Cruise report of the second phase of the Japanese Whale Research Program under Special Permit in the western North Pacific (JARPN II) in 2013 (Part III) – Coastal component off Kushiro

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ABSTRACT

The JARPN II coastal component off Kushiro, northeast Japan (the sub-area 7CN) was conducted from 6 September to 25 October 2013, using four small-type whaling catcher boats as sampling vessels. The sampling was conducted in the coastal waters within the 50 nautical miles from the Kushiro port, and all whales sampled were landed on the land station in the Kushiro port for biological examination. During the survey, a total of 4,629.7 n. miles (451.8 hours) was searched, 126 schools/ 142 individuals of common minke whales were sighted and 58 whales were sampled. Average body length of sampled whales was 6.77m (SD=0.88, n=41) for males and 6.55m (SD=1.39, n=17) for females, respectively. 27 of the 41 males (65.9%) and seven of the 17 females (41.2%) were sexually mature. The dominant prey species found in the stomach was Japanese sardine *Sardinops melanostictus* (63.8%), followed by walleye pollock *Theragra chalcogramma* (22.4%), mackerel *Scomber japonicas* (6.9%), krill *Euphausia pacifica* (5.2%) and Japanese common squid *Todarodes pacificus* (1.7%). In the 2013 survey, Japanese anchovy *Engraulis japonicus* and Pacific saury *Cololabis saira* could not be found in the stomach. From late 1960's to 1987, Japanese sardine and mackerel were recorded as the major prey species of common minke whales taken by the commercial whaling. But, when the coastal component off Kushiro started in 2002, Japanese anchovy was the major prey species found in the stomach, and dominance of the Japanese anchovy was continued until 2011 survey. In 2012, Japanese sardine and mackerels were detected again form the stomach by the survey, and in the present survey, Japanese sardine became the most dominant prey species. Conversely, Japanese anchovy was disappeared. Apparent change in the dominant prey species from Japanese anchovy to Japanese sardine observed here suggested that the distribution and amount of those prey species in the coastal waters off Kushiro were changed, and the stomach contents of the whales could reflect those environmental changes. Such information is valuable in considering the habit of the whales and environmental change in the region, and will be contributed to the objectives of the JARPN II feeding ecology and ecosystem studies.

BACKGROUND

The objectives of the second phase of the Japanese Whale Research Program under Special Permit in the western North Pacific (JARPN II) are: i) feeding ecology and ecosystem studies, involving prey consumption by cetaceans, prey preferences of cetaceans and ecosystem modelling, ii) monitoring environmental pollutants in cetaceans and marine ecosystem, and iii) stock structure of whales (Government of Japan, 2002).

The JARPN II involves two survey components; 'offshore' which is covered by the *Nisshin Maru* research vessels and 'coastal' which is covered by small-type whaling catcher boats, and the latter one is necessary to cover the temporal and spatial gaps, which cannot be covered by the *Nisshin maru* research vessels (Government of Japan, 2002).

After the two-year feasibility surveys of the coastal component conducted in 2002 off Kushiro and 2003 off Sanriku district (Kishiro, *et al*., 2003, Yoshida, *et al*., 2004, Government of Japan, 2004a), the coastal component has been conducted twice a year, with 60 common minke whales being sampled in each of spring off Sanriku and autumn off Kushiro (Government of Japan, 2004b). In January 2009, the expert workshop was carried out in Japan under the IWC/SC, and reviewed the results of the first six years of the full-scale JARPN II (IWC, 2009). Based on the results of the workshop, the coastal components were continued following the original research plan (Government of Japan 2004b), and the survey off Kushiro was conducted annually from 2004 to 2012 (Kishiro, *et al*., 2005, 2006, 2008, 2010, 2012, Yoshida, *et al*., 2007, 2009, 2011, 2013).

This paper presents results of the 2013 survey off Kushiro, conducted from 6 September to 25 October in 2013. The survey was authorized by the Government of Japan in compliance with Article VIII of the international convention for the Regulation of Whaling. The National Research Institute of Far Seas Fisheries

(NRIFSF), Fisheries Research Agency, planned and conducted the survey cooperate with the Institute of Cetacean Research (ICR), Tokyo University of Marine Science and Technology, and the Association for Community-Based Whaling.

MATERIALS AND METHODS

Research area

The research area was same to the previous surveys (Kishiro, *et al*., 2003, 2005, 2006, 2008, 2010, 2012, Yoshida, *et al*., 2007, 2009, 2011, 2013, Yasunaga *et al*., 2012), i.e. the coastal waters off Kushiro, within the 50 nautical miles from the Kushiro port (Fig. 1). This area is included in the middle part of the sub-area 7CN, established by the IWC.

Research vessels, land station, and research period

Four small-type whaling catcher boats were used as sampling vessels: *Taisho Maru* No. 28 (47.3GT), *Koei Maru* No.8 (32.0GT), *Sumitomo Maru* No.51 (30.0GT), and *Katsu Maru* No.7 (32.0GT). All the whales collected were landed on the land station (the JARPN II research station) in the Kushiro port for biological examination. Research period was set for 50 days, from 6 September to 25 October, 2013.

Searching and sampling methods

Searching and sampling methods were almost same with those for the first coastal survey off Kushiro in 2002 (Kishiro *et al*. 2003). The research head office was placed in the research station and controlled the sampling vessels during the survey. All catcher boats were engaged as the sampling vessels. To avoid the concentration of sampling location, the research head office arbitrarily determined the searching area and route (direction from the port) for each sampling vessel in every day, based on the information of the whale distribution. Weather conditions and information on fishing grounds of prey species were also considered. In each vessel, a researcher was on board and recorded the cruise tracks, searching time on effort, sea weather conditions and sighting data. Sighting data would be collected for all baleen whales and sperm whales. The vessel principally continued to cruise and search along the predetermined direction until arrived at 15-30 n. miles from the port, and then freely cruised in the waters within the 50 n. miles radius from the port. Searching was carried out during the day and the vessels returned to the port every night. Sighting was conducted from the top barrel and upper bridge by all the crews and researcher with vessel speed at about 11 knots. All common minke whales sighted were targeted for sampling, except for the cow-calf pair. When a sighting consisted of more than one animal, first targeted animal was selected following the random sampling digits. Sampling was made by 50 mm whaling cannon. Once a vessel caught a whale, it returned to the Kushiro 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 an 11 tons freight trailer. At that time, body weight of the whale was measured with the truck scale.

Biological research on common minke whales collected

All the whales sampled were biologically examined by researchers at the research station. Research items of the biological studies are summarized in Table 2, with the number of data and samples obtained. These items were related to studies on feeding ecology, stock structure, life historical biology and pollutions.

RESULTS

Searching effort made by sampling vessels

The cruise tracks made by the sampling vessels during the survey are shown in Figure 2. The searching areas covered widely coastal waters within 30 nautical miles from the Kushiro port. Searching distance and time are shown in Table 1. Here, we defined the searching distance and time as that with sighting effort, i.e. the periods of the searching conducted from the top barrel. During the research period, total searching distance and time were 4,629.7 n. miles and 451.8 hours, respectively.

Sightings and sampling of common minke whales

Figure 3 shows distribution of common minke whales sighted by the sampling vessels. Sighting positions distributed in inshore areas off Kushiro port to the waters in around 30 n. miles from the port, and relatively concentrated on the slope of the continental shelf regions in the south eastern side of the research area. During the survey, a total of 126 schools/ 142 individuals of common minke whales were sighted, consisting of 104 schools/ 115 individuals of primary sightings and 22 schools/ 27 individuals of secondary sightings (Table 1). These figures probably include some duplicated sightings because sampling vessels searched almost same areas in every day. Density index of common minke whales was calculated as 2.48 for DI (the number of primary sightings per 100 nautical miles searching) and 0.25 for SPUE (the number of primary sightings per 1 hour searching). Of the 142 common minke whales sighted, 58 common minke whales were sampled. In the sampling process, there were no struck and lost animals. Fig.3 showed sighting positions of sampled whales. Distribution of these whales almost covered all of the areas where the sightings were made during the survey period.

Sightings of other large cetacean

During the survey, a total of 29 schools/ 32 individuals of humpback whales, one individual of fin whale, one individual of sei whale, and 2 schools/ 2 individuals of sperm whales were sighted (Table 1). Sighting positions of those whales are shown in Figure 4.

Sex ratio, body length and maturity of common minke whales caught

The 58 sampled whales were consisted of 41 males and 17 females (sex ratio of males was 0.71). Average body length of the whales was 6.77m (max=8.04, min=4.75, SD=0.88) for males, and 6.55m (max=8.68, min=4.42, SD=1.39) for females, respectively (Table 3). Composition of sex and sexual maturity of the whales is listed in Table 4. Male with a single testis weight of 290g or more, and female had at least one corpus luteum or albicans in their ovaries were determined as sexually mature. In males, 27 of 41 individuals (65.9%) were sexually mature. This figure was higher than that of the last two years surveys, e.g. 54.3% in 2011, and 22.2% in 2012. In females, seven of 17 individuals (42.9%) were sexually mature, and maturity ratio of females was also higher than that of the last two years surveys, e.g. 12.0% in 2011, and 19.0% in 2012. Mature females were consisted of four resting animals and three pregnant animals. Body lengths of foetus found in the pregnant animals were 111.2cm (female), 139.5cm (male), and 186.0cm (male), respectively.

Prey species of common minke whale found in the stomach

Following the same methods used in the JARPN II feasibility surveys (Fujise, *et al*., 2002), stomach contents were weighted to the nearest 0.1 Kg by each four chamber in both cases of including and excluding liquid. Then, a sub-sample of stomach contents was collected and frozen for the later laboratory work. The weights of forestomach contents including liquid ranged from 3.0Kg to 86.1Kg, and average weight was 26.9Kg.

Table 5 shows the forestomach contents of the 58 collected whales. Dominant prey species was Japanese sardine *Sardinops melanostictus* (63.8%), followed by walleye pollock *Theragra chalcogramma* (22.4%), mackerel *Scomber japonicas* (6.9%), krill *Euphausia pacifica* (5.2%) and Japanese common squid *Todarodes pacificus* (1.7%). Among them, Japanese sardine was found from September to the middle of October, but disappeared in the late of October. Conversely, krill and Japanese common squid were only found in the late of October. Japanese anchovy *Engraulis japonicas,* which was one of the major prey species found in the stomach in the previous surveys, was not detected in the present survey. Pacific saury *Cololabis saira* was also not detected.

Observation of marine debris

Marine debris was detected from stomach of nine animals. Among them, eight animals had a small piece of plastics (1-10cm), three animals had a rubber glove, and one animal had a cotton glove. A small plastic bottle (15cm) and the top of a can (ca.10cm) were found in the stomach of two animals.

DISCUSSION

The present survey was the eleventh survey of the JARPN II coastal component in the autumn season off Kushiro. As same as the previous surveys, bad weather conditions such as typhoons, low atmospheric pressures

and thick fog often disturbed research activities. Of total 50 day survey period, sampling vessels could conduct the research for 20 days or 40.0%. This figure was lower than those of the previous surveys (e.g. 50.0% in 2012, and 46.0% in 2013). However, the density index of common minke whales recorded by the sampling vessels (DI=2.48) was higher than that of the last year survey (DI=1.71, Yoshida *et al*., 2011). Especially, in September, many whales were sighted (DI=4.30), and high value of the DI suggested that the migration of common minke whales in 2013 season was abundant, especially in September.

Figure 5 shows the body length compositions of common minke whales caught in 2013, with comparison to the results of the previous 2002-2012 surveys. A characteristic of the composition in the present survey is that there were many large males (7m in length class), compared with those of the previous 5 years surveys (2008-2012). The composition of the present survey was similar to those of the 2004 to 2007. With respect to the high value of the DI and the high value of the maturity ratio (Table 4), this indicated that many whales including mature animals migrated in the coastal waters off Kushiro in 2013 autumn season.

Figure 6 shows the yearly change in the composition of prey species found in the stomach of common minke whales through the 2002 to 2013 surveys. Until 2011, Japanese anchovy was one of the major prey species found in the stomach. In 2012, Japanese sardine and mackerels were first detected form the stomach (Yoshida *et al*., 2011), and in the present survey, Japanese sardine became the most dominant prey species. Conversely, Japanese anchovy was disappeared in 2013. From late 1960's to 1987, Japanese sardine and mackerel were recorded as the major prey species of common minke whales taken by the commercial whaling, and also many amounts of those species were taken by coastal fisheries (Kasamatsu and Tanaka, 1992). After that, abundance of Japanese sardine was decreased, and major species taken by the fisheries was shifted from sardine to anchovy in 1990's to 2000's. This phenomenon was well known as the regime shift of marine ecosystem or the alternation of the fish species (Schwartzlose, *et al*., 1999). However, in recent years, abundance of Japanese sardine in the Pacific stock has been gradually increased again (Fisheries Research Agency, 2013), and commercial catch of Japanese sardine in the Kushiro region in September 2013 was 12 times higher than that of the last year season. The drastic change of the dominant prey species in the stomach observed here were well coincided with those recent information.

Japanese sardine was taken by both immature and mature whales (Fig.7). This suggested that Japanese sardine could be attracted both immature and mature common minke whales. Based on the previous survey, Pacific saury was thought to be preferred by mature whales (Kishiro, *et al*., 2009). As shown in Figure 5 and 6, when Pacific saury was detected in the stomach, large whales (especially 7m in length class) were frequently taken as in 2004 to 2007. The body length composition of the present survey was similar to those of the 2004 to 2007, but no Pacific saury was detected. This implied that Japanese sardine instead of Pacific saury attracted many common minke whales including mature animals in this season. The reason of the lack of Pacific saury in this season might be due to fewer migration of Pacific saury in the restricted research area (within a 50 nautical miles from the Kushiro port). Fishing grounds for Pacific saury during the present survey period were located in the offshore waters far from the research area (Japan Fisheries Information Service Center, 2013).

Japanese common squid was taken by only mature animals as reported previously (Kishiro, *et al*., 2009), but walleye pollock, which was thought to be preferred by immature animals, was taken by both immature and mature whales in this year (Fig. 7). Figure 8 shows geographical positions of the whales by their maturity status and prey species found in the stomach. Mature animals distributed slightly offshore region, compared with immature animals, but both immature and mature animals taking Japanese sardine were distributed widely, while both immature and mature animals taking walleye pollock were concentrated along the 200-500m isobaths on the continental slop region. These results indicated that the whale stomach contents were affected by the distribution of prey species, and mature animals also taking walleye pollock in some case.

Anyway, the present survey revealed an apparent change in the dominant prey species from Japanese anchovy to Japanese sardine. These results suggested that the distribution and amount of those prey species in the coastal waters off Kushiro were changed, and the stomach contents of the whales could reflect those environmental changes.

It has been six years from the first IWC review meeting for the JARPN II (IWC, 2009). After the meeting reviewed the first results from 2002 to 2007, apparent change of the body length compositions of the whales and prey species composition in the stomach were observed, as mentioned above. These changes are might be related with the environmental change and the migration manner of the whales in the coastal waters off Kushiro region. Such information is valuable in considering the habit of common minke whales within the same waters in the long time scale, and will be contributed to the objectives of the JARPN II feeding ecology and

ecosystem studies. The analyses of the samples and data obtained through the surveys are ongoing with respect to the various aspects such as the feeding ecology, stock structure, pollution, and ecosystem studies. These progress and results will be presented at the future next IWC review meeting for the JARPN II.

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Table 1. Searching days, hours, distances, and number of sightings made by sampling vessels in the 2013JARPN II coastal component off Kushiro.

					Number of sightings					
					Primary		Secondary		Total	
Period	Days	Hours	Distances (n.miles)	Species	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.
6 Sept.-25 Oct.	50	451.8	4,629.7	Common minke whale	104	115	22	27	126	142
				Like minke whale	32	32	0	0	32	32
				Humpback whale	25	28	4	4	29	32
				Fin whale	1	1	0	0	1	1
				Sei whale	1	1	0	0	1	1
				Sperm whale	2	2	0	0	2	2
				Unidentifed cetaceans	14	17	2	3	16	20

Table 2. Summary of biological data and samples collected during the 2013 JARPN II coastal component off Kushiro.

Samples and data	Number of whales		
	Male	Female	Total
Body length and sex	41	17	58
External body proportion	41	17	58
Photographic record and external character	41	17	58
Diatom film record	41	17	58
Body scar record	41	17	58
Measurements of blubber thickness (five points)	41	17	58
Detailed measurements of blubber thickness (eleven points)	1	-	1
Body weight	41	17	58
Body weight by parts	1	-	1
Skin tissues for DNA study	41	17	58
Muscle, liver, kidney and blubber tissues for heavy metal analysis	41	17	58
Muscle, liver, kidney and blubber tissues for organic chlorine analysis	41	17	58
Muscle and blubber tissues for byproduct analysis	41	17	58
Muscle, liver, spleen, heart and blubber tissues for chemical analysis	41	17	58
Urine for chemical analysis	16	2	18
Mammary grand; lactation status, measurement and histological sample	-	17	17
Uterine horn; measurement and endometrium sample	-	17	17
Collection of ovary	-	17	17
Foetus	2	1	3
Testis and epididymis; weight and histological sample	41	-	41
Stomach content, conventional record	41	17	58
Volume and weight of stomach content in each compartment	41	17	58
Stomach contents for feeding study	37	17	54
Stomach contents for multipurpose study	2	1	3
Record of external parasites	41	17	58
Earplug for age determination	41	17	58
Largest baleen plate for morphologic study and age determination	41	17	58
Baleen plate measurements (length and breadth)	41	17	58
Photographic record of baleen plate series	41	17	58
Length of each baleen plate series	41	17	58
Crystalline lens in eyeball for age determination	41	17	58
Blood serum for chemical analysis	32	12	44
Vertebral epiphyses sample	33	10	43
Number of ribs	41	17	58
Brain weight	1	-	1
Skull measurement (length and breadth)	41	17	58

Table 3. Body length (m) of common minke whales sampled by the 2013 JARPN II coastal component off Kushiro.

	Male					Female				
Period	Mean	S.D.	Min.	Max.	n	Mean	S.D.	Min.	Max.	n
6 Sept.- 15 Sept.	6.92	0.90	4.75	8.04	20	5.62	1.24	4.42	7.89	7
16 Sept. - 30 Sept.	6.70	0.93	4.85	7.80	16	7.37	0.43	6.88	7.71	3
1 Oct. -15 Oct.	6.20	0.03	6.18	6.22	2	7.27	1.41	5.85	8.68	4
16 Oct. -25 Oct.	6.57	0.91	5.57	7.34	3	6.95	1.56	5.17	8.07	3
Total	6.77	0.88	4.75	8.04	41	6.55	1.39	4.42	8.68	17

Table 4. Composition of sex and sexual maturity of common minke whales sampled by the 2013 JARPN II coastal component off Kushiro.

	Male				Female							
Period	Imm.	Mat.	Total	Marutity (%)	Imm.	Rest.	Lact.	Preg.	Total	Pregnancy (%)*1	Maturity (%)	Sex ratio (%males)
9 Sept.-15 Sept.	5	15	20	75.0	6	0	0	1	7	100.0	14.3	74.1
16 Sept.- 30 Sept.	6	10	16	62.5	1	2	0	0	3	0.0	66.7	84.2
1 Oct.- 15 Oct.	2	0	2	0.0	2	1	0	1	4	50.0	50.0	33.3
16 Oct.- 30 Oct.	1	2	3	66.7	1	1	0	1	3	50.0	66.7	50.0
Total	14	27	41	65.9	10	4	0	3	17	42.9	41.2	70.7

*1: Apparent pregnancy rate

Table 5. Number of common minke whales by major prey species found in their forestomach contents sampled by the 2013 JARPN II coastal component off Kushiro.

	No. of whales (%)							
Period	Walleye pollock	Krill	Japanese anchovy	Japanese sardine	Mackerel	Pacific saury	Common Squid	Total
9 Sept.-15 Sept.	9 (33.3)	0 (-)	0 (-)	18 (66.7)	0 (-)	0 (-)	0 (-)	27
16 Sept.- 30 Sept.	0 (-)	0 (-)	0 (-)	15 (78.9)	4 (21.1)	0 (-)	0 (-)	19
1 Oct.- 15 Oct.	2 (33.3)	0 (-)	0 (-)	4 (66.7)	0 (-)	0 (-)	0 (-)	6
16 Oct.- 30 Oct.	2 (33.3)	3 (50.0)	0 (-)	0 (-)	0 (-)	0 (-)	1 (16.7)	6
Total	13 (22.4)	3 (5.2)	0 (-)	37 (63.8)	4 (6.9)	0 (-)	1 (1.7)	58

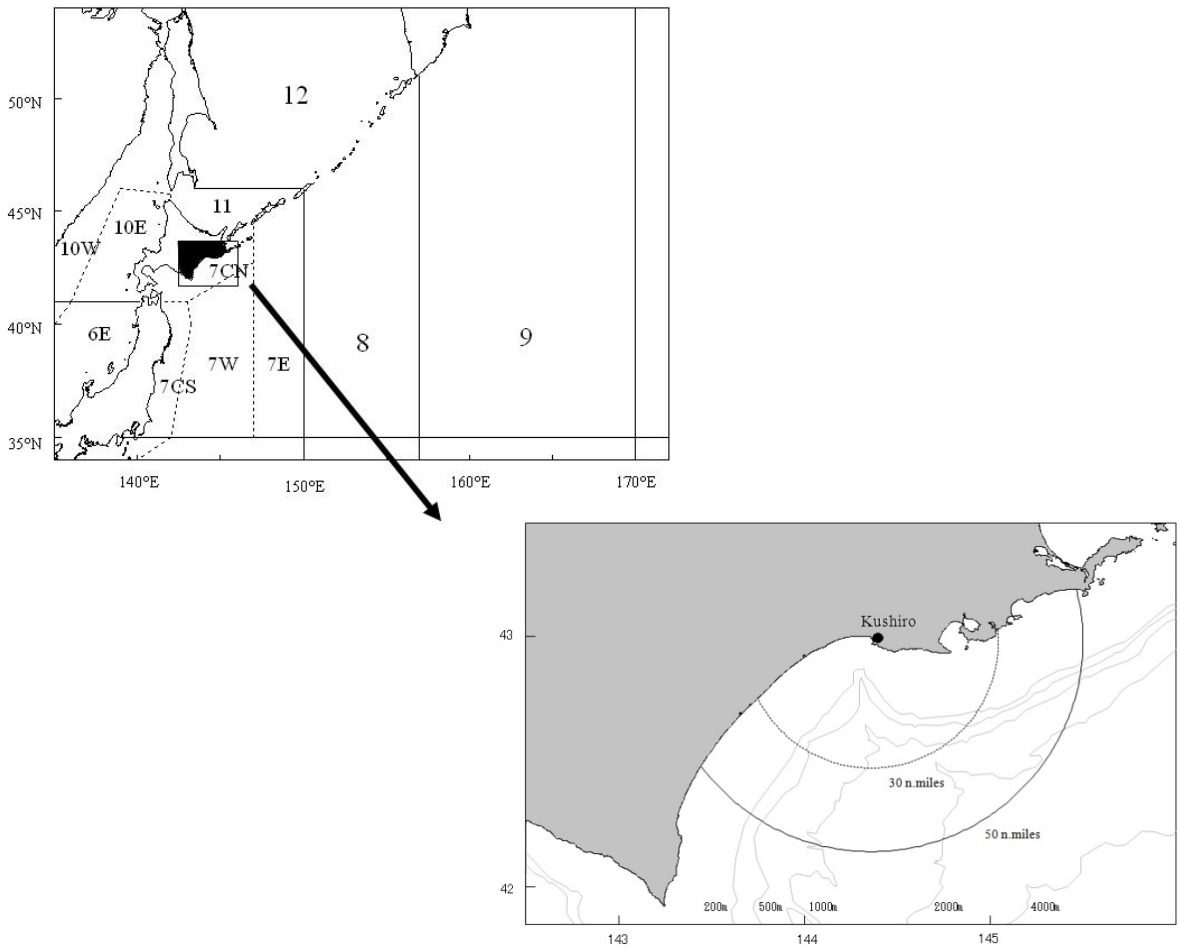

Fig.1. The IWC sub-area for western North Pacific minke whales (upper) and research area for the 2013 JARPN II coastal component off Kushiro (lower).

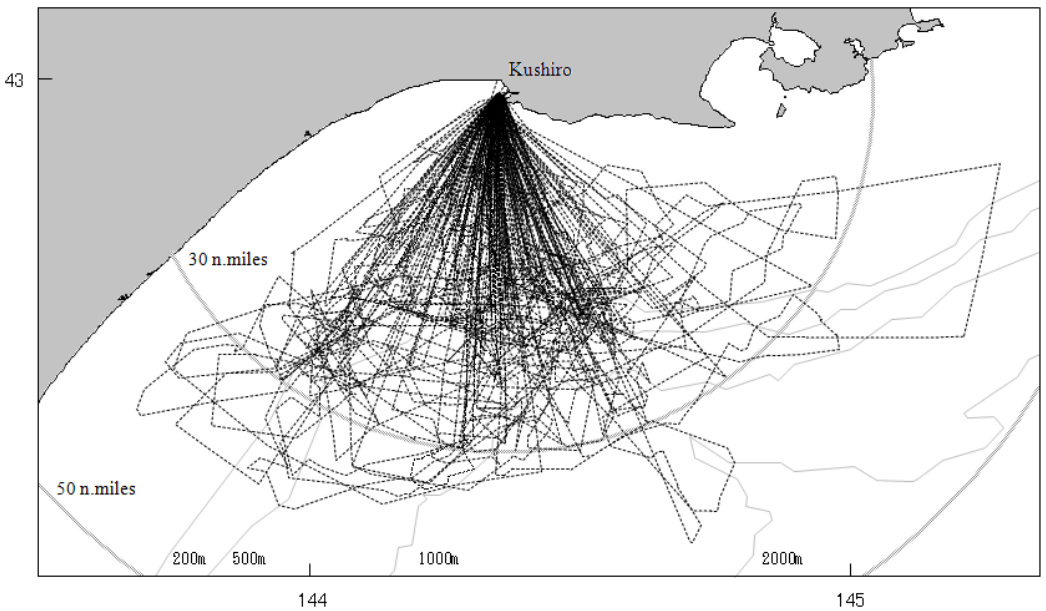

Fig.2. Cruise tracks of the sampling vessels in the 2013 coastal component off Kushiro.

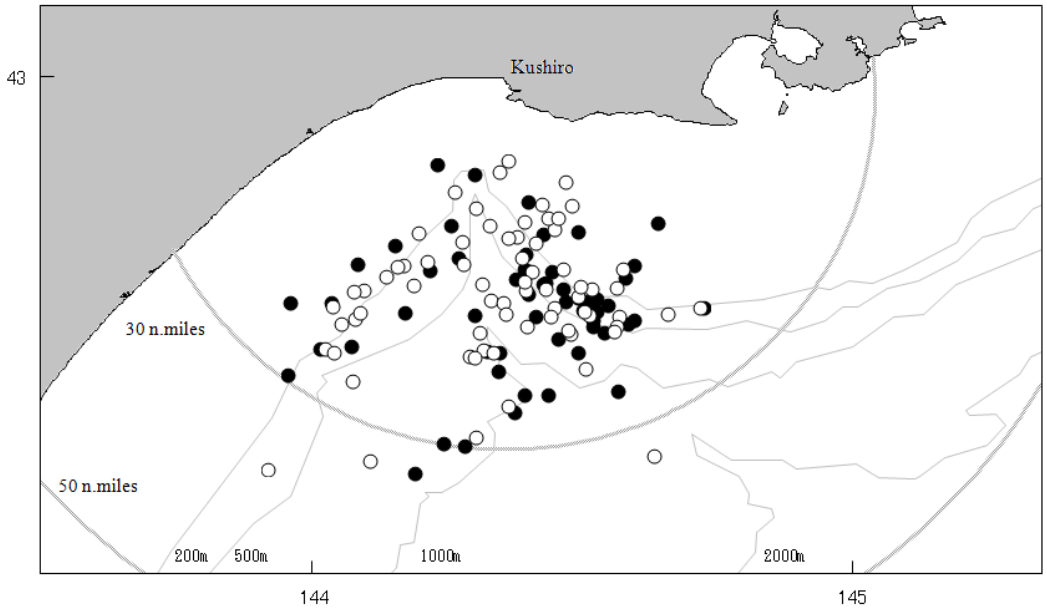

Fig.3. Sighting positions of common minke whales in the 2013 coastal component off Kushiro. Closed circle indicates sighting position of sampled whale.

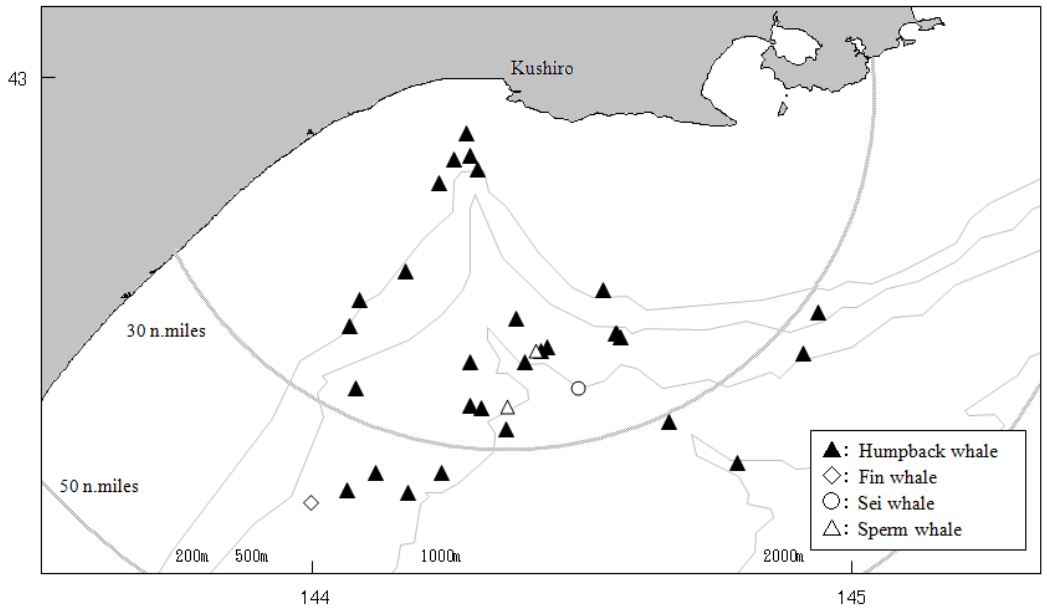

Fig.4. Sighting positions of humpback (closed triangle), fin (open square), sei (open circle), and sperm whales (open triangle), in the 2013 coastal component off Kushiro.

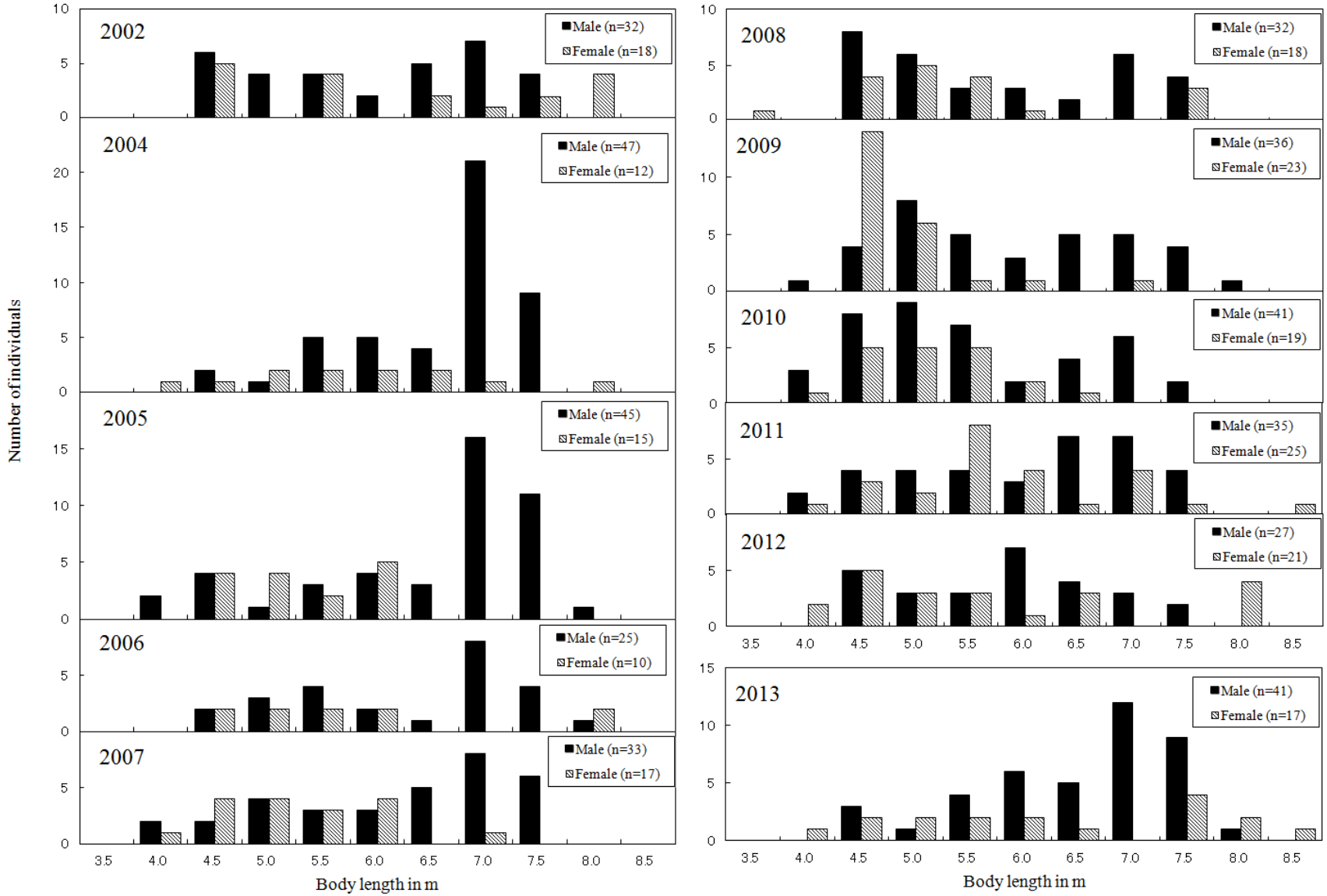

Fig 5. Body length frequency of common minke whales sampled during the 2013 coastal component off Kushiro, with comparison to the results of the previous surveys.

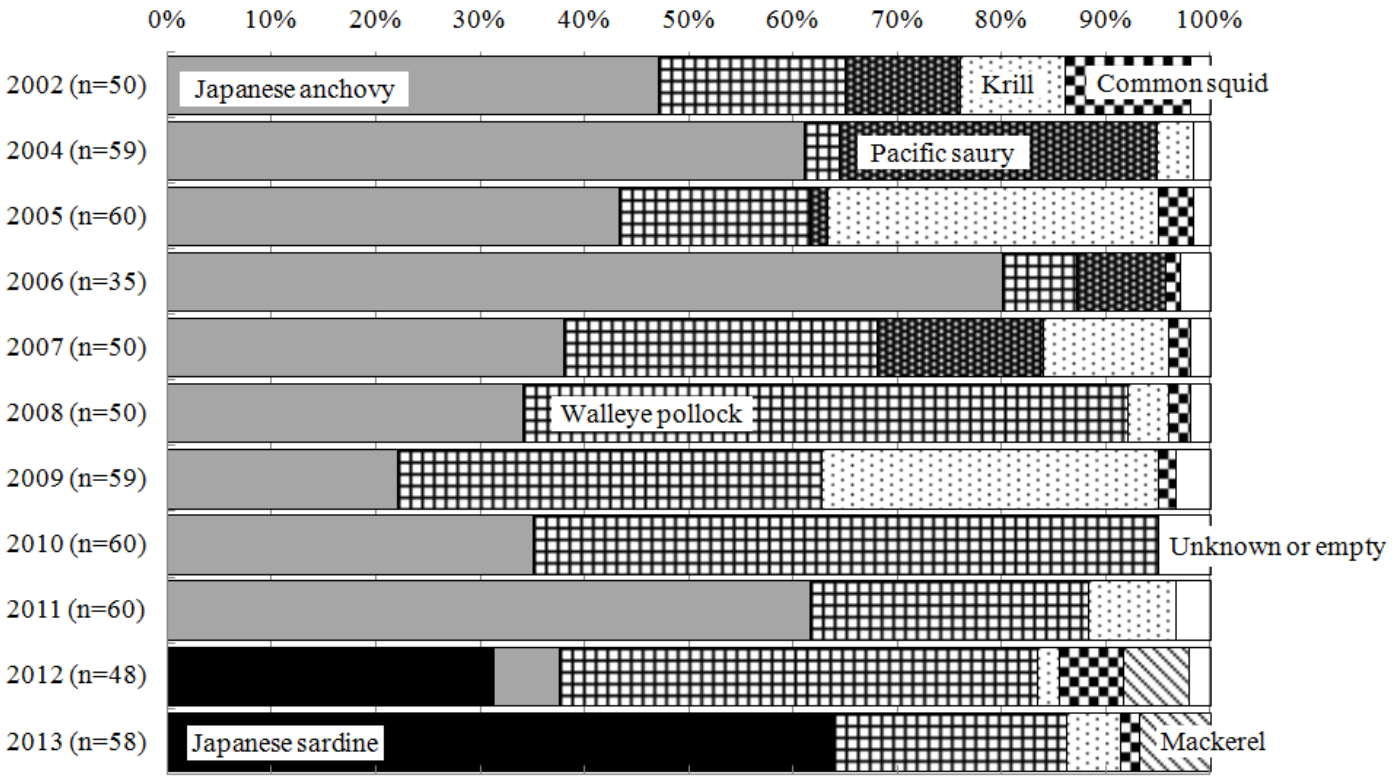

Fig. 6. Composition of prey species of common minke whales sampled during the 2013 coastal component off Kushiro, with comparison to the results of the previous surveys.

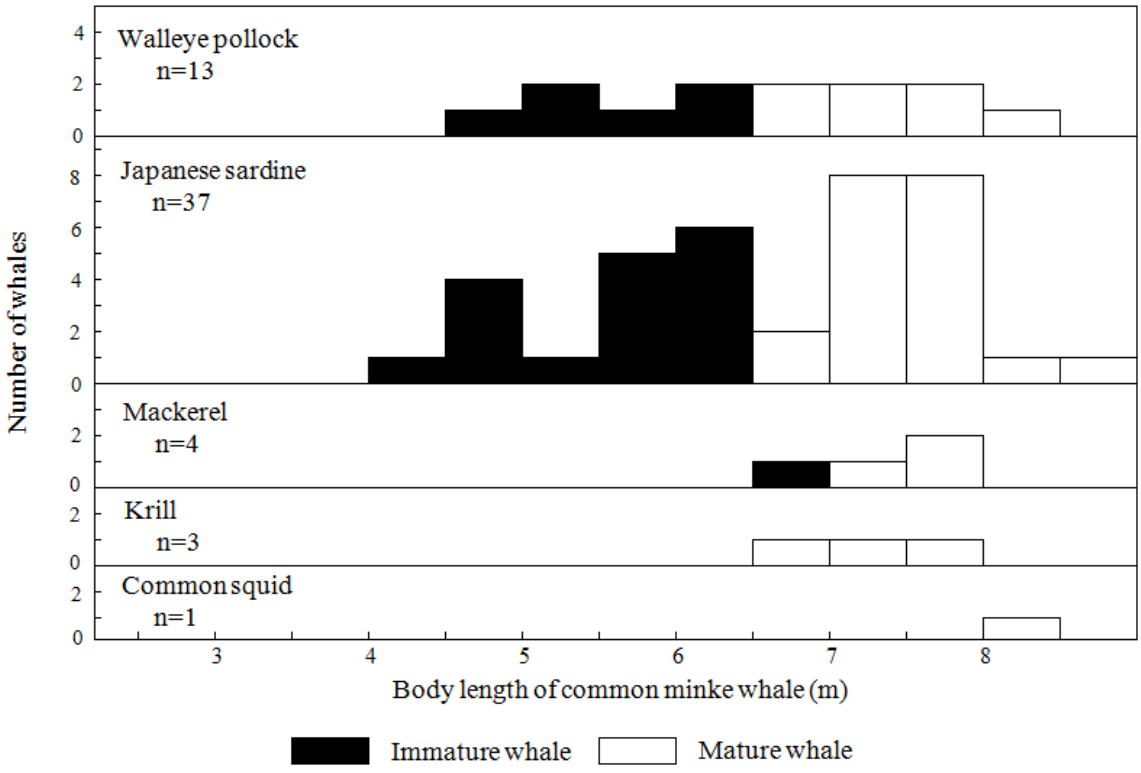

Fig.7. Sexual maturity and body length frequency of common minke whales by their major prey species found in the forestomach in the 2013 coastal component off Kushiro.

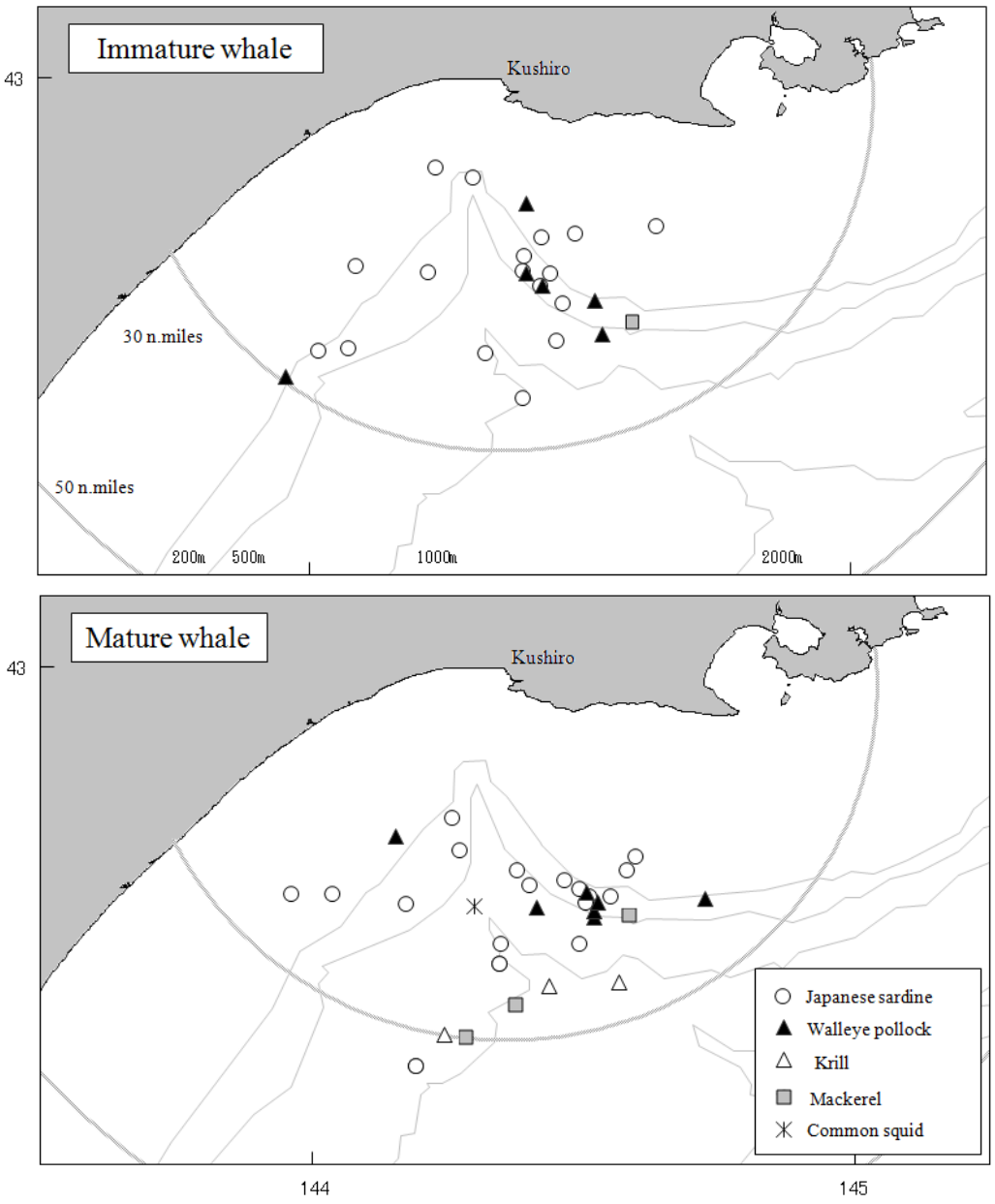

Fig.8. Sighting positions of common minke whales in the 2013 coastal component off Kushiro, by their sexual maturity and major prey species found in the forestomach