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Cruise Report of the Second Phase of the Japanese Whale Research Program under Special Permit in the Western North Pacific (JARPNII) in 2016 - (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 (JARPNII) in 2016 - (Part II) - Coastal component off Sanriku

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ABSTRACT

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 (JARPNII) in 2016. The survey was carried out on the Pacific coast of Japan (the sub-area 7CS) from 9 April to 25 May 2016. The research took place 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 sighting and sampling vessels. A total of 5,432.7 n.miles (560.5 hours) was surveyed. Sixteen animals were sampled from 28 schools (28 individuals) of primary sightings of common minke whales.

Density index (the number of primary sightings of schools per 100 n.miles searching) of common minke whales within and outside of Sendai Bay were calculated as 0.45 and 0.57, respectively, and those of humpback whales were calculated as 0.41 and 0.50, respectively. The density index of common minke whales within Sendai Bay in 2016 was approximately 30% less than that before 2009, and the same as levels outside of Sendai Bay for 2009-2016, while humpback whales gradually increased in all research areas after 2008. During the survey, a biopsy experiment was conducted using the Larsen system for 74 hours ten minutes. One sample was collected in five trials. Average body length of the whales was 5.75m (min.=4.74m, max.=7.90m, SD=1.21m) for males, and 5.55m (min.=4.03m, max.=7.98m, SD=1.24m) for females. In males, two of seven individuals (29 %) were sexually mature, and in females, two of nine individuals (22 %) were sexually mature. Regarding dominant prey species found in the forestomach, three prey species were identified in the stomach contents of 14 individuals. Adult sand lance (50.0%) and Japanese sardine (50.0%) were observed from those within Sendai Bay, whereas only Japanese sardine (100.0%) was observed from those outside of Sendai Bay. Over the last decade, the distribution (individual/m³) of juvenile Japanese sand lance within Sendai bay in January after 2013 was apparently lower than before 2012, and was distributed in only the near shore area. The reasons for the decreasing number of sighting and sampling of common minke whale after 2013 may be caused by increasing numbers of humpback whales in Sendai Bay and/or decreasing recruitment of sand lance.

BACKGROUND

The full-scale survey of the JARPNII started in 2002, after conducting two-year feasibility studies in 2000 and 2001 (Government of Japan, 2002). The objectives of the full-scale research are: i) to conduct feeding ecology and ecosystem studies, involving studies of prey consumption by cetaceans, prey preferences of cetaceans and ecosystem modeling; ii) to monitor environmental pollutants; iii) to study stock structure. Target species were common minke whale (*Balaenoptera acutorostrata*), Bryde's whale (*B. edeni*), sei whale (*B. borealis*) and sperm whale (*Physeter macrocephalus*). The coastal survey component was firstly implemented as a two-year

feasibility study conducted in 2002 and 2003 (Government of Japan, 2004). Coastal research is conducted by small-type whaling catcher boats to cover the temporal and spatial gap, which could not be covered by the *Nisshin Maru*. After the two years of feasibility surveys, the coastal component of JARPNII was revised to be conducted twice a year in spring (Sanriku) and autumn (Kushiro), and target species and sample sizes of the coastal component were set at 120 common minke whales (60 to be sampled in each season).

Following the March 2014 Judgment of the International Court of Justice (ICJ) in the case Whaling in the Antarctic (Australia v. Japan: New Zealand intervening), the Government of Japan voluntarily reviewed the state of JARPNII. This resulted in the reprioritization of the research focus as well as recalculation of sample sizes to be pursued during the 2014-2016 JARPNII surveys with the results of the three years surveys to be duly utilized for the establishment of a new research plan (IWC, 2015). As the result of the recalculation, the sample sizes for common minke whale was adjusted from 60 to 51 animals in each of the coastal components. These adjustments of sample sizes included the allocation of some samples to non-lethal means in order to carry out a comparative study for verifying the feasibility of non-lethal methods with the intention of taking into account the results of such study in the future research programmes (IWC, 2015).

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) conducted the surveys in cooperation with the National Research Institute of Far Seas Fisheries (NRIFSF), the Japan Fisheries Research and Education Agency, Tokyo University of Marine Science and Technology and the Association for Community-Based Whaling.

RESEARCH METHODS

Research area

The research area was set in the coastal waters off Sanriku, within 50 n.miles from the Ayukawa port (Figure 1), which was same as the previous surveys (Mogoe *et al.*, 2016). This area is included in the middle part of the sub area 7CS of the revised sub areas for the implementation review for the Western North Pacific common minke whales (IWC, 2012). The research area was further divided into 3 sectors. In order to take account of logistical constraints and the accident at the Fukushima nuclear power stations in 2011, the area south of the administrative boundary between Miyagi and Fukushima Prefecture (37.54°N) has been excluded from the research area since 2012.

Research vessels, land station and research period

Four small-type whaling catcher boats, *Taisho Maru No. 28* (47.3 GT), *Koei Maru No. 8* (32.0 GT), *Katsu Maru No. 7* (32.0 GT) and *Sumitomo Maru No. 51* (30.0 GT) conducted the survey for sampling. 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 9 April to 25 May in 2016. The prey species surveys were conducted by the trawl-type RV *Miyashio* (199.0 GT) for four days; 19-20 April and 19-20 May.

Searching and sampling methods

The standard procedure of searching and sampling for the coastal survey off Sanriku were described in Kishiro

et al. (2016). In the present survey, the four sighting courses of equal intervals (15 degree) were firstly set in the range of 190˚ to 245˚ from Ayukawa port from 9 to 25 April, and were reset in the range of 90˚ to 210˚ in Area 2 from 26 April to the end of the survey. The small-type whaling catcher boats conducted the research along the course from the port until common minke whales were sighted, or the boats arrived at 30 n.miles from the port.

Sighting activities were carried out during the day and the vessels returned to port every night. Searching effort was conducted within acceptable weather, visibility and sea conditions, by the crew in the top barrel and upper bridge. On each vessel, one dedicated researcher 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 the sighting records were all baleen whales, sperm whale and killer whale. All common minke whales sighted were targeted for sampling, except for cow-calf pairs.

Feasibility research of non-lethal methods

The feasibility research of biopsy and faecal sampling was conducted by the four small- type whaling catcher boats equipped with a Larsen system and a circle net with 100μm mesh size. During the biopsy experiments, data on time spent, sea conditions, and visibility were recorded to analyze the influence of these factors on the sampling efficiency. The collected skin samples were put in polyethylene bags and stored at −20°C. Faecal observation was conducted as much as possible for the whales encountered and chased during the whale sampling surveys. In case of finding faeces, crews or researchers attempted to collect faecal samples using the circle net. The sampled faeces were stored in polyethylene bottles at −20°C.

Biological research on common minke whales

For all sampled whales, biological research was conducted at the land station. Research items of this research are summarized in Table 1. Body length and external proportions of the whale were measured in the same manner as for the offshore component of JARPNII (Bando *et al.*, 2016). 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 maturity of the females 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 being over 290g. Stomach contents were weighed to the nearest 0.1kg for each of the four chambers including and excluding liquid (Tamura *et al.*, 2016).

Prey species survey

The prey species surveys with oceanography were conducted using the *Miyashio*. The acoustic data for prey species were collected using a quantitative echosounder (EK60). Oceanographic data were recorded by CTD and EPCS. These results are summarized in the Appendix.

RESULTS

Searching effort by sampling vessels

The cruise tracks of the sampling vessels during the research periods are shown in Figure 2. The survey was conducted on 47 days, a total of 560.5 hours and 5,432.7 n.miles of effort. Searching effort mainly covered the

area within 30 n.miles from the Ayukawa port. Table 2 shows an outline of the sighting activities. During the 47 days of the survey period, the sampling vessels actually conducted searching for only 17 days (37.0 % of the predetermined days). Out of 30 days of cancellation of the research cruise, the most frequent reason was unsuitable weather conditions, e.g., a strong wind and fog. The ratio of days when searching was conducted in this survey was the lowest compared to the former coastal component surveys.

The main sighting courses of small-type whaling catcher boats were changed from the sector of Area 1 to Area 2 in the middle of the research period. In the first half of the research period, the density index of common minke whales was much lower than previous surveys in Area 1 including Sendai Bay in which most of the research effort devoted. It is necessary to investigate the extent of distribution of common minke whales outside of Sendai Bay (Areas 2 and 3). During the second half of the research period, research effort was devoted to the area outside of Sendai Bay. Consequently, research effort evenly covered the research Area within 30 n.miles.

Sightings and sampling of common minke whales

A total of 28 schools (28 individuals) of common minke whales (Table 3), seven schools (seven individuals) of like common minke whales, 26 schools (26 individuals) of humpback whales (Table 4), five schools (14 individuals) of killer whales and three school (three individuals) of unknown large whales were sighted during the research period. Density index (DI: the number of primary sightings of schools per 100 n.miles searching) of common minke whales within (Area 1) and outside (Areas 2 and 3) of Sendai Bay were calculated as 0.45 and 0.57, respectively (Table 3), and those of humpback whales were calculated as 0.41 and 0.50, respectively (Table 4). Sixteen common minke whales were sampled during the research period, and there was no struck and lost animals in the sampling process.

Feasibility research activities of non-lethal methods

Biopsy sampling was tried for three common minke whales, and one skin sample with blubber was collected from one animal. For 28 animals encountered during the survey, observation of excretion and vomiting behavior was conducted. One case of excretion was observed, but faecal sample could not be collected because it was a liquid state. No vomiting behavior was observed.

Sex ratio, body length and maturity

Body length and reproductive status of sampled whales (a total of 16 whales; seven males and nine females) are summarized in Tables 5 and 6, respectively. Average body length of the whales was 5.75m (min.= 4.74m, max.=7.90m, SD=1.21m) for males, and 5.55m (min.=4.03 m, max.=7.98m, SD=1.24m) for females (Table 5). For males, two of seven individuals (29 %) were sexually mature (Table 6), and for females, two of nine individuals (22 %) were sexually mature (Table 6).

Prey species of common minke whale found in the stomach

Table 7 shows the composition of the dominant prey species obtained from forestomach contents and weight of stomach contents in common minke whales. Three prey species were identified in the stomach contents of 14 of 16 individuals. Adult sand lance (50.0%) and Japanese sardine (50.0%) were observed in Area 1, whereas only Japanese sardine (100.0%) was observed in Areas 2 and 3. The weight of stomach contents including in forestomach ranged from between 2.3kg and 27.8kg, and average weight was 17.7kg for all areas.

Observation of marine debris

Marine debris was observed in the stomach of five animals. All ingested debris were pieces of plastics and/or vinyl sheets.

DISCUSSION

Distribution and density of whales

In the present survey, common minke whales were sparsely distributed both within and outside of Sendai Bay, whereas they had been broadly distributed and a few hot spots had been formed within Sendai Bay for the 2008 and 2012 surveys (Figure 3). The density index of common minke whales within Sendai Bay in 2016 was approximately under 30% of that before 2009 (Figure 4), and same levels in Areas 2 and 3 for 2009-2016 (Table 3, Figure 5). On the other hand, sighting numbers of humpback whales gradually increased in all research areas after 2008, while there had been only a few such sightings in 2003-2007 (Table 4). Furthermore, humpback whales have entered to the central area of Sendai Bay since 2010 (Figure 5). This was the same period of decreasing sightings of common minke whales, suggesting that recent behavior of humpback whales may affect the migration of common minke whales within Sendai Bay.

Composition of sexual maturity

Common minke whales sampled within and outside of Sendai Bay consisted of mostly immature whales of both sexes. This corresponded to the previous surveys (Figure 6).

Composition of prey items

In the present survey, common minke whales fed on adult sand lance and Japanese sardine within Sendai Bay, while they fed only on Japanese sardine outside of Sendai Bay (Figure 7). The dominant prey species outside Sendai Bay changed from Japanese anchovy and krill to Japanese sardine after 2014 (Figures 7 and 8). In recent years, Japanese sardine increasingly appeared in the stomach contents of sei whales sampled offshore (Bando *et al.*, 2017) and common minke whales sampled in the Kushiro region (Yoshida *et al.*, 2017) to replace Japanese anchovy. On the other hand, sand lance which had been the dominant prey species within Sendai Bay were observed in the forestomach of less than 50% of individuals after 2012, whereas the occured in almost all individual before 2010 (Figures 7 and 8), indicating that availability of sand lance could have decreased for common minke whales within Sendai Bay.

Figure 9 illustrates density distribution (individual/m^3) of juvenile of Japanese sand lance within Sendai bay in January (Miyagi prefecture Fisheries Technology Institute, 2016), which is a good index of recruitment of Japanese sand lance in this area. Over the last decade, the indices after 2013 were apparently lower than before 2012, and the species was distributed in only the near shore area. The reasons for this may be disturbance caused by the 2011 Great East Japan Earthquake, because sand bottom area in the central Sendai Bay had been important for estivation and spawning (Kobayashi *et al.*, 1995).

The number of sighting and sampling of common minke whale have decreased since 2013. The reasons of this may be caused by increasing of humpback whales migrating into Sendai Bay and/or decrease of recruitment of sand lance (e.g. by disturbance of the 2011 Great East Japan Earthquake).

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Table 1. Summary of biological data and samples collected in the 2016 JARPNII coastal survey off Sanriku

Samples and data	Number of animals		
	Male	Female	Total
Body length and sex	7	9	16
External body proportion	7	9	16
Photographic record and external character	7	9	16
Diatom film record	7	9	16
Body scar record	7	9	16
Measurements of blubber thickness (5 points)	7	9	16
Detailed measurements of blubber thickness (11 points)	0	1	1
Whole body weight	7	9	16
Body weight by parts	0	1	1
Skin tissues for DNA study	7	9	16
Muscle, liver, kidney, spleen, blubber, heart and ventral groove for various analysis	7	9	16
Urine for various analysis	3	3	6
Muscle, liver, kidney, and blubber for heavy metal analysis	7	9	16
Muscle, liver, kidney, and blubber for organochlorine analysis	7	9	16
Collection of blood plasma	6	7	13
Muscle and vertebra for lipid analysis	0	1	1
Mammary grand; lactation status, measurement and histological sample	-	9	9
Uterine horn; measurements and endometrium sample	-	9	9
Collection of Ovary	-	9	9
Photographic record of fetus	0	2	2
Fetal length and weight	0	2	2
Skin tissues for DNA study of fetus	0	2	2
External measurement of fetus	0	2	2
Eye lens of fetus for age determination	0	2	2
Collection of fetus	0	2	2
Testis and epididymis; weight and histological sample	7	-	7
Stomach contents, convenient record	7	9	16
Volume and weight of stomach content in each compartment	7	9	16
Observation of marine debris in stomach	7	9	16
Collection of stomach contents for feeding study	7	9	16
Record of external parasites	7	9	16
Earplug for age determination	6	9	15
Eye lens for age determination	7	9	16
Largest baleen plate for morphologic study and age determination	1	2	3
Baleen plate measurements (length and breadth)	7	9	16
Photographic record of baleen plate series	7	9	16
Length of baleen series	7	9	16
Vertebral epiphyses sample	2	3	5
Number of ribs	7	9	16
Skull measurement (length and breadth)	7	9	16
Skull measurement (detail)	5	6	11
Measurement of flipper pigment	5	8	13
Measurement of skull around nasal born	3	5	8

Table 2. Summary of research activities in off Sanriku of JARPNII during the period from 2007 to 2016

Research year	Whole research days	Actual resarch days*	Operating rates (%)**	Total searching effort (n.miles)			Biopsy sampling effort (mininute)
				Area all	Area 1	Areas 2+3	
2007	46	26	56.5	7,883.8	7,602.2	281.7	
2008	35	18	52.9	5,239.1	5,042.2	196.8	
2009	30	15	51.7	4,439.5	4,041.2	398.2	
2010	47	27	58.7	8,957.0	6,842.5	2,114.4	
2012	45	24	54.5	6,488.1	2,961.5	3,526.6	
2013	47	24	52.2	7,188.4	5,290.5	1,897.9	
2014	47	18	39.1	5,732.7	4,122.5	1,610.2	3,646
2015	47	20	43.5	6,302.8	3,780.1	2,522.7	3,272
2016	47	17	37.0	5,432.7	2,444.4	2,988.3	4,450

*: Actual research day was defined as a total amount of searching distances per day in all small catcher boats more than 100 n.miles

**: Acctual research days / Whale research days (%)

After Bando *et al.* (2008); Yasunaga *et al*. (2009-2011, 2013, 2014); Mogoe *et al.* (2015, 2016)

Table 3. Searching distances, number of sightings for common minke whales in the JARPNII coastal off Sanriku in the period 2007-2016

	Area all								Area 1								Areas 2+3							
	distance	primary		secondary		total		DI	distance	primary		secondary		total		DI	distance	primary		secondary		total		DI
	(n. miles)	sch.	ind.	sch.	ind.	sch.	ind.		(n. miles)	sch.	ind.	sch.	ind.	sch.	ind.		(n. miles)	sch.	ind.	sch.	ind.	sch.	ind.	
2007	7883.8	149	153	16	17	165	170	1.89	7602.2	148	152	16	17	164	169	1.95	281.7	1	1	0	0	1	1	0.36
2008	5239.1	83	85	11	11	94	96	1.58	5042.2	83	85	11	11	94	96	1.65	196.8	0	0	0	0	0	0	0.00
2009	4439.5	99	100	12	12	111	112	2.23	4041.2	96	97	10	10	106	107	2.38	398.2	3	3	2	2	5	5	0.75
2010	8957.0	59	59	3	3	62	62	0.66	6842.5	51	51	3	3	54	54	0.75	2114.4	8	8	0	0	8	8	0.38
2012	6488.1	88	90	7	7	95	97	1.36	2961.5	72	74	7	7	79	81	2.43	3526.6	16	16	0	0	16	16	0.45
2013	7188.4	54	54	5	5	59	59	0.75	5290.5	50	50	5	5	55	55	0.95	1897.9	4	4	0	0	4	4	0.21
2014	5732.7	50	50	1	1	51	51	0.87	4122.5	41	41	1	1	42	42	0.99	1610.2	9	9	0	0	9	9	0.56
2015	6302.8	31	31	2	2	33	33	0.49	3780.1	25	25	0	0	25	25	0.66	2522.7	6	6	2	2	8	8	0.24
2016	5432.7	28	28	0	0	28	28	0.52	2444.4	11	11	0	0	11	11	0.45	2988.3	17	17	0	0	17	17	0.57

After Bando *et al.* (2008); Yasunaga *et al*. (2009-2011, 2013, 2014); Mogoe *et al.* (2015, 2016)

Table 4. Searching distances, number of sightings for humpback whales in the JARPNII coastal off Sanriku in the period 2007-2016

	Area all								Area 1								Areas 2+3							
	distance	primary		secondary		total		DI	distance	primary		secondary		total		DI	distance	primary		secondary		total		DI
	(n. miles)	sch.	ind.	sch.	ind.	sch.	ind.		(n. miles)	sch.	ind.	sch.	ind.	sch.	ind.		(n. miles)	sch.	ind.	sch.	ind.	sch.	ind.	
2007	7883.8	0	0	0	0	0	0	0.00	7602.2	0	0	0	0	0	0	0.00	281.7	0	0	0	0	0	0	0.00
2008	5239.1	12	12	3	3	15	15	0.23	5042.2	12	12	3	3	15	15	0.24	196.8	0	0	0	0	0	0	0.00
2009	4439.5	29	30	5	5	34	35	0.65	4041.2	28	29	5	5	33	34	0.69	398.2	1	1	0	0	1	1	0.25
2010	8957.0	58	65	4	4	62	69	0.65	6842.5	51	57	2	2	53	59	0.75	2114.4	7	8	2	2	9	10	0.33
2012	6488.1	41	55	2	3	43	58	0.63	2961.5	20	26	1	1	21	27	0.68	3526.6	21	29	1	2	22	31	0.60
2013	7188.4	44	49	0	0	44	49	0.61	5290.5	31	34	0	0	31	34	0.59	1897.9	13	15	0	0	13	15	0.68
2014	5732.7	41	48	1	2	42	50	0.72	4122.5	41	48	1	2	42	50	0.99	1610.2	0	0	0	0	0	0	0.00
2015	6302.8	22	22	1	1	23	23	0.35	3780.1	10	10	1	1	11	11	0.26	2522.7	12	12	0	0	12	12	0.48
2016	5432.7	25	25	1	1	26	26	0.46	2444.4	10	10	1	1	11	11	0.41	2988.3	15	15	0	0	15	15	0.50

After Bando *et al.* (2008); Yasunaga *et al*. (2009-2011, 2013, 2014); Mogoe *et al.* (2015, 2016)

Table 5. Mean body, standard deviation and range of body length of common minke whales sampled in the 2016 JARPNII costal off Sanriku

Area	Male					Female				
	Mean	SD	Min.	Max.	*n*	Mean	SD	Min.	Max.	*n*
Area 1	4.88	-	4.74	5.02	2	5.34	1.08	4.38	6.89	4
Areas 2+3	6.10	1.28	5.08	7.90	5	5.71	1.46	4.03	7.98	5
All areas	5.75	1.21	4.74	7.90	7	5.55	1.24	4.03	7.98	9

Table 6. Reproductive status of common minke whales sampled in the 2016 JARPNII coastal off Sanriku

Area	Male				Female			
	Immature	Mature	Total	Maturity	Immature	Mature (pregnancy)	Total	Maturity
Area 1	2	0	2	0.00	3	1 (1)	4	0.25
Areas 2+3	3	2	5	0.40	4	1(1)	5	0.20
All areas	5	2	7	0.29	7	2(2)	9	0.22

Table 7. Frequency appearance and weight of fore and second stomach contents (kg) of dominant prey species found in forestomach contents of common minke whales sampled in the 2016 JARPNII coastal off Sanriku

a) Frequency of stomach contents (numbers in parentheses are percentage)

Area	Sand lance (Adult)	Japanese sardine	Unknown*	Total
Area 1	2 (33.3%)	2 (33.3%)	2 (33.3%)	6
Areas 2+3	0	10 (100%)	0	10
All areas	2 (12.5%)	12 (75.0%)	2 (12.5%)	16

*Stomach was broken by harpoon

b) Weight (kg) of stomach cnotents (numbers in parentheses are range)

Area	Sand lance (Adult)	Japanese sardine	Total
Area 1	15.4 (2.90-27.8)	19.0 (13.7-24.2)	17.2 (2.9-27.8)
Areas 2+3		18.0 (2.3-27.6)	18.0 (2.3-27.6)
All areas	15.4 (2.90-27.8)	18.1 (2.3-27.6)	17.7 (2.3-27.8)

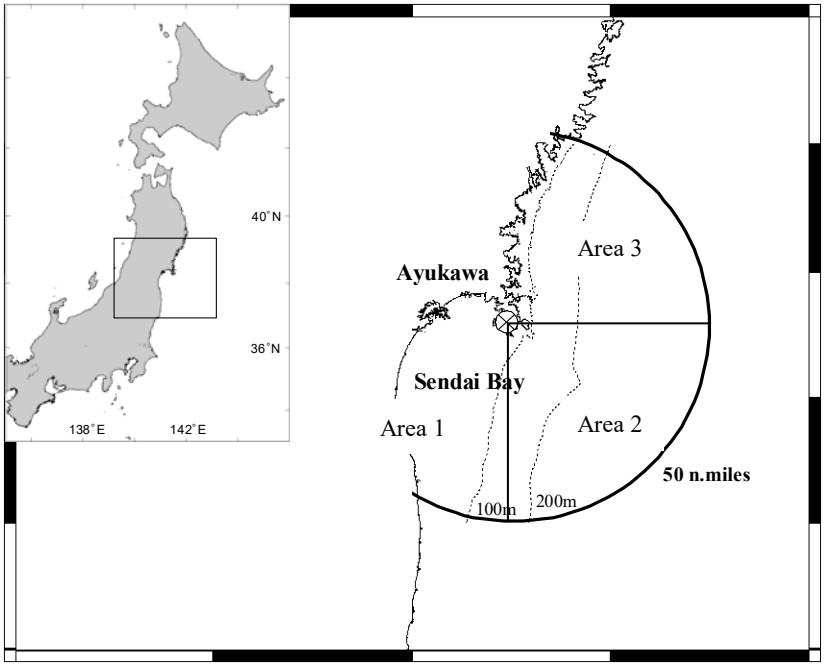

Figure 1. Research area of the 2016 JARPNII coastal survey off Sanriku

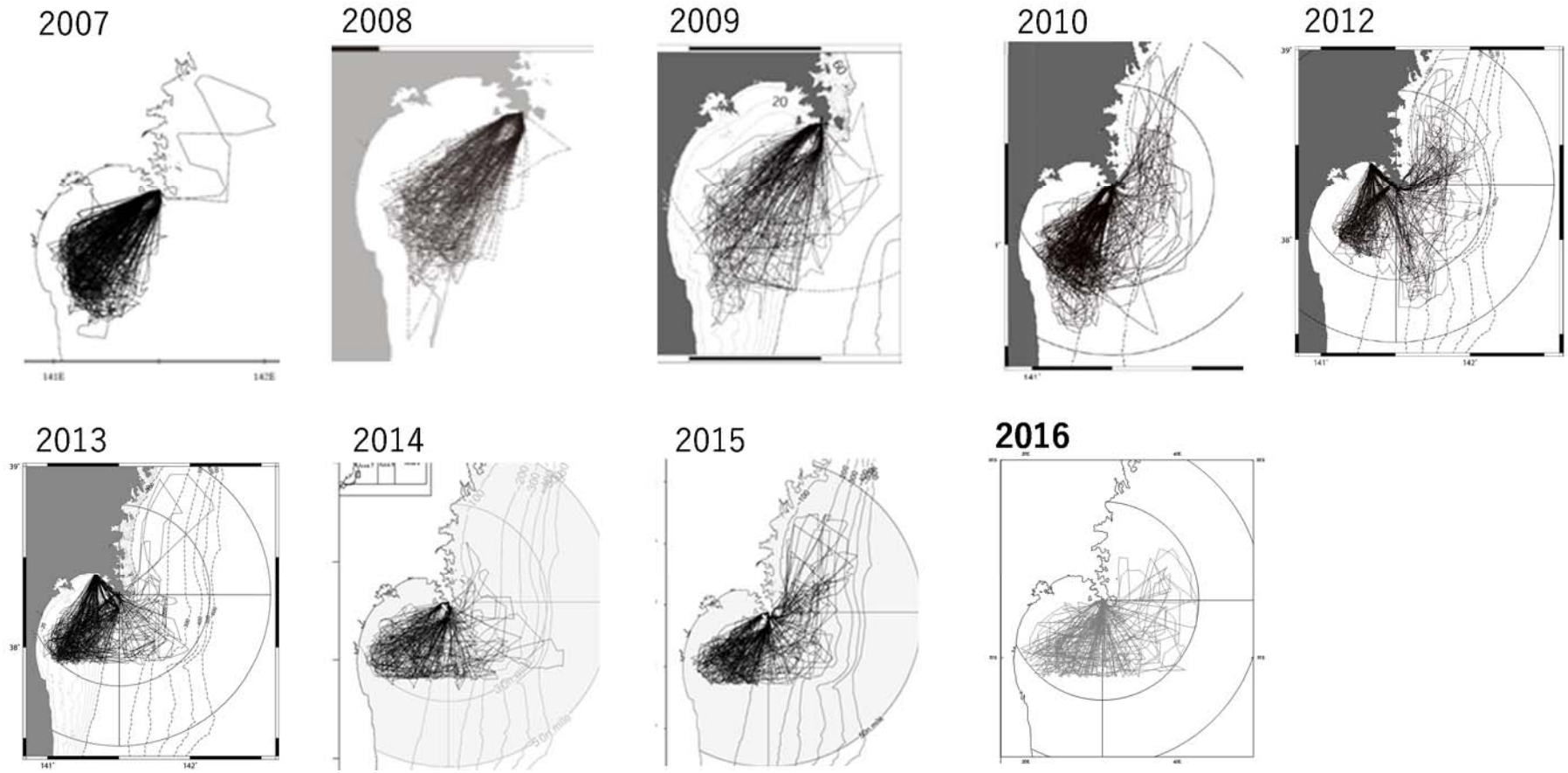

Figure 2. Cruise tracks by four sampling vessels in the JARPNII coastal survey off Sanriku for 2007-2016
After Bando *et al.* (2008); Yasunaga *et al.* (2009-2011, 2013, 2014); Mogoe *et al.* (2015, 2016)

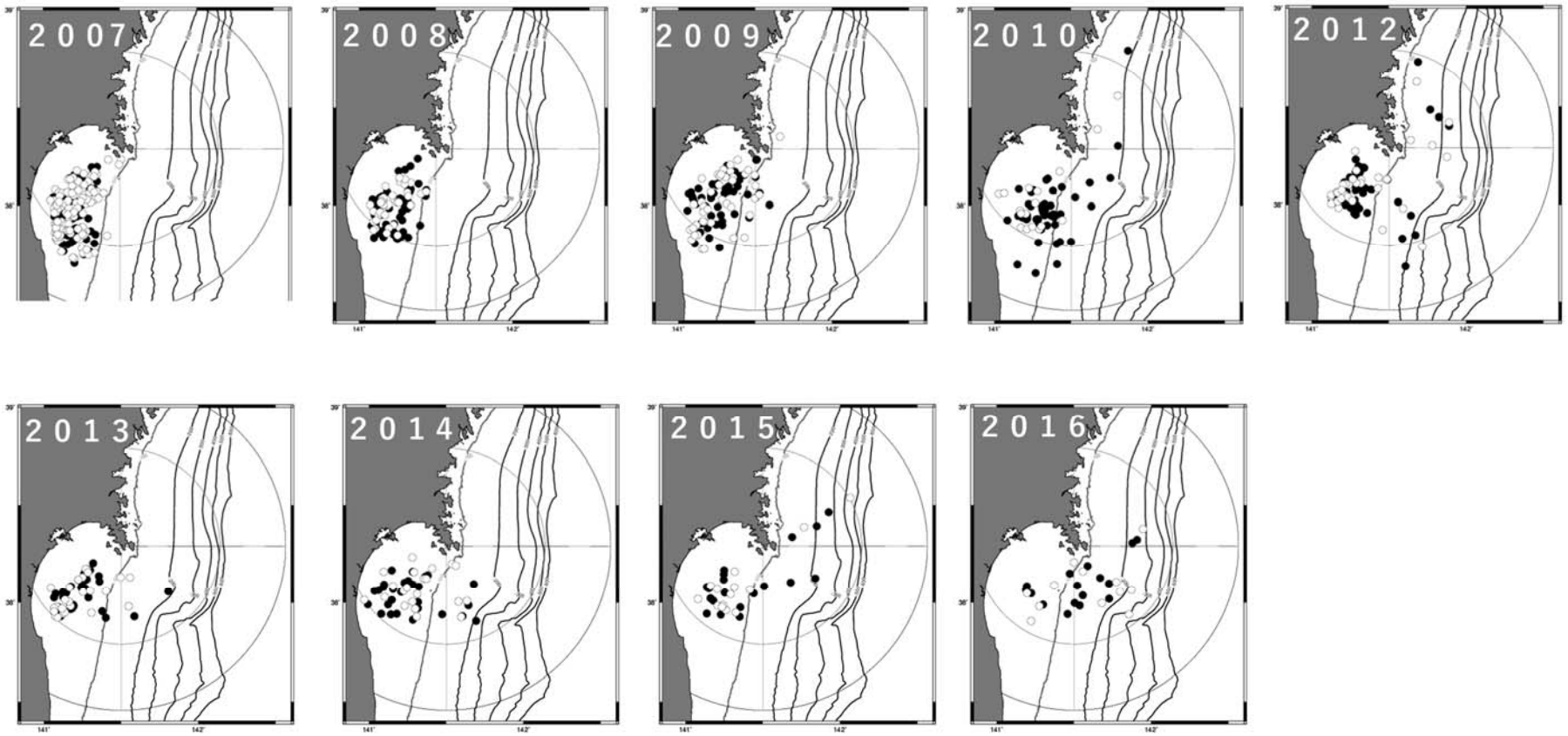

Figure 3. Sighting positions of common minke whales in the 2007-2016 JARPNII coastal surveys off Sanriku (●: sighting and sampled; ○: only sighting)
After Bando *et al.* (2008); Yasunaga *et al.* (2009-2011, 2013, 2014); Mogoe *et al.* (2015, 2016)

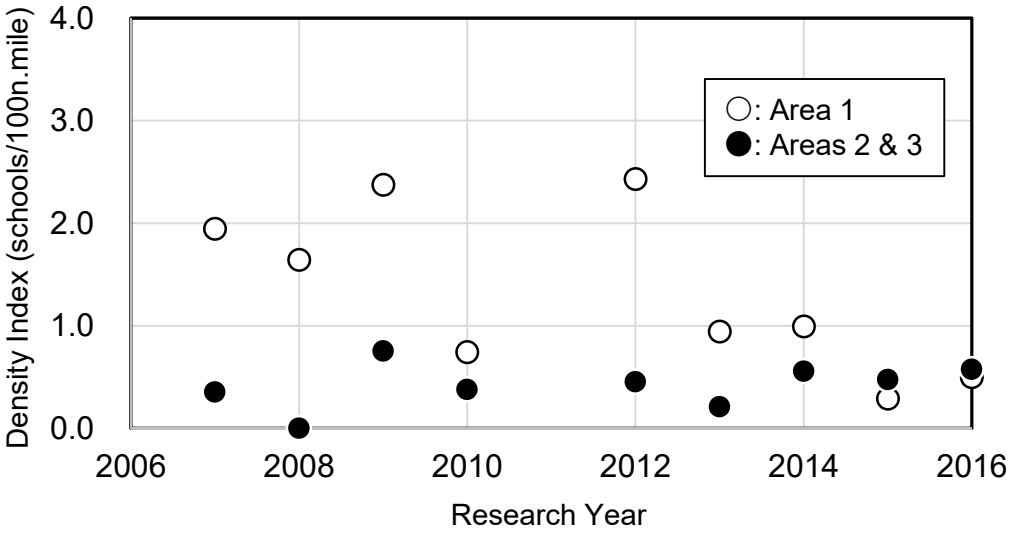

Figure 4 Yearly changes of density index (schools /100 n.mile) of common minke whales in Area 1 and Areas 2 and 3 in the JARPNII Sanriku component for 2007-2016
After Bando *et al.* (2008); Yasunaga *et al.* (2009-2011, 2013, 2014); Mogoe *et al.* (2015, 2016)

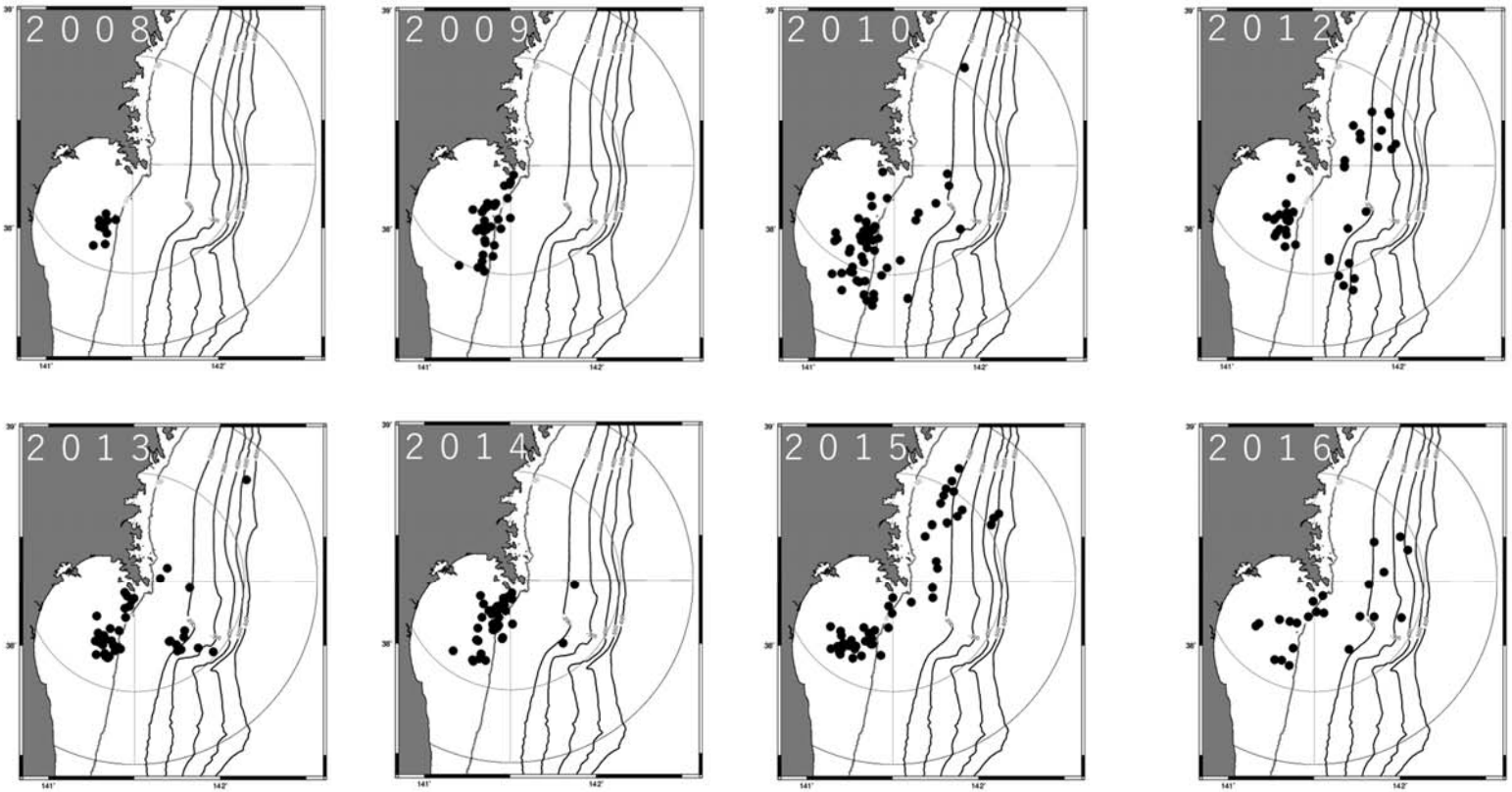

Figure 5. Sighting positions of humpback whales in the 2008-2016 JARPNII coastal surveys off Sanriku

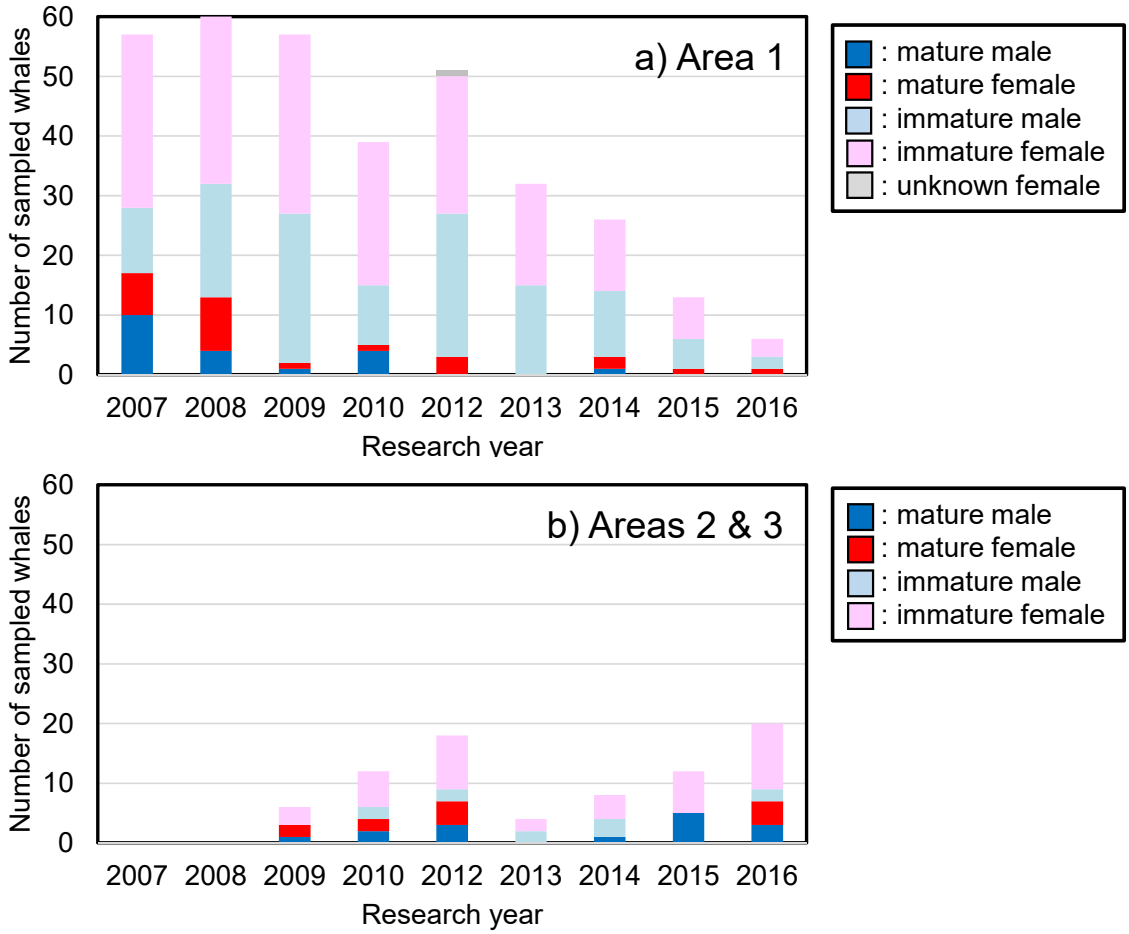

Figure 6. Yearly changes of frequency of sexual maturity in sampled common minke whales in Area 1 (upper) and Areas 2 and 3 (lower) in the JARPNII Sanriku component for 2007-2016

After Bando *et al.* (2008); Yasunaga *et al.* (2009-2011, 2013, 2014); Mogoe *et al.* (2015, 2016)

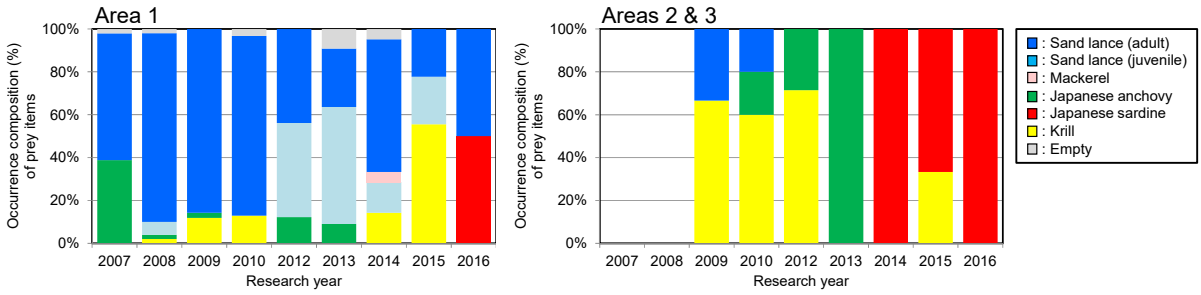

Figure 7. Yearly changes of occurrence composition of dominant prey items found in forestomach of common minke whales sampled in Area 1 (left) and Areas 2 and 3 (right) in the JARPNII costal surveys off Sanriku during a period of 2007 and 2016

After Bando *et al.* (2008); Yasunaga *et al.* (2009-2011, 2013, 2014); Mogoe *et al.* (2015, 2016)

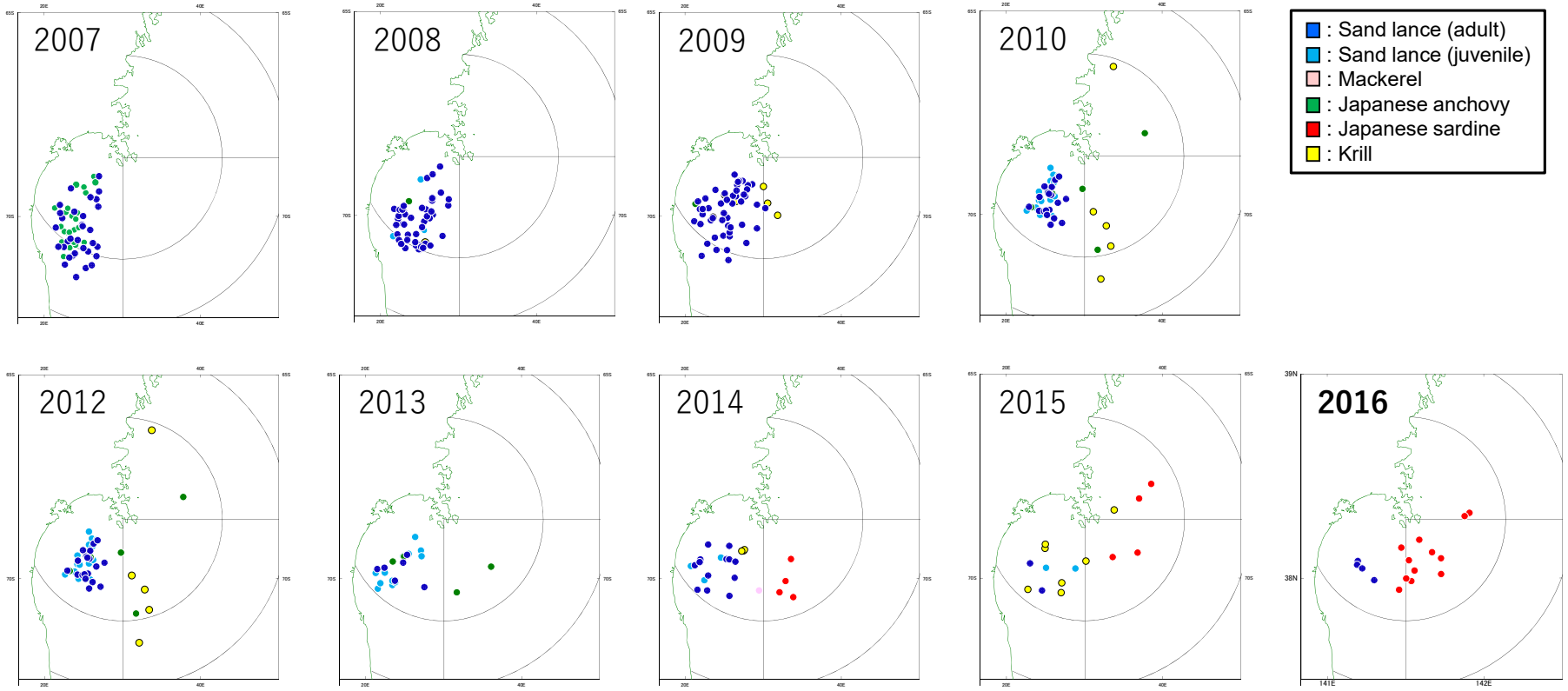

Figure 8. Sighting position and dominant prey species of common minke whales sampled in the JARPNII coastal survey off Sanriku for 2007-2016
After Bando *et al.* (2008); Yasunaga *et al.* (2009-2011, 2013, 2014); Mogoe *et al.* (2015, 2016)

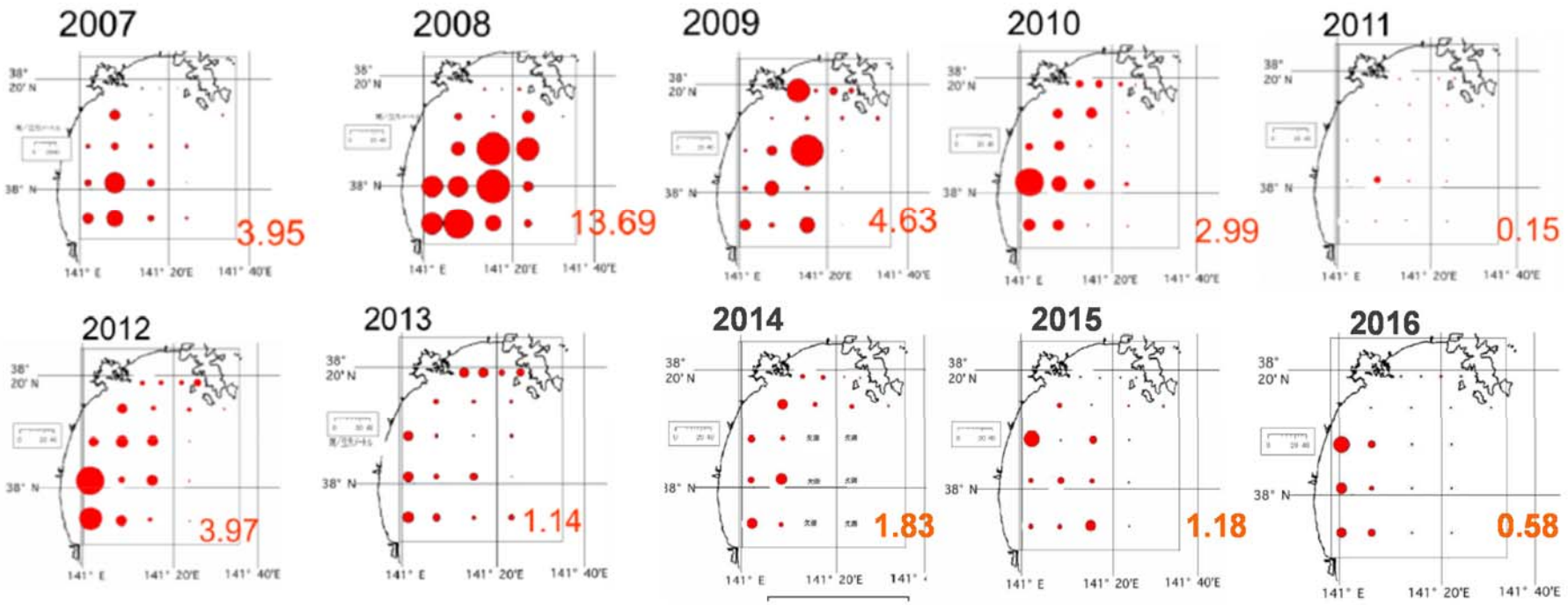

Figure 9. Density distribution (individual/m³) of Japanese sand lance (juvenile) in Sendai bay for 2007-2016 based on data from Miyagi Prefecture Fisheries Technology Institute (2016)

Appendix

Coastal prey species survey of JARPN II off Sanriku in 2016

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ABSTRACT

A prey species survey was conducted in the coastal region off Sanriku, northeastern Japan in spring 2016 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 (19, 20 April) and May (19, 20 May). Four stratified blocks were surveyed in April (B, C Survey Blocks) and the two blocks (A, D Survey Blocks) were surveyed in May. Zigzag tracklines were set in the blocks. A trawler type RV, "Miyashio", conducted the survey. Acoustic data were recorded continuously along tracklines by a quantitative echosounder. Samplings using a midwater trawl net were conducted at 5 stations to identify species and body size compositions of acoustic backscatterings. Vertical oceanographic conditions were recorded at 17 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 except for 2011 with the Great East Japan Earthquake as a component of the JARPNII coast since 2003.

In this document, the results of the prey species survey off Sanriku in 2016 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 37º 54' N to 38º 40' 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 echosoudner data (Fig 1). 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 and Fukushima nuclear accident, only 2 blocks (B, C) were surveyed in April and 2 blocks (A, D) were surveyed in May in 2016(Fig. 1). 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 (19, 20 April) and May (19, 20 May). 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, "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 tracklines. Acoustic data were stored with an aid of software, Echoview (Sonar Data, Australia). A calibration was carried out in the survey area on 19 April and on 13 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 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, about 40 grams krill was taken. But juvenile sand lance and adult sand lance weren't probably taken for an escape.

RESULTS

The planned tracklines were almost surveyed by the quantitative echosounder. Trawl was towed at 5 stations. A summary of the midwater trawl samplings was shown in Table 2. CTD casts were conducted at 17 stations.
In April, backscatterings of juvenile sand lance and adult sand lance were observed in 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.

ACKNOWLEDGEMENT

We would like to thank the captain of RV "Miyashio", Mr. Tatsuo Kanomata, 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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Government of Japan. 2002. Research Plan for Cetacean Studies in the Western North Pacific under Special Permit (JARPN II). IWC/SC/54/O2 submitted to the 54th IWC Scientific Committee Meeting, 115pp.

Table 1. Waypoints and planed lines.

Block A

Waypoint	Latitude				Longitude				Course (degree)	Distance (n.mile)
A1	38	-	40.0	N	141	-	52.0	E	247	13.7
A2	38	-	34.5	N	141	-	36.0	E	115	13.0
A3	38	-	29.0	N	141	-	51.0	E	239	11.5
A4	38	-	23.0	N	141	-	38.5	E	130	12.4
A5	38	-	15.0	N	141	-	51.0	E	-	-
									Total	50.5

Block B

Waypoint	Latitude				Longitude				Course (degree)	Distance (n.mile)
B1	38	-	20.0	N	141	-	18.0	E	223	8.1
B2	38	-	14.0	N	141	-	11.0	E	291	3.8
B3	38	-	11.0	N	141	-	14.0	E	243	9.8
B4	38	-	06.5	N	141	-	03.0	E	115	10.5
B5	38	-	02.0	N	141	-	15.0	E	244	11.4
B6	37	-	57.0	N	141	-	02.0	E	109	9.2
B7	37		54.0	N	141	-	13.0	E	-	-
									Total	52.8

Block C

Waypoint	Latitude				Longitude				Course (degree)	Distance (n.mile)
C1	37	-	54.0	N	141	-	25.0	E	295	9.6
C2	37	-	58.0	N	141	-	14.0	E	67	10.3
C3	38	-	02.0	N	141	-	26.0	E	297	8.8
C4	38	-	06.0	N	141	-	16.0	E	71	12.5
C5	38	-	10.0	N	141	-	31.0	E	290	10.1
C6	38	-	13.5	N	141	-	19.0	E	65	3.5
C7	38	-	15.0	N	141	-	23.0	E	-	-
									Total	54.7

Block D

Waypoint	Latitude				Longitude				Course (degree)	Distance (n.mile)
D1	37	-	54.0	N	141	-	41.0	E	297	13.3
D2	38	-	00.0	N	141	-	26.0	E	72	19.5
D3	38	-	06.0	N	141	-	49.5	E	293	15.0
D4	38	-	12.0	N	141	-	32.0	E	78	14.9
D5	38	-	15.0	N	141	-	50.5	E	-	-
									Total	62.6

Table 2. A summary of the trawl sampling.

Station		St-1	St-2	St-3	St-4	St-5	
Block		B	C	D	D	A	
Date		20 Apr.	20 Apr.	19 May	19 May	20 May	
Time		06:24	09:11	10:17	15:32	7:39	
Latitude		37-57N	37-53N	38-08N	37-58N	38-30N	
Longitude		141-02E	141-26E	141-42E	141-31E	141-48E	
Temp (°C) by depth	0 m	10.3	9.9	12.1	12.2	12.5	
	10 m	10.14	9.77	11.55	11.81	11.56	
	20 m	10.15	9.61	10.90	11.10	10.92	
	30 m		9.66	9.73	10.52	10.16	
	40 m		9.75	9.62	10.20	10.08	
	50 m		9.79	9.53	9.94	10.05	
	75 m		8.43	9.41	9.57	9.47	
	100 m		8.27	9.37	9.18	9.18	
	Bottom (m)	9.67 (21)	8.28 (104)	9.27 (154)	9.12 (136)	7.97 (179)	
Trawl sampling depth (m)		10-20	40-50	50-130	25-65	25-35	
Major sampled species		Cod (juvenile) Jellyfish	Copepoda krill	krill	krill	Nothing	

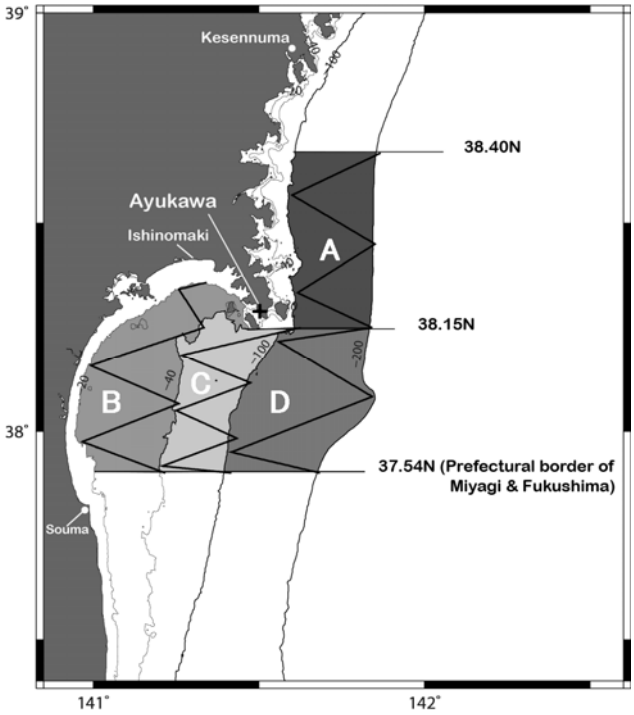

Fig. 1. Survey Blocks and planed tracklines in 2016