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Results of the dedicated sighting survey under the Japanese Abundance and Stock structure Surveys in the Antarctic (JASS-A) in the eastern part of Area VI in the 2021/2022 austral summer season

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ABSTRACT

The results of the sighting survey of the Japanese Abundance and Stock structure Surveys in the Antarctic (JASS-A) in the 2021/2022 austral summer season are reported. A dedicated sighting vessel was engaged in the line transect method survey in the eastern part of Antarctic Area VI East (130°W–120°W) for 33 days, from 11 January to 12 February 2022. For the survey, the research area was divided into northern and southern strata. In addition, surveys were conducted successfully in coastal ice-free waters, south of 72°S, an area that is normally covered by pack-ice and difficult for vessels to access. The total searching distance in the research area was 1,333.5 n.miles (2,469.6 km). Four baleen whale species and at least four toothed whale species were sighted in the research area. Other research activities such as biopsy sampling, photo-ID, satellite tagging, and oceanographic observations were also conducted. The data and samples collected are required for the main and secondary research objectives of JASS-A.

INTRODUCTION

Long-term systematic surveys on whales and the ecosystem in the Antarctic, such as the JARPA/JARPAII[1], NEWREP-A[2], and IDCR/SOWER[3], obtained important data pertaining to the study of abundance and abundance trends of large whales and their biology as well as the role of whales in the Antarctic ecosystem. All these research programs have been terminated. The last NEWREP-A survey was carried out in the 2018/2019 austral summer season.

The Japanese Abundance and Stock structure Surveys in the Antarctic (JASS-A) commenced in the 2019/2020 austral summer season because it was considered important to continue with the whale and ecosystem surveys in the Indo-Pacific region of the Antarctic Ocean through dedicated sighting surveys and other non-lethal research techniques. JASS-A has two main research objectives, i) the study of the abundance and abundance trends of large whale species, and ii) the study of the distribution, movement, and stock structure of large whale species. JASS-A also has several secondary research objectives related to oceanography, marine debris, genetic data to estimate abundance, whale biology, and study on the utility of Unmanned Aerial Vehicle (UAV). The JASS-A program was presented to the 2019 meeting of IWC SC[4] (GOJ, 2019a), the 2019 meeting of CCAMLR-EMM[5] (GOJ, 2019b), and the 2019 meeting of NAMMCO SC[6] (GOJ, 2019c).

The approach of JASS-A is systematic vessel-based sighting surveys utilizing the 'line transect method'. Surveys are designed and conducted following the protocols included in the 'Requirements and Guidelines for Conducting Surveys and Analysing Data within the Revised Management Scheme' (IWC, 2012). Sighting protocols are the same as those used in the former IDCR/SOWER surveys (Matsuoka *et al.*, 2003). The JASS-A surveys are conducted alternatively in IWC Management Areas III, IV, V, and VI by one or two specialized vessels, over a tentative period of eight austral summer seasons.

[1] Japanese Whale Research Programs under Special Permit in the Antarctic, Phases I and II

[2] New Scientific Whale Research Program in the Antarctic Ocean

[3] International Decade for Cetacean Research/Southern Ocean Whale and Ecosystem Research

[4] International Whaling Commission-Scientific Committee

[5] Commission for the Conservation of Antarctic Marine Living Resources-Working Group on Ecosystem Monitoring and Management

[6] North Atlantic Marine Mammal Commission-Scientific Committee

The first and second JASS-A surveys were carried out in the 2019/2020 and 2020/2021 austral summer seasons and covered the sector 000°–035°E of Antarctic Area III West. The third survey was carried out during the 2021/2022 season and covered the sector 130°W–120°W of Antarctic Area VI East. This paper presents a summary of the 2021/2022 JASS-A survey results. The Appendix shows photographs of whales, experiments and Antarctic environment taken during the 2021/2022 survey.

SURVEY DESIGN

Research area

The research area of JASS-A is comprised of IWC Management Areas III, IV, V, and VI, south of 60°S (Figure 1). The research area in the 2021/2022 season was the eastern part of Antarctic Area VI East (130°W–120°W), south of 60°S (Figure 1). The area was divided into northern and southern strata. The boundary between these strata was defined by a line 45 n.miles from the northern edge of the pack-ice (Figure 2). In addition, an area of ice-free waters (polynya) was formed between the southern edge of the pack-ice and the ice shelf, south of 72°S in early January (Figure 2). Details of the ice configuration are shown in Figure 3. The ice-free waters (in the range of 125°W to 110°W) became accessible to the vessel in early February.

Research vessel

The dedicated sighting vessel *Yushin-Maru* No. 2 (*YS2)* was engaged in the survey. Its specifications are indicated in Figure 4. Three Japanese researchers participated in the survey. They had experience in conducting line transect surveys, biopsy sampling, photo-identification (photo-ID), satellite tagging, and oceanographic survey in the Antarctic through the previous JARPA/JARPAII and NEWREP-A programs.

Sighting procedures, mode and experiments

See Isoda *et al.* (2022) for details of the procedures used for sighting surveys and other research activities such as sighting distance and angle experiment, photo-ID, biopsy sampling, satellite tagging, oceanographic survey, marine debris observation, and survey using UAV.

RESULTS OF THE SURVEY

Narrative of the survey

Table 1 shows the itinerary of the survey. The duration of this cruise was 109 days. The *YS2* departed Shiogama, Japan on 3 December 2021, arriving back at the home port on 20 December 2021. The *YS2* started the sighting survey in Antarctic Area VI East at 68°37′S; 120°00′W on 11 January. The survey was completed at 73°51′S; 120°00′W on 12 February. The *YS2* arrived back at the home port on 1 March and in Japan on 21 March.

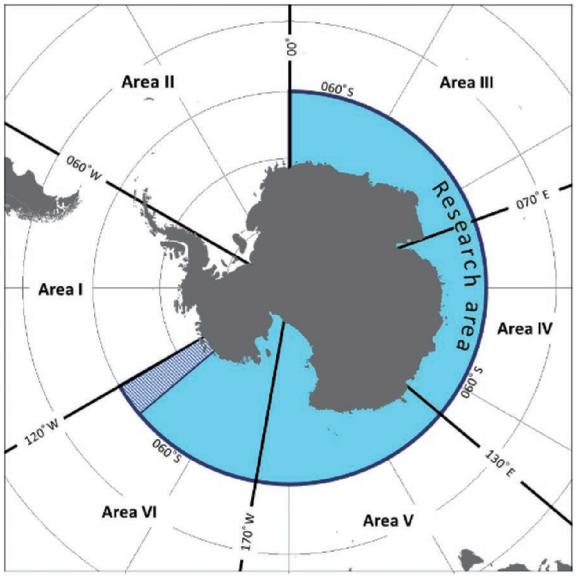

Figure 1. Research area of JASS-A. The shaded area (130°W–120°W) indicates the surveyed area in the 2021/2022 austral summer season.

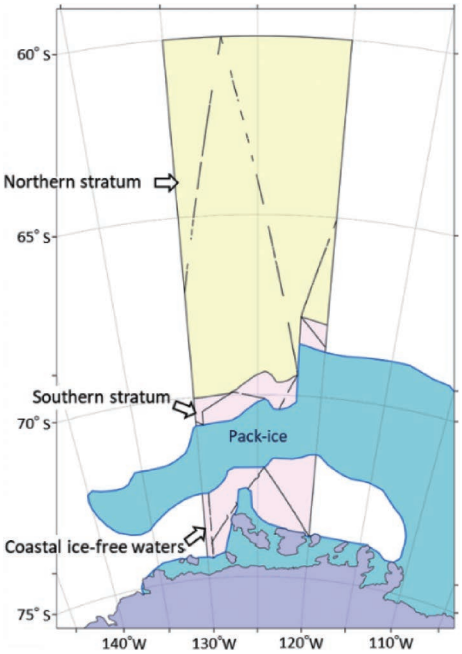

Figure 2. Research area (130°W–120°W) indicating northern and southern strata, and searching efforts (black lines) of the JASS-A survey in 2021/2022 austral summer season. The research commenced at 68°37′S; 120°00′W and ended at 73°51′S; 120°00′W. Note the ice-free waters south of 72°S.

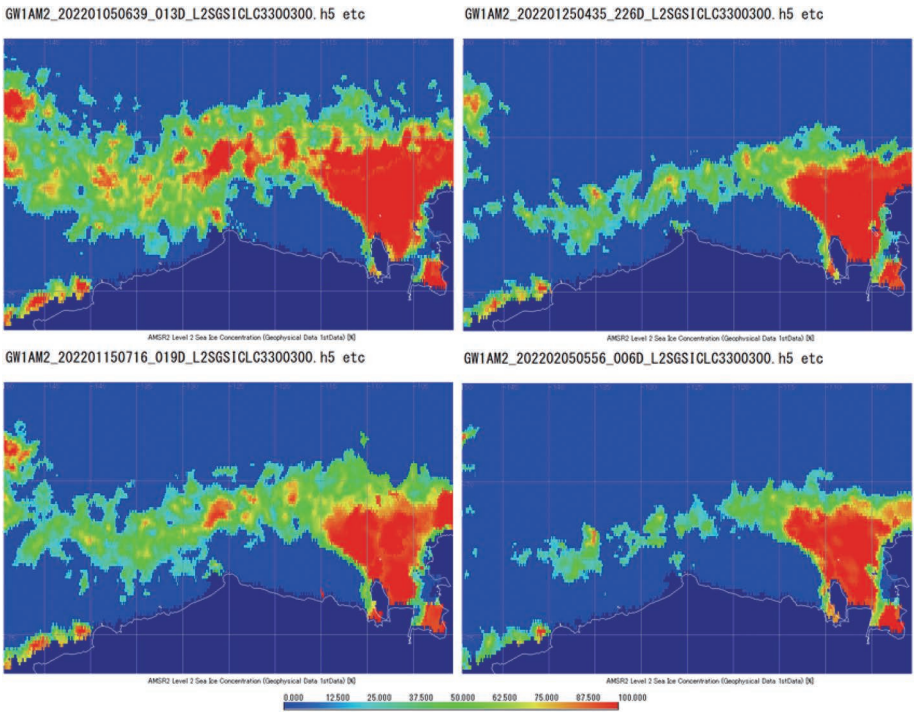

Figure 3. Maps of the pack-ice distributions in the research area for dates 5 January (upper left), 15 January (lower left), 25 January (upper right) and 5 February (lower right) 2022, constructed by Japan Aerospace Exploration Agency (JAXA), based on observational data acquired by the Advanced Microwave Scanning Radiometer 2 (AMSR2). Note that the ice-free waters became accessible to the vessel in early February.

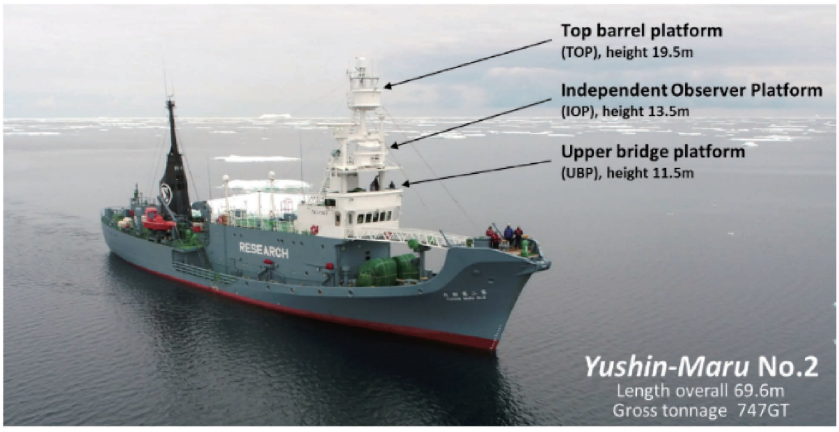

Figure 4. The dedicated sighting vessel *Yushin-Maru* No. 2 and its three observation platforms: top barrel platform (TOP), Independent Observer Platform (IOP) and Upper Bridge Platform (UBP).

Research effort in the research area

Table 2 shows a summary of the searching effort spent during the survey. The *YS2* was engaged in the research for 33 days, from 11 January to 12 February 2022. The total searching effort was 1,333.5 n.miles (2,469.6 km); 659.0 n.miles in NSP mode during 60 hour 27 minutes of research and 674.4 n.miles in IO mode during 62 hour 21 minutes of research. In the northern stratum, the total searching effort was 731.2 n.miles (NSP: 322.7 n.miles; IO: 408.5 n.miles), and the searching effort coverage was 62%. In the southern stratum, the total searching effort was 254.6 n.miles (NSP: 145.8 n.miles; IO: 108.8 n.miles), and the searching effort coverage was 92%. In the coastal ice-free waters, the total searching effort was 347.7 n.miles (NSP: 190.5 n.miles; IO: 157.2 n.miles), and the searching effort coverage was 83%.

Therefore, a good distribution of effort within both strata and survey mode was achieved. The total experimental time for photo-ID, biopsy sampling, tagging, and distance and angle experiment was 22 hours 00 minutes.

Table 1
Itinerary of the 2021/2022 JASS-A dedicated sighting survey.

Date (y/m/d)	Event
2021/11/16	Planning meeting at Tokyo, Japan
2021/12/2	Pre-cruise meeting in Shiogama, Japan
2021/12/3	*YS2* departed Shiogama, Japan
2021/12/13	Transit survey started at 0°00′; 163°00′E
2021/12/20	*YS2* arrive at the home port
2022/1/11	Transit survey finished and survey started in the research area at 68°37′S; 120°00′W
2022/2/12	Survey completed in the research area (33 days) and transit survey start at 73°51′S; 120°00′W
2022/3/1	*YS2* arrive at the home port
2022/3/9	Transit survey completed at 0°00′; 163°00′E
2022/3/21	*YS2* arrived in Japan and post cruise meeting carried out in Shiogama, Japan

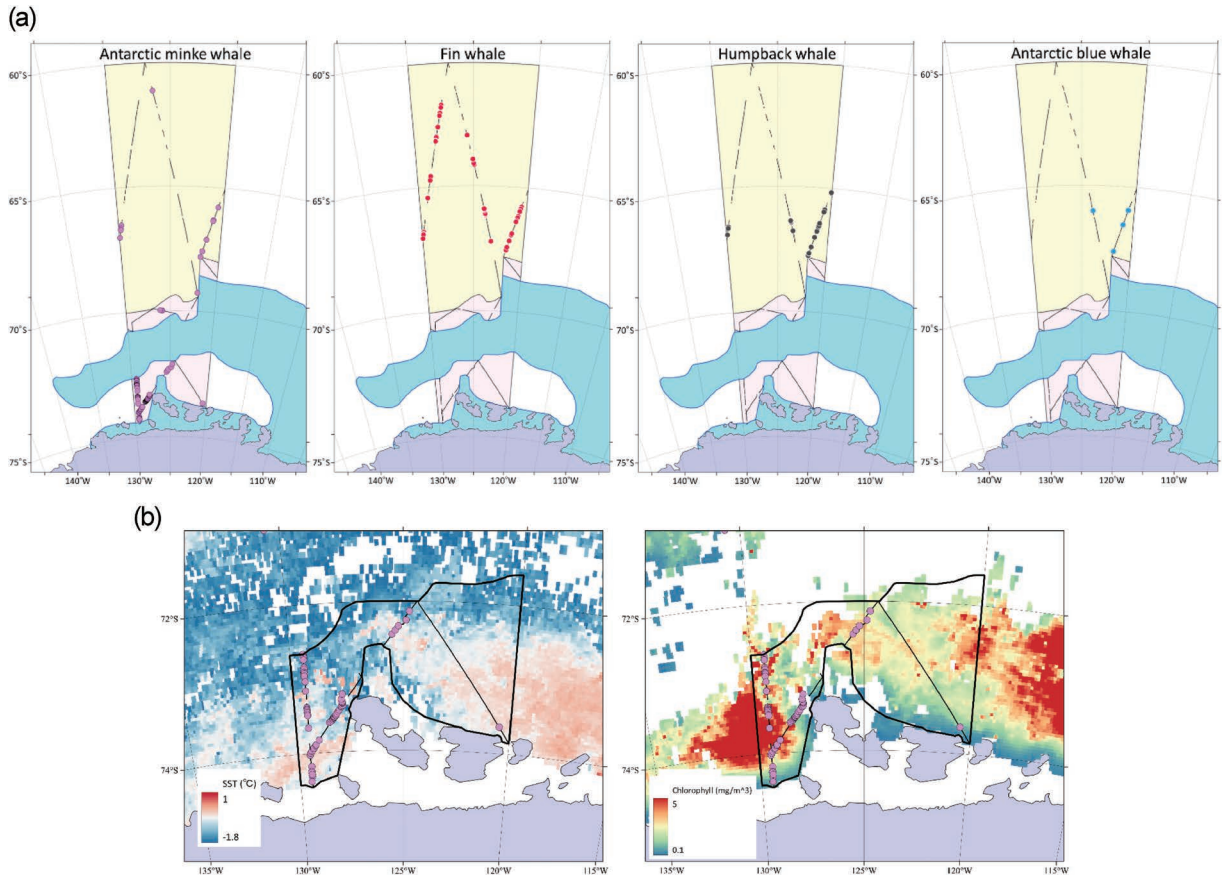

Figure 5 (a) Geographical distribution of primary sightings of Antarctic minke, fin, humpback, and Antarctic blue whales. (b) The distribution of Antarctic minke whales (pink circle) in the ice-free waters. Rolling 32 days average sea surface temperature (left) and chlorophyll concentration (right) from 17 January to 17 February 2022 were observed by MODIS-Aqua and MODIS-Terra (Original data: Ocean colour web, from https://oceancolor.gsfc.nasa.gov/ (Accessed 2022-7-30)). Note that sea surface temperature was lower and chlorophyll concentration was higher in the western part, where the density of Antarctic minke whales was high.

Whale sightings in the research area

Four baleen whale species and at least four toothed whale species were sighted in the research area. The dominant whale species in the research area was the Antarctic minke whale (83 schools/142 individuals) followed by the fin whale (44/64). Sightings of other species were as follows: humpback (26/36), Antarctic blue (5/6), sperm (9/10), Arnoux's beaked (1/8), southern bottlenose (1/1), killer (5/71, include Types B, C and undetermined type) and Ziphiidae (4/6) whales (Table 3).

Table 2
Summary of searching effort (time and distance) and time (hours) spent during the 2021/2022 JASS-A survey.

Survey Sections	Date and time		Searching effort (distance [n.miles] and time [hours:minutes:seconds])				Experiment time [hours:minutes:seconds]	
	Start	End	NSP		IO		Photo-ID, Biopsy, Satellite tag experiment	Estimated angle and distance training/ experiment
Transit survey (0°00–Entering foreign countries EEZ)	2021/12/13 14:59	2021/12/18 18:00	124.2	10:44:29	—	—	0:14:08	—
Transit survey (Leaving foreign countries EEZ–Research area)	2021/12/26 8:35	2022/1/11 9:02	579.9	50:46:32	—	—	2:55:24	1:40:57
Research area (Area VIE 130°W–120°W)	2022/1/11 9:02	2022/2/1 18:08	468.5	43:18:40	517.2	47:36:56	13:18:08	3:44:27
Navigation/transit survey to the coastal ice-free waters, south of 72°S	2022/2/1 18:08	2022/2/8 14:06	—	—	—	—	3:56:13	—
Coastal ice-free waters, south of 72°S (130°W–120°W)	2022/2/8 14:06	2022/2/12 10:03	190.5	17:08:29	157.2	14:44:45	1:02:08	—
Transit survey (Research area–Entering foreign countries EEZ)	2022/2/12 10:03	2022/2/22 17:05	782.2	67:39:37	—	—	6:20:12	—
Transit survey (Leaving foreign countries EEZ–0°00)	2022/3/8 6:30	2022/3/9 12:05	177.9	14:45:22	—	—	—	—
Total	2021/12/13 14:59	2022/3/9 12:05	2323.2	204:23:09	674.4	62:21:41	27:46:13	5:25:24

Table 3
Number of sightings made during the 2021/22 JASS-A survey in the research area, by stratum and species.

Species	Eastern part of Area VIE (130°W–120°W)												Sub-total				Total	
	Southern stratum				Northern stratum				Coastal ice-free waters, south of 72°S									
	Prim.		Second.		Prim.		Second.		Prim.		Second.		Prim.		Second.			
	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.
Antarctic blue whale	0	0	0	0	4	5	1	1	0	0	0	0	4	5	1	1	5	6
Fin whale	0	0	0	0	41	60	3	4	0	0	0	0	41	60	3	4	44	64
Like fin	0	0	0	0	1	1	0	0	0	0	0	0	1	1	0	0	1	1
Antarctic minke whale	4	6	0	0	11	13	1	1	64	119	3	3	79	138	4	4	83	142
Like minke	0	0	0	0	0	0	0	0	2	2	1	2	2	2	1	2	3	4
Humpback whale	0	0	0	0	18	24	8	12	0	0	0	0	18	24	8	12	26	36
Like humpback	0	0	0	0	2	2	0	0	0	0	0	0	2	2	0	0	2	2
Baleen whale	1	1	0	0	2	2	0	0	0	0	0	0	3	3	0	0	3	3
Sperm whale	5	5	0	0	3	4	1	1	0	0	0	0	8	9	1	1	9	10
Southern bottlenose whale	1	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	1
Arnoux's beaked whale	0	0	0	0	0	0	0	0	1	8	0	0	1	8	0	0	1	8
Killer whale (undetermined type)	0	0	0	0	0	0	0	0	3	44	0	0	3	44	0	0	3	44
Killer whale (type B)	1	21	0	0	0	0	0	0	0	0	0	0	1	21	0	0	1	21
Killer whale (type C)	0	0	0	0	0	0	0	0	1	6	0	0	1	6	0	0	1	6
Ziphiidae	1	1	0	0	2	3	1	2	0	0	0	0	3	4	1	2	4	6
Unidentified whale	0	0	0	0	3	3	0	0	0	0	0	0	3	3	0	0	3	3

Prim.: primary sighting, Second.: secondary sighting, Sch.: school, Ind.: individual.

Table 4
Summary of the results of experiments conducted during the 2021/2022 JASS-A survey.

Experiments	Results and descriptions
Sighting distance and angle experiment	128 trials completed by 30 January
Photo-ID	Obtained from 7 Antarctic blue, 9 humpback and 10 killer whales
Biopsy sampling	Collected from 2 Antarctic blue, 12 fin, 15 Antarctic minke, 11 humpback, 1 Bryde's whales and 2 killer whales
Satellite tagging	Deployed on 9 fin and 15 Antarctic minke whales
Oceanographic survey	116 XCTD casts
Marine debris observation	A fishing buoy was observed in the research area
UAV	Aerial images collected from 2 Antarctic blue, 6 Antarctic minke and 3 humpback whales

Antarctic minke whales

Antarctic minke whales were widely distributed in the research area (Figure 5a). It was the only species sighted in the ice-free waters with high density. This observation is consistent with the interpretation of Fujise and Pastene (2021) that larger numbers of this species are being distributed in polynyas within the pack-ice in recent years, possibly in search of alternative feeding areas in response to the increase in abundance and geographical expansion of other large whale species (e.g. humpback and fin whales). A sighting survey using an icebreaker vessel (Ainley *et al.*, 2007) found no Antarctic minke whales within coastal polynyas in an area similar to that surveyed in the present survey. However, this earlier survey was conducted in 1994 and the distribution of this species in polynyas is postulated for recent years.

The density of Antarctic minke whales in ice-free waters was generally high. However, the number of sightings east of 125°W (eastern side) was noticeably lower. The sea surface temperature (SST) map shows that the SST in the eastern side was relatively high and the chlorophyll concentration was relatively low compared to the western side (Figure 5b). In addition, the water colour in the eastern side was clear, while the colour in the western side was brownish and muddy suggesting waters with higher productivity. Therefore, a possible explanation for the lower whale density on the eastern side is that waters on this side are less productive, as suggested by low chlorophyll concentration, which could be translated into less phytoplankton and less krill for the whales to feed. Future detailed analysis of the XCTD observation data will lead to a better understanding of environmental factors affecting the Antarctic minke whale distribution in ice-free waters.

Fin whales

Fin whales were widely distributed only in the northern stratum (Figure 5a). The density was higher than that in the previous 2000/2001 SOWER survey in the same sector (Ensor *et al.*, 2001). The abundance of this species appears to be increasing, as suggested for Antarctic Areas V+VI West (Matsuoka and Hakamada, 2014).

Humpback whales

Humpback whales were widely distributed in the northern stratum with higher concentrations observed in the southern part of this stratum (Figure 5a). The density was higher than that in the 2000/2001 SOWER cruise in the same sector (Ensor *et al.*, 2001), confirming the view that this species is increasing in this area.

Antarctic blue whales

All Antarctic blue whales were observed in the northern stratum (Figure 5a). The density was a little higher than in the 2000/2001 SOWER cruise in the same sector (Ensor *et al.*, 2001).

Duplicate sightings

Duplicates sightings were those sightings made concurrently by both the IOP and TOP barrel observers during the IO mode survey. These data will be used to estimate ***g***(0), which in turn will be used to adjust estimates of abundance. There was a total of 31 duplicates involving several whale species.

Other research activities

Table 4 shows a summary of results of different experiments.

Sighting distance and angle experiment

The sighting distance and angle experiment was conducted in order to evaluate the accuracy of sighting distance and angle provided by primary observers. The results of

this experiment will be used for the calculation of abundance estimates. A training for this experiment was conducted on 7 January. The actual experiments, comprising 128 trials, were successfully completed on 30 January.

Photo-ID

Photo-ID data is used for individual matching exercise to investigate distribution and movement of large whales. A total of 7 Antarctic blue, 9 humpback and 10 killer whales were successfully photo-identified during the entire survey. These data will be registered into the Institute of Cetacean Research (ICR) database (see Matsuoka and Pastene, 2014).

Biopsy sampling for large whales

Biopsy samples are used for genetic studies on stock structure of large whales and for other feasibility studies related to the specific objectives of the JASS-A. For the entire survey, a total of 43 biopsy samples were collected from 2 Antarctic blue, 12 fin, 15 Antarctic minke, 11 humpback, 1 Bryde's (in transit area), and 2 killer whales, using the Larsen system (Larsen, 1998). Biopsy samples were stored at −20°C.

Satellite tagging

Satellite tagging is used for the study of movement, distribution and stock structure of whales. The satellite-monitored tags (SPOT and SPLASH-types, Wildlife Computers, Redmond, Washington, USA) were deployed with the Air Rocket Transmitter System (ARTS) (LK-ARTS, Skutvik, Norway). The detail of deployment system and protocols, and research results to date were described in Konishi *et al.* (2020). In the research area, 9 and 15 satellite tags were deployed on fin and Antarctic minke whales respectively.

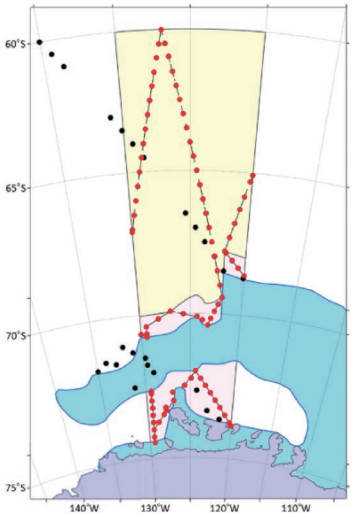

Figure 6. Oceanographic stations (XCTD casting points). Red circle: research area; black circle: transit.

Oceanographic survey

Oceanographic observations are important to understand the relationship of whales and the physical environment. The vertical distribution of water temperature and salinity were recorded from sea surface to 1,850 m water depth using XCTD system (eXpendable Conductivity, Temperature and Depth profiler, Tsurumi-Seiki Co., Ltd., Yokohama, Japan; probe type: XCTD-4 and XCTD-4N) with Digital Converter MK-150P at 116 stations along the survey track lines (Figure 6). Oceanographic data will be analysed to study the oceanographic structure of the research area and the relationship with whale distribution.

Marine debris observation

Studies on marine debris in the Antarctic are very scarce. It is therefore important to continue with this kind of survey in order to monitor future trends in the occurrence of marine debris. One fishing buoy was observed in the research area. These data will be registered into the ICR database and reported in the future (e.g. Isoda *et al.*, 2021).

Feasibility study on the utility of UAV

This technique will be used to refine observations related with whale abundance and distribution, e.g. determine the number of individuals in the schools. The technique can be used also for photogrammetry studies. Aerial images were collected for a total of two Antarctic blue, six Antarctic minke and three humpback whales using small UAV, Inspire 2 Pro and DJI phantom 4 Pro (video clips can be accessed at https://www.youtube.com/channel/UCz3c9IIMiQPVeryAogmJIig). These data will be registered into the photo-ID catalogue of ICR.

Sighting survey in low-middle latitude area

Sighting survey was conducted between the equator and the research area (includes transit to the starting point within the research area), excluding areas of the foreign countries' EEZs. The searching effort was 704.1 n.miles and the total sightings included fin (4/4), Antarctic minke (4/5), and humpback (1/2), Bryde's (1/1) and sperm (4/4) whales.

During the transit survey from the Antarctic research area to the equator (includes transit from the ending point within the research area), the searching effort was 960.1 n.miles and the total sightings included fin (10/24), Antarctic minke (2/2), humpback (8/15), sperm (1/1) and Arnoux's beaked (1/3) whales.

During the transit surveys, biopsy samples were col-

lected from five fin, two Antarctic minke, seven humpback, and one Bryde's whales.

HIGHLIGHTS OF THE SURVEY

The 2021/2022 JASS-A survey covered the eastern part of Area VI East (130°W–120°W) and succeeded in collecting sighting data necessary for the abundance estimation of cetaceans in this area. Of particular importance was the survey conducted in ice-free waters south of 72°S. Several other data necessary for understanding stock structure, movement and the environment of whales were collected during the survey. The data collected through the JASS-A will be analysed in conjunction with the data collected by the previous JARPA/JARPA, NEWREP-A and IDCR/SOWER surveys in the same region so that the analyses can be based on a long and consistent data set.

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Appendix 1.

Photographs from 2021/2022 JASS-A survey

Photo 1. Antarctic minke whale.

Photo 2. Antarctic minke whale within the pack ice.

Photo 3. Antarctic blue whale.

Photo 4. Fin whale.

Photo 5. Humpback whale.

Photo 6. Killer whale.

Photo 7. Navigating within the pack-ice.

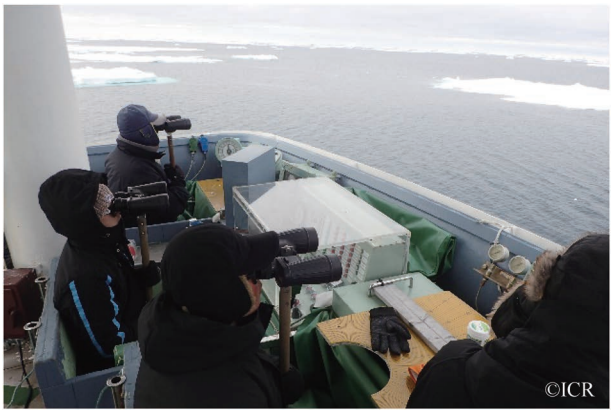

Photo 8. Sighting activity at the Upper Bridge Platform.

Photo 9. Sighting activity near an iceberg.

Photo 10. Buoy used in the angle and distance experiment.

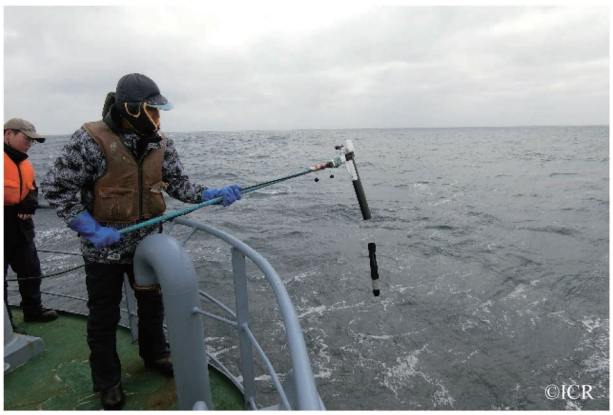

Photo 11. Oceanographic observation using XCTD.

Photo 12. Biopsy sampling on humpback whale.