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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 2015 (Part II) coastal component off Sanriku

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INTERNATIONAL WHALING COMMISSION

Cruise report of the second phase of the Japanese whale research program under special permit in the western North Pacific (JARPN II) in 2015 – (Part II) – coastal component off Sanriku

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ABSTRACT

As part of the JARPN II in 2015, four small-type whaling catcher boats, *Taisho Maru No.28*, *Koei Maru No.8*, *Katsu Maru No.7* and *Sumitomo Maru No.51* conducted the whale sampling survey in the coastal region of Japan. This paper reports the results of the coastal component (off Sanriku) of the Japanese whale research program under special permit in the western North Pacific (JARPN II) in 2015. The survey was carried out on the Pacific coast of Japan (the sub-area 7CS) from 10 April to 26 May 2015. The research was set in coastal waters within 50n.miles from Ayukawa Port in Miyagi Prefecture in the Sanriku district of Japan using four small-type whaling catcher boats as sampling vessels. During the survey, a total of 5,776n.miles (596 hours) was surveyed, a total of 31 sightings of common minke whales was made. The trial of biopsy sampling and faecal sampling for common minke whales was conducted in this survey using the Larsen biopsy gun system. On April 5, 2015 Gunners and researchers had a meeting for the experiment and treatment of the system. The trial of shooting was carried out. During the survey, one sighting of common minke whale had been encountered during a total searching 54 hours 32 minutes. A trial for biopsy skin sampling was conducted. After one hour 36 minutes chasing, no samples were collected because of the quick movement of target whale. A total of 19 animals were lethally sampled from 31 primary sightings of common minke whales. All sampled animals were landed at the land research station in Ayukawa where biological examinations were carried out. Regarding dominant prey species found in the forestomach, most were classified as krill (44.4%), followed by adult sand lance (22.2%), Japanese sardine (22.2%) and juvenile sand lance (11.1%). Among the four prey species observed in this survey, Japanese sardine were continuously observed. In terms of body length, average body length of the sampled animals was 4.99m (SD=0.78) for males, and 5.49m (SD=1.24) for females. A prey species survey was conducted in parallel and in the same time period as the main survey. In April, backscatterings of juvenile sand lance and Japanese anchovy were observed in southern Sendai bay. In May, backscattering of krill was observed off the coast of Sendai bay. From the result of prey species survey and stomach contents from sampled animals, distribution of the common minke whales in Sanriku region was related to sand lance distribution.

KEYWORDS: BIOPSY SAMPLING; COMMON MINKE WHALE; FOOD/PREY; SCIENTIFIC PERMITS

BACKGROUND

The full-scale survey of the JARPN II started in 2002, after conducting two-year feasibility studies in 2000 and 2001 (GOJ, 2002). The objectives of the full-scale research are: i) to study on feeding ecology and ecosystem studies, involving studies of prey consumption by cetaceans, prey preferences of cetaceans and ecosystem modelling; ii) to monitor environmental pollutants; iii) to study on stock structure, particularly for minke whales. Target species are common minke whale (*Balaenoptera acutorostrata*), Bryde's whale (*Balaenoptera edeni*), sei whale (*Balaenoptera borealis*) and sperm whale (*Physeter macrocephalus*). In the full JARPN II plan, the coastal survey component was firstly implemented as a two-year feasibility study conducted in 2002 and 2003 (GOJ, 2004). Coastal research is conducted by small-type whaling catcher boats and has features that cover the temporal and spatial gap, which could not be covered by the Nisshin Maru unit. After the two years feasibility survey, the coastal component of JARPN II was revised to be conducted twice a year in spring and autumn. The first revised

survey was carried out at off Kushiro in autumn of 2004 (Kishiro *et al*., 2005). Target species of the coastal component were set at 120 common minke whales (60 common minke whales to be sampled in each season). The results of these coastal survey have revealed that common minke whales consume various prey species. In the off Kushiro survey, krill (*Euphausia pacifica*), Japanese anchovy (*Engraulis japonicus*), Pacific saury (*Cololabis saira*), walleye pollock (*Theragra chalcogramma*) and Japanese flying squid (*Todarodes pacificus*) were consumed by the common minke whales. On the other hand, krill (*Euphausia pacifica*), Japanese sand lance (*Ammodytes personatus*) and Japanese anchovy (*Engraulis japonicus*) were consumed by whales in the off Sanriku area (Tamura *et al*., 2009). The findings of different prey species in a different year or places suggest the elasticity of prey preference of common minke whales in the coastal area of Japan. The coastal component off Sanriku of JARPN II in 2015 was carried out following the research plan of the earlier cruise which took place in the same waters off Sanriku in 2014 (Mogoe *et al*., 2015). These surveys were mainly undertaken in order to obtain the information of feeding ecology of common minke whales which migrate through Sendai Bay.

RESEARCH METHODS

Research area

The research sector was set in the coastal waters off Sanriku, within the 50n.miles from the Ayukawa port (Figure 1), which was same as the previous surveys (Mogoe *et al*., 2015). This sector is included in the middle part of the sub area 7CS of the revised sub areas for the implementation review for Western North Pacific common minke whales (IWC, 2012). The research area was further divided into 3 sectors. Because of logistical constraint and the accident at the Fukushima nuclear power stations in 2011, the southern boundary line of the research area is set at the administrative boundary between Miyagi and Fukushima Prefecture (due east of 37.54°N from land).

Research vessels, land station and research period

Four small-type whaling catcher boats, *Taisho Maru No.28* (47.3GT), *Koei Maru No.8* (32.0GT), *Katsu Maru No.7* (32.0GT) and *Sumitomo Maru No.51* (30.0GT) conducted the survey for sampling. *Miyashio* (199.0GT) conducted the prey species survey and collected oceanographic data for the research area in the same period. All of the sampled whales were landed at the Ayukawa port. Biological surveys and sampling took place at the land station. The research period was set for 47 days, from 10 April to 26 May 2015.

Searching and sampling methods

Searching and sampling methods were similar to the past coastal survey off Sanriku (Kishiro *et al*., 2016). The research head office was placed in the research station and controlled the sampling vessels during the survey. To avoid the concentration of the sampling location, the research head office arbitrarily determined the searching sector and direction from the base point for each sampling vessel every day. The vessels continued to cruise and search along the predetermined direction from the base point until they arrived at 30n.miles and then freely cruised in the waters within the research area. Sighting activities were carried out during the day and the vessels returned to port every night. Searching effort were conducted within acceptable weather, visibility and sea conditions, by the crew in the top barrel and upper bridge. In each vessel, one dedicated researcher was on board and recorded the cruise tracks, searching time on effort, sea and weather conditions, and the species and the estimated number of whales in the sighted schools. Target species for sighting record were all baleen whales, sperm whales and killer whales. All common minke whales sighted were targeted for sampling, except for cow-calf pairs. When a sighting consisted of more than one animal, the first targeted animal was selected following the random sampling digits. 50mm explosive harpoon guns equipped with penthrite grenades were used as the primary killing method. Once a 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 lifted up from the vessel using wire nets and a crane, and transported to the station by an 11 ton freight trailer.

Practicability survey for collection of biopsy and faecal samples

The practicability survey for collection of the skin biopsy and faecal samples was conducted using the four small-type whaling catcher boats. The system for biopsy skin sampling was the Larsen biopsy gun. Large intestine contents from three sampled whales were collected for genetic analysis of prey species identification. Observation of excretion was conducted for common minke whales targeted for lethal and biopsy sampling.

Biological research on common minke whales

All sampled whales were biologically examined by researchers at the research station. Research items of the biological studies are summarised in Table 3. Body length and external proportions of the whale were measured in the same manner as the offshore component of JARPN II. Body weights were measured using a crane scale. Body parts and organ weights of each whale were measured by summing of body parts using an electronic hanging scale. The stage of maturity was categorised according to the gonads. The maturity of the female was determined by the presence of corpus luteum or corpus albicans in either ovary. In the case where no corpus luteum or corpus albicans was observed in both ovaries, the female was categorized as immature. Conversely, if either corpus luteum or corpus albicans was observed in ovaries, the female was categorized as sexually mature. The 'mature' male was defined preliminary based on the weight of one testis over 290g. The weight of stomach contents was measured by the same methods used in the offshore component of the JARPN II. Stomach contents were weighed to the nearest 0.1kg for each of the four chambers including and excluding liquid (Fujise *et al*., 2002). For further biological studies of feeding ecology, stock structure, life historical biology and pollutions, the data and samples were collected from the captured whales. These included skin, tissue sample, eye lens, ear plug, and morphometric measurements.

Prey species survey

The prey species survey with oceanography were conducted using *Miyashio*. The acoustic data for prey species were collected using a quantitative echosounder. Oceanographic data were recorded by CTD and EPCS. These results are summarised in the Appendix.

RESULTS

Searching effort by sampling vessels

The cruise tracks of the sampling vessels during the research periods are shown in Figure 1. The survey was conducted on 47 days, a total of 596 hours and 5,776.5n.miles of effort. Searching effort mainly covered the south-western part of the whole research area. Table 1 shows an outline of the sighting activities. During the 47 days of the survey period, the sampling vessels conducted searching for only 23 days (48.9% of the predetermined days). Out of 24 days of cancellation in the research cruise, the most frequent reason was unsuitable weather conditions, e.g., low atmospheric pressure and fog. The ratio of days when searching was conducted in this survey was the lowest compared to the former coastal component surveys.

Sightings and sampling of common minke whales

Figure 2 shows the distribution of sighted and sampled common minke whales by the sampling vessels. A total of 33 schools (33 individuals) of common minke whales, were sighted during the survey period. Density index of common minke whales was calculated as 0.51 for DI (the number of primary sightings per 100n.miles searching effort) and 0.09 for SPUE (the number of primary sighting per 1 hour searching effort). Out of 31 schools (31 individuals), were targeted for sampling and 19 individuals were sampled for biological research. Sampling efficiency (the rate of successful sampling for targeted whales) was 0.61. In the sampling process, there was no struck and lost animals.

Sighting of other large whales

Humpback whales and one unknown large whales were identified during the research period. Figure 3 shows the geographical distribution of sighting position of humpback and unknown large whales. Table 2 shows the number of sightings for these 4 species including common minke whales during the survey. Humpback whales were distributed widely along the 100m depth contour line.

Practicability survey for collection of biopsy and faecal samples

Practicability survey for biopsy sampling and faecal sampling for common minke whales was carried out in this survey. As for biopsy sampling, the system for the sampling was the Larsen biopsy gun system. On 5 April 2015, Gunners and researchers had a meeting for discussing the experiment, and training in the use of the Larsen biopsy gun took place on 12 April (Figure 4). During this training, gunners and crew of small-type whaling catcher boats had used a number of darts for the first time. During the non-lethal survey, one sighting of common minke whale had been encountered during a total searching 54 hours 32 minutes. The trial for biopsy skin sampling was conducted on this whale. After one hour 36 minutes chasing, no samples were collected because of the quick movement of target whale.

Biological research on common minke whales

Sex ratio, body length and maturity of common minke whales caught
Table 5 summarises the reproductive status of the sampled whales. Sampled whales consisted of a total of 19 whales; 9 females and 10 males. Body length of sampled whales is summarized in Table 4. Average body length of the whales was 4.99m (min=4.22m, max=6.56m, SD=0.78m) for males, and 5.49m (min=4.10m, max=8.05m, SD=1.24m) for females. Immature whales ranged from 4.10m to 6.56m (4.22-6.56m for males, 4.10- 5.58m for females). No matured male animals were sampled. Mature whales ranged from 6.82 and 8.05m (female only). Mean body length of female and male sampled in the first half of the research period (10 Apr–3 May) were 5.33m (n=7) and 4.62m (n=8), respectively. In the second half period (4 May–26 May), male and female were 6.82m and 5.85m, respectively.

Prey species of common minke whale found in the stomach
The weight of stomach contents including liquid in forestomach ranged from between 0.0kg and 47.3kg, and average weight was 13.8kg (0.54% of mean body weight). Table 6 provides the composition of the dominant prey species obtained from forestomach contents in common minke whales. Three prey species were confirmed in the stomach contents of 18 individuals from 19 samples, and dominant prey species were krill (44.4%), followed by adult sand lance (22.2%), Japanese sardine (22.2%) and juvenile sand lance (11.1%).

Observation of marine debris
Marine debris was detected from the stomach of 3 mature animals. Ingested debris were pieces of wood and plastics. One whale entanglement in fishing gear of the upper jaw was recognized by observation of body surface from all sampled animals.

DISCUSSION

The JARPN II coastal component off Sanriku in the spring season in 2015 was conducted using the small-type whaling catcher boats. This report provides continuous data of biological study in the coastal region off Sanriku. The sampling vessels conducted the research for 23 days (48.9%) out of 47 days of the total survey period. The ratio of research days was the lowest in those of the off Sanriku surveys so far. On the whole, the poor weather conditions such as strong winds or poor visibility reduced sighting efforts. Although the composition and distribution of whale species were similar to the previous survey (Mogoe, *et al*., 2015), a low value of the DI for common minke whales was observed. Even though the DI was not so high, a dense distribution area of common minke whales was formed in the Sendai Bay as in the past surveys. Since all vessels investigated the same area every day, the sighting record probably includes some duplicated sightings.

A practicability survey for collection of biopsy and faecal samples for common minke whales was conducted. No sample was collected because of low density and few opportunity of a trial, although shooting training using the Larson gun was conducted. During the survey, effort was made to collect the samples through 54 hours 32 minutes searching. One sighting of common minke whale had been encountered however, after 1 hour 35 minutes 45 seconds chasing, no sample collected because of the quick movement of target whale.

Figure 5 shows the composition of prey species of common minke whales off Sanriku during the seasons 2003–2015. Sand lance is an important food item of common minke whales off Sanriku. The rate of occurrence of krill and anchovy changed, although sand lance remained the dominant prey species. In recent years, juvenile sand lance (less than 10cm) newly appeared as prey species of common minke whales. Japanese sardine and mackerels were found as prey species of common minke whales in early May (second half period of this survey). Both species were dominant prey species of common minke whales in the areas around Japan during the commercial whaling period from the 1960s to the late 1980s (Kasamatsu and Tanaka, 1992). The recent possible change of the prey species found in the stomachs of common minke whales suggested that this could have influenced to the distribution of common minke whales in the Sanriku district.

As for other large whales sighted in this research, humpback whales were sighted in the research area. The total number of sightings in the research area (46 schools 65 individuals) was twice that sighted for common minke whales (33 schools 33 individuals) in this survey. Humpback whales sightings have increased over last year's survey (Mogoe *et al*., 2015; 2014: 42 schools 50 individuals). Krill was the most numerous large prey species for common minke whales in a first half period of 2015 survey and humpback whales were sighted in the same period in parallel with common minke whale sightings. The 100m contour line was same as the krill fishing area in this region. Therefore, it may be possible to explain that krill was a prey species for these two whale species and that this might effect the distribution of two species. One minke whale sample was attacked and partly eaten by killer whales during the capture at the small-type whaling catcher boat. As a result, some biological data could not be obtained for this individual.

The eleventh survey off Sanriku district was conducted from 10 April to 26 May 2015. During the 47 day survey period, a total of 596 hours and 5,776n.miles of effort, 31 schools of common minke whales were made by four small-type whaling catcher boats. Thirty-one schools of common minke whales were sighted. A total of 19 whales were caught. Average body length of the sampled animals was 5.49m (SD=1.24, n=9) for females and 4.99m (SD=0.78, n=10) for males (sex ratio: 0.53 of male). Dominant prey species were krill (44.4%), followed by adult sand lance (22.2%), Japanese sardine (22.2%) and juvenile sand lance (11.1%). This report provided the continued data of biological and ecological information on common minke whales in the off Sanriku region.

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TABLES AND FIGURES

Table 1
Summary of searching effort (hours and distances) conducted during the 2015 JARPN II coastal component off Sanriku.

	Sampling vessels				Total
	28T	08K	07K	51S	
Days	22	22	23	22	
Hours	158:51:37	141:27:51	135:44:10	160:19:43	596:23:21
Distance(n.miles)	1,590.3	1,383.7	1,327.1	1,475.4	5,776.5

Table 2
Summary of whale sightings conducted by sampling vessels in the research area.

Species	Primary		Secondary		Total	
	School	Individuals	School	Individuals	School	Individuals
First half period (10 Apr–3 May)						
Common minke whale	26	26	0	0	26	26
Like minke whale	18	18	0	0	18	18
Fin whale	0	0	0	0	0	0
Humpback whale	40	57	0	0	40	57
Killer whale	5	14	2	11	7	25
Unknown large whale	7	7	0	0	7	7
Second half period (4 May–26 May)						
Common minke whale	5	5	2	2	7	7
Like minke whale	6	6	2	2	8	8
Fin whale	0	0	0	0	0	0
Humpback whale	5	7	1	1	6	8
Killer whale	4	10	0	0	4	10
Unknown large whale	3	3	0	0	3	3
Total						
Common minke whale	31	31	2	2	33	33
Like minke whale	6	6	2	2	8	8
Fin whale	0	0	0	0	0	0
Humpback whale	45	64	1	1	46	65
Killer whale	9	24	2	11	11	35
Unknown large whale	10	10	0	0	10	10

Table 3
Summary of biological data and samples collected in the 2015 JARPN II coastal survey off Sanriku.

Samples and data	Number of animals		
	Female	Male	Total
Body length and sex	9	10	19
External body proportion	9	10	19
Photographic record and external character	9	10	19
Diatom film record	9	10	19
Body scar record	9	10	19
Measurements of blubber thickness (5 points)	9	10	19
Detailed measurements of blubber thickness (11 points)	1	0	1
Whole body weight	9	10	19
Body weight by parts	1	0	1
Skin tissues for DNA study	9	10	19

Table 3
Continued.

Samples and data	Number of animals		
	Female	Male	Total
Muscle, liver, kidney, spleen, blubber, heart and ventral groove for various analysis	9	10	19
Urine for various analysis	1	3	4
Muscle, liver, kidney, and blubber for heavy metal analysis	9	10	19
Muscle, liver, kidney, and blubber for organochlorine analysis	9	10	19
Collection of blood plasma	8	8	16
Muscle and vertebra for lipid analysis	9	10	19
Mammary gland; lactation status, measurement and histological sample	9	–	9
Uterine horn; measurements and endometrium sample	9	–	9
Collection of Ovary	9	–	9
Photographic record of foetus	0	–	0
Foetal length and weight	0	–	0
Skin tissues for DNA study of foetus	0	–	0
External measurement of foetus	0	–	0
Muscle, liver, kidney, heart, blubber and skin tissues of foetus	0	–	0
Eye lens of foetus for age determination	0	–	0
Collection of foetus	0	–	0
Testis and epididymis; weight and histological sample	–	10	10
Testis for examination of gene expression	–	5	5
Stomach contents, convenient record	9	10	19
Volume and weight of stomach content in each compartment	9	10	19
Observation of marine debris in stomach	9	10	19
Collection of stomach contents for feeding study	1	6	7
Stomach wall for digestion study	2	1	3
Record of external parasites	9	10	19
Earplug for age determination	8	8	18
Eye lens for age determination	9	10	19
Tympanic bulla for age determination	0	0	0
Largest baleen plate for morphologic study and age determination	0	1	1
Baleen plate measurements (length and breadth)	9	10	19
Photographic record of baleen plates series	9	10	19
Length of baleen series	9	10	19
Vertebral epiphyses sample	2	2	4
Number of ribs	9	10	19
Skull measurement (length and breadth)	8	10	18
Skull measurement (detail)	5	1	6
Measurement of the skull around nasal bone	9	9	18
Content of large intestine	2	2	4
Measurement and sampling of pelvic bone	4	4	8
External measurement of nostril	9	9	18
Collection of diatoms on the skin	5	3	8
Measurement of flipper white patch	9	10	19
Tissues for cell culture	4	2	6

Table 4
Mean body length of common minke whales sampled in 2015 JARPN II coastal component off Sanriku.

Period	Male					Female				
	Mean	SD	Min	Max	N	Mean	SD	Min	Max	N
First half period (10 Apr–3 May)	4.62	0.38	4.22	4.90	7	5.33	1.21	4.10	8.05	8
Second half period (4 May–26 May)	5.85	0.86	4.90	6.56	3	6.82	NA	NA	NA	1
Total	4.99	0.78	4.22	6.56	10	5.49	1.24	4.10	8.05	9

Table 5
Reproductive status of common minke whales sampled in 2015 JARPN II coastal component off Sanriku.

Period	Male				Female					Sex ratio
	Immature	Mature	Total	Maturity (%)	Immature	Mature (Preg)	Total	Pregnancy (%)	Maturity (%)	(% males)
First half period (10 Apr–3 May)	7	0	7	0.0	7	1 (0)	8	0.0	12.5	46.7
Second half period (4 May–26 May)	3	0	3	0.0	0	1 (0)	1	0.0	100	75.0
Total	10	0	10	0.0	7	2 (0)	9	0.0	22.2	52.6

Table 6
Frequency appearance of dominant prey species found in forestomach contents of common minke whales sampled by the 2015 JARPN II coastal component off Sanriku*.

	Krill	Sand lance		Japanese sardine	Total
		Juvenile	Adult		
Sendai bay	6 (44.4%)	2 (11.1%)	4 (22.2%)	0 (0.0%)	12 (66.7%)
Other area	2 (11.1%)	0 (0.0%)	0 (0.0%)	4 (22.2%)	6 (33.3%)
	8 (44.4%)	2 (11.1%)	4 (22.2%)	4 (22.2%)	18 (100%)

*: Excluding one animal with an empty stomach.

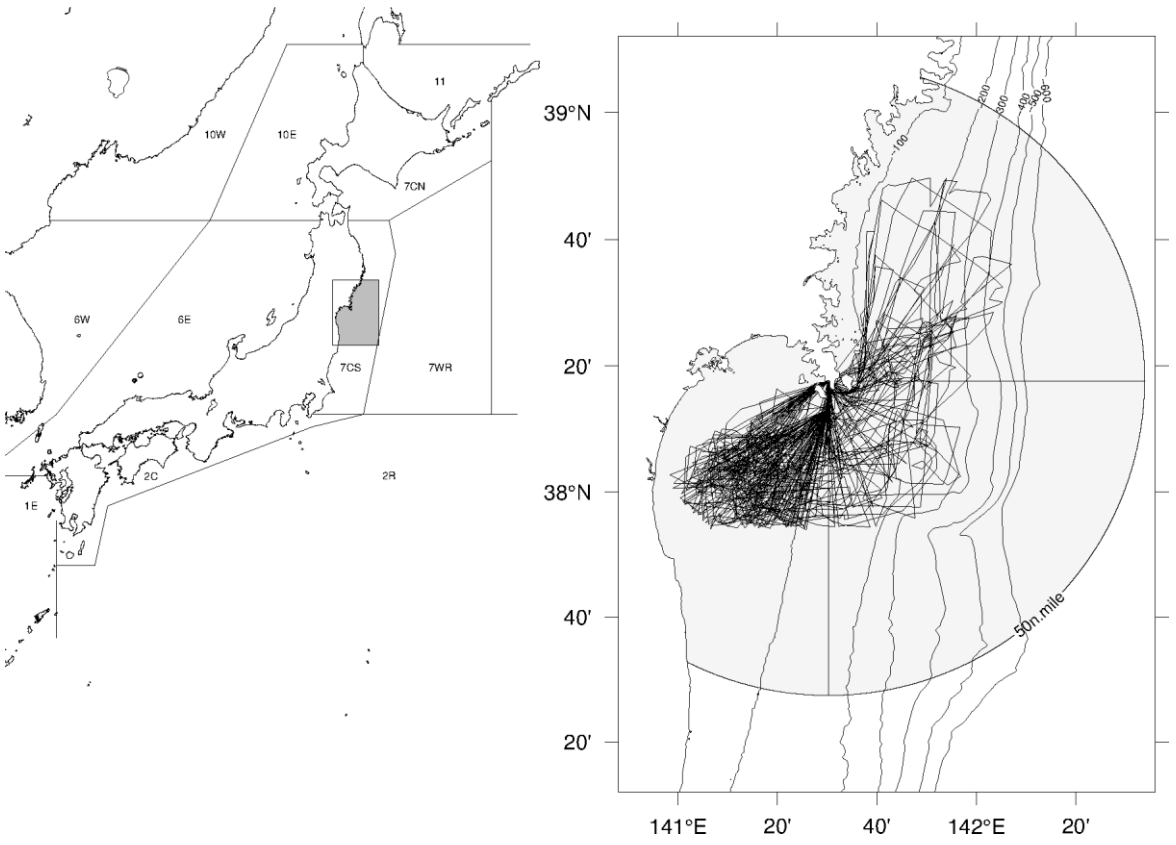

Figure 1. Geographical location of the research area and cruise track-lines of four sampling vessels in 2015 JARPN II coastal component off Sanriku.

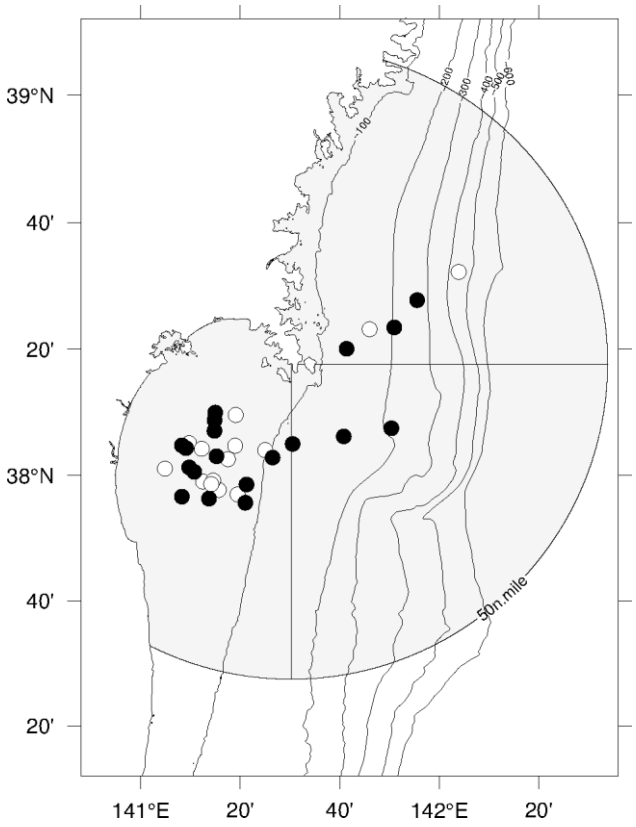

Figure 2. Geographical distribution of sighting position of common minke whales made by sampling vessels in 2015 JARPN II coastal component off Sanriku. Closed circle: sighting and sampling school; open circle: only sighting school. Each plot is based on the position of sighting school.

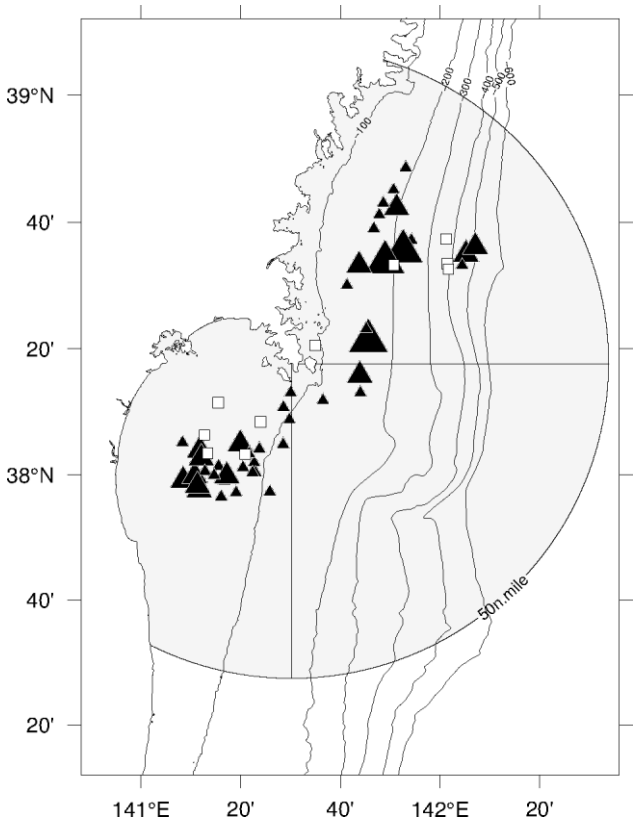

Figure 3. Geographical distribution of sighting position of humpback and unknown large whales sighted by sampling vessels in 2015 JARPN II coastal component off Sanriku. Closed triangle: humpback whale; open square: unknown large whales. The size of the plot means school size (1 to 3 individuals).

Figure 4. Training of shooting of the Larsen biopsy gun. The styrene foam was used for dummy target predetermined shooting distance.

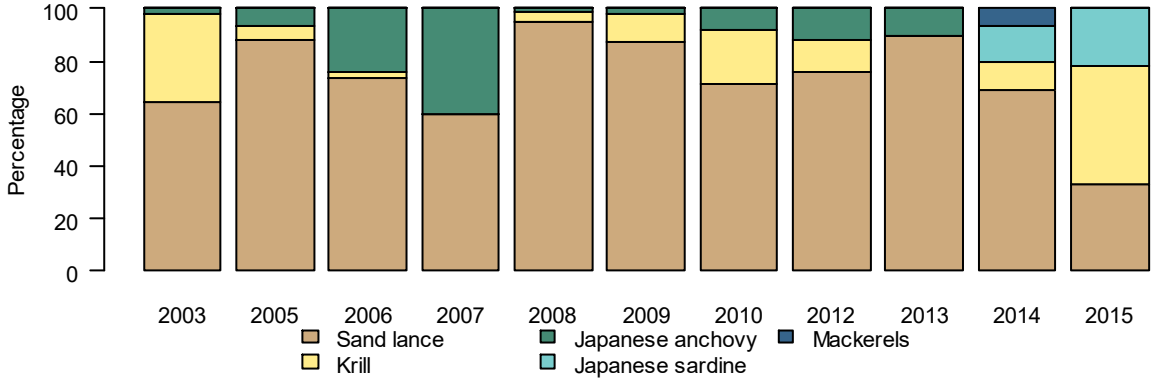

Figure 5. The yearly composition of dominant prey species which were found in the forestomach of common minke whales in JARPN II coastal component off Sanriku during the seasons 2003–2015 (percentage of the frequency appearance). Individuals which have broken forestomach by a harpoon or have empty forestomach were excluded from the analysis.

APPENDIX

Coastal prey species survey of JARPN II off Sanriku in 2015

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ABSTRACT

A prey species survey was conducted in the coastal region off Sanriku, northeastern Japan in spring 2015 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 on April 23 and 24 and May 15 and 22. Four stratified blocks were surveyed in April (B, C Survey Blocks) and the two blocks (A,D Survey Blocks) were surveyed in May. Zigzag track-lines were set in the blocks. A trawler type R/V, "*MIYASHIO*", conducted the survey. Acoustic data were recorded continuously along track-lines by a quantitative echosounder. Samplings using a midwater trawl net were conducted at two stations to identify species and body size compositions of acoustic backscatterings. Vertical oceanographic conditions were recorded at 15 stations by using a CTD. Subsurface oceanographic conditions were recorded continuously along track-lines.

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 modelling. To accomplish the goal, a sampling survey of common minke whales (*Balaenoptera acutorostrata*) and a survey to estimate biomass of their prey species have been conducted concurrently off Sanriku as a component of JARPN II since 2003 except for 2011 with the Great East Japan Earthquake. This document presents the results of the prey species survey off Sanriku in 2015.

SURVEY METHODS

While the sampling survey of minke whales was conducted in the coastal waters within the 50n.miles (mainly within 30n.miles) from Ayukawa, Miyagi prefecture, Japan, the prey species survey was conducted in a wider area at bottom depths between 20 m and 200 m from 37º 54' N to 38º 40' N off Sanriku, north-eastern Japan, to elucidate the distribution and abundance of main prey species. Seven survey blocks (A-G) have been set within the survey area since 2005 for the purpose of biomass estimation of prey species based on a stratified random sampling method using echosounder data (Figure 1). Stratification of blocks was based on bottom depth (20, 40, 100, and 200m) and the boundary between Miyagi and Fukushima prefecture. Because of logistical constraint and the Fukushima nuclear accident, only 2 blocks (B, C) were surveyed in April and 2 blocks (A, D) were surveyed in May in 2015(Figure 1). A zigzag track-line was set in each block. The waypoints of planned track-lines in each block are shown in Table 1.

The survey was conducted on April 23 and 24 and May 15 and 22. 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 R/V, "*MIYASHIO*" (Miyagi prefecture, 199 GT). Data of distribution and abundance of the prey species were recorded by a quantitative echosounder, EK60 (Simrad, Norway) with operating frequency at 38, 120 and 200 kHz. The RV steamed at 9-10 knots along the track-lines. Acoustic data were stored with the aid of software, Echoview (Sonar Data, Australia). Calibration was carried out in the survey area on 17 April and on 14 May using the copper sphere technique described in EK 60 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 track-lines.

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. The towing speed of the trawl net was 2-4 knots. Catches were identified to the species level and weighed aboard the vessel. For the major species, 39 Japanese anchovy

and 5 adult sand lances and about 500 grams juvenile sand lance were 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. Some samples were frozen for further analysis in the laboratory.

RESULTS

The planned track-lines were almost surveyed by the quantitative echosounder. The trawl was towed at two stations. A summary of the midwater trawl samples is shown in Table 2. CTD casts were conducted at 15 stations. In April, backscatterings of juvenile sand lance and Japanese anchovy were observed in southern Sendai bay. In May, backscatterings of krill were observed off the coast of Sendai bay. Detailed analysis will be conducted in the laboratory and the results will be presented in the near future.

ACKNOWLEDGEMENTS

We would like to thank the captain of R/V "*MIYASHIO*", Mr. Tatsuo Kanomata, and his crew who assisted us to collect a valuable data set. This survey was supported by the Fisheries Agency of Japan and Miyagi Prefecture. We thank these institutions for their support.

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TABLES AND FIGURES

Table 1
Waypoints and planned lines.

Block A

Waypoint	Latitude				Longitude				Course (degree)	Distance (n.mile)
A1	38	-	15.0	N	141	-	50.5	E	297°	11.0
A2	38	-	20.0	N	141	-	38.0	E	055°	11.4
A3	38	-	26.5	N	141	-	50.0	E	331°	12.0
A4	38	-	37.0	N	141	-	42.5	E	066°	7.3
A5	38	-	40.0	N	141	-	51.0	E	-	-
									Total	41.7

Block B

Waypoint	Latitude				Longitude				Course (degree)	Distance (n.mile)
B1	37	-	54.0	N	141	-	00.5	E	063°	11.1
B2	37	-	59.0	N	141	-	13.0	E	291°	11.0
B3	38	-	03.0	N	141	-	00.0	E	064°	13.6
B4	38	-	09.0	N	141	-	15.5	E	296°	9.2
B5	38	-	13.0	N	141	-	05.0	E	071°	12.5
B6	38	-	17.0	N	141	-	20.0	E	332°	5.1
B7	38	-	21.5	N	141	-	20.5	E	-	-
									Total	62.5

Table 1
Continued.

Block C

Waypoint	Latitude				Longitude				Course (degree)	Distance (n.mile)
C1	38	-	15.5	N	141	-	33.0	E	142°	2.5
C2	38	-	13.5	N	141	-	35.0	E	251°	10.8
C3	38	-	10.0	N	141	-	22.0	E	142°	5.1
C4	38	-	06.0	N	141	-	26.0	E	245°	9.5
C5	38	-	59.0	N	141	-	15.0	E	115°	7.0
C6	37	-	59.0	N	141	-	23.0	E	235°	8.7
C7	37	-	54.0	N	141	-	14.0	E	-	-
									Total	43.6

Block D

Waypoint	Latitude				Longitude				Course (degree)	Distance (n.mile)
D1	38	-	15.0	N	141	-	51.0	E	252°	13.2
D2	38	-	11.0	N	141	-	35.0	E	117°	13.2
D3	38	-	05.0	N	141	-	50.0	E	248°	18.7
D4	37	-	58.0	N	141	-	28.0	E	112°	10.6
D5	37	-	54.0	N	141	-	40.5	E	-	-
									Total	55.7

Table 2
A summary of the trawl sampling.

Station		St-1	St-2				
Block		C	B				
Date		23 Apr.	23 Apr.				
Time		10:23	14:03				
Latitude		38-02N	37-55N				
Longitude		141-16E	141-03E				
Temp (°C) by depth	0 m	10.6	11.3				
	10 m	9.17	9.65				
	20 m	8.28	7.38				
	30 m	7.66					
	40 m						
	50 m						
	75 m						
	100 m						
	Bottom (m)	7.03 (38m)	7.29 (20m)				
Trawl sampling depth (m)		10-25	10-20				
Major sampled species		Sand lance (juvenile)	Sand lance (adult and juvenile) Japanese anchovy Sea sponge				

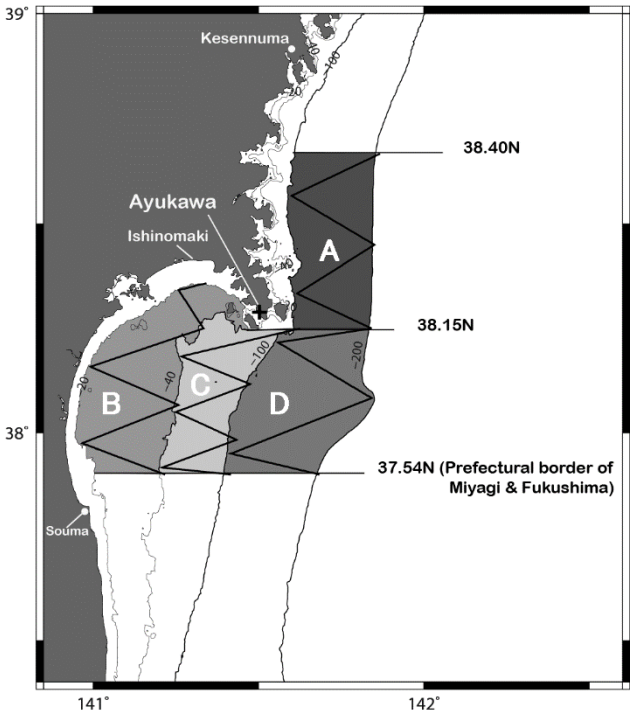

Figure 1. Survey blocks and planned track-lines in 2015.