Cruise report of the second phase of the Japanese Whale Research Program under Special Permit in the Western North Pacific (JARPN II) in 2006 - Coastal component off Sanriku.

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ABSTRACT
The third survey of the JARPN II coastal component was conducted from 12 April to 24 May 2006, off Sanriku district, northeastern Japan (middle part of the sub-area 7), using four small-type whaling catcher boats, two echo sounder-trawl survey vessels, and one dedicated sighting survey vessel. Based on results from the two-year feasibility study conducted in 2002 and 2003, the coastal component of JARPN II was revised to be conducted twice a year and to sample 60 common minke whales in each of spring and autumn, and then the first revised survey was carried out off Kushiro in autumn of 2004. In the present survey, sampling of common minke whales was conducted in coastal waters mainly within 30 nautical miles from Ayukawa port in the Sanriku district, and all animals collected were landed on the JARPN II research station established in the port for biological examination. During the survey, a total of 6340.0 nautical miles (634.1 hours) was surveyed for whale sampling, the 139 schools (143 individuals) of common minke whales were detected, and 60 animals were caught. Average body length of the animals was 6.15m (SD: 1.12, *n*=26) for males and 5.83m (SD: 1.04, *n*=34) for females. Dominant prey species found from forestomach of animals was Japanese sand lance (*Ammodytes personatus*) during the first half of the survey period. However, both Japanese sand lance and Japanese anchovy (*Engraulis japonicus*) were dominant during second half period. Krill (*Euphausia pacifica*) was observed from only one individual in the second half period. Seasonal pattern of the dominant prey species through the survey period was different from the past two coastal surveys off Sanriku in 2003 in which krill was dominant, and 2005 in which Japanese sand lance was also dominant. These results indicate that feeding habit of common minke whales in coastal waters off Sanriku changes year by year.

KEYWORDS: COMMON MINKE WHALE; NORTH PACIFIC; COASTAL WATERS OF JAPAN; FOOD/PREY; ECOSYSTEM; SCIENTIFIC PERMITS.

INTRODUCTION

After the two-year feasibility study in 2000-2001, the full-scale survey of the second phase of the Japanese Whale Research Program under Special Permit in the Western North Pacific (JARPN II) was started in 2002. The purpose of the program is, i) to evaluate the feeding ecology and ecosystem studies, involving prey consumption by cetaceans, prey preferences of cetaceans and ecosystem studies, ii) to monitor environmental pollutants in cetaceans and the marine ecosystem and iii) to elucidate the stock structure of whales (Government of Japan, 2002a).

The JARPN (1994-1999) and the JARPN II feasibility study (2000-2001) revealed that common minke whales are widely distributed from offshore waters to coastal waters and feed on various prey species such as Japanese anchovy, Pacific saury, and walleye pollock (Government of Japan, 2002b;

Tamura and Fujise, 2002). The coastal waters of Japan are also very important fishing ground. Thus, it was thought that the coastal waters are also very important research area for the full-scale JARPN II program. However, the *Nisshin Maru* research vessels can not be operated in the near shore areas, because of their movement restrictions from shallow water depth, and many fishing gears and boats. Furthermore, the vessels can not work from late autumn to early spring because of their practical availability. In order to cover the temporal and spatial gap of the vessels, sampling of common minke whales in the coastal waters using small-type whaling catcher boats was planned.

In the original JARPN II plan, the coastal component was presented as the two-year feasibility study to examine the logistic aspects of the methodology (Government of Japan, 2002a). First feasibility survey was carried out in the coastal waters off Kushiro in fall 2002 (Kishiro, *et al*., 2003) and then the second feasibility survey was conducted in the coastal waters off Sanriku district in spring 2003 (Yoshida, *et al*., 2004). In each of the surveys, 50 common minke whales were caught. From detailed examination of logistic aspects in the surveys, it was concluded that no substantial problem occurred and that 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 (Government of Japan, 2004b, Kato, *et al*., 2004). However, re-calculation of required sample size from the survey data suggested that the size should be modified to be at least 60 individuals in each area/season (Tamura, *et al*., 2004), and from 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). The first revised survey off Sanriku was carried out in spring 2005 (Yoshida, *et al*., 2006).

In the present paper, we show results of the third survey carried out in coastal waters off the Sanriku district, Japan, from 12 April to 24 May 2006. This survey was authorized by the Government of Japan in compliance with Article VIII of the International Convention for the Regulation of Whaling. The Institute of Cetacean Research (ICR) planned and conducted the survey cooperate with National Research Institute of Far Seas Fisheries, Tokyo University of Marine Science and Technology and Miyagi Prefecture Fisheries Research and Development Center.

MATERIALS AND METHODS

Research area

Research area was set in the same waters where the 2003 and 2005 JARPN II coastal surveys off the Sanriku district were conducted (Yoshida *et. al*, 2004; 2006). The district occupies northeastern part of the Japanese main island, Honshu (see, Fig. 1). In coastal waters off the Sanriku district, common minke whales were taken by the past land-based coastal whaling (Miyashita and Hatanaka, 1997). The waters are also very important fishing grounds. So, the waters were thought to be suitable for the research area of the JARPN II, and thus the 2003 and 2005 coastal survey were conducted in this area. The present research area was also set in the same waters: within 50 nautical miles (mainly 30 n. miles) from the Ayukawa port in the Sanriku district (Fig. 1). The survey area is included in the middle part of the sub-area 7 established by the IWC (1994).

Research vessels and station

Whale sampling survey

Four small-type whaling catcher boats were used as sampling vessels: *Taisho Maru* No. 28 (hereinafter referred as 28T; 47.3GT), *Koei Maru* No. 75 (75K; 46.0GT), *Katsu Maru* No.7 (7K; 32.0GT), and *Sumitomo Maru* No.31 (31S; 32.0GT). The whale sampling survey was conducted in a period from 12 April to 24 May, 2006. All the animals sampled were landed on the JARPN II research station established by the Ayukawa port for biological examination.

Prey species survey

The *Takuyo Maru* (TAK, 120.0GT) and *Shunyo Maru* (SHM, 887.0GT), the trawler-type research vessels, conducted the prey species survey in research area set off northeast coast of Honshu from 10 to 25 April and from 7 to 28 April, respectively. Detail of the both of prey species surveys are shown in Appendices 1 and 2. The both research vessels TAK and SHM also carried out oceanographic observation using CTD and EPCS.

Dedicated sighting survey
The *Shonan Maru No.2* (SM2; 712.0GT) joined as the dedicated sighting vessel. The dedicated sighting survey was conducted from 19 April to 2 May, following zigzag track lines pre-determined in coastal waters off northeast coast of Honshu. Detail of the survey is shown in Appendix 3.

Sighting and sampling methods
Sighting and sampling methods by whale sampling vessels were almost same in the past two coastal surveys conducted in Ayukawa in 2003 and 2005 (Yoshida *et al*. 2004, Yoshida *et al*. 2006). The research head office was placed in the research station and controlled the sampling vessels during the survey. In order to avoid concentration of sampling vessels, research area was divided into 3 small areas (Fig. 1). The office determined searching area and routes of sampling vessels everyday by weather conditions, whale distribution and information on coastal fisheries.

A researcher was on board each of four sampling vessels, and recorded sighting and sampling information, e.g., coordinates and time of common minke whales sighting and sampling made, weather conditions, and vessel activity. Two experienced researchers boarded on sampling vessels for training two newcomer researchers both on 75K for first 12days and on 7K for first 9 days. Sighting information was also recorded for other baleen whales and sperm whales. Searching activity was conducted from top barrel and upper bridge by crews and researchers. All common minke whales sighted were targeted for sampling, except cow-calf pair. When a school consisted of plural animals, an individual was selected randomly from the school and then caught. Once the vessel sampled a whale, she returned to the Ayukawa port as soon as possible, to transport the animal to the research station. During the return cruise, even if common minke whales were sighted, sampling was not conducted. At the port, animals taken were lift up from the vessels by a crane, using a wire net and then carried to the station by an 11-tons freight trailer. At that time, animal body weight was measured with the truck scale.

Biological research for common minke whales collected
All the animals collected were examined biologically by researchers at the research station. Research items of the biological examination are summarized in Table 4. These items are related to studies on feeding ecology, stock structure, life history and pollutions.

RESULTS
Searching effort made by sampling vessels
Cruise tracks made by sampling vessels (28T, 75K, 7K and 31S) during the present survey are shown in Fig. 2. The sampling vessels tried to cover widely research areas within 30 n. miles from Ayukawa port. In offshore waters, however, searching activity was very difficult from changeable weather condition and bigger waves for small sampling vessels, which resulted in more searching effort in Area 1. Searching distance and time made by four sampling vessels are listed in Table 1. Here, searching distance and time are defined as distance and time recorded under searching activity conducted from top barrel of vessels. Total searching distance and time made by the four vessels were 6340.0 n. miles and 634.1 hours, respectively.

Common minke whale sightings made by sampling vessels
Sighting positions of common minke whale schools made by the sampling vessels are shown in Fig. 3. All of common minke whale sightings were recorded in middle part of Sendai Bay. As shown in Table 2, a total of 139 schools (143 individuals) of common minke whales were sighted. These were 116 primary sightings (118 animals/116 schools) and 23 secondary sightings (25 animals/23 schools). Of 139 schools sighted, only 2 schools consisted of 2 individuals in primary sightings and 1 school consisted of 3 individual in secondary sighting and others were solitary animals. No cow-calf pairs were sighted.

Table 3 shows density index (SPUE: number of primary school sightings per one hour searching;

DI: number of primary school sightings per 100 n. miles searching) of common minke whales recorded by the sampling vessels. Both SPUE and DI increased twice from the first half to second half period of the survey.

Sampling of common minke whales
A total of 60 common minke whales were taken for biological examination. In the sampling process, two common minke whales were struck but lost due to technical failure. Sampling positions of individuals are shown in Fig. 4. Animals were taken evenly from whales sighted.

Prey species survey and dedicated sighting survey
The distribution and abundance of the prey species were investigated with the quantitative echo sounder (EK 500 and ER 60) on board TAK and SHM. Acoustic data were acquired with operating frequency at 38, 120 and 200 kHz. Species/size compositions of echo signs were identified by targeting mid-water trawling. As the water temperature was high, many schools of anchovy were distributed. Echo signs identified as adult sand lance (> 10 cm in standard length) occurred at depths between 20m and 60m, especially off Fukushima prefecture. The echo signs were in the shape of patches on the bottom or sticks rising from the bottom. Many echo signs identified as juvenile sand lance occurred as smaller patches in the mid-layer in the shallower area. Krill was frequently found at depths deeper than 50 m.

The dedicated sighting survey was carried out using the sighting survey vessel (SM2). All the 29 common minke whale schools (29 animals) were sighted. Most of the sightings were obtained in middle part of Sendai Bay, as recorded by the sampling vessels. The sighting number in the present survey was smaller than in the 2005 survey off Sanriku, in which 49 common minke whale sightings were obtained by the dedicated sighting survey vessel (Yoshida, *et al*. 2006). Results from the prey species survey and the dedicated sighting survey are noted in Appendices 1 and 2 (the prey species survey) and Appendix 3 (the dedicated sighting survey).

Sex ratio, body length and weight of animals caught
Research items of biological examination are summarized in Table 4, with number of data and samples obtained. The 60 animals taken consisted of 26 males and 34 females. Sex ratio of males to all animals was 0.43. The ratio was almost same as recorded in the 2003 (0.42) and 2005 (0.38) coastal surveys off Sanriku.

Average body length was 6.15m (max=7.62, min=4.29, SD: 1.12) for males and 5.83m (max=8.07, min=4.08, SD=1.04) for females (Table 5). Frequency of body length of common minke whale by sex was shown in Fig. 5. Average body weight was 2.85 tons (max=4.86, min=0.99, SD=1.24) for males and 2.50 tons (max=7.04, min=0.86, SD=1.34) for females (Table 6).

Frequency of body weight of common minke whale by sex was shown in Fig.6. In both sexes, average body length and weight of first half period were larger than that of second half period of the survey. In comparisons with females collected during the past two coastal surveys off Sanriku, in the present survey females showed markedly smaller values in body length and body weight (6.30 m and 3.12 tons in the 2003 and 6.55m and 3.47 tons in the 2005 surveys). The both values of male were a little smaller than that of in the 2003 (6.28 m and 2.92 tons) and 2005 (6.29m and 2.92 tons) surveys.

Composition of sexual maturity of animals collected is listed in Table 7 and frequency of sexual maturity of male and female were shown in Fig. 7 and 8, respectively. In males, eleven of 26 animals were sexually mature (42.3%), and 3 of 33 females attained sexual maturity (9.1%). All the mature females were pregnant. Lactating females were not observed. Frequency of sexually mature males was higher than that of the 2003 (38.1%) and 2005 (34.8%) surveys, but markedly lower in the 2003 (31.0%) and 2005 (37.8%) females.

Prey species of common minke whale found from forestomach
Following the same methods used in the JARPN II feasibility survey conducted in 2001 (Fujise, *et*

al., 2002), stomach contents were weighted to the nearest 0.1 Kg, by each of four chamber, in both cases of including and excluding liquid contents. Then, small sample of forestomach contents was collected and frozen for laboratory analysis.

The maximum weight of forestomach contents including liquid was 106.38kg, of which consisted sand lance. This individual was male with body length of 7.44m and body weight of 4.00 tons. The maximum contents weight was 2.66% of her body weight.

Forestomach contents found from common minke whales during the present survey are listed in Table 8. Dominant prey species was Japanese sand lance (*Ammodytes personatus*) (43.3%, from 26 of 60 animals). Sand lance was detected throughout the survey. Japanese anchovy (*Engraulis japonicus*) was not observed during the first half period except one individual which forestomach contents were consisted of sand lance and Japanese anchovy, but increased during the second half period (21.7%, from 15 of 60 animals). Krill (*Euphausia pacifica)* was recorded from only one animal during the second half period. Most of unidentified fishes (35.6%) were also assumed to be sand lance in the first period and sand lance and/or Japanese anchovy in the second half period (Table 8).

By-products of the whales

After biological examination, all the animals were processed according to the International Convention for Regulation of Whaling, Article VIII. Total weight of productions including meat and blubber was 76.2 tons.

DISCUSSION

The present survey was the third coastal survey carried out in coastal waters off Sanriku district. During the survey period, low atmospheric pressure and thick fog often disturbed the research activities. Furthermore, changeable weather condition and bigger waves obstructed searching activities of sampling vessels in offshore waters. These bad whether and sea conditions were caused to concentrate for sighting and sampling effort within Area 1.

Seasonal pattern of the dominant prey species of common minke whale found from forestomach through the survey period was different from the past two coastal surveys off Sanriku. In the 2003 coastal survey off Sanriku, dominant species changed with time (Yoshida, *et al*. 2004): krill were dominant in the first period (74.8%), then the occurrence frequency reduced with time, and in the third period sand lance were found most frequently (92.2%). On the other hand, dominant prey species was Japanese sand lance (45.0%) in the 2005 coastal survey off Sanriku. Sand lance were detected throughout the survey. Krill and Japanese anchovy were also found, but their frequency was much lower (6.7%) (Yoshida *et al*., 2006). These results indicate that feeding habit of common minke whales in coastal waters off Sanriku changes year by year, probably from environmental factors, e.g., oceanographic conditions or prey species distribution.

Seasonal report of Miyagi Prefecture Fisheries Research and Development Center (fourth information of spring fisheries in Miyagi prefecture in 2006) reported that total catch of sand lance by fisheries in Miyagi prefecture until the end of May in 2006 was 61% lower than that of same period in 2005. According to the results of monthly fisheries survey conducted by the TAK, both southward cold water derived from Oyashio current and northward warm water derived from Kuroshio current off Sanriku flew into the Sendai bay and made complicated sea circumstances of this region since April. After the late of April more strong northward warm water (surface temperature of 12 ℃) off Sanriku flew into the Sendai Bay. Japanese anchovy which was distributed in the marginal of this warm water also moved into the Sendai bay. Consequently fisheries ground of the sand lance was dispersed and reduced by rising the sea water temperature and intrusion of Japanese anchovy to the Sendai Bay. The stomach contents revealed by present study reflect these fisheries and sea circumstances conditions. These results indicate that common minke whales and coastal fisheries caught adult sand lance and Japanese anchovy at the same time and area, which indicate existence of interaction between them.

Density index of common minke whales recorded by sampling vessels in the present survey (0.19 for SPUE and 1.86 for DI) was lower than that of in the 2003 survey (0.47 for SPUE and 4.20 for DI) (Yoshida, *et al*. 2004) and 2005 survey (0.37 for SPUE and 3.26 for DI) (Yoshida, *et al*. 2006). One of the reasons for this result was thought to be bad weather condition in the present survey. Another reason was assumed to be sea circumstances conditions occurred in Sendai Bay mentioned above. Hatanaka and Miyashita (1997) hypothesized that migration pattern of western North Pacific common minke whale was different by sex and sexual maturity: young animals migrate into the coastal area of southern sub-area 7 (off Sanriku) in April and then disperse to northern sub-area 7, mature males appear widely from coastal waters to offshore waters in May, and :some of mature females distribute in sub-area 7 but they are rare in the southern sub area 7 and the offshore waters of western North Pacific. When a comparison was made composition of sex and sexual maturity recorded in the present survey and past two surveys off Sanriku, frequency of sexually mature males was higher than that of the 2003 (38.1%) and 2005 (34.8%) surveys, but frequency of mature females in present survey (9.1%) was markedly lower than in the 2003 (31.0%) and 2005 (37.8%). This lower frequency of mature female was assumed to be migrated to more northern area at research period or migrate to more offshore area because of low prey species abundance and/or sea circumstances conditions.

From the present survey, we could obtain valuable information including feeding ecology of minke whales. To evaluate more precise values on food consumption of minke whales and to obtain more information on interaction between the whales and coastal fisheries, further studies are needed.

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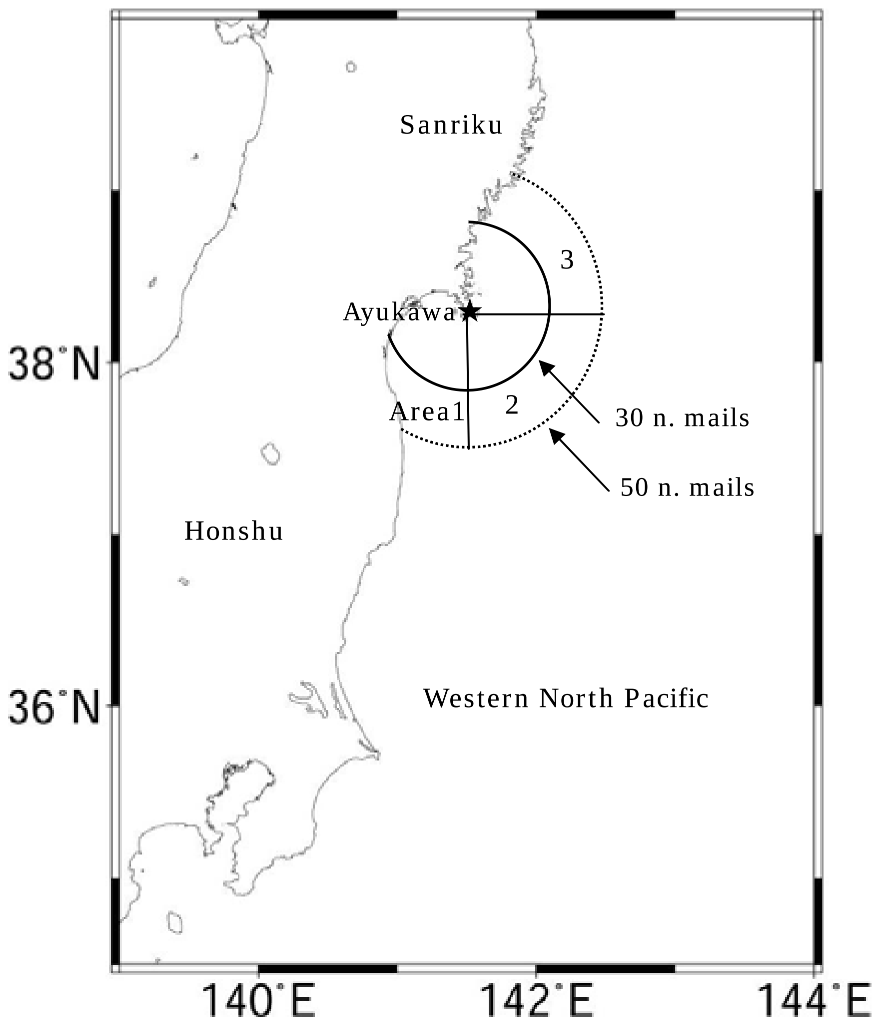

Fig. 1. Research area of the 2006 JARPNII coastal survey off Sanriku.

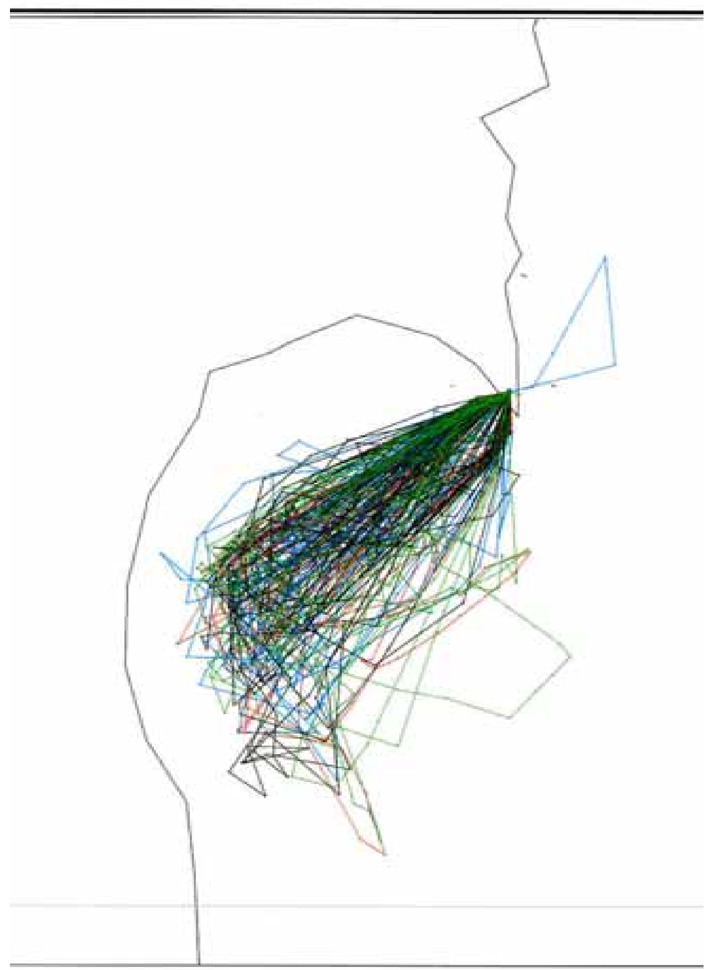

Fig. 2. Cruise trucks made by four sampling vessels in the 2006 JARPNII coastal survey off Sanriku.

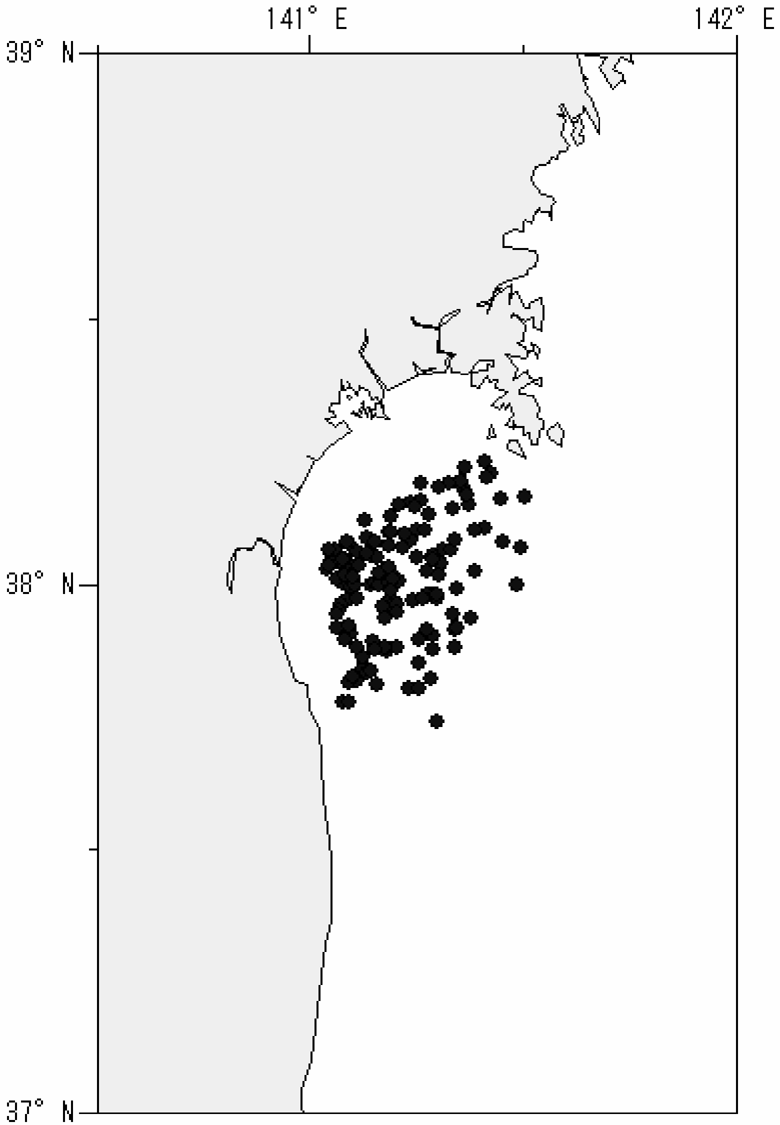

Fig. 3. Sighting position of common minke whales made by sampling vessels in the 2006 JARPNII coastal survey off Sanriku.

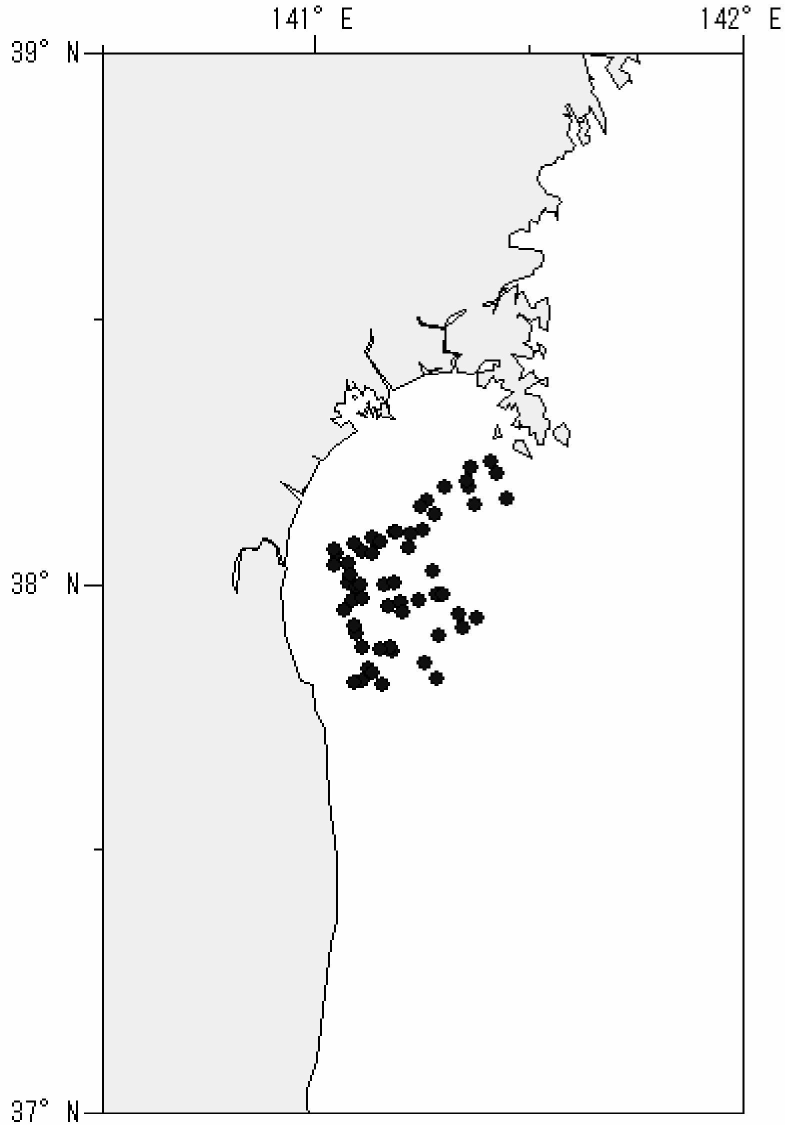

Fig. 4. Sampling position of common minke during the 2006 JARPNII coastal survey off Sanriku.

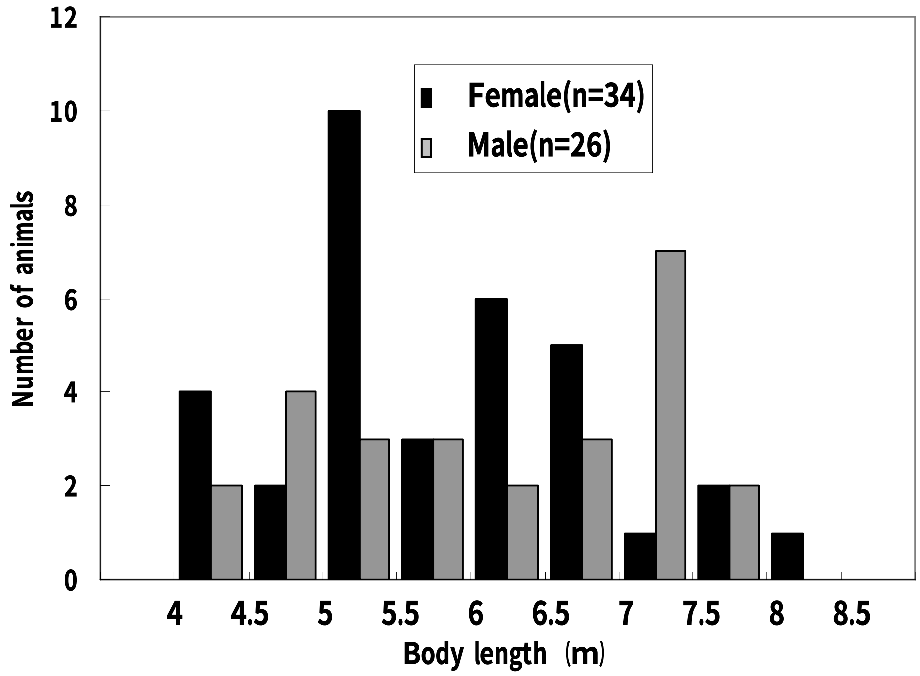

Fig. 5. Frequency of body length of common minke whales taken in the 2006 JARPNII coastal survey by sex.

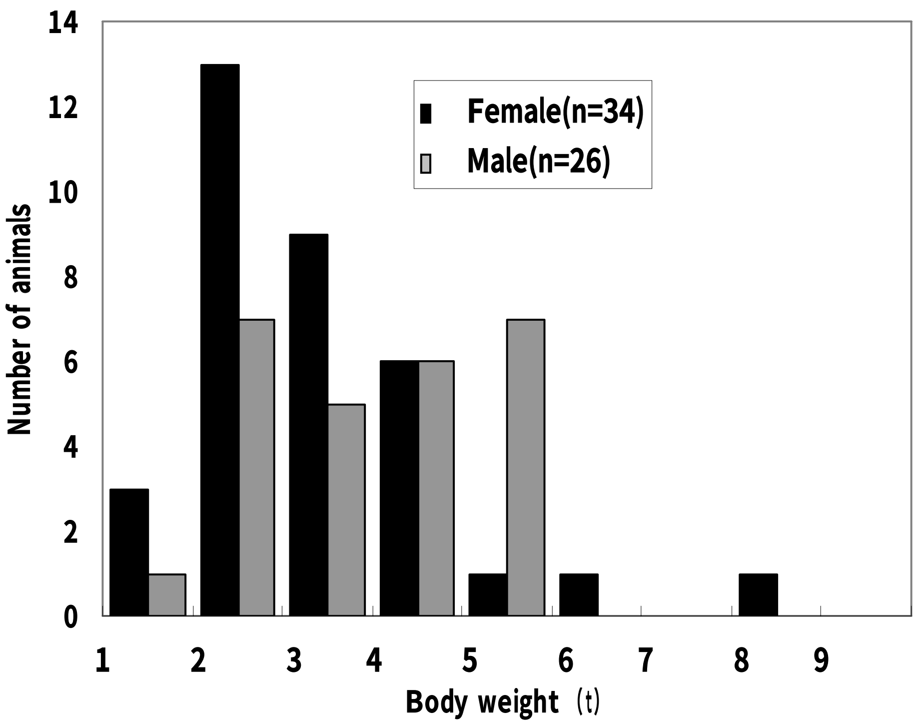

Fig. 6. Frequency of body weight of common minke whales taken in the 2006 JARPNII coastal survey by sex.

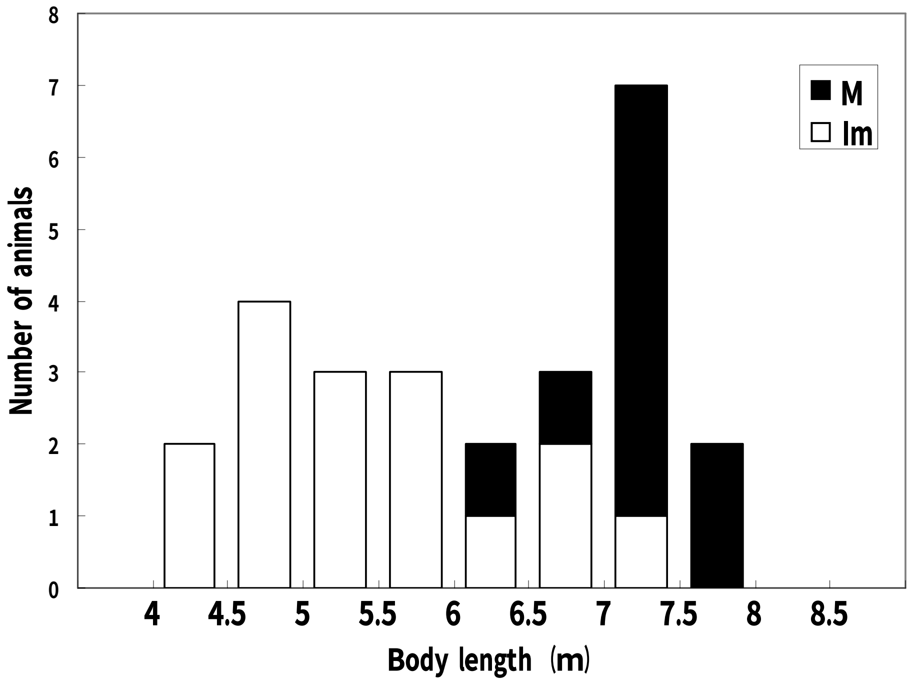

Fig. 7. Frequency of sexual maturity of male of common minke whales taken in the 2006 JARPNII coastal survey. Im：immature； M：mature.

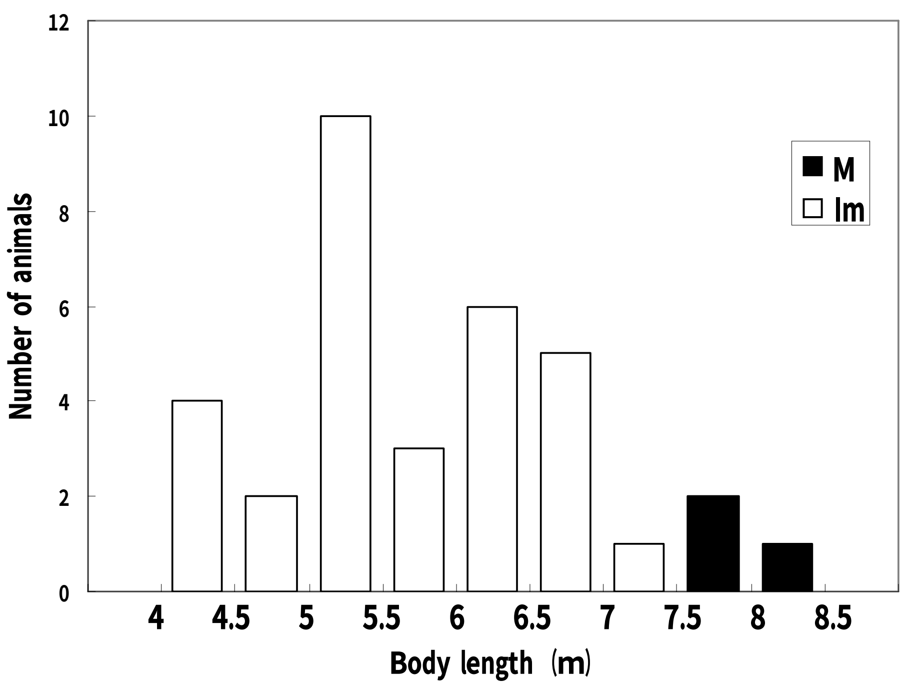

Fig. 8. Frequency of sexual maturity of female of common minke whales taken in the 2006 JARPNII coastal survey. Im：immature； M：mature.

Table1. Searching days, hours, distances by four sampling vessels in the 2006 JARPNII coastal survey off Sanriku .

Period		Sampling vessels*1				
		28T	75K	07K	31S	Total
First half period	Days	12	12	10	12	46
(12-30 April)	Hours	86.7	80.8	69.5	79.6	316.6
	Distances (N. mail)	880.8	792.0	665.3	808.5	3146.5
Second half period	Days	19	19	19	19	76
(1-24 May)	Hours	88.2	70.3	88.2	70.8	317.5
	Distances (N. mail)	866.2	709.2	871.7	746.3	3193.5
Total	Days	31	31	29	31	122
	Hours	174.9	151.0	157.7	150.4	634.1
	Distances (N. mail)	1747.0	1501.3	1537.0	1554.8	6340.0

*1: 28T; *Taisho Maru* No. 28; 75K: *Koei maru* No. 75; 7K: *Katsu Maru* No. 7; 31S: *Sumitomo maru* No. 31.

Table 2. List of cetacean species and number of sightings (no. schools/no. individuals) made by four sampling vessels in the 2006 JARPN II coastal survey off Sanriku.

Period	Species	Primary		Secondary		Total	
		Sch.	Ind.	Sch.	Ind.	Sch.	Ind.
First half period	Common minke whale	37	39	6	8	43	47
(12-30 April)	Like minke whale	12	12	0	0	12	12
	Unidentified baleen whale	1	1	0	0	1	1
	Unidentified large whale	2	2	0	0	2	2
Second half period	Common minke whale	79	79	17	17	96	96
(1-24 May)	Like minke whale	18	18	0	0	18	18
	Unidentified baleen whale	0	0	0	0	0	0
	Unidentified large whale	1	1	0	0	1	1
Total	Common minke whale	116	118	23	25	139	143
	Like minke whale	30	30	0	0	30	30
	Unidentified baleen whale	1	1	0	0	1	1
	Unidentified large whale	3	3	0	0	3	3

Table 3. Density index of common minke whales by sampling vessels in the 2006 JARPNII coastal survey off Sanriku .

Period	SPUE*1	DI*2
First half period (12-30 April)	0.12	1.24
Second half period (1-24 May)	0.25	2.47
Total	0.19	1.86

*1: No. of primary school sightings per 1 hour searching.
*2; No. of primary school sightings per 100 n. miles searching.

Table 4. Summary of whale sampling in the 2006 JARPN II coastal survey off Sanriku.

	Number of whales		
Samples and data	Male	Female	Total
Body length and sex	26	34	60
External body proportion	26	34	60
Photographic record and external character	26	34	60
Diatom film record and sampling	26	34	60
Body scar record	26	34	60
Measurements of blubber thickness (eleven points)	26	34	60
Body weight	26	34	60
Body weight by parts	0	3	3
Skin tissues for DNA study	26	34	60
Muscle, liver, and heart tissues for allozyme analysis	26	34	60
Muscle, liver, kidney, and blubber tissues for chemical analysis	26	34	60
Muscle, liver, blubber, vertebrae, and stomach contents for lipid analysis	0	3	3
Mammary grand; lactation status, measurement and histological sample	-	34	34
Uterine horn; measurements and endometrium sample	-	34	34
Collection of Ovary	-	34	34
Photographic record of foetus	0	3	3
Foetal length and weight	0	3	3
External measurement of foetus	0	3	3
Collection of foetus	0	3	3
Testis and epididymis; weight and histological sample	24	-	24
Stomach contents, convenient record	26	34	60
Volume and weight of stomach content in each compartment	24	32	56
Observation of marine debris in stomach	26	34	60
Stomach contents for feeding study	26	33	59
Record of external parasites	26	34	60
Earplug for age determination	26	34	60
Tympanic bulla for age determination	25	34	59

Eye lens for age determination	24	34	58
Largest baleen plate for morphologic study and age determination	26	34	60
Baleen plate measurements (length and breadth)	26	34	60
Photographic record of baleen plate series	26	34	60
Length of each baleen series	26	34	60
Sampling of serum	19	24	43
Vertebral epiphyses sample	26	34	60
Number of vertebrae	26	34	60
Number of ribs	26	34	60
Skull measurement (length and breadth)	26	34	60

Table 5. Statistics of body length (m) of common minke whales collected by the 2006 JARPN II coastal survey off Sanriku.

Period	Male					Female				
	Mean	S.D.	Min.	Max.	n	Mean	S.D.	Min.	Max.	n
First half period (12-30 April)	7.02	0.58	5.84	7.62	8	6.06	0.75	4.65	7.01	11
Second half period (1-24 May)	5.76	1.09	4.29	7.44	18	5.72	1.15	4.08	8.07	23
Total	6.15	1.12	4.29	7.62	26	5.83	1.04	4.08	8.07	34

Table 6. Statistics of body weight (tons) of common minke whales collected by the 2006 JARPN II coastal survey off Sanriku.

Period	Male					Female				
	Mean	S.D.	Min.	Max.	n	Mean	S.D.	Min.	Max.	n
First half period (12-30 April)	3.70	0.64	2.37	4.37	8	2.55	0.72	1.3	3.81	11
Second half period (1-24 May)	2.47	1.26	0.99	4.86	18	2.47	1.56	0.86	7.04	23
Total	2.85	1.24	0.99	4.86	26	2.50	1.34	0.86	7.04	34

Table 7. Composition of sex and sexual maturity of common minke whales collected by the 2005 JARPN II coastal survey off Sanriku.

Period	Male				Female			
	Im	M*	Total	Maturity (%)	Im	M	Total	Maturity (%)
First half period (12-30 April)	2	6	8	75.0	11	0	11	0.0
Second half period (1-24 May)	13	5	18	27.8	19	3	22**	13.6
Total	15	11	26	42.3	30	3	33	9.1

Im：Immature、M：Mature、P：Pregnant

Table 8. Prey species found in forestomach of common minke whales collected by the 2006 JARPN II coastal survey off Sanriku.

Period	Sample size	Prey species					
		Sand lance	Japanese anchovy	Sand lance +Japanese anchovy	Krill	Unidentified fish	None
First half period	19	10	0	1	0	7	1
(12-30 April)	(%)	52.6	0.0	5.3	0.0	36.8	5.3
Second half period	40	12	10	3	1	14	0
(1-24 May)	(%)	30.0	25.0	7.5	2.5	35.0	0.0
Total	59	22	10	4	1	21	1
	(%)	37.3	16.9	6.8	1.7	35.6	1.7

Appendix 1

2006 coastal prey species survey of JARPN II off Sanriku-Johban

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ABSTRACT

A prey species survey was conducted in the coastal region off Sanriku-Johban, northeastern Japan, concurrently with the coastal sampling survey for minke whale during spring 2006 as a part of JARPN II study. The objective of concurrent surveys was to estimate the prey preference (selection) of minke whale. While the sampling survey for minke whale was conducted within 30 nautical miles (max 50 nautical miles) from Ayukawa, Miyagi prefecture, the prey species survey was conducted in wider area at depths between 20 m and 200 m from 37º 00' N to 38º 40' N off Sanriku-Johban, northeastern Japan. The survey area was divided into 10 blocks with depth and latitude. The distribution and abundance of the prey species were investigated with the quantitative echosounder (EK 500 and ER 60) on board Takuyo Maru (120 GT) and Shunyo Maru (887 GT) steaming at 9 – 10 knots along the track lines during daytime. Acoustic data were acquired with operating frequency at 38, 120 and 200 kHz. Species/size compositions of echo signs were identified by targeting mid-water trawlings. As the water temperature was high, many schools of anchovy were distributed. Echo signs identified as adult sand lance (> 10 cm in standard length) occurred at depths between 20m and 60m, especially off Fukushima prefecture. The echo signs were in the shape of patches on the bottom or sticks rising from the bottom. Many echo signs identified as juvenile sand lance occurred as smaller patches in the mid-layer in the shallower area. Krill was frequently found at depths deeper than 50 m.

INTRODUCTION

The 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 preference (selection) of cetaceans and ecosystem modeling. 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. As in 2003 and 2005 surveys (Kawahara et al., 2004; Yonezaki et al., 2005), a prey species survey was conducted in the coastal region off Sanriku-Johban, northeastern Japan, concurrently with the coastal sampling survey for minke whale during spring 2006. In this document, the results of the 2006 prey species survey off Sanriku-Johban are presented.

MATERIALS AND METHODS

While the sampling survey of minke whale was conducted in the coastal waters within the 30 nautical miles (max 50 nautical miles) from Ayukawa, Miyagi prefecture, the prey species survey was conducted in wider area at depths between 20 m and 200 m from 37º 00’ N to 38º 40’ N off Sanriku-Johban, northeastern Japan, to elucidate the distribution and abundance of main prey species (Fig. 1). To avoid the conflict with set nets in the coastal waters, the waters 10 miles from the coastal lines were excluded in principle. The survey area was divided into 10 blocks (A, B, C, D, E, F, G, H, I, and J) at depths of 40m/100m and 37º 40’ N/37º 54’ N/38º 15’ N. Blocks E, F, G, H, I and J south of 37º 54’ N are located off Fukushima prefecture. A zigzag track line was set to cover each block. The waypoints of planned track lines in each block were shown in Table 1. However, since the width of the sea areas of Blocks H and I were narrow in the south off Fukushima prefecture, both blocks were considered the one block, and the investigation line was set.

The prey species survey was conducted from April 11 to 27 in blocks A, B, C, D, E, F and G by Takuyo Maru (Miyagi prefecture, 120 GT), and from April 8 to 14 in blocks H, I and J by Shunyo Maru (National Research Institute of Far Seas Fisheries, 887 GT). The distribution and abundance of the prey species were investigated with the quantitative echosounder (Takuyo Maru: EK 500, Shunyo Maru: ER 60) steaming at about 9-10 knots along the track lines. The survey was conducted during the daytime from an hour after sunrise to an hour before sunset. Oceanographic observations were conducted with CTD-EPCS (Continuous Sea Surface Water Monitoring System) (Takuyo Maru) and XCTD-OPCS (Continuous Sea Surface Water Monitoring System) (Shunyo Maru). With EPCS and OPCS, temperature, salinity and chlorophyll in the surface water were measured every minute. Preliminary sighting survey was made for marine mammals such as northern fur seals.

Acoustic data were acquired with Echoview Ver.3 (Sonar Data Co., Ltd.) with operating frequency at 38, 120 and 200 kHz. Calibrations were carried out at a depth around 30m in Ishinomaki Bay (Takuyo Maru,April 10 2006) in Shiogama Bay (Shunyo Maru, April 15 2006) using the copper sphere technique described in EK 500 manual. Trawl sampling, Bongo net sampling, Sabiki sampling (Takuyo Maru), Multiple Opening/Closing Net and Environmental Sampling (MOCNESS) (Shunyo Maru) and Isaaca-kidd midwater trawling (IKMT) (Shunyo Maru) were conducted to identify the species and size compositions of targeting echo signs. The trawl net had a mouth opening of 7 m width/3.5 m height and a 3 mm liner cod end. The depth and the height of the mouth of the net were monitored with a net recorder. Towing speed of the trawl net was 2-4 knots. Catches of trawl, Sabiki, Bongo net, MOCNESS and IKMT were identified to the species level and weighed aboard the vessel. For the major species, a sample of 100 animals was taken, and lengths and weights were measured. Scaled and standard lengths were used to anchovy and adult/juvenile sand lance, respectively. Total length from the tip of the rostrum to the end of the telson was used for krill. Some frozen samples were taken for further analysis in the laboratory.

RESULTS

The planned track lines were almost covered in the acoustic survey. A summary of the midwater trawl operations, temperature by depth and catches was shown on Table 2 (Takuyo Maru) and 3 (Shunyo Maru). Targeting trawlings were made 25 times (Takuyo Maru: 15 times, Shunyo Maru: 10 times) and CTD and XCTD observations were made at the trawling points and 50 waypoints (Takuyo Maru: 39 points, Shunyo Maru: 11 points). The oceanographic conditions are described in Appendix 2 in the report.

Acoustic data were analyzed with Echoview Ver.3 at the laboratory and the results are as follows. The surface water temperature in the survey area was between 6.7 ^{o}C and 13.9 ^{o}C based on EPCS and OPCS. The surface water temperature of survey area was higher than last year (Yonezaki et al., 2005), and many schools of Japanese anchovy were occurred during the prey species survey (Table 2). Echo signs identified as adult sand lance (> 10 cm in standard length) occurred at depths between 20 m and 60 m in blocks B, C, E, F, H, I, and J. Especially, many echo signs identified as adult sand lance were found in blocks F off Fukushima prefecture. The echo signs on the echograms were in the shape of patches on the bottom or sticks rising from the bottom. Juvenile sand lance could be identified from the difference in average Sv values between 38 and 120 kHz. Many echo signs identified as juvenile sand lance occurred in the shallower area of Sendai Bay (blocks B and E). Most of the echo signs were smaller patches, usually found in the mid-layer. Although the difference in average Sv values by frequency is similar to that of krill, juvenile sand lance could be identified based on the distribution patterns and the size of the echo signs. Krill was frequently found at depths deeper than 60 m. In most cases the echo signs were large patches and in the shape of belts in the mid/bottom layers or sticks rising from the bottom.

Hydrographic condition in this year was greatly different with last year (Yonezaki et al., 2005). According to a inflow warm water in the survey sea area from off shore division, many patches of Japanese anchovy were confirmed and the number of krill school was less than last year (Yonezaki et al., 2005).

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Table 1. Waypoints of planned lines.

Block A

WP	Latitude				Longitude				Course	Distance
A1	38	-	40.0	N	141	-	41.3	E	105	7.7
A2	38	-	38.0	N	141	-	50.8	E	256	12.4
A3	38	-	35.0	N	141	-	35.4	E	104	12.3
A4	38	-	32.0	N	141	-	50.6	E	256	12.1
A5	38	-	29.0	N	141	-	35.7	E	104	12.1
A6	38	-	26.0	N	141	-	50.6	E	254	11.0
A7	38	-	23.0	N	141	-	37.1	E	106	10.7
A8	38	-	20.0	N	141	-	50.2	E	255	11.4
A9	38	-	17.0	N	141	-	36.2	E	106	7.4
A10	38	-	15.0	N	141	-	45.3	E	-	-
									TOTAL	97.0

Block B

WP	Latitude				Longitude				Course	Distance
B1	38	-	21.0	N	141	-	16.6	E	108	6.5
B2	38	-	19.0	N	141	-	24.4	E	261	12.2
B3	38	-	17.0	N	141	-	9.1	E	104	8.1
B4	38	-	15.0	N	141	-	19.1	E	262	13.9
B5	38	-	13.0	N	141	-	1.6	E	100	11.1
B6	38	-	11.0	N	141	-	15.4	E	261	13.4
B7	38	-	8.9	N	140	-	58.7	E	98	13.9
B8	38	-	7.0	N	141	-	16.1	E	262	14.8
B9	38	-	5.0	N	140	-	57.5	E	98	13.7
B10	38	-	3.0	N	141	-	14.6	E	262	14.2
B11	38	-	1.0	N	140	-	56.8	E	99	13.4
B12	37	-	59.0	N	141	-	13.6	E	260	12.0
B13	37	-	57.0	N	140	-	58.6	E	101	10.7
B14	37	-	54.9	N	141	-	11.9	E	259	4.8
B15	37	-	54.0	N	141	-	6.0	E	-	-
									TOTAL	162.8

Block C

WP	Latitude				Longitude				Course	Distance
C1	38	-	17.0	N	141	-	22.2	E	119	3.1
C2	38	-	15.5	N	141	-	25.6	E	254	5.3
C3	38	-	14.0	N	141	-	19.1	E	98	10.8
C4	38	-	12.5	N	141	-	32.7	E	264	13.7
C5	38	-	11.0	N	141	-	15.5	E	98	11.4
C6	38	-	9.5	N	141	-	29.8	E	262	10.8
C7	38	-	8.0	N	141	-	16.2	E	99	9.1
C8	38	-	6.5	N	141	-	27.6	E	261	9.7
C9	38	-	5.0	N	141	-	15.5	E	100	8.7
C10	38	-	3.5	N	141	-	26.4	E	261	9.1
C11	38	-	2.0	N	141	-	15.0	E	100	8.7
C12	38	-	0.5	N	141	-	25.8	E	261	9.6
C13	37	-	59.0	N	141	-	13.8	E	100	8.6
C14	37	-	57.5	N	141	-	24.5	E	262	10.2
C15	37	-	56.0	N	141	-	11.7	E	99	10.1
C16	37	-	54.5	N	141	-	24.3	E	261	3.2
C17	37	-	54.0	N	141	-	20.3	E	-	-
									TOTAL	142.3

Block D

WP	Latitude				Longitude				Course	Distance
D1	38	-	15.0	N	141	-	40.7	E	106	7.1
D2	38	-	13.0	N	141	-	49.3	E	259	15.3
D3	38	-	10.0	N	141	-	30.3	E	102	15.0
D4	38	-	7.0	N	141	-	48.9	E	260	17.7
D5	38	-	4.0	N	141	-	26.8	E	100	17.0
D6	38	-	1.0	N	141	-	47.9	E	261	18.4
D7	37	-	58.0	N	141	-	24.9	E	103	13.1
D8	37	-	55.0	N	141	-	41.0	E	257	4.9
D9	37	-	53.9	N	141	-	35.0	E	-	-
									TOTAL	108.5

Block E

WP	Latitude				Longitude				Course	Distance
E1	37	-	54.0	N	141	-	4.0	E	261	3.2
E2	37	-	53.5	N	141	-	0.0	E	99	10.0
E3	37	-	52.0	N	141	-	12.5	E	260	8.5
E4	37	-	50.5	N	141	-	2.0	E	100	8.9
E5	37	-	49.0	N	141	-	13.0	E	260	8.8
E6	37	-	47.5	N	141	-	2.1	E	107	5.1
E7	37	-	46.0	N	141	-	8.2	E	251	4.7
E8	37	-	44.5	N	141	-	2.6	E	105	5.8
E9	37	-	43.0	N	141	-	9.7	E	254	5.5
E10	37	-	41.5	N	141	-	3.0	E	103	6.6
E11	37	-	40.0	N	141	-	11.1	E	-	-
									TOTAL	67.2

Block F

WP	Latitude				Longitude				Course	Distance
F1	37	-	54.0	N	141	-	18.3	E	103	4.5
F2	37	-	53.0	N	141	-	23.9	E	257	8.9
F3	37	-	51.0	N	141	-	13.0	E	104	8.2
F4	37	-	49.0	N	141	-	23.0	E	259	10.0
F5	37	-	47.0	N	141	-	10.6	E	102	9.3
F6	37	-	45.0	N	141	-	22.1	E	258	10.0
F7	37	-	43.0	N	141	-	9.8	E	102	9.4
F8	37	-	41.0	N	141	-	21.3	E	258	4.8
F9	37	-	40.0	N	141	-	15.4	E	-	-
									TOTAL	

Block G

WP	Latitude				Longitude				Course	Distance
G1	37	-	54.0	N	141	-	40.4	E	262	13.6
G2	37	-	52.0	N	141	-	23.4	E	99	12.5
G3	37	-	50.0	N	141	-	39.0	E	261	12.8
G4	37	-	48.0	N	141	-	23.1	E	100	11.9
G5	37	-	46.0	N	141	-	37.9	E	261	13.1
G6	37	-	44.0	N	141	-	21.6	E	100	11.8
G7	37	-	42.0	N	141	-	36.2	E	260	12.0
G8	37	-	40.0	N	141	-	21.3	E	-	-
									TOTAL	87.7

Block HI

WP	Latitude				Longitude				Course	Distance
HI 1	37	-	40.0	N	141	-	2.6	E	102	5.7
HI 2	37	-	38.8	N	141	-	9.7	E	102	8.3
HI 3	37	-	37.0	N	141	-	19.9	E	256	8.1
HI 4	37	-	35.1	N	141	-	10.1	E	256	4.7
HI 5	37	-	34.0	N	141	-	4.3	E	106	5.2
HI 6	37	-	32.5	N	141	-	10.5	E	106	5.3
HI 7	37	-	31.0	N	141	-	17.0	E	254	5.9
HI 8	37	-	29.4	N	141	-	9.9	E	254	4.5
HI 9	37	-	28.0	N	141	-	4.5	E	109	3.7
HI 10	37	-	26.9	N	141	-	8.9	E	109	5.2
HI 11	37	-	25.0	N	141	-	15.0	E	251	5.9
HI 12	37	-	23.1	N	141	-	8.1	E	251	3.3
HI 13	37	-	22.0	N	141	-	4.1	E	111	3.1
HI 14	37	-	20.9	N	141	-	7.7	E	111	4.8
HI 15	37	-	19.0	N	141	-	13.4	E	249	6.0
HI 16	37	-	16.9	N	141	-	6.3	E	249	2.4
HI 17	37	-	16.0	N	141	-	3.5	E	117	2.2
HI 18	37	-	15.0	N	141	-	5.9	E	117	4.4
HI 19	37	-	13.0	N	141	-	10.9	E	246	5.3
HI 20	37	-	10.9	N	141	-	4.8	E	246	2.3
HI 21	37	-	10.0	N	141	-	2.1	E	118	1.9
HI 22	37	-	9.1	N	141	-	4.3	E	118	4.1
HI 23	37	-	7.0	N	141	-	8.7	E	245	5.7
HI 24	37	-	4.8	N	141	-	2.1	E	245	1.7
HI 25	37	-	4.0	N	141	-	0.3	E	122	1.6
HI 26	37	-	3.1	N	141	-	2.0	E	122	4.0
HI 27	37	-	1.0	N	141	-	6.3	E	243	2.2
HI 28	37	-	0.0	N	141	-	3.8	E	-	-
									TOTAL	117.7

Block J

WP	Latitude				Longitude				Course	Distance
J1	37	-	0.0	N	141	-	15.7	E	82	7.3
J2	37	-	1.0	N	141	-	24.7	E	282	13.9
J3	37	-	4.0	N	141	-	7.7	E	80	17.9
J4	37	-	7.0	N	141	-	29.8	E	281	16.3
J5	37	-	10.0	N	141	-	9.7	E	81	18.8
J6	37	-	13.0	N	141	-	33.0	E	280	17.0
J7	37	-	16.0	N	141	-	12.0	E	80	17.2
J8	37	-	19.0	N	141	-	33.3	E	281	15.4
J9	37	-	22.0	N	141	-	14.3	E	79	16.2
J10	37	-	25.0	N	141	-	34.3	E	282	14.6
J11	37	-	28.0	N	141	-	16.3	E	79	15.6
J12	37	-	31.0	N	141	-	35.6	E	282	14.5
J13	37	-	34.0	N	141	-	17.8	E	78	14.7
J14	37	-	37.0	N	141	-	35.9	E	285	12.0
J15	37	-	40.0	N	141	-	21.3	E	-	-
									TOTAL	211.4

Table 2. A summary of the sampling operations, temperature by depth and catches by Takuyo Maru.

Station		St-1	St-2	St-3	St-4	St-5	St-6	St-7
Date		4/11	4/11	4/14	4/15	4/18	4/18	4/18
Time		8:41	12:11	10:14	6:10	8:02	9:06	15:43
Latitude		38-17.884	38-13.083	38-05.459	37-56.358	38-14.816	38-14.310	38-04.027
Longitude		141-16.905	141-04.146	141-02.583	141-02.711	141-41.811	141-44.093	141-26.411
Surf. Temp.		6.80	7.10	7.80	8.20	8.60	10.40	9.60
Depth temp.	10 m	6.64	6.75	7.13	7.78	9.52	10.28	9.37
	20 m	6.76	6.84	6.80	6.98	9.79	10.30	9.72
	30 m	6.48				9.74	10.30	10.26
	40 m					9.72	10.23	10.24
	50 m					9.72	9.91	9.05
	75 m					8.60	7.98	8.37
	100 m					6.85	6.91	7.95
	125 m					5.59	6.37	
Depth (m)		30	23	27	23	142	148	108
Sampling method		Trawl	Trawl	Trawl	Trawl	Trawl	Trawl	Trawl
Net depth (m)		10-20	10-20	15-25	15-25	100-110	30-40	80-90
Species caught, Length mode and range (mm)		Juvenile sand lance, 37, 30-50, Jelly fish	Juvenile sand lance, 47, 34-57	Adult sand lance, 104, 98-131, Juvenile sand lance, 48, 31-57, Jelly fish	Adult sand lance, 107, 91-132, Juvenile sand lance, 30, 24-54, Japanese anchovy, 70 and 78, Jelly fish	*Maurolicus japonicus*, 34, 18-37	Nothing	Krill, 17, 13-22, Jelly fish
Catches (kg)		2.7	19.8	8.0	12.6	0.3	0.0	0.2

Station		St-8	St-9	St-10	St-11	St-12	St-13	St-14
Date		4/19	4/19	4/22	4/23	4/25	4/26	4/26
Time		8:07	12:26	10:47	9:26	10:19	6:56	7:22
Latitude		37-56.591	38-08.474	38-19.603	38-35.703	37-40.485	37-54.268	37-54.246
Longitude		141-32.492	141-32.731	141-48.619	141-39.054	141-18.193	141-17.963	141-18.146
Surf. Temp.		11.26	9.02	8.55	7.60	10.73	9.80	9.80
Depth temp.	10 m	-	9.23	-	7.22	-	10.51	10.51
	20 m	-	9.73	-	8.03	-	10.60	10.60
	30 m	-	9.11	-	8.38	-	10.25	10.25
	40 m	-	9.15	-	9.36	-	9.73	9.73
	50 m	-	9.52	-	7.50	-	9.29	9.29
	75 m		8.39		5.72			
	100 m		6.98		5.20			
	125 m				4.86			
Depth (m)		142	117	207	138	86	62	62
Sampling method		Sabiki	Bongo	Trawl	Trawl	Sabiki	Trawl	Trawl
Net depth (m)		20-60	115	70-80	125-135	20-70	10-20	15-25
Species caught, Length mode and range (mm)		Japanese anchovy, 116, 116-128	Krill	Nothing	Krill, 16, 13-21, *Maurolicus japonicus*, 23,30,48, etc.	Japanese anchovy, 114, 111-117	Adult sand lance, 118, 97-144, Jelly fish	Adult sand lance, 118, 97-144, Jelly fish
Catches (kg)		0.17	< 0.1	0.0	10.8	0.09	0.5	0.3

Station	St-15
Date	4/27
Time	7:50
Latitude	37-50.549
Longitude	141-33.857
Surf. Temp.	11.50

Depth temp.	10 m	11.42
	20 m	11.25
	30 m	11.21
	40 m	10.84
	50 m	10.20
	75 m	8.52
	100 m	8.27
	125 m	7.97
Depth (m)		135
Sampling method		Trawl
Net depth (m)		125-135
Species caught, Length mode and range (mm)		Krill, 18, 15-22
Catches (kg)		0.1

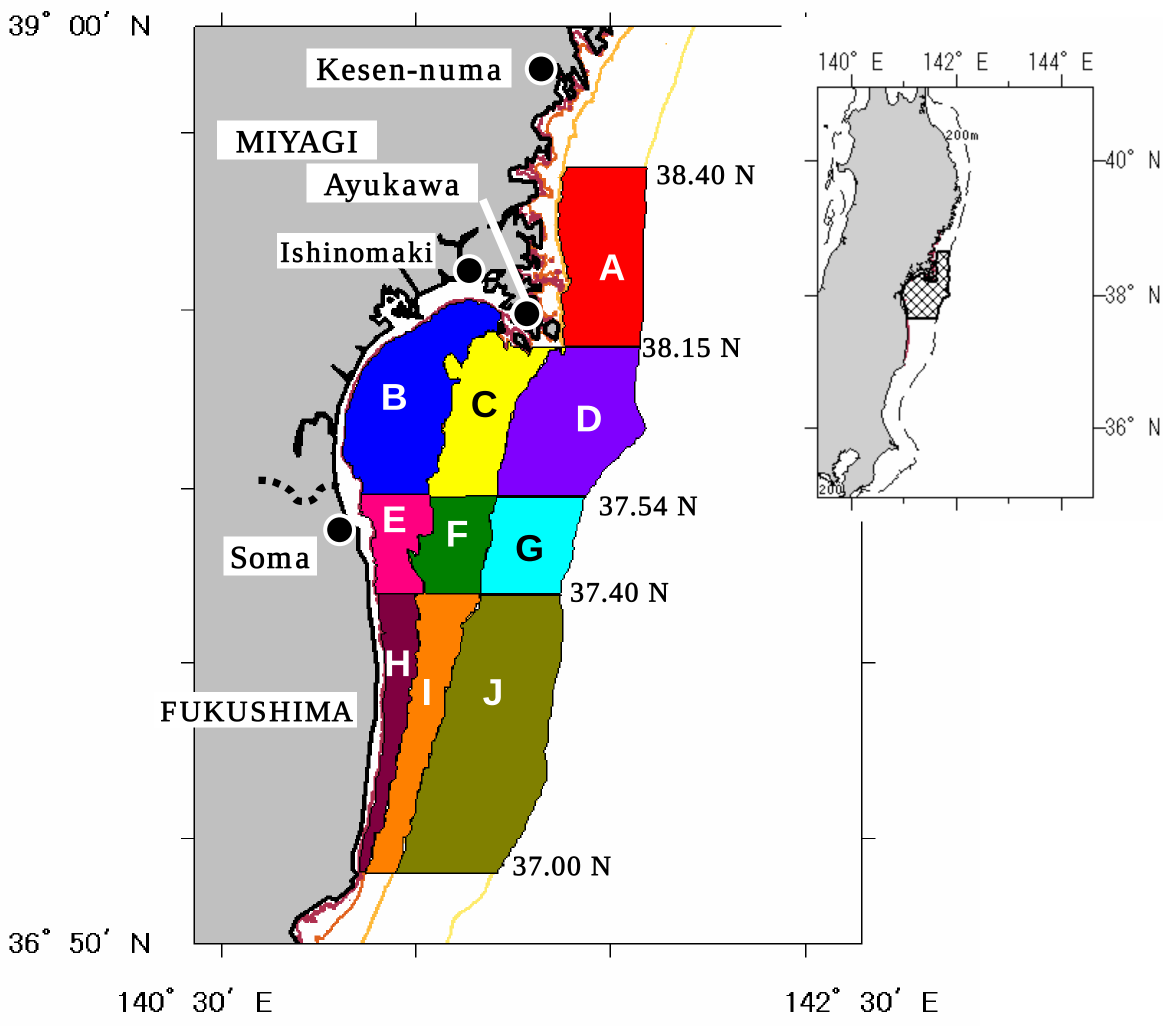

Fig. 1. Survey area and blocks of prey species survey in 2006 off Sanriku.

Appendix 2

Oceanographic conditions in the coastal survey of JARPN II off Sanriku, northeastern Japan, in April 2006

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ABSTRACT

A prey species survey was conducted in the coastal region off Sanriku, northeastern Japan, concurrently with the coastal sampling survey for minke whale during spring 2006 as a part of JARPN II study. Oceanographic observations were conducted with CTD from 11 to 27 April 2006 by *Takuyo-Maru* and XCTD from 8 to 13 April 2006 by *Shunyo-Maru*. According to the CTD data at 39 stations and XCTD data at 11 stations, water masses in the survey area have characteristics of the Cold water (5ºC < temperature < 10ºC at 100m depth). The offshore water was affected by the Warm water spread from the Kuroshio

Introduction

The oceanographic condition at the Tohoku area, northeastern Japan, is one of the most complicated areas in the world. In this area, there are a lot of fronts and water masses. The Kuroshio flows northward along the east coast of Japan to the southern part of the Tohoku area with warm high-salinity water. The Oyashio flows southwestward along the Kuril Islands to the northern part of the Tohoku area with cold low-salinity water. The Kuroshio and the Oyashio flows eastward from the Tohoku area, and the area between the Kuroshio and Oyashio was usually called the Kuroshio-Oyashio Inter-frontal Zone or perturbed area. The Tsugaru warm water enters into the Inter-frontal Zone through Tsugaru Strait, and also the warm-core ring is cut off from the Kuroshio extension into the Inter-frontal Zone. Each water mass is mixed with others, and make a new water mass. The coastal area off Sanriku is the most variable in the Tohoku area, because the Kuroshio, the warm-core ring, the Oyashio, the Tsugaru warm water and other water arrive here by turns.

A prey species survey was conducted on board *Takuyo-Maru* (Miyagi prefecture, 120 GT) and *R/V Shunyo-Maru* (National Research Institute of Far Seas Fisheries, 887GT) in the coastal region off Sanriku, northeastern Japan, concurrently with the coastal sampling survey for minke whale during spring 2006 as a part of JARPN II study. Oceanographic observations were conducted with Conductivity Temperature Depth profiler (CTD) by *Takuyo-Maru* and Expendable Conductivity Temperature Depth profiler (XCTD) by *Shunyo-Maru*. In this paper, we analyzed the CTD and XCTD data to make clear the oceanic environment in the survey area.

Data and Methods

Hydrographic observations with CTD (SBE 19) were carried out at 39 stations from 11 to 27 April 2006 in the coastal area off Sanriku, northeast of Japan (Fig. 1, upper panel). XCTD (Tsurumi MK-130) observations were done at 11 stations from 8 to 13 April 2006 in the southern part of the coastal area (Fig. 1, lower panel).

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. So, the oceanographic conditions in April 2006 (Fig. 2) are detected by 100m and 200m temperature maps using the monthly mean subsurface temperature in seas around Japan from NEAR-GOOS database.

Oceanographic conditions in the survey area

Figure 3 shows the Temperature-Salinity diagrams using CTD and XCTD station data. Almost all water mass in the survey area have characteristics of the Cold water with surface subtropical water. A few stations show cold low-salinity water (less than 33.5 psu), which is mixed with the Oyashio water.

Figure 2 shows the schematic hydrographic map in April 2006. The northern limit of the Warm water spread from the Kuroshio Extension moves northward from March to November. The position of the Warm water in April 2006 was at 38°N on 144°E line, which was a slightly southward position from monthly mean location in April (38°40'N). Tsugaru warm water was obscure because it restricted near the coastal area called by coastal mode in April. The southern limit of the first Oyashio Intrusion located around 39°N, 143°E, which was a little northward position from monthly mean location in April (38°30'N). All stations in the survey area were distributed in the Cold water defined by 100 m temperature which is over 5°C and less than 10°C.

Figure 4 and 5 show temperature and salinity maps at the depth of 100 m, observed by *Takuyo-Maru* and *Shunyo-Maru.* Water of 6°C to 10°C and 33.7 to 34.2 psu were dominant at the depth of 100 m in Fig. 4 and 5. It means that the Cold water occupied in these survey area.

Figure 6 and 7 show vertical section of temperature and salinity. Warm (over 10°C) high-salinity (over 34 psu) water distributed at the offshore area. Low salinity water less than 33 psu was dominant at the shallow layer near the coast in Fig. 6. Although the cold water occupied in these survey area, onshore water was colder and lower salinity than offshore water.

All of these figures show that all stations are distributed in the cold area, but shallow coastal area was modified by the Oyashio water and offshore area was affected by the Warm water spread from the Kuroshio.

Acknowledgment

A special thank is given to Crews of *Takuyo-Maru* and *Shunyo-Maru* for their dedication in collecting data.

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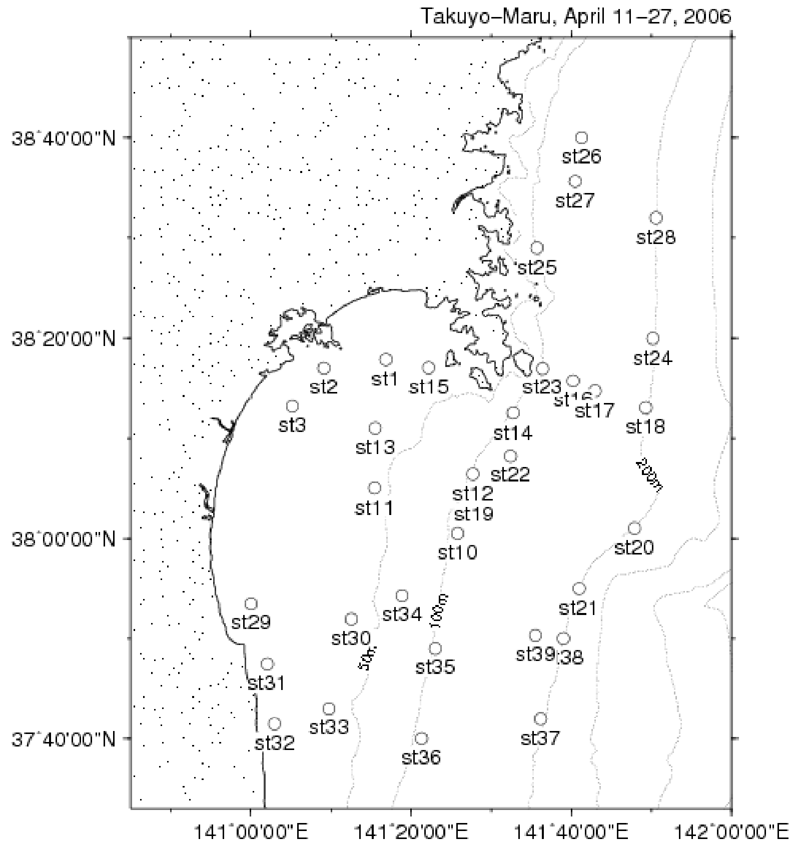
Table 1. Extraction method from temperature map to determine the position of each water mass according to Kawai (1969) and Murakami (1994).

Target characteristics	Extraction method
Kuroshio Extension Axis	14 ºC isotherm at 200m
Warm-core ring	Temperature front at 200m
Oyashio front	5ºC isotherm at 100m
Oyashio water	Area with T < 5ºC at 100m
Cold water	Area with 5ºC < T < 10ºC at 100m
Warm water	Area with T > 10ºC at 100m and T < 14ºC at 200m



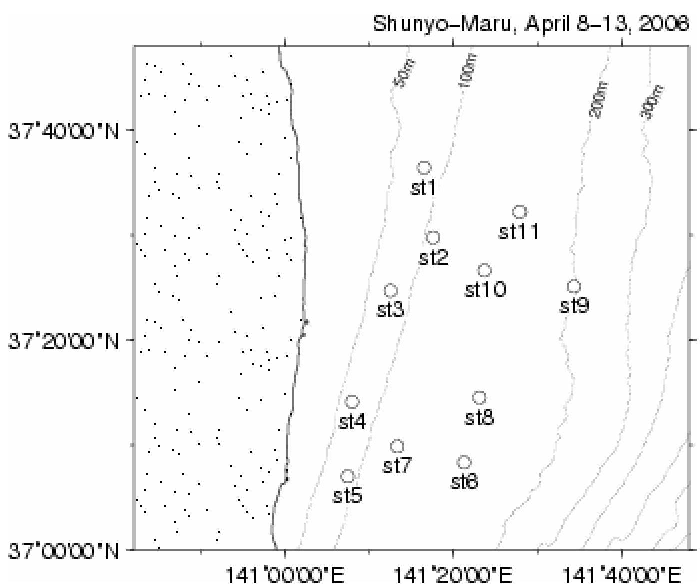


Fig. 1. Station map observed by *Takuyo-Maru* in 11 to 27 April 2006 (upper panel) and *Shunyo-Maru* in 8 to 13 April 2006 (lower panel).

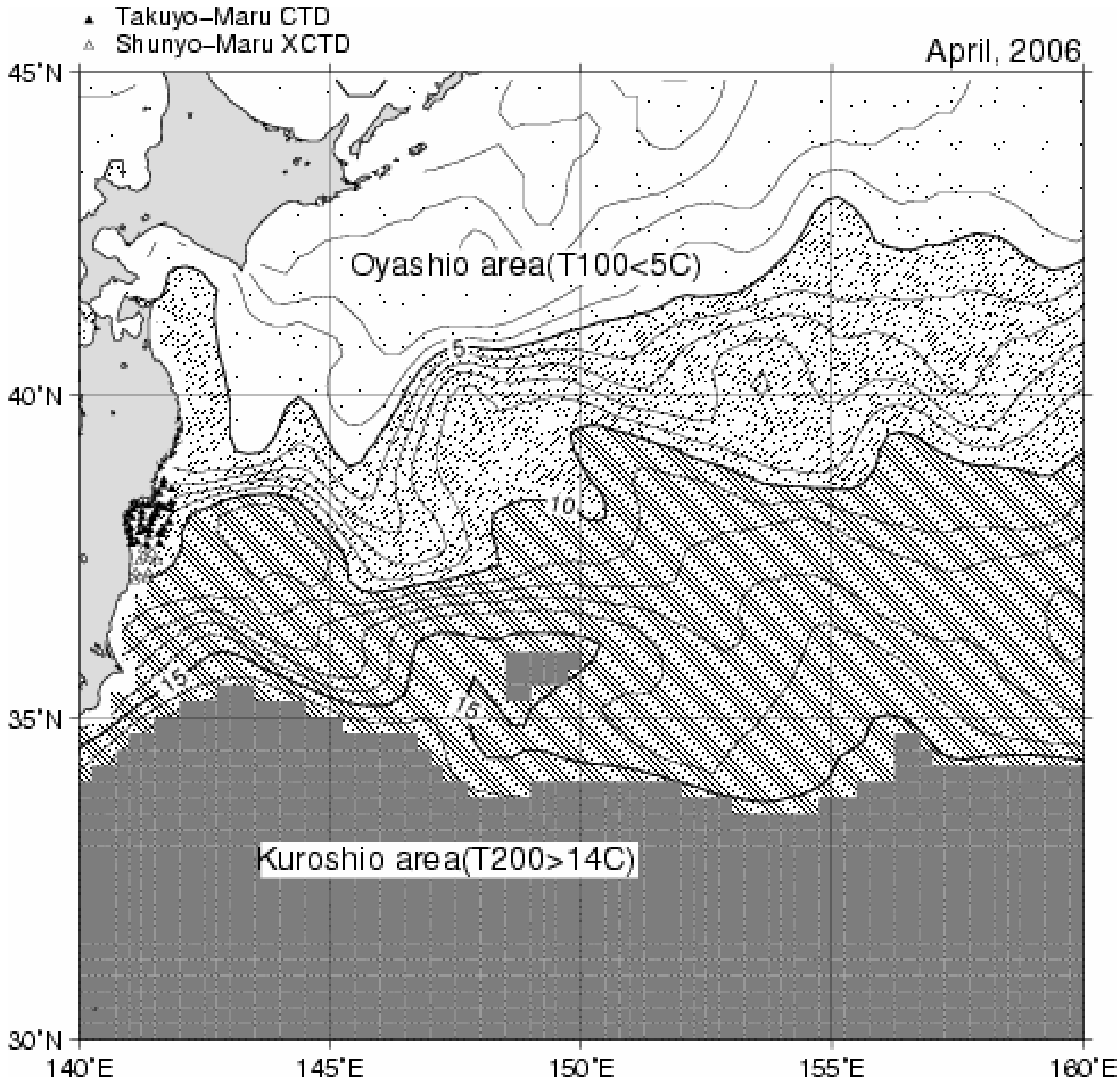


Fig. 2. Schematic hydrographic map in Tohoku area, northwestern Pacific, in April 2006 with station map observed by *Takuyo-Maru* (▲) and *Shunyo-Maru* (△).

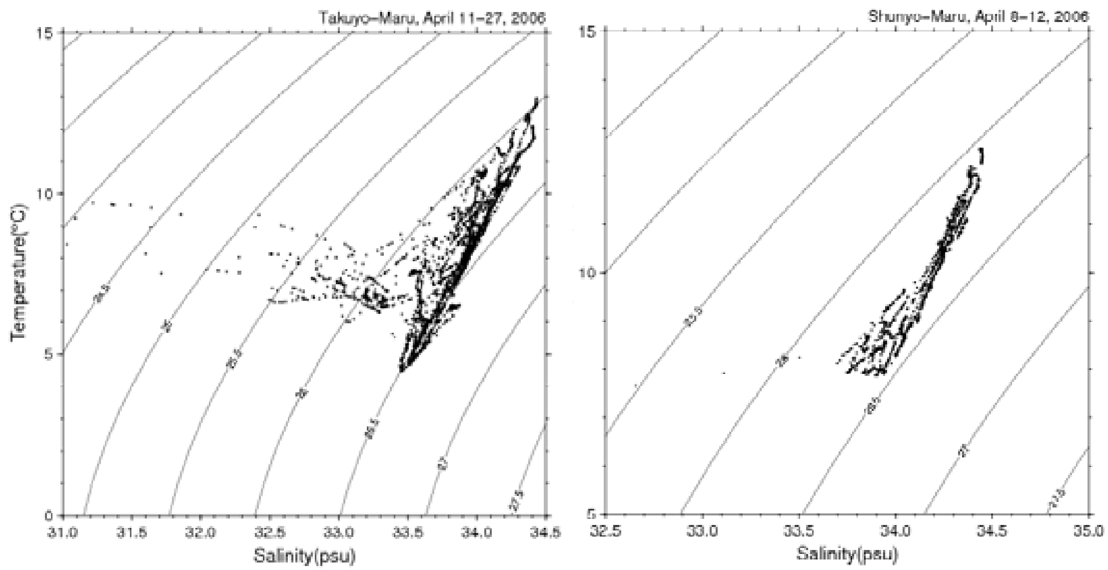


Fig. 3. Temperature-Salinity diagrams using CTD station data observe by *Takuyo-Maru* in 11 to 27 April 2006 (left panel) and *Shunyo-Maru* in 8 to 13 April 2006 (right panel). Each thin line in this figure denotes a density line of sigma-t.

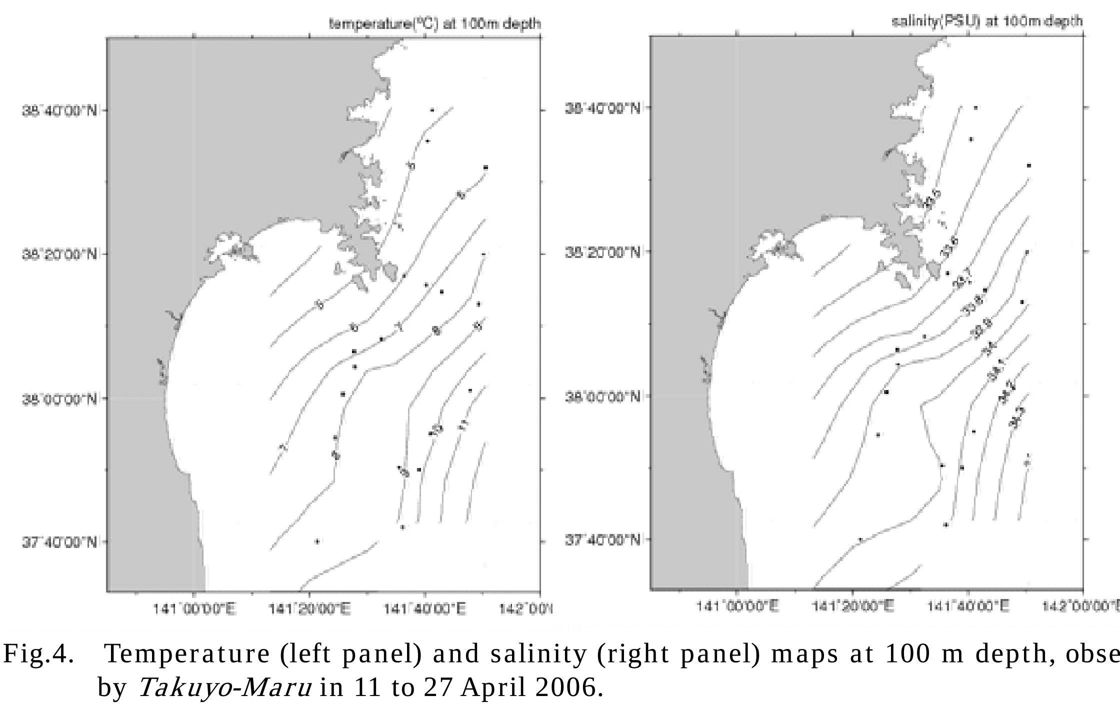


Fig.4. Temperature (left panel) and salinity (right panel) maps at 100 m depth, observed by *Takuyo-Maru* in 11 to 27 April 2006.

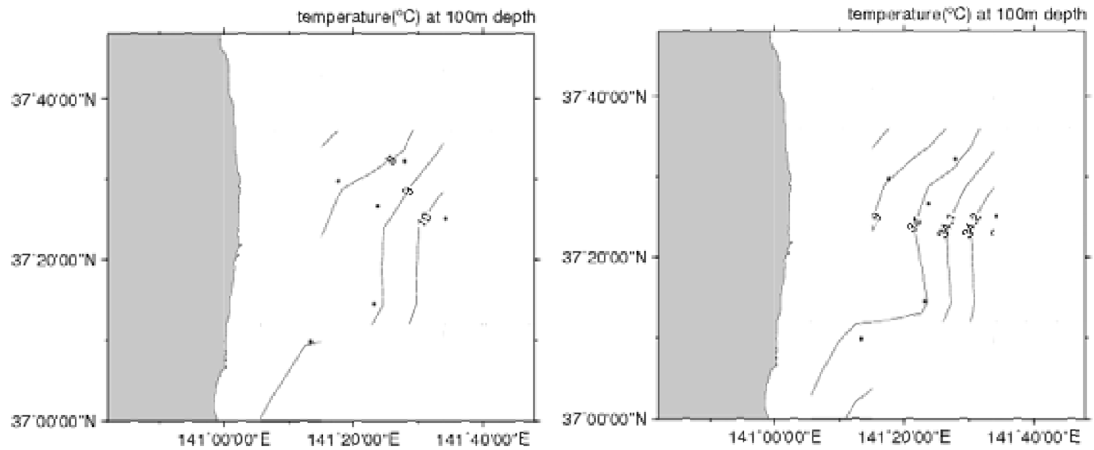


Fig.5. Temperature (left panel) and salinity (right panel) maps at 100 m depth, observed by *Shunyo-Maru* in 8 to 13 April 2006.

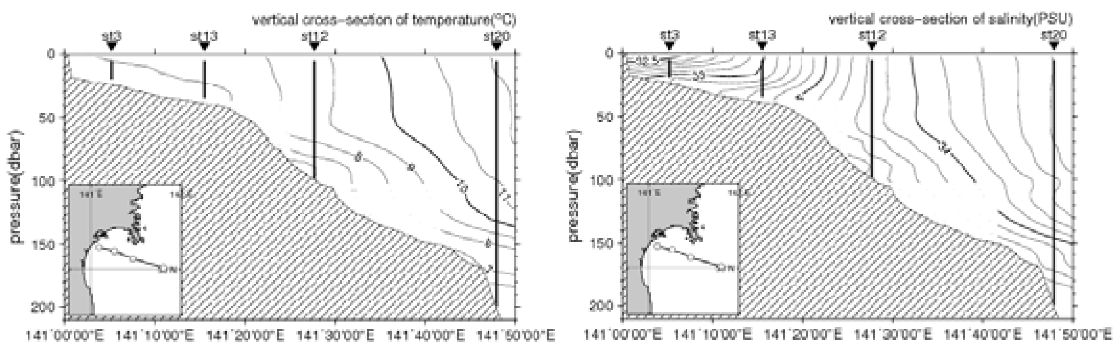


Fig.6. Temperature (left panel) and salinity (right panel) sections, observed by *Takuyo-Maru* in 11 to 27 April 2006.

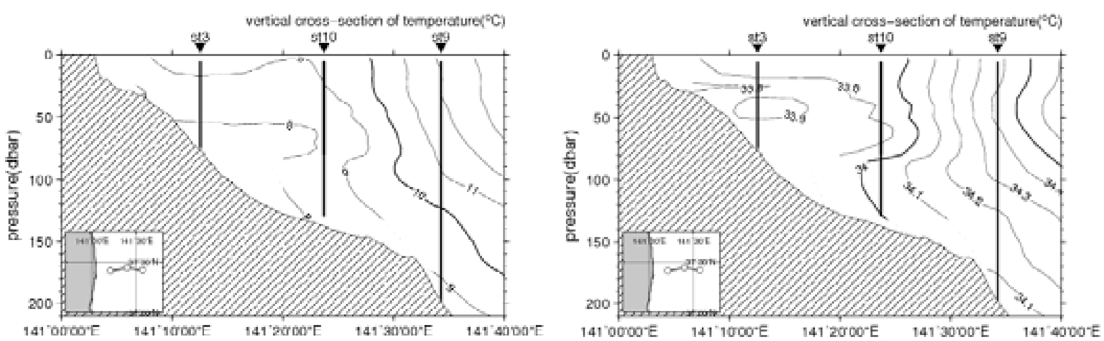


Fig.7. Temperature (left panel) and salinity (right panel) sections, observed by *Shunyo-Maru* in 8 to 13 April 2006.

Appendix 3

Cruise report of the dedicated sighting survey in 2006 JARPNII coastal survey off Sanriku, northeast Japan

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ABSTRACT

A cetacean sighting survey using the line transect method was conducted concurrently with the whale sampling survey and the whale prey survey off the Sanriku coast, Japan from 20 Apr. to 3 May, 2006. The primary objective of the sighting survey was the abundance estimation of baleen whales in the survey area. *Shonan-maru No.2* was dedicated to the sighting survey. Total primary searching distance was 1003.1 n.miles, and the 34 schools (34 individuals) of primary sightings were made.

INTRODUCITON

A cetacean sighting survey using the line transect method was conducted concurrently with the whale sampling survey and the whale prey survey off the Sanriku coast, Japan from 20 April to 3 May, 2006, as a part of coastal component of 2006 JARPN II full scale study (Government of Japan, 2002). The primary objective of this survey was to obtain information on abundance of baleen whales in the survey area. Preliminary results of the cetacean sighting survey are presented in this paper.

MATERIALS AND METHODS

The cetacean sighting survey area was set within Sub-area 7 (Fig. 1). Though the sampling of whales was conducted within the 30 n.miles from Ayukawa port, sighting survey area had larger are extent to see the overall baleen whale distribution pattern off the coast of the Sanriku, between 37N to 39N and shorelines to 142E. Near shore area of the survey block where the water depth is less than 20m was not surveyed because many fisheries gears were set in there. The survey was conducted from 20 Apr. to 3 May, 2006. *Shonan-maru No.2* (SM2, 712GT) engaged in the cetacean sighting survey. Sighting survey procedures were same as offshore component of 2006 JARPN II. The right (*Eubalaena japonica*), blue (*Balaenoptera musculus*), and humpback (*Megaptera novaeangliae*) whales can be approached to obtain the Natural marking record experiments as the opportunistic basis. Large baleen whale feeding behavior visual observation was attempted. If the behavior was observed, it was recorded on video tape.

RESULTS AND DISCUSSION

Tracklines surveyed are shown in Fig. 1. Total primary searching distance was 1003.1 n.miles. The 34 schools (34 individuals) of primary sightings were obtained and one secondary sighting (one animal/one school) was also made. Details of sightings are listed in Table 1. Sightings of common minke whales were recorded. Sighting positions of these sightings are noted in the Fig. 1. No feeding behavior of large baleen whales was observed.

ACKNOWLEDGEMENT

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Table 1. Summary of cetacean sightings made during the dedicated sighting survey in 2006 JARPNII coastal survey.

Species	Primary		Secondary	
	Sch.	Ind.	Sch.	Ind.
Common minke whale	28	28	1	1
Like Common minke whale	1	1		
Fin whale	1	1		
Unidentified large cetaceans	1	1		
Unidentified cetaceans	3	3		
Total	34	34	1	1

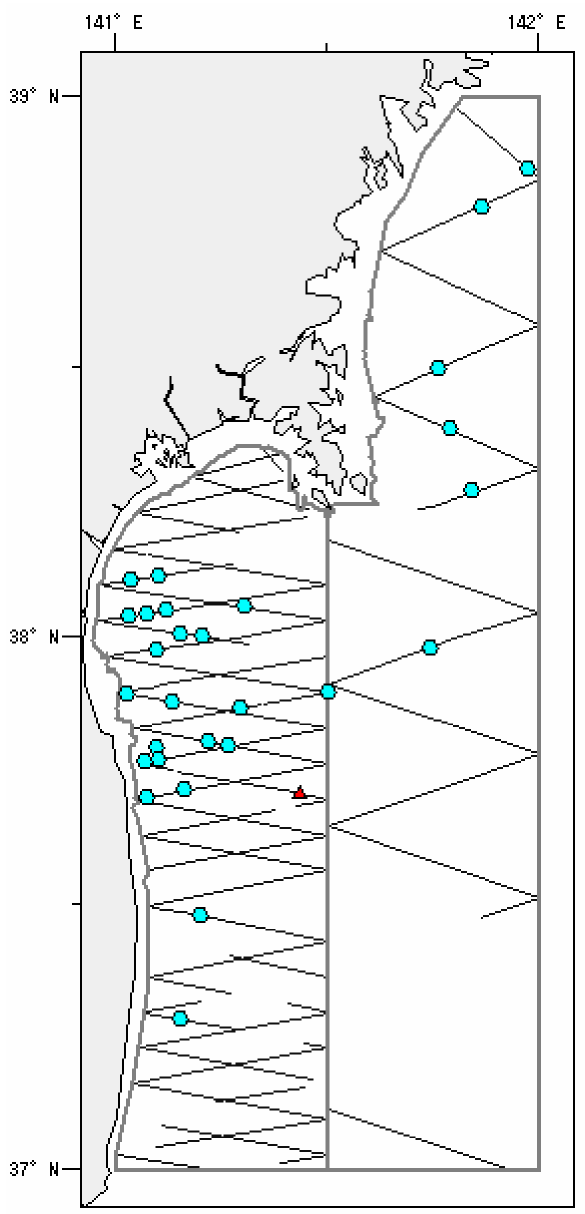

Fig. 1. Survey area and predetermined tracklines, and surveyed tracklines and sighting positions of common minke (●) and fin (▲) whales.