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INTERNATIONAL WHALING COMMISSION

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ABSTRACT

This paper reports the results of the biological sampling of Antarctic minke whales during the third New Scientific Whale Research Program in the Antarctic Ocean (NEWREP-A) conducted in Area VI (170°W-120°W, south of 60°S) during the 2017/18 austral summer season. The paper also reports the results of the sighting surveys and non-lethal experiments. Two sighting and sampling vessels (SSVs) and one research base vessel engaged in the survey for 83 days. A total of 392 sightings (involving 925 individuals) of Antarctic minke whale were made during 4,164 n.miles of searching distance. A total of 333 Antarctic minke whales (152 males and 181 females) were sampled, and a number of biological samples and data required for the two main objectives of NEWREP-A were obtained from each whale taken. In Area VI-East, the survey was conducted early in the season (December to January) for the first time since the start of JARPA survey in 1987/88. A total of 44 Antarctic minke whale (26 males and 18 females) were sampled in Area VI-East. The obtained samples will contribute to elucidation of the stock structure of Antarctic minke whales, especially to elucidation of the eastern boundary of P-stock. A total of two blue, four humpback and one killer whales were photo-identified and one biopsy sample was collected from a blue whale in the research area. The samples and data collected in this survey are available for interested national and international scientists under the guidelines for research collaboration posted at the home page of the Institute of Cetacean Research (ICR): http://www.icrwhale.org/NEWREP-AProtocol.html.

KEYWORDS: SCIENTIFIC PERMITS; ANTARCTIC; FEEDING GROUNDS; ANTARCTIC MINKE WHALE; BIOPSY SAMPLING; PHOTO-ID

INTRODUCTION

The survey of the New Scientific Whale Research Program in the Antarctic Ocean (NEWREP-A) started in the 2015/16 austral summer season, after the review of the research plan by the International Whaling Commission Scientific Committee (IWC SC) following the guidelines in Annex P (IWC, 2015a; GOJ, 2016; Matsuoka *et al*., 2016).

The two main Objectives of NEWREP-A are I) Improvements in the precision of biological and ecological information for the application of the RMP to the Antarctic minke whales, and II) Investigation of the structure and dynamics of the Antarctic marine ecosystem through building ecosystem models.

Under Main Objective I, there are four sub-objectives as follows.

Objective I (i): Abundance estimates for Antarctic minke whales taking into account of g(0) and additional variance

Objective I (ii): Improvement of precision of biological and ecological parameters

Objective I (iii): Refinement of stock structure hypotheses of Antarctic minke whale in Areas III-VI for the implementation of the RMP

Objective I (iv): Specification of RMP ISTs for the Antarctic minke whales

Under Main Objective II, there are four sub-objectives as follows.

Objective II (i): Ecological Research (krill abundance estimation and oceanographic observation)

Objective II (ii): Abundance estimate of some cetacean species as input data for ecosystem modelling

Objective II (iii): Estimation of prey consumption by the Antarctic minke whale and its nutritional condition

Objective II (iv): Ecosystem modelling (Spatial interaction among baleen whales and consideration of predators-prey system and allometric reasoning)

Research under NEWREP-A requires the collection of various types of data and samples which are necessary for addressing main Objectives I and II of the program. For example, under Objective I (ii) samples and data related

to age, sexual maturity and body length of the whales are required. Under Objective I (iii), data and samples for studying morphometric, morphological and genetic differences among whales are required. All that information together with others obtained by non-lethal means (e.g. abundance under Objective I (i)) is necessary for the specifications of RMP *ISTs* for Antarctic minke whales (Objective I (iv)) will be used in the analysis.

Under Objective II (iii), stomach contents of the whales are required to estimate prey composition and consumption by Antarctic minke whales. Blubber thickness, fat weight and girth data are required to study the nutritional condition of the whales. All that information together with other obtained by non-lethal means (*e.g.* whale abundance under Objective II (ii) and krill biomass and oceanographic information under Objective II (i)) is necessary for the ecosystem modelling work (Objective II (iv)) will be used in the analysis.

Age data at the annual scale is required for the Statistical Catch-at-Age Analysis (SCAA) under objective I (ii). Age information can be obtained only from internal earplugs and therefore only through lethal sampling methods. The NEWREP-A review workshop agreed that at present, the technique commonly used for the determination of the biological parameters used in the SCAA model require earplugs for age determination (IWC, 2015b).

Calculation of sample size of Antarctic minke whale in NEWREP-A was based on the biological parameter, Age at Sexual Maturity (ASM). ASM is of great importance not only for contributing information on the proportion of matured animals in the SCAA (related to the main Objective I) but also as an important indicator of changes in the nutritional condition of the whale stock (related to main Objective II). The age-at-50% sexual maturity (ASM 50) was used to set the annual sample size of 333 Antarctic minke whales (see GOJ, 2015 for details).

The third whale sighting and sampling survey of the NEWREP-A was conducted in Areas VI (170°W-120°W) during the austral summer season 2017/18. Sighting and sampling survey in Area VI-East was conducted for the first time since the start of JARPA survey in 1987/88. The objective of this paper is to present the results of the biological survey of 333 Antarctic minke whale sampled during the field survey of 2017/18 NEWREP-A. Sighting data obtained by the sighting and sampling vessels (SSVs) are also presented in Appendix.

The report of the dedicated sighting survey is presented by Mogoe *et al*. (2018) and that of the krill and oceanographic survey is presented by Wada *et al.* (2018).

SURVEY DESIGN

Research area

The research area of whale sighting and sampling survey was set as south of 60°S in Area VI (170°W-120°W, south of 60°S; Figure 1). The area was divided into the East and West sectors at 145°W (Figure 2). Each sector was divided into the South and North strata. The boundary between the South and North strata was defined by a line 45n.miles from the ice-edge. The West-South stratum was further divided into the north and south strata at 69°S. Estimated pack-ice line (ice-edge) was obtained from direct observation from the vessels and from the Defence Meteorological Satellite Program (DMSP; Maslanik and Stroeve, 1999).

Research vessels

Two sighting and sampling vessels (SSVs) *Yushin-Maru* (*YS1*) and *Yushin-Maru* No.3 (*YS3*) engaged in the sighting and sampling survey. They were equipped with a top barrel platform (TOP), upper bridge platform (UBP), and a whaling cannon. One researcher was on board on each SSV. Biological research of the sampled whales was carried out on board the research base vessel, *Nisshin-Maru* (*NM*). A total of twelve researchers, including the cruise leader, were on board the *NM*.

Cruise track-line

Survey courses were established in offshore and ice edge waters of the research area by the line transect method. Two SSVs advanced along parallel track-lines 7n.miles apart (Main course and sub-course). Each of the SSVs changed the track-line order every day to avoid possible sighting bias by fixed position. Starting point of the day was set in principle at the position where one of the vessels ended the surveys on the previous day in the most advanced position. The other vessel moved to the starting position of the next day after the end of the daily survey.

The predetermined track-line of the sighting and sampling survey is shown in Figure 2. Track-line for each vessel consisted of two legs in the northern stratum at 1°40' longitudinal degree intervals, and four or six legs in the southern stratum at 1°40' longitudinal degree intervals in a 10° longitudinal band (Nishiwaki *et al*., 2014) except for the West-South (south of 69°S) stratum. A latitudinal zig-zag line was set for the West-South (south of 69°S)

stratum. Starting point of the survey was decided based on the pre-determined longitudinal or latitudinal line, which was selected at random in the each stratum. The interval of legs and number of legs in each stratum could be changed in consideration of progress of the survey caused by weather conditions or other factors.

Sighting and sampling protocols

Sighting protocols were the same as those in IDCR/SOWER (Matsuoka *et al*., 2003). Research effort began 60 minutes after sunrise and ended 60 minutes before sunset, with a maximum 12 hour per day (approximately 06:00–18:00). Searching activity was conducted when the weather conditions were suitable for observations: minke whale visibility better than 1.5n.miles and the wind speed less than 21knots (northern stratum) or 26knots (southern stratum). Vessel speed during the sighting survey was 11.5knots with slight adjustment to avoid vibration of the vessels. Sighting effort was conducted from the TOP (three primary observers in the TOP) and the upper bridge.

Sample size for Antarctic minke whales was set as 333 animals (GOJ, 2015). Whales were sampled using a random sampling procedure (Kato *et al*., 1989). One or two minke whales were sampled randomly from each primary sighted school using harpoons with a 30g penthrite grenade. Sampled whales were immediately transported to the research base vessel, where biological measurements and sampling were carried out.

Biological measurements and sampling

Body proportion, blubber thickness and body weight

After photographing the lateral side of each whale, a series of standard measurements was taken, including body length to the nearest 1cm and body proportion at five different points (to the nearest 1cm). Skull measurements (length and breadth to the nearest 0.1cm) were taken using a large vernier calliper. Measurements of blubber thickness were taken at two points on the lateral side of the body. Girth dimensions at axilla and umbilicus were taken from all animals. Body weights of each whale were measured using an electronic track scale (EDP-1801 and EDI-801, Yamato Scale Co., Ltd., Japan) on board the *NM* to the nearest 0.01tons. Body parts and organs were weighed using an electronic hanging scale (Kubota) and a marine scale (M1100, Marel, Iceland).

Total fat weight

Blubber weight for assessment of nutritional condition was measured from one Antarctic minke whale on each survey day using an electronic hanging scale and a marine scale.

Definition of sexual maturity

The maturity of the females was determined by the presence of at least one corpus luteum or corpus albicans in either ovary. In the case where no corpus luteum or corpus albicans was observed, the female was categorized as immature. The definition of male sexual maturity was defined preliminary based on the weight of one testis. If the testis weight was over 400g, the whale was determined as sexually mature (Kato, 1986). Reproductive status of mature female whales was classified into five categories (ovulating, pregnant, resting, lactating and "pregnant and lactating"), based upon observations of ovary, uterus, and mammary gland. Pregnancy was defined based on conceptus with placental development in the uterus. Body length and weight of foetus was measured in the same way as for adult whales.

Sampling of earplugs

Left and right earplugs were collected for age determination by the routine procedure (Omura, 1963). After removing the mandibles, the external auditory meatus was exposed using a knife for subsequent incision. The external auditory meatus was carefully cut open so as not to incise the earplug, and then the earplug was collected with glove-finger using a scalpel. Earplugs were fixed and stored in 10% formalin neutral buffer solution.

Stomach contents

Conventional stomach content records (species, amount, size of krill and freshness) were obtained from all sampled whales. Stomach contents of the fore- and main-stomach were weighed for each whale. A part of contents were sampled, and then stored in 10% formalin solution or stored at −20°C for several analyses.

Other biological samples

As a supplement for age determination, the largest baleen plates were collected from whales with *V*-shape notch on their baleen plate (Zenitani and Kato, 2010). Ocular lenses were collected from each whale and foetus, and stored at −80°C for age estimation. Skin tissue samples were collected for age-determination study based on DNA methylation analysis. Ovaries were collected and stored at −20°C, and mammary glands were collected and stored in 10% formalin neutral buffer solution for reproductive study. Tissue samples of testes were collected and fixed using 10% formalin neutral buffer solution for the histological observation. After measurements of blubber thickness (two points), blubber samples were taken from all specimen for the study of feeding ecology. Muscle, liver and blubber samples were collected and stored at −20°C for pollutant studies. Skin samples were collected and fixed in ethanol solution (99%) for genetic studies.

RESULTS AND DISCUSSION

Narrative of the cruise

Two SSVs (*YS1* and *YS3*) departed from Shimonoseki (Japan) and the *NM* departed from Innoshima on 9 November 2017 (Table 1). During transit from Japan to the research area, the sighting survey was conducted from 27 November to 7 December 2017 in the area between 20°S and 60°S outside of national EEZs. Two SSVs and one research base vessel engaged in the whale sighting and sampling survey for 83 days from 8 December 2017 to 28 February 2018. Sighting survey in medium/low latitude was conducted from 5 March to 14 March 2018 during transit from research area to Japan in the area between 20°S and 60°S outside of national EEZs. The *NM* arrived at Shimonoseki on 31 March 2018.

Geographical distribution of sampled whales

A total of 392 sightings (involving 925 individuals) of Antarctic minke whale were made by the two SSVs during survey period. Among then, a total of 333 Antarctic minke whales were caught. All whales were sampled in a random manner. Sighting positions of sampled whales are shown in Figure 3. Samples were collected from a wide range of the research area.

Sampling efficiency

A total of 333 whales was sampled from 344 targeted individuals. The technical sampling efficiency (number of sampled whales per number of targeted individuals) was 0.968. The main reason for missing was escape of the target animal into the high density sea ice area (eight cases out of 11). No struck and lost cases occurred in this survey.

Biological measurements and sampling

A total of 333 Antarctic minke whales (152 males and 181 females) were sampled, and a number of biological samples and data required for the two main objectives of NEWREP-A were obtained from each whale taken.

Sex and reproductive status of samples

Sex and reproductive status of sampled animals are shown in Table 2. Immature animals of both sex were dominant in the northern (58.8%) and southern (55.6%) strata of Area VI-East. Immature animals are also dominant in the northern and southern (north of 69°S) strata of Area VI-West (65.2%), however, maturity rate was high for both sexes (83.6% and 87.2% for males and females, respectively) and mature females were dominant in the southern (south of 69°S) stratum of Area VI-West. Apparent pregnancy rate of sampled animals was high (95.3%) and no lactating animal was observed in this survey.

Body length distribution

Summary of body length statistics and length distribution by sex and stratum are shown in Table 3 and Figure 4. The range of body length of sampled whales were 4.74m to 9.00m for males and 4.60m to 9.68m for females.

Various size of animals ranging from 4.5m to 9m were sampled in all strata excepting southern (south of 69°S) stratum of Area VI-West, where whales of more than 8m were dominant for both sexes.

Stomach contents

Table 4 shows the frequency of dominant prey species found in the forestomach, by stratum. Antarctic krill (*Euphausia superba*) was the dominant prey species in the research area. *Thysanoessa*. *sp*. was found in mainly northern strata. In the southern part of Area VI, south of 69°S, ice krill (*Euphausia crystallorophias*) was observed in three animals.

Other sampling

Summary of biological data and samples collected from each whale was shown in Table 5. During the survey, earplugs were collected from all animals. Eye lenses were also collected from all animals for the purpose of age determination based on the ratio of aspartic acid enantiomers in the lens nucleus. To conduct a feasibility study of the age determination method based on DNA methylation, tissue samples were collected from the sampled whales. Other samples such as baleen plate, prey species from stomach contents, blood, muscle, and internal organs would be used to achieve objectives of NEWREP-A.

Data and samples obtained from this survey will be validated and stored at the Institute of Cetacean Research (ICR), Japan, and they are available to national (Japan) and international scientists under established guidelines (see http://www.icrwhale.org/NEWREP-AProtocol.html).

First sighting and sampling survey in Area VI-East

Sighting and sampling survey in Area VI-East was conducted for the first time since the start of JARPA in 1987/88. The survey was conducted in the early season (December to January). Antarctic minke whales were widely distributed from offshore to the sea ice area, although the density was not so high even at the southern stratum (Figure 3). Immature individuals of both sexes dominated in both north and south strata (Table 2 and Figure 4). The obtained samples will contribute to elucidation of the stock structure of Antarctic minke whales, especially to elucidation of the eastern boundary of P-stock.

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Table 1.

Cruise narrative of the 2017/18 NEWREP-A sighting and sampling survey.

Event	Date
Departure from Japan	9 Nov. 2017
Low and middle latitudinal sighting survey	27 Nov. 2017 - 7 Dec. 2017
Whale sampling survey (VI-East)	8 Dec. 2017 - 1 Jan. 2018
Whale sampling survey (VI-West)	30 Dec. 2017 - 21 Jan. 2018
Whale sampling survey (VI-West: South of 69˚S)	22 Jan. 2018 28 Feb. 2018
Low and middle latitudinal sighting survey	5 Mar. 2018 - 14 Mar. 2018
Arrival in Japan	31 Mar. 2018

Table 2.

Sex and reproductive status of Antarctic minke whales sampled in each stratum.

		Male			Female					Total
						Mat.			Total	
Area	Stratum	Imm.	Mat.	Total	Imm.	Ovu.	Rest.	Preg.		
VI-East	North	5	3	8	5	0	0	4	4	9	17
	South	9	9	18	6	0	0	3	3	9	27
VI-West	North	16	7	23	10	0	0	2	2	12	35
	South (North of 69˚S)	21	21	42	15	0	0	3	3	18	60
	South (South of 69˚S)	10	51	61	17	1	5	110	116	133	194
Combined		61	91	152	53	1	5	122	128	181	333

Table 3.

Body length statistics of Antarctic minke whales collected during the 2017/18 NEWREP-A survey.

		Male					Female				
Area	Stratum	n	mean	S.D.	min	max	n	mean	S.D.	min	max
VI-East	North	8	6.64	1.27	5.19	8.56	9	6.60	1.88	4.60	9.07
	South	18	7.07	1.24	4.74	8.85	9	6.52	1.72	4.60	9.18
VI-West	North	23	6.89	1.30	4.76	8.72	12	6.14	1.27	5.09	9.10
	South (North of 69˚S)	42	7.21	1.36	4.92	9.00	18	6.32	1.36	4.75	9.10
	South (South of 69˚S)	61	8.08	0.72	4.96	8.97	133	8.54	0.66	5.37	9.68
Combined		152	7.46	1.23	4.74	9.00	181	7.96	1.36	4.60	9.68

Table 4.

Main prey species found in the stomach of Antarctic minke whales.

Strataum	Prey species			Empty	Broken*	Total
	Euphausia superba	*Thysanoessa spp.*	*E. crystallorophias*			
East-North	4	5	0	8	0	17
East-South	15	2	0	5	5	27
West North	11	5	0	18	1	35
West-south (North of 69˚S)	34	0	0	24	2	60
West-south (South of 69˚S)	125	0	3	59	7	194
Combined	189	12	3	114	15	333

*Broken: animals with broken stomach by harpoon.

Table 5.

Summary of data and samples collected during the 2017/18 NEWREP-A survey.

	Items	Male	Female	Total
Data	Catch date and location	152	181	333
	Photographic record of external character	152	181	333
	Record of internal and external parasites	152	181	333
	Sex and body length	152	181	333
	Body proportion for stock structure	152	181	333
	Skull measurements (length and breadth) for stock structure	150	178	328
	Body weight for feeding ecology	152	181	333
	Organ weight for feeding ecology	3	3	6
	Total fat weight for feeding ecology	29	27	56
	Diatom film record for feeding ecology	152	181	333
	Blubber thickness for feeding ecology	152	181	333
	Weight of stomach content for feeding ecology	152	181	333
	Testis weight for reproductive study	152	-	152
	Mammary gland: lactation status and measurement for reproductive study	-	181	181
	Foetal number, sex, length and weight for reproductive study	59	58	122*
	Observation of marine debris (stomach)	152	181	333
	Gross pathological observation and sampling	152	181	333
Samples	Prey species in stomach for feeding ecology	35	24	59
	Testis for reproductive study	152	-	152
	Ovary for corpora counting and reproductive study	-	181	181
	Mammary grand for reproductive study	-	181	181
	Earplug for age determination	152	181	333
	Ocular lens for age determination	152	181	333
	Skin tissue samples for age determination	2	3	5
	Baleen plates for age determination	29	28	57
	Tissue samples for genetic study	152	181	333
	Tissue and organ samples for chemical study	152	181	333
	Tissue and plasma samples for physiological study	118	147	265
	Vertebral epiphyses for growth study	102	141	243

* Including five fetus of sex undetermined.

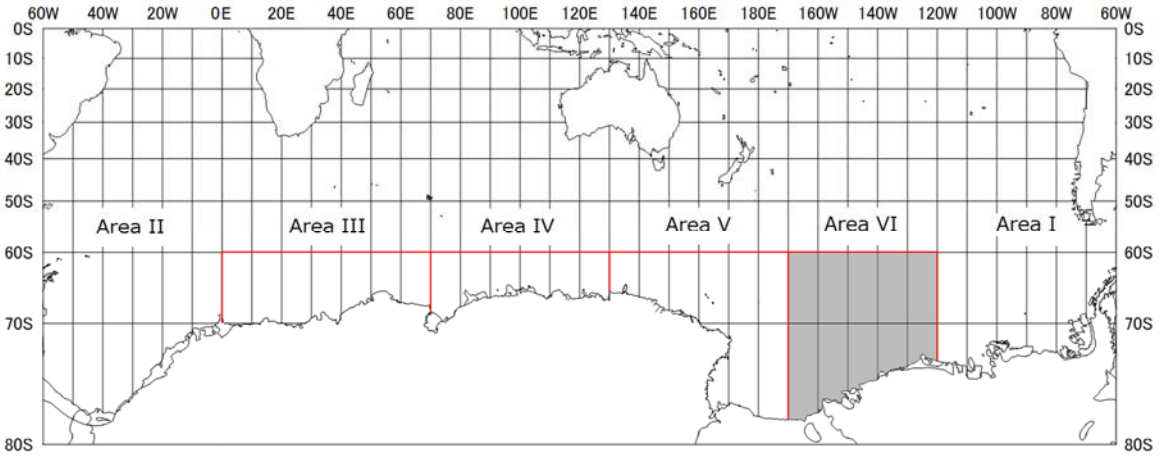

Figure. 1. Research area of the 2017/18 NEWREP-A sighting and sampling survey.

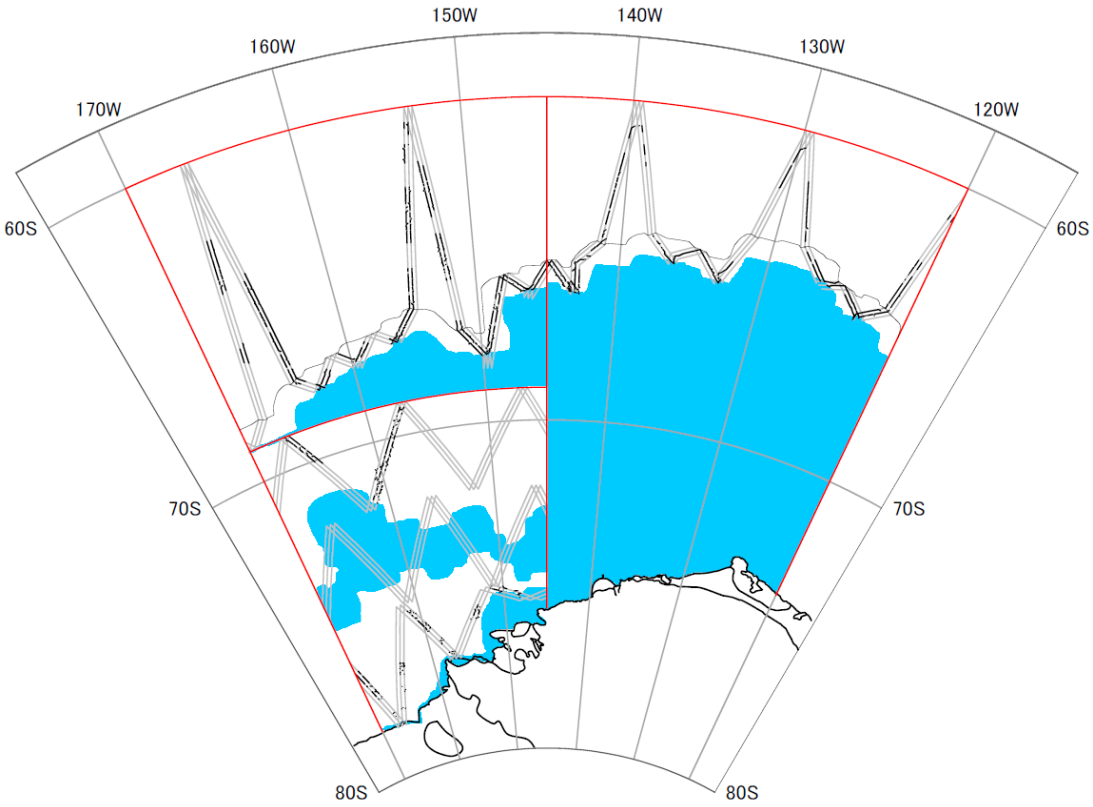

Figure 2. Pre-determined (gray) and actually covered (bold black) track lines made by two SSVs. The light blue area shows sea-ice distribution.

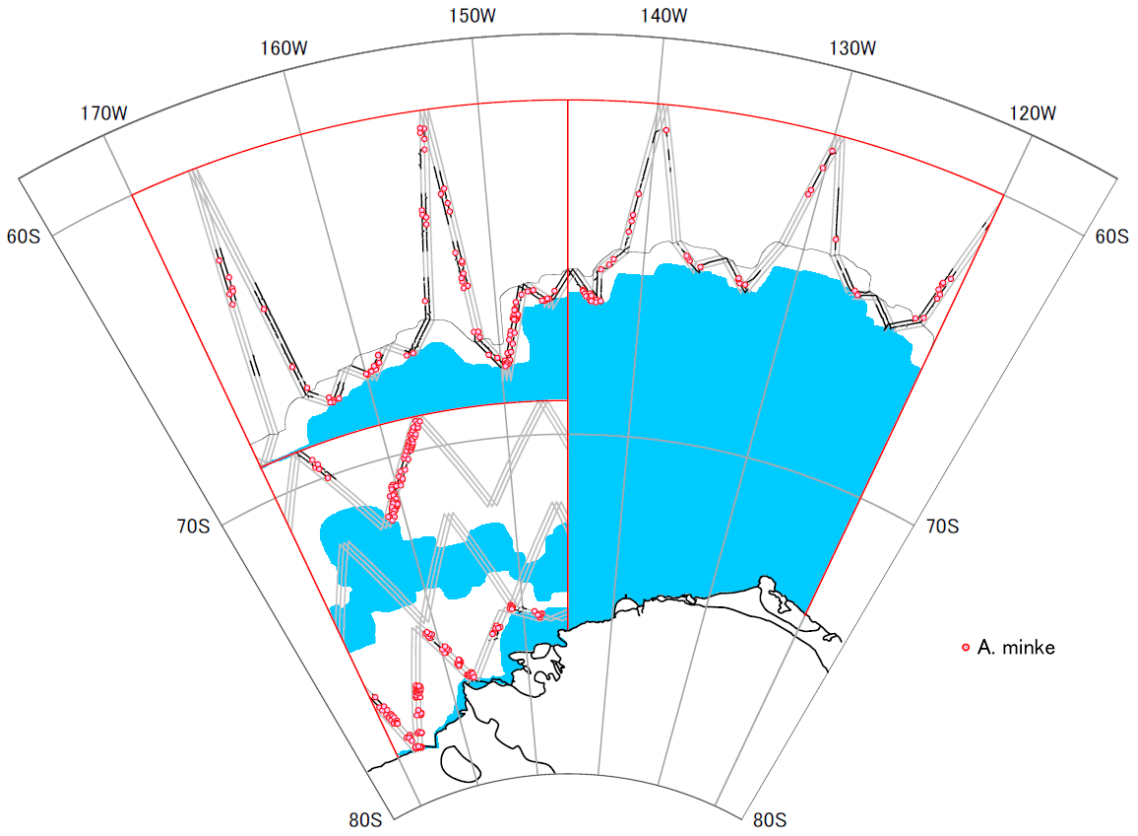

Figure 3. Sighting positions of sampled Antarctic minke whales.

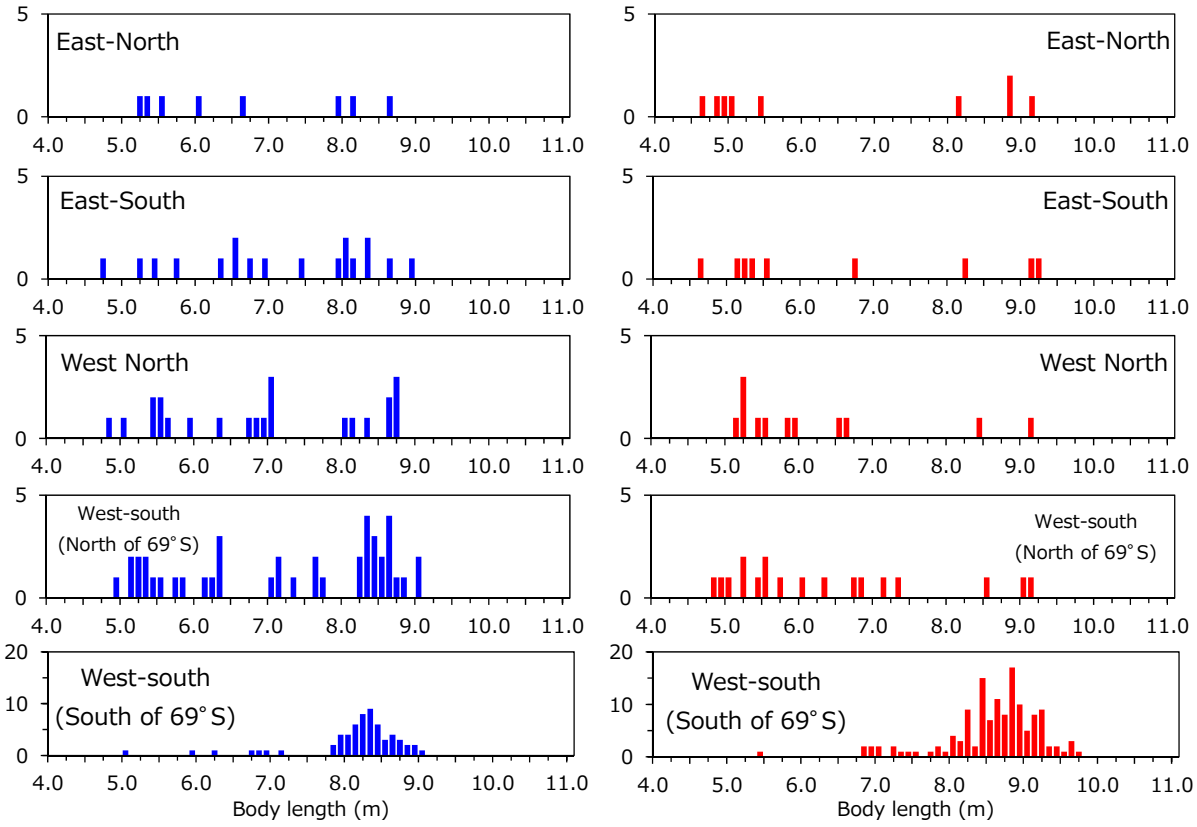

Figure 4. Body length distribution of Antarctic minke whales sampled in each stratum.

APPENDIX

Sighting results by the sighting and sampling vessels during the 2017/18 NEWREP-A survey in Area VI (170°W-120°W)

IDENTIFICATION OF SPECIES

Guidelines for species identification were based on the IWC-SOWER methods for classification of identification (IWC, 2008): 'Positive identification of species was based on multiple cues and usually required clear observation of the whale's body. Occasionally, repeated observations of the shape of the blow, surfacing, and other behavioural patterns were sufficient; this judgement was made only by the Cruise leader or other designated researcher. Identification of species was recorded as 'probable' based on multiple cues, which were nevertheless insufficient to be absolutely confident of identification. This usually occurred when blows and surfacing patterns could be confirmed, but the whale's body could not be clearly seen. Details of recording procedures during sightings can be found in 'Information for Researchers''. From initial observations of morphologic characteristics, killer whale (*Orcinus orca*) data were divided into three ecotypes (Pitman and Ensor, 2003).

DETERMINATION OF GROUP SIZE

The following guidelines were used in determining group size (IWC, 2008): 'Schools where the number of animals or an accurately estimated range of the number of animals was determined, were classified as confirmed schools. Data from the confirmed schools can be used to determine a mean school size. Therefore, it is critical that the confirmed schools accurately represent the size of schools in the survey area. Normally, schools believed to be confirmed for school size are approached to within 1 n. mile for large whales and to within 0.3 n. miles for Antarctic minke whales (*Balaenoptera bonaerensis*). Allowing for context-specific differences (i.e. environmental conditions and animal behaviour), every effort was made to be consistent with regard to the maximum time spent on the identification of species and confirmation of numbers. Normally, if the sighting was thought to be Antarctic minke whales, no more than 20 minutes (after the closure has been completed) should be spent on confirmation. This reduces the potential for confusion with other sightings in the vicinity. Counts of individuals provided by the sighting summary represent best estimates of school sizes in the research area, except when indicated otherwise.

OTHER RESEARCH ACTIVITIES

Photo-ID

Photo-ID data of individual whales was collected for stock structure analyses as well as examining mixing and movements during the research period. Data were captured by digital photograph using Digital camera (300mm lens, Canon Co., Ltd., Japan). Target species for Photo-ID were blue whale (*B. musculus*), humpback whale (*Megaptera novaeangliae*), southern right whale (*Eubalaena australis*), and killer whale.

Biopsy sampling for large whales

Samples of skin biopsy were collected by biopsy from the target whales. The target species were blue whale, fin whale (*B. physalus*), sei whale (*B. borealis*), southern right whale, sperm whale (*Physeter macrocehpalus*), killer whale, pygmy right whale (*Caperea marginata*), and southern bottlenose whale (*Hyperoodon planifrons*) sighted in the research time. The system for biopsy sampling was a Larsen system (Larsen, 1998). The open sight was replaced with an electronic aiming device (red-dot-sight), which allows faster aiming and thus faster shooting. The biopsy darts consisted of a carbon fibre shaft, which is high-pressure moulded to a polyethylene float that also functions as a stop to limit penetration into the tissue. In the float end of the dart, a threaded insert is used for attaching the screw-on biopsy-sampling tip. The biopsy tip is a stainless steel cylinder with a 9mm outer diameter, an internal diameter of 7mm and three internal barbs for sample retention. All collected samples were stored at −20°C.

Feasibility study on satellite tracking of Antarctic minke whale

A feasibility study on satellite tracking of Antarctic minke whales was carried out by the SSV during the sighting and sampling survey. Results of the feasibility study are presented by Mogoe *et al*. (2018).

RESULT

Sightings

The searching effort is summarised in Table 1. The WP of the SSV's track-line of sighting and sampling survey is shown in Table 2. Total searching distance in the research area was 4,164 n.miles (main and sub course). The sighting records are not suitable for design-based abundance estimation as the sighting records of the sampling and survey vessels were made by NSC mode using TOP and UBP except for examination of the distribution of specified species using model-based estimation. The sightings recorded in the sighting and sampling survey are shown in Table 3. Figures 1a–b show the geographical distribution of large whales sighted in survey. In Area VI, Antarctic minke whales were the most abundant species followed by humpback and fin whales (Table 3).

Antarctic minke whale were found in a wide area from the ice edge to offshore in the Area VI with a high density area in the West-South (south of 69°S) stratum. Humpback and fin whales were also found in wide area in northern strata (north of 69°S), however, they were not found in the West-South (south of 69°S) stratum.

Effort was made to identify killer whales into three ecotypes (types A, B and C) based on differences of morphological characteristics. A total of 10 schools (51 individuals) were sighted. Only one school was identified to an ecotype due to the difficulty of approaching the whales. Others were recorded as 'killer whales (undetermined)'. One school consisting of nine individuals was identified as type A. Further observation, experiments, and analysis of this species will be continued during the next cruise under this programme.

Photo ID and biopsy

Photo-ID data was obtained from two blue, four humpback and one killer whale. In terms of biopsy skin sampling, one sample was collected from blue whale. The number of Photo-ID and biopsy samples are summarised in Table 4. The records will provide useful data for understanding the stock structure, mixing and movements of these species. These data will be submitted to the IWC secretary and will be analysed by comparing previous IWC and other relevant catalogues (e.g. Olson, 2012, Matsuoka and Pastene, 2009). Biopsy samples obtained during surveys of the NEWREP-A 2017/18 will be used for microsatellite DNA loci analysis for studies of stock structure in the Antarctic feeding ground. Biopsy samples may also be used for other research (e.g. chemical markers as body condition indicator, stable isotope, or hormones).

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Table 1

Summary of research effort (n. miles) conducted by the two SSVs during the 2017/18 NEWREP-A survey. *NSC* mode represents sighting and sampling survey and *ASP* mode represents sighting survey. *BC* and *BI* means survey under normal and sea ice condition, respectively.

		Survey mode				Total
		NSC		*ASP*		
Area	Stratum	*BC*	*BI*	*BC*	*BI*	
VI-East	North	576	0	0	0	576
	South	617	279	0	0	896
VI-West	North	1,296	19	0	0	1,315
	South (North of 69˚S)	594	281	0	0	875
	South (South of 69˚S)	394	55	53	1	502
Combined		3,477	634	53	1	4,164

Table 2

Predetermined waypoints (WP) and the actually covered (main course) ratio of sighting and sampling survey.

Stratum	WP	Latitude	Longitude	Leg No.	Distance	Effort	Covered (%)
East-North	401	60°54'S	120°00'W	401	218.7	96.5	44.1
	402	64°30'S	121°21'W	-	-	-	-
	406	63°30'S	128°01'W	406	215.3	106.9	49.6
	407	60°00'S	129°41'W	407	220.1	79.5	36.1
	408	63°35'S	131°21'W	-	-	-	-
	412	64°05'S	138°01'W	412	249.4	38.0	15.2
	413	60°00'S	139°41'W	413	274.0	163.5	59.7
	414	64°30'S	141°21'W	-	-	-	-
	Total				1177.6	484.3	41.1
West-North	421	67°05'S	151°21'W	421	427.3	150.7	35.3
	422	60°00'S	153°01'W	422	377.7	180.8	47.9
	423	66°15'S	154°41'W	-	-	-	-
	429	67°30'S	164°41'W	429	452.1	168.4	37.2
	430	60°00'S	166°21'W	430	496.9	119.8	24.1
	431	68°15'S	168°01'W	-	-	-	-
	Total				1754.0	619.7	35.3
East-South	302	64°30'S	121°21'W	302	54.2	49.4	91.2
	303'	65°02'S	123°01'W	-	-	-	-
	303	65°00'S	123°01'W	303	62.2	58.8	94.6
	304	64°15'S	124°41'W	304	52.8	31.7	60.0
	305'	64°23'S	126°21'W	-	-	-	-
	305	64°30'S	126°21'W	305	68.9	51.7	75.1
	306	63°30'S	128°01'W	-	-	-	-
	308	63°35'S	131°21'W	308	109.9	49.1	44.7
	309'	65°15'S	133°01'W	-	-	-	-
	309	65°05'S	133°01'W	309	69.6	66.2	95.1
	310	64°20'S	134°41'W	310	61.5	63.1	102.5
	311'	64°54'S	136°21'W	-	-	-	-
	311	64°40'S	136°21'W	311	65.3	39.7	60.8
	312	64°05'S	138°01'W	-	-	-	-
	314	64°30'S	141°21'W	314	113.4	93.6	82.6
	315'	66°05'S	143°01'W	-	-	-	-
	315	65°10'S	143°01'W	315	72.9	56.8	77.9
	316	65°05'S	144°41'W	316	15.7	14.3	91.2
	317	65°19'S	145°00'W	-	-	-	-
	Total				746.3	574.4	77.0

Table 2

Continued.

Stratum	WP	Latitude	Longitude	Leg No.	Distance	Effort	Covered (%)
West-South	317	65°19'S	145°00'W	317	80.6	48.9	60.6
(north of 69°S)	318′	66°15'S	146°21'W	318	50.9	45.0	88.5
	318	66°00'S	146°21'W	-	-	-	-
	319	65°30'S	148°01'W	319	199.5	114.5	57.4
	320'	67°55'S	149°41'W	-	-	-	-
	320	68°20'S	149°41'W	320	63.0	54.0	85.7
	321	67°05'S	151°21'W	-	-	-	-
	323	66°15'S	154°41'W	323	67.8	60.3	89.0
	324	67°10'S	156°21'W	324	46.5	14.5	31.1
	325	66°45'S	158°01'W	325	72.3	25.5	35.3
	326'	67°35'S	159°41'W	-	-	-	-
	326	67°40'S	159°41'W	326	48.9	0.2	0.5
	327	67°05'S	161°21'W	327	67.0	35.6	53.1
	328	68°00'S	163°01'W	328	48.3	15.9	32.8
	329	67°30'S	164°41'W	-	-	-	-
	331	68°15'S	168°01'W	331	57.9	0.0	0.0
	332	69°00'S	169°41'W	332	10.8	0.0	0.0
	333	68°52'S	170°0'W	333	-	-	-
	Total				813.4	414.4	50.9
West-South	701	70°52'S	170°00'W	701	128.6	0.0	0.0
(south of 69°S)	702	69°00'S	166°58'W	702	205.9	61.6	29.9
	703	72°00'S	161°58'W	703	205.9	94.1	45.7
	704	69°00'S	156°58'W	704	205.9	0.0	0.0
	705	72°00'S	151°58'W	705	205.9	0.0	0.0
	706	69°00'S	146°58'W	706	84.7	0.0	0.0
	707	70°14'S	145°00'W	707	-	-	-
	721	74°25'S	170°00'W	721	160.8	0.0	0.0
	722	72°00'S	166°02'W	722	199.1	0.0	0.0
	723	75°00'S	161°02'W	723	199.1	0.0	0.0
	724	72°00'S	156°02'W	724	199.1	0.0	0.0
	725	75°00'S	151°02'W	725	199.1	0.0	0.0
	726	72°00'S	146°02'W	726	44.1	0.0	0.0
	727	72°40'S	145°00'W	727	-	-	-
	741	76°28'S	170°00'W	741	127.8	38.9	30.4
	742	78°30'S	166°02'W	742	220.9	3.7	1.7
	743	75°00'S	161°02'W	743	140.2	33.1	23.6
	744	77°00'S	156°02'W	744	140.2	14.8	10.6
	745	75°00'S	151°02'W	745	82.1	11.9	14.5
	746	75°30'S	146°02'W	746	31.7	0.0	0.0
	747	75°18'S	145°00'W	747	-	-	-
	Total				2780.9	258.1	9.3

Table 3

Species and number of whales sighted in the Area VI (170°W-120°W) by the two SSVs during the 2017/18 NEWREP-A survey.

	Stratum (Area VI)																							
	East-North				East-South				West-North				West-South (North of 69°S)				West-South (South of 69°S)				Total				
	Primary		Secondary		Primary		Secondary		Primary		Secondary		Primary		Secondary		Primary		Secondary		Primary		Secondary		Total
Species	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Ind.
Blue whale	1	2	0	0	2	3	0	0	1	1	0	0	0	0	1	2	3	5	0	0	7	11	1	2	13
Fin whale	14	19	0	0	12	31	0	0	50	120	0	0	36	97	0	0	3	5	0	0	115	272	0	0	272
Antarctic minke whale	18	18	0	0	33	43	3	4	34	39	1	1	66	82	6	6	207	632	24	100	358	814	34	111	925
Like minke	0	0	0	0	1	1	0	0	1	1	0	0	4	9	0	0	3	25	1	1	9	36	1	1	37
Humpback whale	25	41	1	2	54	69	0	0	85	144	2	3	40	54	1	4	0	0	0	0	204	308	4	9	317
Baleen whale	8	16	0	0	7	10	0	0	23	60	0	0	11	31	0	0	1	1	0	0	50	118	0	0	118
Sperm whale	0	0	0	0	15	15	0	0	8	8	0	0	14	14	1	1	0	0	0	0	37	37	1	1	38
Southern bottlenose whale	0	0	0	0	1	1	0	0	2	2	0	0	0	0	0	0	0	0	0	0	3	3	0	0	3
Killer whale (type A)	0	0	0	0	0	0	0	0	1	9	0	0	0	0	0	0	0	0	0	0	1	9	0	0	9
Killer whale (undetermined)	1	2	0	0	2	6	0	0	1	2	0	0	3	8	0	0	2	24	0	0	9	42	0	0	42

Table 4

Summary of biopsy and photo-ID experiment conducted by the SSVs.

Species	Photo-ID	Biopsy
Blue whale	2	1
Humpback whale	4	0
Killer whale	1	0

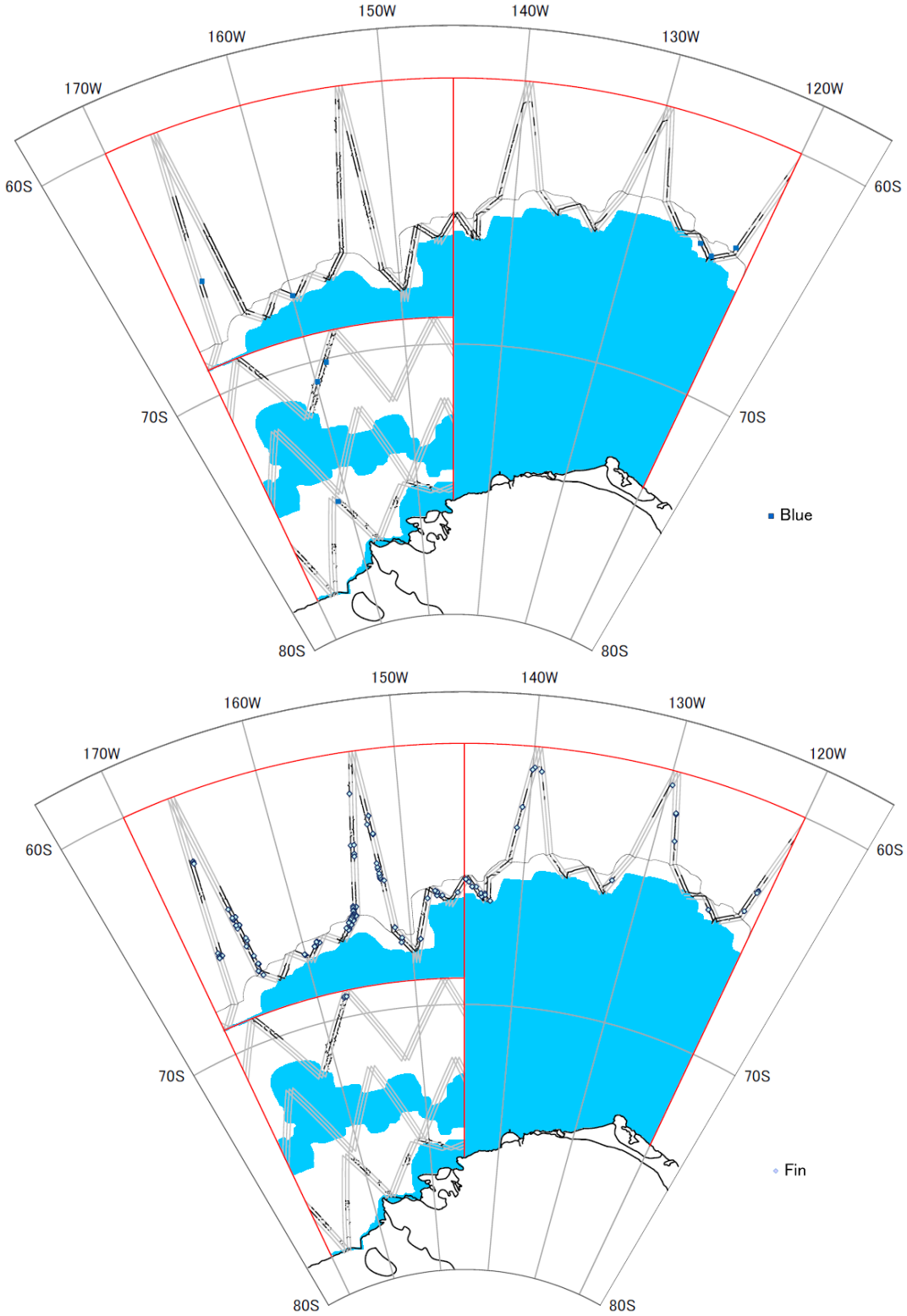

Figure 1a. Geographical distribution of primary sighting position of blue (upper) and fin (lower) whales sighted in the 2017/18 NEWREP-A sighting and sampling survey. The gray line shows pre-determined track-lines and black bold line shows on-effort lines. The light blue area shows sea-ice distribution.

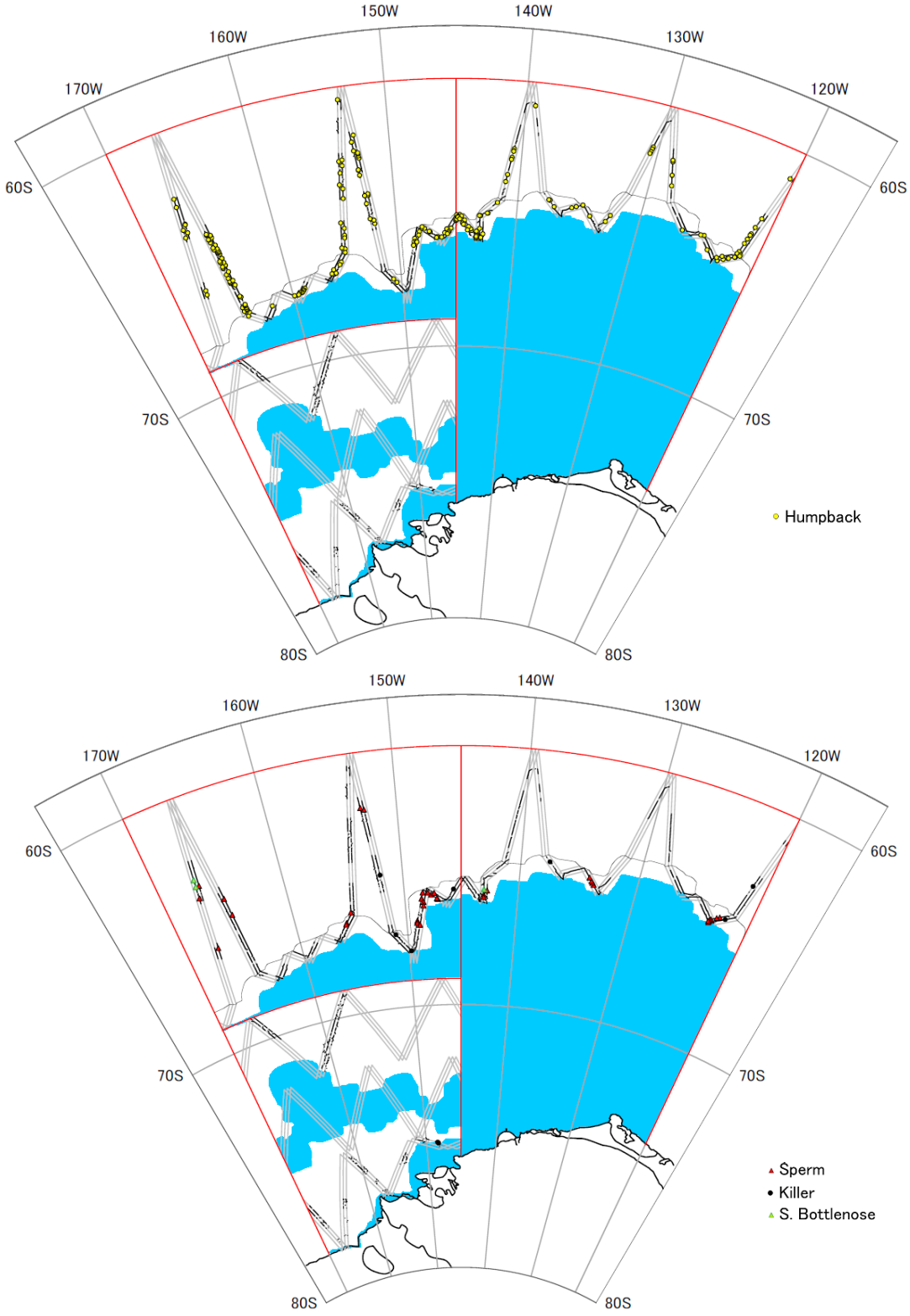

Figure 1b. Geographical distribution of primary sighting position of humpback (upper), sperm, killer and southern bottlenose (lower) whales sighted in the 2017/18 NEWREP-A sighting and sampling survey. The gray line shows pre-determined track-lines and black bold line shows on-effort lines. The light blue area shows sea-ice distribution.