Cruise Report of the Japanese Whale Research Program under Special Permit in the western North Pacific -Phase II (JARPN II) in 2004 (part I) - Offshore component – <Draft>

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ABSTRACT

The full-scale survey of the second phase of the Japanese Whale Research Program under Special Permit in the North Pacific (JARPN II) started in 2002. The objectives of the full-scale research are (1) to study on feeding ecology and ecosystem studies, involving studies of prey consumption by cetaceans, prey preferences of cetaceans and ecosystem modeling, (2) to monitor environmental pollutants, and (3) to study on stock structure. Target species are common minke whale *Balaenoptera acutorostrata*, Bryde's whale *B. edeni*, sei whale *B. borealis* and sperm whale *Physeter macrocephalus*. The third cruise of the JARPN II survey -offshore component- was conducted from 15 June to 18 September 2004 in sub-areas 7, 8 and 9 of the western North Pacific. In the survey a total of six research vessels were used: one trawl survey vessel equipped with scientific echo sounder (TSV), one dedicated sighting vessel (SV), three sighting/sampling vessels (SSVs) and one research base vessel. A total of 10.695.0n.miles was surveyed for whale searching in a period of 96 days. During that period 119 common minke, 180 Bryde's, 385 sei and 523 sperm whales were sighted by the SSVs. A total of 100 common minke, 100 sei, 50 Bryde's and 3 sperm whales was sampled by the SSVs. The cooperative survey on ecosystem research with the participation of six vessels was conducted in a part of sub-area 9 from 15 to 17 September. All whales sampled were examined on board the research base vessel. Common minke whales fed mainly on Pacific saury (*Cololabis saira*), Minimal armhook squid (*Berryteuthis anonychus*) and Japanese anchovy (*Engraulis japonicus*). Bryde's whales fed mainly on Japanese anchovy and Chub mackerel (*Scomber japonicus*). Sei whales fed mainly on Japanese anchovy, copepods and Pacific saury. Dominant preys in the stomach of three sperm whales were various kinds of squids, which inhabit the mid- and deep-waters.

KEYWORDS: COMMON MINKE WHALE; BRYDE'S WHALE; SEI WHALE; SPERM WHALE; NORTH PACIFIC OCEAN; DISTRIBUTION; FOOD/PREY; ECOSYSTEM; SCIENTIFIC PERMITS

INTRODUCTION

Feasibility study of the second phase of the Japanese Whale Research Program under Special Permit in the North Pacific (JARPN II) was conducted in 2000 and 2001 (Government of Japan, 2000). A two year results were presented to the 2002 SC meeting (Government of Japan, 2002a). Based on these results of the feasibility study, Japan presented the research plan for the full-scale JARPN II (Government of Japan, 2002b) to the 2002 SC meeting.

The full-scale study was aimed at i) feeding ecology and ecosystem, ii) monitoring of environmental pollutants in cetaceans and the marine ecosystem and iii) to elucidate the stock structure (Government of Japan, 2002b).

The full-scale JARPN II plan involved two survey components: the 'offshore' survey was covered by the *Nisshin Maru* research unit and the 'coastal' survey was covered by catcher boats of small type whaling. The coastal component was necessary to cover the temporal and spatial gaps, which could not be covered by the *Nisshin Maru* unit (Government of Japan, 2002b).

The research area was set in sub-areas 7, 8 and 9, and the target species and sample sizes in 2004 were set as follows: 160 common minke whales *Balaenoptera acutorostrata* (100 were to be sampled by the offshore survey and 60 - by the coastal survey); 100 sei whales *B. borealis* (offshore survey), 50 Bryde's whales *B. edeni* (offshore survey) and 10 sperm whales *Physeter macrocephalus* (offshore survey) (Government of Japan, 2004a, 2004b).

In this paper, we present an outline of offshore component in the third full scale survey of the JARPN II -offshore component-, which was conducted from 15 June to 18 September 2004.

MATERIALS AND METHODS

Research area

Sub-areas 7, 8 and 9, excluding the EEZ zones of foreign countries, were research area (Fig. 1). These sub areas were further divided as follows:

Sub-area 7: Five small blocks (7N, 7MI, 7MO, 7SI, 7SO stratified for taking into account satellite information on water temperature.

Sub-area 8, 9: Four small blocks (8N, 8S, 9N and 9S) were divided at 40ºN.

In the case of the cooperative survey, a special block was predetermined in the survey areas. One special block (SB) was settled in offshore area as shown in Fig. 1. We conducted the whale and prey surveys in the SB concurrently.

Research vessels

Six research vessels were used.

The research base vessel *Nisshin Maru* (NM: 7,659GT) commanded the research and was engaged in the biological examination of whale samples and of by-products. The *Yushin Maru* (YS1: 720GT), *Yushin Maru* No.2 (YS2: 747GT) and *Kyo Maru* No.1 (K01: 812.08G) were used as the sighting/sampling vessels (SSVs), which conducted sighting activities, sampling of targeted whale species and various experiments and observations. The *Kyoshin Maru* No. 2 (KS2: 372GT) was used as dedicated sighting vessel (SV). The *Shunyo Maru* (SYO: 887GT) was engaged in trawl surveys and echo sounder surveys. This vessel also conducted the mid-water trawl net and MOCNESS net sampling. Furthermore, this vessel conducted the oceanographic observations using CTD.

Survey components

The survey was composed of three main components: whale survey, sighting survey and the cooperative survey.

Whale survey

Vessels: Four research vessels (NM, YS1, YS2 and K01)

Research area: Sub-areas 7, 8 and 9. In addition, a 'special monitoring survey' (SMS) was settled in an area where the number of common minke, Bryde's and sei whales were expected to be large.

Research period (Table 1):

First period: Between 15 June and 10 August.

Second period: Between 11 August and 4 September.

Third period: Between 15 and 12 September.

Forth period: 18 September

Dedicating Sighting survey (Table 1)

Vessels: One research vessel (KS2)

Research area: Sub-areas 7, 8 and 9

Research period:

Entire period: Between 14 May and 5 September.

Cooperative survey on the prey species and whale sampling (Table 1)

Vessels: Five research vessels (NM, YS1, YS2, K01 and SYO)

Research area: In the cooperative survey on ecosystem research, one special block (A) was settled.

Reseach period:

First period (A) : Between 5 September and 8 September for the A (offshore-block).

Methods for setting cruise track line for the whale survey

Track lines and allocation of vessels were made as in previous JARPN and JARPN II surveys (Fujise *et al.*, 1995, 1996, 1997, 2000, 2001, 2002; 2003, Ishikawa *et al.*, 1997, Zenitani *et al.*, 1999, Tamura *et al*., 2004). The zigzag-shaped track line was established on an arbitrary basis in each sub-area and month, taking into consideration previous sighting information of target whales and sea conditions.

Furthermore, some 'special monitoring survey' (SMS) were conducted in areas where the abundance of common minke whales, Bryde's and sei whales were expected to be large. Track line in the SMS was designed separately from the original track line. Three SSVs were allocated to these tracks with the allocation being changed every day.

The track line of the prey survey vessel in the cooperative survey was determined in the following manner. The zigzag-shaped track line was set independent of whale survey. If the SYO detected the existence of the prey species by response of echo sounder, the SYO conducted the trawl survey and/or MOCNESS survey for the target depth to identify these prey species, at the same time. The whale research fleet surveyed in the following manner: the research course consisted of one main track and two parallel tracks established in six n.miles apart from both sides.

Apart from these sampling activities, an independent track line for dedicated sighting survey was determined in the research area. The track lines were determined randomly.

Sighting surveys

Sighting procedure both for the whale survey and dedicating sighting survey was similar to the previous surveys of JARPN and JARPN II (Fujise *et al.*, 1995, 1996, 1997, 2000, 2001, 2002; 2003, Ishikawa *et al.*, 1997; Zenitani *et al.*, 1999, Tamura *et al*., 2004). In the research area sighting was conducted mainly under closing mode. Furthermore two modalities of sighting in closing mode were adopted, *NSC* and *NSS modes*, by taking into consideration weather and sea conditions mainly. The *NSC* and *NSS modes* were the same as *BC* and *BS modes* in the previous JARPN surveys, respectively. The conditions to conduct surveys under *NSC mode* were similar to those established in Japanese sighting surveys conducted by the National Research Institute of Far Seas Fisheries (*i.e*. visibility of 2 n.miles or more and wind force of 4 or below). The *NSS mode* was used under more critical weather conditions but under this condition the collection of whale samples was possible. This *NSS mode* was used only by SSV vessels. These two mode surveys were recorded separately for future analysis. Also an *ASP mode* was used (closing mode survey without sampling activities under normal sighting conditions).

During the transit from homeport (HP) to research area (RA) and from RA to HP, the *NSP mode* was adopted (passing mode without sampling activities under normal sighting conditions).

Closing was performed mainly on sightings of common minke, Bryde's, sei and sperm whales. Furthermore it was planned to use closing was made on sightings of large whales, such as blue, humpback, right and fin whales. In these cases, closing was done in order to confirm species and school size and in order to conduct some experiments.

Sampling of common minke, Bryde's, Sei and sperm whales

Most of the target whale species sighted on the trackline were approached for sampling. Furthermore sampling effort was applied outside the established research hours (SSV: 06:00-19:00, SV: 06:00-18:00), if collection of whale samples was considered as possible.

For schools consisting of two or more animals, numbering was made for all the whales in the school; to set sampling order randomly in accordance with the table of random numbers (Kato *et al.*, 1989). Cow and calf pairs were not targeted for sampling.

Sampled whales were immediately transported to a research base vessel, where biological measurements and sampling were carried out.

Prey species survey

Detailed report on this activity is shown in Appendix I.

A quantitative echo sounder (Simrad EK60 with program version 1.4.3.64) was used on board SYO to acquire acoustic data with operating frequency at 38, 70 and 120 kHz. Those data were collected as the reference information for qualitative analysis. Calibrations were carried out at Kushiro (23 September 2004) using the copper sphere technique described in EK 60 online help manual.

The mid-water trawl net was 86.3 m long with a mouth opening of ca. 900 m^2 and a 6.0 m cod end with a 17.5 x 17.5 mm mesh. Surface and mid-water trawl was towed at acoustic identified stations. Trawls were conducted for 0.5 hour to identify the species compositions of biological backscattering detected by the quantitative echo sounder. Routine trawls were conducted at predetermined stations in each block in daytime and nighttime. The purpose of the routine trawls was

to estimate the abundance and distribution patterns of cephalopods and neustonic organisms such as Pacific saury (*Cololabis saira*) that are difficult to detect by the echo sounder. Three different depth layers were sampled at routine trawl stations; 0-30m (surface) 30-60m and 60-100m (mid-water). Nighttime routine trawls were conducted twice to examine day-night difference of prey species composition. All samples were identified to the species as much as possible and wet weight of each species was measured aboard the ship. For the major species, length and weight of 100 individuals were measured to examine their size composition. A part of samples were frozen at –30°C for further analysis in the laboratory.

MOCNESS was used to collect zooplankton such as copepods and krill. This net with a mouth opening of ca. 1 m^2 with a 0.33 x 0.33 mm mesh can take some samples in each depth layer and estimate the quantitative value. Eight different depth layer were sampled at routine trawl stations; 0-20m, 20-40m, 40-60m, 60-80m, 80-100m, 100-150m, 150-200m and 200-250m. Target net samples were conducted to identify the species compositions of biological backscattering detected by the quantitative echo sounder. The depth layer was sampled at target net stations; 0-300m.

Experiments

The following experiments and observations were conducted on board the sighting/sampling vessels:

1. Sighting distance and angle experiments to examine the precision of sighting data (YS1, YS2 and K01).
2. Biopsy sampling on blue, fin, humpback, right, Bryde's, common minke, sei and sperm whales.
3. Photographic records of natural marks in blue, humpback and right whales.
4. Preliminary examination of attachment of data logger to Bryde's whales.
5. Feeding behaviour patterns of large whale species (blue, fin, sei, Bryde's, common minke, humpback, right and sperm whales).
6. Oceanographic observations using EPCS (Electric particle counting and sizing system)(YS2).

On board the SV, the following experiments and observations were conducted:

1. Sighting distance and angle experiment to examine the precision of sighting data.
2. Biopsy sampling on blue, fin, humpback, right, Bryde's, common minke, sei, grey and sperm whales.
3. Photographic records of natural marks in blue, humpback, grey and right whales.
4. Feeding behaviour patterns of large whales.
5. Oceanographic observations using EPCS (Electric particle counting and sizing system).
6. Oceanographic observations using CTD.

On board the prey survey vessel (SYO), the following experiments were conducted:

1. Estimate abundance of prey species of common minke and other large whale species using an echo sounder system.
2. Oceanographic observations using CTD.

Observations of marine debris in the research area were conducted from the wheelhouse of the research base vessel (*NM*) (mainly during transit cruises). Marine debris were also investigated in the stomach contents of common minke, Bryde's, sei and sperm whales sampled. Experiments on killing method were conducted onboard of both the research base vessel and the SSVs.

RESULTS AND DISCUSSIONS

Searching distance

Track line covered by the three sighting/sampling vessels (SSVs) is shown in Figs 2 and 3. The total searching distance for SSVs was 10,695.4 n.miles (Table 2).

In the cooperative survey on ecosystem research, the survey was conducted from 5 to 8 September. Under the cooperative survey, searching distance for SSVs was 141.7 n.miles (Table 2).

Track line covered by the dedicated sighting vessel (SV) is shown in Fig 4. The total searching distance was 3,943.8 n.miles, respectively (Table 2).

Sightings of common minke, Bryde's, sei and sperm whales

Sighting and sampling vessels (SSVs)

A total of 119 schools (119 individuals) of common minke whales was sighted, consisting of 71 schools (71 individuals) of primary and 48 schools (48 individuals) of secondary sightings. For sei whale, 257 schools (385 individuals) were sighted, consisting of 134 schools (181 individuals) of primary sightings and 123 schools (204 individuals) of secondary sightings. For Bryde's whale, 130 schools (180 individuals) were sighted, consisting of 96 schools (127 individuals) of primary sightings and 34 schools (53 individuals) of secondary sightings. For sperm whale, 292 schools (523 individuals) were observed, consisting of 234 schools (410 individuals) of primary sightings and 58 schools (113 individuals) of secondary sightings (Table 3).

Fig 5 shows the distribution of common minke whales sighted by the SSVs in the sub-areas 7, 8 and 9. Figs.6 and 7 show the distribution of Bryde's and sei whales. Common minke whales were usually sighted in northern part of sub-areas 7, 8 and 9, but Bryde's whales were sighted mainly in southern part of sub-areas 8 and 9. Sei whales were sighted mainly in offshore of sub-areas 8 and 9. In the sub-areas 8 and 9, some segregation was observed between sei and Bryde's whales. Fig. 8 shows the distribution of sperm whale sightings in sub-areas 8 and 9. This species was widely distributed in sub-areas 8 and 9.

Dedicated sighting vessel (SV)

During the research cruise, 29 schools (33 individuals) of common minke whales were sighted, consisting of 29 schools (33 individuals) of primary sightings. For sei whale, 53 schools (80 individuals) were sighted, consisting of 51 schools (77 individuals) of primary sightings and 2 schools (3 individuals) of secondary sightings. For Bryde's whale, 35 schools (44 individuals) were sighted, consisting of 35 schools (44 individuals) of primary sightings. For sperm whale, 102 schools (239 individuals) were sighted, consisting of 91 schools (207 individuals) of primary sightings and 11 schools (32 individuals) of secondary sightings (Table 4).

Sightings of other large cetacean species

Sighting and sampling vessels (SSVs)

Table 3 shows the number of sightings for other cetacean species made by the SSVs, including large baleen whales such as blue (61 schs./91 inds.), fin (104 schs./174 inds.) and right whales (2 schs./4 inds.) (Figs. 9, 10 and 11).

Dedicated sighting vessel (SV)

Large baleen whales such as blue (4 schs. /7 inds.), fin (12 schs. /16 inds.) and humpback whales (8 schs. /9 inds.) were found in the sub-areas 7, 8 and 9 (Table 4).

Sampling of common minke, Bryde's, sei and sperm whales

Table 5 shows the number of whales sampled in each sub-area or special block for each research component and period. A total of 100 common minke whales (Male: 90 individuals, Female: 10 individuals) were sampled, 84 during the whale survey component and 16 during the cooperative survey component. A total of 100 sei whales (Male: 47 individuals, Female: 53 individuals) were sampled, 86 during the whale survey component and 14 during the cooperative survey component. A total of 50 Bryde's whales (Male: 19 individuals, Female: 31 individuals) were sampled during the whale survey component. A total of three female sperm whales were sampled during the whale survey component.

Geographical distribution of common minke, Bryde's and sei whale samples are shown in Figs 4-6 based on the sighting positions. Fig. 7 shows the distribution of sperm whale samples based on the sighting positions. One Bryde's whale was struck but lost due to technical failure.

Biological research for common minke, Bryde's and sei whales

Table 6 summarizes the biological data and samples obtained from the common minke, Bryde's, sei and sperm whales sampled. A total of 55 research items were covered. These items are related to the studies conducted under the three main objectives of the JARPN II: study on feeding ecology of whales and marine ecosystem, pollution studies and elucidation of stock structure.

Composition of sex and sexual maturity of common minke, Bryde's, and sei whales is shown in Tables 7, 8 and 9. The rate of mature males in common minke was higher than in Bryde's and sei whales.

Preliminary analyses of biological data and experiments

Body length of sampled whales

The statistics of body length of common minke whales are shown in Table 10. Mean body length of common minke whales is 7.45 m and 7.66 m for males and females, respectively. Mean body length of males and females tended to be higher in the sub-area 9 than those in sub-area 7. For Bryde's whales, the statistics of body length are shown in Table 11. Mean body length of Bryde's whales is 11.93 m and 12.68 m for males and females, respectively. For sei whales, the statistics of body length are shown in Table 12. Mean body length of sei whales is 13.22 m and 13.83 m for males and females, respectively. For sperm whale, mean body length and weight are 10.06 m and 15.13 tons.

Distribution and food habit

During summer (from July to September) in offshore area, common minke whales fed mainly on Pacific saury, and they also fed on Japanese pomfret, chum salmon and minimal armhook squid. On the other hand, the common minke whales fed mainly on Japanese anchovy and Japanese common squid in coastal area. The geographical changes of the prey species of the common minke whales seem to reflect changes in the distribution of prey species in feeding areas. The common minke whales seem to be opportunistic feeders with a broad diet and with flexible feeding habits in the research area (Table 13).

In June, Bryde's whales distributed in the southern part of research area. They fed mainly on Japanese anchovy and chub mackerel. In previous research, they fed mainly on krill in June, after then, they fed mainly on Japanese anchovy. There are yearly changes of their prey species (Table 13).

Sei whales distributed widely in the research area. From June to July, they fed mainly on Japanese anchovy and chub mackerel in the southern part of research area (south of 40^{O} N), they fed mainly on copepods, Japanese anchovy and Pacific saury in the northern part of research area (north of 40^{O} N) from August to September. The sei whales seem to be opportunistic feeders with a broad diet and with flexible feeding habits in the research area. There are geographical and seasonal changes of their prey species (Table 13).

Sperm whales distributed widely in the research area. They fed mainly on deep sea squids in offshore area (sub area 9).

Condition of concurrent survey

In this season, the cooperative survey was conducted on one survey block. The survey area was settled in the offshore area (Fig. 1). During the period, a total of 14 sei whale samples were collected by the SSVs in this period. Information on the prey species distribution was also collected by SYO during this period (See Appendix 1).

Experiments, prey surveys and oceanographic surveys

Biopsy sampling trial for blue, humpback, right, fin, Bryde's and sei whales

Table 14 shows the result of biopsy skin sampling for blue, humpback, right, fin, and Bryde's whales. A total of 22 blue, 9 humpback, 2 right and 1 Bryde's were targeted for biopsy sampling by the SVs and SSVs. As a result, three blue, four humpback and two right whale's biopsy skin samples were collected.

Natural marks (photo ID) for blue, humpback and right whales

Table 15 shows the result of the photo-ID experiments on blue, humpback, and right whales. A total of 32 blue, 17 humpback and 4 right whales were targeted by the SVs and SSVs. A total of 21, 11 and 2 trials were conducted for these species whales, respectively.

Feeding behaviour for large baleen whales

The SV and SSVs had a plan to conduct recording the feeding behaviour of large baleen whales using a video recorder. However, we did not have a chance to record the feeding behaviour of large baleen whales in this year.

Prey species survey

Echo sounder survey was conducted on SYO and they operated to cover the planned track lines. Surface routine trawls were towed at 6 stations. MOCNESS was towed at 3 stations. The details of the prey species survey conducted by SYO are described in Appendix 1.

CTD

CTD casts were made at 29 stations by KS2. In the KS2, CTD (Model SBE 19) casts were conducted down to 500m at each sampling station to measure the temperature and salinity profiles in the study area by KS2. CTD casts were made at some stations by SYO. In the SYO, CTD (Model SBE 9, Seabird Co.) casts were conducted down to 500m at each sampling station to measure the temperature and salinity profiles in the study area by SYO. The details of the oceanographic observations are reported in Appendix 2 of this document.

By-products of whales

After biological measurements and sampling were completed, all the whales were processed according to the International Convention for the regulation of whaling, Article VIII. Total production including red meat and blubber from 100 sampled common minke, 100 sei, 50 Bryde's and 3 sperm whales was 321 tons, 1,276 tons, 508 tons and 10 tons, respectively.

Participation by foreign scientists

In 2004 JARPNII, two foreign scientists participated. They joined our sighting and sampling survey on board. It is expected that these international collaboration will continue in future.

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Table 1. Outline of 2004 JARPN II survey

• Whale sampling survey

Research	Research periods	Days	Sub-area	Small block	Research ships and remark
Whale survey (First period)	**June 15-August 10**	**57**	**8, 9**		**NM, YS1, YS2 and K01**
	June 15-18	4	8		
	June 19-July 18	30	9		
	July 19-20	2	8		
	July 21-August 10	21	9		
Whale survey (Second period)	**August 11-September 4**	**25**	**9**		**NM, YS1, YS2 and K01**
Cooperative survey (SB-A)	**September 5-8**	**4**	**9**		**NM, YS1, YS2, K01 and SHU**
Whale survey (Third period)	**September 9-12**	**4**	**9**		**NM, YS1, YS2 and K01**
Transit	**September 13-14**	**2**	**8**		**NM, YS1, YS2 and K01**
Whale survey (Forth period)	**September 15-18**	**4**	**7**	7N, 7MO	**NM, YS1, YS2, K01 and SHU**
Total	**June 15-September 18**	**96**	**7, 8, 9**		**NM, YS1, YS2, K01 and SHU**

• Sighting survey by Kyoshin Maru No.2

Research	Research periods	Days	Sub-area	Small block	Remarks
Dedicated sighting survey	**May 14-September 5**	**115**	**7, 8, 9**		

Research base ship: *Nisshin Maru (NM)*
Sighting and Sampling vessels (SSVs) : *Yushin Maru (YS1), Yushin Maru No.2 (YS2) and Kyo Maru No.1 (K01)*
Sighting vessel (SV) : *Kyoshin Maru No.2 (KS2)*
Prey species survey vessel : *Shunyo Maru (SHU)*

Table 2. Searching distances made by the three sighting/sampling vessels (YS2, YS1 and K01) and sighting vessels (KS2)

SSVs

	Sub-area	Period	Searching distance (n.miles)			
			NSC	ASP	NSS	Combined
Whale survey (first period)	**8, 9**	**June 15-August 10**	**5,011.7**	**295.9**	**1,383.8**	**6,691.4**
	8	June 15-18	202.1	39.0	0.0	241.1
	9	June 19-July 18	2,540.6	202.8	494.6	3,238.0
	8	July 19-21	319.7	0.0	199.3	519.0
	9	July 21-August 10	1,949.3	54.1	689.9	2,693.3
Whale survey (Second period)	**9**	**August 11-September 4**	**1,677.7**	**29.8**	**601.7**	**2,309.2**
Cooperative survey (SB-A)	**9**	**September 5-8**	**100.9**	**0.0**	**40.8**	**141.7**
Whale survey (Third period)	**9**	**September 9-12**	**600.3**	**48.1**	**92.0**	**740.4**
Transit	**8**	**September 13-14**	**0.0**	**239.9**	**0.0**	**239.9**
Whale survey (Forth period)	**7**	**September 15-18**	**494.6**	**0.0**	**78.2**	**572.8**
Total	**7, 8, 9**	**June 15-September 18**	**7,885.2**	**613.7**	**2,196.5**	**10,695.4**

SV (KS2)

	Sub-area	Period	Searching distance (n.miles)
			ASP
Dedicated sighting survey	7,8,9	**May 14 - Aug. 23**	**3,840.3**
	7	May 14 - May 29	637.8
		May 30 - June 8	743.6
	8	June 10 - June 16	462.4
		June 22 - June 30	454.9
	9	June 30 - July 2	100.8
		July 7 - July 8	92.6
		July 18 - July 31	771.4
		Aug. 2 - Aug. 23	576.8
Transit			**103.5**
		June 16 - June 21	0.0
		July 3 - July 7	0.0
		July 9 - July 17	0.0
		July 31 - Aug. 1	0.0
		Aug. 23 - Aug. 29	0.0
		Aug. 30 - Sept. 5	103.5
	Combined	**May 14-Sept. 5**	**3,943.8**

Table 4. List of cetacean species and number of sightings (no. schools/no. individuals) made by three sighting/sampling vessels

Cetacean species	NSC				NSS				ASP				OE		Total					
	Primary		Secondary		Primary		Secondary		Primary		Secondary		Secondary		Primary		Secondary		Total	
	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.
Common minke whale	57	57	35	35	14	14	6	6	0	0	0	0	7	7	71	71	48	48	119	119
Like minke whale	1	1	4	4	0	0	0	0	0	0	0	0	6	6	1	1	10	10	11	11
Sei whale	98	137	92	156	33	40	23	31	3	4	1	1	7	16	134	181	123	204	257	385
Bryde's whale	52	71	30	44	6	8	0	0	38	48	4	9	0	0	96	127	34	53	130	180
Sperm whale	187	312	42	77	32	33	7	21	15	65	3	3	6	12	234	410	58	113	292	523
Blue whale	47	70	7	11	2	2	1	2	0	0	2	3	2	3	49	72	12	19	61	91
Fin whale	71	119	18	33	6	8	3	4	1	1	0	0	5	9	78	128	26	46	104	174
Humpback whale	42	56	15	21	0	0	0	0	0	0	1	1	5	9	42	56	21	31	63	87
Right whale	2	4	0	0	0	0	0	0	0	0	0	0	0	0	2	4	0	0	2	4

Table 4. List of cetacean species and number of sightings (no. schools/no. individuals) made by dedicated sighting vessel (KS2)

Cetacean species	ASP				OE		Total					
	Primary		Secondary		Secondary		Primary		Secondary		Total	
	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.
Common minke whale	29	33	0	0	0	0	29	33	0	0	29	33
Sei whale	51	77	0	0	2	3	51	77	2	3	53	80
Bryde's whale	35	44	0	0	0	0	35	44	0	0	35	44
Sperm whale	91	207	8	27	3	5	91	207	11	32	102	239
Blue whale	4	7	0	0	0	0	4	7	0	0	4	7
Fin whale	12	16	0	0	0	0	12	16	0	0	12	16
Humpback whale	7	8	1	1	0	0	7	8	1	1	8	9

Table 5. Summary of whale sampling

Research type	**Research periods**	**Sub-area**	**Whale samples**			
			Common minke	**Sei**	**Bryde's**	**Sperm**
Whale survey (First period)	**June 15-August 10**	**8, 9**	**59**	**49**	**44**	**0**
	June 15-18	8	0	2	12	0
	June 19-July 18	9	1	44	32	0
	July 19-20	8	0	0	0	0
	July 21-August 10	9	58	3	0	0
Whale survey (Second period)	**August 11-September 12**	**9**	**25**	**37**	**0**	**0**
Cooperative survey	**September 5-8**	**9**	**0**	**14**	**0**	**0**
Whale survey (Third period)	**September 9-12**	**9**	**0**	**0**	**6**	**3**
Transit	**September 14**	**8**	**-**	**-**	**-**	**-**
Whale survey (Forth period)	**September 15-18**	**7**	**16**	**0**	**0**	**0**
Total	**June 15-September 18**	**7, 8, 9**	**100**	**100**	**50**	**3**

Table 6. Summary of biological data and samples collected during the 2004 JARPN II survey

Samples and data	Common minke			Sei whale			Bryde's whale			Sperm whale		
	M	F	T	M	F	T	M	F	T	M	F	T
Body length and sex	90	10	100	47	53	100	19	31	50	0	3	3
External body proportion	90	10	100	47	53	100	19	31	50	0	3	3
Photographic record and external character	90	10	100	47	53	100	19	31	50	0	3	3
Diatom film record and sampling	90	10	100	47	53	100	19	31	50	0	3	3
Standard measurements of blubber thickness (eleven points)	90	10	100	47	53	100	19	31	50	0	3	3
Detailed measurements of blubber thickness (fourteen points)	25	3	28	13	19	32	6	10	16	0	1	1
Body weight	90	10	100	47	53	100	19	31	50	0	3	3
Body weight by parts	25	3	28	13	19	32	6	10	16	0	1	1
Blubber tissues for DNA study	90	10	100	47	53	100	19	31	50	0	3	3
Muscle, liver and heart tissues for isozyme analysis	90	10	100	47	53	100	19	31	50	0	3	3
Blubber, muscle, liver and kidney tissues for heavy metal analysis	90	10	100	47	53	100	19	31	50	0	3	3
Blubber, muscle, liver and kidney tissues for organochlorines analy	90	10	100	47	53	100	19	31	50	0	3	3
Tissues for lipid analysis	25	3	28	14	20	34	6	10	16	0	1	1
Muscle and liver tissues for stable isotope analysis	90	10	100	47	53	100	19	31	50	0	3	3
Tissues for various analysis	90	10	100	47	53	100	19	31	50	0	3	3
Muscle, blubber and intestine content for energy flow analysis	25	3	28	13	19	32	6	10	16	0	1	1
Intestine contents for prey species identification	4	1	5	1	4	5	1	5	6	0	3	3
Tissues for virus test	57	5	62	0	28	28	0	21	21	0	2	2
Muscle samples for hemoprotein analysis	1	0	1	1	0	1	1	0	1	0	1	1
Mammary grand; lactation status, measurement and histological sa	-	10	10	-	53	53	-	31	31	-	3	3
Collection of maternal milk sample	-	0	0	-	4	4	-	1	1	-	0	0
Uterine horn; measurement and endometrium sample	-	10	10	-	53	53	-	31	31	-	3	3
Uterine mucus for sperm detection	-	10	10	-	51	51	-	29	29	-	3	3
Collection of ovary	-	10	10	-	53	53	-	31	31	-	3	3
Photographic record of foetus	3	3	6	15	13	29[*1]	11	11	22	1	1	2
Foetal sex (identified by visual observation)	3	3	6	15	13	29[*1]	11	11	22	1	1	2
Foetal length and weight	3	3	6	15	13	29[*1]	11	11	22	1	1	2
External measurements of foetus	3	3	6	15	13	29[*1]	11	11	22	1	1	2
Collection of foetus	3	3	6	15	13	29[*1]	11	11	22	1	1	2
Testis and epididymis; weight and histological sample	90	-	90	47	-	47	19	-	19	0	-	0
Urine sample for sperm detection	0	-	0	21	-	21	8	-	8	0	-	0
Collection of serum sample	90	10	100	47	53	100	19	31	50	0	3	3
Collection of whole blood sample	90	10	100	47	53	100	19	31	50	0	3	3
Whole blood samples from umbilical cord	-	3	3	-	24	24	-	10	10	-	0	0
Stomach content, conventional record	90	10	100	47	53	100	19	31	50	0	3	3
Volume and weight of stomach content in each compartment	90	10	100	47	53	100	19	31	50	0	3	3
Stomach contents for feeding study	90	10	100	47	53	100	19	31	50	0	3	3
Record of external parasites	90	10	100	47	53	100	19	31	50	0	3	3
Collection of external parasites	5	0	5	2	3	5	2	2	4	0	3	3
Record of internal parasites	90	10	100	47	53	100	19	31	50	0	3	3
Collection of internal parasites	11	1	12	7	7	14	4	5	9	0	2	2
Earplug for age determination	90	10	100	47	53	100	19	31	50	0	0	0
Tympanic bulla for age determination	90	10	100	47	53	100	19	31	50	0	0	0
Maxillally teeth for age determination	-	-	-	-	-	-	-	-	-	-	3	3
Largest baleen plate for morphologic study and age determination	90	10	100	47	53	100	19	31	50	-	-	-
Baleen plate measurements (length and breadth)	90	10	100	47	53	100	19	31	50	-	-	-
Length of each baleen plate series	90	10	100	47	53	100	19	31	50	-	-	-
Vertebral epiphyses sample	90	10	100	47	53	100	19	31	50	0	3	3
Number of vertebrae	0	0	0	47	53	100	6	10	16	0	3	3
Number of ribs	90	10	100	47	53	100	19	31	50	0	3	3
Brain weight	25	3	28	13	19	32	6	10	16	0	1	1
Skull measurement (length and breadth)	90	10	100	47	53	100	19	31	50	0	3	3
Collection of skull	0	0	0	0	0	0	0	0	0	0	0	0
Collection of whole skeleton	0	0	0	0	0	0	0	0	0	0	0	0

[*1] including a fetus of sex unidentified

Table 7. Compositon of sex and sexual maturity of common minke whales sampled

Sub-area	Male			Female				Combined	Sex ratio	Maturity		Pregnancy
	Imm.	Mat.	Total	Imm	Rest.	Preg.	Total		(% males)	Male	Female	rate*)
7	3 (18.8)	11 (68.8)	14 (87.5)	2 (12.5)	0 (0.0)	0 (0.0)	2 (12.5)	16 (100.0)	87.5	78.6	0.0	0.0
8	0	0	0	0	0	0	0	0	-	-	-	-
9	3 (3.6)	73 (86.9)	76 (90.5)	0 (0.0)	2 (2.4)	6 (7.1)	8 (9.5)	84 (100.0)	90.5	96.1	100.0	75.0
Combined	6 (6.0)	84 (84.0)	90 (90.0)	2 (2.0)	2 (2.0)	6 (6.0)	10 (10.0)	100 (100.0)	90.0	93.3	80.0	75.0

*) Apparent pregnancy rate

Table 8. Compositon of sex and sexual maturity of Bryde's whales sampled

Sub-area	Male			Female							Combined	Sex ratio	Maturity		Pregnancy
	Imm.	Mat.	Total	Imm	Ovu	Rest.	Preg.	Lact.	Preg&Lact	Total		(% males)	Male	Female	rate*)
7	0	0	0	0	0	0	0	0	0	0	0				
8	1 (8.3)	3 (25.0)	4 (33.3)	0 (0.0)	1 (8.3)	0 (0.0)	7 (58.3)	0 (0.0)	0 (0.0)	8 (66.7)	12 (100.0)	33.3	75.0	100.0	87.5
9	4 (10.5)	11 (28.9)	15 (39.5)	7 (18.4)	1 (2.6)	0 (0.0)	14 (36.8)	0 (0.0)	1 (2.5)	23 (60.5)	38 (100.0)	39.5	73.3	69.6	93.8
Combined	5 (10.0)	14 (28.0)	19 (38.0)	7 (14.0)	2 (4.0)	0 (0.0)	21 (42.0)	0 (0.0)	1 (2.0)	31 (62.0)	50 (100.0)	38.0	73.7	77.4	91.7

*) Apparent pregnancy rate

Table 9. Compositon of sex and sexual maturity of sei whales sampled

Sub-area	Male			Female							Combined	Sex ratio	Maturity		Pregnancy
	Imm.	Mat.	Total	Imm	Ovu	Rest.	Preg.	Lact.	Preg&Lact	Total		(% males)	Male	Female	rate*)
7	0	0	0	0	0	0	0	0	0	0	0				
8	0 (0.0)	1 (50.0)	1 (50.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (50.0)	0 (0.0)	0 (0.0)	1 (50.0)	2 (100.0)	50.0	100.0	100.0	100.0
9	15 (15.3)	31 (31.6)	46 (46.9)	14 (14.3)	1 (1.0)	4 (4.1)	27 (27.6)	5 (5.1)	1 (1.0)	52 (53.1)	98 (100.0)	46.9	67.4	73.1	73.7
Combined	15 (15.0)	32 (32.0)	47 (47.0)	14 (14.0)	1 (1.0)	4 (4.0)	28 (28.0)	5 (5.0)	1 (1.0)	53 (53.0)	100 (100.0)	47.0	68.1	73.6	74.4

*) Apparent pregnancy rate

Table 10. Statistics of body length (m) of common minke whales sampled

Sub area	Male					Female				
	Mean	S.D.	Min	Max	n	Mean	S.D.	Min	Max	n
7	7.25	0.44	6.41	7.83	14	6.01	0.22	5.85	7.83	2
8	-	-	-	-	0	-	-	-	-	0
9	7.48	0.24	6.76	7.94	76	8.07	0.25	7.68	8.47	8
Combined	7.45	0.29	6.41	7.94	90	7.66	0.90	5.85	8.47	10

Table 11. Statistics of body length (m) of Bryde's whales sampled

Sub area	Male					Female				
	Mean	S.D.	Min	Max	n	Mean	S.D.	Min	Max	n
7	-	-	-	-	0	-	-	-	-	0
8	12.10	1.39	10.03	13.01	4	13.69	0.53	12.45	14.14	8
9	11.89	1.16	8.90	12.98	15	12.33	1.29	9.40	14.04	23
Combined	11.93	1.17	8.90	13.01	19	12.68	1.28	9.40	14.14	31

Table 12. Statistics of body length (m) of sei whales sampled

Sub area	Male					Female				
	Mean	S.D.	Min	Max	n	Mean	S.D.	Min	Max	n
7	-	-	-	-	0	-	-	-	-	0
8	12.68	-	-	-	1	15.01	-	-	-	1
9	13.23	1.12	9.28	14.60	46	13.81	1.37	9.39	15.22	52
Combined	13.22	1.11	9.28	14.60	47	13.83	1.36	9.39	15.22	53

Table 13. Prey species found in stomach of common minke, Bryde's and sei whales sampled (1st.+2nd. stomachs)

Common minke whale (Broken 8; Empty 4)

	Prey species	N (Dominant)	Range of weight (kg) in the stomachs
Krill	Krill	1	14.4
Fish	Japanese anchovy	11	2.2 - 109.3
	Pacific saury	61	2.9 - 53.1
	Japanese common squids	2	27.7 - 63.7
	Minimal armhook squid	12	9.7 - 68.7
	Kitano hokke	1	27.4
	Japanese pomfret*		-
	Chum salmon*		-
	Salmonidae*		-

*: Minor prey species

Bryde's whale (Broken 1; Empty 13)

	Prey species	N (Dominant)	Range of weight (kg) in the stomachs
Krill	Krill	1	48.9
Fish	Japanese anchovy	31	1.3 - 461.3
	Chub mackerel	4	120.0 - 529.2
	Frigate mackerel*		

*: Minor prey species

Sei whale (Broken 8; Empty 29)

	Prey species	N (Dominant)	Range of weight (kg) in the stomachs
Copepods	Copepods	18	<0.1 - 153.2
Krill	Krill	1	115.4
Fish	Japanese anchovy	33	<0.1 - 953.5
	Pacific saury	8	0.4 - 142.2
	Chub mackerel	3	7.7 - 279.5

Table 14. Summary of biopsy skin sampling for some large whale species

Whale species	Ship	Number of experiments (A)	Targeted individuals (B)	Number of shoots (C)	Number of hits (D)	Number of samples (E)	Effort (hr) (F)	sample per trial (E)/(C)	sample per hit (E)/(D)
Blue whale	SSVs	13	19	18	6	3	6h44m	0.17	0.50
Blue whale	SV	2	3	23	11	0	3h24m	0.00	0.00
Humpback whale	SSVs	6	9	7	4	4	2h36m	0.57	1.00
Right whale	SSVs	1	2	4	2	2	0h43m	0.50	1.00
Bryde's whale	SSVs	1	1	4	0	0	0h32m	0.00	0.00

Table 15. Summary of photo ID for blue, humpback, and right whales

Whale species	Ship	Number of experiments (A)	Targeted individuals (B)	Number of trials (C)
Blue whale	SSVs	21	29	18
Blue whale	SV	2	3	3 *Digital Photo
Humpback whale	SSVs	12	17	11
Right whale	SSVs	2	4	2

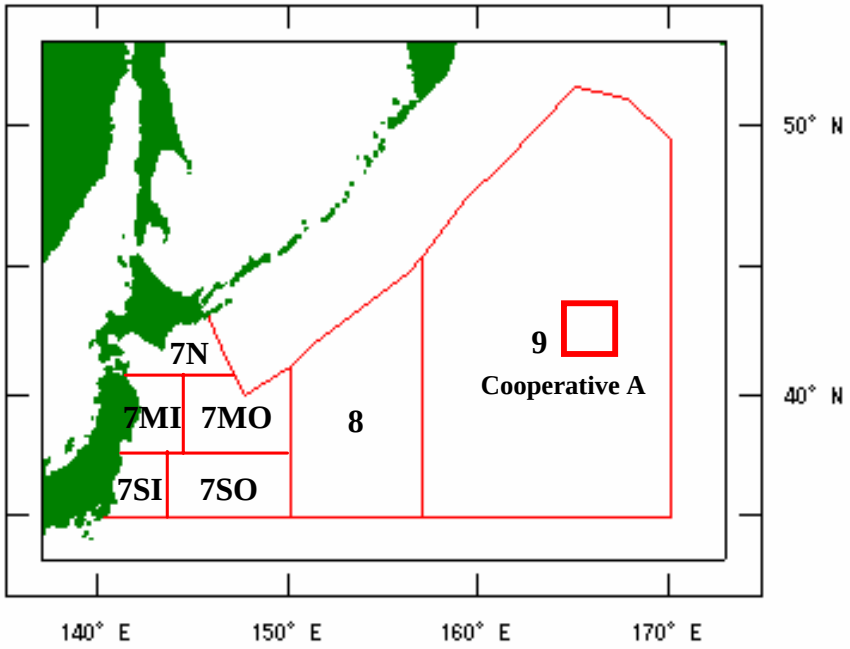

Fig 1. Map showing the research area and strata of the 2004 JARPN II full-scale program.

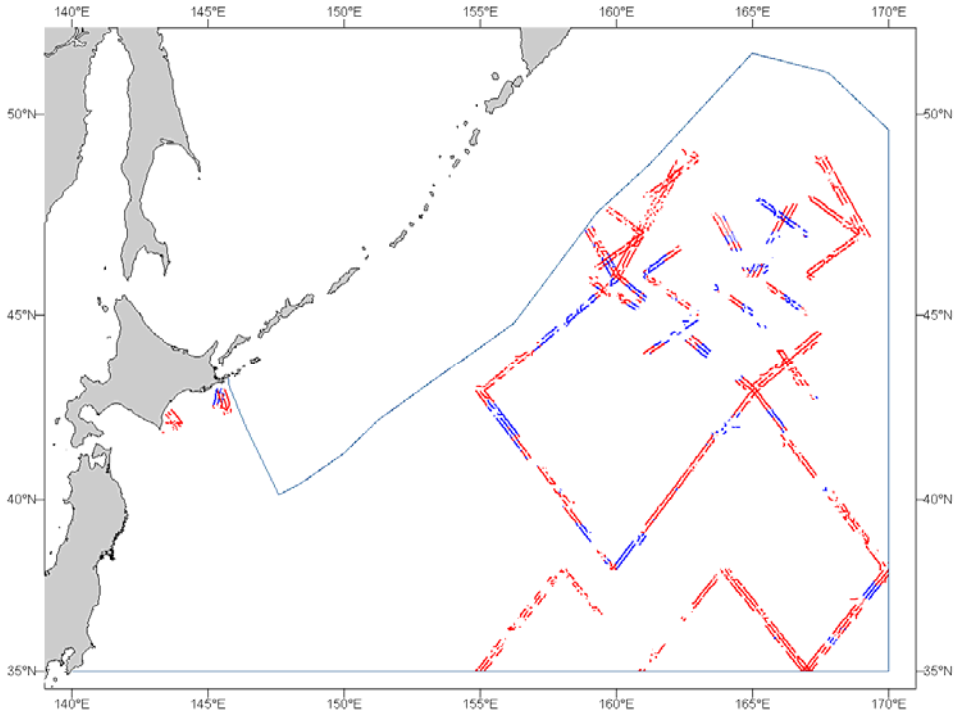

Fig. 2. Track-line covered by the three sighting/sampling vessels (SSVs) during the whale survey of the 2004 JARPN II survey. (Red line: BC/NSC, ASP modes, Blue line: BS / NSS modes)

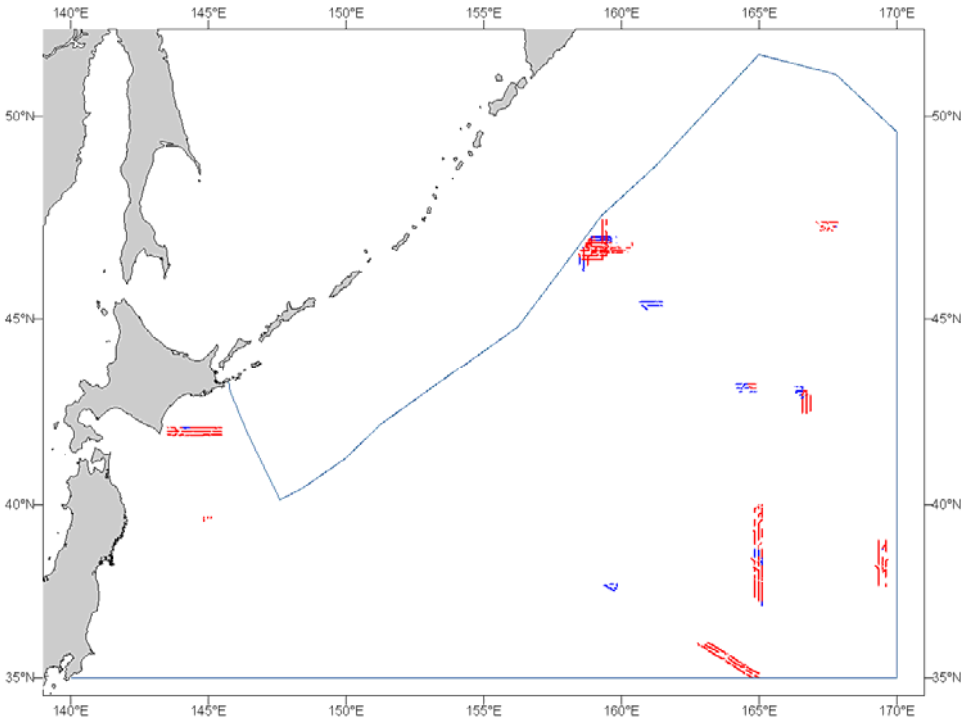

Fig. 3. Track - line covered by the three sighting/sampling vessels (SSVs) during the special monitoring survey (SMS) the 2004 JARPN II survey. (Red line: BC/NSC, ASP modes, Blue line: BS / NSS modes)

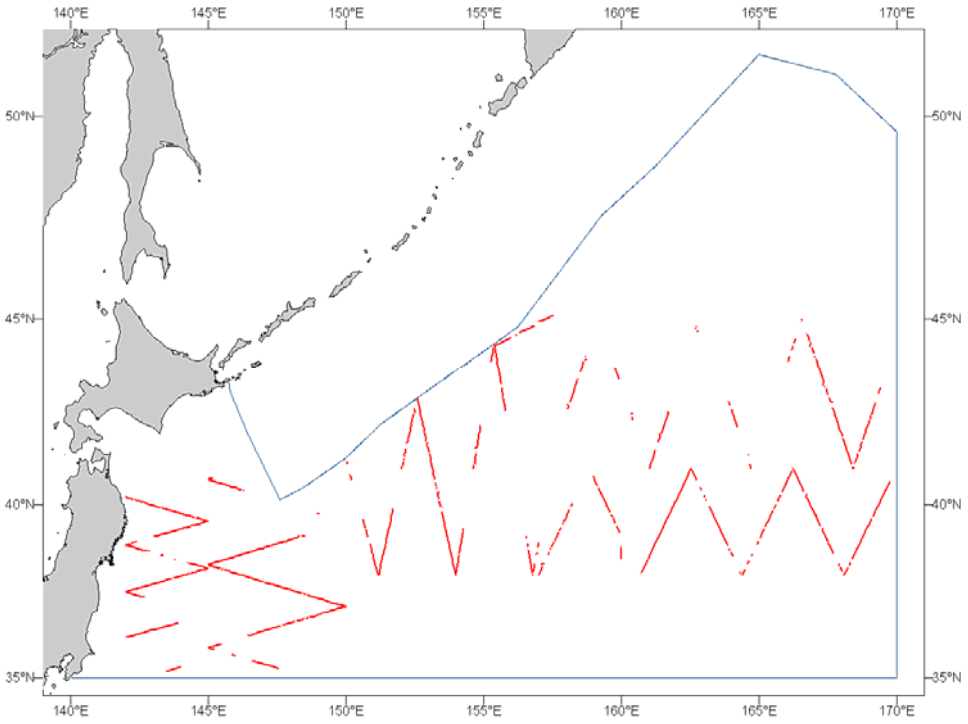

Fig. 4. Track - line covered by the dedicated sighting vessels (SSV:KS2) in the 2004 JARPN II survey.

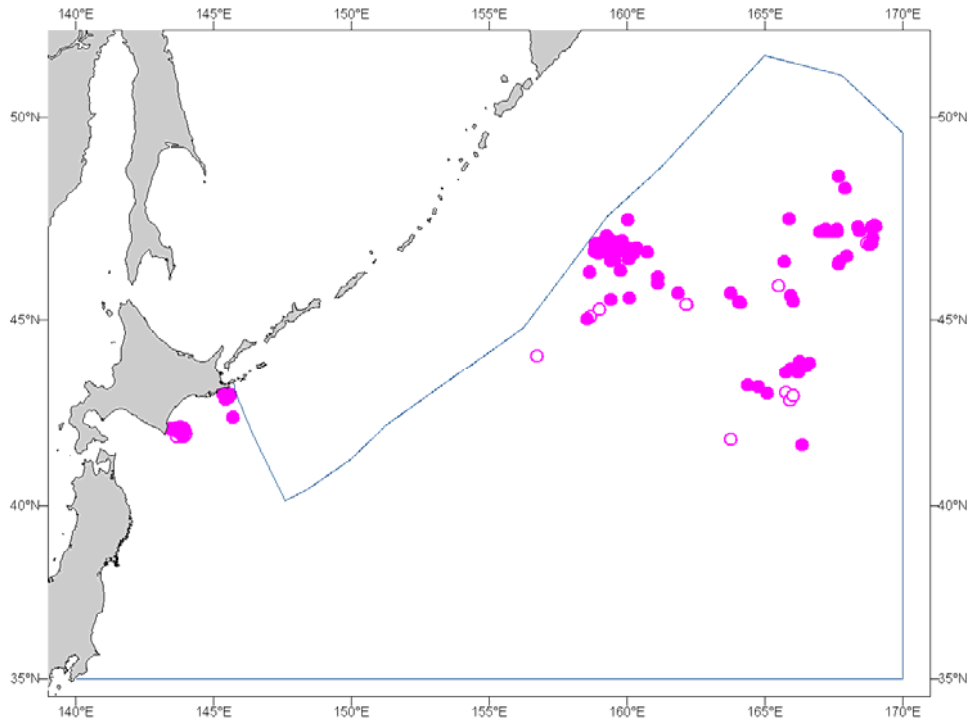

Fig. 5. Comparison of positions of the sightings and samplings of the common minke whales (●: sighted and sampled, ○: sighted only).

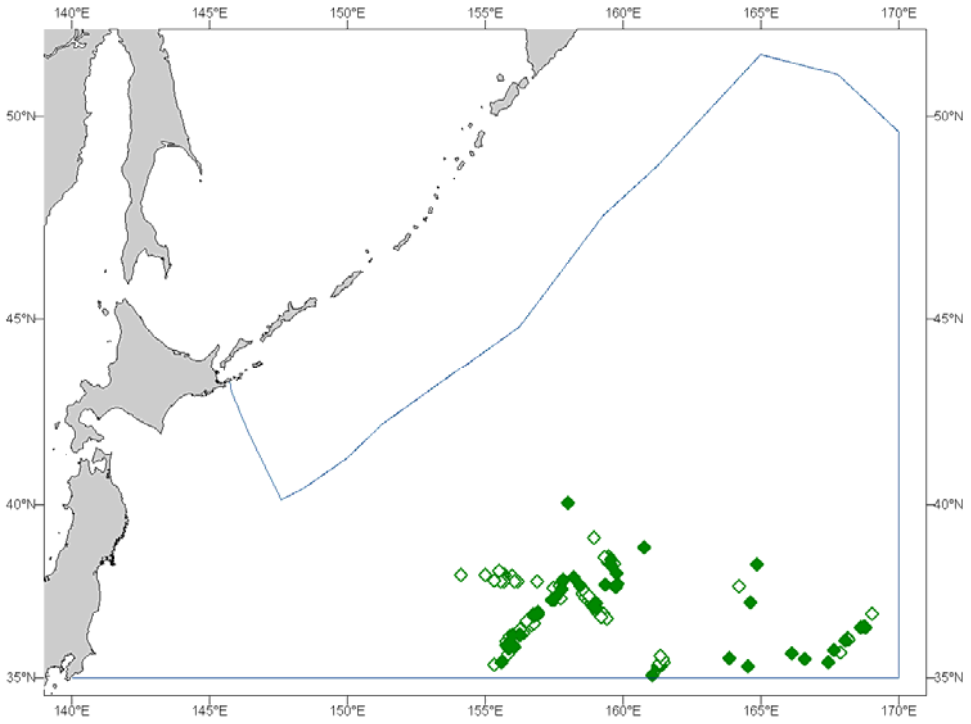

Fig. 6. Comparison of positions of the sightings and samplings of the Bryde's whales (◆: sighted and sampled, ◇: sighted only) .

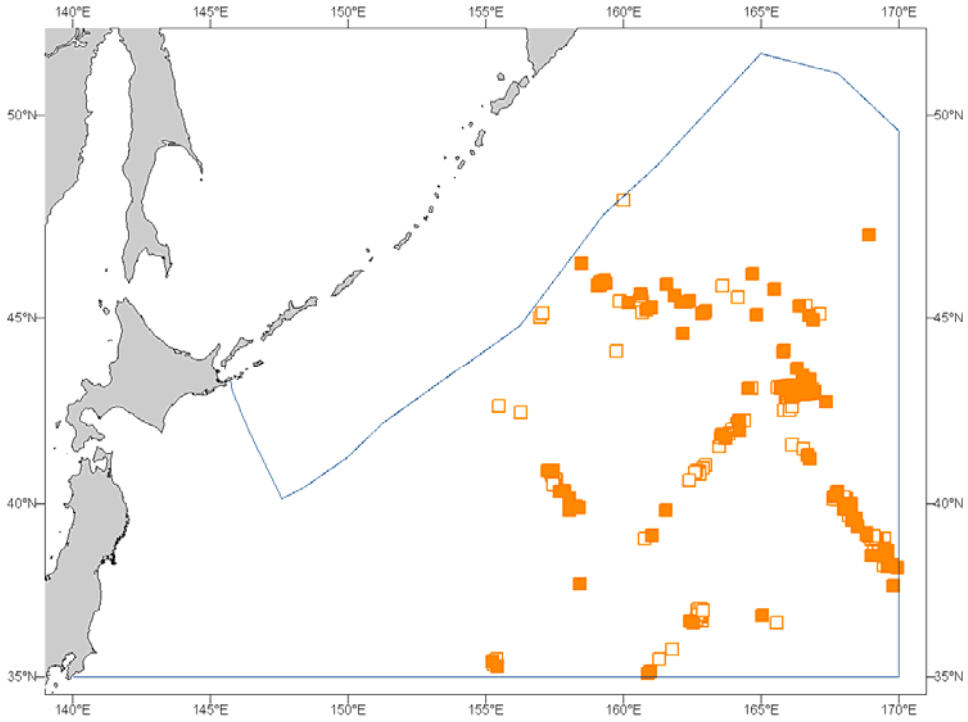

Fig. 7. Comparison of positions of the sightings and samplings of the sei whales
(■: sighted and sampled, □: sighted only) .

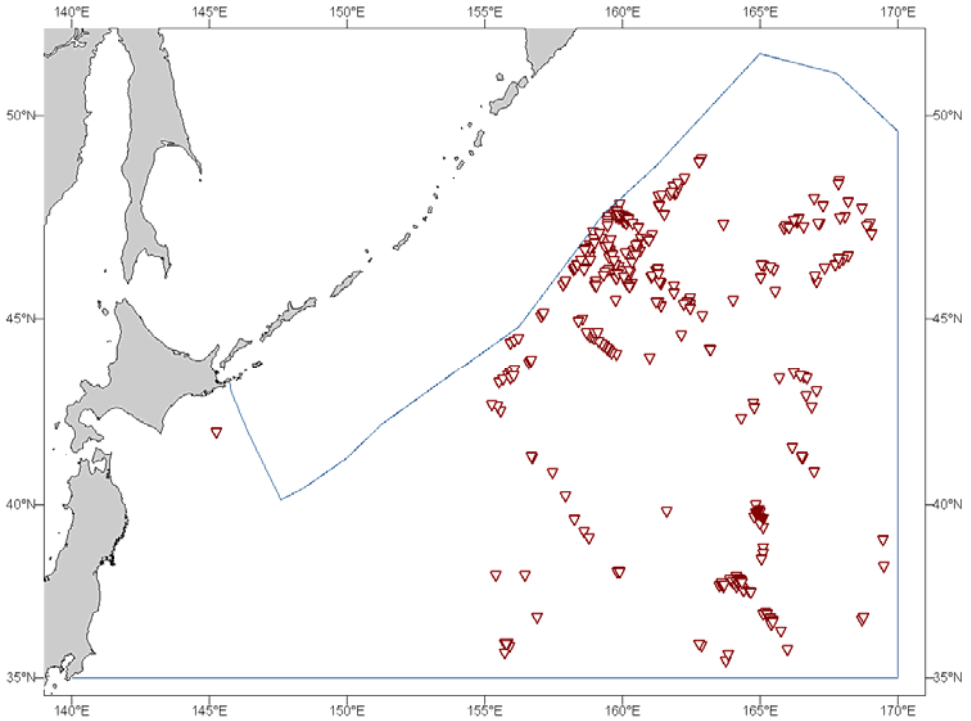

Fig. 8. Comparison of positions of the sightings and samplings of the sperm whales
(▼: sighted and sampled, ▽: sighted only)

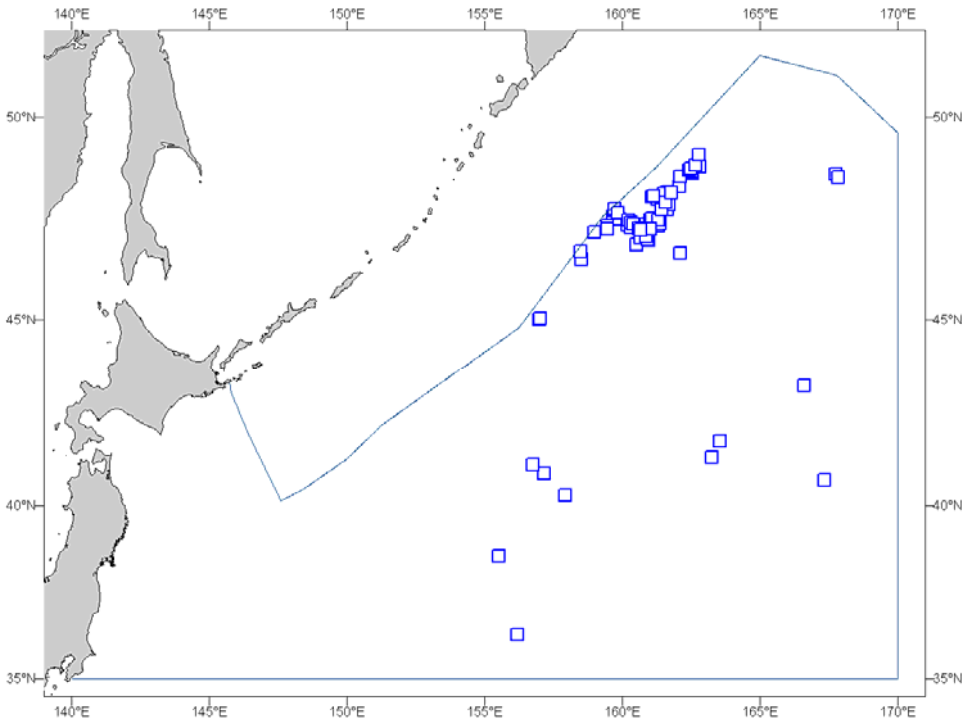

Fig. 9. Distribution of the sightings of the blue whales

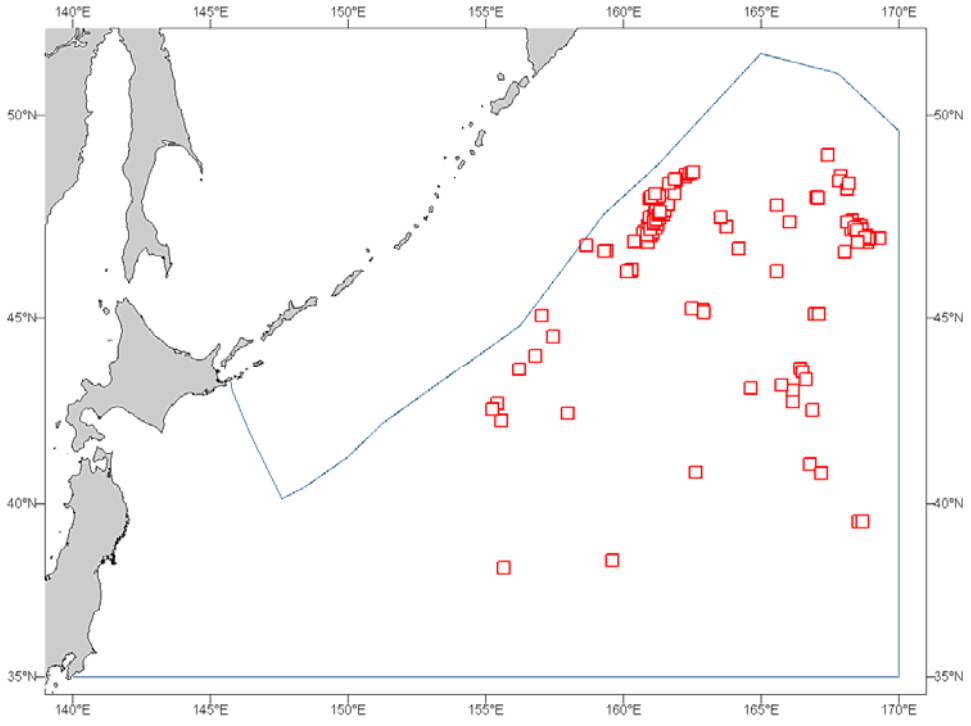

Fig. 10. Distribution of the sightings of the fin whales

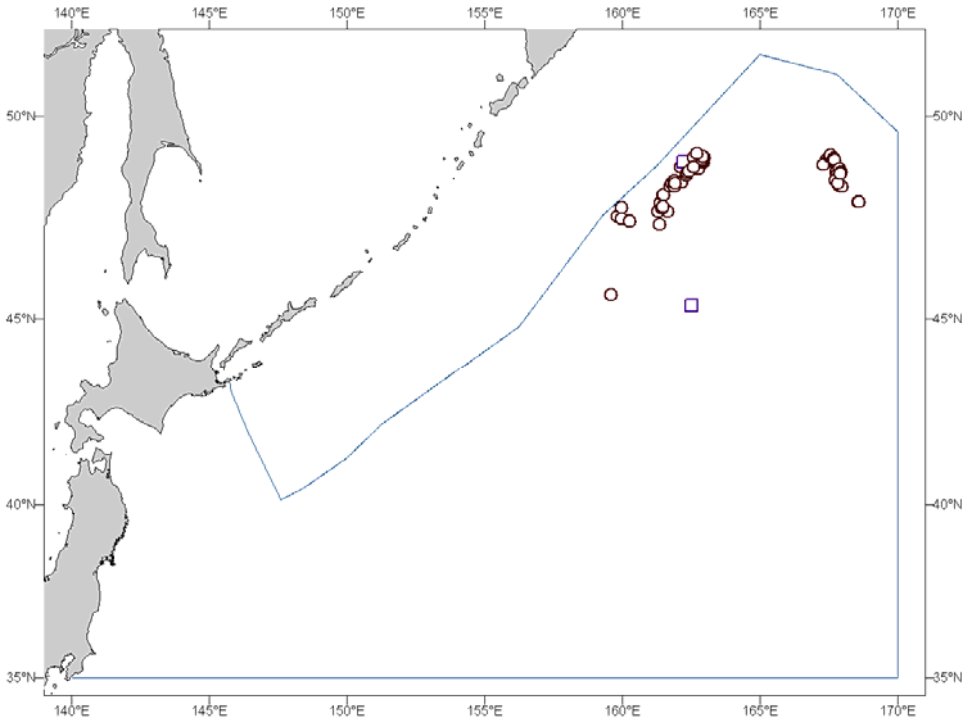

Fig. 11. Distribution of the sightings of the humpback whales (○) and right whales (□).

Appendx 1

Offshore prey species survey of JARPN II in 2004

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ABSTRACT0

A prey species survey was conducted in cooperation with the sampling survey for sei and common minke whales in September 2004 as a part of JARPN II study. The primary objective of the offshore survey was to examine prey environment and prey preference of sei whale during autumn. The distribution and abundance of the prey species were investigated with the quantitative echosounder (EK60), midwater trawl, and MOCNESS of a trawler-type research vessel, Shunyo-maru, during the daytime. Acoustic data were acquired by steaming at about 10 knots along the track lines with operating frequency at 38, 70 and 120 kHz. Species and size compositions of acoustical backscatterings were identified by midwater trawl and MOCNESS. In the offshore region, Japanese anchovy and Pacific saury were main component of the trawl samples, but their abundances were relatively low. The result of MOCNESS sampling indicated that *Neocalanus cristatus*, *N. plumchrus*, and *N. flemingeri*, which were main prey of sei whale in spring and summer seasons, were found below 150 m. The result indicates that there were little prey species for sei whale above 100 m in early autumn.

INTRODUCTION

The government of Japan submitted the Research Plan for Cetacean Studies in the Western North Pacific under Special Permit (JARPN II) (Feasibility Study Plan for 2000 and 2001) to the 52nd IWC/SC (Government of Japan 2000). The overall goal of JARPN II is to contribute to the conservation and sustainable use of marine living resources including whales in the western North Pacific, especially within Japan's EEZ (Government of Japan, 2002). The priority of this plan is to examine feeding habits of major cetacean species and ecosystem studies, including studies on prey consumption by cetaceans, prey preference (selection) of cetaceans, and ecosystem model. In JARPN II, prey species surveys are conducted in cooperation with the whale surveys to estimate the prey selection of cetaceans. In 2004, the cooperative whale/prey surveys were conducted in the offshore region of the western North Pacific and the coastal region off Kushiro, Hokkaido. The objective of the offshore prey species survey was to examine prey environment in autumn for sei whales. This document presents the preliminary results of this survey in the offshore region.

MATERIALS AND METHOD

Survey area and period

The cooperative prey species survey was conducted from September 15 to 19 in the offshore region (Sub-area 9) by Shunyo-maru (887 GT) of National Research Institute of Far Seas Fisheries (Fig. 1). The itinerary of the survey was shown in Table 1. Time difference between the whale and prey species surveys was less than about one week so that results of prey species and cetacean surveys were comparable. Research hour was from an hour after sunrise to an hour before sunset while the maximum research hours were set at 13 hours. Generally, the survey started at 5:00 and ended at 18:00 at local time.

For the offshore survey, one block with a zigzag track line was set to cover the dense distribution area of sei whale and its adjacent area (Fig. 2). The track line was set independently from whale survey. The waypoints of track line were shown in Table 2. The distribution and abundance of the prey species were investigated with the quantitative echosounder, the midwater trawl, and the Multiple Opening and Closing Nets Environmental Sampling System (MOCNESS). CTD casts were conducted down to 500 m at each sampling station to measure vertical temperature and salinity profiles in the study area.

Trawl sampling
The midwater trawl net used was 86.3 m long with a mouth opening of ca. 900 m^2 and a 6.0 m cod end with a 17.5 x 17.5 mm mesh inner. The sampling depth and the height of the mouth of the net were monitored with the Scanmer transducers attached to the head and the bottom rope of the trawl. Towing speed of the trawl net was 4-5 knot. In this study, all samples were collected during daylight period. Two types of trawl samplings, the trawlings with floats in the surface layer and the stairs-like mid-water trawlings from the depths around 100 m, were conducted. The purpose of these samplings was to examine the abundance and distribution pattern of squids and neustonic animals like Pacific saury that are difficult to detect with the echosounder. Also the samples were used to identify the species and size of acoustical backscatterings. Surface trawlings were made with floats at 0-30 m layer for 30 minutes in the area where Pacific saury seemed to be distributed. Stairs-like trawlings were made at three layers (0-30 m, 30-60 m, and 60-90 m). During the offshore survey, we conducted surface and stairs-like trawlings for four and two times, respectively (Table 3).

All samples were identified to the lowest taxonomic level possible and wet weight of each species was measured aboard the ship. For the major species, body length of 100 individuals was measured to examine their size composition. A part of samples were frozen at –30°C for further analysis in the laboratory.

MOCNESS sampling
During the offshore survey period we used MOCNESS to examine species/size compositions and vertical distribution pattern of meso- and macro-zooplanktons. The mouth opening and mesh size of the net were 1 m^2 and 0.33 x 0.33 mm, respectively. At the three predetermined stations, this net was towed at about 2 knots in 8 target depths (0-20m, 20-40m, 40-60m, 60-80m, 80-100m, 100-150m, 150-200m, and 200-250m) during the daytime (Table 5). The volume of water filtered by each net was measured with a flow meter mounted at the net mouth. Samples were preserved in 10 % formalin-buffered seawater at sea for further analysis in the laboratory.

Acoustic data acquisition and analyses
During the daytime, the ship steamed at around 10 knots along the track line. To record acoustic data a quantitative echo sounder (Simrad EK60 with program version 1.4.3.64) with operating frequency at 38, 70 and 120 kHz was used. The transducers were hull-mounted at the depth of 4.3 m from the surface. Calibrations were carried out off the coast of Kushiro in September 23 using the copper sphere technique described in EK 60 online help manual.

Acoustic data are being analyzed now with the aid of Sonar Data Echoview (version 3.00.74.01) at the laboratory. In principle, backscattering on the echosounder is identified based mainly on the results of trawl and MOCNESS samplings. For fishes, data collected at 38 kHz are used with the threshold set at -60dB and the depth range from 10 m to 250 m. For Japanese anchovy, school shape and backscattering intensity of backscattering are also used for species identification. For krills, data collected at 120 kHz are used with the threshold set at –80 dB. The analyzed depth range is from 12 m to 250 m (maximum depth at 120 kHz). Backscattering is identified as krills if ΔSv (the difference of Sv between 38 and 120 kHz) falls between 10 and 15 dB (Miyashita *et al.* 1997). Because most of krill species in the survey area have the body length similar to isada krill (*Euphausia pacifica*) taken in the coastal area off Tohoku, this ΔSv value is applied to. Species identification is based on both ΔSv and the samples form MOCNESS. For copepods, data collected at 120 kHz are used with the threshold set at –110 dB. Target strengths (TS) of copepods are calculated using the Distorted Wave Born Approximation based seformed cylinder model (Stanton and Chu, 2000). Based on the TS, ΔSv (the difference of Sv between 38 and 120 kHz) falls between 10 and 30dB are identified as copepods. Net sampling results as well as school shape are considered to distinguish between krill and copepods. The integration is made at an interval of one nautical mile by 50 m depth zone.

RESULTS AND DISCUSSION
While the acoustic data, plankton samples, and oceanographic conditions are being analyzing now, the preliminary results are as follows.

CTD data indicated that the offshore region was located in the transitional region south of the sub-arctic front. Planned track lines were surveyed about 80 % using the echosounder. We recognized no remarkable echoes during the survey. Small catches of trawl and MOCNESS well reflected this result. Japanese anchovy and Pacific saury were the main components of the trawl sample, but their CPUE (kg/h) was less than 25 kg at each sampling station (Table 3). Results of MOCNESS sampling indicated low abundance of copepods and euphausiids in the 0-100 m layer. *Neocalanus cristatus*, *N. plumchrus*, and *N. flemingeri*, which were mainly distributed in the top 50 m and the main prey of sei

whale during spring and summer, were deepened below 150 m depth due to ontogenetic vertical migration. These results indicate that there were little prey species for sei whale above the depths of 100 m in early autumn of this study area, contrasting with spring and summer seasons. According to Tamura (personal communication), stomach content weight of sei whales sampled in autumn of this year was much lower than in the summer of 2003, which were corresponded with seasonal change in prey abundance above 100 m.

ACKNOWLEDGEMENT

A special thank is given to the crews and researchers for their dedication in collecting data. The authors would like to thank Dr. Hiroshi Hatanaka (The Institute of Cetacean Research, Japan). Dr. Kazushi Miyashita (Hokkaido University) provided useful comments on acoustic data analysis.

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Table 1. Itinerary of the prey species survey in 2004

Date	Evident
5-Sep	Departed Shimizu, Japan
14-Sep	Started offshore survey
19-Sep	Ended offshore survey
23-Sep	Conducting echo sounder calibration
23-Sep	Arrived Kushiro, Japan
24-Sep	Departed Kushiro, Japan
24-Sep	Started coastal survey
29-Sep	Ended coastal survey
2-Oct	Arrived Shimizu, Japan

Table 2. List of waypoints of track line

WP	Lat	Long	Distance (n. mil)
1	44-30N	165-30E	71
2	44-00N	167-00E	72
3	43-30N	165-30E	72
4	43-00N	167-00E	73
5	42-30N	165-30E	73
6	42-00N	167-00E	-
		Total	361

Table 3. Results of trawlings during the offshore survey in 2004

Stn	Date	SST (℃)	Lat	Long	Sampling depth (m)	Towing duration (min)	Total catch (kg)	Sampled weight by species (kg)				
								Japanese anchovy	Pacific saury	Japanese sardine	Squids	Salps
1	2004.9.15	13.8	44-26N	165-48E	0-100	30	0.1	-	-	-	< 0.1	0.1
2	2004.9.16	13.6	44-16N	166-03E	0-30	30	9.5	0.3	9.3	-	-	-
4	2004.9.17	13.9	43-53N	166-36E	0-100	30	0	-	-	-	-	-
5	2004.9.18	14.1	43-22N	165-55E	0-30	30	10.4	10.4	-	< 0.1	-	-
6	2004.9.18	14.6	43-10N	166-28E	0-30	30	2.5	1.7	0.8	-	-	-
8	2004.9.19	15.4	42-47N	166-24E	0-30	30	12.0	-	12.0	-	-	-

Table 4. Results of MOCNESS during the offshore survey in 2004.

Stn	Date	Lat	Long	Target depth (m)	Volume water filtered (m^3)
3	2004.9.16	43-60N	167-01E	250→200	239
3	2004.9.16	43-60N	167-01E	200→150	310
3	2004.9.16	43-60N	167-01E	150→100	243
3	2004.9.16	43-60N	167-01E	100→80	183
3	2004.9.16	43-60N	167-01E	80→60	188
3	2004.9.16	43-60N	167-01E	60→40	137
3	2004.9.16	43-60N	167-01E	40→20	167
3	2004.9.16	43-60N	167-01E	20→10	68
7	2004.9.18	43-01N	166-57E	250→200	253
7	2004.9.18	43-01N	166-57E	200→150	305
7	2004.9.18	43-01N	166-57E	150→100	209
7	2004.9.18	43-01N	166-57E	100→80	177
7	2004.9.18	43-01N	166-57E	80→60	84
7	2004.9.18	43-01N	166-57E	60→40	13
7	2004.9.18	43-01N	166-57E	40→20	102
7	2004.9.18	43-01N	166-57E	20→10	65
9	2004.9.19	42-38N	165-55E	250→200	250
9	2007.7.5	42-38N	165-55E	200→150	296
9	2007.7.5	42-38N	165-55E	150→100	334
9	2007.7.5	42-38N	165-55E	100→80	148
9	2007.7.5	42-38N	165-55E	80→60	121
9	2007.7.5	42-38N	165-55E	60→40	121
9	2007.7.5	42-38N	165-55E	40→20	131
9	2007.7.5	42-38N	165-55E	20→10	38

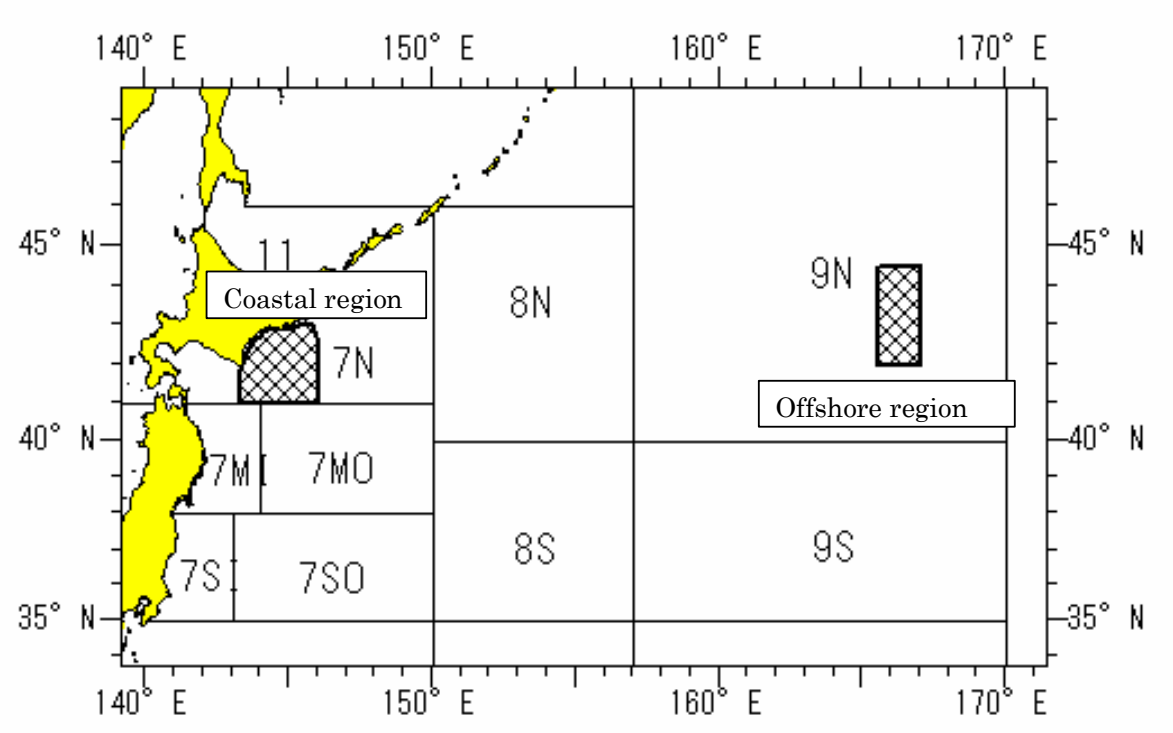

Fig. 1. Prey species survey area in September 2004

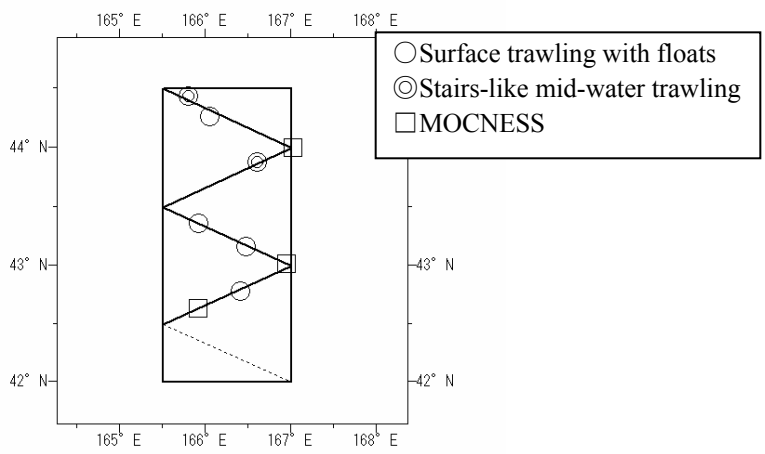

Fig. 2. The block with a zigzag track line and sampling positions of trawls and MOCNESS in Sub-area 9
(Dotted and solid lines show planned and actual lines, respectively)

Appendix 2.

Oceanographic conditions in the western North Pacific in September 2004

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1. Introduction

A prey specific survey was conducted as a part of JARPN II study in the western North Pacific in September 2004 using *R/V Shunyo Maru*. There are a lot of water masses and fronts in the western North Pacific. The Oyashio flows southwestward along the Kuril Islands with cold low-salinity water and turns eastward from the northern coast of Japan. In the high sea of the North Pacific Ocean, there are Subarctic front (temperature front defined by 4°C) and the Subarctic Boundary (salinity front defined by 34.0psu) with a week eastward flow, and the area between these fronts is called the Transition Domain (Favorite *et al*. 1976). Subarctic waters and subtropical waters lie around these fronts, and each water mass has its own ecosystem. In this paper, distributions of water masses and fronts in this survey will be described to make clear the environment of the prey of sei and minke whales.

2. Methods

Hydrographic observations with a conductivity-temperature-depth profiler (CTD; SBE 911plus) were carried out from 15th to 19th September 2004 in the Kuroshio-Oyashio Inter-frontal Zone using *R/V Shunyo Maru* (Fig. 1). Salinity compensation for CTD data was not done using water sampling data.

Oceanic fronts and water masses are usually detected by subsurface temperature map, because they are obscure in sea surface temperature distributions from summer to fall seasons and the Oyashio water spreads into the subsurface layer (Table 1). The Kuroshio Extension is defined by the 14°C isotherm at the depth of 200m (Kawai, 1969). The warm water spread from Kuroshio Extension is defied by temperature more than 10°C at the depth of 100 m . The first and the second Oyashio Intrusions are defined by temperature lass than 5°C at the depth of 100 m (Murakami, 1994). Subarctic front and the Subarctic Boundary is defined by 4°C temperature front and 34.0psu salinity front, respectively (Favorite *et al*. 1976). We use these indices to know the distribution of water mass in the observation area.

3. Oceanographic conditions in the research area

Figure 2 shows the Temperature-Salinity diagrams using CTD station data. Water masses in the research area have characteristics of cold low-salinity water (the subarctic water in the lower part of Fig. 2). Some of these stations show warm surface water above the subarctic water (left upper part of Fig.2).

Figure 3 shows the 100 m depth temperature map observed by *R/V Shunyo Maru*. The cold water less than 5°C was distributed in almost all of the survey area. A little warm water (around 6°C) was observed only one station. The Subarctic front (defined by 4°C isotherm) was observed around 43° N in Fig. 3, that is to say, the subarctic water lies from western part to the middle part in this survey area.

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Table 1. Extraction method from temperature map to determine the position of each water mass.

Target characteristics	Extraction method
Kuroshio Extension Axis	14°C isotherm at 200m
Warm-core ring	Temperature front at 200m
Oyashio front	5 °C isotherm at 100m
Oyashio water	Area with T<5 °C at 100m
Cold water	Area with 5°C <T<10 °C at 100m
Warm water	Area with T>10 °C at 100m and T<14 °C at 200m
Subarctic Boundary	Salinity front defined by 34.0psu
Subarctic Front	Temperature front defined by 4°C

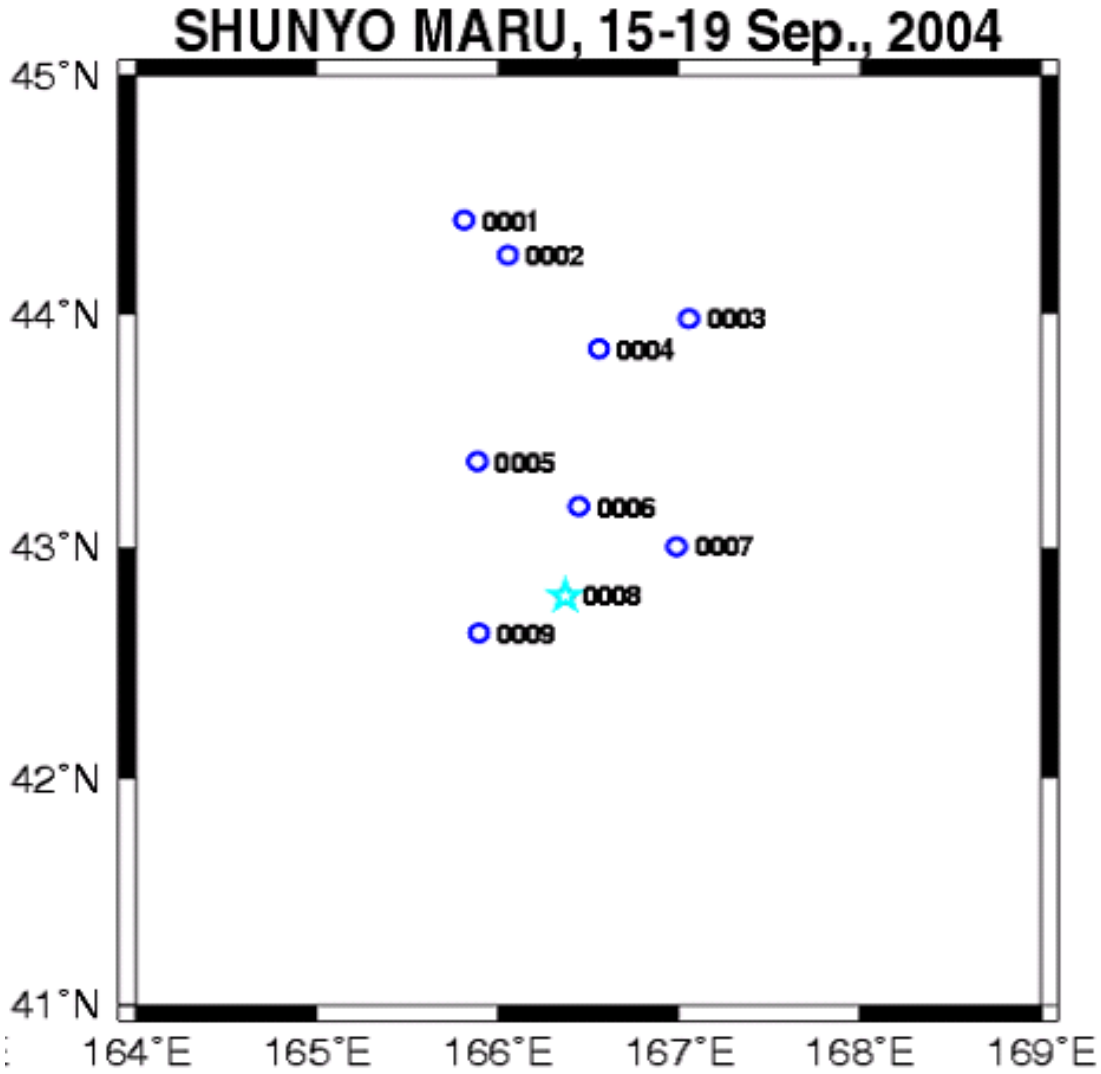

Fig. 1. Station map observed by *R/V Shunyo Maru* in 15 – 19 September 2004. Light blue stars and blue circles denote CTD stations in the cold area (100 m temperature was over 5°C and less than 10°C) and the Oyashio area (100 m temperature was less than 5°C), respectively

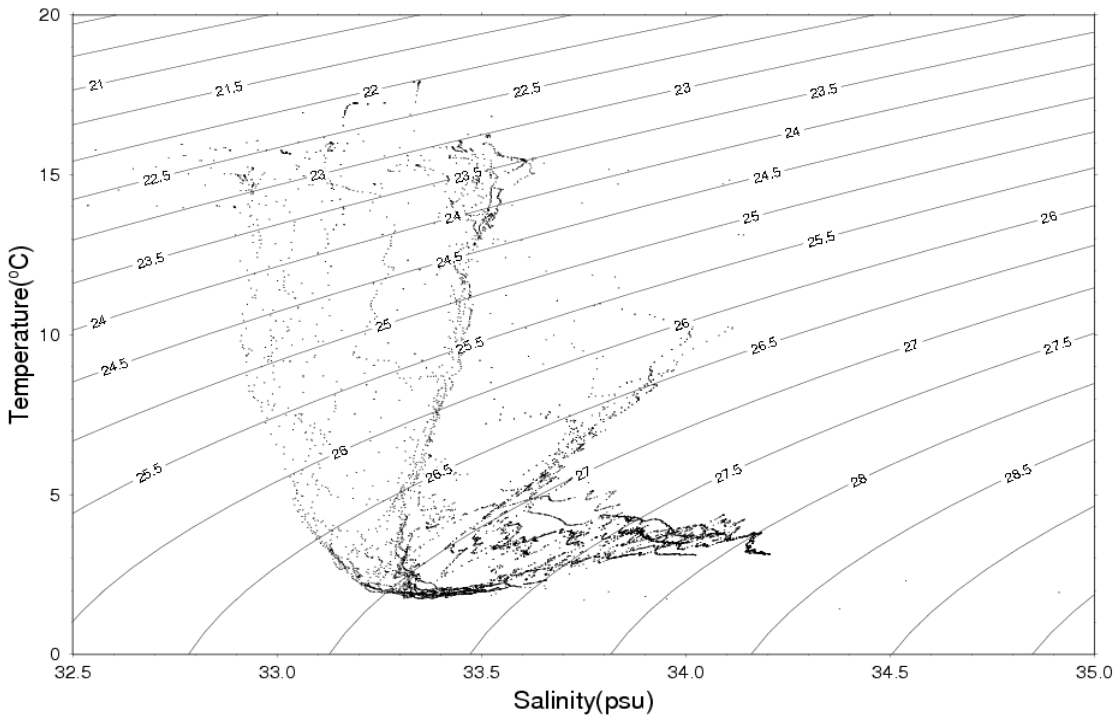

Fig. 2. Temperature-Salinity diagrams using CTD station data observe by *R/V Shunyo Maru* in 15 – 29 September 2004. Each thin line in this figure denotes a density line of sigma-t.

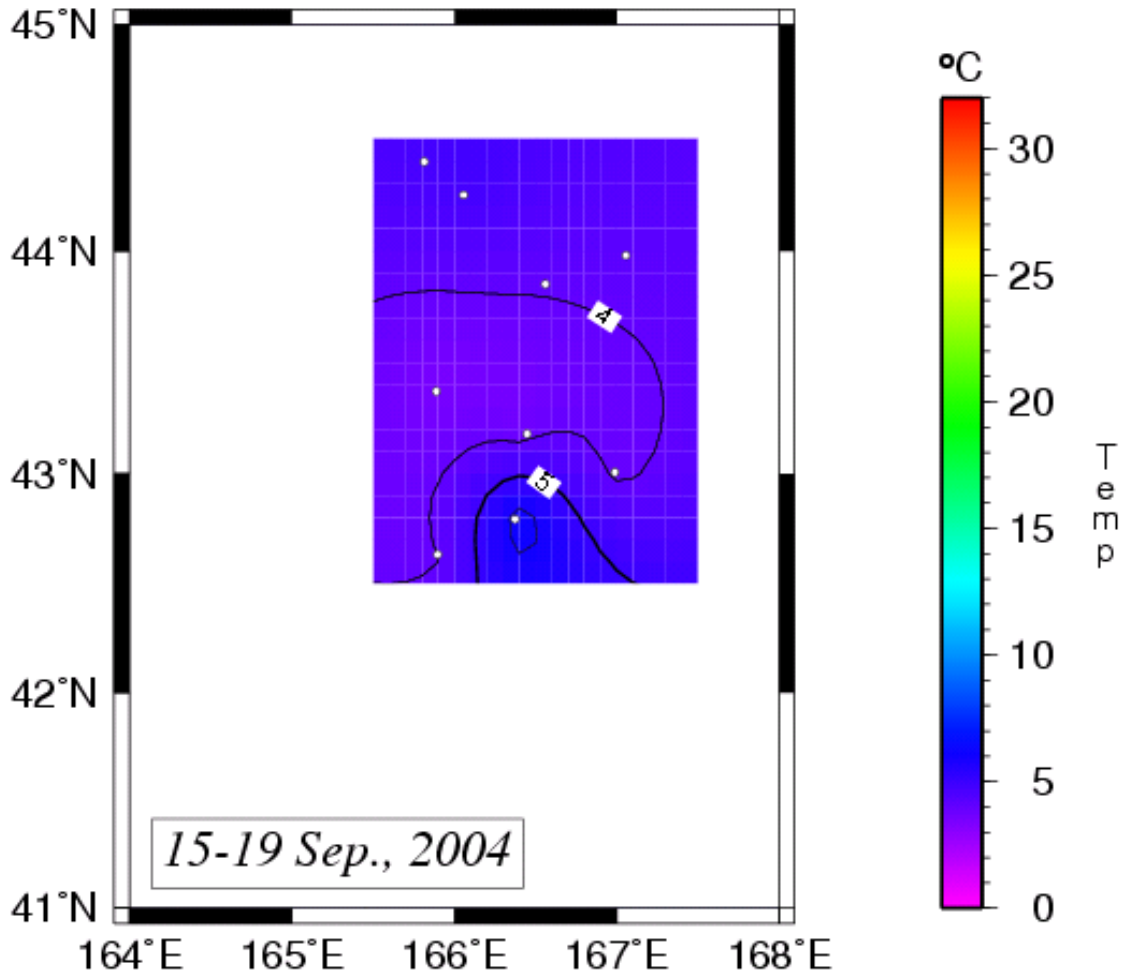

Fig.3. 100m temperature map observed by *R/V Shunyo Maru* in 15 – 19 September 2004.