

Cruise Report of the Japanese Whale Research Program under Special Permit in the Antarctic-Second Phase (JARPA II) in 2009/2010

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ABSTRACT

The third full-scale research plan of the Japanese Whale Research Program under the Special Permit in the Antarctic-Second Phase (JARPA II) was conducted during the 2009/10 austral summer season. Two dedicated sighting vessels (SVs), two sighting and sampling vessels (SSVs) and one research base ship were engaged in the research for 97 days from 14 December 2009 to 20 March 2010 in Areas III East (35°E - 70°E), IV (70°E - 130°E), V West (130°E - 165°E) and part of Area V East (165°E - 175°E). The total searching distance was 8,232.0 n.miles. The research activities were interrupted several times by violent actions of an anti-whaling group over 31 days. Eleven species including six baleen whales (Antarctic minke, blue, fin, sei, humpback and southern right whale) and two toothed whales (sperm and southern bottlenose) were identified during the research period. A total of 986 groups (2,242 animals) of Antarctic minke whales were sighted. It was the dominant species in the research area followed by the humpback whales (603 groups, 1,187 animals), fin whales (56 groups, 186 animals). The number of sightings of the Antarctic minke whales was about 1.9 times higher than that of humpback whales and was considerably higher than those of other species. A total of 506 Antarctic minke whales and one fin whale were sampled. All whales sampled were examined on board the research base vessel. Photo-id experiments were conducted on blue, humpback and southern right whales and a total of 8 blue, 110 humpback and two southern right whales was photographed. A total of 86 skin biopsy samples were collected from fin (1), humpbacks (84) and southern right whale (1). Oceanographic surveys to investigate vertical sea temperature profiles were conducted at 57 points using TDR. The main results of this survey were as follows: 1) whale composition in the research area was stable compared to previous JARPA II surveys in this area; 2) the ice-free extent of the research area was substantially larger than in past seasons. High density areas of Antarctic minke whales were observed near the continental shelf; 3) mature females of Antarctic minke whale were dominant in Prydz Bay; 4) humpback whales were widely distributed in the research area and its density index was higher than that of the Antarctic minke whales in Areas IV West and V East. The 1994/95 IWC/SOWER cruise was conducted in similar areas and periods as in the present survey. In 1994/95 Antarctic minke whales were the most dominant species followed by southern bottlenose whales. These species were widely distributed in the research area. The number of sightings of Antarctic minke whales in 1994/95 was about 5 times higher than that of humpback whales. Comparison of whale between these two surveys suggests that humpback whales were increasing and expanding in the research area.

KEYWORDS: ANTARCTIC MINKE WHALE; FIN WHALE; HUMPBACK WHALE; SCIENTIFIC PERMITS

BACKGROUND

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). Also JARPA found that pollutant concentration in whale's tissues, such as heavy metals and PCBs, was extremely low (Yasunaga *et al.*, 2006). Further, JARPA showed an annual decreasing trend in energy storage in the 18 year period of JARPA (Konishi *et al.*, 2008). 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 full-scale JARPA II started from the 2007/08 season. 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.

The present paper reports the third full scale survey of the JARPA II conducted during the austral summer season 2009/10.

MATERIALS AND METHODS

Research vessels

The research fleet was composed of two dedicated sighting vessels, two sighting and sampling vessels and one research base vessel. The following vessels were used.

Research base vessel

Nisshin-Maru (NM; 8,044 tons)

Dedicated sighting vessels (SVs)

Shonan-Maru No.2 (SM2; 712 tons)

Yushin-Maru No.3 (YS3; 742 tons)

Sighting and sampling vessels (SSVs)

Yushin-Maru (YS1; 720 tons)

Yushin-Maru No.2 (YS2; 747 tons)

Two SVs were engaged in sighting and oceanographic surveys and most of the experiments. Two SSVs were engaged in sighting and sampling surveys and some of the experiments. 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 the same as in JARPA; the eastern part of Area III, Areas IV and V, and the western part of Area VI. The total area extends from 35°E to 145°W, south of 60°S. In this season, JARPA II surveyed the eastern part of Area III, Area IV and western part of Area V (35°E - 175°E). Figure 1 shows the geographic location of the research area for the 2009/2010 JARPA II 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. In this season, the ice-free extent of the research area including the Prydz Bay was substantially larger than previous surveys.

Survey track design

The survey track line for the SVs and the SSVs consisted of a zigzag course changing direction at 1°40' longitudinal degree intervals. For SSVs, two parallel track lines were set at 7n.miles apart. However, in this season, due to the interference of an anti-whaling group the SVs and SSVs could not carry out the research in the planned track line in Area III East (35°E - 70°E), a part of Area IV (90°E - 130°E) and a part of Area V West (130°E - 132°E).

Sighting methods

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). Two SSVs advanced along parallel track lines 7n.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 of more than 1.5 n.miles). In addition to the sighting of Antarctic minke and fin whales, the SVs approached blue (*B. musculus*), humpback, southern right (*Eubalaena australis*), pigmy right (*Caperea marginata*), sei (*B.borealis*), sperm (*Physeter macrocephalus*) 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 methods

Two SSVs were engaged in sampling survey. Sampling of 850 Antarctic minke whales (with 10 % of 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 3n.miles of the track line. Dwarf 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 logistic limitations at the NM. Only one fin whale was planed to be sampled from each primary sighted school within 3n.miles of the track line. If two or more animals smaller than 18m were found in a school, then only one of them was randomly selected and sampled. 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.

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 photo-identification experiment, pygmy right, fin, sei, sperm and 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.

Vomiting and fecal observation

The SVs and SSVs were engaged in observations of vomits and feaces of sighted whales.

Oceanographic survey

Two SVs conducted the following oceanographic survey; 1) consecutive measuring of vertical water temperature profile by TDR, and 2) marine debris recording in the research area.

RESULTS AND DISCUSSIONS

Outline of the cruise

SVs departed Shioyama and Shimonoseki (Japan) on 19 November and started Antarctic sighting survey in the research area on 14 December. SSVs and NM departed from Shimonoseki and Innoshima, respectively on 19 November and started Antarctic sighting and sampling surveys in the research area on 14 December. The Antarctic research period of this cruise was 97 days from 14 December 2009 to 20 March 2010. The research activity was interrupted for 31 days due to violent interferences by the Sea Shepherd group. Due to this interference SSVs cancelled the research in the northern part of the research area, Area IV east, a part of Area IV west, Area V west. SV (SM2) arrived at Tokyo on 12 March and SV (YS3) arrived at Shimonoseki on 27 March. SSVs (YS and YS2) arrived at Shimonoseki on 11 April. NM arrived at Tokyo on 12 April.

Sighting survey and whale species sighted

The total searching distances was 8,232.0 n.miles consisting of 4,620.8 n.miles for the two SVs and 3,611.3 n.miles for the two SSVs. Eleven species including six baleen whales and five toothed whales were identified during the research period. 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 and southern bottlenose.

Table 1 shows the number of sightings during the survey and Figure 2 shows the sighting position of Antarctic minke and humpback whales. The number of sightings of Antarctic minke whales (986 schools and 2,242 individuals in total) was about 1.9 times higher than that of humpback whales (603 schools and 1,187 individuals) and was considerably higher than those of other species. Both Antarctic minke whale and humpback whales were widely distributed in the entire research area, but density was different among strata.

The 1994/95 IWC/SOWER cruise (Ensor *et al.* 1995) was conducted in similar areas and period as in the present survey. This fact provides a good opportunity to compare the whale composition in the area in two different seasons. In 1994/95 season Antarctic minke whales were the most frequent species encountered in the research area followed by the southern bottlenose whales. Humpback whales were also common in the research area. The number of sightings of Antarctic minke whales (291 schools and 508 individuals) was about 5.0 times higher than that of humpback whales (46 schools and 100 individuals). This comparison suggests that humpback whales were increasing and expanding in the research area.

Table 2 shows the density indices (D.I., the number of primary sighted schools per 100 n. miles) and mean school size (M.S.S.) of Antarctic minke, humpback and fin whales for the SVs. The D.I. of Antarctic minke whale was higher in the southern strata excluding the case of Area V East, and the highest index was in the southern strata of Area V West. However the D.I. in the Prydz Bay was relatively low. The density of humpback whale was higher than that of Antarctic minke whale in the southern strata of Area IV West and southern strata of Area V East. The D.I. for humpback whale in southern strata of Area V East was 10.3 times higher than that for Antarctic minke whale.

Figure 3 shows the sighting position of other large baleen whales. The sightings of blue whales and fin whales were concentrated in Area III East and Area IV West.

Sampling for Antarctic minke and fin whales

Out of 511 schools (1,032 individuals) in the primary sightings of Antarctic minke whales by two SSVs, 476 schools (967 individuals) were targeted for sampling. A total of 506 individuals were sampled (246 from Area III East, 49 from Area IV West, 53 from Prydz Bay and 158 from Area V West). Sampling efficiency (the rate of successful sampling for targeted individuals) was 92.9 % for the first targeted individual from schools with single individual and 97.9 % for the first targeted individual from schools with more than one individual. One struck and lost case occurred.

SSVs made only fifteen 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. As a result, only one individual was sampled.

Biological research

Biological research was conducted on the research base vessel for all whales sampled. Table 3 summarizes biological data and samples collected from the Antarctic minke and fin whales.

Biological information of sampled whales

Table 4 shows the reproductive status of sampled Antarctic minke whales by stratum. Figures 4-1, 4-2 and 4-3 show distribution of sighting position of sampled Antarctic minke whales by sex and sexually mature status. Mature females were dominant in the Areas III East and Prydz Bay strata, whereas mature males were dominant in the Areas IV West and V West. Pregnancy rate in mature females was 92.5 % (184 individuals) in the entire research area. Two cases of twins were observed. Ten lactating females were sampled, though neither suckling calf was sampled nor observed.

Figure 5 shows body length distribution of Antarctic minke whales sampled during this survey. Maximum length of the sample was 10.66 m for females and 9.33 m for males. Minimum length was 5.16 m and 5.24 m for female and male, respectively. Maximum body length of immature animals was 8.62 m and 8.26 m for female and male, whereas minimum body length of mature animals was 7.55 m and 7.19 m for female and male, respectively.

Experiments

Photo-ID and biopsy sampling

Table 5 summarizes the results of the photo-identification experiment. A total of 8 blue, 110 humpback and two southern right whales was photographed. Table 6 summarizes results of biopsy sampling. A total of 86 biopsy samples were collected from fin, humpback and southern right whales.

Vomiting and faecal observation

Table 7 summarizes the results of the vomiting and faecal observations. A total of 6 faecal observations was recorded

Oceanographic survey

SVs conducted the oceanographic survey to get the vertical water temperature profile in 57 points using TDR. Figure 6 shows an overview of the oceanographic survey in the research area. The marine debris survey was carried out concomitant with the sighting survey of the two SVs in the research area. A total of 9 debris items was recorded which consisted of 7 buoys or floats, one drum can and one pet bottle.

Sighting distance and angle experiment

A sighting distance and angle experiment was performed on 5 January 2010 by three SSVs and on 26 and 31 January 2010 by YS3 and SM2, respectively. The results of this experiment will be used in calculation of abundance estimates.

By-products from the research

All sampled whales were processed on NM after biological examination, according to the provisions of Article VIII of the Convention. A total of 2,045.6 tons of meat, blubber, viscera, etc. was produced.

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Table 1. List of cetacean species and number of sightings (no. schools/no. individuals)

Species	Sch.	Ind.
Blue whale	24	40
Fin whale	56	189
Sei whale	1	2
Antarctic minke whale	986	2,242
Like Antarctic minke whale	46	88
Humpback whale	603	1,187
Southern right whale	2	2
Unidentified baleen whales	87	189
Sperm whale	127	130
Southern bottlenose whale	30	48

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 2009/10 JARPA II.

Area	Sector	Stratum	Effort [n.miles]	Antarctic minke		Humpback		Fin	
				D.I.	M.S.S	D.I.	M.S.S	D.I.	M.S.S
III	East	North	654.21	16.7	2.2	4.7	1.6	0.3	2.0
		South	1,202.81	37.2	2.6	5.2	2.1	2.6	3.9
IV	West	South	874.29	24.2	2.9	25.0	2.1	3.9	2.8
	Prydz Bay		802.26	15.3	1.7	11.6	1.9	0.6	1.7
V	West	North	227.75	5.7	6.5	5.3	1.7	0.0	-
		South	430.47	37.4	3.6	13.7	1.6	0.0	-
	East	North	289.39	3.8	1.0	2.8	1.1	0.0	-
		South	139.50	0.7	1.0	7.2	1.4	0.0	-

Table 3. Summary of research items conducted for sampled Antarctic minke and fin whales.

Samples and data	Antarctic minke			Fin		
	M	F	Total	M	F	Total
Photographic record of external character	237	267	504	1	0	1
Body length and sex identification	237	269	506	1	0	1
Measurement of external body proportion	237	269	506	1	0	1
Body weight	237	269	506	0	0	0
Body weight by total weight of parts	2	1	3	1	0	1
Skull measurement (length and breadth)	233	264	497	1	0	1
Standard measurement of blubber thickness (two points)	237	269	506	0	0	0
Detailed measurement of blubber thickness (fourteen points)	0	0	0	1	0	1
Lactation status	-	269	269	-	0	0
Measurement of mammary gland	-	269	269	-	0	0
Measurement of uterin horn	-	-	-	-	0	0
Testis weight	237	-	237	1	-	1
Epididymis weight	-	-	-	1	-	1
Weight of stomach content	237	269	506	1	0	1
Photographic record of fetus	83	91	186*	-	0	0
Fetal length and weight	83	91	186*	-	0	0
External measurements of fetus	-	-	-	-	0	0
Fetal ocular lens for age determination	9	8	17	0	0	0
Fetal skin for genetic study	83	91	182*	0	0	0
Number of ribs	-	-	-	1	0	1
Number of vertebra	-	-	-	1	0	1
Diatom film observation	237	269	506	1	0	1
Diatom film sample	-	-	-	1	0	1
Blood plasma for physiological study	215	239	454	1	0	1
Earplug for age determination	236	269	505	1	0	1
Ocular lens for age determination	237	269	506	1	0	1
Tympanic bone for chemical analysis	30	18	48	1	0	1
Largest baleen plate for chemical analysis	237	269	506	1	0	1
Vertebral epiphyses sample	208	230	438	1	0	1
Ovary sample	-	269	269	-	0	0
Histological sample of endometrium	-	17	17	-	0	0
Histological sample of mammary gland	-	269	269	-	0	0
Milk sample for chemical analysis	-	0	0	-	0	0
Histological sample of testis	237	-	237	1	-	1
Histological sample of epididymis	-	-	-	1	-	1
Skin and liver tissues for genetic study	237	269	506	1	0	1
Blubber, muscle and liver tissues for environmental monitoring	237	269	506	1	0	1
Lung and liver tissue for air monitoring	19	20	39	1	0	1
Macro pathological observation (thyroid, lung and liver)	237	269	506	1	0	1
Tissues for histopathological study	12	6	18	1	0	1
Muscle, liver, kidney, lumbar and blubber tissues for lipid analysis	-	-	-	1	0	1
Muscle and blubber tissues for various analysis	3	3	6	1	0	1
Muscle liver and blubber tissues for chemical analysis	-	-	-	1	0	1
Stomach contents for food and feeding study	25	31	56	1	0	1
Stomach contents for environmental monitoring	8	13	21	0	0	0
Stomach contents for lipid analysis	-	-	-	0	0	0
External parasites	4	6	10	1	0	1
Internal parasites	3	2	5	0	0	0
Stomach contents for DNA study	2	5	7	-	-	-
Gut contents for food and feeding study	9	12	21	1	-	1
Fundus for food and feeding study	1	1	2	1	-	1
Tissue samples for construction of monitoring system of infectious disease	198	221	419	1	0	1
Tissues for functional food study	3	2	5	1	0	1
Uterus and placenta tissues for histological study	-	5	5	-	-	-
Fetal sample for clarification of hind-limb disappearance mechanism	-	-	4*	-	-	-

* : including foetus of sex unidentified.

Table 4. Reproductive status of Antarctic minke whales sampled in 2009/10 JARPA II. Maturity of males was tentatively defined by testis weight according to Kato (1986). "Resting" represents non-pregnant mature female without corpus luteum.

Area	Sector	Male			Female								Combined
		Immature	Mature	Total	Immature	No-pregnant			Pregnant		Unknown	Total	
						Maturing	Lactating	Resting	No-Lactating	Lactating			
III	East	21 8.5%	81 32.9%	102 41.5%	30 12.2%	6 2.4%	1 0.4%	2 0.8%	95 39.0%	9 3.3%	1 0.4%	144 58.5%	246
IV	South	7 14.3%	23 46.9%	30 61.2%	10 20.4%	0 0.0%	0 0.0%	0 0.0%	9 18.4%	0 0.0%	0 0.0%	19 38.8%	49
	west Prydz	0 0.0%	10 18.9%	10 18.9%	4 7.5%	1 1.9%	0 0.0%	3 5.7%	34 64.2%	1 1.9%	0 0.0%	43 81.1%	53
V	West	17 10.8%	78 49.4%	95 60.1%	26 16.5%	0 0.0%	0 0.0%	1 0.6%	36 22.8%	0 0.0%	0 0.0%	63 39.9%	158
Combined		45 8.9%	192 37.9%	237 46.8%	70 13.8%	7 1.4%	1 0.2%	6 1.2%	175 34.6%	9 1.8%	1 0.2%	269 53.2%	506

Table 5. Summary of photo-ID collected during 2009/10 JARPA II

Species	Number of experiments (A)	Targeted individuals (B)	Number of photos (C)
Humpback whale	59	110	497
Blue whale	8	8	48
Right whale	2	2	14

Table 6. Summary of biopsy samples collected during 2009/10 JARPA II.

Species	Ship Type	Number of experiments (A)	Targeted individuals (B)	Number of shoots (C)	Number of hits (D)	Number of samples (E)	Effort (hr:min) (F)	sample per trial (E)/(C)	sample per hit (E)/(D)
Blue whale	SSVs	1	1	2	0	0	0:18	0.00	0.00
Blue whale	SVs	7	11	5	0	0	3:44	0.00	0.00
Fin whale	SSVs	4	17	7	1	1	2:05	0.14	1.00
Fin whale	SVs	1	4	1	0	0	0:35	0.00	0.00
Humpback whale	SSVs	45	27	104	68	63	10:56	0.61	0.93
Humpback whale	SVs	14	95	36	23	21	3:41	0.58	0.91
Right whale	SSVs	1	1	1	1	1	0:03	1.00	1.00
Right whale	SVs	1	1	1	0	0	0:44	0.00	0.00

Table 7. Summary of vomiting and fecal observation during 2009/10 JARPA II.

Species	Area	School size	Body size (m)	Distance (miles)	Vomiting or Fecal	Photo (Y or N)	Sample (Y or N)
Fin whale	III	4	16.0	0.1	Fecal	N	N
Fin whale	III	1	21.0	0.1	Fecal	N	N
Antarctic minke whale	III	4	8.0	0.1	Fecal	N	N
Antarctic minke whale	III	1	8.0	0.2	Fecal	N	N
Humpback whale	III	1	11.2	0.2	Fecal	N	N
Humpback whale	IV	2	12.1	0.1	Fecal	N	N

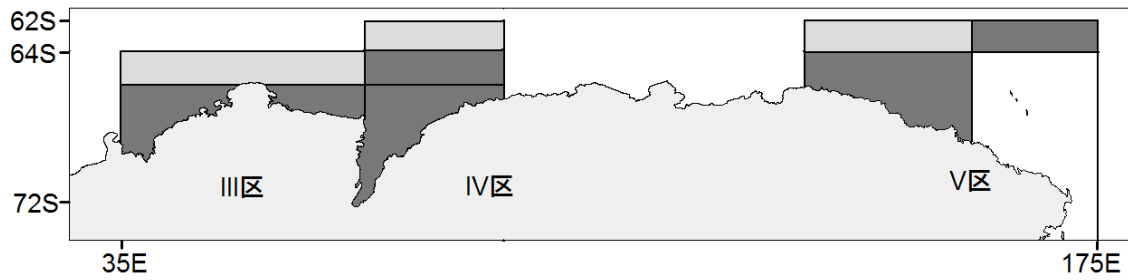


Fig 1. Map showing this research area and strata. Dark grey part shows the research activity zone by SSVs and SVs. Light grey shows the research activity zone by SVs.

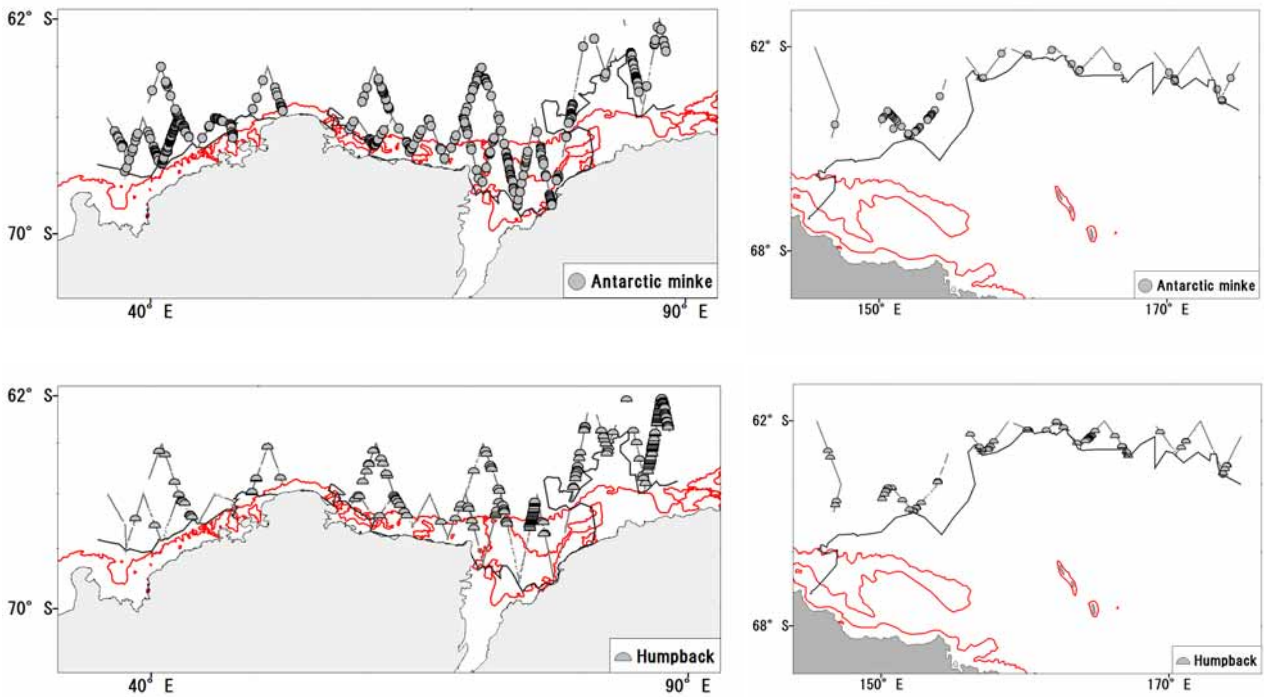


Fig. 2. Distribution of primary sightings of Antarctic minke (upper) and humpback whales (lower) sighted with the searching effort by SVs.

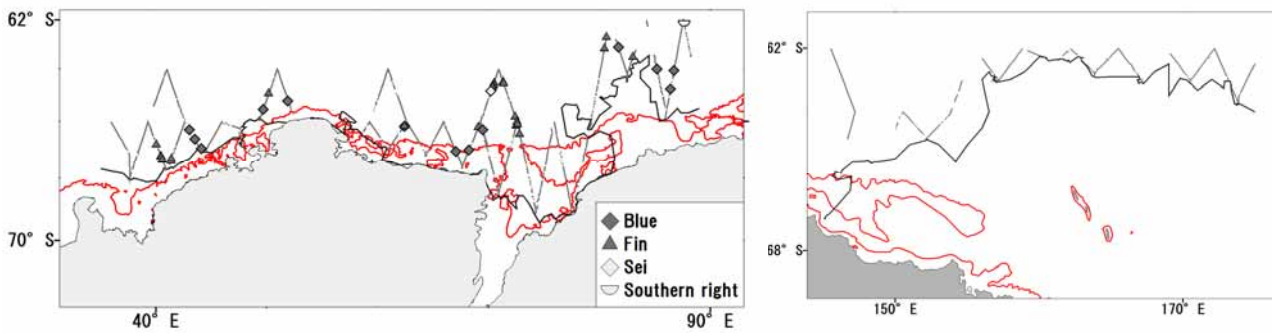


Fig. 3. Distribution of primary sightings of other baleen whales sighted with the searching effort by SVs.

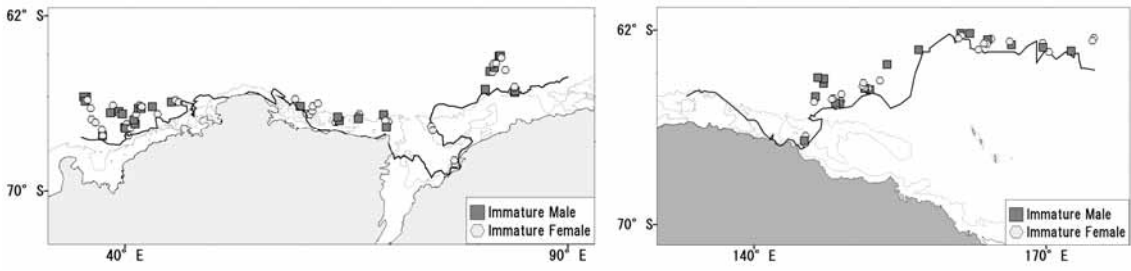


Fig. 4-1. Distribution of sampled immature of Antarctic minke whales

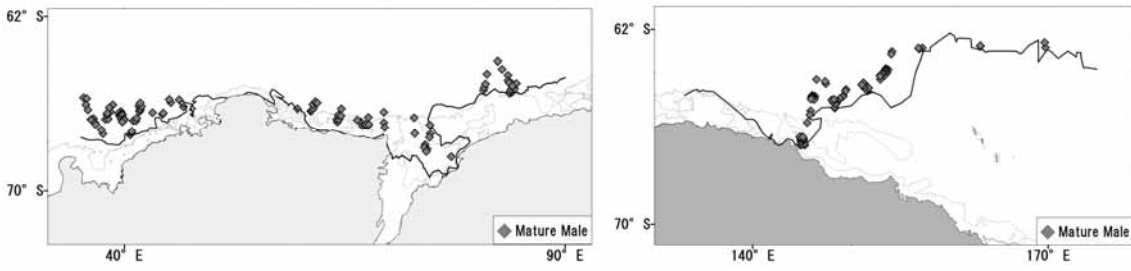


Fig. 4-2. Distribution of sampled mature male of Antarctic minke whales

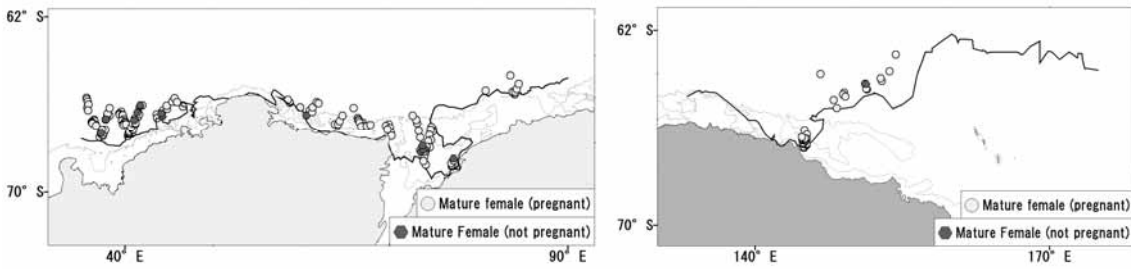


Fig. 4-3. Distribution of sampled mature female of Antarctic minke whales (upper: pregnant; lower: non-pregnant)

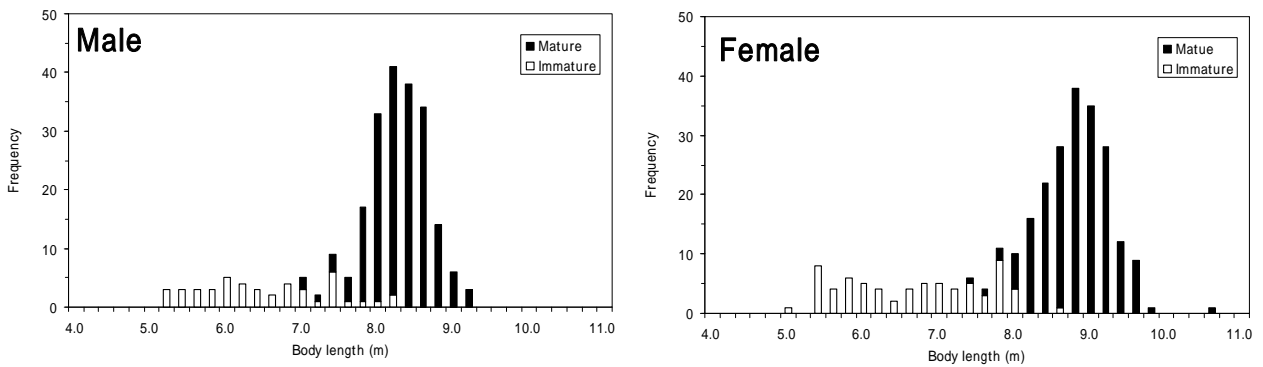


Fig. 5. Body length distribution of sampled Antarctic minke whales in each sexual maturity.

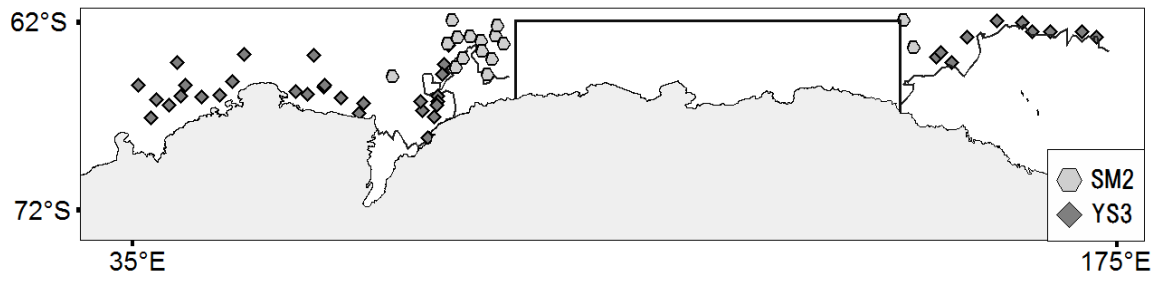


Fig. 6. Geographical locations of TDR conducted by two SVs.