

Cruise report of the second phase of the Japanese Whale Research Program under Special Permit in the Western North Pacific (JARPN II) in 2010 (Part II) - Coastal component off Sanriku.

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ABSTRACT

The seventh survey of the JARPN II coastal component off Sanriku (southern part of the sub-area 7) was conducted from 22 April to 7 June in 2010 using 4 small-type whaling catcher boats and one echo sounder trawl survey vessel. Sampling of common minke whales was conducted in coastal waters within 50n. miles from Ayukawa port in the Sanriku district, and all animals sampled were landed on the research station established for biological examination. During the 47 days survey, a total of 8,957.0n. miles was surveyed and 62 schools (62 individuals) of common minke whales were sighted. A total of 45 whales were sampled. Average body length was 6.02m (SD: 1.15, $n=18$) for males and 5.12m (SD: 0.99, $n=27$) for females. Dominant prey species found in forestomach of the animals were Japanese sand lance (*Ammodytes personatus*) followed by krill (*Euphausia pacifica*). Japanese anchovy (*Engraulis japonicus*) was observed in only one of the animals sampled. The density of sand lance, as detected by echo sounder, was lower than in previous years, which could have affected the distribution pattern of common minke whales.

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

INTRODUCTION

After a 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 objectives of JARPN II are, i) feeding ecology and ecosystem studies, involving prey consumption by cetaceans, prey preferences of cetaceans and ecosystem studies, ii) monitoring environmental pollutants in cetaceans and the marine ecosystem and iii) elucidation of the stock structure of whales (Government of Japan, 2002). The JARPN II has both coastal and offshore component. The coastal component involves surveys in two coastal localities, Sanriku in spring and Kushiro in fall. Annually a maximum of 60 whales is sampled in each locality.

The objective of this paper is to report the results of the seventh survey carried out in coastal waters off the Sanriku district, Japan, from 22 April to 7 June in 2010. 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 in cooperation with the 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

The research area was set in the same manner as in previous JARPN II surveys off Sanriku (Yoshida *et. al.*, 2004; 2006; Goto *et al.*, 2007; Bando *et al.*, 2008; Yasunaga *et al.*, 2009; 2010). The Sanriku district occupies the northeastern part of the Japanese main island, Honshu (Figure 1). The research area coincides with important fishing grounds, and the waters off Sanriku were the whaling ground for the past coastal commercial whaling (Miyashita and Hatanaka, 1997). The research area was set within 50n. miles from the Ayukawa port (Figure 1). The survey area is located in the southern 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). All the animals sampled were landed on the JARPN II research station established in the Ayukawa port for biological examination.

Prey species survey

The *Takuyo Maru* (TAK, 120.0GT), a trawler-type research vessel, conducted the prey species survey in the area off northeast coast of Honshu from 16 April to 22 May. The distribution and abundance of the prey species were investigated using a quantitative echo sounder (EK 500 and ER 60). Acoustic data were acquired with operating frequency at 38, 120 and 200 kHz. Species/size compositions of echo signs were identified by the samples obtained by mid-water trawling. Details of the prey species surveys are shown in Appendix. The research vessel TAK also carried out oceanographic observation using CTD and EPCS.

Sighting and sampling methods

Sighting and sampling methods by whale sampling vessels were almost the same as in the past coastal surveys conducted off Ayukawa. The research head office was placed in the research station and operated the sampling vessels during the survey. To avoid concentration of sampling effort, the research area was divided into three small areas.

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 was collected for all baleen whales, sperm whales and killer whales. 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 pairs. 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 caught a whale, it returned to the Ayukawa port to transport the animal to the research station. While returning to the port, other common minke whales sighted were also targeted for sampling, if the situation allowed. At the port, the sampled whale was lift up from the vessel using wire nets and a crane and transported to the station by freight trailer. At that time, body weight of the whale 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 2. 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, 07K and 31S) are shown in Figure 2. The sampling vessels tried to cover research areas widely within 30n. miles from Ayukawa port. Usually searching activity is low in offshore waters because of changeable weather condition and bigger waves for small sampling vessels. In the present survey a larger amount of sighting effort was put in

offshore waters compared to past surveys. Searching distance made by the four sampling vessels is listed in Table 1. The total searching distance made by the four vessels was 8,957.0n. miles.

Sightings and samplings of common minke whales

Sighting positions of common minke whale schools recorded by the sampling vessels are shown in Figure 3. Much of common minke whale sightings were made in the middle part of Sendai Bay. As shown in Table 1, a total of 62 schools (62 individuals) of common minke whales were sighted. These were 59 primary sightings (59 animals) and three secondary sightings (three animals). No cow-calf pairs were sighted. Density index (DI: the number of primary sightings of schools per 100 n. miles searching) of common minke whales was calculated as 0.66. Of the 62 common minke whales sighted, 45 individuals were sampled. No struck and lost occurred.

Sighting of other large cetaceans

A total of 62 schools (69 individuals) of humpback whales and 13 schools (38 individuals) of killer whales were sighted (Table 1). Sighting positions of those whales were shown in Fig. 3.

Sex ratio, body length and weight of animals caught

Research items of biological examination are summarized in Table 2, including the number of data and samples obtained. The sampled 45 animals consisted of 18 males and 27 females. Sex ratio of males was 0.40. Average body length was 6.02m (max=7.77, min=4.27, SD: 1.15) for males and 5.12m (max=8.45, min=3.69, SD=0.99) for females (Table 3). Frequency of body length of common minke whale by sex was shown in Figure 4. Composition of sex and sexual maturity status is listed in Table 4. In males, six of 18 animals were sexually mature (33.0%). Only one female (in 27 females sampled) was sexually mature (3.7%).

Prey species of common minke whale

Stomach contents of all sampled animals were examined except for nine animals where the stomachs were broken by the harpoon. Forestomach contents were listed in Table 5. The dominant prey species were adult sand lance (*Ammodytes personatus*) (75.0%, found in 27 of 36 animals) following by krill (19.4%, found in seven 7 of 36 animals). Japanese anchovy (*Engraulis japonicus*) was recorded from only one animal.

DISCUSSION

Same as in previous surveys bad weather conditions such as low atmospheric pressure, bigger waves and fog were common in the present survey. Nevertheless, considerable amount of research effort was expended in offshore waters compared to previous surveys (Figure 2).

Distribution of common minke whales was concentrated to Sendai Bay, but some whales were sighted in offshore waters (Figure 3). The density index of common minke whales was 0.66, which was the lowest among the past seven surveys. Abundance of sand lance, which was major prey species of common minke whales in the research area, was low in this season (Onodera personal communication), which might affect distribution pattern of common minke whales. Sea surface temperature in Sendai Bay in April was lower than in usual years and this condition continued until the end of May (Onodera personal communication), which would also affected distribution pattern of common minke whales and their prey species.

Large number of humpback and killer whales was sighted in this survey. Humpback whale was very rare and only two individuals were sighted until 2008 (Yoshida *et al.*, 2004; 2006, Goto *et al.*, 2007, Bando *et al.*, 2008, Yasunaga *et al.*, 2009). Sighting of humpback whales suddenly increased to 34 school/35 individuals in 2009 (Yasunaga *et al.*, 2010) and 62 school/69 individuals were sighted in the present survey. Although these figures probably include some duplicated sightings, the number of humpback whales is becoming similar to that of common minke whales. Increase of humpback sighting was also reported in Kushiro region (Kishiro *et al.*, 2010).

Same as in previous surveys, immature whales dominated in the research area. In the case of females only one mature whale was found among 27 individuals sampled. This segregation pattern was typical of recent surveys (Yasunaga *et al.*, 2009; 2010). This result indicates that research area is important feeding and migration area for immature whales. Dominant prey species of common minke whale were Japanese sand lance followed by krill. Krill was observed especially from whales sighted in water of more than 100m depth (Figure 5). High density of krill in these areas was also observed by the prey species survey (Onodera personal communication), which suggests that common minke whales feed on what is abundant in the area.

From the present survey we obtained valuable information on feeding ecology of minke whales. To increase the precision of estimates of food consumption and to understand the variability in prey consumption the continuation of systematic coastal surveys is required.

ACKNOWLEDGMENTS

We acknowledge Shigeki Takaya, the Fisheries Agency of Japan, for his guidance and implementation to the research. Crewmen of research vessels, staffs of the research station in Ayukawa, and the Japan small-type whaling association contributed greatly to this survey. We also thank all the members of the municipal office of Ishinomaki, the Ojika fisheries Cooperative Association, and the Miyagi Prefectures office, for their kind assistance.

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Table 1. Searcheng days, distances and number of sightings made by the whale sampling survey.

Period	Days	Distances (n. miles)	Species	Number of sightings					
				Primary		Secondary		Total	
				Sch.	Ind.	Sch.	Ind.	Sch.	Ind.
22 Apr. - 7 Jun.	47	8957.0	Common minke whale	59	59	3	3	62	62
			Like minke whale	33	33	1	1	34	34
			Humpback whale	59	66	3	3	62	69
			Killer whale	11	31	2	7	13	38

Table 2. Summary of biological data and samples.

Data and samples	Number of whales		
	Male	Female	Total
Body length and sex	18	27	45
External body proportion	18	27	45
Photographic record and external character	18	27	45
Diatom film record	18	27	45
Body scar record	18	27	45
Measurements of blubber thickness (5 points)	18	27	45
Detailed measurements of blubber thickness (11 points)	0	1	1
Body weight	18	27	45
Body weight by parts	0	1	1
Skin tissues for DNA study	18	27	45
Muscle, liver, kidney, and blubber for heavy metal analysis	18	27	45
Muscle, liver, kidney, and blubber for organochlorines analysis	18	27	45
Muscle and blubber for byproduct analysis	18	27	45
Muscle, liver, kidney, spleen, blubber, heart and ventral goove for various analysis	18	27	45
Muscle and vertebra for lipid analysis	0	1	1
Urine for various analysis	7	6	13
Mammary gland; lactation status, measurement and histological sample	-	27	27
Uterine horn; measurements and endometrium sample	-	27	27
Collection of Ovary	-	27	27
Photographic record of foetus	0	1	1
Foetal sex (identified by visual observation)	0	1	1
Foetal length and weight	0	1	1
External measurement of foetus	0	1	1
Muscle, liver, kidney, heart, blubber and skin tissues of foetus	0	1	1
Testis and epididymis; weight and histological sample	18	-	18
Stomach contents, convenient record	18	27	45
Volume and weight of stomach content in each compartment	18	27	45
Observation of marine debris in stomach	18	27	45
Stomach contents for feeding study	18	27	45
Stomach contents for multipurpose study	1	2	3
Record of external parasites	18	27	45
Earplug for age determination	18	27	45
Tympanic bulla for age determination	18	27	45
Largest baleen plate for morphologic study and age determination	18	27	45
Baleen plate measurements (length and breadth)	18	27	45
Photographic record of baleen plate series	18	27	45
Length of baleen series	18	27	45
Eye lens for age determination	18	27	45
Collection of blood plasma	15	26	41
Vertebral epiphyses sample	18	27	45
Number of ribs	18	27	45
Skull measurement (length and breadth)	18	26	44
Brain weight	0	1	1

Table 3. Statistics of body length (m) of common minke whales.

Period	Male					Female				
	n	mean	S.D.	Min.	Max.	n	mean	S.D.	Min.	Max.
22 Apr. - 5 May	4	6.38	1.39	4.27	7.77	10	5.25	0.66	4.37	6.53
6 May - 20 May	5	6.09	1.03	4.79	7.46	8	4.66	0.72	3.69	5.62
21 May - 7 June	9	5.81	1.04	4.35	7.57	9	5.37	1.32	3.73	8.45
Total	18	6.02	1.15	4.27	7.77	27	5.12	0.99	3.69	8.45

Table 4. Composition of sex and sexual maturity status.

Period	Male				Female				Sex ratio (%males)
	Imm.	Mat.	Total	Maturity (%)	Imm.	Preg.	Total	Maturity (%)	
22 Apr. - 5 May	2	2	4	50.0	10	0	10	0.0	28.6
6 May - 20 May	3	2	5	40.0	8	0	8	0.0	38.5
21 May - 7 June	7	2	9	22.2	8	1	9	11.1	50.0
Total	12	6	18	33.3	26	1	27	3.7	40.0

Table 5. Number of common minke whales by major prey species found in their forestomach contents.

Period	Prey species					Total
	Sand lance (adult)	Krill	Japanese anchovy	None	Unknown*	
22 Apr. - 5 May	10 (71.4)	3 (21.4)	0 (0.0)	0 (0.0)	1 (7.1)	14
6 May - 20 May	7 (53.8)	3 (23.1)	0 (0.0)	0 (0.0)	3 (23.1)	13
21 May - 7 June	10 (55.6)	1 (5.6)	1 (5.6)	1 (5.6)	5 (27.8)	18
Total	27 (60.0)	7 (15.6)	1 (2.2)	1 (2.2)	9 (20.0)	45

*Stomach was broken by harpoon

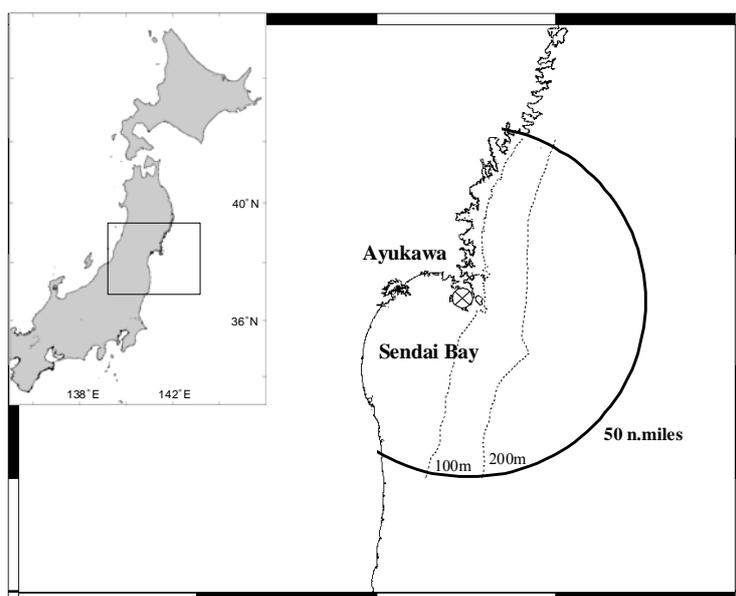


Fig. 1. Research area of the 2010 JARPN II coastal survey off Sanriku.

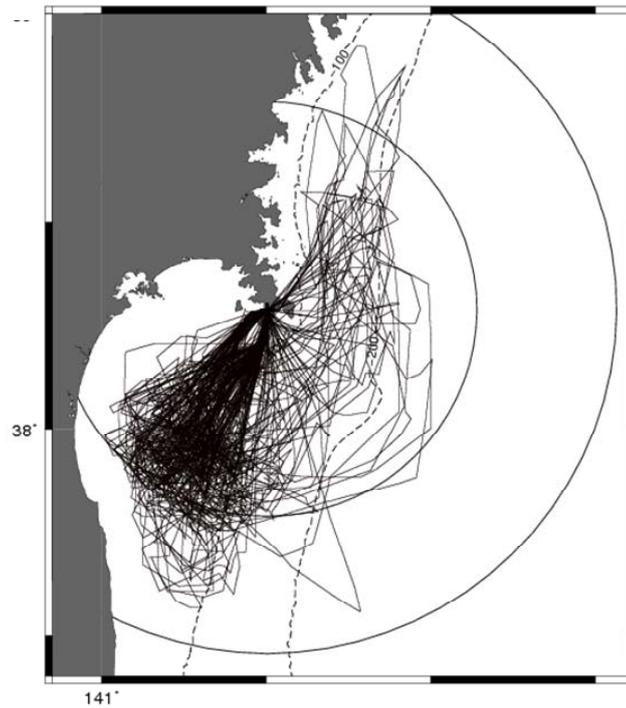


Fig. 2. Cruise trucks made by 4 sampling vessels.

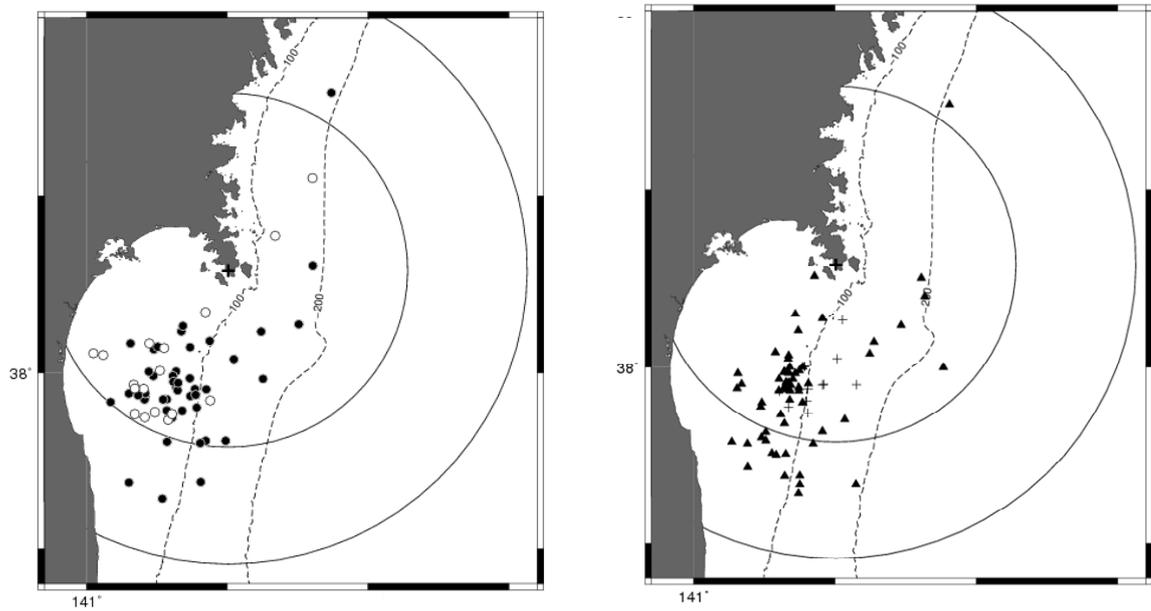


Fig. 3. Sighting position of common minke (left, ●: sighted and sampled, ○: sighted only), humpback (right :▲) and killer (right :+) whales.

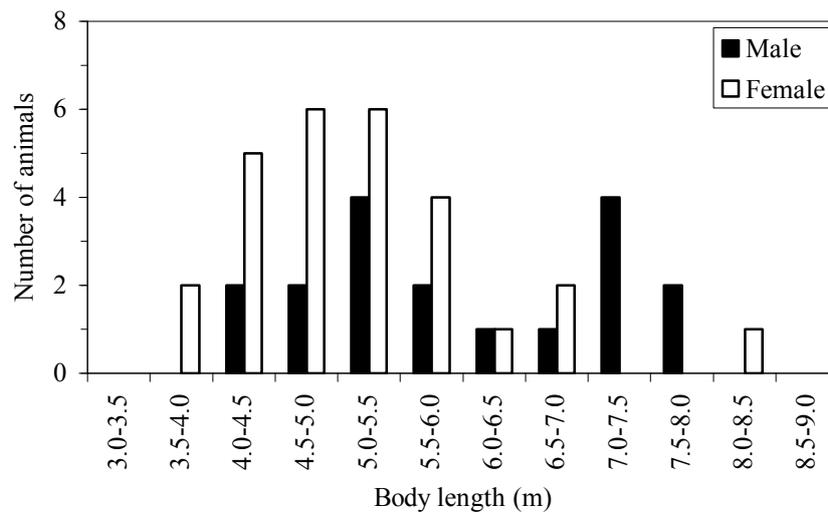


Fig. 4. Body length frequency of common minke whales.

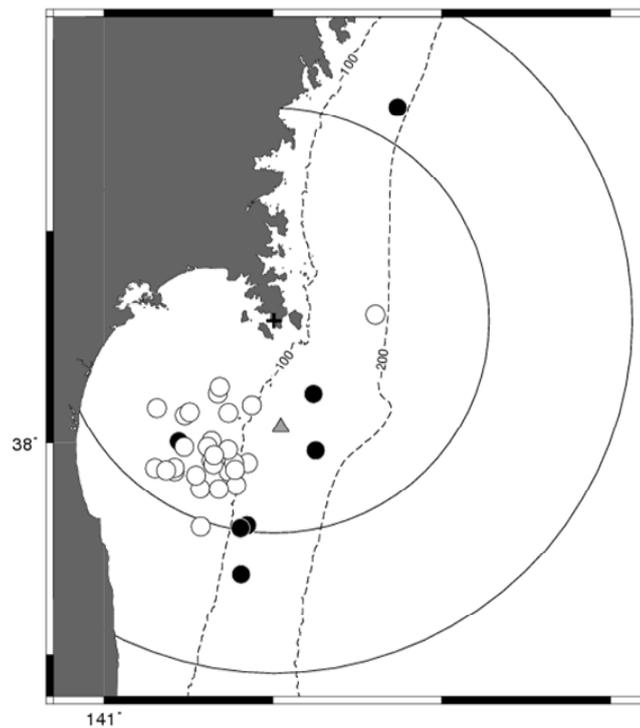


Fig. 5. Sighting position of common minke whales by major prey species (○: sand lance, ●: krill, ▲: Japanese anchovy) found in the forestomach.

Appendix

Coastal prey species survey of JARPN II off Sanriku in 2010

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ABSTRACT

A prey species survey was conducted in the coastal region off Sanriku, northeastern Japan in spring 2010 as a part of JARPNII coastal component off Sanriku. The survey was conducted concurrently with a sampling survey of common minke whales. The survey was conducted in April (16 - 27 April) and May (13 - 22 May). Four stratified blocks were surveyed. Zigzag tracklines were set in the blocks. The Same blocks and tracklines were surveyed in April and May to see whether occurrence patterns of prey species were different between the months. A trawler type RV, Takuyo-maru, conducted the survey. Acoustic data were recorded continuously along tracklines by a quantitative echosounder. Samplings using a midwater trawl net were conducted at 12 stations to identify species and body size compositions of acoustic backscatterings. Vertical oceanographic conditions were recorded at 44 stations by using a CTD. Subsurface oceanographic conditions were recorded continuously along tracklines.

INTRODUCTION

JARPN II is designs to contribute to conservation and sustainable use of marine living resources including whales in the western North Pacific, especially within Japan's EEZ (Government of Japan, 2002). One of the major objectives of JARPNII is to study feeding ecology of cetaceans and ecosystem studies, involving studies of prey consumption by cetaceans, prey preference of cetaceans and ecosystem modeling. To accomplish the goal, a sampling survey of common minke whales (*Balaenoptera acutorostrata*) and a survey on biomass estimation of their prey species have been conducted concurrently off Sanriku, Japan since 2003 as a JARPNII coastal component. In this document, the results of the prey species survey off Sanriku in 2010 are presented.

MATERIALS AND METHODS

While the sampling survey of minke whales was conducted in the coastal waters within the 50 n.miles (mainly within 30 n.miles) from Ayukawa, Miyagi prefecture, Japan, the prey species survey was conducted in wider area at bottom depths between 20 m and 200 m from 37° 40' N to 38° 15' N off Sanriku, northeastern Japan, to elucidate the distribution and abundance of main prey species. Seven survey blocks (A-G) have been set within the survey block since 2005 for the purpose of biomass estimation of prey species based on a stratified random sampling method using echosounder data (Fig 1a). Stratification of blocks was based on bottom depth (20, 40, 100, and 200m) and political boundary (boundary between Miyagi and Fukushima prefecture). Because of logistical constraint, only 4 blocks (B, C, E and F) were surveyed in 2010 (Fig. 1b). A zigzag track line was set in each block. The waypoints of planned tracklines in each block were shown in Table 1.

The survey was conducted in April (16 - 27 April) and May (13 - 22 May). Same blocks and tracklines were surveyed in April and May to see whether occurrence patterns of prey species were different between the months. The survey was conducted during the daytime from

an hour after sunrise to an hour before sunset. Acoustic, trawl and oceanographic surveys were conducted using a trawler-type RV, "Takuyo maru" (Miyagi prefecture, 120 GT). Data of distribution and abundance of the prey species were recorded by a quantitative echosounder, EK500 (Simrad, Norway) with operating frequency at 38, 120 and 200 kHz. The RV steamed at 9-10 knots along the tracklines. Acoustic data were stored with an aid of software, Echoview (Sonar Data, Australia). A calibration was carried out in the survey area on 16 April using the copper sphere technique described in EK 500 manual. Vertical oceanographic observations were conducted with CTD. Subsurface (approximately 5m water depth) temperature, salinity and chlorophyll-a were recorded every minute (in time) along the tracklines.

Trawl sampling was conducted to identify the species and size compositions of targeting echosigns. The trawl net had a mouth opening of 7 m (width) by 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 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. Scale and standard lengths were used to Japanese anchovy (*Engraulis japonicus*) and sand lance (adult and juvenile, *Ammodytes personatus*), respectively. Total length from the tip of the rostrum to the end of the telson was used for krill (*Euphausia pacifica*). Some frozen samples were taken for further analysis in the laboratory.

RESULTS

The planned tracklines were almost surveyed by the quantitative echosounder. Trawl was towed at 12 stations. A summary of the midwater trawl samplings was shown in Table 2. CTD casts were conducted at 44 stations. Occurrences of prey species were different between April and May. In April, backscatterings of juvenile sand lance and krill were observed while these of adult sand lance and Japanese anchovy were rarely observed. In May, number of backscatterings of adult sand lance and Japanese anchovy was increased. Backscatterings of juvenile sand lance and krill were also observed in May. Detailed analysis will be conducted in the laboratory and the results will be presented in the near future.

ACKNOWLEDGEMENT

We would like to thank the captain of RV "Takuyo-Maru", Mr. Hiroaki Kimura, and his crews who assisted us to collect a valuable data set. This survey was supported by Fisheries Agency of Japan, Miyagi Prefecture and the Institute of Cetacean Research. We thank these institutions for their support.

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Table 1. Waypoints and planed lines.

Block B

Waypoint	Latitude				Longitude				Course (degree)	Distance (n.miles)
B1	37	-	54.0	N	141	-	12.3	E	294	13.5
B2	37	-	59.5	N	140	-	56.7	E	70	15.8
B3	38	-	05.0	N	141	-	15.5	E	294	13.6
B4	38	-	10.5	N	140	-	59.7	E	71	16.7
B5	38	-	16.0	N	141	-	19.8	E	332	5.7
B6	38	-	21.0	N	141	-	16.4	E	-	-
									Total	65.3

Block C

Waypoint	Latitude				Longitude				Course (degree)	Distance (n.miles)
C1	38	-	15.0	N	141	-	31.7	E	108	1.6
C2	38	-	14.5	N	141	-	33.6	E	253	13.3
C3	38	-	10.5	N	141	-	17.5	E	116	9.0
C4	38	-	06.5	N	141	-	27.7	E	248	10.8
C5	38	-	02.5	N	141	-	15.0	E	117	8.8
C6	37	-	58.5	N	141	-	25.0	E	248	10.8
C7	37	-	54.5	N	141	-	12.3	E	116	1.1
C8	37	-	54.0	N	141	-	13.6	E	-	-
									Total	55.4

Block E

Waypoint	Latitude				Longitude				Course (degree)	Distance (n.miles)
E1	37	-	54.0	N	141	-	00.2	E	109	10.8
E2	37	-	50.5	N	141	-	13.1	E	248	9.4
E3	37	-	47.0	N	141	-	02.0	E	121	6.8
E4	37	-	43.5	N	141	-	09.4	E	237	6.4
E5	37	-	40.0	N	141	-	02.7	E	-	-
									Total	33.4

Block F

Waypoint	Latitude				Longitude				Course (degree)	Distance (n.miles)
F1	37	-	54.0	N	141	-	22.9	E	249	8.4
F2	37	-	51.0	N	141	-	13.0	E	114	8.6
F3	37	-	47.5	N	141	-	23.0	E	252	11.5
F4	37	-	44.0	N	141	-	09.1	E	110	10.3
F5	37	-	40.5	N	141	-	21.4	E	247	1.3
F6	37	-	40.0	N	141	-	19.9	E	-	-
									Total	40.2

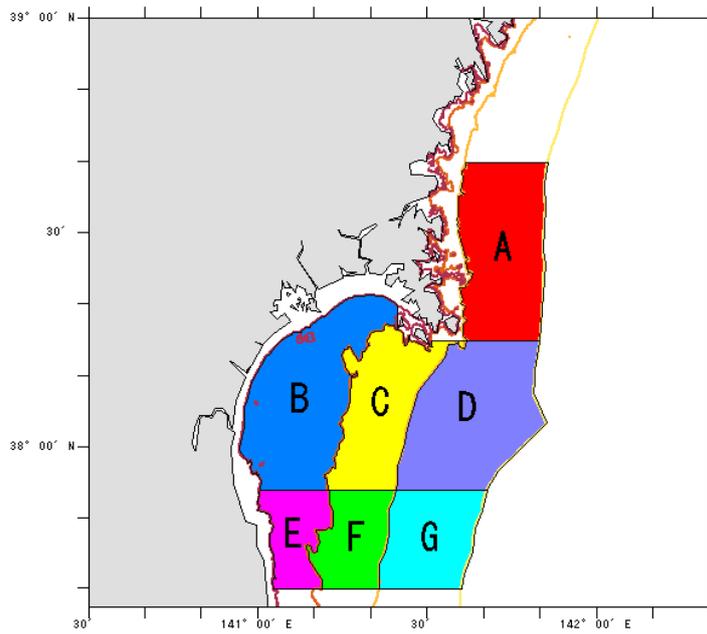
Table 2. A summary of the trawl sampling.

April

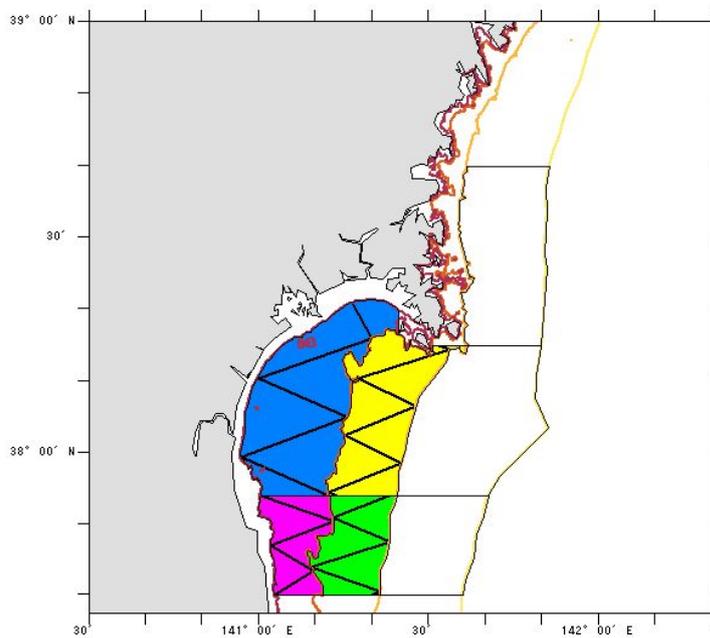
Station	St-1	St-2	St-3	St-4	St-5	St-6	
Block	B	B	B	C	F	F	
Date	19 Apr.	19 Apr.	20 Apr.	20 Apr.	26 Apr.	26 Apr.	
Time	11:16	15:33	9:17	15:15	11:38	15:35	
Latitude	38-11N	38-00N	37-58N	38-05N	37-50N	37-40N	
Longitude	141-04E	140-58E	140-59E	141-24E	141-15E	141-20E	
Temp (°C) by depth	0 m	8.3	8.1	8.2	8.3	7.6	6.9
	10 m	7.3	7.5	7.7	7.1	7.6	6.9
	20 m	7.4	7.5		7.0	7.0	6.7
	30 m				6.7	6.7	6.6
	40 m				7.0		6.0
	50 m				7.1		5.7
	75 m						5.0
	100 m						
	Bottom (m)	7.2 (22m)	7.2 (24m)	7.3 (16m)	5.8 (73m)	5.9 (39m)	5.0 (88m)
Trawl sampling depth (m)	10-20	10-15	10-20	50	40	30-40	
Major sampled species	Sand lance (juvenile)	Sand lance (juvenile)	Sand lance (juvenile)	<i>Maurollicus japonicus</i>	Krill	Krill	

May

Station	St-9	St-10	St-11	St-12	St-13	St-14	
Block	B	B	C	F	F	F	
Date	17 May	18 May	19 May	21 May	22 May	22 May	
Time	12:35	9:07	11:41	13:14	11:04	13:45	
Latitude	38-13N	37-59N	38-06N	37-40N	37-47N	37-54N	
Longitude	141-11E	140-56E	141-26E	141-20E	141-22E	141-23E	
Temp (°C) by depth	0 m	14.0	14.2	12.7	13.8	13.4	14.8
	10 m	10.1	9.7	10.4	11.1	10.5	11.9
	20 m	7.2		8.8	7.0	7.6	10.4
	30 m	6.1		7.3	5.9	6.2	8.3
	40 m			5.6	5.5	5.6	7.2
	50 m			6.8	5.1	5.3	6.2
	75 m			5.5	5.1	5.1	5.7
	100 m						
	Bottom (m)	6.1 (31m)	7.3 (16m)	5.3 (86m)	5.1 (87m)	5.1 (79m)	5.2 (86m)
Trawl sampling depth (m)	5	10	85	80	80	80	
Major sampled species	Japanese anchovy	Sand lance (juvenile)	Krill	Sand lance (adult)	Krill	Sand lance (adult)	



(a)



(b)

Fig. 1. Survey Blocks (a) and planned tracklines (b) in 2010. Block A, D and G were not surveyed in 2010.