# Cruise report of the second phase of the Japanese Whale Research Program under Special Permit in the Western North Pacific (JARPN II) in 2012 (Part III) - Coastal component off Kushiro.

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**ABSTRACT**
The tenth survey of the JARPN II coastal component off Kushiro, northeast Japan (middle part of the sub-area 7CN) was conducted from 9 September to 28 October 2012, using four small-type whaling catcher boats as sampling vessels. Searching and sampling of common minke whales was conducted in coastal waters within 50 nautical miles from Kushiro port. All the whales collected were landed at the JARPN II research station for biological examination. During the survey, a total of 4,843.7 nautical miles (464.6 hours) was searched and the 95 schools (104 individuals) of common minke whales were encountered. Sightings of 28 schools (35 animals) of humpback whales and of two schools (four individuals) of fin whales were also obtained. From the 104 common minke whales, 48 animals were sampled. Average body length of males was 6.09m (SD=0.94, Range=4.70-7.71m, *n*=27) and 5.92m (SD=1.32, Range=4.10-8.21m, *n*=21) for females. Six of the 27 males were sexually mature and four of the 21 females attained to sexual maturity. Three females were pregnant. Dominant prey species detected from whale forestomach was walleye pollock (*Theragra chalcogramma*, 45.8%), followed by Japanese sardine (*Sardinops melanostictus*, 31.3%), mackerels (*Scomber japonicus* and *australasicus*, 6.2%), Japanese anchovy (*Engraulis japonicus*, 6.2%), Japanese common squid (*Todarodes pacificus*, 6.2%), krill (*Euphausia pacifica*, 2.1%), and unidentified fishes (2.1%). The frequency of whales feeding on Japanese anchovy was much low in the present survey, in comparison with the previous JARPN II coastal surveys off Kushiro, where the species was found dominantly (22.0-77.1%). On the other hand, Japanese sardine and mackerels were first detected from stomach of common minke whales since the coastal survey off Kushiro was started. Japanese sardine was the second dominant species in the present survey. This coincided with an increase in catch of commercial fisheries around Kushiro, where Japanese sardine and mackerels were much caught after an interval of around 30 years.

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

## BACKGROUND

The full-scale survey of the second phase of the Japanese Whale Research Program under Special Permit in the Western North Pacific (JARPN II) was started in 2002. The survey mainly aimed at i) feeding ecology and ecosystem studies, involving prey consumption by cetaceans, prey preferences of cetaceans and ecosystem modeling, ii) monitoring environmental pollutants in cetaceans and the marine ecosystem, and iii) elucidation of stock structure of whales (Government of Japan, 2002a).

The full-scale JARPN II consists of two survey components, i.e., offshore and coastal components. The JARPN surveys (1994-1999) and the JARPN II feasibility study (2000-2001) revealed that common minke whales are widely distributed from offshore waters into coastal waters and feed on various prey species

such as Japanese anchovy, Pacific saury, and walleye pollock (Government of Japan 2002b; Tamura and Fujise 2002). Both the waters are very important fishing grounds. Thus, it is thought that the waters are also very important area for the full-scale JARPN II program. However, the *Nisshin Maru* research vessels can not be operated in near shore areas, because of their movement restrictions in shallow waters and the presence of fishing gear and many boats. Furthermore, the research vessels are not available from autumn to early spring. In order to cover the temporal and spatial gap of these vessels, in the full-scale JARPN II, sampling of common minke whales in coastal waters using small-type whaling catcher boats was planned (Government of Japan, 2002a).

In the first two years of the full-scale JARPN II, feasibility studies were conducted, to examine the logistic aspects of the methodology in the coastal component. The first feasibility study was conducted in coastal waters off Kushiro in autumn 2002 and the second one was in coastal waters off Sanriku in spring 2003 (Kishiro *et al.* 2003, Yoshida *et al.* 2004). Since no logistic problem occurred in the studies, it was concluded that the coastal survey could be continued as the component of the full-scale JARPN II, using the same methodology (Government of Japan 2004b, Kato *et al*. 2004), while the survey was revised to be conducted twice a year and to collect 60 common minke whales in each of spring and autumn (Government of Japan 2004a).

The first revised full-scale survey was carried out in coastal waters off Kushiro in autumn 2004 (Kishiro *et al*. 2005), then the coastal survey was conducted annually from 2005 to 2008 (Kishiro *et al*. 2006, 2008, Yoshida *et al*. 2007, 2009). In January 2009, the JARPN II review workshop was carried out in Japan under the IWC/SC, where the progress made in the first six years of the full-scale JARPN II (2002-2007) was reviewed by the scientific specialists. Because there was no critical problem in the survey methodology, the coastal components were continued from 2009 to 2011 (Kishiro *et al*. 2010, 2012, Yoshida *et al*. 2011), under the original research plan (Government of Japan 2004a).

Here, we show results of the tenth survey conducted off Kushiro, from 9 September to 28 October 2012. The present survey, which was authorized by the Government of Japan in compliance with Article VIII of the International Convention for the Regulation of Whaling, was also conducted under the original research plan (Government of Japan 2004a). The National Research Institute of Far Seas Fisheries (NRIFSF) of the Fisheries Research Agency planned and conducted the survey, under cooperation of the ICR, Tokyo University of Marine Science and Technology, and the Association for Community-Based Whaling.

## MATERIALS AND METHODS

### Research area

Research area was set in the same waters where the previous JARPN II coastal surveys off Kushiro were conducted in 2002-2011 (Kishiro *et al.* 2003, 2005, 2006, 2008, 2010, 2012, Yoshida *et al*. 2007, 2009, 2011): the area was in coastal waters within 50 nautical miles from Kushiro port, southeastern Hokkaido (Fig. 1). The area is included in the middle part of the sub-area 7CN, established by the IWC.

### Research vessels, station, and period

Four small-type whaling catcher boats were used as sampling vessels: *Taisho Maru* No. 28 (hereinafter referred as 28T; 47.3GT), *Koei Maru* No. 8 (8K; 32.0GT), *Katsu Maru* No.7 (7K; 32.0GT), and *Sumitomo Maru* No.51 (51S; 30.0GT). All the common minke whales collected were landed at the JARPN II research station established in the Kushiro port, for biological examination. Research period was set for 50 days, from 9 September to 28 October, 2010.

### 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 established in the research station controlled the sampling vessels during the survey. In order to avoid concentration of searching effort in one area, searching areas and courses of vessels were determined from weather conditions, whale distribution, and information on fishing grounds of coastal fisheries. Searching was carried out in the daytime and the vessels returned to the port every night. A researcher was on board each of the vessels and recorded sighting and sampling information, e.g., coordinates and time of common minke whale sighting and sampling made, weather conditions, and vessel activity. Sighting information was also recorded for other baleen whales and sperm whales. Searching was conducted by crews and researchers from the top barrel

and upper bridge of vessels running at around 10.5 knots. All common minke whales sighted were targeted for sampling, except cow-calf pair. When a school consisted of more than 1 animal, an individual was selected randomly from the school and then collected. 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 encountered were also targeted for sampling, if the situation allowed. At the port, animals were lifted from the vessel by the crane, using a wire net and then carried to the station by the 11-ton freight trailer. At that time, body weight of animals was measured using the truck scale.

**Biological research on common minke whales collected**
All the whales collected were examined by biological researchers at the research station. Research items are listed in Table 2. These data and samples were taken for studies on feeding ecology, stock structure, life history and pollutants.

**RESULTS**
**Searching effort made by sampling vessels**
Of the 50 days period predetermined for the present survey, sampling vessels could conduct searching only for 23 days (46.0% of the predetermined days). Other days were not suitable for survey, from bad weather conditions, e.g., low atmospheric pressure and thick fog. The proportion of searching days in this year was lowest in all the 10 surveys conducted off Kushiro. Cruise tracks made by the vessels are shown in Figure 2. Searching distance and time are given in Table 1. Here, searching distance and time are defined as distance and time recorded under searching activity conducted by crews from the top barrel of the vessels. During the survey, a total of 4843.7 nautical miles (464.6 hours) was searched.

**Sightings made by sampling vessels**
All the 95 schools (104 individuals) of common minke whales were sighted during the searching (Table 1, Fig. 2). No cow-calf pairs were encountered. Excretion and vomit of whales were not observed. Cruise tracks were widely distributed in coastal waters of Kushiro port, whereas sightings of common minke whales concentrated on continental slope southwest of Kushiro. Density index of common minke whales was calculated as 1.71 for DI (the number of primary sightings of schools per 100 nautical miles searching) and 0.18 for SPUE (the number of primary sightings of schools per 1 hour searching). During the searching, 28 schools (35 animals) of humpback whales and two schools (four individuals) of fin whales were also observed (Table 1, Fig. 3).

**Sampling of common minke whales**
Of the 104 common minke whales encountered, 48 animals were collected for biological examination. In the sampling process, struck and lost was not occurred. Sighting positions of animals collected are shown in Figure 2.

**Body length, sex ratio, and maturity of animals caught**
Research items of biological examination for the 48 animals are summarized in Table 2, with the number of data and samples collected. The individuals consisted of 27 males and 21 females. Sex ratio of males to all animals was 56.3%, which was lowest in comparison with the previous surveys in 2002-2011 (58.3-79.7%). Average body length was 6.09m (SD=0.94, range=4.70-7.71m) for males and 5.92m (SD=1.32, range=4.10-8.21m) for females (Table 3). In males, the most dominant length class was 6.0 m (Fig. 4). It was 4.5 m for females, but frequency of large animals with length of 8 m or more was also high. Ratio of sexual maturity animals was 22.2% for males (6 of 27 animals) and 19.0% for females (4 of 21). Three mature females were pregnant.

**Prey species found from common minke whale forestomach**
Stomach contents of the 48 animals collected were examined. Following the same methods used in the JARPN II feasibility survey conducted in 2001 (Fujise, *et al*., 2002), stomach contents were weighed to the nearest 0.1 kg, by each of four chambers. Weights were recorded both including and excluding liquid contents. A small quantity of stomach contents was collected and frozen for laboratory analysis. Weight of forestomach contents including liquid ranged from 1.5 kg to 141.4 kg. Average weight was 21.0 kg. Forestomach contents found from the 48 whales are listed in Table 5. Empty stomach was not observed.

Dominant prey species detected from whale forestomach was walleye pollock (*Theragra chalcogramma*,

45.8%), followed by Japanese sardine (*Sardinops melanostictus*, 31.3%), mackerels (*Scomber japonicus* and *australasicus*, 6.2%), Japanese anchovy (*Engraulis japonicus*, 6.2%), Japanese common squid (*Todarodes pacificus*, 6.2%), krill (*Euphausia pacifica*, 2.1%), and unidentified fishes (2.1%). The frequency of whales feeding on Japanese anchovy was much low in the present survey, in comparison with the previous surveys in 2002-2011 (22.0-77.1%, Fig. 5). Japanese sardine and mackerels were first detected from stomach of common minke whales since the JARPN II coastal component was started off Kushiro. Japanese sardine was the second dominant species in the present survey. Figure 6 shows major prey species found in forestomach of common minke whales by their sexual maturity stage. Of 22 animals having walleye Pollock, all but one were sexually immature. Japanese common squid was taken only by mature animals, while mackerels were had only by immature whales.

**Observation of marine debris**

Marine debris was detected from stomach of six animals. Each of three animals swallowed a small fishing hook, which uses for local octopus fishery around Hokkaido, and each of the other three had a small piece of plastic.

## DISCUSSION

In the present survey, bad weather conditions, e.g., low atmospheric pressure and thick fog, often prevented sampling vessels from research activities. During the 50 days survey period, vessels could conduct searching for 23 days (46.0% of the predetermined days). This proportion was lowest in all the surveys conducted off Kushiro. Especially, in September, the proportion was 36.4% (only a third of the period). The proportion appears to have decreased in recent years.

Diet of common minke whales taken by commercial whaling in Pacific coast of Hokkaido was studied. From late 1960's to 1987, mackerel and Japanese sardine were recorded as the major prey species (Kasamatsu and Tanaka, 1992). At that time, the dominant species taken by commercial fisheries around the coast was also mackerel and Japanese sardine. After that, catches of the two species decreased, from a decline in their abundance. In autumn 2012, the Japanese sardine and mackerels were much caught after an interval of around 30 years, by commercial fisheries conducted around Kushiro. The species were also detected from stomach of common minke whales collected during the present survey: Japanese sardine and mackerels were first detected from stomach of common minke whales since the JARPN II coastal component was started off Kushiro (Fig. 5). Japanese sardine was the second dominant species. Composition of prey species in the whale stomach appears to reflect the species composition in the whale feeding ground. Common minke whales are thought to be opportunistic feeder and to have the most abundant or available prey in the ground (Kasamatsu and Hata, 1985). Records of whale stomach contents are expected to provide information on the dominant species in their feeding ground.

Difference in feeding habit between immature and mature common minke whales collected off Kushiro was suggested, where walleye Pollock and krill are taken by immature animals more frequently and Pacific saury and common squid are consumed by mature whales (Kishiro et al. 2009). In the present survey, no Pacific saury was detected. Of 22 animals having walleye Pollock, all but one were sexually immature (Fig. 6). Japanese common squid were taken only by mature animals. Immature and mature animals fed on different prey species, even if they were collected at close distance (Fig. 7). Our results also indicate the difference in feeding habit between immature and mature animals.

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Table 1. Searching days, distances, hours, and number of cetacean sightings made during the 2012 JARPN II coastal survey off Kushiro.

| Period | Days | Distances (n. miles) | Hours | Number of sightings* | | | |
|---|---|---|---|---|---|---|---|
| | | | | Species | Primary (Ind/Sch) | Secondary (Ind/Sch) | Total (Ind/Sch) |
| 9/9 - 10/28 | 50 | 4843.7 | 464.6 | Common minke whale | 88/83 | 16/12 | 104/95 |
| | | | | Like minke whale | 18/18 | 3/3 | 21/21 |
| | | | | Fin whale | 4/2 | 0/0 | 4/2 |
| | | | | Humpback whale | 33/27 | 2/1 | 35/28 |
| | | | | Unknown large whale | 24/24 | 0/0 | 24/24 |

*: The number probably includes some duplicated sightings made by plural vessels.

Table 2. Summary of biological data and samples collected during the 2012 JARPN II coastal survey off Kushiro.

| Samples and data | Number of animals | | |
|---|---|---|---|
| | Male | Female | Total |
| Body length and sex | 27 | 21 | 48 |
| External body proportion | 27 | 21 | 48 |
| Photographic record and external character | 27 | 21 | 48 |
| Diatom film record | 27 | 21 | 48 |
| Body scar record | 27 | 21 | 48 |
| Measurements of blubber thickness (five points) | 27 | 21 | 48 |
| Body weight | 27 | 21 | 48 |
| Skin tissues for DNA analysis | 27 | 21 | 48 |
| Muscle, liver, kidney, spleen, blubber, heart, and ventral groove for various analysis | 27 | 21 | 48 |
| Urine for various analysis | 3 | 5 | 8 |
| Muscle, liver, kidney, and blubber for heavy metal analysis | 27 | 21 | 48 |
| Muscle, liver, kidney, and blubber for organochlorine analysis | 27 | 21 | 48 |
| Collection of blood plasma | 23 | 21 | 44 |
| Mammary grand; lactation status, measurement and histological sample | - | 21 | 21 |
| Uterine horn; measurements and endometrium sample | - | 21 | 21 |
| Collection of ovary | - | 21 | 21 |
| Foetus | 2 | 1 | 3 |
| Testis and epididymis; weight and histological sample | 27 | - | 27 |
| Stomach contents, convenient record | 27 | 21 | 48 |
| Volume and weight of stomach content in each compartment | 27 | 21 | 48 |
| Observation of marine debris in stomach | 27 | 21 | 48 |
| Collection of stomach contents for feeding study | 24 | 18 | 42 |
| Record of external parasites | 27 | 21 | 48 |
| Earplug for age determination | 26 | 21 | 47 |
| Tympanic bulla for age determination | 27 | 20 | 47 |
| Eye lens for age determination | 27 | 21 | 48 |
| Largest baleen plate for morphologic study and age determination | 27 | 21 | 48 |
| Baleen plate measurements (length and breadth) | 27 | 21 | 48 |
| Photographic record of baleen plate series | 27 | 21 | 48 |
| Length of baleen series | 27 | 21 | 48 |
| Vertebral epiphyses sample | 16 | 8 | 24 |
| Number of ribs | 27 | 21 | 48 |
| Skull measurement (length and breadth) | 26 | 21 | 47 |

Table 3. Statistics of body length (m) of common minke whales sampled during the 2012 JARPN II coastal survey off Kushiro.

| Period | Male | | | | | Female | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | S.D. | Min. | Max. | *n* | Mean | S.D. | Min. | Max. | *n* |
| 9/9 - 9/15 | 6.15 | 1.75 | 4.91 | 7.38 | 2 | - | - | - | - | 0 |
| 9/16 - 9/30 | 6.00 | 0.92 | 4.70 | 7.69 | 15 | 5.40 | 1.27 | 4.10 | 8.10 | 9 |
| 10/1 - 10/15 | 6.07 | 1.07 | 4.77 | 7.71 | 6 | 6.80 | 1.24 | 5.22 | 8.21 | 8 |
| 10/16 - 10/28 | 6.44 | 0.74 | 5.59 | 7.38 | 4 | 5.32 | 0.66 | 4.91 | 6.29 | 4 |
| Total (9/9 - 10/28) | 6.09 | 0.94 | 4.70 | 7.71 | 27 | 5.92 | 1.32 | 4.10 | 8.21 | 21 |

Table 4. Composition of sex and sexual maturity of common minke whales sampled during the 2012 JARPN II coastal survey off Kushiro.

| Period | Male | | | | Female | | | | | | Sex ratio (% males) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Im | M | Total | Maturity (%) | Im | R | P | Total | Maturity (%) | Pregnancy (%)* | |
| 9/9 - 9/15 | 1 | 1 | 2 | 50.0 | - | - | - | 0 | - | - | 100.0 |
| 9/16 - 9/30 | 12 | 3 | 15 | 20.0 | 8 | 0 | 1 | 9 | 12.5 | 100.0 | 62.5 |
| 10/1 - 10/15 | 5 | 1 | 6 | 16.7 | 5 | 1 | 2 | 8 | 37.5 | 66.7 | 42.9 |
| 10/16 - 10/28 | 3 | 1 | 4 | 25.0 | 4 | 0 | 0 | 4 | 0.0 | - | 50.0 |
| Total (9/9 - 10/28) | 21 | 6 | 27 | 22.2 | 17 | 1 | 3 | 21 | 19.0 | 75.0 | 56.3 |

Im: Immature; M: Mature; R: Resting; P: Pregnant; *: Apparent pregnancy ratio.

Table 5. Number of common minke whales by major prey species found in forestomach, sampled during the 2012 JARPN II coastal survey off Kushiro.

| Period | Number of whales (%) | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|
| | Walleye Pollock | Japanese anchovy | Japanese sardine | Mackerels | Common squid | Krill | Unidentified species | |
| 9/9 - 9/15 | 1(50.0) | 0(-) | 1(50.0) | 0(-) | 0(-) | 0(-) | 0(-) | 2 |
| 9/16 - 9/30 | 11(45.8) | 0(-) | 11(45.8) | 0(-) | 2(8.3) | 0(-) | 0(-) | 24 |
| 10/1 - 10/15 | 6(42.9) | 1(7.1) | 3(21.4) | 2(14.3) | 1(7.1) | 0(-) | 1(7.1) | 14 |
| 10/16 - 10/28 | 4(50.0) | 2(25.0) | 0(-) | 1(12.5) | 0(-) | 1(12.5) | 0(-) | 8 |
| Total (9/9 - 10/28) | 22(45.8) | 3(6.2) | 15(31.3) | 3(6.2) | 3(6.2) | 1(2.1) | 1(2.1) | 48 |

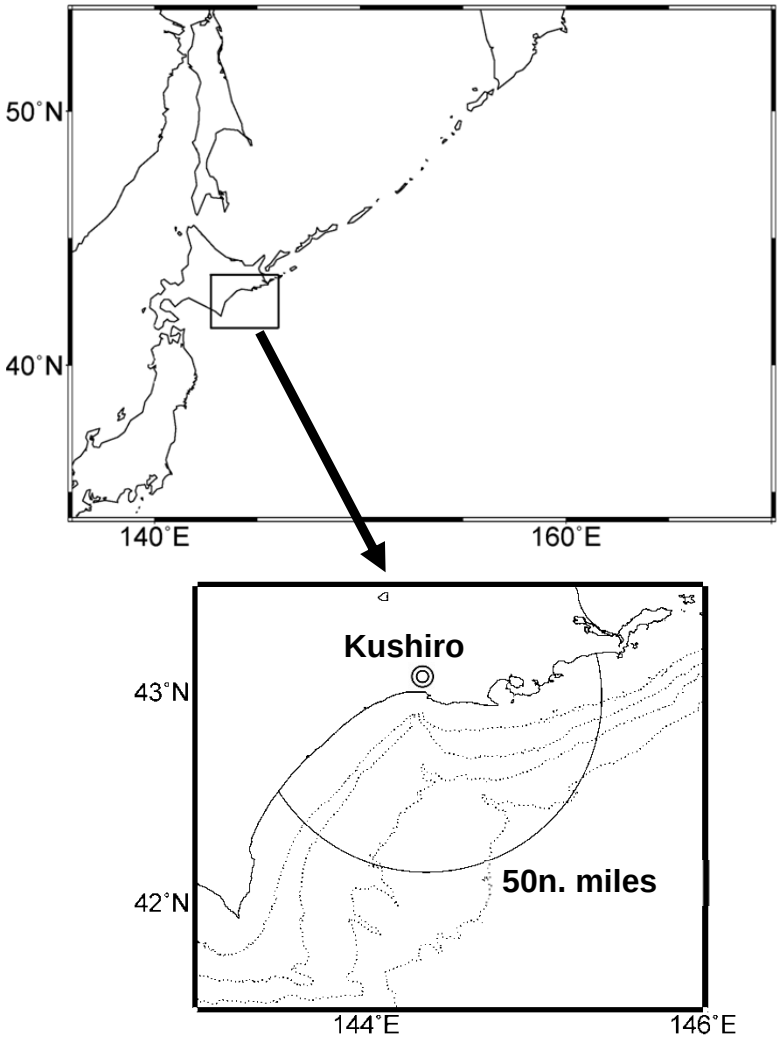


Figure 1. Research area set for the 2012 JARPN II coastal survey off Kushiro. Isobaths are 100m, 200m, 1000m, and 2000m.

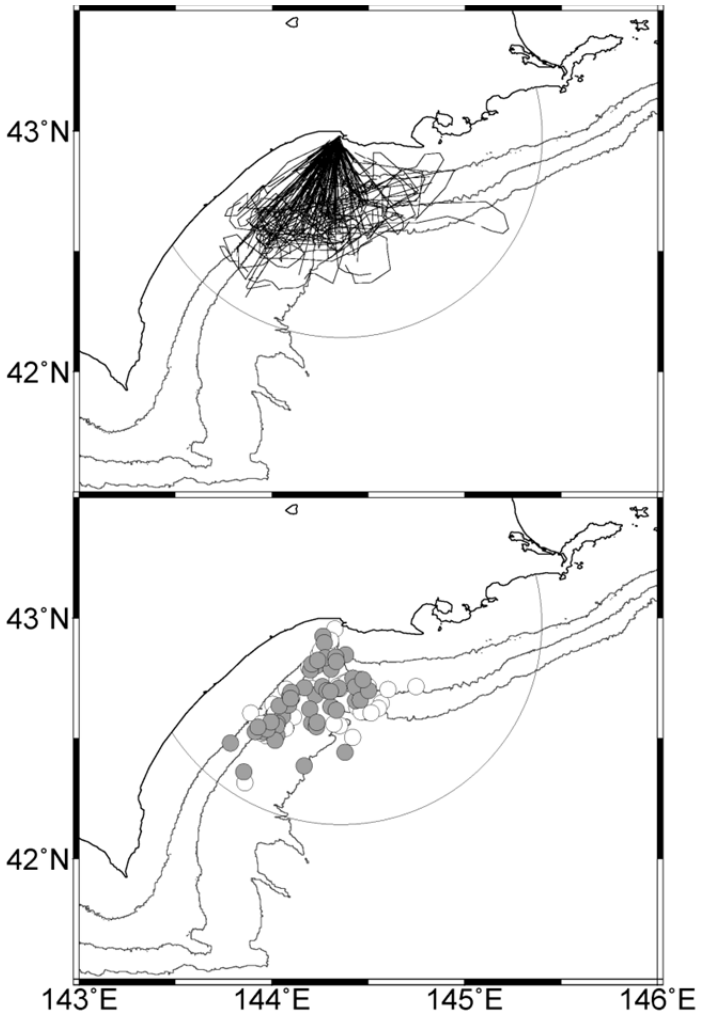


Figure 2. Cruise tracks (upper) and sighting positions (lower) of common minke whales made by sampling vessels during the 2012 JARPN II coastal survey off Kushiro. Gray circles are sighting positions of common minke whales collected. Isobaths are 100m, 200m, and 1000m.

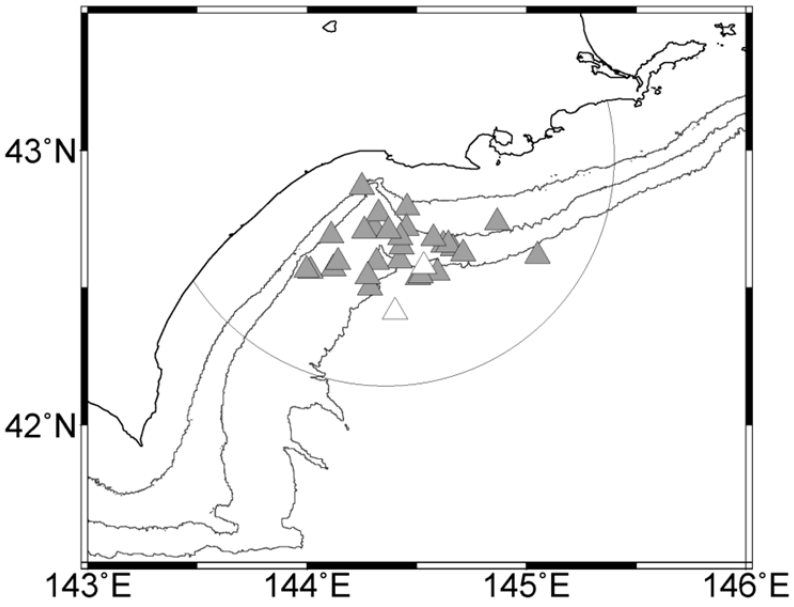


Figure 3. Sighting positions of humpback (gray triangle) and fin (white triangle) whales made by sampling vessels during the 2012 JARPN II coastal survey off Kushiro. Isobaths are 100m, 200m, and 1000m.

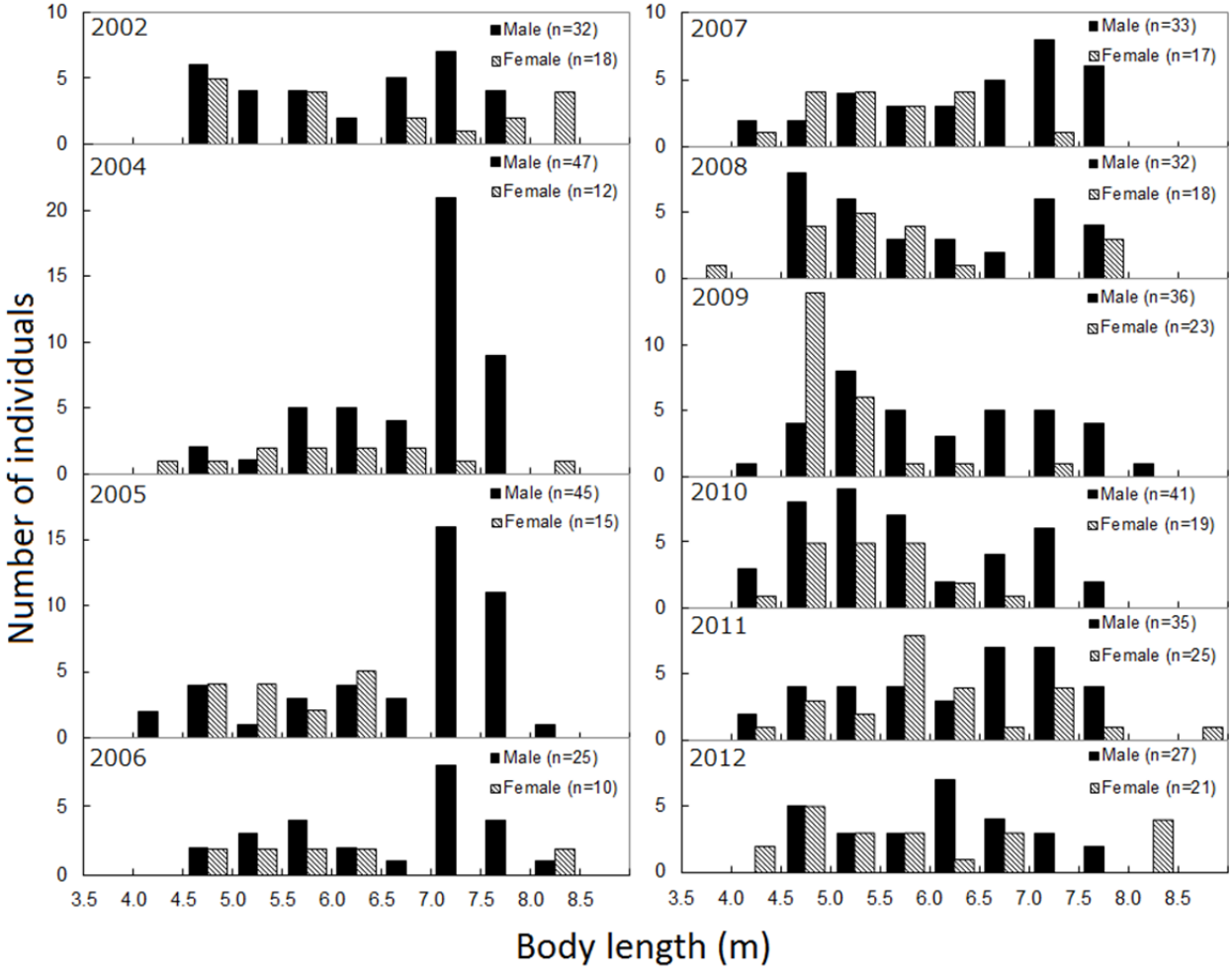


Figure 4. Body length frequency of common minke whales sampled during the 2012 JARPN II coastal survey off Kushiro, with comparison to results of the previous 2002-2011 surveys.

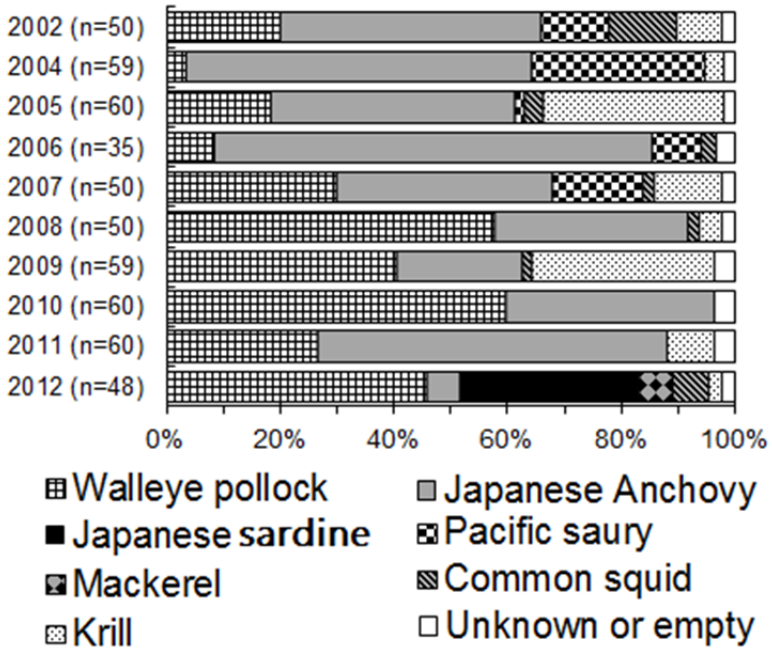


Figure 5. Composition of prey species of common minke whales sampled during the 2012 JARPN II coastal survey off Kushiro, with comparison to results of the previous 2002-2011 surveys.

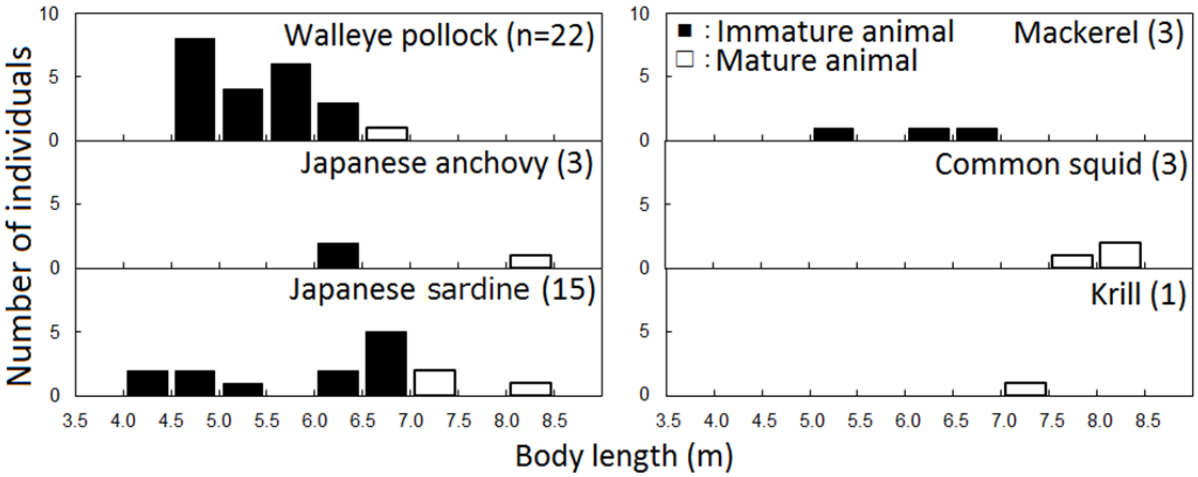


Figure 6. Sexual maturity and body length frequency of common minke whales by their prey species found in forestomach in the 2012 JARPN II coastal survey off Kushiro.

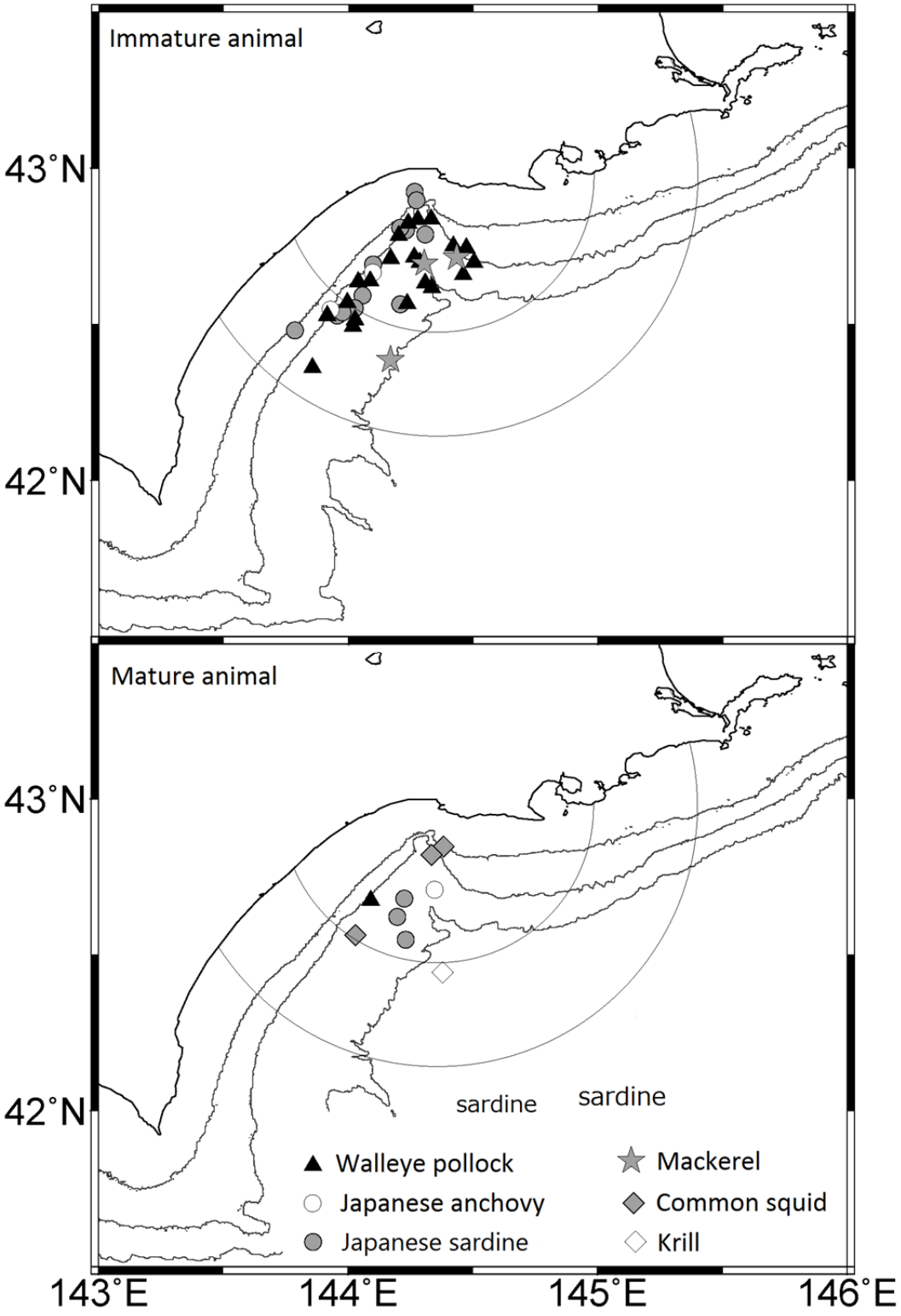


Figure 7. Sighting positions of common minke whales collected during the 2012 JARPN II coastal survey off Kushiro, shown by their maturity stage and prey species. Isobaths are 100m, 200m, and 1000m.