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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 III) Coastal
component off Kushiro

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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 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 5 September to 22 October 2015, with additional dedicated sighting surveys for biopsy sampling in 2 September and 23 October. The surveys were carried out using four small-type whaling catcher boats, in the coastal waters within the 50 nautical miles from the Kushiro port. All whales sampled were landed on the land station in the Kushiro port for biological examination. During the survey, a total of 5,811.9 n. miles (587.1 hours) was searched, 88 schools/94 individuals of common minke whales were sighted and 51 whales were sampled. Average body length of sampled whales was 6.67m (SD=0.91, n=35) for males and 6.07m (SD=1.35, n=16) for females, respectively. The 21 animals of 35 males (60.0%) and four of 16 females (25.0%) were sexually mature. The dominant prey species found in the stomach was Japanese sardine *Sardinops melanostictus* (51.0%), followed by mackerel *Scomber japonicus* and *S. australasicus* (19.6%), krill *Euphausia pacifica* (9.8%), walleye pollock *Gadus chalcogrammus* (7.8%), and Japanese common squid *Todarodes pacificus* (2.0%). The dominant occurrence of Japanese sardine and mackerel observed in the stomach in recent years suggested that the change in main prey species with reflect to the environmental change in the waters have been occurred as suggested by the previous 2012-2014 surveys. During the surveys, faecal searching was made for 31.4 hours on 59 animals encountered, and one case of excretion was observed, but no sample was collected. A total of 65.4 hours (11.1% of a total searching efforts) was allocated to the dedicated sighting surveys for biopsy sampling. Seven animals encountered were targeted, and four biopsy darts were hit, however no sample was collected.

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). The survey off Kushiro was conducted annually from 2004 to 2013 (Kishiro, *et al.*, 2005, 2006, 2008, 2010, 2012, 2014; Yoshida, *et al.*, 2007, 2009, 2011, 2013).

In 2014, following the 31 March 2014 Judgement 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 JARPN II, which resulted in modification of maximum lethal sample size of 60 to 51 for

each survey, and non-lethal method was introduced into the surveys. These modifications were applied in the 2014 surveys (Mogoe, *et al.*, 2015, and Yoshida, *et al.*, 2015). The 2015 survey was conducted following the same framework and modifications introduced in 2014.

This paper summarized results of the 2015 survey off Kushiro. The National Research Institute of Far Seas Fisheries (NRIFSF), Japan Fisheries Research and Education 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, 2014, Yoshida, *et al.*, 2007, 2009, 2011, 2013, 2015, 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: *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 for whale sampling was set for 50 days in advance, from 5 September to 24 October 2015, and actual period for sampling of 51 animals was 48 days from 5 September to 22 October. In addition, dedicated sighting surveys for biopsy sampling were conducted four days (2 and 6 September, and 22 and 23 October).

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.

Non-lethal sampling methods

Biopsy sampling and faecal sampling trials for common minke whales was carried out by small-type whaling catcher boats. Biopsy sampling was tried during the dedicated sighting surveys conducted in the outside of the whale sampling activities. Searching and chasing methods was same as the whale sampling survey mentioned above. The compound crossbow and Larsen guns were used for sampling. Faecal searching was conducted as much as possible for the whales encountered and chased during both the whale sampling survey and dedicated sighting survey. If the excretion were observed, faecal samples were planned to be collected using a handy long pole with a plankton net.

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 vessels

All cruise tracks during the surveys 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 5,811.9 n. miles and 587.1 hours, respectively.

Sightings and sampling of common minke whales

Figure 2 shows distribution of common minke whales sighted. Sighting positions distributed in inshore areas off Kushiro port to the waters in around 30 n. miles from the port, and apparent concentration was not observed in the research area. During the survey, a total of 88 schools/ 94 individuals of common minke whales were sighted, consisting of 79 schools/ 85 individuals of primary sightings and 9 schools/ 9 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 1.46 for DI (the number of primary sightings per 100 nautical miles searching) and 0.14 for SPUE (the number of primary sightings per 1 hour searching). Of the 94 common minke whales sighted, 51 common minke whales were sampled. In the sampling process, there were no struck and lost animals. Fig.2 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.

Non-lethal sampling of common minke whales

Biopsy sampling

A total of 65.4 hours (11.1% of a total searching efforts) was allocated to the dedicated sighting surveys for biopsy sampling of common minke whales. Seven animals encountered during the survey were targeted, and four biopsy darts were shot and hit on three animals using Larsen guns, however one dart did not contain the skin sample when it was retrieved, and one was lost at the sea (could not be retrieved). Two darts were damaged, when they hit the animal body. From these, no samples were collected.

Faecal sampling

During the surveys, faecal searching was made for 31.4 hours on 59 animals encountered, and one case of excretion was observed. However, faecal was disappeared before sampling, and could not be collected.

Sightings of other large cetacean

During the survey, a total of 14 schools/ 19 individuals of humpback whales, 9 schools/ 10 individuals of fin whale, and 2 schools/ 3 individuals of sperm whales were sighted (Table 1). Sighting positions of those whales are shown in Figure 3.

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

51 sampled whales were consisted of 35 males and 16 females (sex ratio of males was 0.69). Average body length of the whales was 6.67m (max=8.00, min=4.85, SD=0.91) for males, and 6.07m (max=8.17, min=4.28, SD=1.35) 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, 21 of 35 individuals (60.0%) were sexually

mature. In females, four of 16 individuals (25.0%) were sexually mature. Mature females were consisted of one resting animal and three pregnant animals. Among them, one pregnant female had twin foetus (125cm male and 103cm female). Other two pregnant females had 111cm (female) and 180cm (male) foetus, 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 1.2Kg to 72.1Kg, and average weight was 23.9Kg.

Table 5 shows the forestomach contents of the 51 collected whales. Dominant prey species was Japanese sardine *Sardinops melanostictus* (51.0%), followed by mackerel *Scomber japonicus* and *S. australasicus* (19.6%), krill *Euphausia pacifica* (9.8%), walleye pollock *Gadus chalcogrammus* (7.8%), and Japanese common squid *Todarodes pacificus* (2.0%). Among them, Japanese sardine was found throughout the research period from September to October. Other prey species (Mackerel, krill, walleye pollock and Japanese common squid) were found in only September. Japanese anchovy *Engraulis japonicus*, which was one of the major prey species found in the stomach in the previous 2002-2011 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 three animals. One animal had a plastic sheet (ca. 15cm x 40cm), one animal had a plastic tape and an empty can (ca. 7cm x 12 cm), and one animal had a small piece of plastics product (3cm x 9cm). The other 48 animals had no debris in their stomach.

DISCUSSION

As same as the previous surveys, bad weather conditions such as typhoons, low atmospheric pressures and thick fog often disturbed the research activities. During the 48 days survey period, sampling vessels could conduct the research for 25 days or 52.1% of a total survey period. This figure was lower than that of the last 2014 survey (77.3%). The density index of common minke whales in the present survey (DI=1.46) was also lower than that of the 2014 survey (DI=3.30), but almost same with those of the 2007 and 2008 surveys (DI=1.24 to 1.67).

Figure 4 shows the body length compositions of common minke whales caught in 2015, with comparison to the results of the previous 2002-2014 surveys. In the present survey, large male (7m in length class) was frequently caught, and body length composition was similar to those in the 2013 and 2004 to 2007 surveys. These results implied that mature males frequently migrated to the coastal waters in mid-2000th, and migrated again in recent years.

Figure 5 shows the yearly change in the composition of prey species found in the stomach of common minke whales through the 2002 to 2015 surveys. Until 2011, Japanese anchovy was one of the major prey species found in the stomach. Japanese sardine was first detected in 2012, and became the dominant prey species in recent years, instead of Japanese anchovy. Pacific saury in the stomach has been disappeared since 2008, and Mackerel has been appeared since 2012. Further in 2015, frequency of Mackerel became high compared with those in previous years. The apparent changes in the prey species compositions were well coincided with fisheries catch information (Tamura, *et al.*, 2016), and distributed abundance of prey species in the waters (Kishiro, *et al.*, 2016). These results suggested that the stomach contents of the whales could reflect the environmental changes in the waters, and the regime shift of the marine ecosystem or the alternation of the fish species has been occurred in recent years.

Japanese sardine was taken by both immature and mature animals (Fig.6). This suggested that Japanese sardine could be attracted both immature and mature common minke whales, as same as Japanese anchovy in the past (Kishiro, *et al.*, 2009). Although sample size was small, Mackerel was frequently taken by mature animals, and walleye pollock was frequently taken by immature animals. As same as previous surveys, Japanese common squid was taken by only mature animal. Difference in prey preference observed here might be explained by the trade-offs of the cost for foraging activity and energy demands between immature and mature animals as suggested in previous surveys (Kishiro, *et al.*, 2009).

Figure 7 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 in nearshore to offshore waters, while both immature and mature animals taking walleye pollock were concentrated along the 200-500m isobaths on the continental slope region. These results indicated that the stomach contents of the whale was also affected by the distribution of prey species.

Regarding the aspects on the non-lethal methods, no biopsy samples could be obtained in the present survey, though four darts hit the whale body. One of the reasons was thought to be the damage of the darts caused from the short distance shooting. The technical improvements in darts are considered for future surveys. In the faecal searching, the present survey revealed that the encounter of faeces was rare as same as in the previous survey. Contents of the intestine were collected at the biological research on the sampled animals, and these samples will be analysed for the comparative studies on the stomach contents. Tissue samples including skin by the biological research will be also used in the feasible examination on the stable isotope and fatty acids analyses. These trials will be continued in the next year survey, and the results of these trials in the three years from 2014 to 2016 will be summarized and presented at the future IWC meetings.

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Table 1. Searching days, hours, distances, and number of sightings in the 2015JARPN II coastal component off Kushiro.

Period	Days	Hours	Distances (n.miles)	Species	Number of sightings					
					Primary		Secondary		Total	
					Sch.	Ind.	Sch.	Ind.	Sch.	Ind.
2 Sept.-23 Oct.	50	587.1	5,811.9	Common minke whale	79	85	9	9	88	94
				Like minke whale	28	28	3	3	31	31
				Humpback whale	12	17	2	2	14	19
				Fin whale	9	10	0	0	9	10
				Sperm whale	1	2	1	1	2	3
				Unidentified cetaceans	19	19	2	2	21	21

Table 2. Summary of biological data and samples collected during the 2015 JARPN II coastal component off Kushiro.

Samples and data	Number of whales		
	Male	Female	Total
Body length and sex	35	16	51
External body proportion	35	16	51
Photographic record and external character	35	16	51
Diatom film record	35	16	51
Body scar record	35	16	51
Measurements of blubber thickness (5 points)	35	16	51
Detailed measurements of blubber thickness (11 points)	1	-	1
Body weight	35	16	51
Body weight by parts	1	-	1
Skin tissues for DNA study	35	16	51
Muscle, liver, kidney, spleen, blubber, heart and ventral groove for various analysis	35	16	51
Urine for various analysis	11	2	13
Muscle, liver, kidney, and blubber for heavy metal analysis	35	16	51
Muscle, liver, kidney, and blubber for organochlorine analysis	35	16	51
Muscle and blubber for byproduct analysis	35	16	51
Blubber for stable isotope analysis	35	16	51
Blubber for fatty acids analysis	35	16	51
Collection of blood plasma	29	12	41
Mammary gland; lactation status, measurement and histological sample	-	16	16
Uterine horn; measurements and endometrium sample	-	16	16
Collection of Ovary	-	16	16
Photographic record of fetus	3*	1	4
Fetal sex (identified by visual observation)	3*	1	4
Fetal length and weight	3*	1	4
Skin tissues for DNA study of fetus	3*	1	4
External measurement of fetus	3*	1	4
Muscle, liver, kidney, heart, blubber and skin tissues of fetus	3*	1	4
Eye lens of fetus for age determination	3*	1	4
Testis and epididymis; weight and histological sample	35	-	35
Stomach contents, convenient record	35	16	51
Volume and weight of stomach content in each compartment	35	16	51
Observation of marine debris in stomach	35	16	51
Stomach contents for feeding study	28	14	42
Record of external parasites	35	16	51
Earplug for age determination	35	16	51
Eye lens for age determination	35	16	51
Photographic record of baleen plate series	35	16	51
Length of baleen series	35	16	51
Vertebral epiphyses sample	27	7	34
Number of ribs	35	16	51
Skull measurement (length and breadth)	35	16	51
Brain weight	1	-	1
Skull measurement (43 points)	1	-	1
Measurements of flipper pigment	35	13	48
Collection and measurement of pelvic bone	17	8	25
Measurement of the skull around nasal bone	14	10	24
Content of large intestine	4	3	7
External measurement of nostril	19	11	30

*: including twin fetus.

Table 3. Body length (m) of common minke whales sampled by the 2015 JARPN II coastal component off Kushiro.

Period	Male					Female				
	Mean	S.D.	Min.	Max.	n	Mean	S.D.	Min.	Max.	n
5 Sept.- 15 Sept.	6.71	0.75	5.67	7.52	9	6.80	1.32	4.93	8.09	6
16 Sept. - 30 Sept.	7.14	0.57	6.10	8.00	16	4.42	0.19	4.28	4.55	2
1 Oct. -15 Oct.	6.38	0.91	5.73	7.02	2	8.17	-	8.17	8.17	1
16 Oct. -22 Oct.	5.74	1.04	4.85	7.11	8	5.61	0.84	4.94	6.93	7
Total	6.67	0.91	4.85	8.00	35	6.07	1.35	4.28	8.17	16

Table 4. Composition of sex and sexual maturity of common minke whales sampled by the 2015 JARPN II coastal component off Kushiro.

Period	Male				Female							Sex ratio (%males)
	Imm.	Mat.	Total	Marurity (%)	Imm.	Rest.	Lact.	Preg.	Total	Pregnancy (%) ^{*1}	Maturity (%)	
5 Sept.-15 Sept.	4	5	9	55.6	3	1	0	2	6	66.7	50.0	60.0
16 Sept.- 30 Sept.	4	12	16	75.0	2	0	0	0	2	0.0	0.0	88.9
1 Oct.- 15 Oct.	1	1	2	50.0	0	0	0	1	1	100.0	100.0	66.7
16 Oct.- 22 Oct.	5	3	8	37.5	7	0	0	0	7	0.0	0.0	53.3
Total	14	21	35	60.0	12	1	0	3	16	75.0	25.0	68.6

*1: Apparent pregnancy rate

Table 5. Number of common minke whales by major prey species found in their forestomach contents sampled by the 2015 JARPN II coastal component off Kushiro.

Period	Number of whales (%)						
	Walleye pollock	Krill	Japanese sardine	Mackerel	Common squid	Empty or unknown	Total
5 Sept.- 15 Sept.	2 (13.2)	1 (6.7)	7 (46.7)	4 (26.7)	0 (-)	1 (6.7)	15
16 Sept.- 30 Sept.	2 (11.1)	4 (22.2)	3 (16.7)	6 (33.3)	1 (5.6)	2 (11.1)	18
1 Oct.- 15 Oct.	0 (-)	0 (-)	2 (66.7)	0 (-)	0 (-)	1 (33.3)	3
16 Oct.- 22 Oct.	0 (-)	0 (-)	14 (93.3)	0 (-)	0 (-)	1 (6.7)	15
Total	4 (7.8)	5 (9.8)	26 (51.0)	10 (19.6)	1 (2.0)	5 (9.8)	51

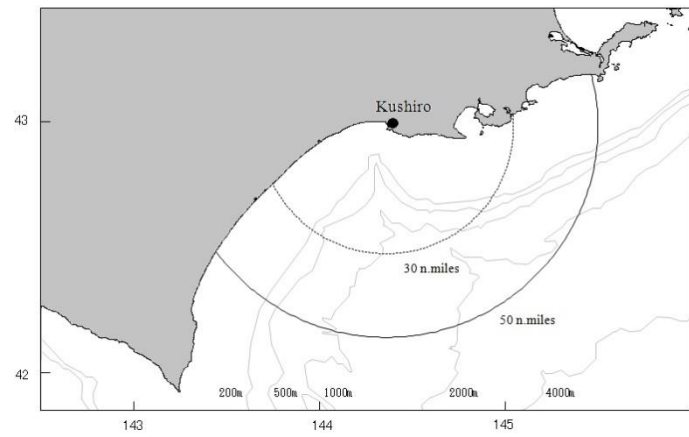
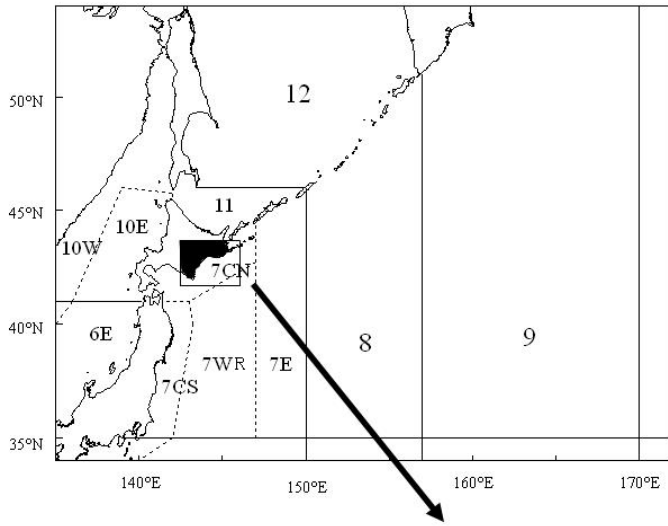


Fig.1. The IWC sub-area for western North Pacific minke whales (upper) and research area for the 2015 JARPN II coastal component off Kushiro (lower).

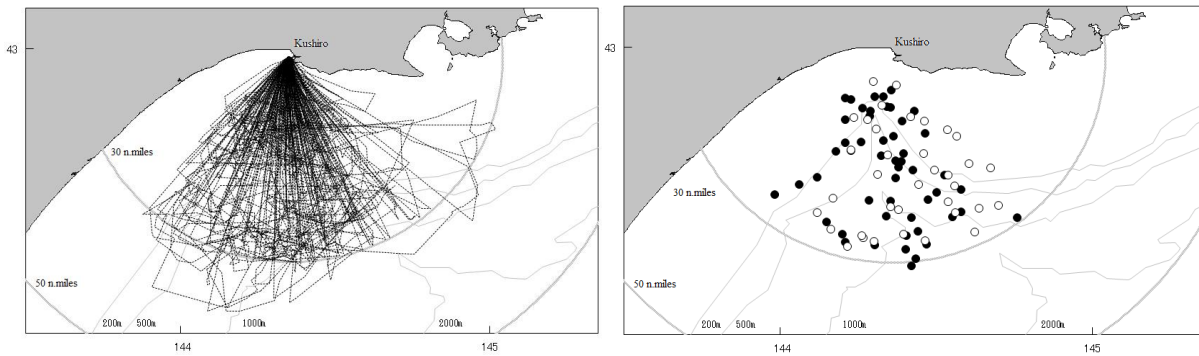


Fig.2. Cruise tracks (left) and sighting positions of common minke whales (right) during the 2015 coastal component off Kushiro. Closed circles are sighting position of whales taken.

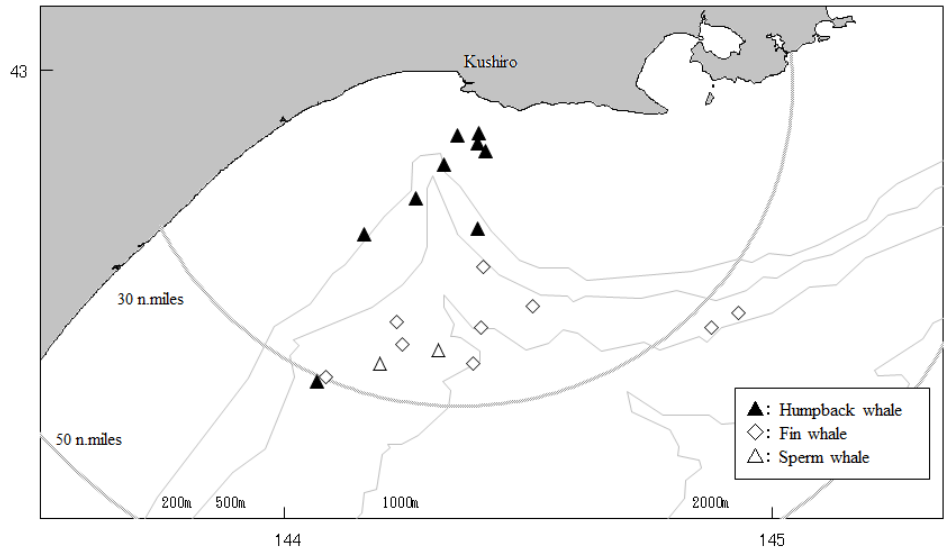


Fig.3. Sighting positions of humpback (closed triangle), fin (open square), and sperm whales (open triangle), in the 2015 coastal component off Kushiro.

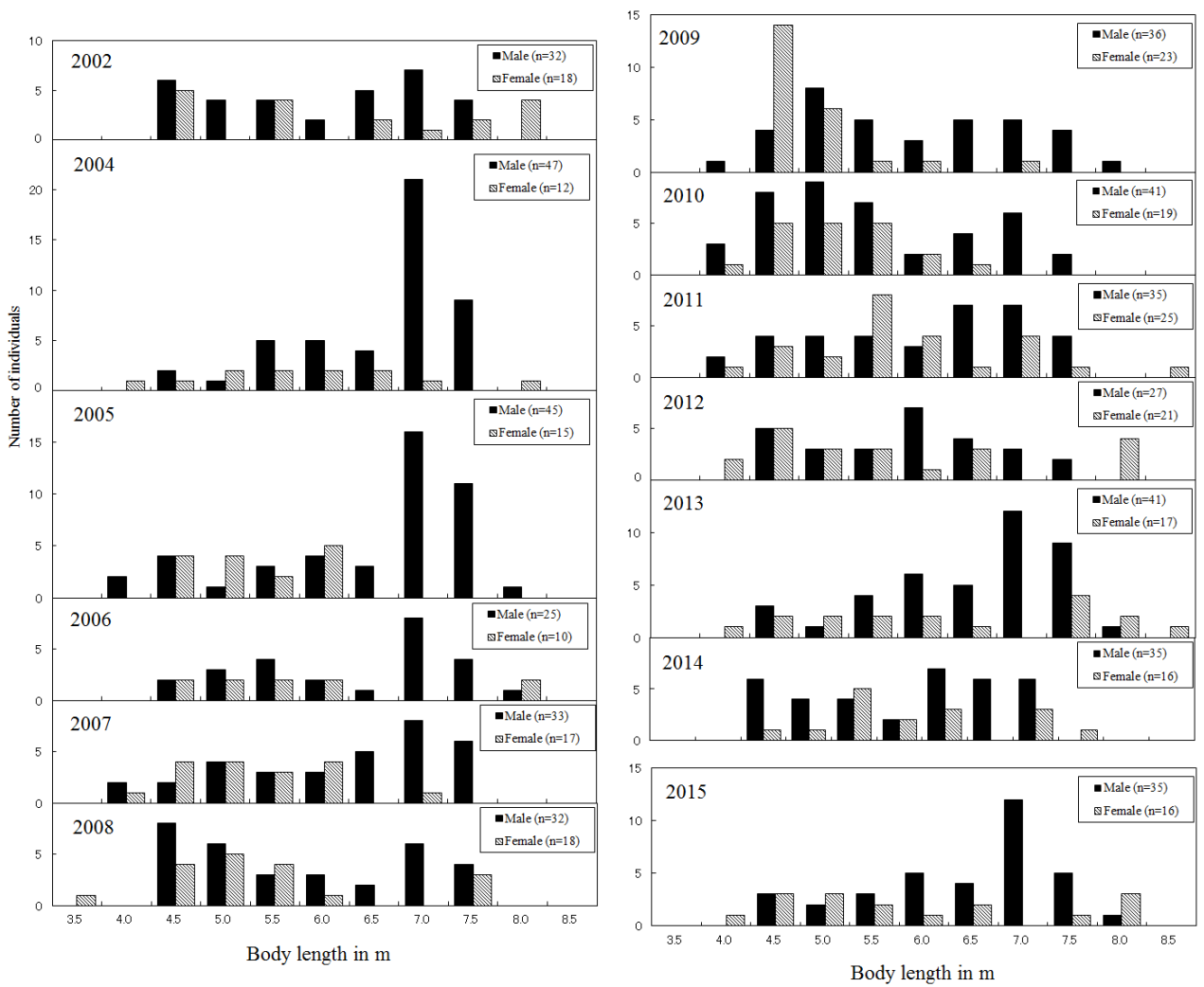


Fig 4. Body length frequency of common minke whales sampled during the 2015 coastal component off Kushiro, with comparison to the results of the previous surveys

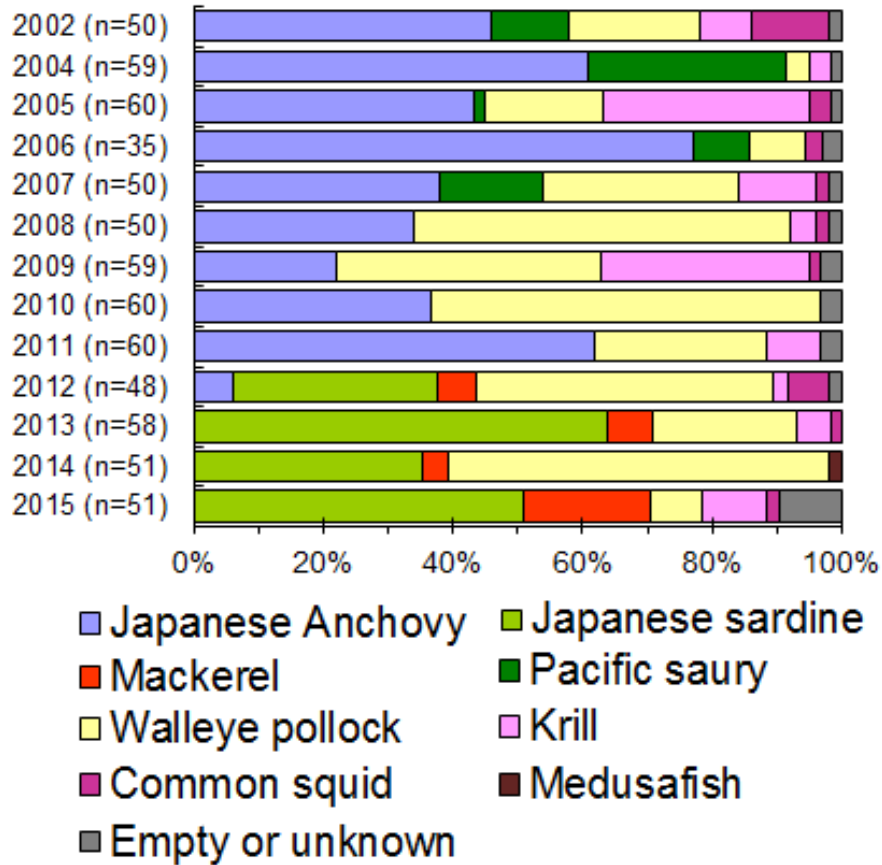


Fig. 5. Composition of prey species of common minke whales sampled during the 2015 coastal component off Kushiro, with results of the previous surveys.

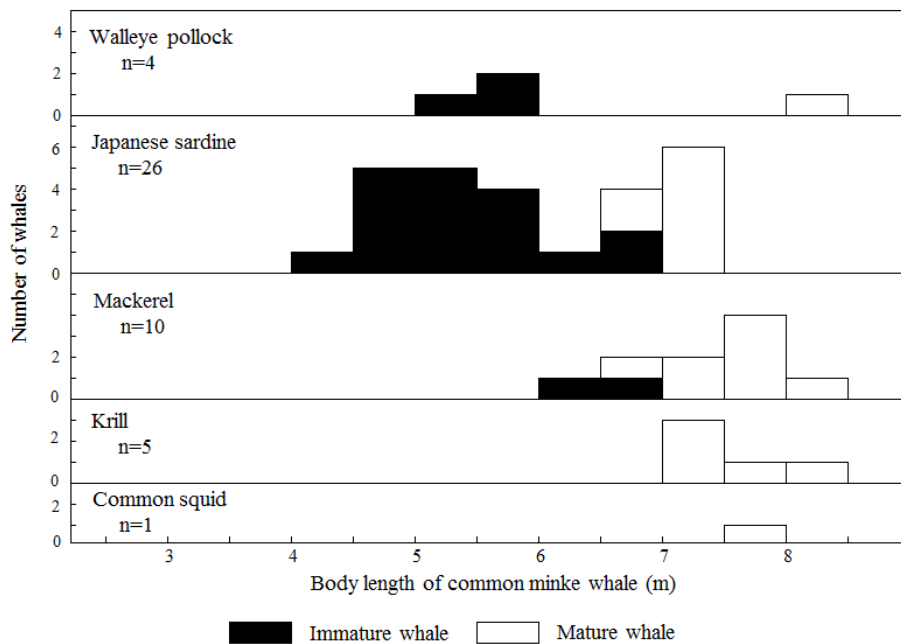


Fig.6. Sexual maturity and body length frequency of common minke whales by their major prey species found in the forestomach in the 2015 coastal component off Kushiro.

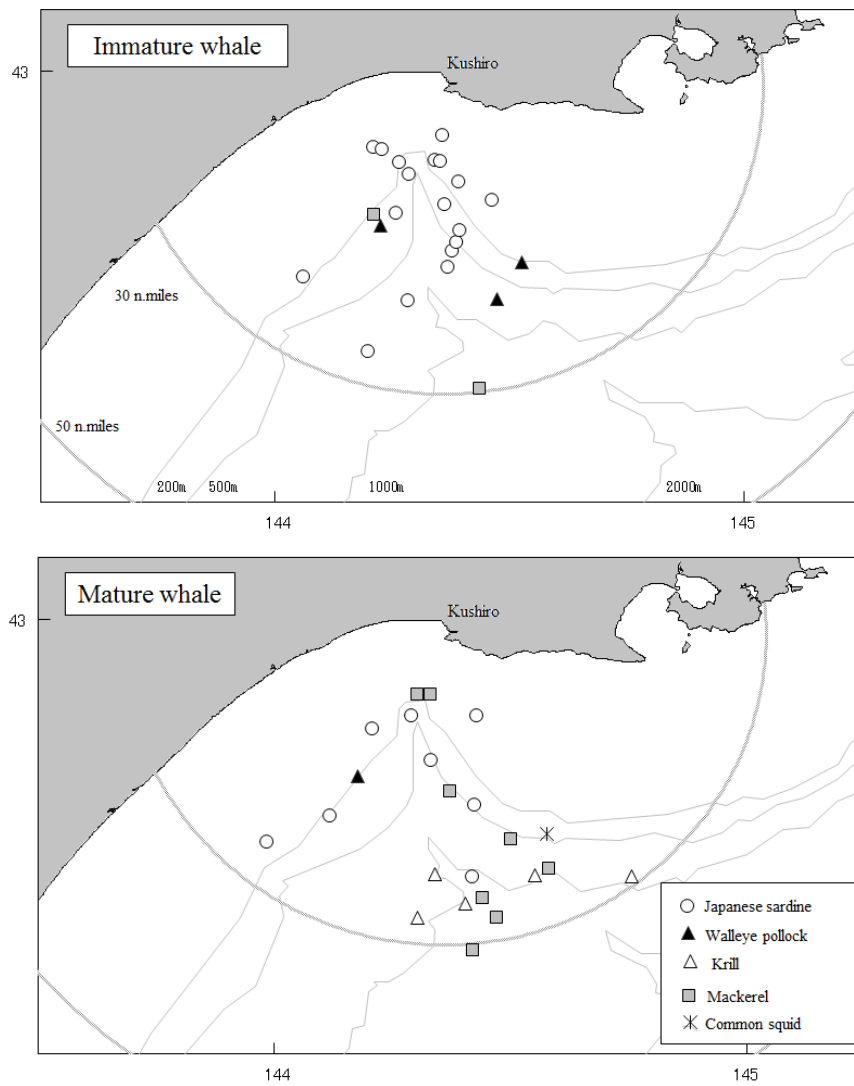


Fig.7. Sighting positions of common minke whales in the 2015 coastal component off Kushiro, by their sexual maturity and major prey species found in the forestomach