Cruise Report of the Second Phase of the Japanese Whale Research Program under Special Permit in the Antarctic (JARPA II) in 2008/2009

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ABSTRACT

During the 2008/09 austral summer season, the Second Phase of the Japanese Whale Research Program under the Special Permit in the Antarctic (JARPA II) was conducted following the full-scale research plan. Two dedicated sighting vessels (SVs), three sighting and sampling vessels (SSVs) and one research base ship were engaged in the research for 103 days from 10 December 2008 to 22 March 2009 in the Area V (130°E -170°W) and western part of Area VI (170°W - 145°W). The total searching distance was 14,351.45 n.miles and the following species were sighted: Antarctic minke, blue, fin, sei, humpback, southern right, sperm and southern bottlenose whales. The Antarctic minke whale 1,973 schools (4,883 individuals) were the dominant species. Out of 700 schools (1,553 individuals) in the primary sightings of Antarctic minke whales by SSVs, 642 schools (1,339 individuals) were targeted for sampling. A total of 679 individuals was sampled. Out of 34 schools (111 individuals) in the primary sightings of fin whales by SSVs, 1 school (1 individual) was targeted and sampled. The body length of this fin whale was 14.79m (immature female). Photo-id experiments were conducted on blue and humpback whales and a total of 50 animals was photographed. A total of 14 skin biopsy samples was collected from fin and humpback whales. EPCS (Electric Particle Counting and Sizing System) survey was conducted for 83 days by SV. SVs conducted the quantitative echo sounder survey for 164 days and IKMT and NORPAC net sampling 46 and 46 times, respectively in the whole research area. CTD and XCTD castings were conducted at 160 and 43 locations, respectively. The main results of the survey were as follows: 1) Whale composition in the research area was stable compared to previous surveys. Antarctic minke whale was dominant, humpback was second and fin whale was third. 2) The ice-free extent of the Ross Sea was substantially larger than in past seasons. High density areas of Antarctic minke whales were observed in the Ross Sea and Area VI West. The Density index of this species was higher than the latest two surveys, 3) Mature male of Antarctic minke was dominant in Area VI West which was surveyed for the first time in January, which contrast with the Ross sea, 4) fin whales were widely distributed in the northern and southern strata and large schools were observed in Area V. Stomach content of fin whales sampled was 300 kg of krills, 5) Humpback whales were widely distributed in the research area and density index was higher than the last survey. The research activity in part of Areas V and VI West was interrupted several times by violent actions of an anti-whaling group over 16 days.

INTRODUCTION

The Japanese Whale Research Program under 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. 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 maturity as well as narrowing down the parameters of relevance for stock management (IWC, 1998, Anonymous, 2005). JARPA also elucidated that there were at least two stocks of Antarctic minke whales in the research area but their geographical boundaries were different from those used for the IWC Areas (Pastene, 2006). Further, JARPA found that pollutant concentration in whale's tissues, such as heavy metals and PCBs, was extremely low (Yasunaga *et al*, 2006). JARPA has thus successfully obtained data related to the initially proposed objectives (IWC, 2008).

Based on these considerations, the Government of Japan launched a new comprehensive study under the Second Phase of the Japanese Whale Research Program under Special Permit in the Antarctic (JARPA II), combining lethal and non-lethal methods, starting from the 2005/2006 austral summer season. The research plan for the JARPA II was presented to the 2005 meeting of the IWC/SC. The research methods for the JARPA II are basically the same as the previous JARPA with some modifications. The program involves both non-lethal research techniques such as sighting surveys, biopsy sampling, acoustic surveys for prey species and the collection of oceanographic data, and lethal sampling since collection of certain information, of vital importance to the overall study, requires examination of internal organs such as ovaries, earplugs and stomachs. The first two seasons (2005/2006 and 2006/2007) were dedicated to feasibility studies. Evaluation of two feasibility studies concluded that the practicability and appropriateness of the planned sighting and sampling methods 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. A comprehensive review will be conducted following completion of the first 6 years of the research (Government of Japan. 2005).

The full-scale JARPA II started from the 2007/08 season. It 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 (*Balaenoptera bonaerensis*), humpback whale (*Megaptera novaeangliae*), fin whale (*B. physalus*) and possibly other species in the Antarctic ecosystem that are major predators of Antarctic krill. Annual sample sizes for the full-scale research (lethal sampling) are 850 (with 10% of allowance) Antarctic minke whales (Eastern Indian Ocean and Western South Pacific Stocks), 50 humpback whales (D and E-Stocks) and 50 fin whales (Indian Ocean and the Western South Pacific Stocks). During the feasibility study, the annual sample size was 850+-10% Antarctic minke and ten fin whales. Humpback whales are not sampled during the feasibility study. This is a cruise report of the 2008/09 JARPA II. During this season, as was the case last year, the survey area could not be covered completely and the number of whale sample was reduced as a result of the violent actions of an anti-whaling group over 16 days. 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.

Research base ship

Nisshin-Maru (NM; 8,044 tons)

Dedicated sighting vessels (SVs)

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

Sighting and sampling vessels (SSVs)

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

Two SVs were dedicated to the 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 and ice edge

The area 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. In this season, JARPA II surveyed the Eastern Indian Ocean Stock and the Western South Pacific Ocean Stock of Antarctic minke whales (Pastene, 2006) in a longitudinal span of 85° on the eastern side of the JARPA II research area (130°E - 145°W). Figure.1 shows geographic location of the research area for the 2008/2009 JARPAII survey.

For this survey, our best estimate of the position of the ice edge was based on our visual and radar observations of the ice edge as well as satellite predictions. The satellite predictions were 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). In this season, the ice-free extent of the Ross Sea was substantially larger than previous surveys (See Appendix A).

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. 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. The two legs of track line for the northern stratum were set every six legs for the 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. However, in this season, due to the interference the SSVs canceled the research in the northern part of Areas V and VIW.

The longitudinal interval and number of the survey track line in the sub-research area

The longitudinal interval and number of teeth in the unit of survey track line in each sub research area were as follows:

1) The western part of Area V (including west of 170°E in the eastern part of Area V)

The research area was south of 60°S and from 170°E to 130°E. The starting points of SVs were at 130°E. The survey track line was set zigzag in north and south to eastward. The longitudinal interval of one leg of survey track line was 1° 40' for SSVs in south strata, and 5 ° in north stratum and 2° 30' in south stratum for SVs. SVs surveyed in order of one tooth (two legs) in the north stratum and two teeth (four legs) in the south stratum.

2) The western part of Area VI

The research area was south of 60°S and from 145°W to 170°W. The starting points of the SVs and SSVs were

at 145°W. The survey track line was set zigzag in north and south to westward. The longitudinal interval of one leg of survey track line was 1° 40' for the SSVs in south strata, and 5 ° in north stratum and 2°30' of south stratum for the SVs. SVs surveyed in order of one tooth (two legs) in the north stratum and two teeth (four legs) in the south stratum.

3) The eastern part of Area V

East-North stratum

The research area ranged from 60°S to 69°S and from 170°W to 170°E. The starting points of the SVs were at 170°W. The survey track line was set zigzag in north and south to westward between 170°W to 170°E. The longitudinal interval of each tooth (two legs) of the survey track line was 5° for SVs. In the range between 170°E and 165°E, the same design of survey track line was continued from that of the western part of Area V.

East-South stratum (Ross Sea)

The research area was south of 69°S between 165°E to 170°W (including west of 165°E and east of 170°W in the inner part of the Ross Sea). The starting and ending points of SVs and SSVs were at 69°S. The survey track line was set zigzag in north and south to westward or eastward in the Ross Sea. The longitudinal interval of the survey track line for SSVs and SVs was 10°. The start point of the longitudinal line in the survey track line was set by the random selection. This longitudinal interval of survey track line was adjusted corresponding to the ice edge line which changed remarkably through the research period.

Sighting method

Sighting procedures were the same as in the previous JARPA surveys (Nishiwaki *et al*. 1999, Ishikawa *et al*. 2000). The sighting surveys by SSVs were conducted under limited closing mode (when a sighting of Antarctic minke and fin whales were made on the predetermined track line, the vessel approached the whales and confirmed species and school size). Three SSVs advanced along parallel track lines 7 n.miles apart, at a standard speed of 11.5 knots. The sighting surveys by SVs were 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) at a standard speed of 10.5 knots.

The survey was operated under optimal research conditions (i.e., the wind speed below 25 knot in the south strata and 20 knot in the north strata, and visibility further than 1.5 n.miles). In addition to the sighting of Antarctic minke and fin whales or whales suspected to be those species, the SVs approached blue (*B. musculus*), humpback, southern right (*Eubalaena australis*), pigmy right (*Caperea marginata*), sei (*B.borealis*), sperm (*Physeter macrocehpalus*) and southern bottlenose *(Hyperoodon planifrons*) whales for conducting some experiments. The SSVs also approached the same whale species for experiments while they engaged in sighting survey.

Sampling method

Three SSVs were engaged in sampling survey. Sampling of 850 Antarctic minke whales (with 10 % allowance) and 50 fin whales was planned in the research area south of 62°S. One to two Antarctic minke whales were sampled randomly from each primary sighted school within 3 n.miles of the track line. The dwarf form minke whales were not a target for sampling. Sampling of fin whales was restricted to those animals with an estimated body length less than 18m due to the limitation of NM facility for pulling up the animal onboard. One fin whale smaller than 18m was sampled from each primary sighted school within 3 n.miles of the track line. If two or more animals smaller than 18m were found in the single school, then only one of them was randomly selected.

Low and middle latitudinal sighting survey

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

Biological research

Most of the biological research methods used in this JARPA II survey were developed and improved during the JARPA 18 year research period. Biological research including scaling body weight on all sampled whales was conducted on the NM.

Experiments

Sighting distance and angle experiment

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

Photo-identification experiment

The following species were targeted for photographic record of natural markings by SVs and SSVs: blue, humpback and southern right whales.

Biopsy sampling

In addition to the species targeted for the photo-identification experiment, pygmy right, fin, sei, sperm, southern bottlenose whales were targeted for biopsy skin sampling by the SVs and SSVs using compound-crossbows. All collected sample were preserved at –80°C.

Satellite tagging

The YS1 and the YS2 attempted satellite tag attachment on Antarctic minke and humpback whales.

Preliminary prey species survey

Prey species (krill) samples were collected using the Isaacs-Kidd Mid water trawl (IKMT) on the KK1.

Oceanographic and acoustic survey

SVs and SSVs conducted the following oceanographic surveys.

1) Consecutive measurements of surface temperature, conductivity, surface chlorophyll, dissolved oxygen, surface particle using the Electric Particle Counting and Sizing System (EPCS) on KS2.
2) XCTD and CTD casting by KK1 and KS2.
3) Record of marine debris in the research area by KK1 and KS2. In addition all marine debris found in the stomach of Antarctic minke whales was recorded on NM.
4) Hydro-acoustic survey using a scientific echo sounder (EK500 with operating frequencies at 38kHz, 120kHz, 200kHz, SIMRAD, Norway) to study distribution and abundance of prey species of baleen whales. Hydro-acoustic survey was conducted by KS2 and KK1 along sighting survey through the whole research area.

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 done in cooperation with Japan Marine Science and Technology Center (JAMSTEC) (See http://w3.jamstec.go.jp/ARGO/J_ARGOe.html).

RESULTS

Outline of the cruise

SVs departed from Shiogama (Japan) on 14 November and started Antarctic sighting survey in the research area on 10 December. SSVs and NM departed from Shimonoseki and Innoshima, respectively on 17 November and started Antarctic sighting and sampling surveys in the research area on 10 December.

The Antarctic research period of this cruise was 103 days from 10 December 2008 to 22 March 2009. The research activity was interrupted for 16 days due to violent interference by the Sea Shepherd. Due to this

interference SSVs canceled the research in the northern part of Areas V and VIW and a part of the Ross Sea.

SV (KS2) arrived at Tokyo on 7 April. And SV (KK1) arrived at Shiogama on 9 April. SSVs and NM arrived at Shimonoseki on 13 April and 14 April, respectively.

Results of non-lethal survey

Sighting survey and whale species sighted

The total searching distances were 14,351.45 n.miles consisting of 7,621.76 n.miles for the two SVs and 6,729.69 n.miles for the three SSVs. Ten species were identified during the research period. Table 1 shows the number of sightings during the survey. The following six species of baleen whales were confirmed; Antarctic minke, blue, fin, sei, humpback and southern right whales, and two toothed whale species were confirmed; sperm, southern bottlenose whales (Table 1).

Antarctic minke whales were the most abundant species in the whole research area. The number of total sightings of Antarctic minke whales by five research vessels was 1,973 schools (4,883 individuals). In addition 418 schools (735 individuals) of humpback whales, 122 schools (491 individuals) of fin whales, 77 schools (91 individuals) of sperm whales, 32 schools (61 individuals) of southern bottlenose whales, 15 schools (30 individuals) of blue whales, 5 schools (7 individuals) of sei whales and one school (one individual) of southern right whale were observed.

Geographical distribution, density index (DI) and mean school size (MSS)

1) Antarctic minke whales

The distribution of sightings of the Antarctic minke whales by SVs is shown in Figure 2. They were widely distributed throughout the entire research area. A high concentration area was confirmed in the East-South stratum (Ross Sea) and Western part of Area VI. Table 2 shows density indices (DI; number of schools sighted/ 100 n.miles searching distance) and mean school size (MSS) of two SV's primary sightings of this species by stratum. For the whole research area, DI and MSS for SVs were 15.35 and 2.66, respectively (Table 2).

2) Fin whales

Fin whales were widely distributed throughout the whole research area except south of 69° S. A high concentration area was confirmed between 140° and 165°E, and 180°-150°W (Figure 3). In the western part of Area V, they were sighted near the ice edge. Large schools (35 individuals and 55 individuals) were observed in East-North and West-South stratum in Area V. For the whole research area, DI and MSS for SVs were 0.98 and 4.39, respectively. The DI of the West-South stratum in Area V was high (2.51) compare to other strata (Table 2).

3) Humpback whales

Humpback whales were widely distributed throughout the whole research area except south of 70° S. A high concentration area was confirmed between 130°E and 140°E, and 160°E-170°E in the western part of Area V (Figure 3). These sightings overlapped with those of Antarctic minke whales but humpback whales were rarely observed in the Ross Sea (south of 69°S) where Antarctic minke whales were highly concentrated For the whole research area, DI and MSS for SVs of this species were 2.44 and 1.80, respectively.

4) Blue whales

Blue whales were mainly distributed in the southern part of the research area, especially in the Ross Sea (Figure 3). Most southern sighting was 74°S in the Ross Sea.

5) Southern right whale

This species was observed (65°-39S, 145°-53E) as mixed school with one humpback whale in Area V. This is rare sighting since this species is sighted mainly in Area IV.

6) Sperm and southern bottlenose whales

Sperm whales were widely distributed throughout the research area except south of 70°S. They were distributed in the area outside of the continental slope. A large school (14 large males) of this species was observed (64°-11S, 157°-00E) in a small sea ice area within the pack ice. This is a very rare sighting in the JARPA and JARPA II surveys. Southern bottlenose whales were widely distributed in the whole northern part of the research area. (Figure 4).

Photo-ID and biopsy sampling

Table 3 summarizes the results of the photo-ID experiment. It was conducted throughout the entire research area. A total of 50 targeted individuals were photographed (11 blue whales and 39 humpback whales). Table 4 summarizes the results of biopsy sampling. A total of 14 skin biopsy samples were collected from fin whale (n=1) and humpback whales (n=13).

Prey species and oceanographic survey

Table 5 shows a summary of acoustic and oceanographic surveys. KS2 and KK1 conducted a quantitative echo sounder survey which ranged over 83 days by KS2 and 81 days by KK1 in the whole research area. KK1 also conducted sampling of prey species (Krill) by the IKMT and NORPAC-net at 46 locations in the whole research area (Figure 5).CTD and XCTD castings conducted at 106 and 43 locations, respectively (Figure 6). EPCS survey was conducted for 83 days by KS2.

Survey for the marine debris

The marine debris survey was carried out concomitant with the sighting survey of the SVs in all research areas. A total of 25 items were found.

Sighting distance and angle experiment

A sighting distance and angle experiment was preformed on 20 January 2009 by YS1 and YS3, 28 January 2009 by KS2, 1 February 2009 by KK1, and 23 February 2009 by YS2. The results of this experiment will be used in estimating abundance.

Attachment of the Satellite tag for whales

YS2 attempted the attachment of a satellite tag on one school of humpback whale (1 animal) on 20 March 2009. However, technical problems with the transmission antenna were found with this attachment.

Results of lethal survey

Sampling of Antarctic minke whales and fin whales

1) Antarctic minke whales

Out of 700 schools (1,553 individuals) primarily sighted by SSVs, 642 schools (1,339 individuals) were targeted for sampling. A total of 679 animals were sampled (295 in Area VI-SW, 240 in Area V-SE (Ross Sea) and 144 in Area V-SW). Struck and lost occurred in one case. Due to interruption of sampling activity of SSVs, samples from northern strata and a northern part of the Ross Sea were not collected.

2) Fin whales

Out of 34 schools (111 individuals) primarily sighted by SSVs, 1 school (1 individual) in Area V-SW was targeted and sampled (see DISCUSSIONS). No struck and lost occurred.

Biological research

Biological research was conducted on the research base ship for all whales sampled. Table 6 summarizes research items conducted for the sampled Antarctic minke and fin whales.

Preliminary analyses of biological information

1) Antarctic minke whales

Of 679 samples of Antarctic minke whales, Table 7 shows the reproductive status of samples, by stratum. Figure 7 shows the sighted position of sampled whales, by sex and reproductive status. The collected samples were 144 individuals in the western part of Area V, 240 individuals in the East-South stratum (Ross Sea) and 295 in the Western part of Area VI. The ratio of males, in the West-South stratum in Area V was 58.3 %, 35.4 % in the East-South (Ross Sea) and 69.8 % in the West-South in Area VI.

The mature males were widely distributed throughout the whole research areas. Mature males were dominant in the Western part of Area VI. Some immature males were sampled (3.3%) in the northern part of the East-South stratum (Ross Sea) in Area V.

Females were also widely distributed throughout the whole research area. Mature pregnant females were dominant (54.2%) in the East-South stratum (Ross Sea) in Area V. Females constituted 44.8 % of the collected samples and the pregnancy rate of mature females was 96.0 % for the whole research area. One set of conjoined male twin fetuses of this species was collected. This is a second such observation for this species (Zinchenko and Ivashin, 1987). Maximum length of this species was 9.44 m for males and 9.79 m for females; minimum length was 5.15m and 4.96m, respectively.

2) Fin whales

The body length of the collected fin whale of this season was 14.79 m. This animal was an immature female, and the smallest animal of this species taken during the 2005/06 to 2008/09 JARPA II surveys. About 300 kg of krills was observed from the stomach contents of this animal.

DISCUSSION

This fourth cruise of JARPAII was planned as the second 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 Antarctic minke whales and 50 fin whales. However, preventing collisions with vessels of a violent and obstructive anti-whaling group and ensuring the safety of crew and vessels, resulted in a suspension of research activity for 16 days. Due to the reduction in the number of research days, sampling activity of SSVs was restricted and could not cover the whole research area. However, in spite of the restricted survey, the 2008/09 JARPAII cruise obtained many important results summarized as follows:

1) Antarctic minke whales were the dominant species sighted in this survey (1,973 schools and 4,883 individuals). Second and third dominant species were humpback (418 schools and 735 individuals) and fin 122 schools and 491 individuals) whales. This species composition was the same as in previous surveys. This indicates that the whale species composition in Area V and VI West were stable compare to the Area IV where it was recently reported that humpback whale sightings were dominant and the number of sightings of this species increased year by year (Ishikawa *et al*., 2008). This information is useful for the monitoring of the Antarctic ecosystem.

2) The ice-free extent of the Ross Sea was substantially larger than that of previous surveys (Appendix A). High density areas of Antarctic minke whales were observed in the Ross Sea and Area VI West. The Density index of this species (32.24 whales / 100 n.miles) was higher than that of the latest two surveys (2004/05: 14.44, 2006/07: 17.99). The mean school size of this species (3.00) was also higher than that of the latest two surveys (2004/05: 2.07, 2006/07: 2.05). For the improvement of the management of whales in the Antarctic, elucidation of the year to year changes of habitat and their prey of Antarctic minke whales in the Ross Sea is necessary.

3) Antarctic minke whales were widely distributed throughout the entire research area although the 679 samples

showed segregation by sex and reproductive status. Mature pregnant females were dominant in the Ross Sea (East-South stratum) and mature males and immature animals were concentrated in the western part of Area VI. This information is useful for the elucidation of temporal and spatial changes in stock structure and for improving the management procedure for the Antarctic minke whale stocks.

4) Of 111 primary sighted fin whales by SSVs, one fin whale was targeted and collected, although 50 whales were planned for the sampling. One of the reasons for the limited sampling of fin whales was interruptions of sampling activity of the SSVs, and another was logistics. 110 sightings of fin whales by SSVs were not targeted for sampling due to inappropriate sea conditions for safe transferring and flensing and/or practical works.

5) Highest density index (DI) of humpback (7.68 whales / 100 n.miles) and fin (2.98 whales / 100 n.miles) whales were observed in the southern part of Area V West. High rates of increase for these species were also reported in recent surveys (Matsuoka *et al*., 2006, Branch, 2007). The present result is consistent with these reports. For the improvement of the management of whales in the Antarctic, elucidation of the interactions between humpback, fin and Antarctic minke whales related to their habitat and prey is necessary.

6) Two SVs succeeded in covering almost all of the research area. A full scale prey species survey and several oceanographic surveys as well as the sighting survey were conducted successfully including photo-ID and biopsy sampling. 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. Comparing the stomach contents and net samples is important to understand preference of whales for prey species. Combination of lethal and non-lethal methods is necessary to elucidate the role of whales in the Antarctic ecosystem.

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Table 1. Summary of whale sightings by SVs and SSVs in the research area during 2008/09 JARPA II.

Species	Sch.	Ind.
Blue whale	15	30
Fin whale	122	491
Sei whale	5	7
Antarctic minke whale	1,973	4,883
Like Antarctic minke whale	72	171
Humpback whale	418	735
Southern Right whale	1	1
Unidentified Baleen whales	250	772
Sperm whale	77	91
Southern bottlenose whale	32	61

Table 2. The Density indices (DI, number of schools per 100 n.miles) and mean school size (MSS) of Antarctic minke, fin and humpback whales by SV during 2008/09 JARPA II.

Area	Sector	Stratum	Effort	Antarctic Minke whale				Fin whale				Humpback whale			
			[n.miles]	Sch.	Ind.	D.I.	M.S.S.	Sch.	Ind.	D.I.	M.S.S.	Sch.	Ind.	D.I.	M.S.S.
V	West	North	1,211.47	4	5	0.33	1.25	10	27	0.83	2.70	28	49	2.31	1.75
		South	797.43	27	43	3.39	1.59	20	97	2.51	4.85	67	119	8.40	1.78
	East	North	1,143.44	19	34	1.66	1.79	19	127	1.66	6.68	37	66	3.24	1.78
		South (RossSea)	2,757.76	889	2,667	32.24	3.00	0	0	---	---	6	12	0.22	2.00
VI	West	North	721.57	3	3	0.42	1.00	12	40	1.66	3.33	28	59	3.88	2.11
		South	990.09	228	363	23.03	1.59	14	38	1.41	2.71	20	29	2.02	1.45
Total			7,621.76	1,170	3,115	15.35	2.66	75	329	0.98	4.39	186	334	2.44	1.80

Table 3. Summary of photo-ID collected during 2008/09 JARPA II.

	Area V				Area VI		Total
	West		East		West		
Species	North	South	North	RossSea	North	South	
Blue whale	0	1	2	5	0	3	11
Humpback whale	1	29	5	0	0	4	39
Total	1	30	7	5	0	7	50

Table 4. Summary of biopsy samples collected during 2008/09 JARPA II.

	Area V				Area VI		Total
	West		East		West		
Species	North	South	North	RossSea	North	South	
Fin whale	1	0	0	0	0	0	1
Humpback whale	1	10	2	0	0	0	13
Total	2	10	2	0	0	0	14

Table 5. Summary of oceanographic survey, acoustic survey and plankton net sampling conducted during 2008/09 JARPA II.

				EPCS (days)	Quantitive echo sounder (days)		IKMT (stations)	NORPAC-Net (stations)	CTD (stations)		XCTD (stations)
Vessels				KS2	KS2	KK1	KK1	KK1	KS2	KK1	KK1
Area	V	West	North	11	11	14	5	5	12	6	2
			South	7	6	10	4	4	4	4	0
		East	North	16	16	18	13	13	10	11	17
			RossSea	23	23	18	12	12	22	6	24
	VI	West	North	11	12	10	7	7	7	7	0
			South	15	15	11	5	5	12	5	0
Total				83	83	81	46	46	67	39	43

Table 6. Summary of research items conducted for sampled Antarctic minke and fin whales.

Research item	Antarctic minke			Fin		
	Male	Female	Total	Male	Female	Total
Photographic record of external character	375	303	678	0	1	1
Body length and sex identification	375	304	679	0	1	1
Measurement of external body proportion	375	304	679	0	1	1
Body weight	375	304	679	0	0	0
Body weight by total weight of parts	6	3	9	0	1	1
Skull measurement (length and breadth)	357	288	645	0	1	1
Standard measurement of blubber thickness	375	304	679	0	1	1
Observation of lactation status	-	304	304	-	1	1
Measurement of mammary grand	-	304	304	-	1	1
Testis weight	375	-	375	0	-	0
Weight of stomach content	362	288	650	0	1	1
Diatom film observation	375	304	679	0	1	1
Blood plasma for physiological study	375	300	675	0	1	1
Earplug for age determination	373	303	676	0	1	1
Ocular lens for age determination	97	104	201	0	1	1
Tympanic bulla for chemical analysis	41	30	71	0	1	1
Largest baleen plate for chemical analysis	373	303	676	0	1	1
Vertebral epiphyses for biological study	322	232	554	0	1	1
Observation and collection of ovary	-	304	304	0	1	1
Histological sample of endometrium	-	7	7	0	1	1
Histological sample of mammary gland	-	304	304	0	1	1
Milk sample for chemical study	-	2	2	-	0	0
Histological sample of testis	375	-	375	0	-	0
Tissue samples for genetic study	375	304	679	0	1	1
Blubber, muscle and liver tissues for environmental monitoring	375	304	679	0	1	1
Lung and liver tissues for environmental monitoring	20	20	40	0	1	1
Gross pathological observation (thyroid, lung, stomach and gonad)	375	304	679	0	1	1
Tissues for histopathological study	50	45	95	0	0	0
Tissues for various study	3	3	6	0	1	1
Tissues for lipid analysis	-	-	-	0	1	1
Tissues for nutritional component study	-	-	-	0	1	1
Tissues for chemical study	-	-	-	0	1	1
Tissues for nutrient study	0	1	1	0	1	1
Stomach contents for food and feeding study	43	30	73	0	1	1
Stomach contents for environmental monitoring	13	8	21	0	0	0
Samples of internal and external parasites	3	3	6	0	0	0
Photographic record of fetus	91	98	195[1)]	0	0	0
Fetal length and weight	91	98	195[1)]	0	0	0
Fetal ocular lens for age determination	27	41	68	0	0	0
Fetal skin for genetic study	90	98	193[1)]	0	0	0
Tissues for functional food study	2	4	6	0	1	1
Tissue samples for constraction of monitoring system of infectious disease	6	3	9	0	0	0
Fetal sample for clarification of jaw opening mechanism	1	1	2	-	-	-
Fetal sample for clarification of hind-limb disappearance mechanism	-	-	2[1)]	-	-	-

[1)]including fetus of sex unidentified.

Table 7. Reproductive status of Antarctic minke whales sampled in 2008/09 JARPAII. Maturity of males was tentatively defined by testis weight according to Kato (1986). "Resting" represents non-pregnant mature female without corpus luteum and "Ovulating" represents female that had corpus luteum but fetus was not observed.

Stratum	Male			Female						Combined
					Mature					
	Immature	Mature	Total	Immature	No-pregnant		Pregnant		Total	
					Ovulating	Resting	No-lactating	Lactating		
Area V West-South	25	59	84	29	0	1	30	0	60	144
	17.4%	41.0%	58.3%	20.1%	0.0%	0.7%	20.8%	0.0%	41.7%	100.0%
Area V East-South	8	77	85	25	1	4	125	0	155	240
(Ross Sea)	3.3%	32.1%	35.4%	10.4%	0.4%	1.7%	52.1%	0.0%	64.6%	100.0%
Area VI West-South	49	157	206	50	2		33	4	89	295
	16.6%	53.2%	69.8%	16.9%	0.7%	0.0%	11.2%	1.4%	30.2%	100.0%
Combined	82	293	375	104	3	5	188	4	304	679
	12.1%	43.2%	55.2%	15.3%	0.4%	0.7%	27.7%	0.6%	44.8%	100.0%

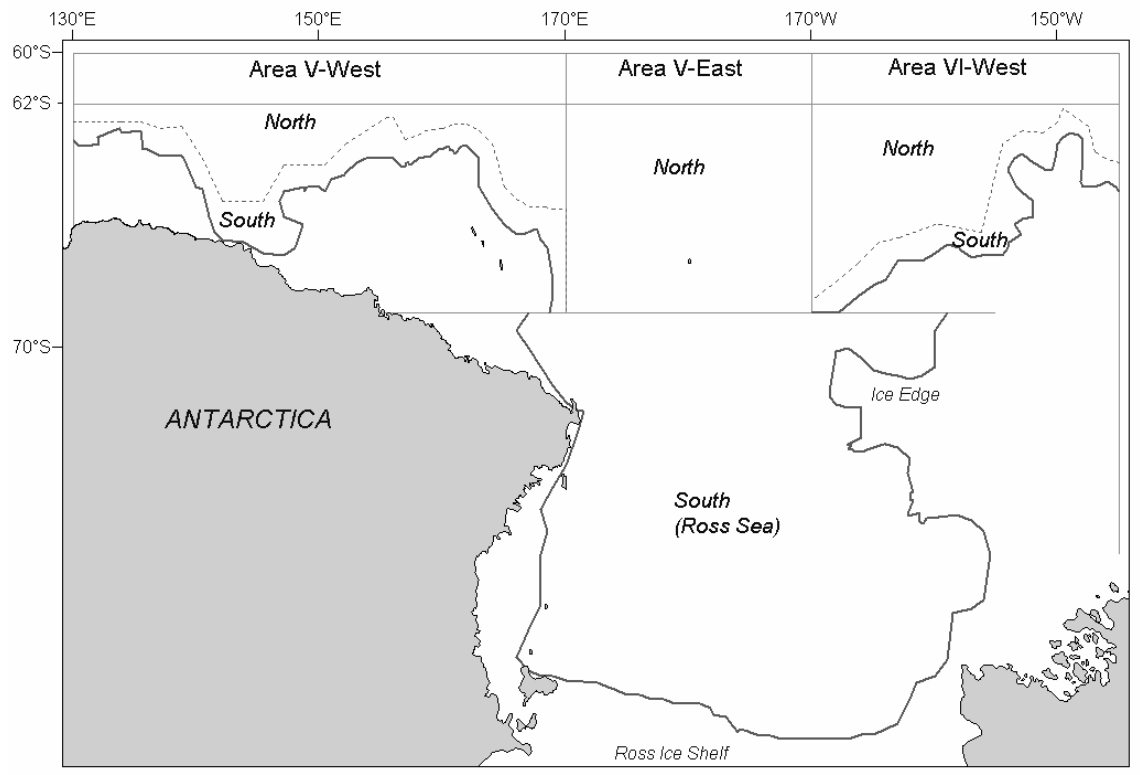

Figure 1. Geographic location of research area of the 2008/2009 JARPAII survey. Solid line shows the ice edge line. Ice edge lines are estimated by observation from research vessels and the information from Near real time DMSP SSM/I daily polar griddled sea ice concentration data set available from the National Snow and Ice Data Center (NSIDC, Cavalieri *et al*. 1999).

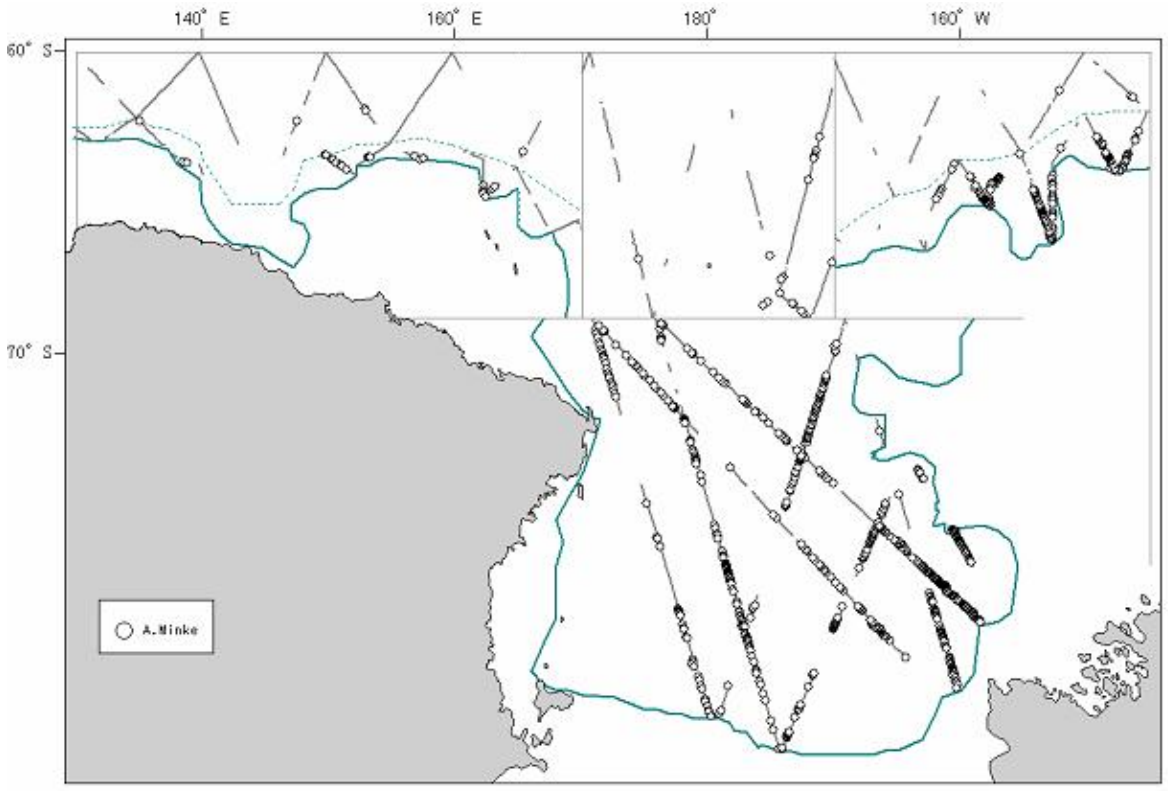

Figure 2. Distribution of primary sightings of Antarctic minke whales sighted with the searching effort by SVs in 2008/09 JARPAII.

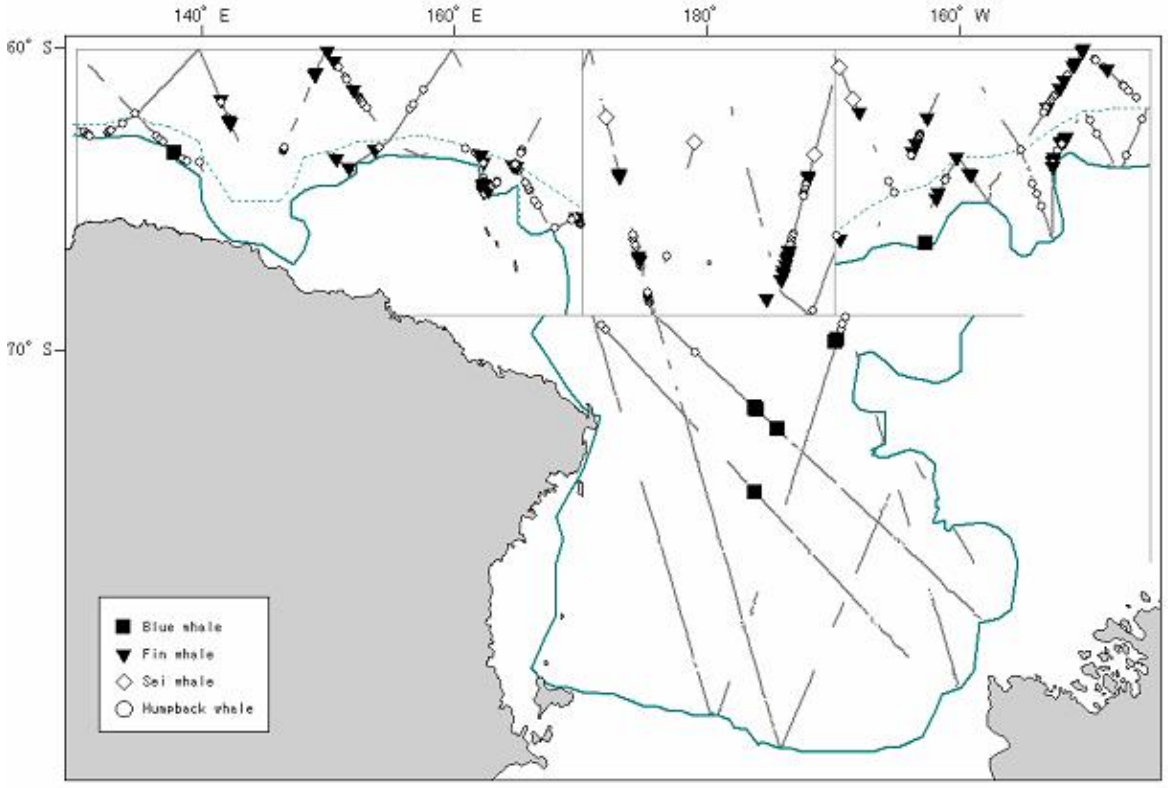

Figure 3. Distribution of primary sightings of blue, fin, sei and humpback whales sighted with the searching effort by SVs in 2008/09 JARPAII.

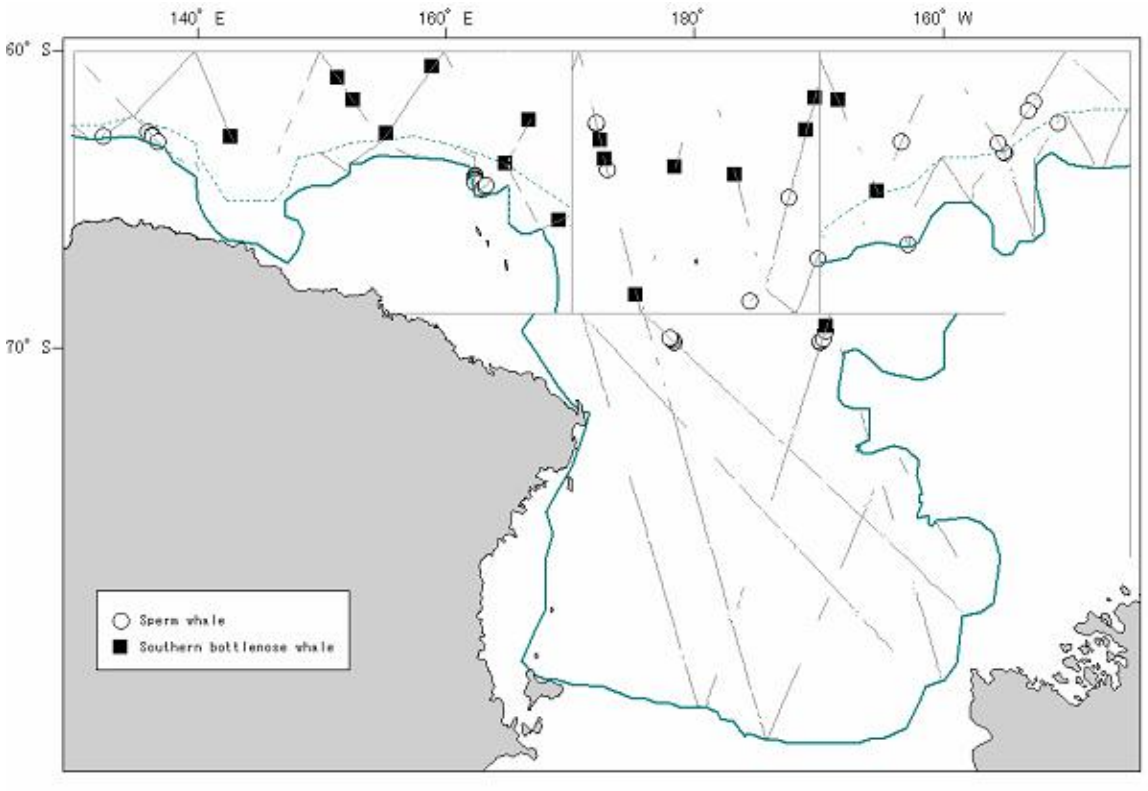

Figure 4. Distribution of primary sightings of sperm and southern bottlenose whales sighted with the searching effort by SVs in 2008/09 JARPAII.

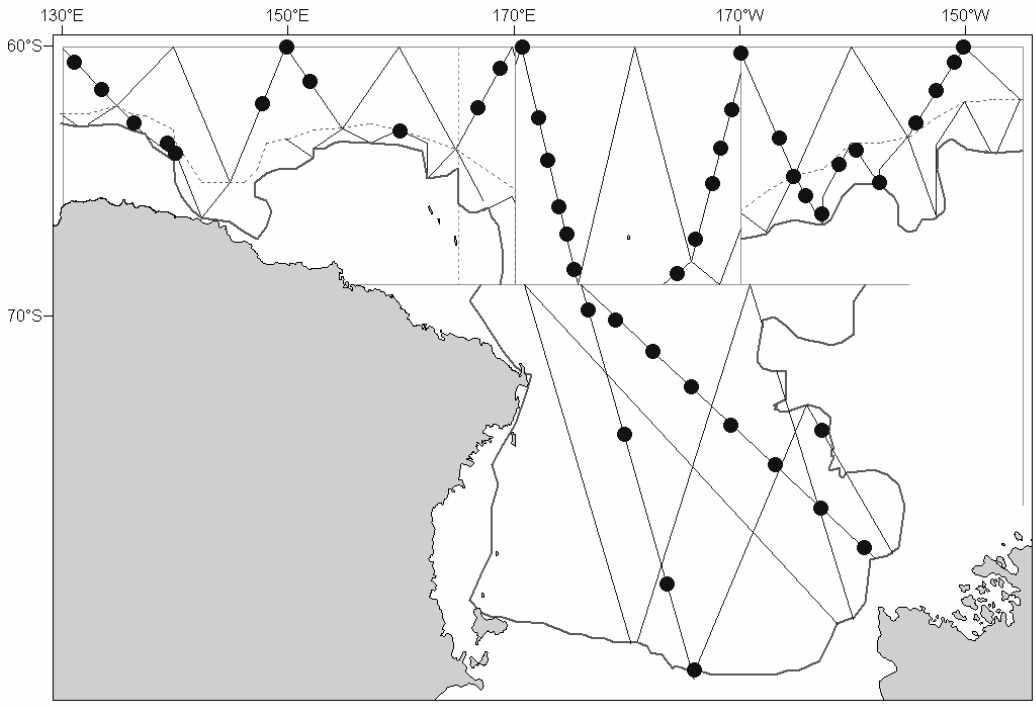

Figure 5. Geographical locations of NORPAC and IKMT net sampling (same positions) conducted by SV/Kaiko-Maru, during 2008/09 JARPAII.

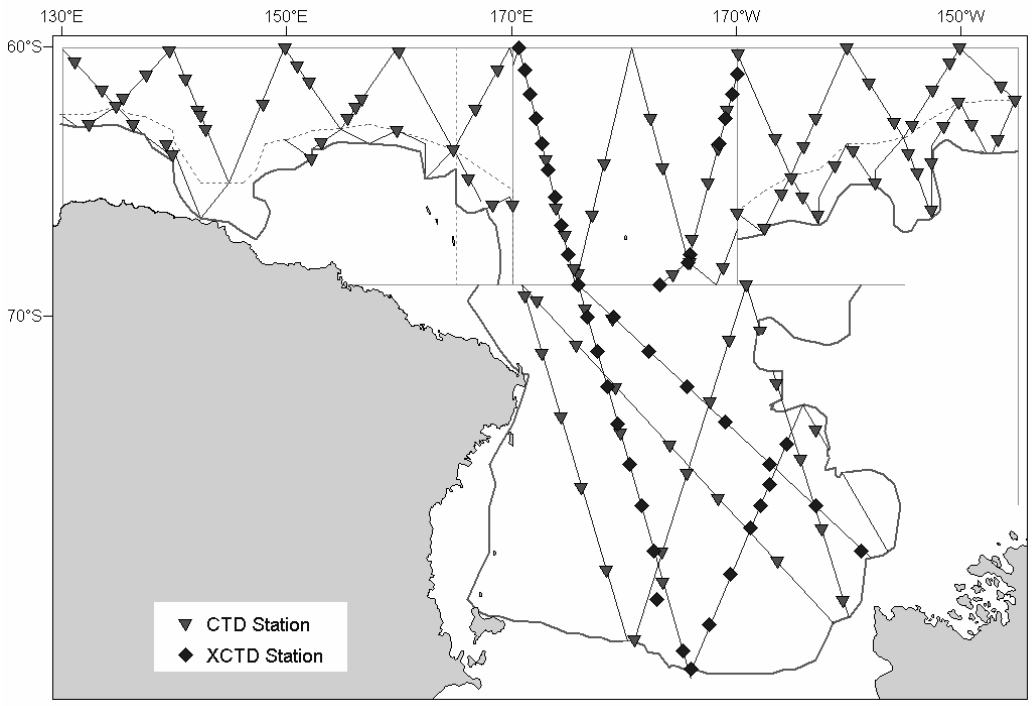

Figure 6. Geographical locations of CTD and XCTD casting conducted by two SVs during 2008/09 JARPAII.

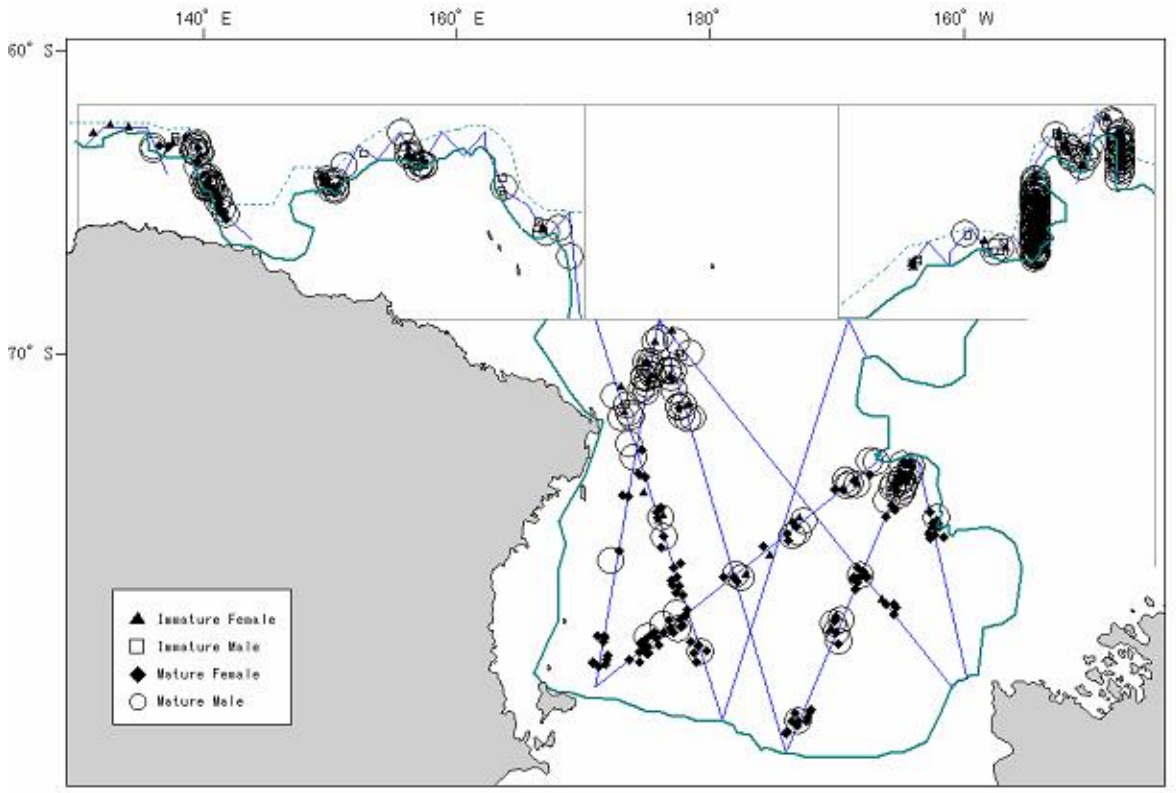

Figure 7. Distribution of sampled Antarctic minke whales by sex and sexual maturity status with the planned cruise track line (main course: a solid line) in 2008/09 JARPAII.

Appendix A. Satellite sea ice information.

Ice-edge 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). See Figures A-C below for examples of daily polar griddled sea ice concentration data using sea ice concentration categories (0-12%(white colored), 13-28%(blue), 29-44%(green), 45-60%(yellow), 61-80%(brown), 81-100%(red-purple) between January and March in 2009.

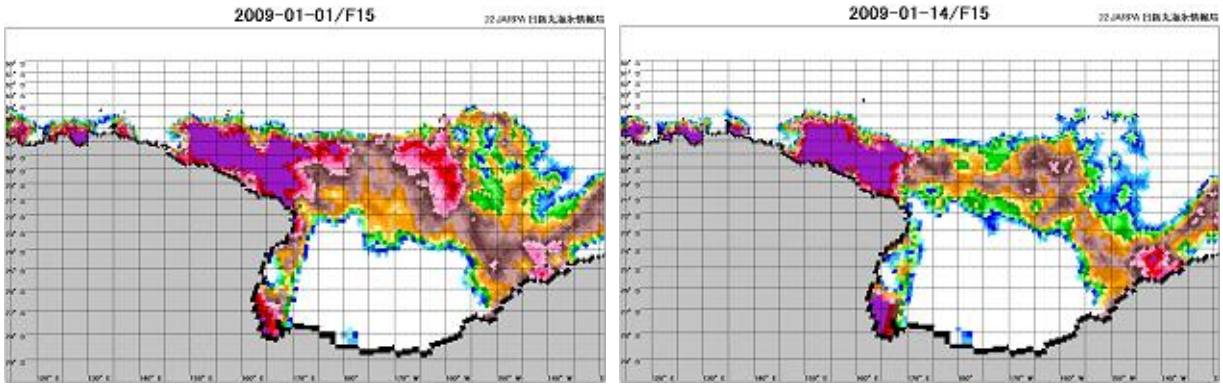

Figure A (**left:** 1st January, **right:** 14 January).

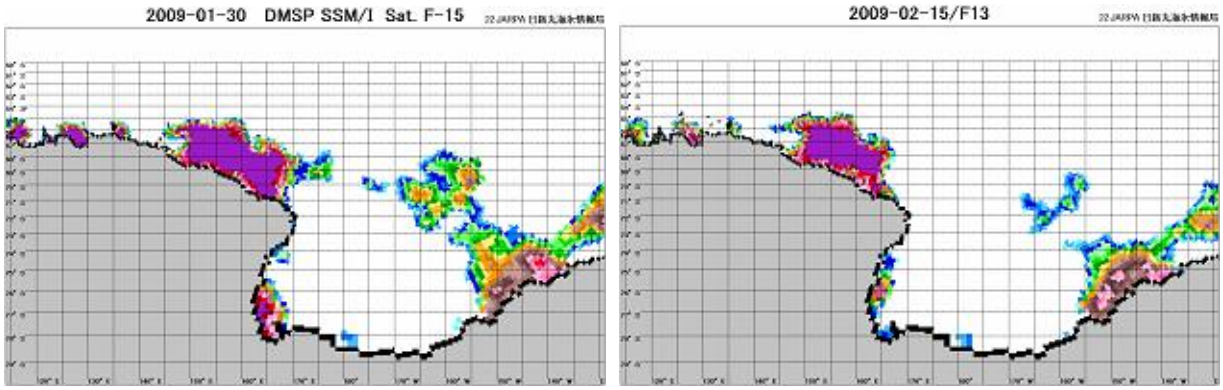

Figure B (**left:** 30 January, **right:** 15 February).

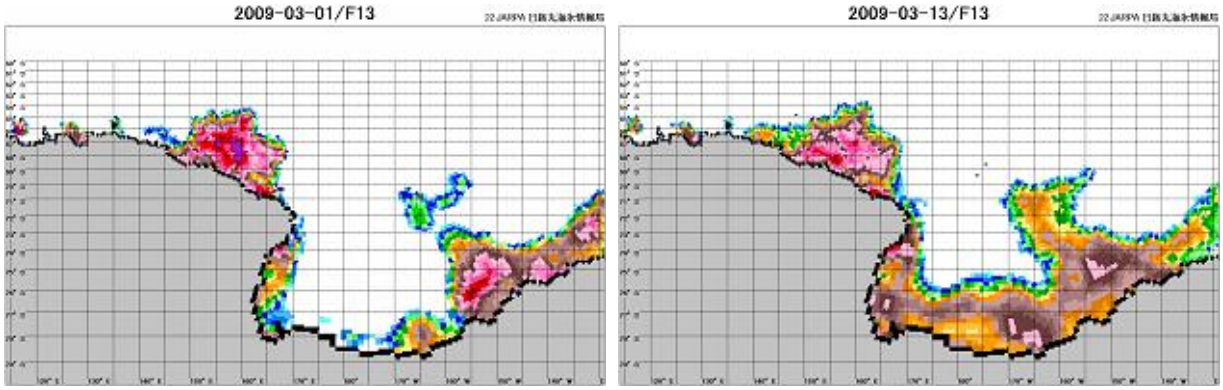

Figure C (**left:** 1st March, **right:** 13 March).