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Cruise report of the coastal survey on common minke whales off Kushiro, northeast Japan: the 2004 JARPN II survey (Part II) - Coastal component.

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ABSTRACT

Based on the results of a two-year feasibility study conducted in 2002 and 2003, the coastal component of JARPN II was revised to be conducted twice a year and 60 common minke whales would be sampled in spring and autumn seasons, respectively. The first survey of revised JARPN II coastal component was conducted from 13 September to 31 October, off Kushiro, northeast Japan (northern part of the sub-area 7), using four small-type whaling catcher boats, one echo sounder-trawl survey vessel and one dedicated sighting survey vessel. In addition, dedicated sighting survey using one small-type whaling catcher boat was tentatively introduced. The sampling was conducted in the coastal waters within the 50 nautical miles form the Kushiro port, and all whales sampled were landed on the land station in the Kushiro port for biological examination. During the survey, a total of 6,923.9 n. miles (635.4 hours) was searched for whale sampling, 151 schools/ 156 individuals of common minke whales were sighted and 59 whales were sampled. Average body length of sampled whales was 6.87m (SD=0.80, n=47) for males and 6.00m (SD=1.09, n=12) for females, respectively. Dominant prey species found in the forestomach contents were Japanese anchovy *Engraulis japonicus* (62.1%) and Pacific saury *Cololabis saira* (31.0%). The concurrent prey survey revealed the distribution of those prey species in the research area, and the dedicated sighting survey sighted 17 schools/ 18 individuals of common minke whales with 809.4 n. miles searched. As compared with the results of the 2002 survey off Kushiro, body length frequency of the whales inclined toward the large-sized male, and composition of prey species found in the forestomach was comparatively simple. These results revealed yearly changes in migration and feeding habits of common minke whales in the coastal waters off Kushiro in autumn season, and suggested those changes might be related to yearly variation in the environmental factors such as the oceanographic conditions and distribution of prey species. To evaluate a long term competition between whales and fisheries in local areas, and to clarify the role of the whales in the marine ecosystem, further surveys should be conducted on a yearly basis.

KEYWORDS: COMMON MINKE WHALE; NORTH PACIFIC; FOOD/PREY; ECOSYSTEM; SCIENTIFIC PERMITS

INTRODUCTION

The full-scale surveys of the Japanese Whale Research Program under Special Permit in the western North Pacific (JARPN II) started in 2002 (Government of Japan, 2002). The objectives of the surveys are: i) feeding ecology and ecosystem studies, involving prey consumption by cetaceans, prey preferences of cetaceans and ecosystem modeling, ii) monitoring environmental pollutants in cetaceans and marine ecosystem, and iii) stock structure of whales (Government of Japan, 2002).

The full-scale JARPN II involves two survey components; 'offshore' which is covered by the *Nisshin Maru* research fleet and 'coastal' which is covered by small-type whaling catcher boats, and the latter one is necessary to cover the temporal and spatial gaps, which can not be covered by the *Nisshin maru* research fleet (Government of Japan, 2002).

In the original JARPN II plan, the coastal component was presented as a two-year feasibility study to examine the logistic aspects of the methodology (Government of Japan, 2002). First survey was carried out in the coastal waters off Kushiro, northeast Japan, during 10 September to 12 October 2002 (Kishiro*, et al*., 2003) and second survey was conducted in the waters off Sanriku district, from 8 April to 2 May 2003 (Yoshida, *et al*., 2004). Both surveys took 50 common minke whales, respectively, in the coastal waters within a 30 nautical miles radius from each survey area. After detailed examination of the results of the logistic aspects of both 2002 and 2003 surveys, it was concluded that no substantial problem occurred and the coastal survey could be continued as a component of the JARPN II using same kind of vessels (small-type whaling catcher boats) and methodology (Kato, *et al*., 2004). However, re-calculation of required sample size using data obtained from both surveys suggested that sample size should be modified to be at least 60 individuals in each area/season (Tamura, *et al*., 2004a), and taking account of the possible geographical and/or temporal variations of prey consumption of the whales, the coastal surveys thought to be needed on a yearly bases in each local area (Government of Japan, 2004a).

Based on these results, revised JARPN II research plan was submitted to the 56th IWC/SC annual meeting (Government of Japan, 2004b). The coastal survey component was revised to be conducted twice a year and 60 common minke whales would be sampled in spring and autumn seasons, respectively. The technical methodology was almost same as the former surveys, i.e. the survey consisted of three research components as follows; 1) coastal whale sampling survey by small-type whaling catcher boats, 2) coastal prey species survey by one echo sounder-trawl survey vessel and 3) dedicated sighting survey by one research vessel. In addition, dedicated sighting survey using one small-type whaling catcher boat was tentatively introduced to examine the logistic capability of the boat for acting as a sighting research vessel. The coastal survey was authorized by the Government of Japan in compliance with Article VIII of the international convention for the Regulation of Whaling. The National Research Institute of Far Seas Fisheries (NRIFSF), Fisheries Research

Agency, planned and conducted this survey entrusted by the Institute of Cetacean Research (ICR).

In this paper, we presented an outline of the first survey of revised JARPN II coastal component conducted in the waters off Kushiro, northeast Japan, from 13 September to 31 October 2004.

MATERIALS AND METHODS

Research area

The research area was same as the 2002 survey (Kishiro, *et al*., 2003), i.e. the coastal waters off Kushiro, within the 30 nautical miles (maximum 50 n. miles) form the Kushiro port (Fig. 1). This area coincided with the northern part of the sub-area 7 determined by the IWC.

Research vessels and land station

Whale sampling survey and sighting survey

Four small-type whaling catcher boats (*Taisho Maru* No. 28 (hereafter referred as 28T; 47.3GT), *Koei Maru* No.75 (75K; 46.0GT), *Sumitomo Maru* No.31 (31S; 32.0GT) and *Katsu Maru* No.7 (7K; 32.0GT) were used as sampling and/or dedicated sighting vessels. The sampling survey was conducted from 13 September to 31 October. All whales sampled were landed on the land station (the JARPN II research station) in the Kushiro port for biological examination of the whales and the by-products.

Prey species survey

The *Shunyo Maru* (SYO; 887.0GT) conducted the echo sounder-trawling survey in wider research area off east coast of Hokkaido, from 24 to 29 September. This vessel also conducted the hydrographic observations using the conductivity-temperature-depth profiler (CTD). Detail of the survey is shown in Appendix 1.

Large-scale dedicated sighting survey

The *Kyoshin Maru* No.2 (KS2; 372.0GT) was engaged as a dedicated sighting survey vessel. This survey was conducted from 9 to 27 September, following the predetermined zigzag-shaped track lines in the identical research area, where the prey species survey was carried out. Detail of the survey is shown in Appendix 2.

Dedicated sighting survey by small-type whaling catcher boat

In order to examine the logistic capability of the small-type whaling catcher boats for acting as the sighting research vessels, one of four catcher boats alternatively carried out the dedicated sighting surveys from 13 September to 4 October. The survey area was established in the coastal waters within 50 nautical miles from the Kushiro port with small blocks (A to D) and systematically designed track lines (Fig.2). The survey largely followed the guidelines of Hammond (1986) and

Hammond and Donovan (1993). Searching was carried out at 10 knots during the day and the vessels returned to the port every night. The vessel cruised along the predetermined cruise track using closing mode, principally closing on primary sightings to confirm species and school size. After closing, the vessel returned to the nearest point on track line that had not been surveyed and resumed searching. Generally, searching was only conducted when the sea conditions were below Beaufort 3 and visibility was more than 1.5 miles. Searching was carried out from the top barrel (6 to 7 m above the water surface) by two persons. Similar sighting data forms to those developed for Japanese North Pacific whale sighting cruises were completed. Weather and sea conditions were recorded each hour. The experiments to evaluate the accuracy of estimated distances and angles from the top barrel were carried out in the first day of the survey for each vessel.

Sampling survey by small-type whaling catcher boat

As same as the former surveys in 2002 and 2003 (Kishiro *et al*., 2003, Yoshida *et al*., 2004), the research head office was placed in the research station and controlled the sampling vessels during the survey. All catcher boats except for one which was engaged as the dedicated sighting vessel carried out the sampling survey. To avoid the concentration of sampling location, two types of the sampling (searching) measure were tentatively introduced as follows.

Type 1 sampling

The research area was divided into four sectors based on the direction from the port (Fig. 3). The searching area of sampling vessels was allocated to one of those sectors. The sector was selected in every day in random turn. After all sectors were surveyed (usually, it took 4 days), type 2 sampling was started.

Type 2 sampling

The searching area and route of the sampling vessels were determined from information on whale distribution obtained by type 1 sampling survey and dedicated sighting survey, weather conditions and information on fishing grounds.

In each vessel, a researcher was on boarded and recorded the cruise tracks, searching time on effort, sea weather conditions and sighting data. Sighting was conducted from the top barrel and upper bridge by all the crews and researcher. All common minke whales sighted were targeted for sampling, except for the cow-calf pair. When a sighting consisted of more than one animal, first targeted animal was selected following the random sampling digits. Sampling was made by 50 mm whaling cannon. Once the vessel sampled the whale, she returned to the Kushiro port as soon as possible, to land the animal on the research station. At the port, the sampled whale was lift up from the vessel using wire nets and a crane and transported to the station by a 11 tons freight trailer. At that time, body weight of the whale was measured with the truck scale.

Biological research for common minke whales sampled

All sampled whales were biologically examined by researchers at the research station. Research items of the biological studies were summarized in Table 4, with the number of data and samples obtained. These items were related to studies on feeding ecology, stock structure, life historical biology and pollutions.

RESULTS

Dedicated sighting survey by small-type whaling catcher boat

Searching effort and the number of sightings of common minke whales made by the dedicated sighting vessels (small-type whaling catcher boats) are listed in Table 1. Cruise tracks and sighting positions of common minke whales are shown in Fig. 4. In the first period from 13 to 16 September, the survey was conducted as the exercise cruises in block B with the experiments for estimation of sighting distances and angles. Since, there was no practical problem in conducting the survey, the second and third periods covered all small blocks, respectively. In the second period from 17 to 23 September, common minke whales were sighted in block A and B (within 30 n.miles of the coast), but in the third period from 24 September to 4 October, the whales were sighted in block C and D (around 50 n.miles from the coast). Total searching distance and time were 641.8 n. miles and 60.1 hours, respectively. A total of 16 schools/16 individuals of common minke whales were primary sighted and 1 school/1 individual of the whale was secondary sighted during the surveys.

Effort and sightings by the sampling vessels

The cruise tracks made by the sampling vessels (28T, 75K, 31S and 7K) during the survey are shown in Fig.5. The searching areas covered widely coastal waters within 30 nautical miles form the Kushiro port. Searching distance and time are shown in Table 2. Here, we defined the searching distance and time as that with sighting effort, i.e. the periods of the searching conducted from the top barrel. During the research period, total searching distance and time were 6,923.9 n. miles and 635.4 hours, respectively.

Fig.6 shows the distribution of common minke whales sighted by the sampling vessels. The sighting positions widely distributed in the inshore areas off Kushiro port to the waters in around 30 n. miles from the port. During the survey, a total of 151schools/ 156 individuals of common minke whales were sighted, consisting of 142 schools/ 146 individuals of primary sightings and 9 schools/ 10 individuals of secondary sightings (Table 2). These figures probably include some duplicated sightings because sampling vessels searched almost same areas in every day. In addition, Humpback whales (2 schools/ 2 individuals) and sperm whales (1 school/ 2 individuals) were sighted during the survey (Table 2).

The temporal change in density index (SPUE: number of schools primary sighted per one hour searching, and DI: number of schools primary sighted per 100 n. miles searching) of common minke whales obtained by the small-type whaling catcher boats are listed in Table 3. There was no critical difference in the figures between the sampling and sighting surveys, and both SPUE and DI decreased from the middle of September to late of October. During the total research periods, 0.22 schools was primary sighted per one hour searched, and 2.05 schools was primary sighted per 100 n. miles searched by the sampling survey. These figures are nearly the half of that recorded in the former survey conducted in Kushiro 2002 (Kishiro, *et al*., 2003).

Sampling of common minke whales

A total of 59 common minke whales were sampled. In the sampling process, one individual was harpooned but missed by the technical reason (the cases of struck and lost). Fig.6 showed sighting positions of sampled whales. Distribution of these whales almost covered all of the areas where the sightings were made during the research period.

Prey species survey and large-scale dedicated sighting survey

The prey species survey was conducted using the echo sounder-trawling vessel (SYO) to investigate the distribution and abundance of the prey species in the wider areas from Cape Erimo (143º15'E) to Cape Nosappu (about 146º00'E)) and north of 41º00'N. Japanese anchovy, walleye pollack and Pacific saury were found by the survey but common squid was not found. The large-scale dedicated sighting survey using sighting vessel (KS2) were conducted in the same research areas of the prey species survey, and sighted 17 schools/18 individuals of common minke whales with 809.4 n.miles searched. Results of these surveys were described in Appendix 1 (the prey species survey), Appendix 2 (the large-scale dedicated sighting survey) and Appendix 3 (the oceanographic observations).

Sex ratio, body length and weight of sampled whales

The 59 sampled whales were consisted of 47 males and 12 females (sex ratio of males was 0.797). Average body length of the whales was 6.87m (max=7.95, min=4.65, SD=0.80) for males and 6.00m (max=8.07, min=4.27, SD=1.09) for females, respectively (Table 5). Average body weight was 4.23 tons (max=6.36, min=1.18, SD=1.31) for males and 2.72 tons (max=5.64, min=0.88, SD=1.47) for females, respectively (Table 6). In males, both the average body length and the average body weight decreased during the seasons from the middle of September to late of October. In females, averages were the lowest in the middle of September but sample size was small.

Composition of sex and sexual maturity of common minke whales is listed in Table 7. In males, 31 of 47 individuals were sexually mature (66.0%). On the other hand, in females, the ratio of sexually mature individuals was only 16.7% (two of 12 individuals). Pregnant or lactating female was not

observed.

Pray species of common minke whale found in the stomach contents

Except for 1 stomach destroyed by the harpoon, we could examine 58 stomach contents of common minke whales. Following the same methods conducted in the JARPN II feasibility surveys (Fujise, *et al*., 2002) stomach contents were weighted to the nearest 0.1 Kg by each four chamber in both cases of including and excluding liquid. Then, a sub-sample of forestomach contents was collected and frozen for the later laboratory work. Major prey species found in the forestomach contents were Japanese anchovy *Engraulis japonicus* (62.1%, 36 out of 58 whales) and Pacific saury *Cololabis saira* (31.0%, 18 whales). Walleye pollock *Theragra chalcogramma* (3.4%, 2 whales) and Krill (3.4%, 2 whales) were also observed but Japanese common squid *Todarodes pacificus* (which was found in the samples corrected in 2002 Kushiro survey) was not observed. The range of forestomach contents weights was form 3.0Kg to 80.8Kg, and the maximum of % body weight was 1.6 %. This whale fed on Pacific saury.

By-products of the whales

After biological examination, all whales sampled were processed according to the International Convention for Regulation of Whaling, Article VIII. A total weight production including meat and blubber was 140.2 tons.

DISCUSSION

The present survey was the first survey of the revised JARPN II coastal component to take 60 common minke whales in the coastal waters of Japan. There was no practical problem in conducting the surveys as same as the 2002 and 2003 surveys. However, we could not obtain the planed sample size (we collected a total of 59 individuals). One of the reasons is thought to be bad weather condition during the research period. In 2004 autumn season, we got a twice of typhoons and several impacts from the low atmospheric pressures. Big waves and strong winds seriously prevent to conduct the surveys with small boats (32-47.6GT) and as a result, more days were spent to the survey (research period was 49 days form 13 September to 31 October in 2004 as compared with 33 days from 10 September to 12 October in 2002). A typhoon also partly prevented activities of large vessel (887GT) in the prey species survey (Appendix 1).

Another reason is thought to be related to yearly change in the timing of the migration of common minke whales into restricted coastal area. As compared with the results of the 2002 survey off Kushiro, sex ratio of males in the samples was higher and body length frequency of the whales inclined toward large-sized mature males (Fig. 7). The distribution of the whales in the survey area was relatively dispersed with low density of the sighted whales (Fig. 6 and Table 3) and the concentrated area observed in the 2002 survey (near the continental shelf and slope in the southeast

region from the Kushiro port) was not detected. Minke whale is well known to have segregation in their migration as the predominance of females around the northern limit of their distribution in both the Southern Hemisphere (Kato, *et al*., 1990) and off northern Japan (Wada, 1989), and coastal waters off Kushiro is thought to be located in the migration corridor of their north-south migration. In the case of Gary whales, it is known that females generally migrate earlier than males and adults earlier than sexually immature whales in their coastal north-south migration (Wolman, 1985). These implied that the differences observed in the composition of samples between the 2002 and 2004 surveys might be related to the difference of the timing of the migration of whale groups to the survey area, and suggested that the migration of main groups including mature females into the coastal waters off Kushiro was scarce at the time in 2004 survey period.

Furthermore, composition of prey species found in the stomach contents was also different and apparently simple than that of the 2002 surveys (Fig.8). These changes were related to the difference of the prey species distribution and oceanographic conditions between the years revealed by the prey species surveys (Appendix 1 and 3). These environmental differences possibly affect the change in migration of common minke whales into the coastal area.

In the present survey, the dedicated sighting survey using small-type whaling catcher boats was tentatively introduced and conducted with no serious problem. However, it was difficult to continue the survey through the research period due to the logistic reasons such as the difficulty in collecting the whales by limited number of sampling vessels and the shortage of the boats for acting as the sampling vessels. The sighting survey area was also restricted in small area compared with the large–scale dedicated sighting survey due to the capability of the boat. Thus, the dedicated sighing survey using small boat was suspended in 4 October and all of the boats had acted as sampling vessels from 5 October. Taking account of these situations, we recommend that large-scale dedicated sighting survey using large vessel will be still needed in future survey even if the small-type whaling catcher boats could be used as a dedicated sighting vessel in the restricted survey area.

Based on the results of the 2002 surveys, prey preferences of common minke whales and interaction between common minke whales and fisheries were preliminary examined and presented to the 56th IWC/SC annual meeting (Tamura, *et al*., 2004b; Kawahara, *et al*., 2004). However, the present survey revealed large yearly change in migration and feeding habit of common minke whales in the coastal waters off Kushiro in autumn season and suggested that those changes might be related to yearly change in the environmental factors such as the oceanographic conditions and distribution of prey species. To evaluate a long term competition between whales and fisheries in local areas, and to clarify the role of the whales in the marine ecosystem, further surveys should be conducted on a yearly basis.

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Table 1. Searching days, hours, distances and number of sightings of common minke whales made by the dedicated sighting survey conducted by small-type whaling vessels.

Period	Days	Hours	Distances (n.miles)	No. of sightings						DI[*1]	SPUE[*2]
				Primary		Secondary		Total			
				Sch.	Ind.	Sch.	Ind.	Sch.	Ind.		
First period (13 Sept.-16 Sept.	4	16.1	170.42	7	7	-	-	7	7	4.11	0.44
Second period (17 Sept.-23 Sept.	6	22.7	243.30	5	5	1	1	6	6	2.06	0.22
Third period (24 Sept.-4 Oct.)	7	21.3	228.03	4	4	-	-	4	4	1.75	0.19
Total	17	60.1	641.76	16	16	1	1	17	17	2.49	0.27

*1: No. of primary schools sighted per 100 n.miles searching.
*2: No. of primary schools sighted per 1 hour searching.

Table 2. Searching days, hours, distances, number of sightings and catch of common minke whales made by the sampling survey.

Period (sampling type*1)			Species	No. of sightings: Primary Sch.	Primary Ind.	Secondary Sch.	Secondary Ind.	Total Sch.	Total Ind.	No. of catch	DI*2	SPUE*3
13 Sept.- 16 Sept.	No. of vessels	3	Common minke whale	28	29	-	-	28	29	11	3.57	0.38
(Type 1)	Days	4	Unidentified cetacean	2	4	-	-	2	4			
	Hours	73.3										
	Distances	784.8										
17 Sept.- 20 Sept.	No. of vessels	3	Common minke whale	26	26	-	-	26	26	12	4.82	0.52
(Type 2)	Days	3	Like minke whale	2	2	—	—	2	2			
	Hours	49.7										
	Distances	539.9										
21 Sept.- 24 Sept.	No. of vessels	3	Common minke whale	24	26	1	1	25	27	8	2.91	0.32
(Type 1)	Days	4	Unidentified cetacean	2	6	—	—	—	—			
	Hours	75.0										
	Distances	825.8										
27 Sept.- 29 Sept.	No. of vessels	3	Common minke whale	16	16	2	2	18	18	4	2.07	0.22
(Type 2)	Days	3	Like minke whale	1	1	-	-	1	1			
	Hours	72.1										
	Distances	771.2										
1 Oct. - 4 Oct.	No. of vessels	3	Common minke whale	-	-	-	-	0	0	0	0.00	0.00
(Type 1)	Days	3										
	Hours	47.3										
	Distances	520.9										
5 Oct. - 15 Oct.	No. of vessels	4	Common minke whale	31	31	3	4	34	35	16	1.91	0.21
(Type 2)	Days	6	Like minke whale	1	1	-	-	1	1			
	Hours	144.6	humpback whale	1	1	-	-	1	1			
	Distances	1,619.7	Unidentified cetacean	1	1	-	-	1	1			
16 Oct.- 31 Oct.	No. of vessels	4	Common minke whale	17	18	3	3	20	21	8	0.91	0.10
(Type 2)	Days	12	Like minke whale	1	1	-	-	1	1			
	Hours	173.4	humpback whale	1	1	-	-	1	1			
	Distances	1,861.7	sperm whale	1	2	-	-	1	2			
			Unidentified cetacean	4	6	-	-	4	6			
Total	Hours	635.4	Common minke whale	142	146	9	10	151	156	59	2.05	0.22
	Distances	6,923.9	Like minke whale	5	5	-	-	5	5			
			humpback whale	2	2	-	-	2	2			
			sperm whale	1	2	-	-	1	2			
			Unidentified cetacean	9	17	-	-	9	17			

*1: See text.
*2: No. of primary schools sighted per 100 n.miles searching.
*3: No. of primary schools sighted per 1 hour searching.

Table 3. Seasonal change in density index of common minke whales obtained by small-type whaling vessels surveys in the coastal waters off Kushiro in 2002 and 2004.

	2004 Season				2002 Season	
	Sighting survey		Sampling survey		Sampling survey	
Period	DI*1	SPUE*2	DI	SPUE	DI	SPUE
10 Sept.-14 Sept.	5.31	0.56	3.31	0.34	5.19	0.57
15 Sept.-19 Sept.	3.47	0.37	4.09	0.45	6.87	0.65
20 Sept.-24 Sept.	0.92	0.10	3.38	0.37	4.04	0.41
25 Sept.-29 Sept.	3.75	0.40	2.07	0.22	2.74	0.30
30 Sept.- 4 Oct.	0.00	0.00	0.00	0.00	2.67	0.26
5 Oct. - 9 Oct.	-	-	2.10	0.24	2.94	0.33
10 Oct.- 14 Oct.	-	-	1.01	0.11	4.79	0.50
15 Oct.- 19 Oct.	-	-	2.02	0.22	-	-
20 Oct.- 24 Oct.	-	-	0.47	0.05	-	-
25 Oct.- 29 Oct.	-	-	0.82	0.09	-	-
30 Oct.- 31 Oct.	-	-	0.46	0.05	-	-
Total	2.49	0.27	2.05	0.22	4.03	0.43

*1: No. of primary schools sighted per 100 n.miles searching.
*2: No. of primary schools sighted per 1 hour searching.

Table 4. Summary of biological data and samples collected during the 2004 coastal whale survey off Kushiro, in the JARPN II.

	Number of whales		
Samples and data	Male	Female	Total
Body length and sex	47	12	59
External body proportion	47	12	59
Photographic record and external character	47	12	59
Diatom film record and sampling	47	12	59
Body scar record	47	12	59
Measurements of blubber thickness (eleven points)	47	12	59
Body weight	47	12	59
Skin tissues for DNA study	47	12	59
Muscle, liver and heart tissues for isozyme analysis	47	12	59
Muscle, liver, kidney and blubber tissues for chemical analysis	47	12	59
Mammary grand; lactation status, measurement and histological sample	-	12	12
Uterine horn; measurement and endometrium sample	-	12	12
Collection of ovary	-	12	12
Testis and epididymis; weight and histological sample	47	-	47
Stomach content, conventional record	47	12	59
Volume and weight of stomach content in each compartment	47	12	59
Stomach contents for feeding study	47	11	58
Record of external parasites	47	12	59
Earplug for age determination	47	11	58
Tympanic bulla for age determination	47	11	58
Largest baleen plate for morphologic study and age determination	47	12	59
Baleen plate measurements (length and breadth)	47	12	59
Photographic record of baleen plate series	47	12	59
Length of each baleen plate series	47	12	59
Vertebral epiphyses sample	47	12	59
Number of vertebrae	47	12	59
Number of ribs	47	12	59
Skull measurement (length and breadth)	47	12	59

Table 5. Body length (m) of common minke whales sampled by the 2004 coastal whale survey in the JARPN II.

	Male					Female				
Period	Mean	S.D.	Min.	Max.	n	Mean	S.D.	Min.	Max.	n
13 Sept.-30 Sept.	7.02	0.58	5.70	7.82	27	5.44	0.69	4.27	6.55	8
1 Oct. - 15 Oct.	6.94	0.94	4.65	7.95	14	7.12	1.34	6.17	8.07	2
16 Oct. - 31 Oct.	6.03	0.92	4.99	7.23	6	7.13	0.52	6.76	7.49	2
Total	6.87	0.80	4.65	7.95	47	6.00	1.09	4.27	8.07	12

Table 6. Body weight (t) of common minke whales sampled by the 2004 coastal whale survey in the JARPN II.

	Male					Female				
Period	Mean	S.D.	Min.	Max.	n	Mean	S.D.	Min.	Max.	n
13 Sept.-30 Sept.	4.45	1.09	2.16	6.36	27	1.97	0.78	0.88	3.16	8
1 Oct. - 15 Oct.	4.30	1.44	1.18	5.92	14	4.18	2.06	2.72	5.64	2
16 Oct. - 31 Oct.	3.03	1.50	1.50	5.30	6	4.29	1.23	3.42	5.16	2
Total	4.23	1.31	1.18	6.36	47	2.72	1.47	0.88	5.64	12

Table 7. Composition of sex and sexual maturity of common minke whales sampled by the 2004 coastal whale survey in the JARPN II.

	Male				Female						
Period	Imm.	Mat.	Total	Marutity (%)	Imm.	Rest.	Preg.	Total	Pregnancy (%)*1	Maturity(%)	Sex ratio (%males)
13 Sept.-30 Sept.	8	19	27	70.4	8	0	0	8	-	0.0	77.1
1 Oct.- 15 Oct.	4	10	14	71.4	1	1	0	2	0.0	50.0	87.5
16 Oct.- 31 Oct.	4	2	6	33.3	1	1	0	2	0.0	50.0	75.0
Total	16	31	47	66.0	10	2	0	12	0.0	16.7	79.7

*1: Apparent pregnancy rate

Table 8. Number of common minke whales by major prey species found in their forestomach contents sampled by the 2004 coastal whale survey in the JARPN II.*

	No. of whales (%)				
Period	Japanese anchovy	Pacific saury	Walleye pollock	Krill	Total
13 Sept.-30 Sept.	32 (94.1)	- (0.0)	1 (2.9)	1 (2.9)	34
1 Oct.- 15 Oct.	1 (6.7)	15 (93.7)	- (0.0)	- (0.0)	16
16 Oct.- 31 Oct.	3 (37.5)	3 (37.5)	1 (12.5)	1 (2.9)	8
Total	36 (62.1)	18 (31.0)	2 (3.4)	2 (3.4)	58

* An animal with broken stomach by harpoon is unlisted.

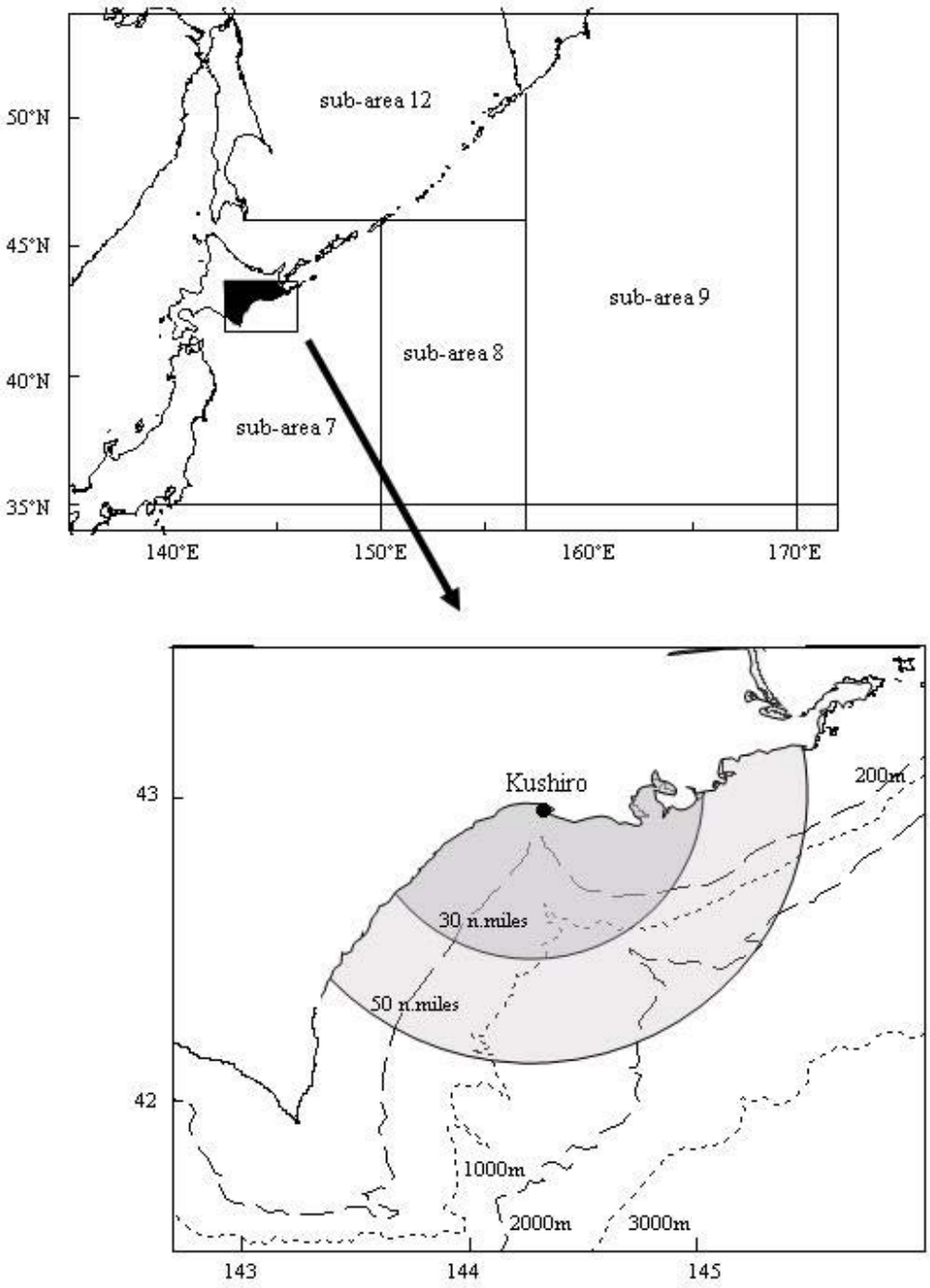

Fig. 1. The IWC sub-areas for western North Pacific minke whales (upper) and research area of the 2004 coastal whale survey in the JARPN II (lower).

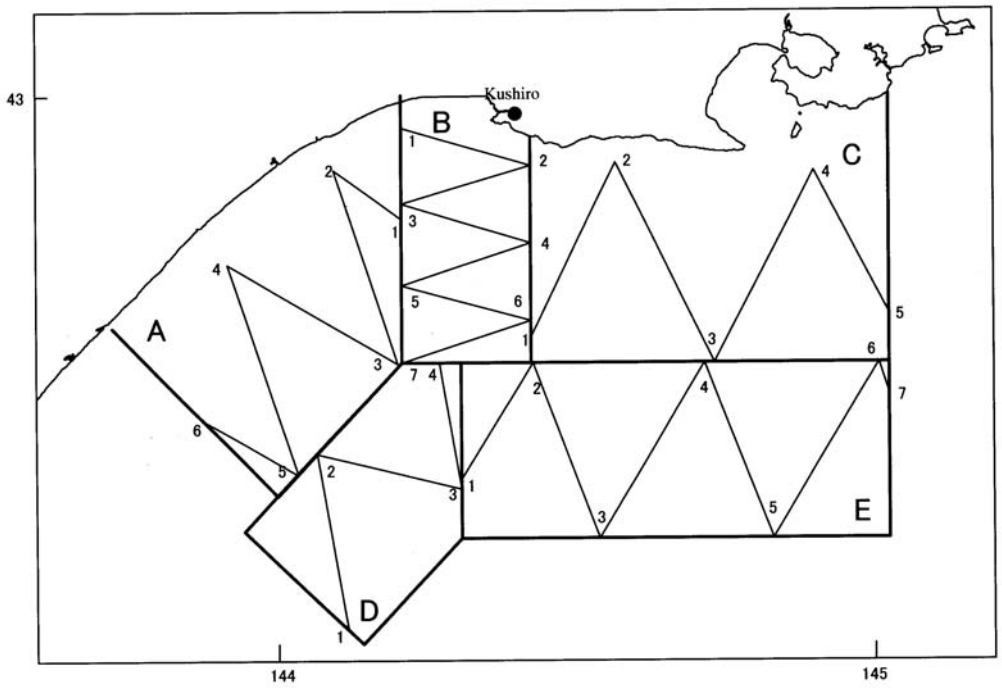

Fig. 2 Survey blocks and example of the planed tracklines for dedicated sighting survey by small-type whaling vessel in the 2004 JARPN II coastal survey.

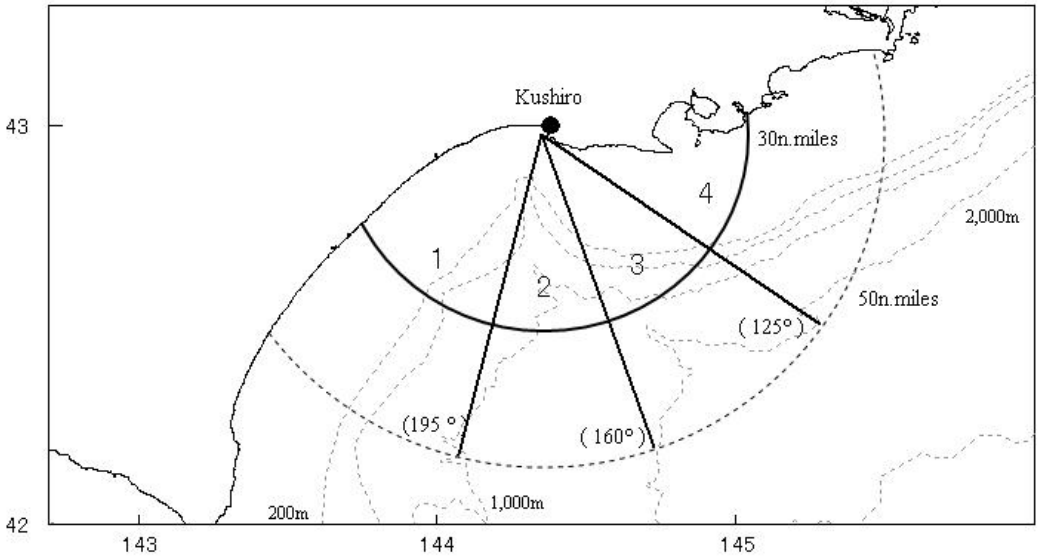

Fig.3 Allocation of the sectors for type 1 whale sampling in the 2004 JARPN II coastal survey.

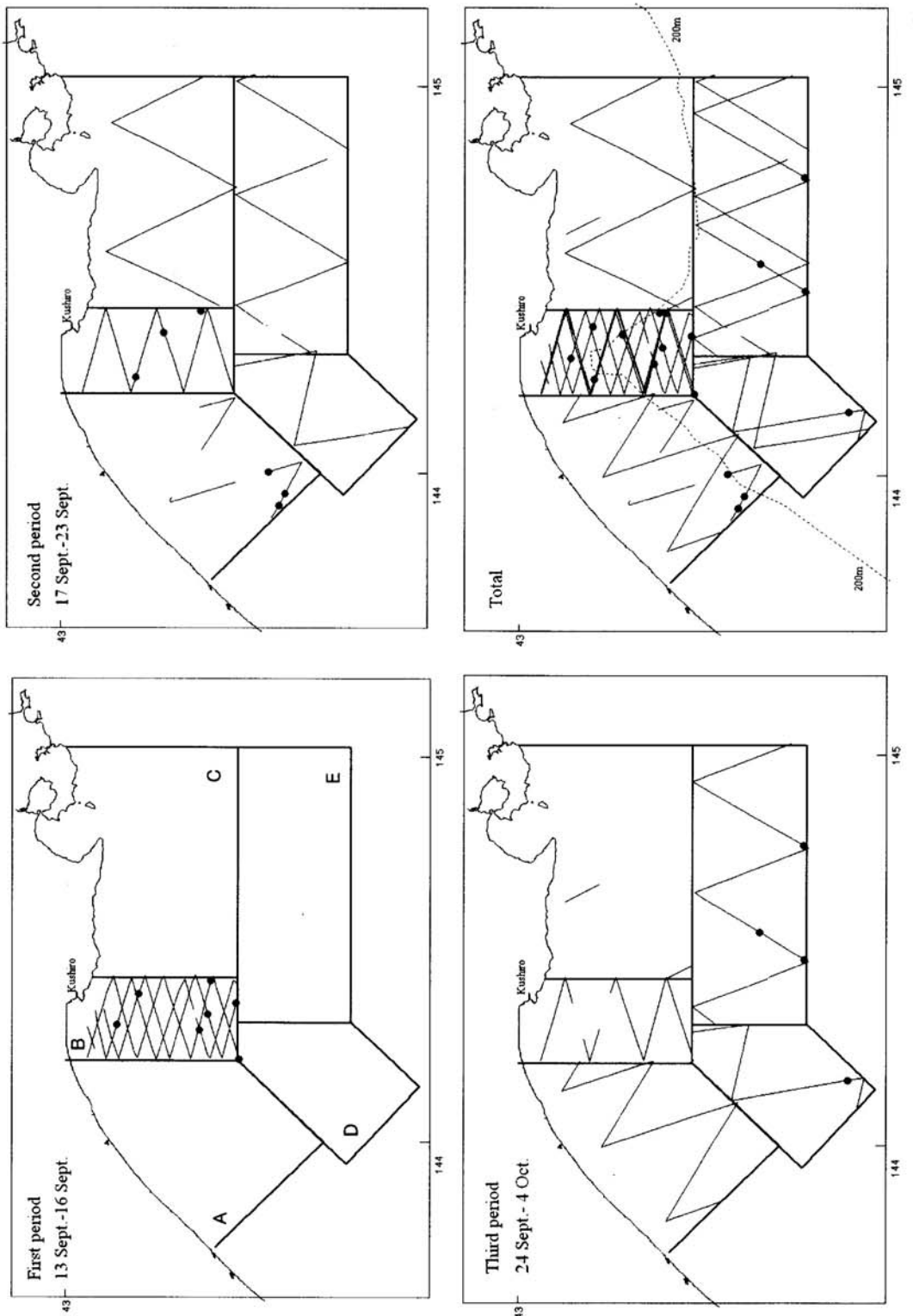

Fig. 4 Cruise tracks with searching effort and sighting positions of common minke whales (●) from dedicated sighting survey by small-type whaling vessels in the 2004 JARPN II coastal survey.

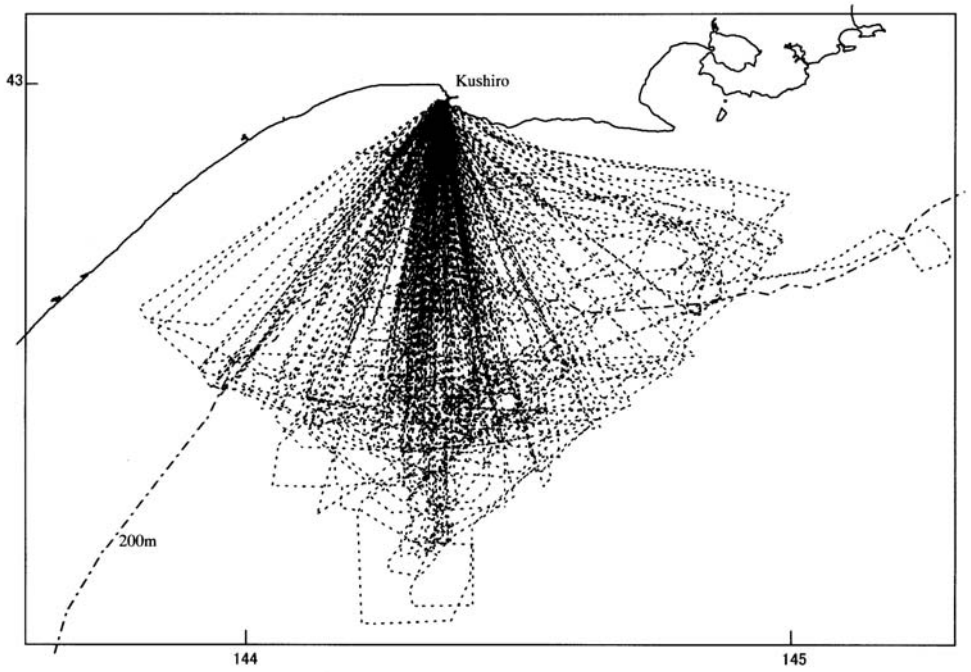

Fig. 5 Cruise tracks of the whale sampling survey in the 2004 JARPN II coastal survey.

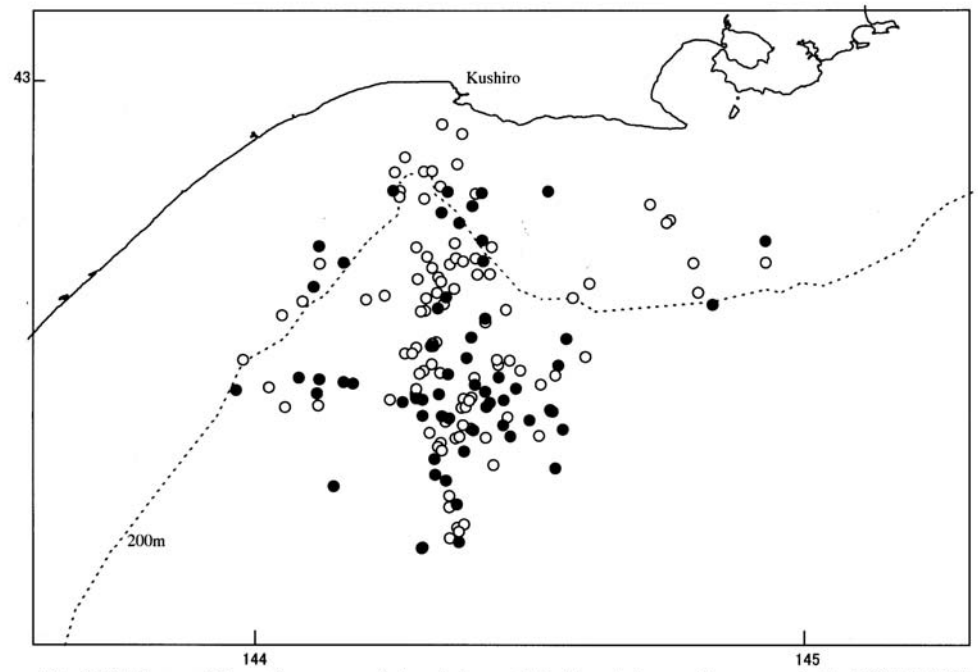

Fig. 6 Sighting positions of common minke whales made by the whale sampling survey in the 2004 JARPN II coastal survey. Closed circle indicates sighting position of sampled whale.

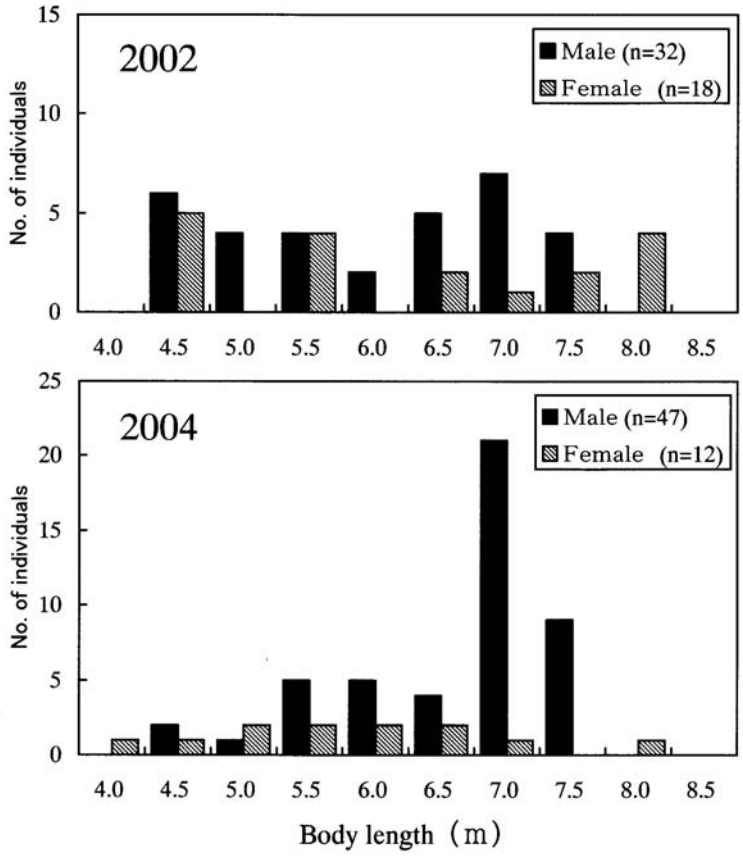

Fig.7 Body length frequency of common minke whales sampled by the 2002 and 2004 JARPN II coastal survey off Kushiro.

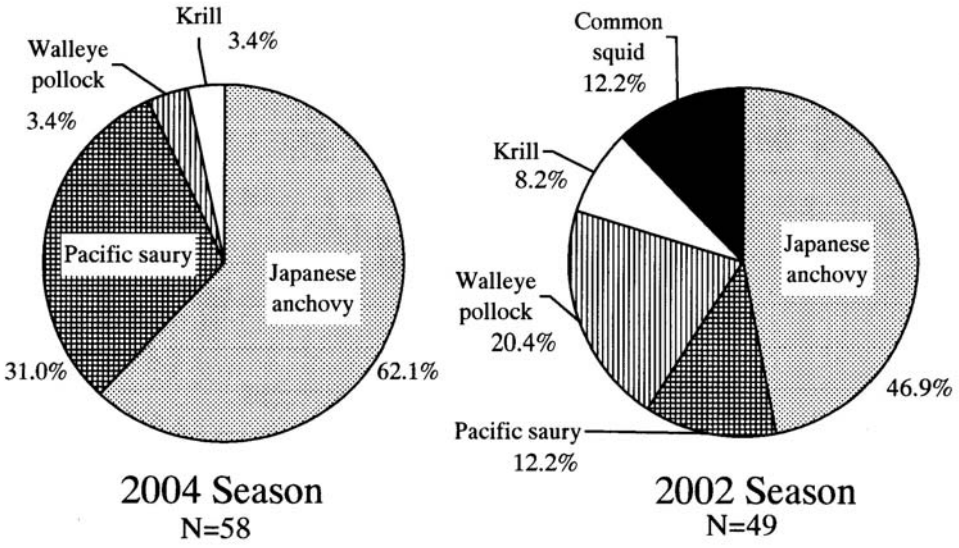

Fig. 8 Composition of common minke whales with major prey species found in the forestomach contents in the 2002 and 2004 JARPN II coastal survey off Kushiro.

Appendx 1

Coastal prey species survey of JARPN II in 2004

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ABSTRACT

Prey species surveys were conducted in cooperation with the sampling surveys for sei and minke whales in September 2004 as a part of JARPN II study. Offshore and coastal surveys were conducted in the western North Pacific and off Kushiro, Hokkaido, respectively. The primary objective of the coastal survey was to examine prey environment and prey preference of minke whale during autumn. The distribution and abundance of the prey species were investigated with the quantitative echosounder (EK60) and midwater trawl 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. Dense schools of Japanese anchovy and walleye pollack were found in the acoustic survey. CPUE was low for Pacific saury and no catches for common squid. The results coincided with the information from the fisheries and were different from those in September 2002, suggesting large yearly changes in the prey environment surrounding minke whales.

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. Since 2002, JARPN II has started a new coastal survey for minke whale using small-type whaling catcher boats. 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 this survey was to examine prey environment in autumn for minke whales. This document presents the preliminary results of the prey species survey in the coastal region.

MATERIALS AND METHOD

Survey area and period

The cooperative prey species survey was conducted in September 2004 with two periods; first from September 15 to 19 in the offshore region (Sub-area 9) and second from September 24 to 29 in the coastal region off Kushiro, Hokkaido (Sub-area 7), 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 the results 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.

The coastal survey area is divided into inshore and offshore sides and track lines were set to cover the both sides (Fig. 2). The track lines were set independently from whale survey. The waypoints of track lines were shown in Table 2. The distribution and abundance of the prey species were investigated with the quantitative echosounder and the midwater trawl. CTD casts were conducted down to 500 m or near the bottom 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 150 m, were conducted. The purpose of these samplings was to examine the abundance and distribution pattern of squids and neustonic animals (especially common squid and 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 30-40 minutes in the area where Pacific saury seemed to be

distributed. Stairs-like trawlings were made at three layers shallower than 150 m (0-50 m, 50-100 m, and 100-150 m). During the coastal survey, surface and stairs-like trawlings were made four and 10 times (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.

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 result of trawl 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 and walleye pollack, 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 ΔSv. The integration is made at an interval of one nautical mile by 50 m depth zone.

RESULTS AND DISCUSSION

Due to the time constraints caused by a typhoon, the track lines in the offshore side were not covered. While the acoustic data and oceanographic conditions are being analyzing now, the preliminary results are as follows.

CTD data indicated that the temperature in the coastal region off Kushiro was low due to the Oyashio Current while the temperature was relatively higher in the northern (continental shelf) and southern (oceanic water) parts in the survey area. In the acoustic survey, dense schools of Japanese

anchovy were mainly found on the eastern continental shelf. Japanese anchovy sampled were mainly consisted of large-sized fish (11-14 cm SL). Walleye pollack (35-54 cm FL) was found along the edge of the continental shelf. Although middle-sized Pacific saury was caught at some stations in the central and eastern parts, the CPUE (kg/h) was low. In this fishing season the southern migration of Pacific saury was delayed due to the higher water temperature and a large warm eddy. No common squid was caught by the mid-water trawlings during the survey. The results of the survey coincided with the information from the fisheries and were different from those in the first survey off Kushiro in September 2002 (Kawahara et al., 2003), suggesting large yearly changes in the prey environment surrounding minke whales.

During the survey the acoustic data were also collected by Kyoshin-maru No. 2 that carried out the dedicated sighting survey in the same area. The data will be analyzed together with those from Shunyo-maru to estimate the prey preference of minke whales.

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 lines

WP	Lat	Long	Distance (n. mil)
1	42-50N	145-26E	54
2	43-03N	145-30E	
3	42-23N	145-45E	
4	42-39N	144-55E	68
5	42-55N	145-00E	
6	42-12N	145-15E	
7	42-42N	144-25E	65
8	42-54N	144-30E	
9	42-03N	144-45E	
10	42-24N	143-57E	78
11	42-46N	143-59E	
12	42-45N	144-18E	
13	42-25N	143-34E	100
14	42-01N	144-00E	
15	42-00N	143-22E	
16	41-40N	144-02E	
17	41-00N	146-00E	80
18	42-16N	145-30E	
19	41-00N	145-00E	60
20	41-52N	144-18E	
		Total	451

Table 3. Results of trawlings during coastal survey

Date	SST (℃)	Lat	Long	Sampling depth (m)	Towing duration (min)	Total catch (kg)	Sampled weight by species (kg)							
							Japanese anchovy	Common mackerel	Other mackerel	Pacific saury	Myctophid	Walleye pollock	Pacific pomfret	Squids
2004/9/24	16.8	42-46N	144-23E	0-150	40	305.4	14.6	2.7	-	-	78.7	193.5	-	13.6
2004/9/25	16.0	42-42N	144-27E	0-120	40	50.4	49.3	-	-	-	-	-	-	-
2004/9/25	15.7	42-23N	144-32E	0-30	30	5.0	0.0	-	-	5.0	-	-	-	-
2004/9/26	16.6	42-37N	144-01E	0-170	40	1.9	0.0	0.4	0.1	0.1	-	-	-	-
2004/9/26	16.5	42-25N	144-04E	0-30	40	373.4	359.0	0.2	0.4	1.9	-	-	10.9	-
2004/9/26	17.0	42-14N	144-08E	0-110	40	0.8	-	-	-	-	-	-	-	0.0
2004/9/27	15.9	42-40N	145-04E	0-170	40	16.5	-	0.4	-	15.8	-	-	-	-
2004/9/27	15.8	42-23N	145-11E	0-30	30	17.4	16.2	0.1	-	1.1	-	-	-	-
2004/9/27	17.8	42-13N	145-13E	0-120	30	0.0	0.0	-	-	-	-	-	-	-
2004/9/28	15.3	42-51N	145-32E	0-160	40	6.1	-	0.1	-	-	-	-	5.8	0.0
2004/9/28	15.9	42-37N	145-39E	0-30	30	0.2	0.1	0.1	-	-	-	-	-	-
2004/9/28	16.7	42-27N	145-42E	0-150	30	6.3	6.1	0.1	-	-	-	-	-	0.1
2004/9/29	16.5	42-02N	143-59E	0-120	30	0.0	-	-	-	-	-	-	-	-
2004/9/29	16.1	42-01N	143-43E	0-190	40	2.0	0.0	-	-	-	-	-	-	0.0

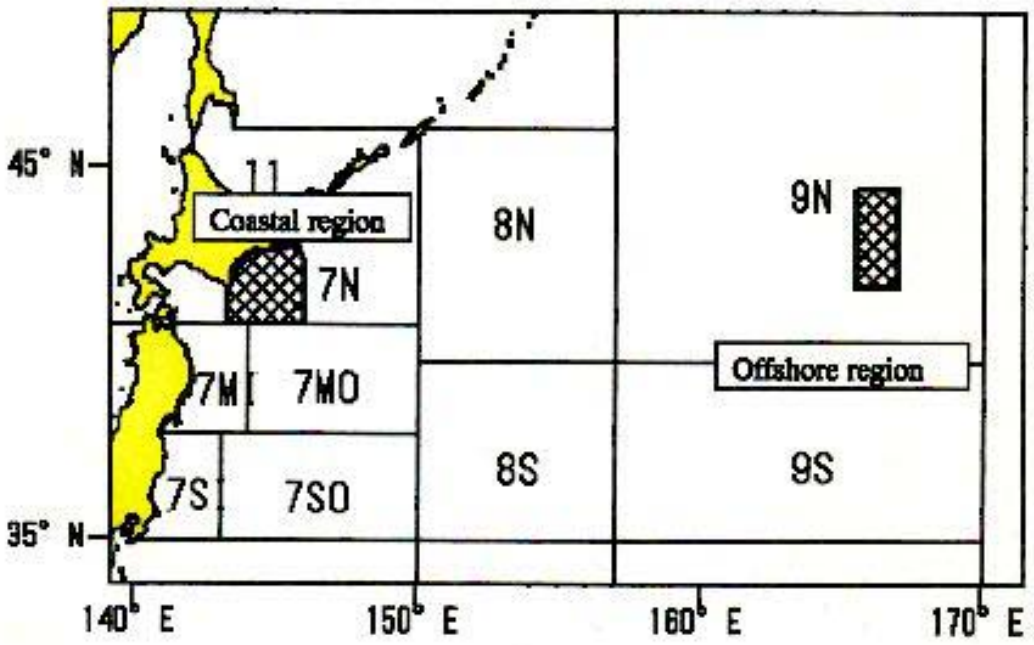

Fig. 1. Prey species survey area in September 2004

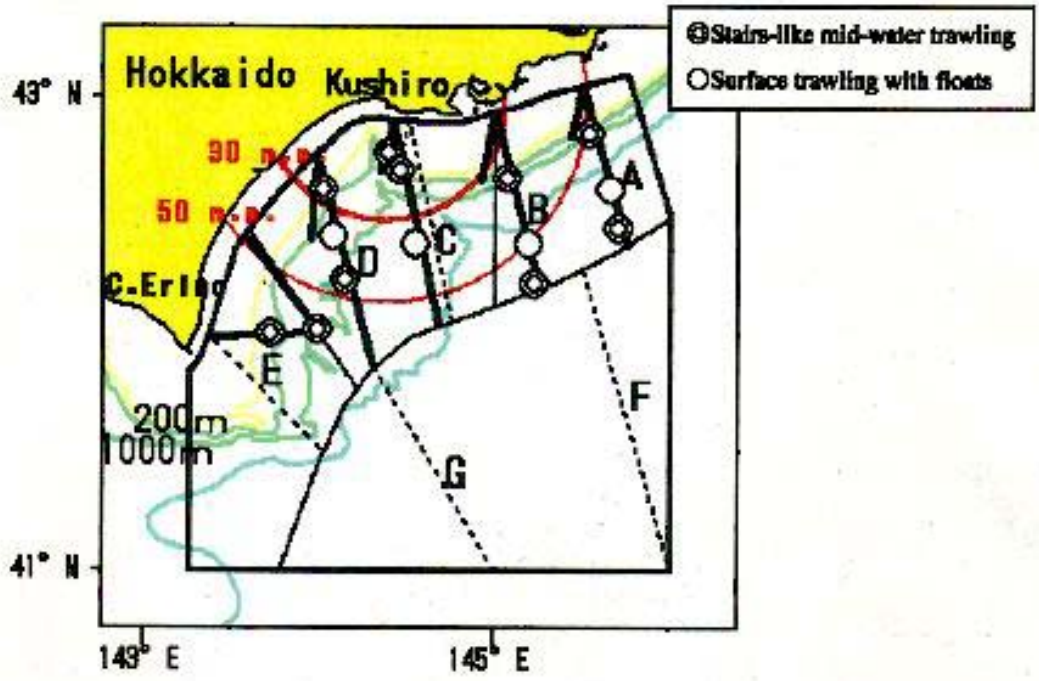

Fig. 2. Track lines and sampling positions of trawls in Sub-area 7
(Dotted and solid lines show planned and actual lines, respectively)

Appendix 2

Cruise report of the dedicated sighting survey in 2004 JARPNII coastal survey off Kushiro, northeast Japan.

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ABSTRACT

A cetacean sighting survey using the line transect method was conducted concurrently with the whale sampling and the whale prey surveys off the coast of Kushiro, Hokkaido, Japan in September 2004 as a part of coastal component of 2004 JARPN II full scale study. The primary objective of the sighting survey was abundance estimation of baleen whale in the survey area. The research vessel *Kyoshin-Maru No.2* was dedicated to the sighting survey. Total searching distances were 809.4 n.miles. A total of 53 individuals of 43 schools primary sightings were made. They included 18 common minke and 25 sperm whales.

INTRODUCITON

A cetacean sighting survey using the line transect method was conducted concurrently with the whale sampling and the whale prey surveys off the coast of Kushiro, Hokkaido, Japan in September 2004 as a part of coastal component of 2004 JARPN II full scale study (Government of Japan, 2004). The primary objective of this survey was to estimate baleen whale abundance in the coastal component survey area. Preliminary results of the cetacean sighting survey are presented in this paper.

MATERIALS AND METHODS

The cetacean sighting survey was conducted in small survey block "7N", which were set within Sub-area 7 as northern part from latitude 41-00N (Fig 1). Near shore area of the survey block where the water depth is less than 50m, was not surveyed because many fisheries gears were set in there. The survey block was further divided into the coastal and offshore area. The boundary between coastal and offshore area was set on the line parallel to the coastline and the distance between the boundary and coastline was 60 n.miles. The survey was conducted from 10 to 27 September 2004. Details of itinerary were shown in Table 1. *Kyoshin-maru No.2* (KS2, 372GT) engaged in the cetacean sighting survey. Sighting survey procedures were same as offshore component of 2004 JARPN II but the survey mode was only restricted to closing mode (ASP). Natural marking record experiment was attempted at grey, blue, humpback and right whales. Natural marking experiments

were attempted at the opportunistic basis. Visual observation of large baleen whale feeding behaviour was attempted. If the behaviour was observed, it was recorded on camera.

RESULTS AND DISCUSSION

Surveyed tracklines were shown on Fig 1. Sighting positions of Sperm and common minke whales (*Balaenoptera acutorotrata*) were shown on Fig 2. Total searching distances were 809.4 n.miles. A total of 53 individuals of 43 schools were sighted in primary sightings. They included 18 common minke and 25 sperm whales. Secondary sightings were not made. Details of sightings were listed on Table 2. Natural marking record and biopsy sampling experiment were not made. No large baleen whale feeding behavior was observed.

ACKNOWLEDGEMENT

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Table 1. Details of survey itinerary.

Date	Event
9/09	Depart from Kushiro Port, Hokkaido, Japan
9/10	Start sighting survey
9/27	End sighting survey
9/30	Arrive at Shiogama Port, Miyagi, Japan

Table 2. Summary of cetacean sightings.

	Primary		Secondary	
Species	Sch.	Ind.	Sch.	Ind.
Common minke whale	17	18	0	0
Sperm whale	20	25	0	0
Unidentified cetaceans	6	10	0	0
Total	43	53	0	0

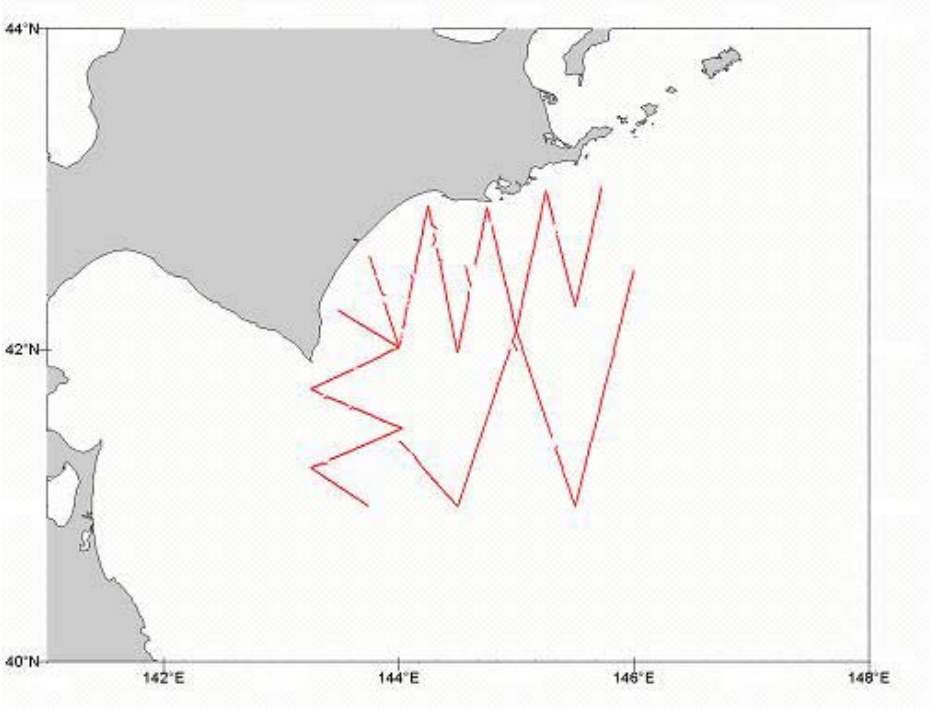

Fig 1. Searching effort by dedicated survey vessel "Kyoshin-Maru No.2", in the 2004 JARPN II coastal survey.

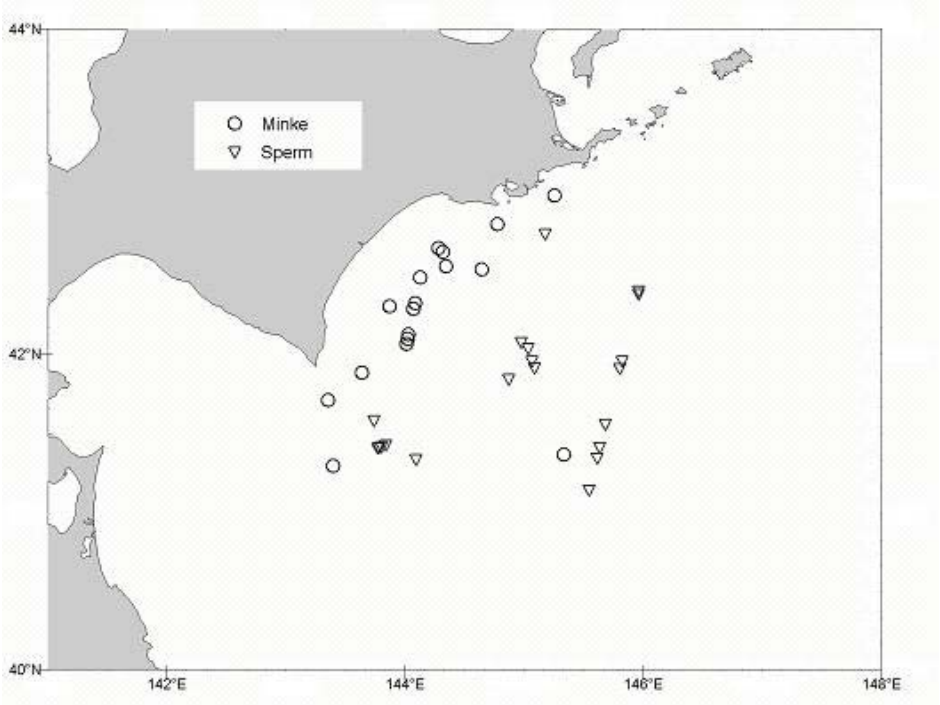

Fig 2. Sighting positions of Common Minke whales(○), and Sperm whales(△) by dedicated survey vessel "Kyoshin-Maru No.2" in the 2004 JARPN II coastal survey.

Appendix 3

Oceanographic conditions in the Kuroshio-Oyashio Inter-frontal zone in September 2004

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Introduction

The oceanographic condition at the Tohoku area east of Japan is the most complicated area in the world. There are both of subtropical water (the Kuroshio water) and subarctic water (the Oyashio water), and also, both water masses are mixed each other and form new water masses in the Kuroshio-Oyashio Inter-frontal Zone. Each water mass has its own ecosystem, like a Kuroshio ecosystem, an Oyashio ecosystem, warm-core ring ecosystem, etc. So, we must make clear the oceanographic condition around whale's prey to build up a marine ecosystem model in the Tohoku area.

In this paper, we analyzed the CTD data, which were observed by *R/V Shunyo Maru* cruise in a part of JARPN II (Japan's whale Research Program in the Western North Pacific) study to make clear the oceanic environment in the research area.

Data and Methods

Hydrographic observations with a conductivity-temperature-depth profiler (CTD; SBE 911plus) were carried out from 23rd to 29th September 2004 in the Kuroshio-Oyashio Inter-frontal Zone (Fig. 1).

The oceanographic conditions in September 2004 were analyzed by Tohoku National Fisheries Research Institute (TNFRI), which used quasi-real-time data from several cooperative organs and prefectures, those were Fisheries Research Agency, Meteorological Agency, Hydrographic Department and Fisheries Experiment Stations, etc. TNFRI published temperature maps and schematic hydrographic maps using World Wide Web (http://www.myg.affrc.go.jp/index-j.html). Oceanic fronts and water masses are usually detected by subsurface temperature map (sea Table 1), because they are obscure in sea surface temperature distributions from summer to fall seasons and the Oyashio water spreads into the subsurface layer.

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 Oyashio water in the lower part of Fig. 2) with warm surface water (left upper part of Fig. 2), warm high-salinity water (Kuroshio water

in the right upper part of Fig.2) and the mixed water of the Kuroshio water and Oyashio water. In this figure, the Oyashio water was the most dominant although the Kuroshio water was observed only one station.

Figure 3 shows the schematic hydrographic map in September 2004, presented by TNFRI. The northern limit of the warm water spread from the Kuroshio Extension moves northward from March to November. Its position in September 2004 was north of 42°N on 147°E line. This northward spreading is developed well caused by the Kuroshio warm-core ring that is detected around 41°30'N, 145°E. Tsugaru warm water spreaded eastward to around 143°E. The southern limit of the first Oyashio Intrusion was located 39°30'N on 143°30'E line, which were more southern position from monthly mean location in September (40°20'N). The southern limit of the second Oyashio Intrusion was around 39°50'N, 147°E which was a little southern position from a monthly mean position in September. Almost all stations were distributed in the Oyashio area.

Figure 4 shows the 100 m depth temperature map observed by *R/V Shunyo Maru*. The Oyashio water colder than 5°C at the depth of 100 m was spreading to the south-eastern part of the observation area. The warm water was observed at a few stations in the coastal area of Hokkaido. The cold water was observed at few stations between the Oyashio water and the warm water along the Hokkaido coast.

All of these figure show almost of all stations are distributed in and around the Oyashio 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℃ isotherm at 200m (Kawai, 1969)
Warm-core ring	Temperature front at 200m
Oyashio front	5 ℃ isotherm at 100m
Oyashio water	Area with T<5 ℃ at 100m
Cold water	Area with 5℃<T<10 ℃ at 100m
Warm water	Area with T>10 ℃ at 100m and T<14 ℃ at 200m
Tsugaru warm current	Temperature front at 100m near the Tsugaru Strait
Subarctic Boundary	Salinity front defined by 34.0psu
Subarctic Front	Temperature front defined by 4℃

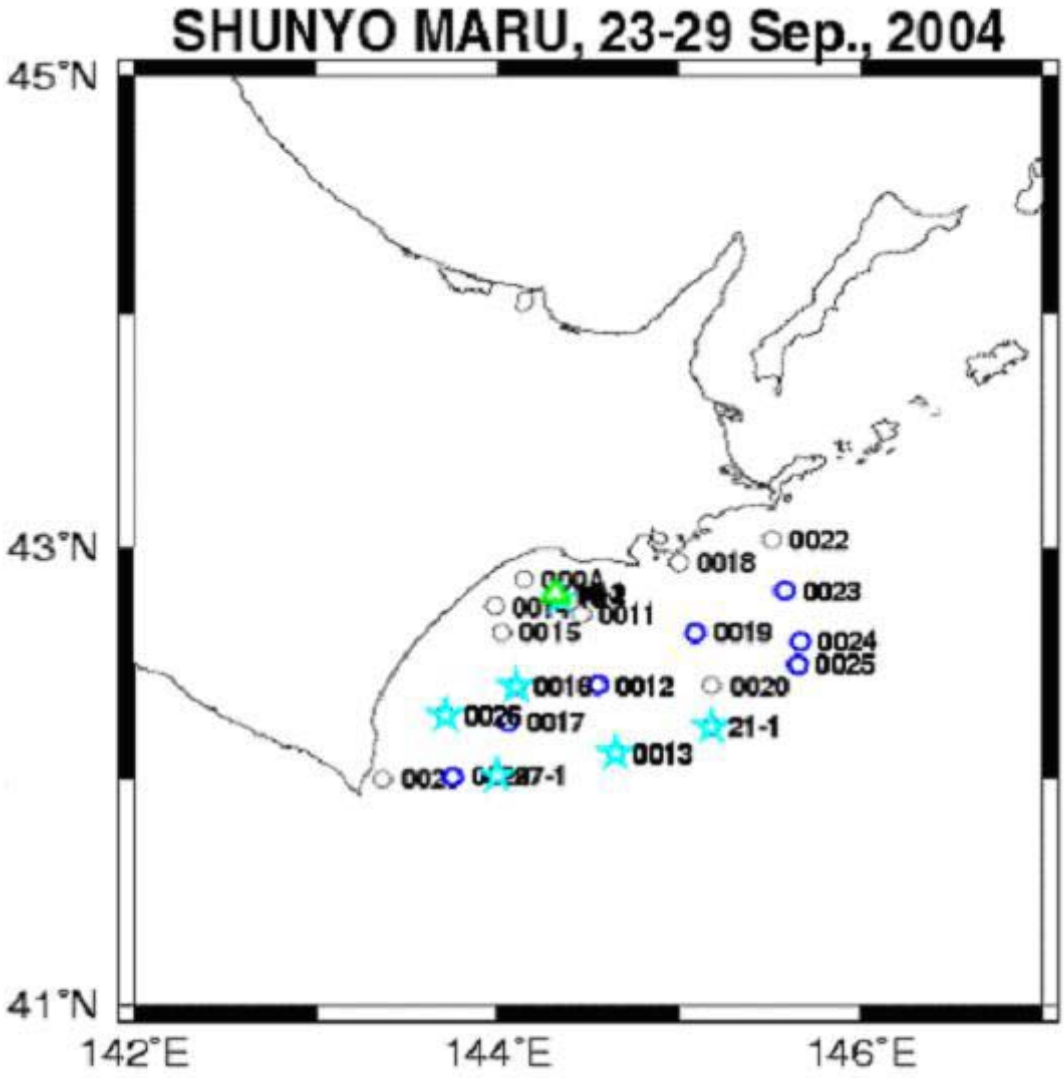

Fig. 1. Station map observed by *R/V Shunyo Maru* in 23 – 29 September 2004. Green triangles, light blue stars and blue circles denote CTD stations in the warm area (100 m temperature was over 10℃ and 200 m temperature was less than 14℃), the cold area (100 m temperature was over 5℃ and less than 10℃) and the Oyashio area (100 m temperature was less than 5℃), respectively.

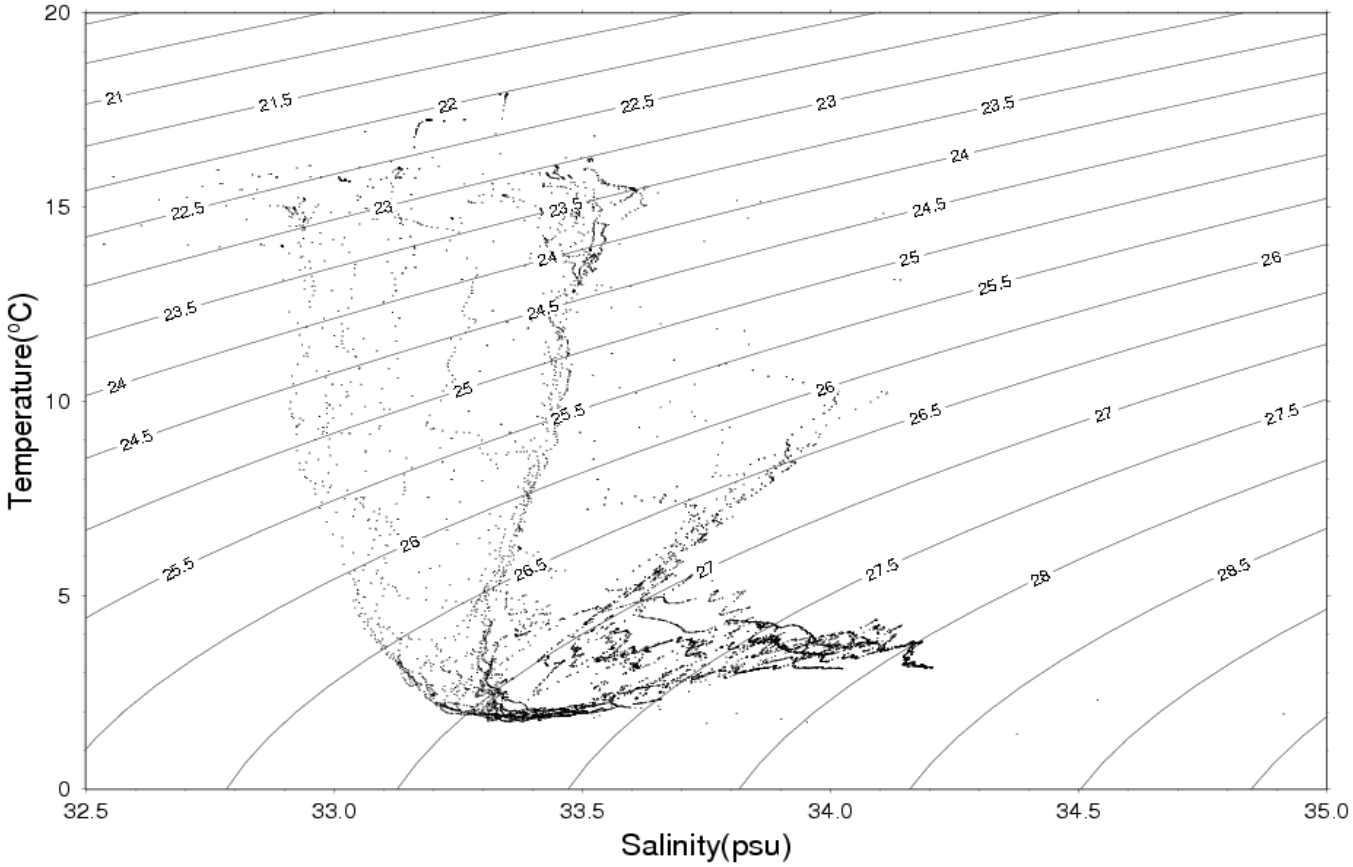

Fig. 2. Temperature-Salinity diagrams using CTD station data observe by *R/V Shunyo Maru* in 15 – 29 September 2004. Each thin line in this figure denotes a density line of sigma-t.

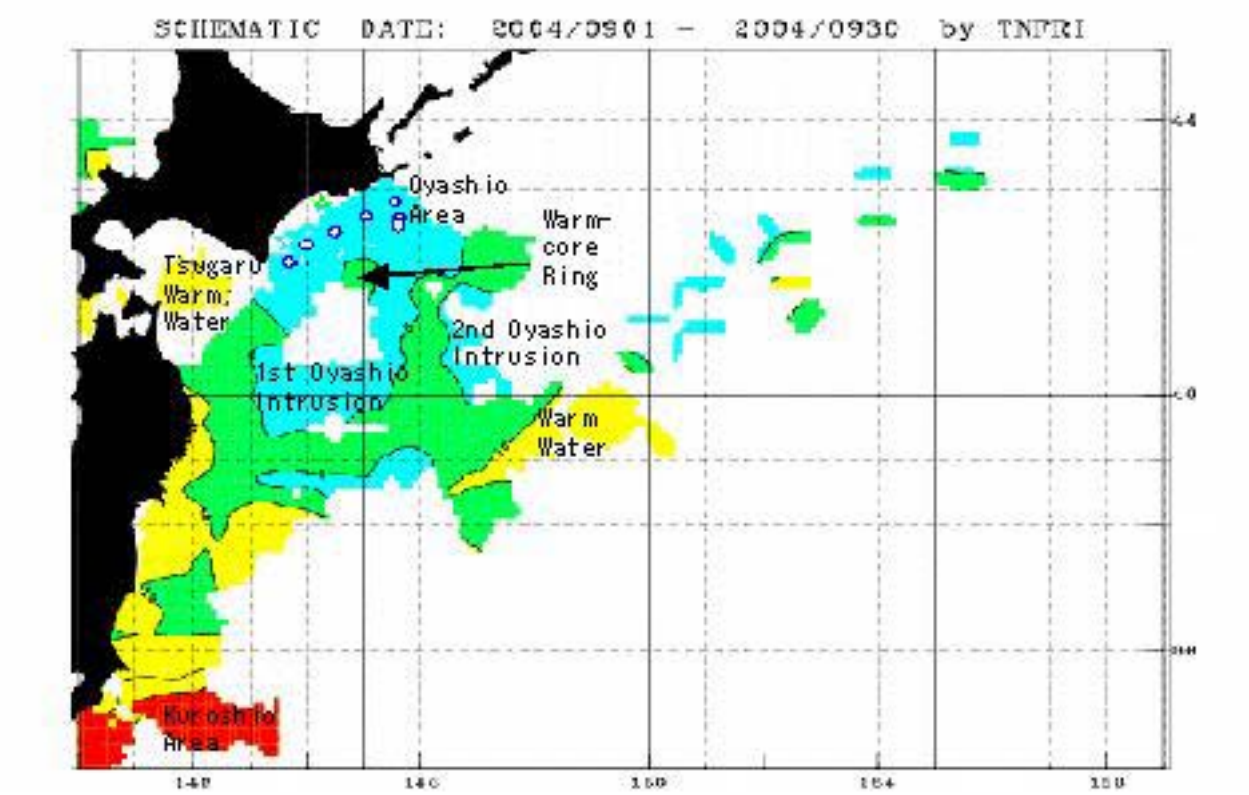

Fig. 3. Schematic hydrographic map in Tohoku area, northwestern Pacific, in September 2004 (presented by Tohoku National Research Institute) with station map observed by R/V Shunyo Maru. Blue, yellow and red area show distributions of the Oyashio, the warm water spread from the Kuroshio Extension and the Kuroshio Extension, respectively. Green triangle, light blue star and blue circle denote CTD stations observed from *Shunyo Maru* in the warm area, cold area and the Oyashio area, respectively.

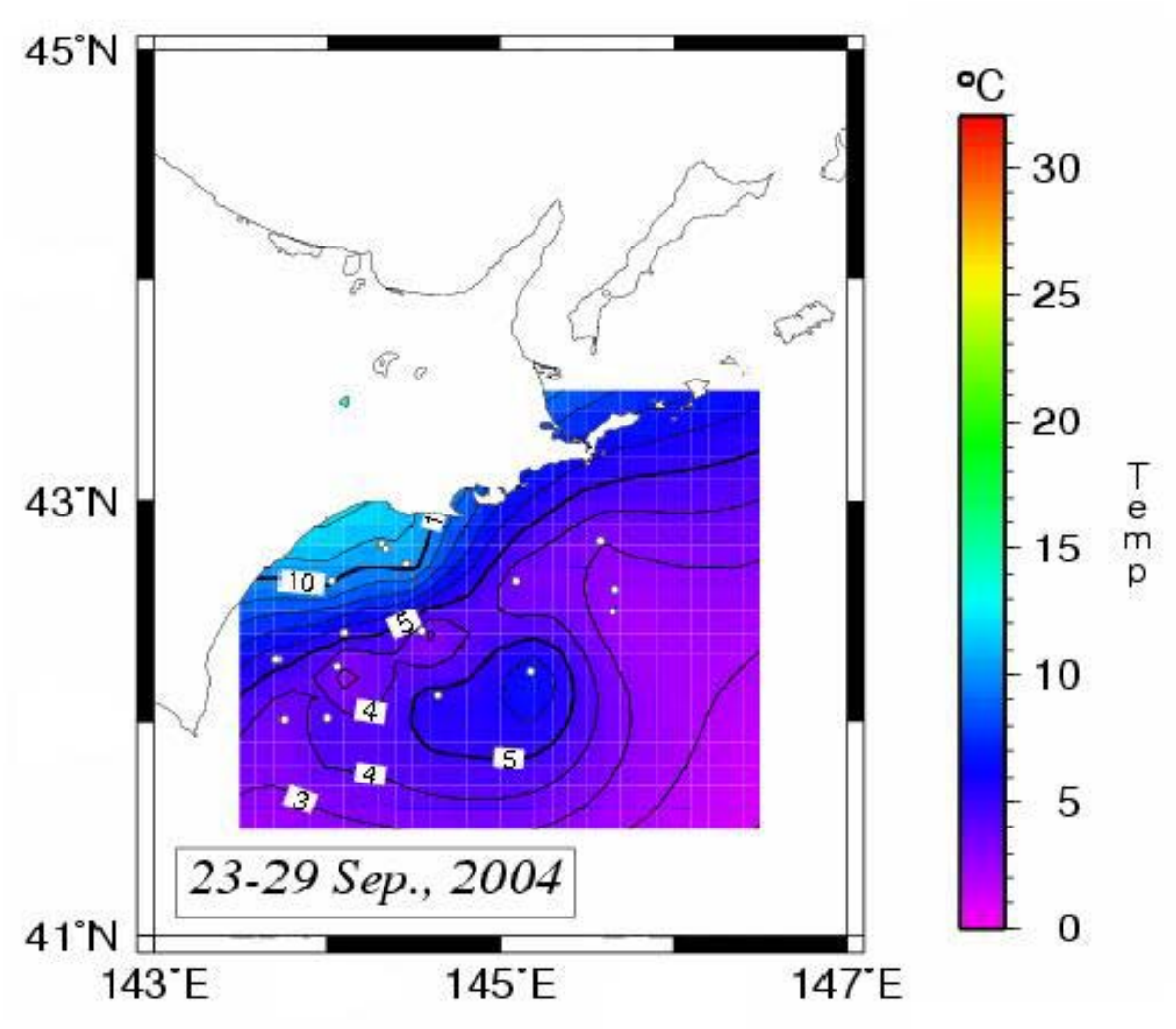

Fig.4. 100m temperature map observed by *R/V Shunyo Maru* in 23 – 29 September 2004.