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Cruise Report of the New Scientific Whale Research Program in the western North Pacific (NEWREP-NP) in 2019 -Coastal component off Abashiri in the southern Okhotsk Sea-

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ABSTRACT

The third survey of the NEWREP-NP coastal component off Abashiri, was conducted in the southern Okhotsk Sea (part of sub-area 11), from 1 to 24 June 2019. The survey was carried out using five small-type whaling catcher boats as sampling vessels, in coastal waters mainly within about 40 nautical miles from Abashiri port. Common minke whales collected were landed at the NEWREP-NP research station for biological examination. During the survey, a total of 2,486.9 nautical miles (251.9 hours) was searched and 61 schools (62 animals) of the common minke whale were encountered. Sightings of 97 schools (155 animals) of the fin whale, and 5 schools (7 animals) of the humpback whale were also made. Of the 62 common minke whales encountered, 32 animals were collected. Earplugs and eye lenses for age determination and gonad for reproductive study were collected from the whales. Sex of animals caught was biased towards the female (5 males and 27 females), as same with the past two surveys conducted off Abashiri. Average body length of males was 6.04m (SD=1.35, Range=4.14-7.50m) and 7.32m (SD=0.86, Range=5.50-8.40m) for females. All the males were assigned to J stock (100.0%). No males were identified as O stock. Of 27 females, 16 animals (61.5%) and 10 individuals (38.5%) were assigned to J stock and O stock, respectively. A female could not be assigned. Sex ratio of males was calculated as 23.8% for J stock and as 0.0% for O stock. Average body length of J stock males was 6.04m (SD=1.35, range=4.14-7.50m). Average body length of J stock females was 7.18m (SD=0.86, range=5.50-8.11m) and 7.65m (SD=0.75, range=6.01-8.40m) for O stock females. Two of five males (40.0%) and 20 of 27 females (74.1%) were sexually mature. Sexually maturity rate of J stock females was 75.0% (12 of 16 animals) and 80.0% (8 of 10 animals) for O stock females. The 16 of 20 mature females were pregnant (80.0%): eight of 12 J stock mature females (66.7%) and eight of eight O stock mature females (100.0%) were pregnant. Four females were resting. These were all J stock animals. Lactating females were not observed. From foetus body length, conception date was estimated using the growth formula. Results show that the peak of conception was in February and another lesser peak in autumn season. The distribution shape was almost the same as that observed in the 2017 survey conducted in same season. The dominant prey species detected from whale forestomach was krill. All but one animal fed on krill (96.9%). An animal fed on the walleye pollock (3.1%). It should be noted that the NEWREP-NP program was terminated in June 2019 due to the withdrawal of Japan from the International Convention for the Regulation of Whaling (ICRW) on 30 June 2019. Therefore, this paper reports the last survey in sub-area 11 conducted under the NEWREP-NP. Results of the analyses of samples and data obtained under NEWREP-NP will be summarized and reported in the future. Research outputs will be used for the management of Japanese commercial whaling on western North Pacific common minke whales.

KEYWORDS: COMMON MINKE WHALE; OKHOTSK SEA; COASTAL WATERS OF JAPAN; STOCK ASSIGNMENT; REPRODUCTIVE STATUS; SCIENTIFIC PERMITS.

INTRODUCTION

The New Scientific Whale Research Program in the western North Pacific (NEWREP-NP) was started in 2017. The Primary Objective I of the program was 'Contribution to optimizing the establishment of a sustainable catch limit for common minke whales in the coastal waters of Japan', with four Secondary Objectives i) investigate the spatial and temporal occurrence of J stock common minke whales around Japan, by sex, age and reproductive status, ii) estimate the abundance of the J and O stocks in coastal waters of Japan, iii) verify that there is no structure in the O stock in the Pacific side of Japan, and iv) improve RMP trials by incorporating age data in their conditioning (Government of Japan, 2017).

The common minke whale is widely distributed in the North Pacific, from the equator to the Chukchi Sea (Perrin and Brownell, 2002). Two stocks of the common minke whales have been reported in the western North Pacific, i.e., the Sea of Japan - Yellow Sea - East China Sea stock (J stock) and the Okhotsk Sea – West Pacific stock (O stock) (Hatanaka, 1997). Morphological (external body proportions and colouration of flippers and baleens; Kato *et al*., 1992; Nakamura *et al*., 2016), genetic (mtDNA haplotype frequencies; Goto and Pastene, 1997; 1998 and microsatellites allele frequencies; Pastene *et al*., 2016), and biological (conception dates; Kato, 1992) differences have been reported between the two stocks. In feeding season from spring to autumn, they migrate to the northern productive waters from their winter southern breeding/calving ground. It is known that common minke whales of both stocks migrate to the Okhotsk Sea and mix there (Hatanaka and Miyashita, 1997; Pastene *et al*., 1998).

Unlike the case of sub-areas 7CS and 7CN, there were only limited and dated data on mixing proportion between the J and O stocks in northern Hokkaido (Abashiri, sub-area 11). Therefore, under NEWREP-NP, the priority sub-area for addressing Objective I (i) (investigate the spatial and temporal occurrence of J stock common minke whales around Japan, by sex, age and reproductive status) was sub-area 11 (GOJ, 2017). Segregation by sex, age and reproductive status occurs during migration of common minke whales along the Japanese coast (Hatanaka and Miyashita, 1997). Therefore, information on genetics alone is not sufficient and simultaneous collection of both genetics and biological information including age and sexual maturity data is essential to evaluate the spatial and temporal migration pattern of this species, and to estimate patterns of stock mixing by age and sexual maturity stages (GOJ, 2017).

The estimated sample size for sub-area 11 in NEWREP-NP was 47 animals (see details in Annex 11 of GOJ, 2017), and it was calculated to estimate the J stock proportion with sufficient precision.

The first NEWREP-NP's coastal component survey off Abashiri was conducted in early summer of 2017 in the southern Okhotsk Sea (part of sub-area 11); the second survey was conducted in summer of 2018 in the same research area. Both surveys were completed successfully (Yoshida *et al*., 2018, 2019). This paper outlines the third survey in sub-area 11, which was conducted in early summer of 2019 following the same methods and manner as in the past two surveys. The National Research Institute of Far Seas Fisheries (NRIFSF) of Japan Fisheries Research and Education Agency planned and conducted the survey, under cooperation with the Institute of Cetacean Research (ICR), Tokyo University of Marine Science and Technology, and the Association for Community-Based Whaling.

It should be noted that the NEWREP-NP program was terminated in June 2019 due to withdrawal of Japan from the International Convention for the Regulation of Whaling (ICRW) on 30 June 2019. Therefore, this paper reports the last survey in sub-area 11 conducted under the NEWREP-NP. Results of the analyses of samples and data obtained under NEWREP-NP will be summarized and reported in the future. Research outputs will be used for the management of Japanese commercial whaling on western North Pacific common minke whales.

MATERIALS AND METHODS

Research area

Research area was set in coastal waters around Abashiri, northeastern Hokkaido (southwestern part of sub-area 11 (Figure 1).

Target species and sample size

The target species and sample size for lethal sampling was 47 common minke whales (GOJ, 2017).

Research vessels, station, and period

Five small-type whaling catcher boats were used as sampling vessels: *Taisho Maru* No. 3 (19.0GT), *Koei Maru* No. 8 (32.0GT), *Katsu Maru* No.7 (32.0GT), *Sumitomo Maru* No.51 (30.0GT), and *Seiwa Maru* (15.0GT). All the common minke whales collected were landed at the NEWREP-NP research station established in the Abashiri port, for biological examination. The research period was set for 24 days, from 1 to 24 June 2019.

Searching and sampling methods

Searching and sampling methods were almost the same as those adopted at the JARPNII coastal component (Kishiro *et al*. 2016). 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 an area, searching areas and direction of vessels were determined by the office.

After the vessels left the port, they principally continued to cruise along the predetermined direction until arriving at around 30n. miles from the port, then changed their direction chosen by themselves and continued searching within the research area. Searching was carried out in the daytime and vessels returned to the port every night. A researcher was on board of each vessel and recorded sighting and sampling information, e.g., coordinates and time when common minke whale sighting and sampling were 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 11 knots.

Whale sampling was not conducted in coastal zone within about 10n. miles from the shoreline for safety, because many fishing boats and nets operated there. In the coastal zone, only observation of common minke whales encountered was made. All common minke whales sighted outside the zone were targeted for sampling, except cow-calf pairs. When a school consisted of more than one animal, an individual was selected randomly from the school and then collected. Once a vessel caught a whale, it transported the whale to the research station in the Abashiri port. 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 trailer. At that time, body weight of animals was measured using the truck scale and/or the crane scale. At the survey, biopsy sampling was not conducted.

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 items were required for Objective I (i) and other Ancillary Objectives of NEWREP-NP.

Females having at least one corpus luteum or albicans in their ovaries were identified as sexually mature. In the case where no corpus luteum or corpus albicans was observed, the female was categorized as immature. Sexual maturity of males was defined preliminary from the weight of a single testis. Animals with a single testis weight of 290g or more were determined as sexually mature (Government of Japan, 2017). Reproductive status of females was classified into three categories (resting, pregnant, and lactating), from observation of the ovary, uterus, and mammary gland. Pregnancy of animals was defined on conceptus with placental development in the uterus. Body length and weight of foetus was measured in the same manner as in adult animals. Sex of foetus was classified into three categories (female, male or sex unidentified).

Kato and Miyashita (1991) estimated conception date of Antarctic common minke whales from the following formula, i.e.:

$L < 15$ cm $\quad t = 0.0655L^{2.676}$

$L \geqq 15$ cm $\quad t = 1.6220L^{0.892} + 74$

where L is the foetal body length in cm and t is the number of days since conception. Conception date of common minke whales collected at the present survey was estimated from the formula.

Left and right earplugs were collected for age determination by the routine procedure (Omura, 1963). After removing the mandibles, the proximal part of the earplug was exposed along the surrounding the external part of the ear canal from the tympanic bulla using a knife, for subsequent incision. The external part of the ear canal was carefully cut opened so as not to incise the earplug, and then the earplug was collected with glove-finger using a scalpel. Gelatinized Extraction Method (Maeda *et al*., 2013) was used to reduce damage at extracting earplugs from small animals (body length < 7 m). Earplugs were fixed and stored in 10% formalin solution. Eye lenses of each animal and, if possible, eye balls from fetus were collected and stored in polyethylene bags at -80°C for age estimation.

Assignment of J and O stocks was conducted from sixteen nuclear microsatellite loci extracted from animal

skin tissues, using the program STRUCTURE (see details in the Appendix).

Stomach contents research on common minke whales collected
Stomach contents of animals collected were examined following the same methods adopted in the JARPNII 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.

RESULTS

Searching effort
The survey was started on 1 June and finished on 24 June, as planned. Of the 24 days, vessels conducted searching for 13 days (54.2%). The remaining days were not suitable for survey, e.g., from bad weather conditions. Survey track lines are shown in Figure 1. Searching distance and time (distance and time recorded under searching activity conducted by crews from the top barrel of the vessels) are given in Table 1. During the survey, a total of 2,486.9 nautical miles (251.9 hours) was searched.

Sightings
A total of 61 schools (62 individuals) of common minke whales were sighted during the searching (Table 1, Figure 2). No cow-calf pairs were encountered. Track lines were widely distributed in coastal waters within around 40n. miles from the Abashiri port. Sightings of common minke whales were concentrated along 200m isobath north of Abashiri, same as in the 2018 survey. Density index (DI, the number of primary sightings of schools per 100 nautical miles searching) of common minke whales was calculated as 2.25. The SPUE (the number of primary sightings of schools per 1 hour searching) was calculated as 0.22. At the survey, 97 schools (155 animals) of the fin whale and 5 schools (7 animals) of the humpback whale were also encountered (Table 1, Figure 2).

Sampling of common minke whales
Of the 62 common minke whales encountered, 32 animals were collected for biological examination. Sighting positions of animals collected are shown in Figure 2. No case of struck and lost occurred.

Stock assignment of animals caught
The program STRUCTURE assigned 21 animals to J stock and 10 individuals to O stock. An animal could not be assigned (see details in the Appendix). Mixing proportion of J and O stock animals was calculated by period. Proportion of J stock animals increased from the first half of the survey (61.5%), i.e., in a period from 1 to 12 June, to the second half (100.0%), though sample size in the second half was small.

Body length, sex ratio, maturity of animals, and conception date
Biological items from the 32 animals collected are summarized in Table 2. Earplugs and eye lenses for age determination and reproductive organs for sexual maturity identification were collected from all the whales. Individuals consisted of 5 males and 27 females (Table 3). Sex ratio of males was 15.6% (Table 4). Average body length of males was 6.04m (SD=1.35, range=4.14-7.50m) and 7.32m (SD=0.86, range=5.50-8.40m) for females (Table 3).

All the males were assigned to J stock (100.0%). No males were identified as O stock. Of 27 females, 16 animals (61.5%) and 10 individuals (38.5%) were assigned to J stock and O stock, respectively. A female could not be assigned. Sex ratio of males was calculated as 23.8% for J stock and as 0.0% for O stock. Average body length of J stock males was 6.04m (SD=1.35, range=4.14-7.50m). Average body length of J stock females was 7.18m (SD=0.86, range=5.50-8.11m) and 7.65m (SD=0.75, range=6.01-8.40m) for O stock females. Two of five males (40.0%) and 20 of 27 females (74.1%) were sexually mature (Table 4). Sexually maturity rate of J stock females was 75.0% (12 of 16 animals) and 80.0% (8 of 10 animals) for O stock females. The 16 of 20 mature females were pregnant (80.0%): eight of 12 J stock mature females (66.7%) and eight of eight O stock mature females (100.0%) were pregnant. Four females were resting. These were all J stock animals. Lactating females were not observed.

From foetus body length, conception date was estimated using the growth formula. Figure 4 shows the

number of conceptions by month. Results show that the peak of conception was in February and another lesser peak in autumn season. The distribution shape of conception by month was almost the same as that observed in the 2017 survey conducted in the same season. Stock assignment of animals showed that all females assigned to O stock conceived in a period from winter to spring. Females conceiving in a period from summer to autumn were identified as J stock.

Prey species found from common minke whale forestomach

Stomach contents of the 32 animals were examined. Weight of forestomach contents including liquid ranged from 4.7 kg to 71.3 kg. Forestomach contents found from the whales are listed in Table 5 and shown in Figure 5. Dominant prey species was the krill (*Euphausia pacifica*). All but one animal fed on krill (96.9%). An animal fed on the walleye pollock (*Theragra chalcogramma*, 3.1%). The animal was assigned to J stock. No obvious difference was observed between sighting positions of whales feeding on the krill and the walleye pollock (Figure 7).

Observation of marine debris

Seven objects of marine debris were detected from the stomach of three animals. They were all males. The debris was six small pieces of plastic products and a plastic cap of bottle. Five pieces of plastic objects were found in a single individual.

DISCUSSION

At the present survey, sampling vessels could conduct searching for 13 days of the 24 days survey period (54.2%). The remaining days were not suitable for searching due to bad weather conditions. The weather condition was worse in the second half from 13 to 24 June. In the second half, searching was conducted only for 3 days of the 12 days (25.0%). The number of common minke whales encountered was also lower in the second half. The density index of common minke whales decreased from 2.60 in the first half to 1.24 in the second one. At the first half, the 27 common minke whales were collected. It was more than half of the planned sample size of 47 animals. If weather condition and common minke whale density in the second half were same with these recorded in the first one, possibly, all the planed sample size could be collected during the 24 days survey period. Contrary to sighting results of common minke whales, density index of fin whales increased from 2.98 in the first half to 3.58 in the second one. Average sea surface temperature (sst) recorded at sighting positions of fin whales (9.3 °C) was one degree lower than that recorded at sighting positions of common minke whales (10.3°C). Average sst fell from 10.3 °C in the first half to 9.4 °C in the second one. Lower sst in the second half may have resulted in higher density of fin whales and lower one of common minke whales.

Sighting positions of common minke whales changed among the surveys. At the first NEWREP-NP survey conducted in 2017, some animals were sighted at offshore waters deeper than 1,000m. At the present survey, however, no animals were encountered at those waters, same as in the 2018 survey. Sighting positions of fin whales also changed among the surveys. No animals were sighted at the offshore waters in the present survey (Fig. 2), while, at the past two surveys, there were animals sighted at the offshore waters. The results suggest that whales encountered at the coastal waters gradually increased year by year. Between J and O stock animals, there was no visible difference in sampling positions (see details in the Appendix). Figure 7 shows sampling positions of common minke whales by maturity stage in each sex. No obvious tendency was observed between sighting positions of immature and mature whales in each sex (Figure 7). There was no obvious difference in distribution pattern of common minke whales in the research area by sex, maturity stage, and stock.

At the present survey, sex of animals collected was biased towards the female (Table 4). Large females with body length larger than 7.0 m were dominant (Figure 3). No significant difference was found in average body length between J and O stock females. Sexually maturity rate of J stock females was 75.0% and 80.0% for O stock. Two thirds of J stock mature females and all the O stock mature females (100.0%) were pregnant. These results were same with that recorded at the past two surveys conducted off Abashiri (Yoshida *et al*., 2018, 2019). On the other hand, maturity and pregnant rate were lower at surveys conducted at the Pacific coast off Kushiro from 2002 to 2018 (e.g., Kishiro *et al*., 2003 and Isoda *et al*., 2019). Of 260 females caught off Kushiro, only 46 animals attained sexual maturity (17.7%). Of the sexually mature females, 22 were

pregnant (47.8%). The results suggest that coastal waters off Abashiri is important for mature and pregnant females of both J and O stocks. Maturity rate was also higher in males collected at the past two surveys conducted off Abashiri (88.9% in 2017 and 75.0% in 2018) than that recorded at Pacific coast off Kushiro (48.3%). It appears that the results support a hypothesis on feeding migration of common minke whales in the western North Pacific, that is, mature animals migrate to higher latitudinal waters (Hatanaka and Miyashita, 1997).

Results of estimation on foetus conception date showed that the peak of conception was in February and another lesser peak in autumn season (Figure 4). The distribution shape was almost same with that observed in the previous study on conception date in the southern Okhotsk Sea (Kato, 1992). Stock assignment of animals showed that all females assigned to O stock conceived in a period from winter to spring. Females conceiving in a period from summer to autumn were identified as J stock. The results suggest that animals of separate two stocks migrate to the Okhotsk Sea and mix there, as described by Kato (1992).

Dominant prey species of animals collected at the present survey was the krill. All but one animals fed on the krill (Table 5). An animal fed on the walleye pollock. It was J stock animal. The results that the krill was dominant were same with the past two surveys conducted in the Okhotsk Sea. On the other hand, animals caught at the Pacific coast off Kushiro fed on fishes at high frequency and krill was rare (Figure 5). Prey species composition of common minke whales caught at the surveys was different between waters, which suggests that the difference in prey species composition is from different prey availability to whales between the waters.

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Table 1. Searching days, distances, hours, and number of cetacean sightings made during the 2019 NEWREP-NP coastal component off Abashiri.

Period	Search days	Distances (n. miles)	Hours	Number of sightings*			
				Species	Primary (Ind/Sch)	Secondary (Ind/Sch)	Total (Ind/Sch)
6/1-6/12	10	1,843.9	186.3	Common minke whale	49/48	3/3	52/51
				Like minke whale	8/8	1/1	9/9
				Fin whale	79/55	6/5	85/60
				Humpback whale	6/4	1/1	7/5
6/13-6/24	3	642.9	65.6	Common minke whale	8/8	2/2	10/10
				Like minke whale	1/1	0/0	1/1
				Fin whale	63/34	7/3	70/37
Total	13	2,486.9	251.9	Common minke whale	57/56	5/5	62/61
				Like minke whale	9/9	1/1	10/10
				Fin whale	142/89	13/8	155/97
				Humpback whale	6/4	1/1	7/5

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

Table 2. Summary of biological data and samples collected during the 2019 NEWREP-NP coastal component off Abashiri.

Samples and data	Number of animals		
	Male	Female	Total
Body length and sex	5	27	32
External body proportion	5	27	32
Photographic record and external body character	5	27	32
Diatom film record	5	27	32
Body scar record	5	27	32
Measurements of blubber thickness (five points)	4	26	30
Body weight	5	27	32
Skin tissues for DNA analysis	5	27	32
Muscle, liver, kidney, spleen, blubber, and heart for various analysis	4	27	31
Urine for various analysis	2	5	7
Muscle, liver, kidney, and blubber for heavy metal analysis	5	27	32
Muscle, liver, kidney, and blubber for organochlorine analysis	5	27	32
Collection of blood plasma	3	21	24
Mammary grand; lactation status, measurement and histological sample	-	27	27
Uterine horn; measurements and endometrium sample	-	26	26
Collection of ovary	-	27	27
Photographic record of foetus	5	10	16*
Foetal length and weight	3	8	11
Skin tissues for DNA study of foetus	5	10	15
Muscle, liver, kidney, heart, blubber and skin tissues of foetus	3	3	6
Eye lens of foetus for age determination	3	3	6
Collection of foetus	0	1	2*
Testis and epididymis; weight and histological sample	5	-	5
Stomach contents, convenient record	5	27	32
Volume and weight of stomach content in each compartment	5	24	29
Observation of marine debris in stomach	5	27	32
Collection of stomach contents for feeding study	5	26	31
Record of external parasites	5	27	32
Earplug for age determination	5	27	32
Eye lens for age determination	5	27	32
Baleen plate with V-shape notch on its outer edge for age determination	1	0	1
Baleen plate measurements (length and breadth)	5	27	32
Photographic record of baleen plate series	5	27	32
Length of baleen series	5	27	32
Vertebral epiphyses sample	5	27	32
Number of ribs	5	27	32
Skull measurement (length and breadth)	4	27	31

*: A sex unidentified foetus is included.

Table 3. Body length (m) of common minke whales collected in the 2019 NEWREP-NP coastal component off Abashiri.

Period	Male					Female				
	Mean	S.D.	Min.	Max.	*n*	Mean	S.D.	Min.	Max.	*n*
6/1-6/12	6.08	1.56	4.14	7.50	4	7.33	0.87	5.50	8.40	23
6/13-6/24	5.86	-	-	-	1	7.24	0.94	6.01	8.11	4
Total	6.04	1.35	4.14	7.50	5	7.32	0.86	5.50	8.40	27

Table 4. Composition of sexual maturity of common minke whales collected in the 2019 NEWREP-NP coastal component off Abashiri.

Period	Male				Female							Sex ratio
	Im	M	Total	Maturity*	Im	R	P	L	Total	Pregnancy*	Maturity*	(%males)
6/1-6/12	2	2	4	50.0	6	3	14	0	23	82.3	73.9	14.8
6/13-6/24	1	0	1	0.0	1	1	2	0	4	66.7	75.0	20.0
Total	3	2	5	40.0	7	4	16	0	27	80.0	74.1	15.6

Im: Immature; M: Mature; R: Resting; P: Pregnant; L: Lactating; *: %.

Table 5. Number of common minke whales by major prey species found in forestomach, collected in the 2019 NEWREP-NP coastal component off Abashiri.

	Number of whales (%)		
Period	Walleye pollock	Krill	Total
6/1-6/12	0 (0.0)	27 (100.0)	27 (100.0)
6/13-6/24	1 (20.0)	4 (80.0)	5 (100.0)
Total	1 (3.1)	31 (96.9)	32 (100.0)

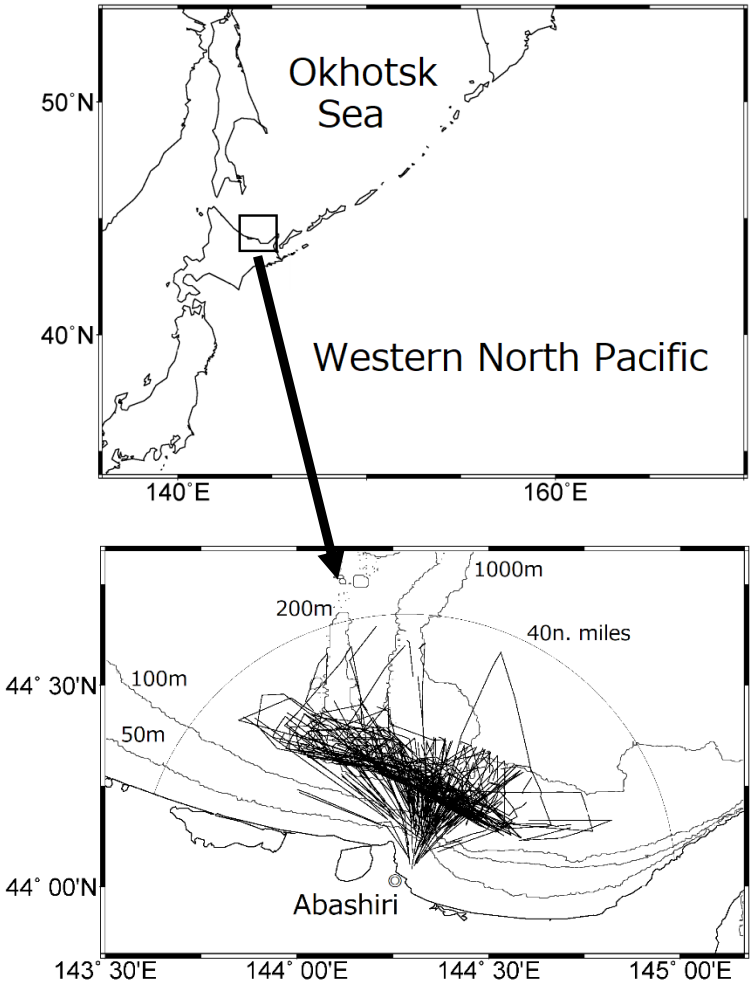


Figure 1. Research area set for the 2019 NEWREP-NP coastal component off Abashiri (upper) and cruise tracks made by sampling vessels at the component (lower). The survey was conducted mainly in 40 nautical miles from Abashiri port.
Isobaths are 50m, 100m, 200m, and 1000m.

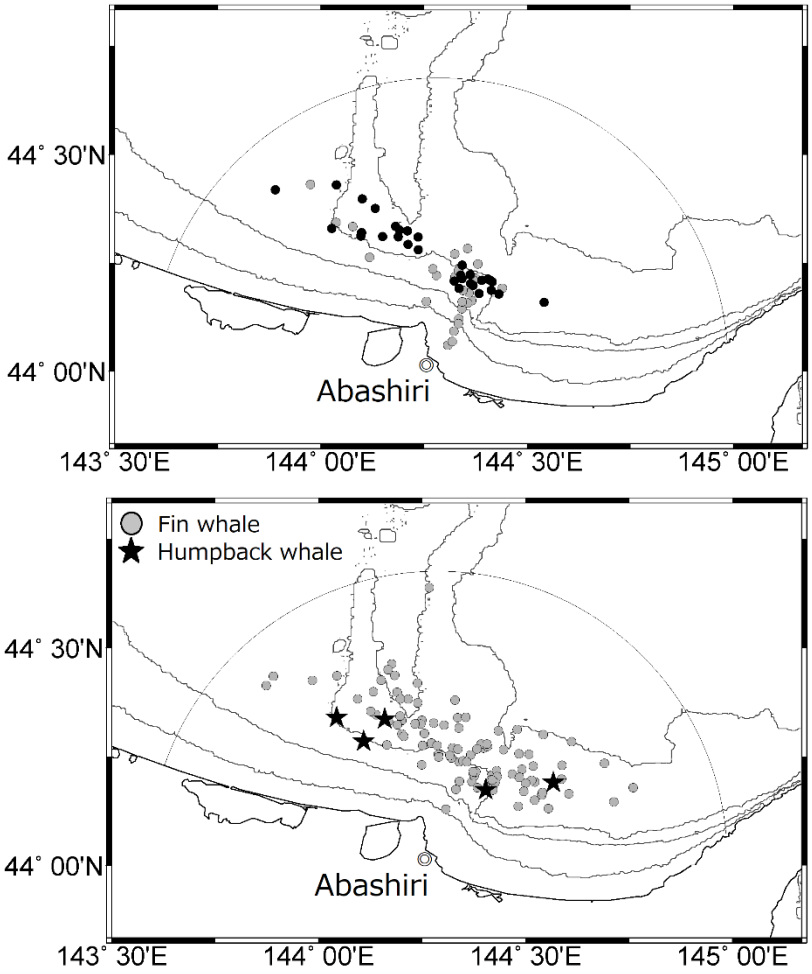


Figure 2. Sighting positions of common minke whales (upper) and large whales (lower) made by sampling vessels at the 2019 NEWREP-NP coastal component off Abashiri. Black circles in upper map shows sighting positions of common minke whales collected. Isobaths are 50m, 100m, 200m, and 1000m.

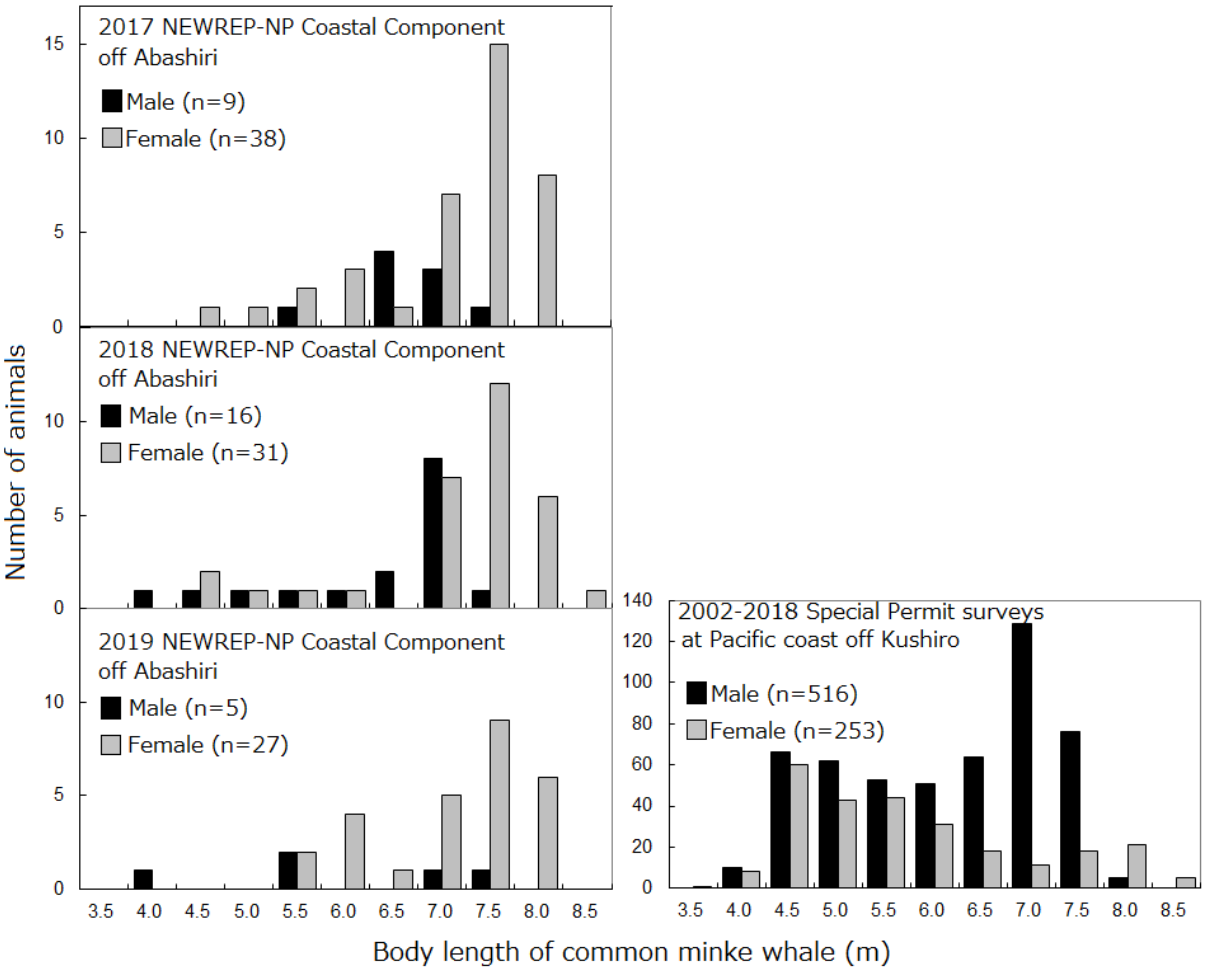


Figure 3. Body length frequency of common minke whales collected at the 2019 NEWREP-NP coastal component off Abashiri, with results of the 2017 and 2018 NEWREP-NP coastal component off Abashiri (Yoshida *et al*. 2018). Body length frequency of common minke whales collected at Special Permit surveys conducted at Pacific coast off Kushiro from 2002 to 2018 (e.g., Kishiro *et al*. 2003, Isoda *et al*. 2019) is also shown.

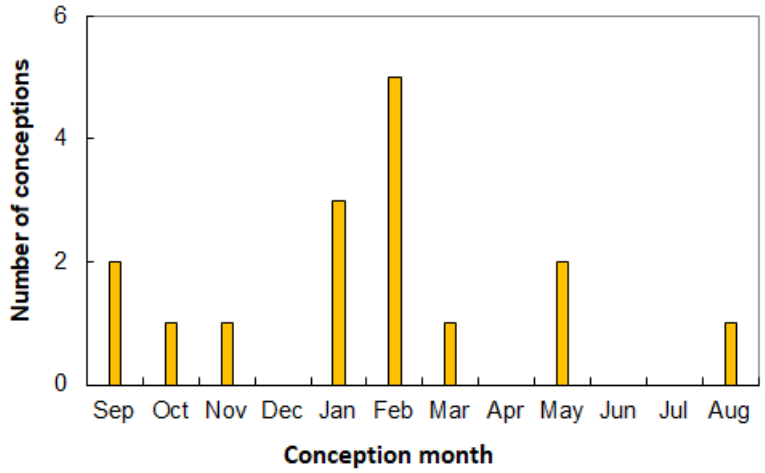


Figure 4. Number of conceptions by month, estimated from body length of foetus collected at the 2019 NEWREP-NP coastal component off Abashiri.

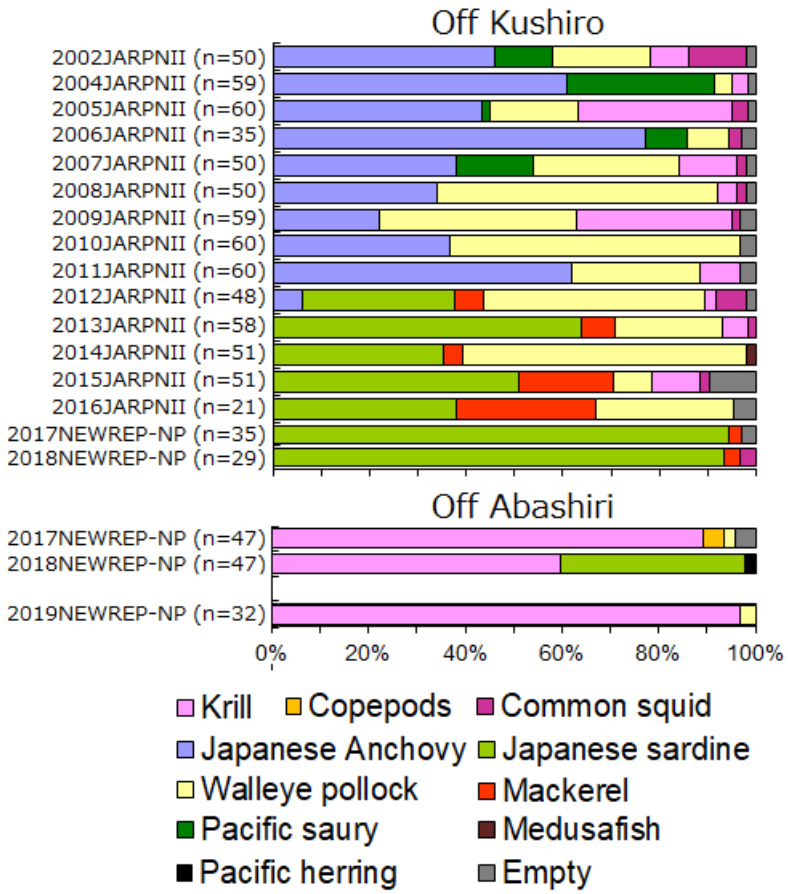
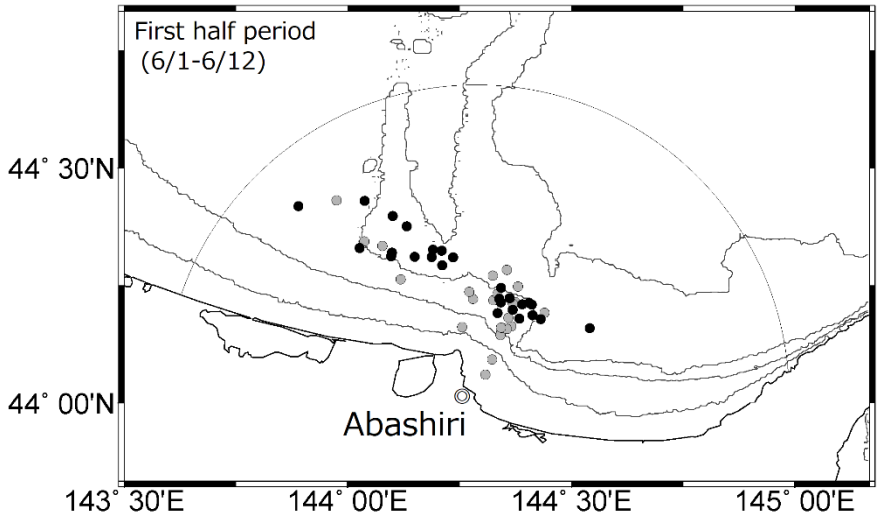


Figure 5. Prey species composition of common minke whales collected at the 2019 NEWREP-NP coastal component off Abashiri, with results of the 2017 and 2018 NEWREP-NP coastal component off Abashiri (Yoshida *et al*. 2018). Prey species composition of common minke whales collected at Special Permit surveys conducted at Pacific coast off Kushiro from 2002 to 2018 (e.g., Kishiro *et al*. 2003, Isoda *et al*. 2019) is also shown.



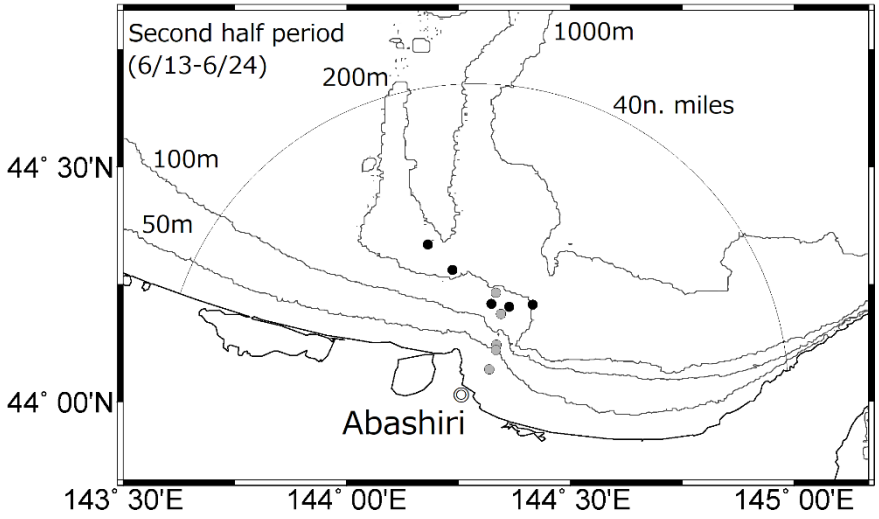
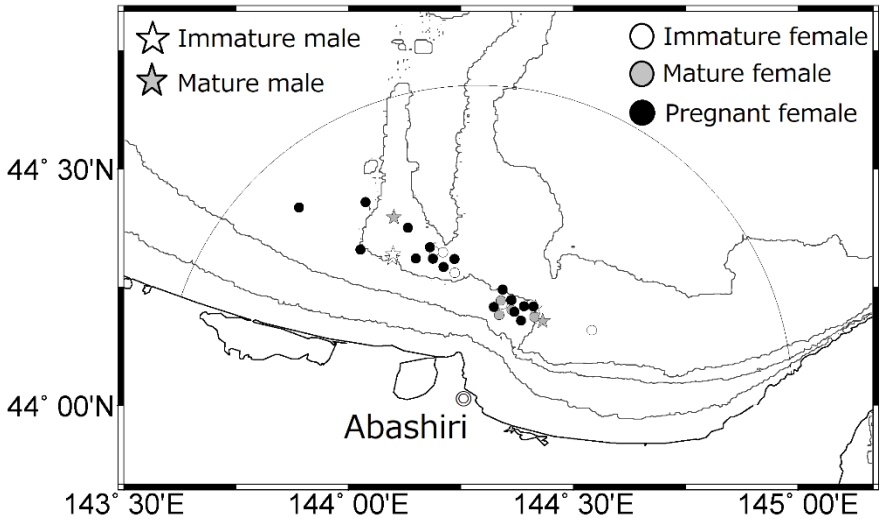


Figure 6. Sighting positions of common minke whales made by sampling vessels at the 2019 NEWREP-NP coastal component off Abashiri, by period. Black circles are sighting positions of common minke whales collected. Isobaths are 50m, 100m, 200m, and 1000m.



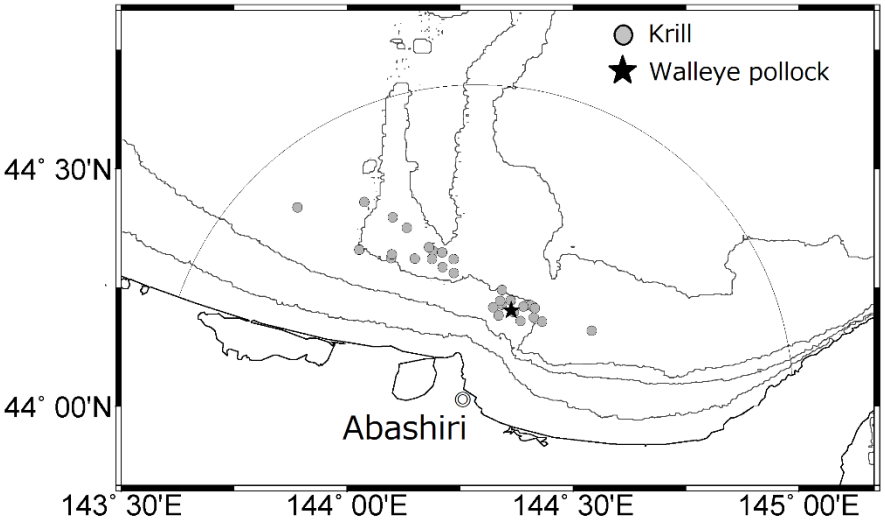


Figure 7. Sighting positions of common minke whales at the 2019 NEWREP-NP coastal component off Abashiri, shown by sex and reproductive status (upper) and by prey species (lower). Isobaths are 50m, 100m, 200m, and 1000m.

Appendix

Genetic assignment and biological characteristics of J and O stock common minke whales off Abashiri under the 2019 NEWREP-NP coastal survey

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This appendix describes the biological characteristics of J and O stock common minke whale *i.e.*, mixing proportion, reproductive status and body length, based on a total of 32 common minke whales sampled in Abashiri under the 2019 NEWREP-NP coastal survey.

Genetic stock assignment

Total DNA for a total of 32 sampled common minke whales was extracted, and all individuals were genotyped for sixteen nuclear microsatellite loci. The details of laboratory procedures are available in Pastene *et al*. (2016).

A Bayesian clustering analysis was performed to estimate an assignment probability for each sample using the program STRUCTURE version 2.3.4 (Pritchard *et al*., 2000). In the genetic assignment, all available microsatellite data of common minke whales from JARPN, JARPNII and NEWREP-NP until 2019 and from bycatch until 2018, were used. The details of analytical procedures for the stock assignment are available in Pastene *et al*. (2016).

Biological outline of common minke whales observed in 2019

There was no difference in sampling position between the stocks in 2019 (Figure 1).

Of 32 common minke whales collected off Abashiri in 2019, 21 (female, n=16; male, n=5) and 10 (female, n=10) individuals were assigned to J and O stocks, respectively (Table 1). The remaining one female could not be assigned to the stock (Table 1).

The proportion of J and O stock females was roughly equal in the first half of research period, and no O stock females were observed in the second half period (Figure 2). Although it should be noted that the number of males sampled was much smaller than females (Table 1), all of them were from J stock (Figure 2). The overall mixing proportion was thus different between the first and second half of the research period (Figure 2), which varied from 60:40 to 100:0.

For J stock, 12 of 16 females and 2 of 5 males reached sexual maturation (Table 1). Reproductive status of the mature females consisted of 8 pregnant and 4 resting individuals, which resulted in the apparent pregnancy rate of 66.7% in J stock (Table 1). The composition of reproductive status of J stock was not largely different between the first and second half of the research period in females (Figure 3), but the comparison was not possible for males due to the small sample size. For O stock, 8 of 10 females reached sexual maturation, and they all were pregnant (Table 1).

The body length of J stock ranged from 5.5 to 8.1 m in females, and from 4.1 to 7.5 m in males. The box plot distribution in the body length was not largely different between the first and second half of the research period in females (Figure 4), but the comparison was not possible for males due to the small sample size. On the other hand, the O stock females showed a body length ranging from 6.0 to 8.4 m.

Biological outline of common minke whales observed in the NEWREP-NP (2017-2019)

There was no difference in sampling position between J and O stocks through the past three years of NEWREP-NP (Figure 1).

The mixing proportion of the two stocks (J:O) in females during 2017-2019 varied among seasons or years (Figure 2), nevertheless it was roughly 50:50. The number of males sampled was smaller than females in any research periods, most of which was from J stock (Table 1). As a whole, the mixing proportion fell within the range from approximately 70:30 to 60:40 through the past three years of NEWREP-NP (Figure 2).

In J stock, both immature and mature whales were observed in the past three surveys for both sexes, and the mature females consisted of resting and pregnant individuals (Table 1). As with the J stock, both immature and mature whales were observed in O stock (Table 1). The mature females of O stock consisted of resting and pregnant individuals (Table 1), except the two ovulating individuals sampled in the second half of June in 2017. The apparent pregnancy rate was high for both stocks (J: 66.7-100%, O: 72.7-100%) through the three years of NEWREP-NP (Table 1). The composition of reproductive status of females in each stock was not largely different among years or seasons (Figure 3). Although it seemed that the proportion of immature and mature males of J stock seemed to vary among seasons or years, this should be interpreted with a caution, given the small sample size of males (Figure 3).

The mean body length in each research period of J stock ranged from 6.7 to 7.7 m for females and from 5.5 to 7.0 m for males, which contained a wide range of body length (Figure 4). For O stock, the mean body length ranged from 7.5 to 7.8 m for females and from 4.4 to 7.5 m for males (Figure 4). The body length in each stock was not largely different among years or seasons at least for females.

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Table 1 Sample size of common minke whale sampled in the coastal component off Abashiri under the NEWREP-NP during 2017-2019 by sex, reproductive status and stock.

Month Year	Stock	Female								Male			Total
		Immature	Mature	(Ovulating,	Resting,	Pregnant,	Unknown)	Apparent	Total	Immature	Mature	Total	
Jun. 2019	J	4	12	(0,	4,	8,	0)	66.7	16	3	2	5	21
	O	2	8	(0,	0,	8,	0)	100.0	10	0	0	0	10
	Unassigned	1	0	(0,	0,	0,	0)		1	0	0	0	1
	Total	7	20	(0,	4,	16,	0)	80.0	27	3	2	5	32
Jun. 2017	J	4	7	(0,	1,	6,	0)	85.7	11	1	4	5	16
	O	1	11	(2,	1,	8,	0)	72.7	12	0	1	1	13
	Unassigned	0	1	(0,	1,	0,	0)	0.0	1	0	0	0	1
	Total	5	19	(2,	3,	14,	0)	73.7	24	1	5	6	30
Jul. 2017	J	3	7	(0,	0,	7,	0)	100.0	10	0	3	3	13
	O	0	4	(0,	0,	4,	0)	100.0	4	0	0	0	4
	Unassigned	0	0	(0,	0,	0,	0)		0	0	0	0	0
	Total	3	11	(0,	0,	11,	0)	100.0	14	0	3	3	17
Aug. 2018	J	2	13	(0,	2,	11,	0)	84.6	15	3	10	13	28
	O	2	11	(0,	3,	8,	0)	72.7	13	1	1	2	15
	Unassigned	1	2	(0,	0,	2,	0)	100.0	3	0	1	1	4
	Total	5	26	(0,	5,	21,	0)	80.8	31	4	12	16	47

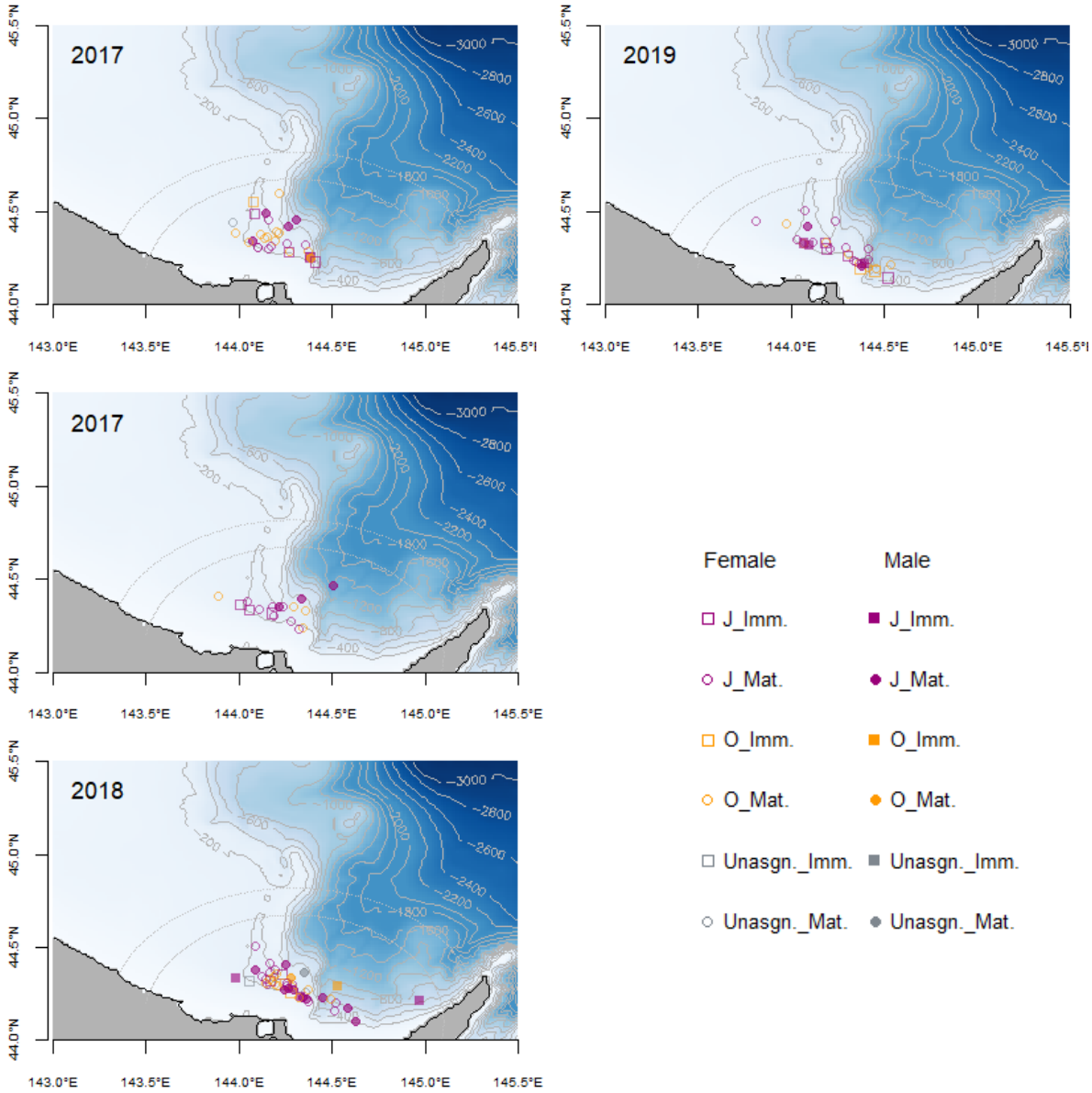

Figure 1 Sampling position of common minke whales in the NEWREP-NP during 2017-2019. Dashed gray line indicates the main area surveyed ranging 40 nautical miles from Abashiri.

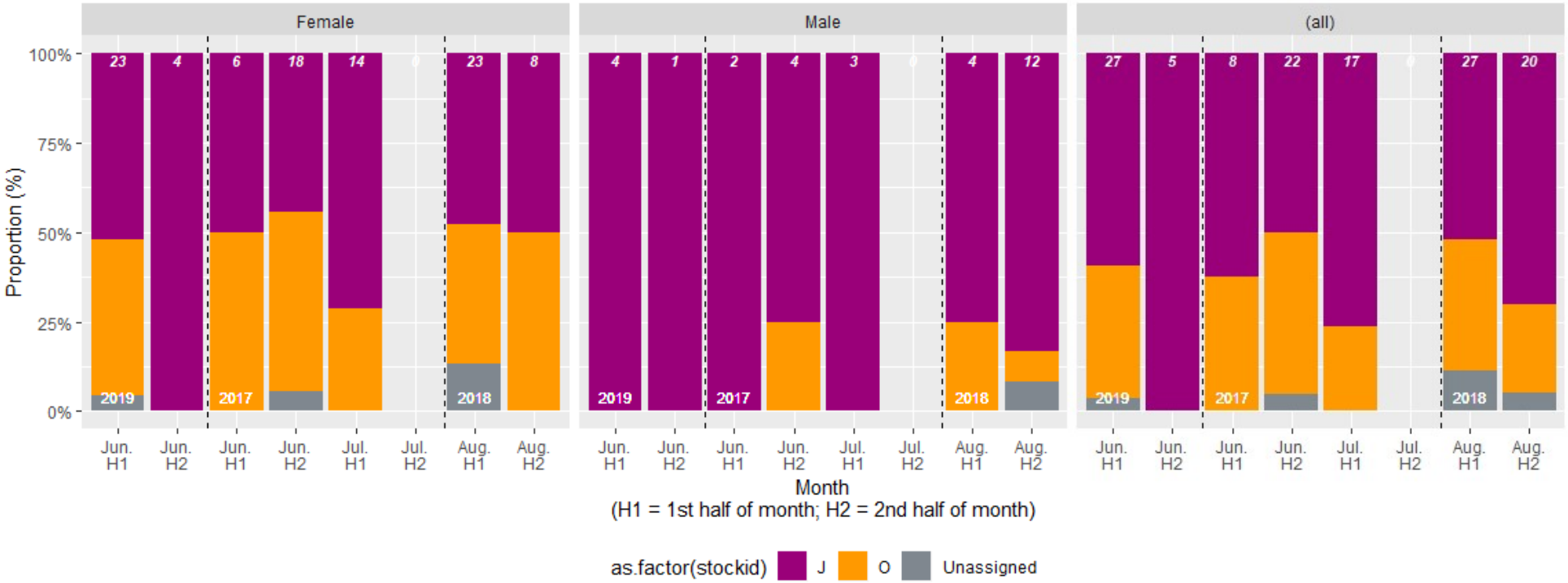

Figure 2 Half-monthly mixing proportion of J and O stocks, by sex in the NEWREP-NP during 2017-2019. Color indicates the stock: J, violet; O, orange; Unassigned, gray. Figures shown in the top of each bar indicate sample size in each category.

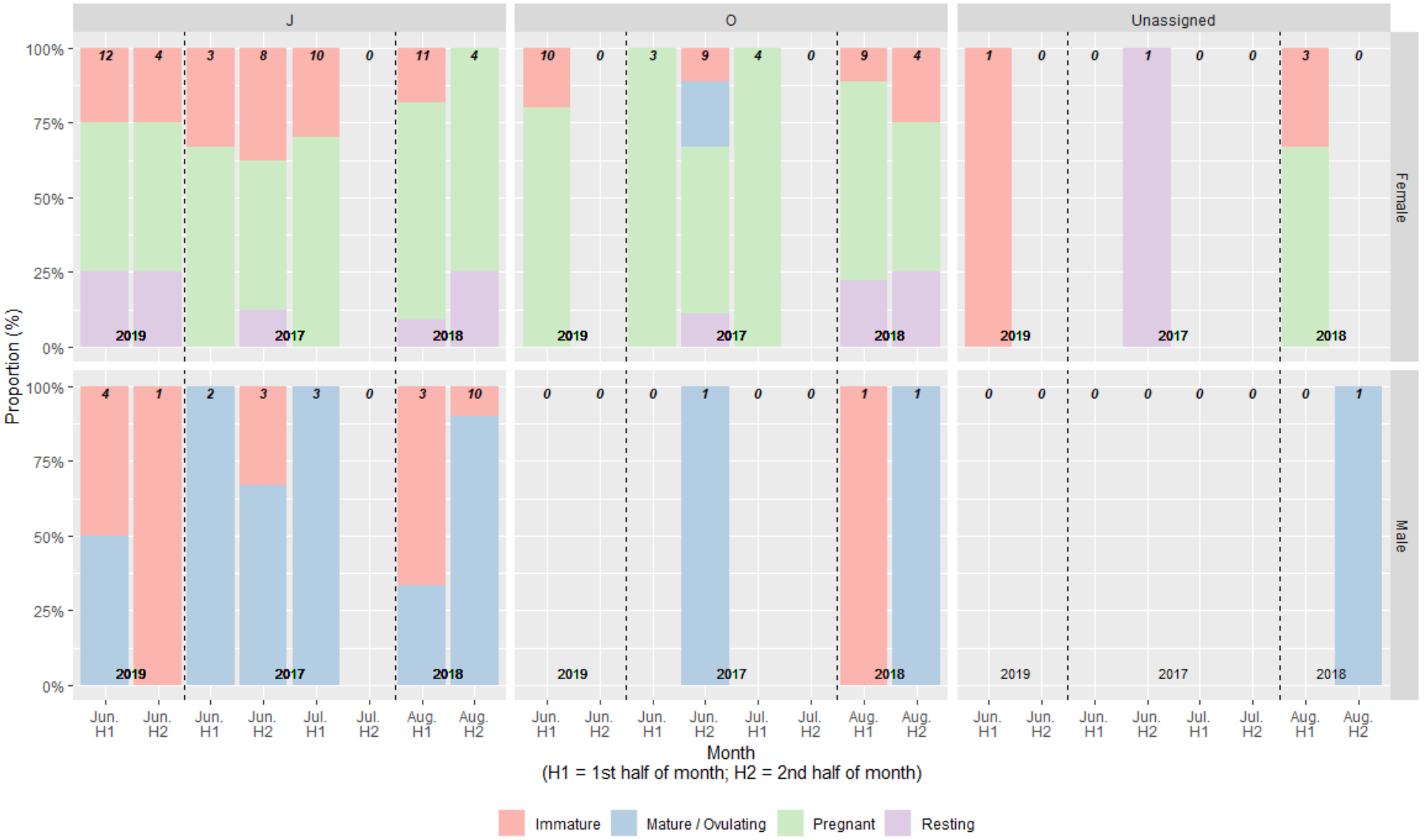

Figure 3 Half-monthly composition of reproductive status of common minke whales caught under the NEWREP-NP during 2017-2019. Figures shown in the top of each bar indicate sample size in each category.

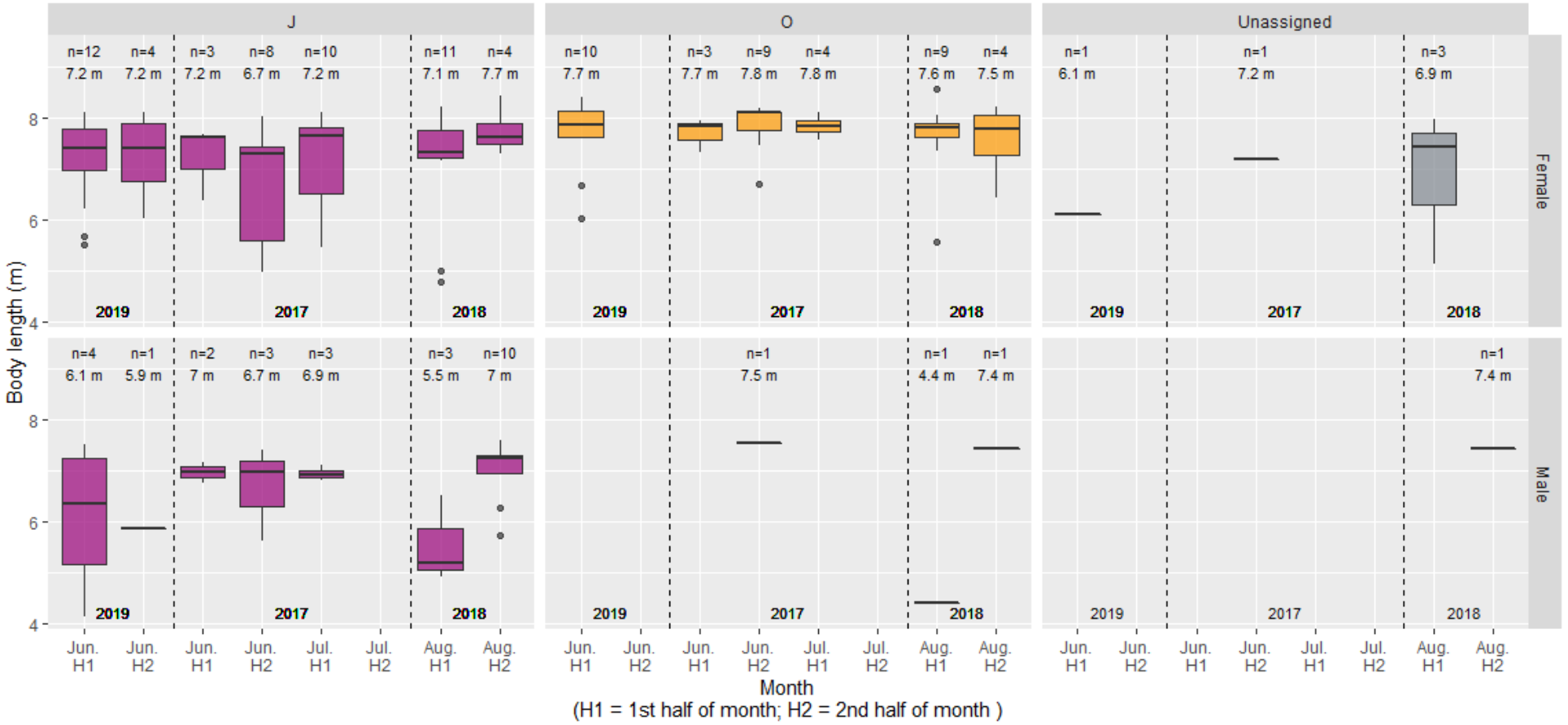

Figure 4 Boxplot of seasonal body length of common minke whales caught under the NEWREP-NP during 2017-2019. Figures shown in the top of each box indicate sample size with mean body length in each category.