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Cruise report of the Second phase of the Japanese Whale Research Program under Special Permit in the western North Pacific (JARPN II) in 2005 – Coastal component off Kushiro

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ABSTRACT

The third survey of revised JARPN II coastal component was conducted from 7 September to 12 October 2005, 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. 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 6,653.7 n. miles (602.3 hours) was searched for whale sampling, 144 schools/ 145 individuals of common minke whales were sighted and 60 whales were sampled. Average body length of sampled whales was 6.77m (SD=1.07, n=45) for males and 5.48m (SD=0.60, n=15) for females, respectively. Dominant prey species found in the forestomach contents were Japanese anchovy *Engraulis japonicus* (43.3%), Krill *Euphausia pacifica* (31.7%) and walleye pollock *Theragra chalcogramma* (18.3%). The concurrent prey survey revealed the distribution of those prey species in the research area, and the dedicated sighting survey sighted 20 schools/ 21 individuals of common minke whales with 827.1 n. miles searched. Sighting ratio and body length frequency of sampled whales were similar to those in 2004 survey but composition of prey species found in the forestomach was different and Krill was relatively dominant compared with the results of the last two years surveys. Those results suggested the existence of the large yearly change in the feeding habit and migration of common minke whales in the coastal waters off Kushiro and the variability in the effects of the whales for the local coastal fisheries and the inshore marine ecosystem.

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

INTRODUCTION

The full-scale surveys of the second phase 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 vessels 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 vessels (Government of Japan, 2002).

Based on the results of the two-year feasibility study conducted in 2002 and 2003 (Kishiro*, et al*., 2003, Yoshida, *et al*., 2004, Government of Japan, 2004a), the coastal survey component has been revised to be conducted twice a year, with 60 common minke whales being sampled in the spring and autumn seasons, respectively (Government of Japan, 2004b). Revised survey was started in 2004 autumn season. The second (but first one of revised plan) survey was carried out during 13 September to 31 October and took 59 common minke whales in the coastal waters off Kushiro, northeast Japan (Kishiro*, et al*., 2005). In 2005, at first, the survey was conducted in spring season form 11 April to 21 May in the coastal waters off Sanriku district, and took 60 common minke whales (Yoshida, *et al*., 2006). And then the present survey was conducted in autumn season off Kushiro as the third survey in the revised JARPN II coastal component. In this paper, we presented an outline of the survey of 2005 JARPN II coastal component conducted in the waters off Kushiro, northeast Japan, from 7 September to 12 October 2005.

The present 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).

Response to the discussion in the IWC/SC meeting

The revised JARPN II research plan was presented in the 56th IWC/SC annual meeting (Government of Japan, 2004b), and the result of the first revised survey off Kushiro in 2004 was submitted to the 57th IWC/SC annual meeting (Kishiro, *et al*., 2005). Although some discussions were made at those meetings, there remained divided views in the Committee members and no critical or agreed recommendation for the research plan was made (IWC, 2005; 2006). Thus, the 2005 surveys were conducted following the original plan and the almost same methodology in the 2004 revised surveys.

MATERIALS AND METHODS

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 large research vessel. The dedicated sighting survey using small-type whaling catcher boat which was tentatively introduced in 2004 was not carried out in the 2005 survey due to the logistic reasons as mentioned in Kishiro, *et al*., 2005.

Research area

The research area was same to the previous surveys (Kishiro, *et al*., 2003; 2005), 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

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 the whale sampling vessels. The sampling survey was conducted from 7 September to 12 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 *Kaiyo Maru* No.7 (KY7; 499.0GT) conducted the echo sounder-trawling survey in wider research area off east coast of Hokkaido, from 11 to 28 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 1 to 21 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.

Sampling survey by small-type whaling catcher boat

As same as the former surveys in 2002 and 2004 (Kishiro *et al*., 2003; 2005, 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 were engaged as the sampling vessels. To avoid the concentration of sampling location, two types of the sampling (searching) measure were planed as follows.

Type 1 sampling

Based on the information of the whale distribution obtained by the dedicated sighting survey and the past sampling surveys, the research head office arbitrarily determined the searching area and route (direction from the port) for each sampling vessel in every day. Weather conditions and information on fishing grounds of prey species were also considered.

Type 2 sampling

If the sampling positions tend to be concentrated in restricted area, the research area would be divided into four sectors as shown in Figure 2, and the searching area of sampling vessels would be evenly allocated to those sectors. Although we planed this type of surveys, the type 2 sampling was not conducted, since all of the research area could be covered by the type 1 sampling surveys.

In each vessel, a researcher was on board and recorded the cruise tracks, searching time on effort, sea weather conditions and sighting data. Sighting data would be collected for all baleen whales, sperm whales, Baird's beaked whales, killer whales and short-finned pilot whales. The vessel principally continued to cruise and search along the predetermined direction until arrived at 30 n. miles from the port, and then freely cruised in the waters within the 30 n. miles (maximum 50 n. miles) radius from the port. Searching was carried out during the day and the vessels returned to the port every night. Sighting was conducted from the top barrel and upper bridge by all the crews and researcher with vessel speed at about 11 knots. 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 an 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 3, with the number of data and samples obtained. These items were related to studies on feeding ecology, stock structure, life historical biology and pollutions. In addition, staff of the Obihiro University of Agriculture and Veterinary Medicine collected samples of sperms (from 10 males) and oocytes (4 females) for in vitro fertilization study, which had been conducted under the cooperative study with the ICR.

RESULTS

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.3. The searching areas covered widely coastal waters within 30 nautical miles form the Kushiro port. Searching distance and time are shown in Table 1. 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 6,653.7 n. miles and 602.3 hours, respectively.

Fig.4 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 144 schools/ 145 individuals of common minke whales were sighted, consisting of 135 schools/ 136 individuals of primary sightings and 9 schools/ 9 individuals of secondary sightings (Table 1). These figures probably include some duplicated sightings because sampling vessels searched almost same areas in every day. In addition, fin whale (1 school/ 1 individual) and some small cetaceans were sighted during the survey (Table 1).

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 2. Both SPUE and DI decreased from the middle of September to late of September, but increased in the early of October. During the total research periods, 0.22 schools was primary sighted per one hour searched, and 2.03 schools was primary sighted per 100 n. miles searched. These figures are nearly the half of that recorded in 2002 survey (Kishiro, *et al*., 2003), but almost same as that recorded in the last year 2004 survey (Kishiro, *et al*., 2005).

Sampling of common minke whales

A total of 60 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.4 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 (KY7) 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 and walleye pollack were found in the research area but Pacific saury was relatively scarce as compared with the 2004 survey. The large-scale dedicated sighting survey using sighting vessel (KS2) were conducted in the same research areas of the prey species survey, and sighted 20 schools/21 individuals of common minke whales with 827.1 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 60 sampled whales were consisted of 45 males and 15 females (sex ratio of males was 0.75). Average body length of the whales was 6.77m (max=8.29, min=4.12, SD=1.07) for males and 5.48m (max=6.45, min=4.66, SD=0.60) for females, respectively (Table 4). Average body weight was 3.78 tons (max=6.26, min=0.66, SD=1.51) for males and 1.95 tons (max=3.16, min=0.98, SD=0.66) for females, respectively (Table 5). In both males and females, the average body length and weight were the lowest in the middle of September. Composition of sex and sexual maturity of common minke whales is listed in Table 6. In males, 30 of 45 individuals were sexually mature (66.7%), and this figure was almost same as the 2004 survey (66.0%, n=47). On the other hand, all females sampled were immature (n=15), and sexually mature females was not observed. Among them, one immature male (body length=5.11m, body weight=1.50t, mean testis weight=76.5g) was thought to be sexually undeveloped, because the penis could not be observed and shape of the testicles were also unique (long and narrow). Further examinations such as the detailed histological or sex chromosome analyses will be conducted for this individual in future.

Pray species of common minke whale found in the stomach contents

We could examine 60 stomach contents of common minke whales. Following the same methods conducted in the JARPN II feasibility surveys (Fujise, *et al*., 2002) and the former coastal component surveys (Kishiro, *et al*., 2005) 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* (43.3%, 26 out of 60 whales), Krill *Euphausia pacifica* (31.7%, 19 whales) and Walleye pollock *Theragra chalcogramma* (18.3%, 11 whales). Only one whale mainly fed on Pacific saury *Cololabis saira* (1.7 %) and two whales fed on Japanese common squid *Todarodes pacificus* (3.3%). The range of forestomach contents weights was form 0.14Kg to 131.6Kg, and the maximum of % body weight was 3.1 %. This whale fed on small-sized Walleye pollock.

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 118 tons.

Fishing grounds of coastal fisheries during the 2005 survey period

Fig.5 shows the distribution of fishing grounds of the local coastal fisheries for Pacific saury (dip net fisheries), Japanese anchovy (purse seine fisheries) and Japanese common squid (jigging fisheries)

around the coastal waters off Kushiro during the 2005 survey period (Japan Fisheries Information Service Center, 2005). In early to middle of September, the fishing ground of Pacific saury was scarce and distributed in out side of the research area (farther than 30 n. miles from the Kushiro port), and some squid jigging fisheries were operated in the near shore areas. In late of September to early of October, the fishing ground of Pacific saury was expanded and somewhat concentrated in the research area off Kushiro. The fishing ground of Japanese anchovy was distributed along the coastal waters off Sanriku district (out side of the research area) during the whole survey period.

DISCUSSION

The present survey was the third survey of the revised JARPN II coastal component to take 60 common minke whales off Japan and of which conducted in the autumn season off Kushiro, east coast of Hokkaido. There was no practical problem in conducting the surveys as same as the former surveys. Although bad weather conditions such as a typhoon, the low atmospheric pressures and the fog partly prevented our research activities as same as the 2004 surveys, we could obtain the planed sample size of 60 common minke whales during the survey period of 36 days from 7 September to 12 October.

Composition of common minke whales sampled was similar to those in the 2004 survey off Kushiro, i.e. sex ratio of males in the samples was higher and body length frequency of the whales inclined toward large-sized mature males as compared with the results of the 2002 feasibility study off Kushiro (Fig. 6), and furthermore, mature female was not observed in the present survey. Sighting ratio (SPUE and DI) of common minke whales by the sampling vessels was also same as that of the 2004 survey (nearly the half of that in the 2002 survey) and the distribution of the whales in the survey area was relatively dispersed with no concentrated area (Table 2 and Fig.4). These results suggested that the timing of the migration of common minke whales into research area was similar to those in 2004, and the migration of main groups including mature females was also scarce at the time in 2005 survey period, as supposed in 2004 (Kishiro, *et al*. 2005).

However, composition of prey species found in the stomach contents in the present survey was apparently different and Krill was relatively dominant compared with the results of last two years surveys (Fig.7). The amount of Pacific saury (which was one of the major prey species in 2004) was especially small and only one whale mainly fed on this species. These differences are thought to be related to the yearly variation in the oceanographic condition and prey species distribution. The results of the prey species survey (Appendix 1) and the oceanographic observations (Appendix 3) suggested that the northward extrusion of warm water mass occurred in the 2005 autumn season off Kushiro possibly prevented migration of Pacific saury from the offshore waters to the coastal research area during the survey period. Furthermore, the prey species survey revealed that the abundance of Japanese anchovy in the research area was also lower in 2005 compared with the

previous surveys. The distribution of fishing grounds for those species also supported above results (Fig.5). It is supposed that those circumstances might be not favorable for lactating or pregnant female common minke whales to visit there, since they are thought to be needed more energy cost than males or immature individuals. Under these situations, they might be migrated to more suitable waters such as the abundant grounds of Pacific saury in offshore areas. On the other hand, some males and immature individuals is thought to be migrated to the coastal waters off Kushiro even when the abundance of the prey is low, and take the other available prey species such as Krill and Walleye pollock.

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 as mentioned above, 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. Results of the survey also suggested the variability in the possible effects of the whales for the local coastal fisheries. In conclusion, the 2005 survey off Kushiro was conducted successfully and we could obtain the valuable information for the future ecosystem modeling and multi-species managements.

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Table 1. Searching days, hours, distances, number of sightings and catch of common minke whales made by the sampling survey off Kushiro in 2005.

Period	Days	Hours	Distances (n.miles)	Species[*3]	No. of sightings						No. of Catch	DI[*1]	SPUE[*2]
					Primary		Secondary		Total				
					Sch.	Ind.	Sch.	Ind.	Sch.	Ind.			
7 Sept. - 15 Sept.	7	129.9	1,405.8	Common minke whale	28	28	1	1	29	29	13	1.99	0.22
				Like minke whale	3	3	-	-	3	3			
				Unidentified cetaceans	5	5	-	-	5	5			
16 Sept. - 30 Sept.	12	311.6	3,435.6	Common minke whale	64	64	4	4	68	68	22	1.86	0.21
				Like minke whale	10	10	-	-	10	10			
				fin whale	1	1	-	-	1	1			
				Unidentified cetaceans	8	8	-	-	8	8			
1 Oct. - 12 Oct.	10	160.7	1,812.3	Common minke whale	43	44	4	4	47	48	25	2.37	0.27
				Like minke whale	4	4	-	-	4	4			
				Unidentified cetaceans	5	5	-	-	5	5			
Total	29	602.3	6,653.7	Common minke whale	135	136	9	9	144	145	60	2.03	0.22
				Like minke whale	17	17	-	-	17	17			
				fin whale	1	1	-	-	1	1			
				Unidentified cetaceans	18	18	-	-	18	18			

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

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

*3: Sightings of small cetaceans are not listed following the governmental policy of Japan.

Table 2. Seasonal change in density index of common minke whales obtained by the whale sampling surveys in the coastal waters off Kushiro in 2002, 2004 and 2005.

	2005		2004		2002	
Period	DI[*1]	SPUE[*2]	DI	SPUE	DI	SPUE
5 Sept. - 9 Sept.	3.06	0.34	-	-	-	-
10 Sept. - 14 Sept.	1.69	0.18	3.31	0.34	5.19	0.57
15 Sept. - 19 Sept.	2.50	0.27	4.09	0.45	6.87	0.65
20 Sept. - 24 Sept.	2.75	0.31	3.38	0.37	4.04	0.41
25 Sept. - 29 Sept.	0.76	0.08	2.07	0.22	2.74	0.30
30 Sept. - 4 Oct.	0.30	0.03	0.00	0.00	2.67	0.26
5 Oct. - 9 Oct.	1.99	0.22	2.10	0.24	2.94	0.33
10 Oct. - 14 Oct.	4.24	0.49	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	2.03	0.22	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 3. Summary of biological data and samples collected during the 2005 coastal survey off Kushiro, in the JARPN II.

	Number of whales		
Samples and data	Male	Female	Total
Body length and sex	45	15	60
External body proportion	45	15	60
Photographic record and external character	45	15	60
Diatom film record and sampling	45	15	60
Body scar record	45	15	60
Measurements of blubber thickness (eleven points)	42	15	57
Detailed measurements of blubber thickness (fourteen points)	3	-	3
Body weight	45	15	60
Body weight by parts	3	-	3
Skin tissues for DNA study	45	15	60
Muscle, liver and heart tissues for isozyme analysis	45	15	60
Muscle, liver, kidney and blubber tissues for chemical analysis	45	15	60
Mammary grand; lactation status, measurement and histological sample	-	15	15
Uterine horn; measurement and endometrium sample	-	15	15
Collection of ovary	-	15	15
Testis and epididymis; weight and histological sample	45	-	45
Stomach content, conventional record	45	15	60
Volume and weight of stomach content in each compartment	45	15	60
Stomach contents for feeding study	45	15	60
Record of external parasites	45	15	60
Earplug for age determination	45	15	60
Tympanic bulla for age determination	45	15	60
Largest baleen plate for morphologic study and age determination	45	15	60
Baleen plate measurements (length and breadth)	45	15	60
Photographic record of baleen plate series	45	15	60
Length of each baleen plate series	45	15	60
Vertebral epiphyses sample	45	15	60
Number of vertebrae	45	15	60
Number of ribs	45	15	60
Brain weight	3	-	3
Skull measurement (length and breadth)	45	15	60
Collection of whole skeleton	1	-	1

Table 4. Body length (m) of common minke whales sampled by the 2005 coastal survey off Kushiro, in the JARPN II.

	Male					Female				
Period	Mean	S.D.	Min.	Max.	n	Mean	S.D.	Min.	Max.	n
7 Sept.- 15 Sept.	7.02	1.03	4.48	8.29	11	5.60	0.58	5.19	6.01	2
16 Sept. - 30 Sept.	6.58	1.19	4.61	7.76	14	5.28	0.60	4.66	6.04	8
1 Oct. -12 Oct.	6.76	1.00	4.12	7.57	20	5.76	0.61	5.09	6.45	5
Total	6.77	1.07	4.12	8.29	45	5.48	0.60	4.66	6.45	15

Table 5. Body weight (t) of common minke whales sampled by the 2005 coastal survey off Kushiro, in the JARPN II.

	Male					Female				
Period	Mean	S.D.	Min.	Max.	n	Mean	S.D.	Min.	Max.	n
7 Sept.- 15 Sept.	4.15	1.48	1.04	6.26	11	1.91	0.66	1.44	2.38	2
16 Sept. - 30 Sept.	3.53	1.74	0.98	5.72	14	1.76	0.66	0.98	2.54	8
1 Oct. -12 Oct.	3.75	1.34	0.66	5.36	20	2.26	0.68	1.42	3.16	5
Total	3.78	1.51	0.66	6.26	45	1.95	0.66	0.98	3.16	15

Table 6. Composition of sex and sexual maturity of common minke whales sampled by the 2005 coastal survey off Kushiro, in the JARPN II.

	Male				Female						
Period	Imm.	Mat.	Total	Marutity (%)	Imm.	Rest.	Preg.	Total	Pregnancy (%)*1	Maturity (%)	Sex ratio (%males)
7 Sept.-15 Sept.	3	8	11	72.7	2	0	0	2	-	0.0	84.6
16 Sept.- 30 Sept.	6	8	14	57.1	8	0	0	8	-	0.0	63.6
1 Oct.- 12 Oct.	6	14	20	70.0	5	0	0	5	-	0.0	80.0
Total	15	30	45	66.7	15	0	0	15	-	0.0	75.0

*1: Apparent pregnancy rate

Table 7. Number of common minke whales by major prey species found in their forestomach contents sampled by the 2005 coastal survey off Kushiro, in the JARPN II.

	No. of whales (%)						
Period	Japanese anchovy	Pacific saury	Walleye pollock	Krill	Common Squid	Empty	Total
7 Sept.-15 Sept.	2 (15.4)	- (0.0)	2 (15.4)	7 (53.8)	2 (15.4)	- (0.0)	13
16 Sept.- 30 Sept.	7 (31.8)	- (0.0)	5 (22.7)	9 (40.9)	- (0.0)	1 (4.5)	22
1 Oct.- 12 Oct.	17 (68.0)	1 (4.0)	4 (16.0)	3 (12.0)	- (0.0)	- (0.0)	25
Total	26 (43.3)	1 (1.7)	11 (18.3)	19 (31.7)	2 (3.3)	1 (1.7)	60

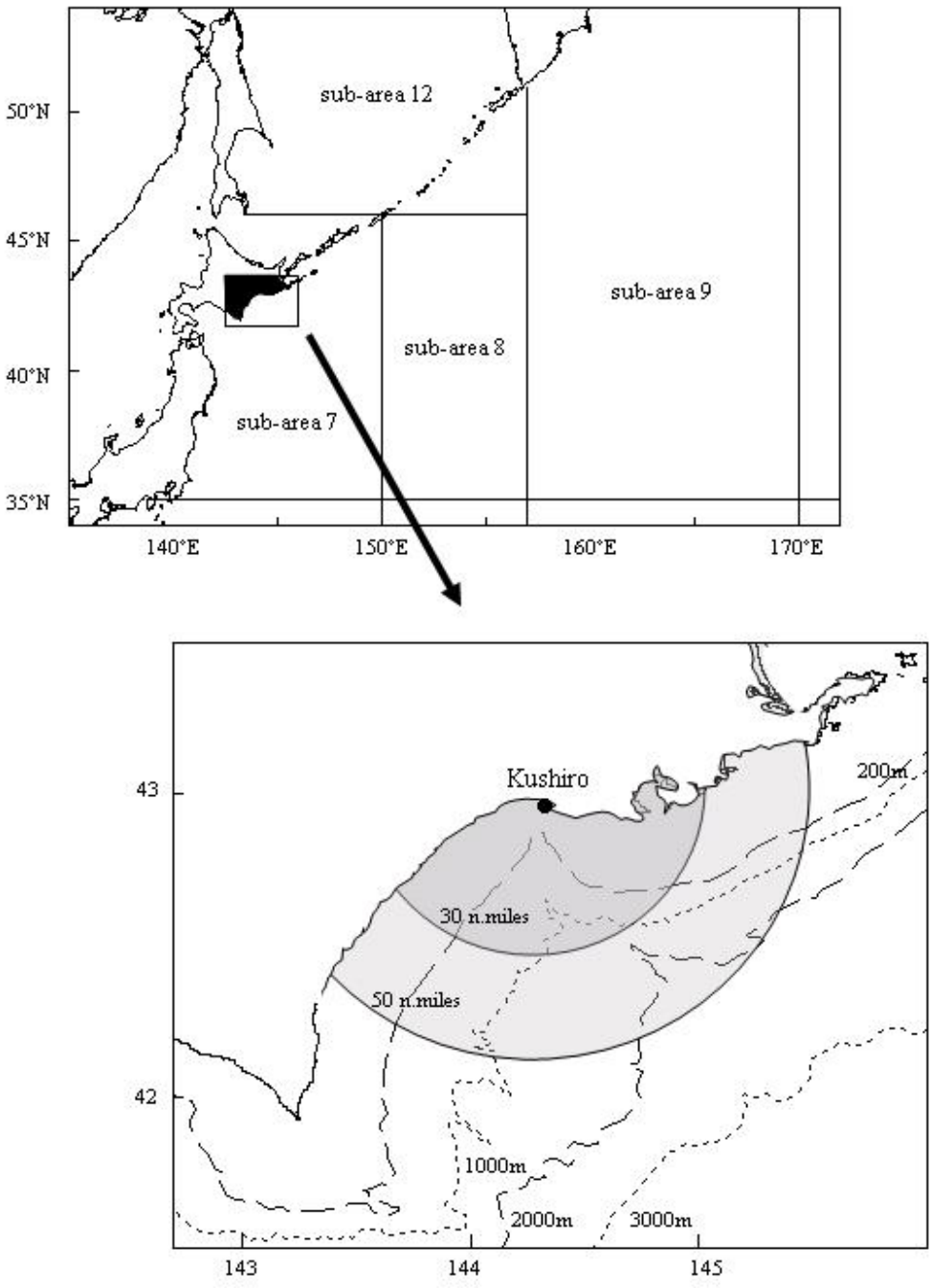

Fig. 1. The IWC sub-areas for western North Pacific minke whales (upper) and research area of the 2005 coastal survey off Kushiro, in the JARPN II (lower).

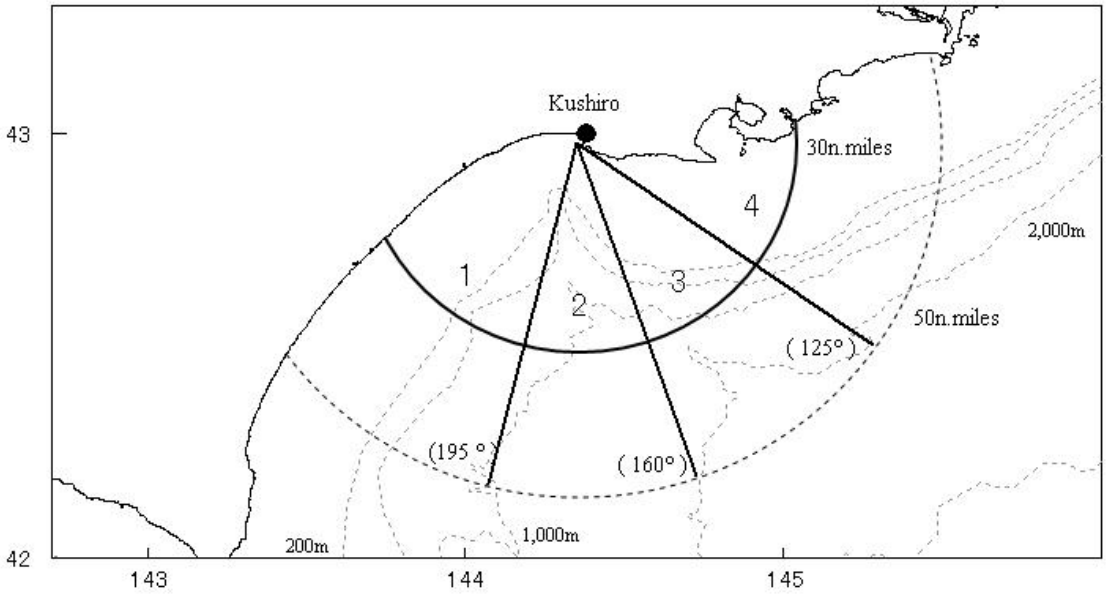

Fig.2 Allocation of the sectors for whale sampling in the 2005 coastal survey off Kushiro, in the JARPN II.

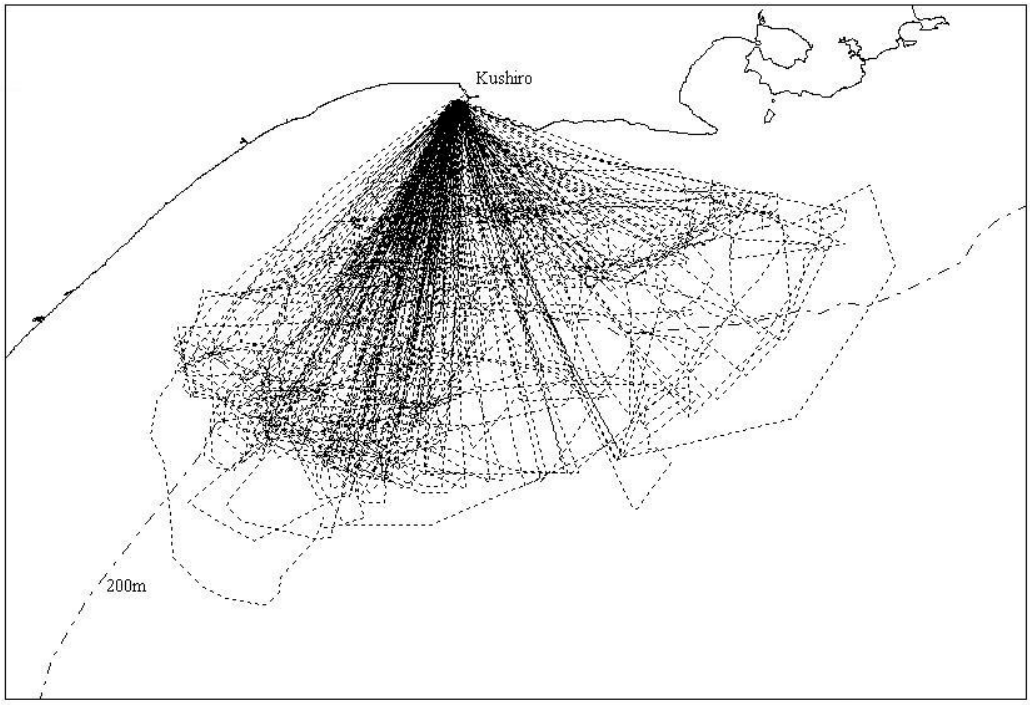

Fig.3 Cruise tracks of the whale sampling survey in the 2005 coastal survey off Kushiro.

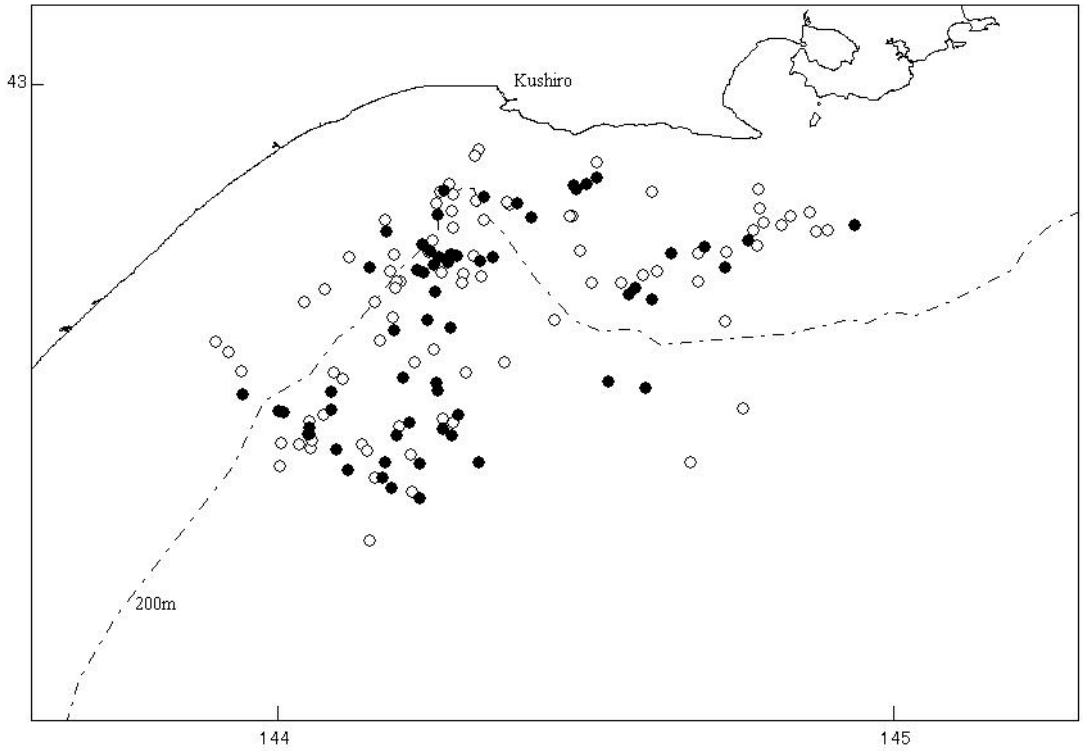

Fig.4 Sighting positions of common minke whales made by the whale sampling survey in the 2005 coastal survey off Kushiro. Closed circle indicates sighting position of sampled whale.

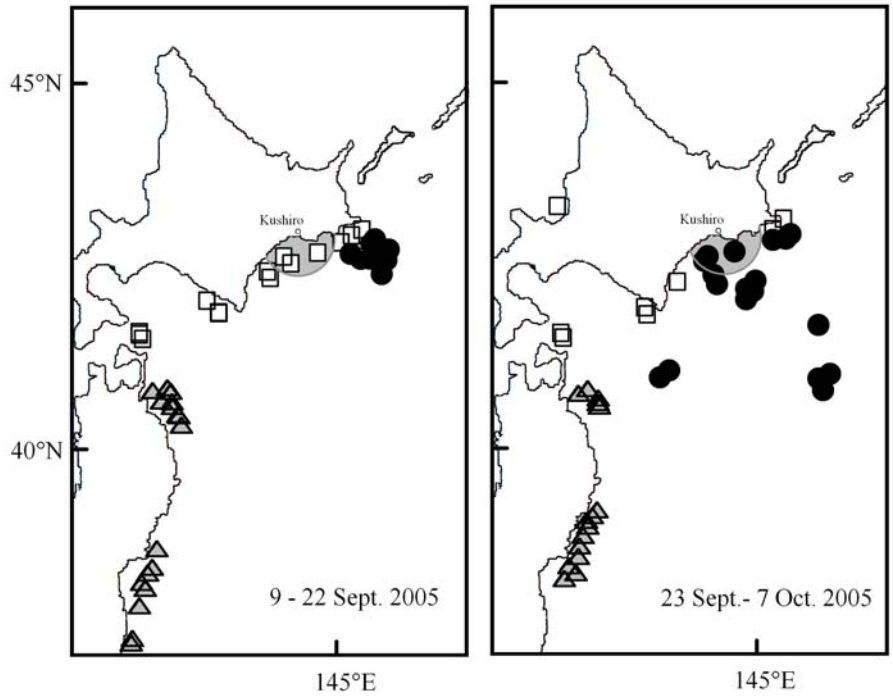

Fig. 5 Fishing grounds of the coastal fisheries for prey species in 2005 autumn season. Closed circle: Pacific saury; Open square: common squid; Gray triangle: Japanese anchovy; shaded area: research area for the whale sampling

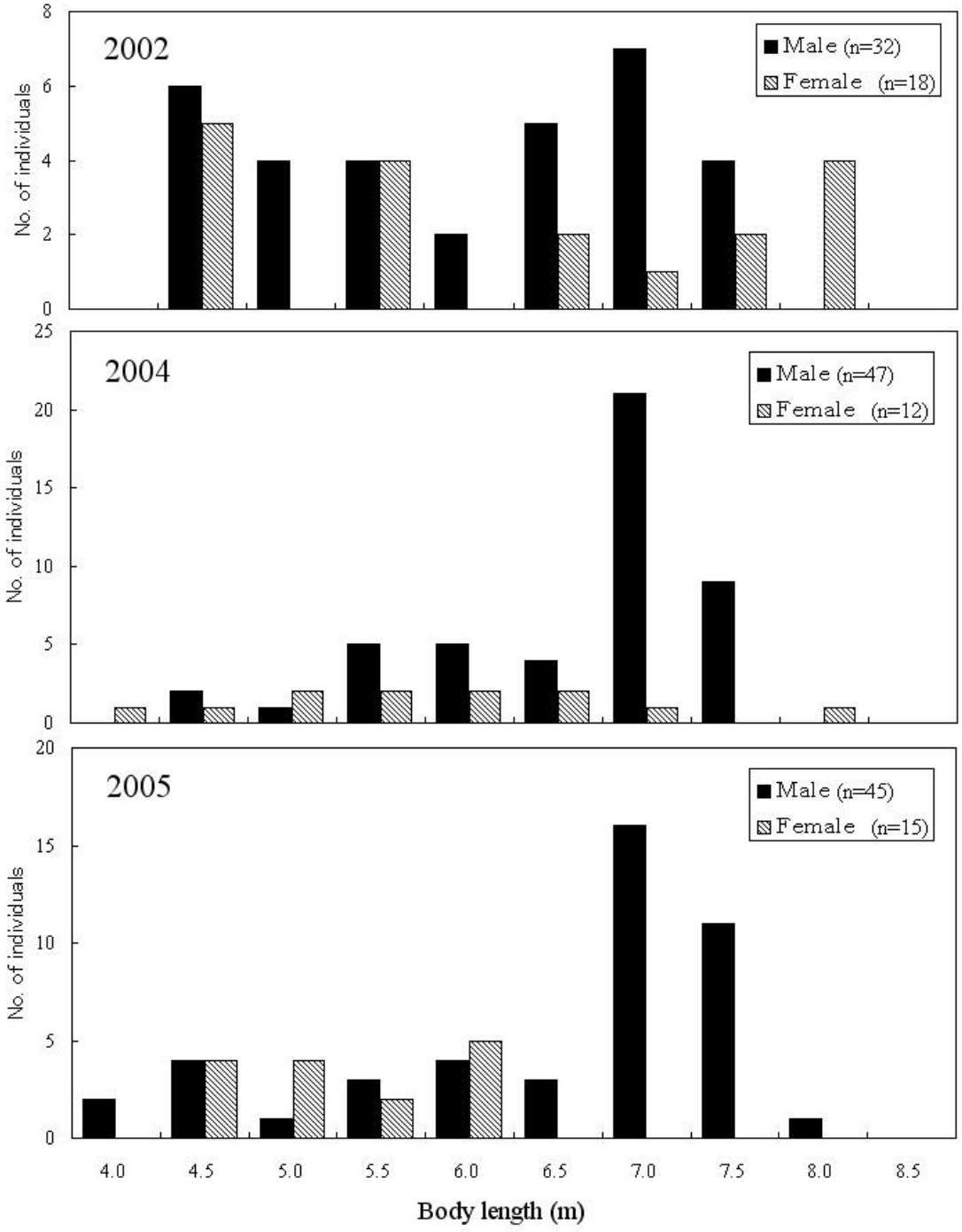

Fig.6 Body length frequency of common minke whales sampled by the 2002, 2004 and 2005 coastal survey off Kushiro.

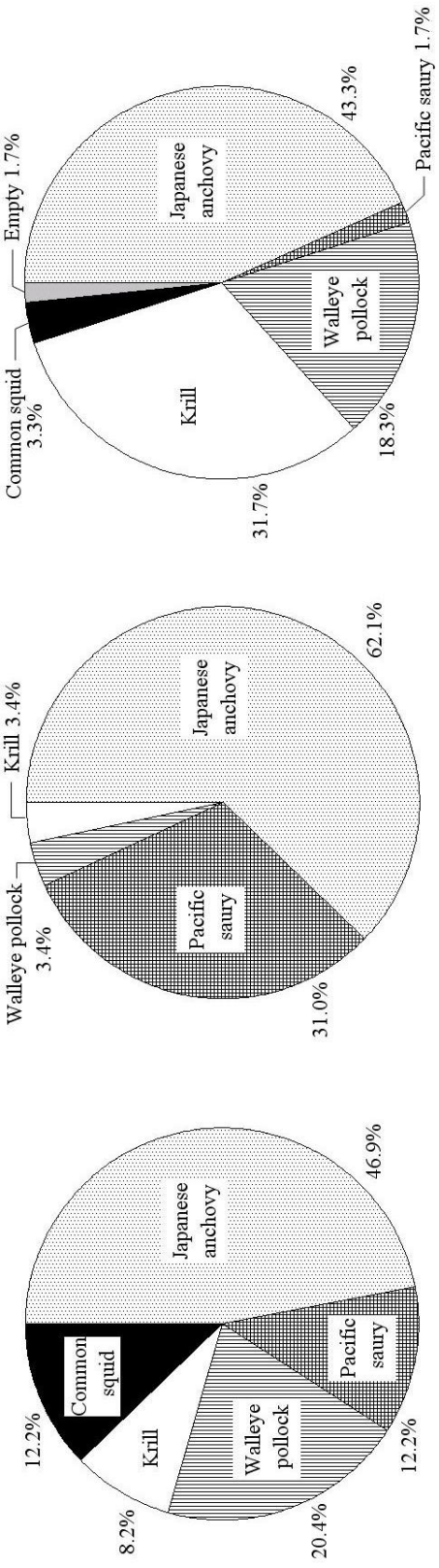

Fig. 7 Composition of common minke whales with major prey species found in the forestomach contents in the 2002, 2004 and 2005 coastal survey off Kushiro.

Appendix 1

2005 coastal prey species survey of JARPN II off Kushiro

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ABSTRACT

A prey species survey was conducted in cooperation with the sampling survey by small-type whaling catcher boats for minke whales off Kushiro, eastern Hokkaido, in September 2005 as a part of JARPN II study. The objective of the prey species survey was to examine prey environment and prey preference of minke whale off Kushiro during autumn. The distribution and abundance of the prey species were investigated with the quantitative echosounder (ER60) and midwater trawling at predetermined stations on a trawler-type research vessel, Kaiyo maru No. 7. Acoustic data were acquired by steaming at about 10 knots during the daytime along the track lines with operating frequency at 38 and 120 kHz. Species and size compositions of acoustical backscatterings were identified by targeting midwater trawl and IKMT. The abundance of Japanese anchovy seems to be lower than previous surveys in 2002 and 2004. The catches of Pacific saury were limited due to the delay of the migration to eastern Hokkaido. Adult walleye pollock and common squid were caught near Kushiro Canyon. Krill swarms were not found on the continental shelf. The results of the survey generally coincided with the information from the fisheries. In summary, the prey environment surrounding minke whale was not good in autumn 2005 off Kushiro and the environment seems to change year by year.

INTRODUCTION

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 is put on feeding ecology and ecosystem studies, involving studies of prey consumption by cetaceans, prey preferences (selection) of cetaceans and ecosystem modelling. As it is difficult to cover the coastal area, especially in spring and autumn, by the Nisshin Maru, the full-scale JARPN II has a new coastal component, that is, the sampling survey for minke whale by small-type whaling catcher boats. In September 2005, the cooperative whale/prey surveys were conducted in the coastal region off Kushiro, eastern Hokkaido, as in 2002

and 2004. This document presents the preliminary results of the prey species survey. While a dedicated sighting vessel, Kyoshin Maru No. 2, also conducted cooperative acoustic survey and oceanographic observations with CTD, the results are not included in the document.

MATERIALS AND METHOD

The prey species survey covered wider area off the eastern Hokkaido, east of Cape Erimo (143º15'E), west of 146º00'E and north of 41ºN to elucidate the distribution and abundance of main prey species while the sampling survey of minke whale was conducted in the coastal waters within the 30 nautical miles (max 50 nautical miles) from Kushiro (Fig. 1). As many gears were set near the shore, the waters shallower than 50m were excluded in principle. The survey area was divided into two parts; coastal and offshore parts. The coastal part was further divided into east, central and west parts. Zigzag track lines were set to cover each part. The waypoints of planned track lines are shown in Table 1.

The prey species survey was conducted from September 11 to 28 2005. The distribution and abundance of the prey species were investigated with the quantitative echosounder (ER60), midwater trawl and Isaacs-kidd Midwater Trawl (IKMT) on board a stern trawler-type research vessel, Kaiyo maru No. 7 (499.0 GT) steaming at about 10 knots along the track lines. The survey was conducted during the daytime from an hour after sunrise to an hour before sunset (generally from 6:00 to 17:00 in local time). Acoustic data were acquired with Echoview Ver.3 (Sonar Data Co., Ltd.). Calibrations were carried out off Shiranuka near Kushiro (September 11 and 24 2005) using the copper sphere technique. The mid-water trawl net used had a mouth opening of about 30x30m and a 17.5mm liner cod end. The sampling depth and the height of the mouth of the net were monitored with Scanmer and recorded with the small-type depth recorders (SBT). Towing speed of the trawl net was 3-5 knots. In this study, all samples were collected during daylight period.

Two types of mid-water trawlings were made. Targeting trawlings were to identify the species and size compositions of biological backscatterings detected by the echosounder. Another type of trawlings was made at predetermined stations to estimate the distribution and abundance of cephalopods and neustonic organisms that are difficult to detect with the echosounder. At predetermined stations the midwater trawl net was towed in a stairs-like fashion at three depth layers (0-30m, 30-60m and 60-90m) shallower than 100 m (0-30m, 60-90m, and 120-150m in the case of 150m). Towing duration was 30 minutes in total, 10 minutes for each layer. 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. Some frozen samples were taken for further analysis in the laboratory.

Also, IKMT was used for the biological backscatterings expected as micronekton and/or

zooplankton such as krills on the echosounder. Samples were preserved in 10 % formalin for species identification at the laboratory. Oceanographic observation with CTD was made down to 500 m or near the bottom at each sampling station just before or after the sampling operation and at stations for CTD.

RESULTS AND DISCUSSION

Predetermined/targeting trawlings, IKMT and CTD observations were made 5 times, 27 times, 3 times and 54 times during the survey, respectively (Fig. 2). The trawling operations and the catches by species are shown in Table 2. The oceanographic conditions are described in Appendix 3 in the report. While the acoustic data are being analyzing now, the preliminary results on distribution, abundance and size composition of main prey species of minke whale are as follows.

While Japanese anchovy was found in the surface layer from the continental shelf to the open sea, the abundance seems to be lower than previous surveys in 2002 and 2004 (Kawahara et al., 2003; 2005). It is known that the recruitment of 2004 year class of Japanese anchovy failed. Two modes at 10cm and 13cm in body length were observed in the size composition. Large catches of Pacific saury were made at a few stations on the edge of the continental shelf in the east part of the survey area and the catches consisted of large-sized fish above 30cm in knob length. The fishing grounds of Pacific saury were formed off southern Kuril Islands during the survey period. The landings also consisted of large-sized fish. The southern migration of Pacific saury to the eastern Hokkaido was delayed due to an extrusion of the higher temperature water from the south. Yearlings of walleye pollock (about 12cm in fork length) were distributed on the bottom, sometime to the mid-water layer, on the continental shelf, and adults with modes at 31 and 40cm were caught at depths around 200m near Kushiro Canyon in the central part of the survey area. Also large common squid were caught at depths around 200m in Kushiro Canyon (Table 3). Squid fishing season in 2005 seems to be good as many jigging vessels were found widely along the edge of the continental shelf. Krill was distributed from the edge of the continental shelf to the open sea. While swarms were found in the mid-layer on the continental shelf in the previous surveys, the phenomenon was not observed in 2005 survey. In summary, the prey environment surrounding minke whales was not good in autumn 2005 off Kushiro and changes in distribution, abundance and size composition may occur year by year. The results of the survey generally coincided with the information from the fisheries. The acoustic and CTD data will be analyzed including data collected by Kyoshin-maru No. 2 and a comparison with data from the whaling survey will be made to estimate the prey preference of minke whale.

ACKNOWLEDGEMENT

A special thank is given to Captain S. Tabata and crews of Kaiyo maru No. 7 for their dedication in collecting data.

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Table 1. Waypoints of planned track lines.

Area	WP	Latitude		Longitude	
Offshore	O-1	41	0	146	0
	O-2	42	16.4	145	30
	O-3	41	0	145	0
	O-4	41	59.1	144	30
	O-5	41	0	144	0
Coast East	E-1	42	29.3	146	0.1
	E-2	43	3.0	145	28.5
	E-3	42	22.8	145	45.5
	E-4	42	59.7	145	15.2
	E-5	42	12.1	145	15.8
	E-6	42	56.2	145	0.2
Coast Central	C-1	42	7.7	145	0.1
	C-2	42	53.8	144	30.5
	C-3	42	4.0	144	45.3
	C-4	42	44.6	143	57.4
	C-5	41	47.7	144	12.8
Coast West	W-1	41	47.7	144	12.8
	W-2	42	18.5	143	29.6
	W-3	41	26.6	143	59.0
	W-4	41	55.0	143	19.9
	W-5	41	0.0	143	19.9

Table 2. Trawl operations and the catches by species

Station	Year	Mon.	Day	Targeting /Predetermined	Time cast	Time Lift	Position Latitude	Position Longitude	Surf. Temp.	Catch Total(kg)	Japan. anchovy	Walleye pollock	Pacific saury	Comm. squid
02	2005	9	11	Prede. (Surface)	16;53	17:39	42 36.8	143 59.4	16.0	0.4	0.1			0.3
03	2005	9	12	Prede.(100m)	8:32	9:35	42 17.2	144 05.1	15.0	0.0				
04	2005	9	12	Prede. (Surface)	12:31	13:22	41 55.7	144 11.0	16.8	0.0	0.0			0.0
05	2005	9	12	Prede. (Surface)	16:20	17:00	41 56.8	144 00.7	16.6	0.1				0.1
07	2005	9	13	Targeting(30-50m)	11:00	11:57	42 15.3	143 29.9	18.3	4.7		0.1		4.6
08	2005	9	13	Prede.(100m)	14:43	15:39	41 54.7	143 43.4	16.9	0.2				0.2
10	2005	9	14	Prede.(100m)	7:39	8:23	42 34.6	144 09.2	15.5	16.7	16.6			0.1
11	2005	9	14	Prede. (Surface)	10:43	11:26	42 23.0	144 22.5	17.5	25.2	25.2			
12	2005	9	14	Prede. (Surface)	14:47	15:29	42 05.9	144 42.1	18.7	0.0	0.0			
15	2005	9	16	Prede.(100m)	11:25	12:21	41 25.2	145 10.3	18.6	0.0				
17	2005	9	17	Prede.(100m)	7:06	8:02	42 17.2	145 30.4	18.8	0.0	0.0			
18	2005	9	17	Prede.(100m)	12:34	13:25	41 36.1	145 46.0	19.8	0.0	0.0			
20	2005	9	18	Prede.(100m)	6:27	7:38	42 29.9	146 00.3	18.6	0.0	0.0			
21	2005	9	18	Prede. (Surface)	9:43	10:34	42 41.9	145 48.7	15.1	0.0				
22	2005	9	18	Prede. (Surface)	12:29	13:23	42 51.9	145 39.4	14.8	201.6	201.3		0.3	
24	2005	9	19	Prede. (Surface)	7:02	7:54	42 55.3	145 31.7	14.9	98.7			98.7	
25	2005	9	19	Prede.(100m)	10:12	11:07	42 41.9	145 37.6	15.3	2.6			2.6	
26	2005	9	19	Prede. (Surface)	15:06	15:49	42 30.3	145 40.6	18.5	0.0	0.0			
27	2005	9	20	Targeting(40-60m)	8:35	9:15	42 58.1	145 13.7	15.6	0.0		0.0		0.0
28	2005	9	20	Prede. (Surface)	10:22	11:09	42 54.5	145 15.4	15.6	0.0	0.0		0.0	
31	2005	9	21	Prede.(100m)	8:18	9:14	42 30.4	145 09.3	16.1	0.0	0.0			
32	2005	9	21	Prede. (Surface)	10:52	11:43	42 40.3	145 05.0	14.3	8.0	0.4		7.4	0.2
35	2005	9	21	Targeting(0-20m)	14:57	15:35	42 51.8	144 52.8	16.3	174.1	174.1			
37	2005	9	22	Targeting(0-20m)	6:44	7:24	42 06.6	144 44.2	18.1	0.0				
38	2005	9	22	Prede. (Surface)	10:52	11:43	42 39.0	144 34.4	17.8	0.2	0.0		0.2	
42	2005	9	23	Targeting(0-40m)	6:20	6:53	42 50.8	144 06.1	16.5	83.6	83.6			
44	2005	9	23	Prede.(150m)	12:55	14:13	42 44.6	144 09.2	15.6	846.6		587.0		259.6
48	2005	9	23	Prede.(170m)	14:03	15:24	42 44.9	144 25.9	15.0	1318.6		1317.6		1.0
50	2005	9	25	Prede.(90m)	10:00	10:58	41 26.5	143 58.4	19.0	0.0				
51	2005	9	25	Prede. (Surface)	13:59	14:42	41 37.4	143 33.4	18.2	0.0				
53	2005	9	27	Prede.(170m)	7:45	8:50	41 37.3	143 19.6	17.2	0.0				
54	2005	9	27	Prede. (Surface)	12:23	13:04	41 17.4	143 33.2	17.6	0.0				

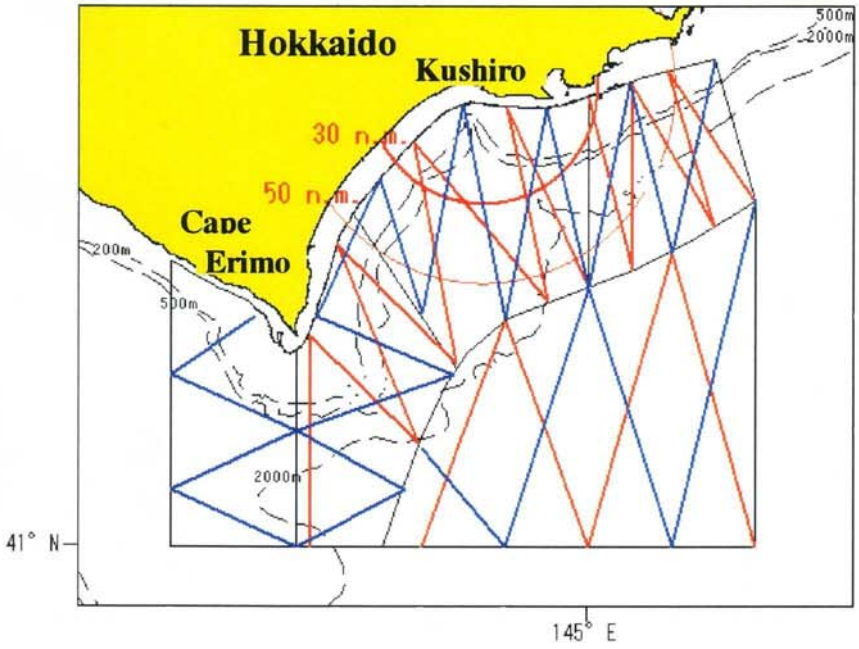

Fig. 1. Survey area and planned track lines (red lines) of prey species survey in 2005 off Kushiro. Red circles and blue lines show the sampling area of minke whale and the track lines for Kyoshin Maru No. 2.

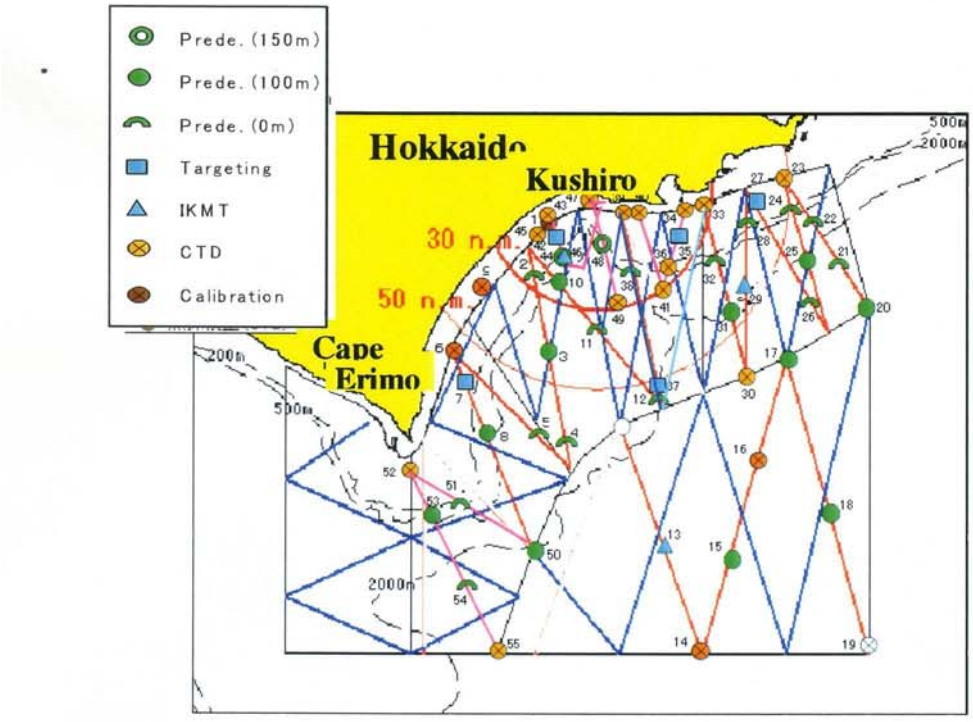

Fig. 2. Locations for Targeting/predetermined trawlings, IKMT and CTD observations of prey species survey in 2005 off Kushiro.

Appendix 2

Cruise report of the dedicated sighting survey in 2005 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 2005, as a part of coastal component of 2005 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 827.1 n.miles. A total of 63 individuals of 44 schools primary sightings were made. They included 21 common minke and 29 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 2005 as a part of coastal component of 2005 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. 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 2 to 19 September 2005. 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 2005 JARPN II, but the survey mode was only restricted to passing mode (NSP). Natural marking record and biopsy sampling experiments were attempted at grey, blue, humpback and right whales. These 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 827.1 n.miles. A total of 63 individuals of 44 schools were sighted in primary sightings. They included 21 common minke and 29 sperm whales. Details of sightings were listed on Table 2. Natural marking record and biopsy sampling experiments were not made. No large baleen whale feeding behavior was observed.

ACKNOWLEDGEMENT

Special thanks are given to the crews for their dedication in collecting data. The authors would like to thank Dr. Hiroshi Hatanaka (The Institute of Cetacean Research).

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Table 1. Details of survey itinerary.

Date	Event
9/01	Depart from Kushiro Port, Hokkaido, Japan
9/02	Start sighting survey
9/19	End sighting survey
9/21	Arrive at Sendai-Shiogama Port, Miyagi, Japan

Table 2. Summary of cetacean sightings.

	Primary		Secondary	
Species	Sch.	Ind.	Sch.	Ind.
Common minke whale	20	21		
Sperm whale	11	29	1	1
Like common minke whale	3	3		
Unidentified Large cetaceans	1	1		
Unidentified cetaceans	9	9		
Total	44	63	1	1

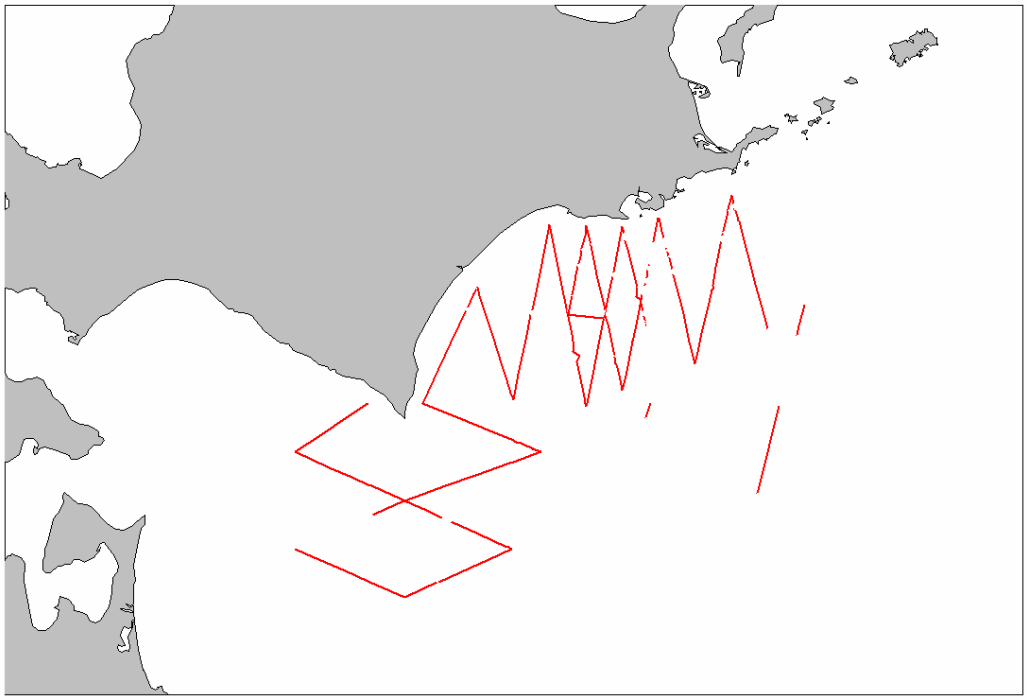

Fig 1. Searching effort by dedicated survey vessel "Kyoshin-Maru No.2", in the 2005 JARPN II coastal survey.

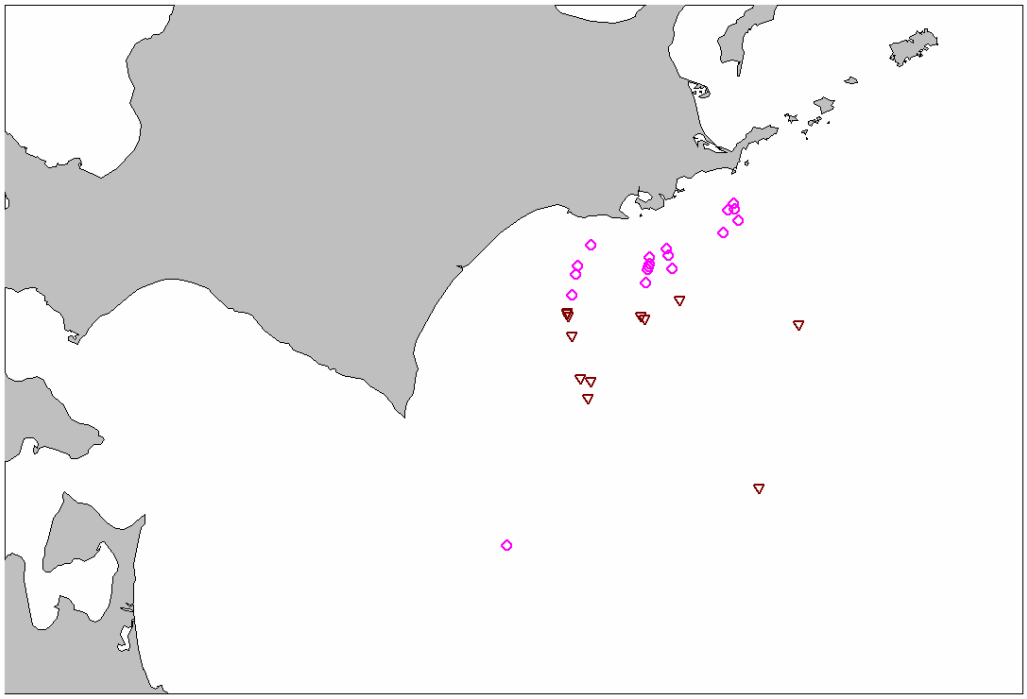

Fig 2. Sighting positions of Common Minke whales (○), and Sperm whales (▽) by dedicated survey vessel "Kyoshin-Maru No.2" in the 2005 JARPN II coastal survey.

Appendix 3

Oceanographic conditions in the JARPN II survey area off Kushiro, northeast Japan, in September 2005

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ABSTRACT

A prey species survey was conducted in cooperation with the sampling survey by small-type whaling catcher boats for minke whales off Kushiro in September 2005 as a part of JARPN II study. During the survey, Oceanographic observation with CTD was made 54 times to make clear the oceanic environment in the survey area. The cold Oyashio water was observed at depths deeper than 50m in almost whole survey area. The warm water over 15°C spread at the surface layer above the seasonal thermocline which lies around the depth of 20-30 m. The western coastal area was affected by Tsugaru warm current. A warm-core ring was placed around 42° N, 147° E.

INTRODUCTION

The oceanographic condition off the northeast Japan is the most complicated area in the world. In this area, there are a lot of fronts and water masses. The Kuroshio, which is one of the strongest west-boundary currents of subtropical gyre, flows northward from the offshore area of Philippine to the waters off Japan with warm high-salinity water. The Oyashio flows southward along the Kuril Islands to the east coast of Hokkaido and Tohoku with cold low-salinity water. The Kuroshio and the Oyashio flows eastward from the Japan coastal area, and the area between the Kuroshio and Oyashio east of Japan was usually called the Kuroshio-Oyashio Inter-frontal Zone or perturbed area. The warm-core ring, which is cut off from the Kuroshio extension, usually distribute in the Inter-frontal Zone and move northeastward to our survey area, south of Kushiro. 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 off northeast Japan.

A prey species survey was conducted in cooperation with the sampling survey by small-type whaling catcher boats for minke whales off Kushiro in September 2005 as a part of JARPN II study. In this paper, we analyzed the CTD data to make clear the oceanic environment in the survey area as 2004 survey (Inagake *et al*., 2005).

DATA AND METHODS

Hydrographic observations with a conductivity-temperature-depth profiler (CTD; SBE 19plus) were carried out 54 times from 11 to 27 September 2005 in the survey area south of Kushiro, northeast Japan (Fig. 1). The oceanographic conditions in September 2005 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/kaiyo/temp/temp.html). Oceanic fronts and water masses are usually detected by subsurface temperature map (see 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 the Oyashio water and the cold water. Light blue dots show the data in the cold water defined by 100 m temperature which is over 5 degree C and less than 10 degree C. Blue dots show the data in the Oyashio water defined by 100 m temperature which is less than 5 degree C with cold low-salinity water (lower part of Fig. 2) with warm surface water (left upper part of Fig. 2). Right part of light blue dots in Fig. 2 show warm high-salinity water affected by Kuroshio water, and other light blue dots are affected by the Oyashio water rather than the Kuroshio water.

Figure 3 shows the schematic hydrographic map in September 2005, presented by TNFRI. It is appear that the Oyashio water was dominant in the survey area, south of Hokkaido. The southern limit of the first Oyashio Intrusion was located around 39° 30'N on 145° 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° 30'N, 147° 30'E which was a little southern position from a monthly mean position in September. The Tsugaru warm water spread eastward to around 143° E. The warm water spread from the Kuroshio and the Tsugaru warm water appear in the middle of survey area. The Kuroshio warm-core ring is nearby eastern part of the survey area around 42° N, 147° E.

Figure 4 shows the 100 m and 200 m depth temperature maps observed by Kaiyo maru No. 7. The Oyashio water colder than 5 degree C at the depth of 100 m was spreading through the middle part of the survey area. The cold water, which is over 5 degree C and less than 10 degree C at 100 m depth, was observed western part and northeastern part of this area. At 200 m depth, the cold water less than 4 degree C is dominant in this area.

Figure 5 shows the vertical temperature sections along 42° N, 42° 30'N and 43° N. The cold Oyashio water was observed in the almost whole of the survey area (deeper than 50 m depth). The warm water over 15 degree C spread at the surface layer above the seasonal thermocline which lies around the depth of 20-30 m. A thickness of the surface warm water is deepened in the western part of 43° N section, which is on the shelf along Hokkaido coast. It is suggested that the warm water affected by the Tsugaru warm water spreads northeastward along the coast on the shelf.

All of these figure show almost offshore stations are distributed in the Oyashio area and cold area, but western part of inshore stations was in warmer area affected by Tsugaru warm current.

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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

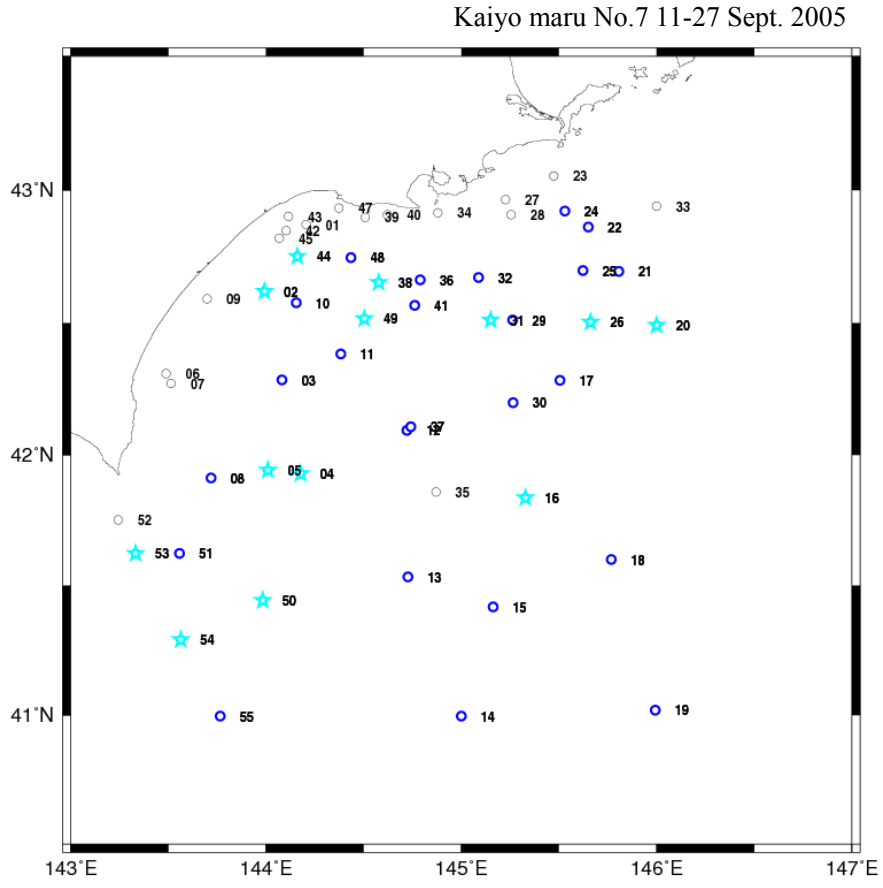

Fig. 1. Station map observed by Kaiyo maru No. 7 in 11 to 27 September 2005. Light blue stars and blue circles denote CTD stations in the cold area (100 m temperature was over 5°C and less than 10°C) and the Oyashio area (100 m temperature was less than 5°C), respectively.

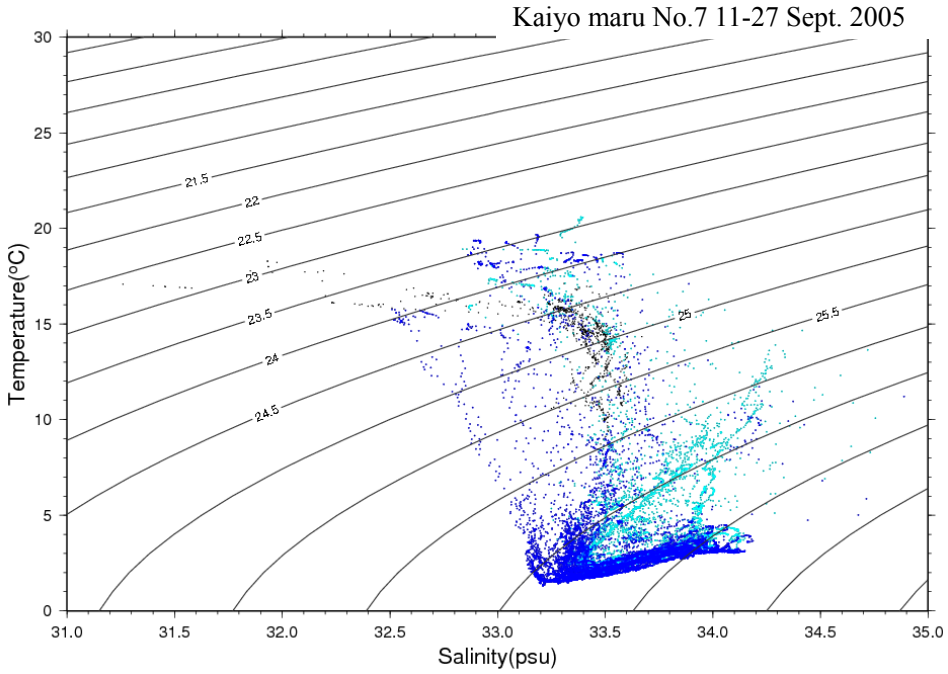

Fig. 2. Temperature-Salinity diagrams observed by Kaiyo maru No. 7 in 11 to 27 September 2005. Each thin line in this figure denotes a density line of sigma-t.

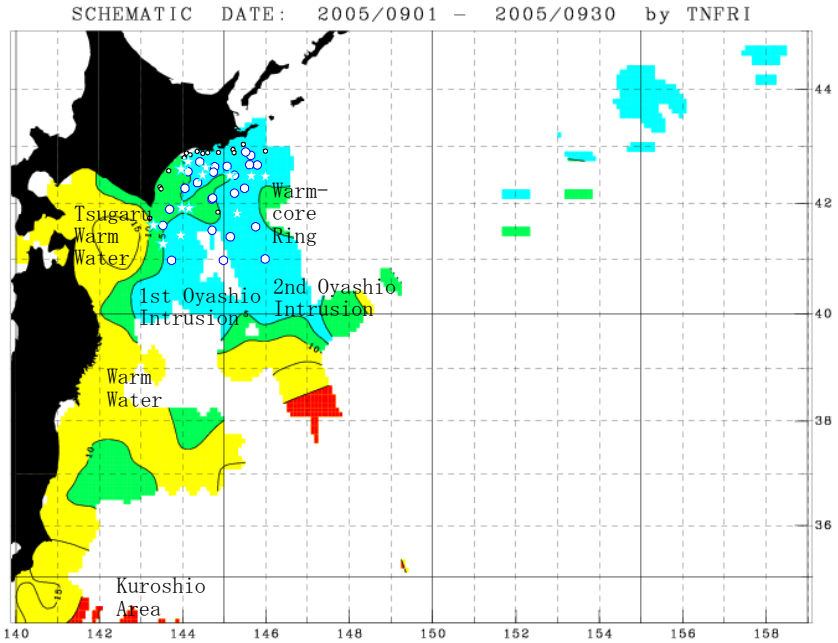

Fig. 3. Schematic hydrographic map off the northeast Japan, northwestern Pacific, in September 2005 (presented by TNFRI). Blue, green, yellow and red area show distributions of the Oyashio, the cold water, the warm water spread from the Kuroshio Extension and the Kuroshio Extension, respectively. Light blue star and blue circle denote CTD stations observed by Kaiyo maru No. 7 in the cold area and the Oyashio area, respectively.

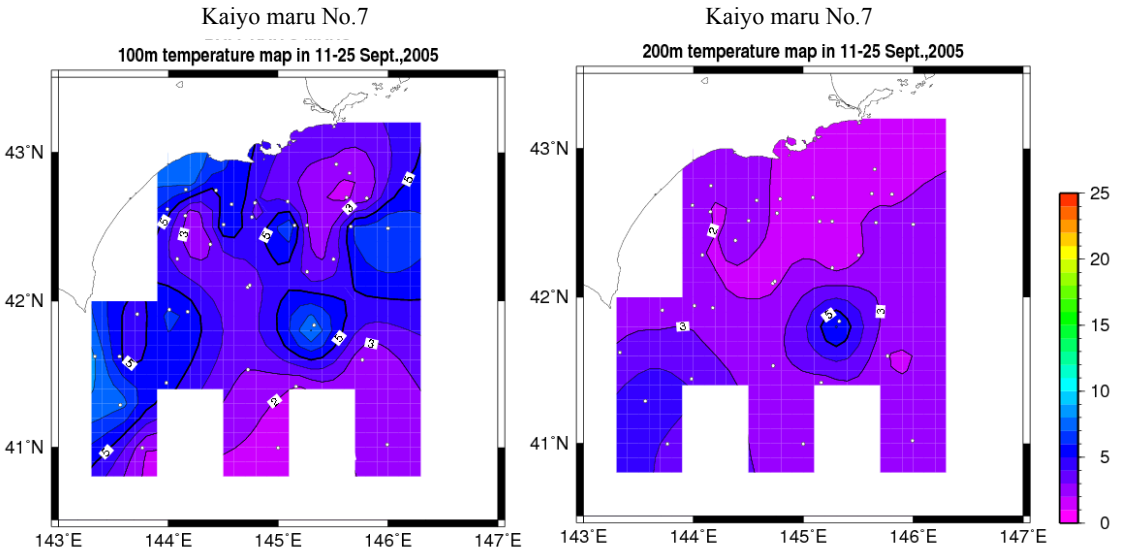

Fig.4. 100 m (left panel) and 200 m (right panel) temperature map observed by Kaiyo maru No. 7 in 11 to 27 September 2005.

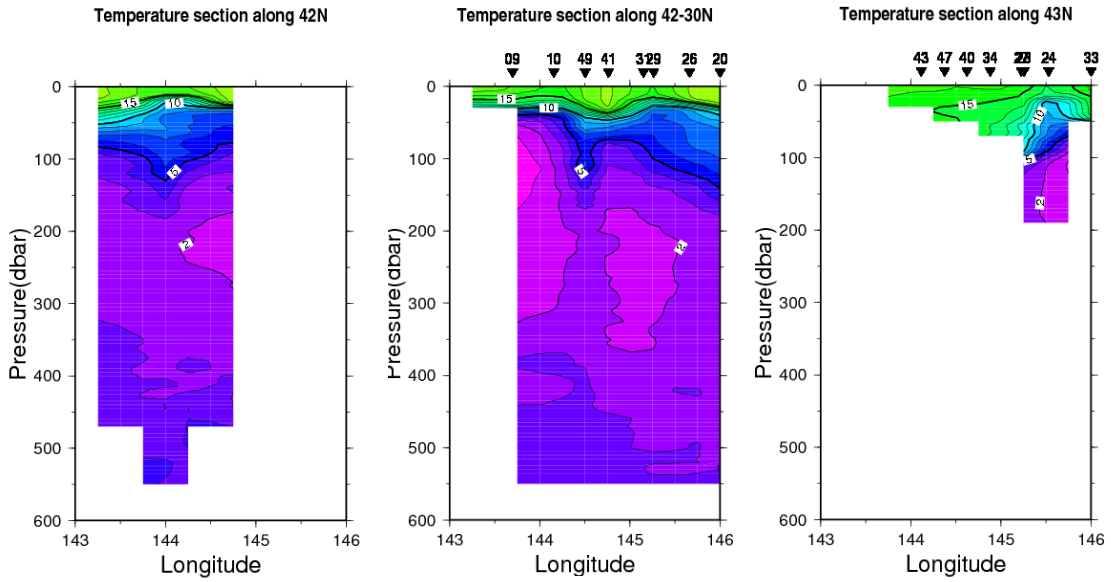

Fig. 5. Vertical sections of temperature along 42° N (left panel), 42° 30'N (middle panel) and 43° N (right panel) by Kaiyo maru No. 7 in 11 to 27 September 2005