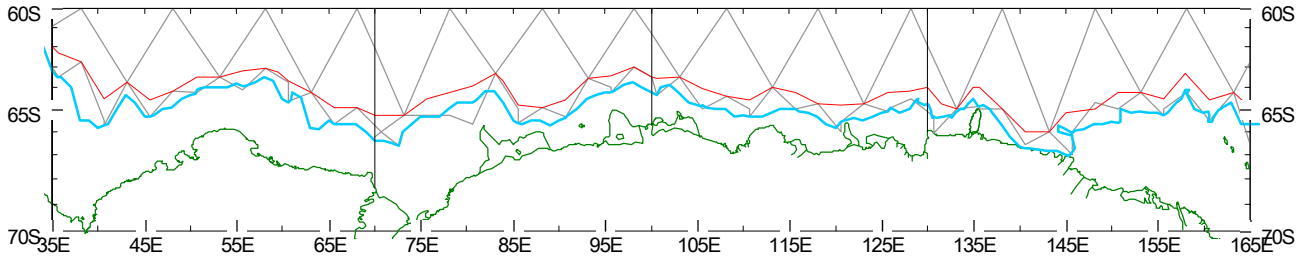

Fig 2. Predetermined survey track lines of two sighting vessels (SVs) in 2007/08 JARPAII. A solid line (red) represents a border between northern and southern strata. A bold line (blue) represents the ice edge line. The ice edge line was estimated by direct observation of research vessels and the information from near real time DMSP SSM / I daily polar griddled sea ice concentration data set available from the National Snow and Ice Data Center (NSIDC, Cavalieri *et al.* 1999), US.

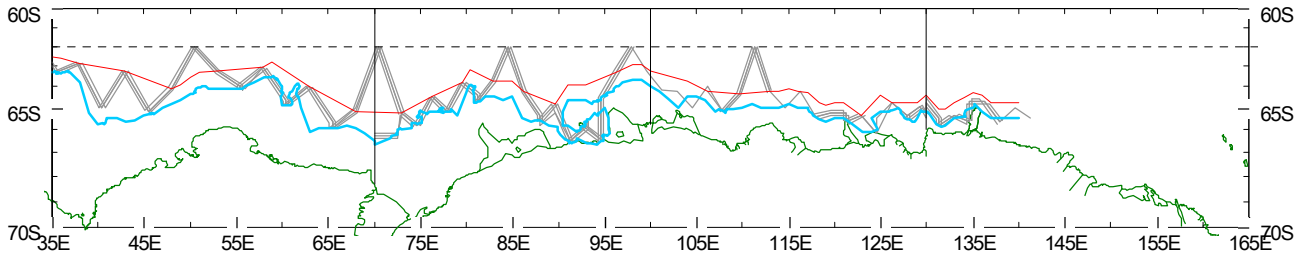

Fig. 3. Predetermined survey track lines of three sighting and sampling vessels (SSVs) in 2007/08 JARPAII. A single track line represents the track line which was planned but cancelled because of shortage of the research period. Elements in the map are referred to Fig. 2.

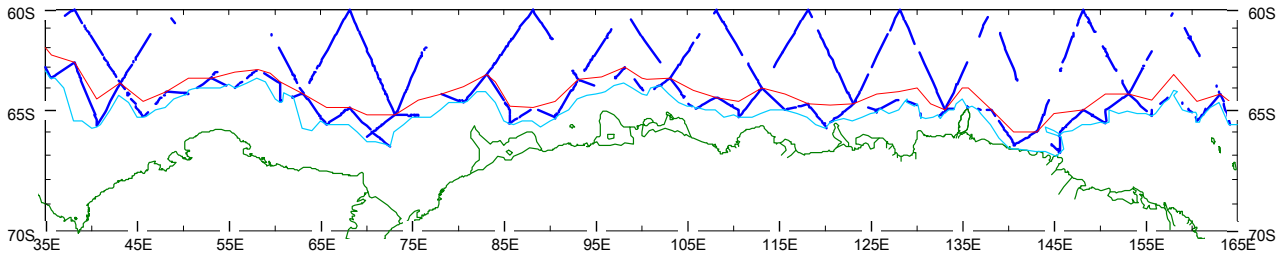

Fig. 4. Searching effort on the predetermined track lines of two SVs in 2007/08 JARPAII. Elements in the map are referred to Fig. 2.

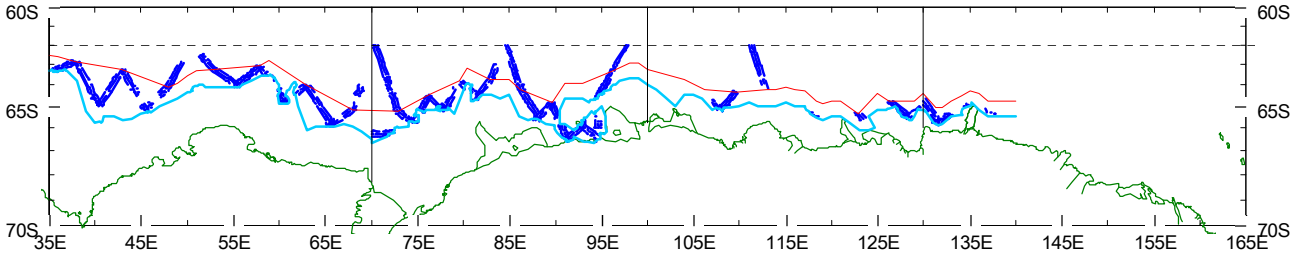

Fig. 5. Searching effort on the predetermined track lines of three SSVs in 2007/08 JARPAII. Elements in the map are referred to Fig. 2.

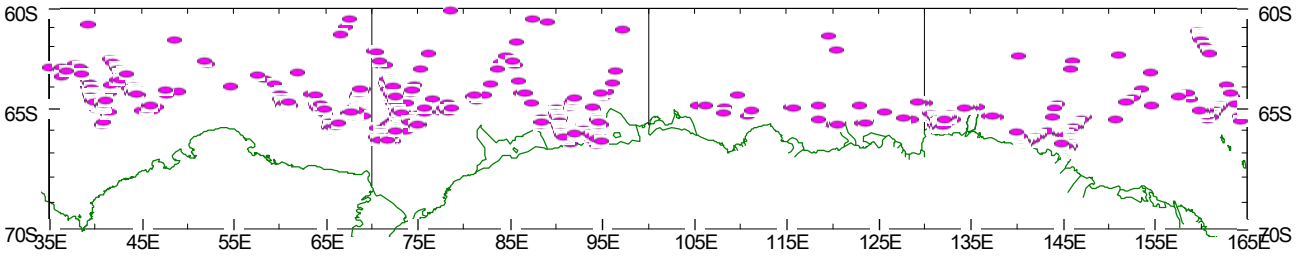

Fig. 6. Distribution of all sightings of Antarctic minke whales sighted by SVs and SSVs in 2007/08 JARPAII.

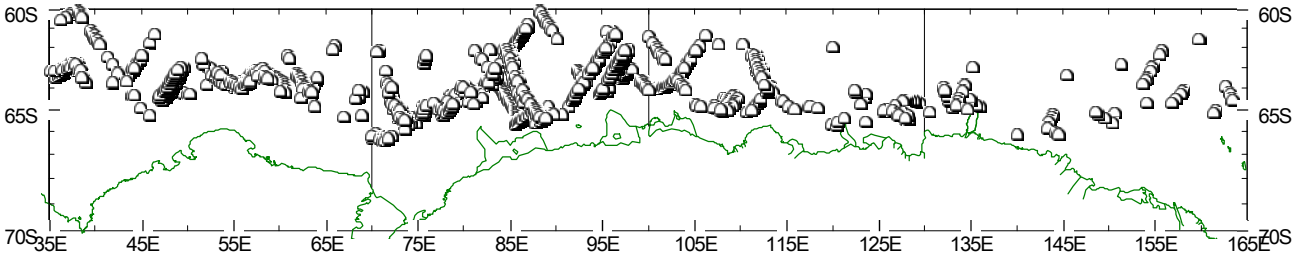

Fig. 7. Distribution of all sightings of humpback whales sighted by SVs and SSVs in 2007/08 JARPAII.

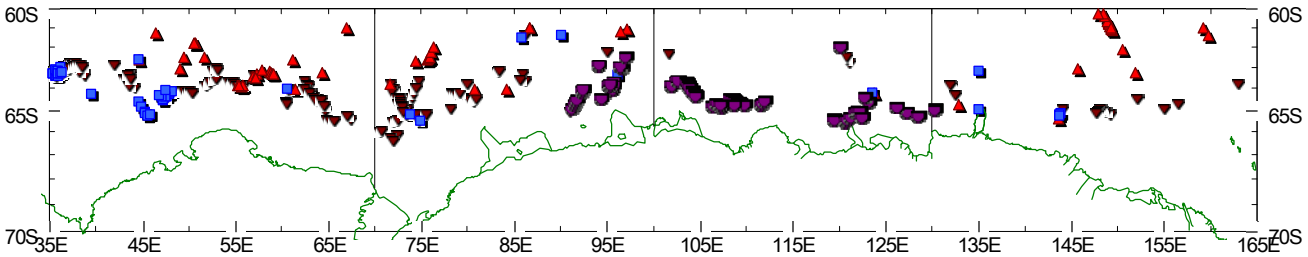

Fig. 8. Distribution of all sightings of fin (▲), blue (■), Southern right (⛊) and sperm (▼) whales sighted by SVs and SSVs in 2007/08 JARPAII.

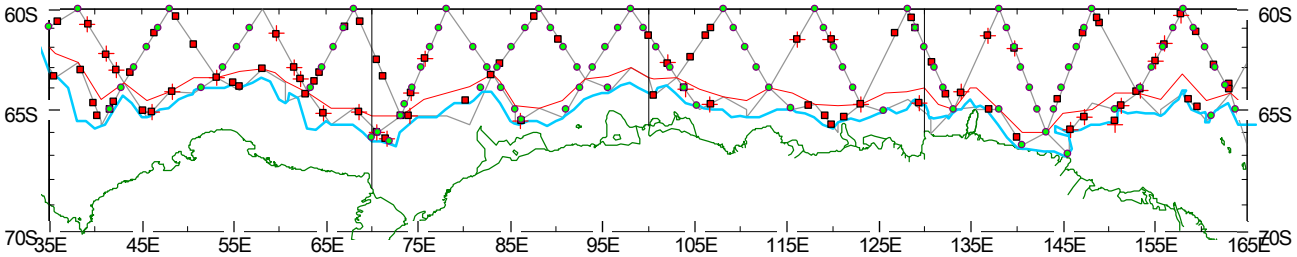

Fig. 9. Geographical localities of NORPAC and IKMT (+) sampling and CTD (■) and XCTD (◆) casting conducted by two SVs during 2007/08 JARPAII.

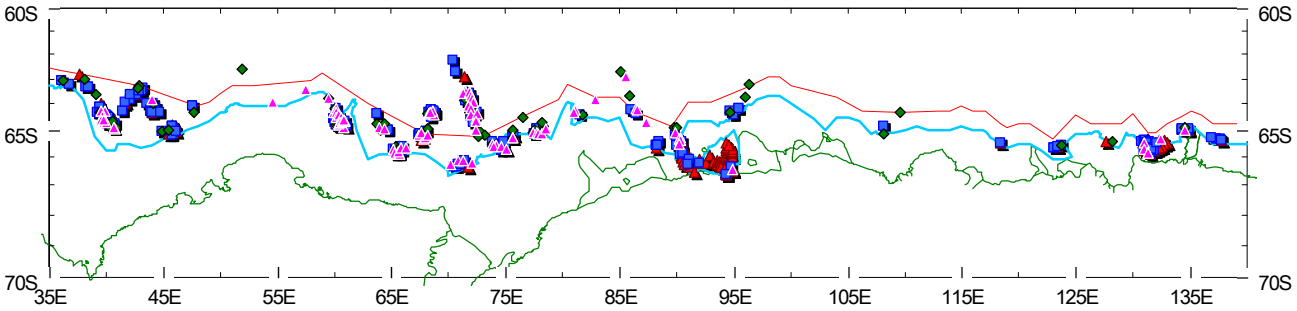

Fig. 10. Distribution of sampled Antarctic minke whales by sex and sexual maturity status in 2007/08 JARPAII.
■: Mature male, ◆: Immature male, ▲:Mature female and ▲ : Immature female

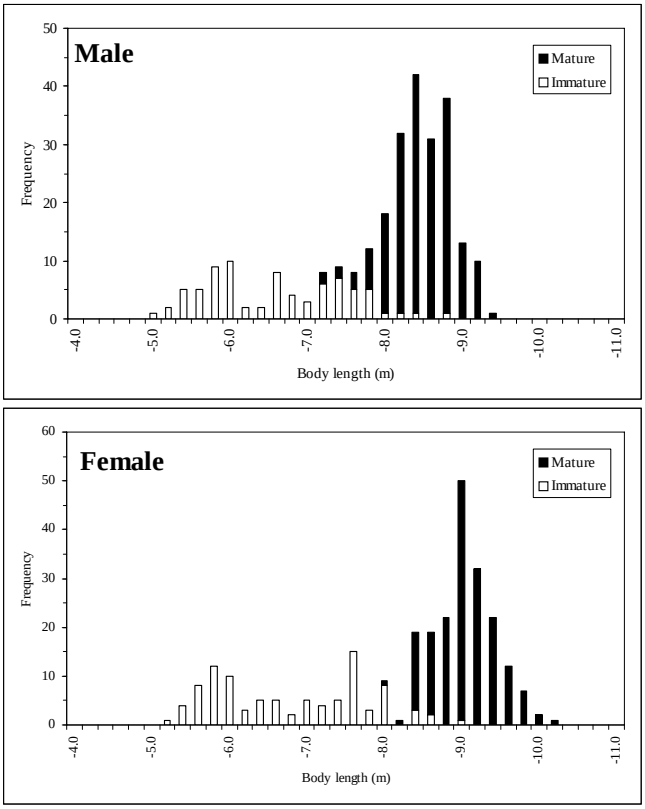

Fig. 11. Body length distribution of Antarctic minke whales sampled during 2007/08 JARPA II survey.

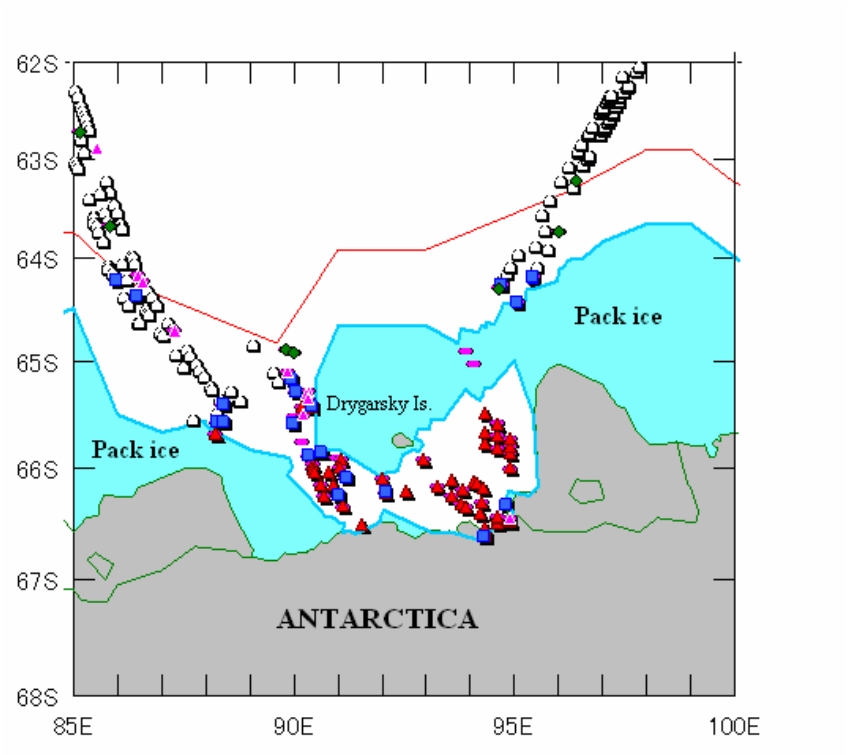

Fig. 12. Segregated distribution between Antarctic minke whales and humpback whales in the Davis Sea. Humpback whale ( ) was dominant north of pack ice that covered the Davis Sea, whereas Antarctic minke whales was concentrated in a polynya formed by the pack ice and most of them were matured female. Sexual maturity of the Antarctic minke whale was represented as follows; matured female ▲, matured male ■, immature female △, immature male ◆, unknown (only sighted) ⬭.

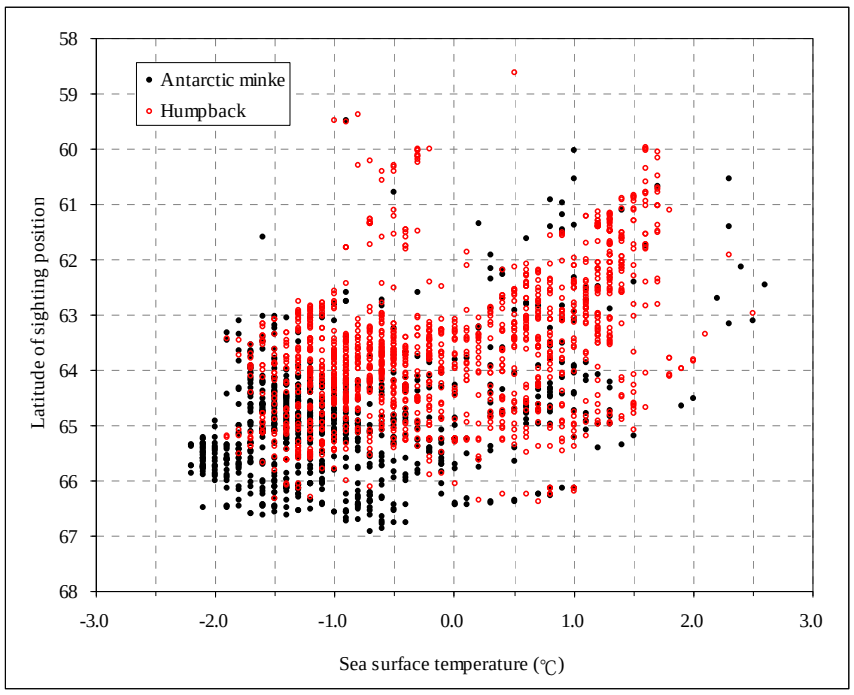

Fig. 13. Relationship between latitude of sighting position and sea surface temperature of Antarctic minke and humpback whales.