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Results of the IWC-Pacific Ocean Whale and Ecosystem Research (IWC-POWER) dedicated sighting survey in 2022—An overview—

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ABSTRACT

This paper outlines the main results of the 2022 dedicated sighting survey of the International Whaling Commission-Pacific Ocean Whale and Ecosystem Research (IWC-POWER). The IWC-POWER surveys are designed and implemented by the IWC Scientific Committee, in special partnership with the Government of Japan. The surveys have been conducted since 2010 as the first phase with the long-term objective: '(to) provide information to allow determination of the status of populations (and thus stock structure is inherently important) of large whales that are found in the North Pacific waters and provide the necessary scientific background for appropriate conservation and management actions'. The 2022 survey was conducted between 2 August and 30 September, south of the western Aleutian Islands, within the U.S. Exclusive Economic Zone. This area was also surveyed in 2010 on the first IWC-POWER cruise. The current survey was conducted aboard the Japanese R/V *Yushin-Maru* No. 2. The acoustic survey was conducted for monitoring the presence of marine mammals, with particular emphasis on North Pacific right whales. Sixty-two percent of the planned survey track line was covered (917.3 n.miles of a planned distance of 1,486.4 n.miles). During the survey, blue (20 schools/21 individuals), fin (36/54), sei (21/23), common minke (3/3), humpback (12/12), sperm (38/38) and killer (14/63) whales were observed in the research area. No North Pacific right whales were seen or acoustically detected during the entire cruise. Photo-identification data were collected for 16 blue, 7 fin, 8 sei, 6 humpback and 8 killer whales. A total of 16 biopsy samples were collected from 4 blue, 4 fin, 6 sei and 2 humpback whales. A total of 34 sonobuoys were deployed, of which 33 were successful, for a total of over 210 monitoring hours. Data collected during this survey will be used mainly for abundance estimation and stock structure research purposes.

INTRODUCTION

The International Whaling Commission-Pacific Ocean Whale and Ecosystem Research (IWC-POWER) program is an international research effort in the North Pacific coordinated by the IWC and designed by the IWC Scientific Committee (SC) in special partnership with the Government of Japan. Scientists from the Institute of Cetacean Research (ICR) and cooperating institutes such as Tokyo University of Marine Science and Technology participate regularly in the IWC-POWER program, both in designing and implementing the surveys.

The IWC-POWER surveys in the North Pacific follow the series of IWC International Decade for Cetacean Research/Southern Ocean Whale and Ecosystem Research (IDCR/SOWER) surveys that were conducted in the Antarctic between 1978/79 and 2009/10. The long-term objective of the IWC-POWER is to 'provide information to allow determination of the status of populations (and thus stock structure is inherently important) of large whales that are found in the North Pacific waters and provide the necessary scientific background for appropriate conservation and management actions'.

The past IWC-POWER surveys provided critical information on rare whale species such as North Pacific right whale (Matsuoka *et al.*, 2022). The first survey of this program was conducted in 2010 and the most recent one in 2022 (IWC, in press). The IWC SC is close to completing the first phase of the IWC-POWER, which focuses on its short-term priorities. The IWC SC is preparing for the second phase which relates to medium-term priorities, based on the results of the first phase (see Matsuoka, 2020).

The objective of this document is to summarize the results of the 2022 IWC-POWER survey based on Morse *et al.* (2023). For a general background of the IWC-

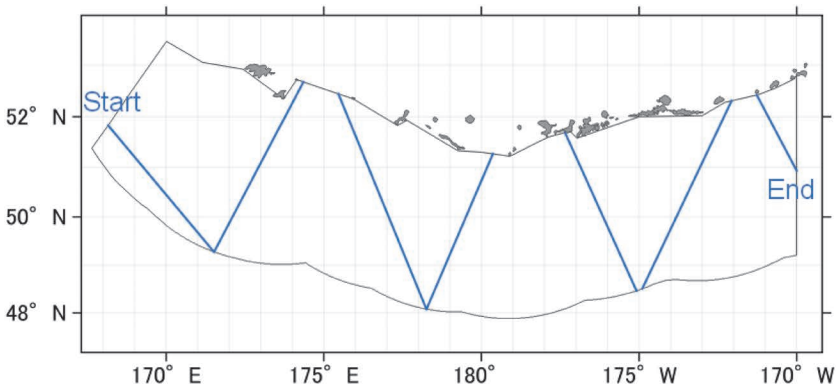

Figure 1. Research area and survey track lines with start and end points for the 2022 IWC-POWER survey.

Table 1
The 2022 IWC-POWER survey itinerary.

Date	Event
2022/08/01	Pre-cruise meeting at Shiogama
2022/08/02	Vessel departed Shiogama
2022/08/10	Vessel arrived at Dutch Harbor
2022/08/15	Cruise leader and US researcher came on board and vessel departed Dutch Harbor
2022/08/20	Survey commenced in the research area
2022/09/13	Survey finished in the research area
2022/09/15	Vessel arrived at Dutch Harbor
2022/09/18	Vessel departed Dutch Harbor
2022/09/30	Vessel arrived at Shiogama

POWER including objectives, research area, and general methodology, see Matsuoka (2020).

RESULTS OF THE 2022 IWC-POWER SURVEY

The main results of the 2022 IWC-POWER survey in this document were based on Morse *et al.* (2023). All research activities (i.e. approaching cetaceans for species identification, school size estimates, digital photography, and biopsy sample collection) that were carried out within the U.S. EEZ were permitted under U.S. National Marine Fisheries Service (NMFS) Permit no. 25563 (issued to AFSC, Marine Mammal Laboratory). Cetacean research activities conducted on the high seas in international waters by Japanese researchers aboard the R/V *Yushin-Maru* No. 2 were authorized under permit SUIKAN 4-1112 (dated 12 July 2022) issued by the Fisheries Agency, Government of Japan.

Itinerary

The 2022 survey was conducted between 2 August and 30 September by the Japanese R/V *Yushin-Maru* No. 2. The itinerary is shown in Table 1.

Figure 2. The R/V *Yushin-Maru* No. 2 in Dutch Harbor (date: 15 August 2022).

Research area

The research area was off the southern Aleutian Islands bounded by the US Exclusive Economic Zone (EEZ), between 167°38'E and 170°00'W (Figure 1).

Research vessel and scientific personnel

The R/V *Yushin-Maru* No. 2 (747GT) was contracted for this cruise (Figure 2 and Table 2). The vessel is a sister ship of the *Yushin-Maru* No. 3 which was contracted in previous years. Four international researchers were nominated by the IWC SC for this survey.

Laura Morse (USA) – Cruise Leader/Chief Scientist; sighting and photo-ID
Jessica Crance (USA) – acoustics and photo-ID
Taiki Katsumata (Japan) – sighting, photo-ID data management and marine debris
Isamu Yoshimura (Japan) – sighting data, marine debris and biopsy sample management

Searching effort

Survey track line coverage in the research area was 62% (917.3 n.miles of a planned distance of 1,486.4 n.miles), with a total of 491.2 n.miles in Passing with abeam closing mode (NSP) and 426.1 n.miles in Independent Observer passing mode (IO). The effort spent on the sighting survey is shown in Table 3.

Table 2
Specifications of the R/V *Yushin-Maru* No. 2.

Call sign	JPPV
Length overall [m]	69.61
Molded breadth [m]	11.5
Gross tonnage (GT)	747
Barrel height [m]	19.5
IO barrel height [m]	13.5
Upper bridge height [m]	11.5
Bow height [m]	6.5
Engine power [PS/kW]	5303/3900

Summary of the sightings

During the survey in the research area, the following sightings were made: blue (20 schools/21 individuals), fin (36/54), sei (21/23), common minke (3/3), humpback (12/12), sperm (38/38) and killer (14/63) whales (Table 4). The sea surface temperature (SST) of each species on the sighting position is summarized in Table 5.

Geographical distribution by species

Blue whale (Balaenoptera musculus)

Blue whales were widely distributed and mainly sighted in the western part of the research area (Figure 3a). They appeared to be spatially separated from sei whales with

Table 3
Summary of the searching effort in the research area conducted during the 2022 IWC-POWER survey. NSP: Normal Passing with abeam Closing Mode, IO: Independent Observer Mode.

Area	Area Code	Leg No.	Start	End	NSP		IO		NSP+IO	
		Start	Date	Date	Time	Dist. (n.m.)	Time	Dist. (n.m.)	Time	Dist. (n.m.)
		End	Time	Time						
Western Stratum (167°38′E–180°)	87	134	20-Aug.	5-Sep.	25:09:19	287.4	23:05:16	265.2	48:14:35	552.6
	US EEZ	114	6:40	11:49						
Eastern Stratum (180°–170°00′W)	86	112	5-Sep.	13-Sep.	17:32:14	203.8	13:46:41	160.9	31:18:55	364.7
	US EEZ	101	11:49	17:35						
Total			20-Aug.	13-Sep.	42:41:33	491.2	36:51:57	426.1	79:33:30	917.3
			6:40	17:35						

Table 4
Number of sightings (schools and individuals) for all species observed in the research area (original and transit track lines in the research area) by effort mode. NSP: Normal Passing with abeam Closing Mode, IO: Independent Observer Mode, OE: Top Down (TD) and Drifting (DR), Sch.: schools, Ind.: individuals.

Species	NSP			IO			OE			Total		
	Sch.	Ind.	Calf	Sch.	Ind.	Calf	Sch.	Ind.	Calf	Sch.	Ind.	Calf
Blue whale	12	13	0	7	7	0	1	1	0	20	21	0
Fin whale	18	28	2	17	25	1	1	1	0	36	54	3
Sei whale	10	11	0	10	11	0	1	1	0	21	23	0
Common minke whale	2	2	0	1	1	0	0	0	0	3	3	0
Humpback whale	6	6	0	5	5	0	1	1	0	12	12	0
Sperm whale	22	22	0	14	14	0	2	2	0	38	38	0
Killer whale	3	15	0	10	47	1	1	1	0	14	63	1

Table 5

Minimum, maximum, range and 25th to 75th quartiles of sea surface temperatures (SSTs) in degrees Celsius for each species sighted in the research area (original track line). Also noted are the number of sightings for each species.

Species	Number of sightings	Minimum SST	Maximum SST	Temperature range	25th to 75th Quartile
Blue whale	20	6.8	10.8	4.0	7.9–10.1
Fin whale	36	5.4	11.2	5.8	8.7–9.6
Sei whale	21	9.3	12.0	2.7	10.0–11.6
Common minke whale	3	8.0	9.9	1.9	8.7–9.6
Humpback whale	12	6.5	12.0	5.5	7.2–9.3
Sperm whale	38	5.7	11.2	5.5	8.9–10.2
Killer whale	14	3.4	11.9	8.5	6.8–10.1

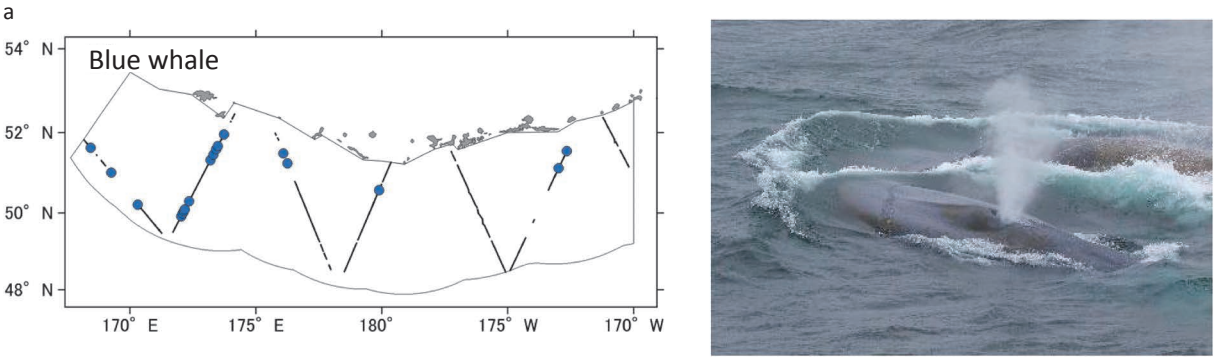

Figure 3a. The searching effort (thin line) and sighting positions (blue circles) of blue whales during the 2022 IWC-POWER survey (left) and surfacing blue whales photographed in the research area (right).

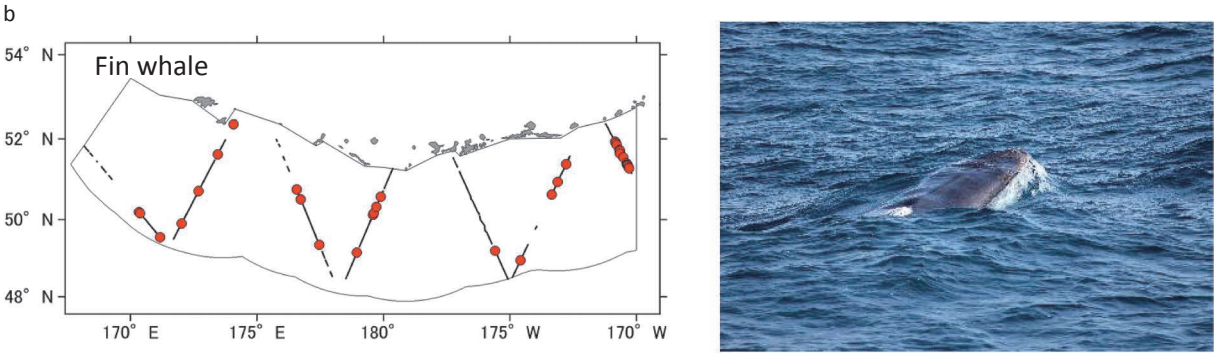

Figure 3b. The searching effort (thin line) and sighting positions (red circles) of fin whales during the 2022 IWC-POWER survey (left) and a surfacing fin whale photographed in the research area (right).

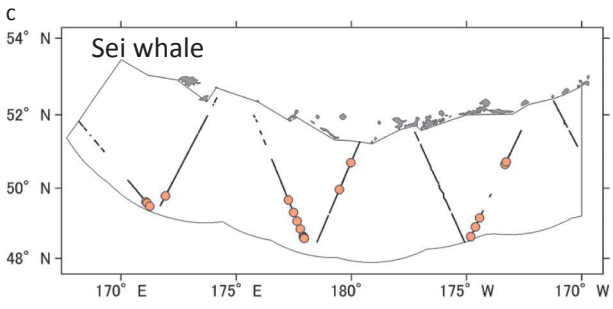

Figure 3c. The searching effort (thin line) and sighting positions (orange circles) of sei whales during the 2022 IWC-POWER survey.

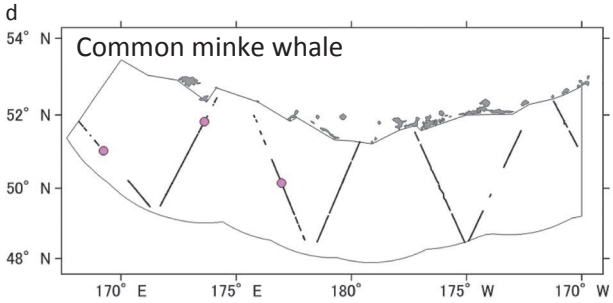

Figure 3d. The searching effort (thin line) and sighting positions (pink circles) of common minke whales during the 2022 IWC-POWER survey.

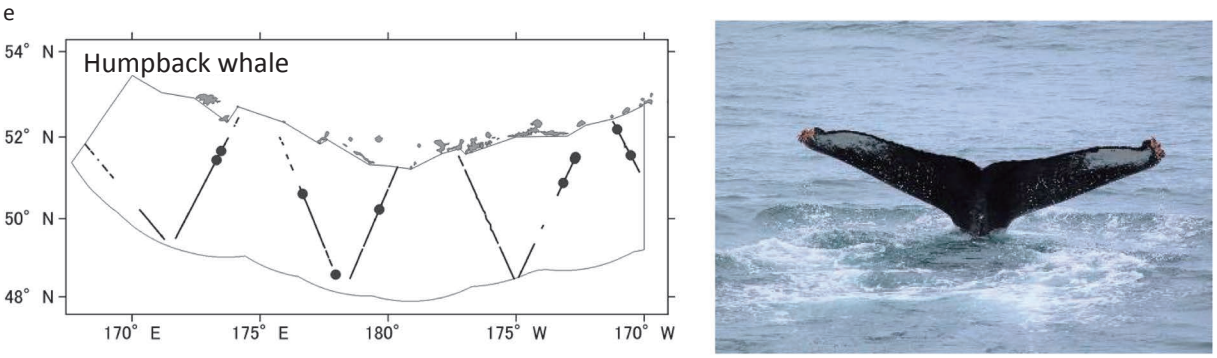

Figure 3e. The searching effort (thin line) and sighting positions (black circles) of humpback whales during the 2022 IWC-POWER survey (left) and fluke of a humpback whale photographed in the research area (right).

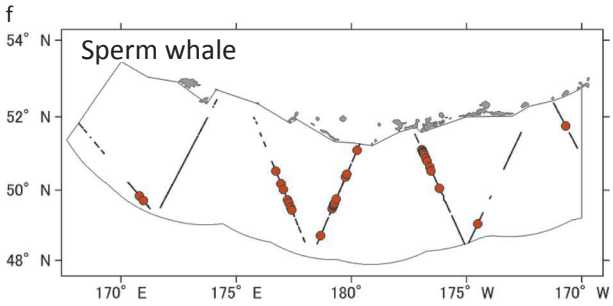

Figure 3f. The searching effort (thin line) and sighting positions (brown circles) of sperm whales during the 2022 IWC-POWER survey.

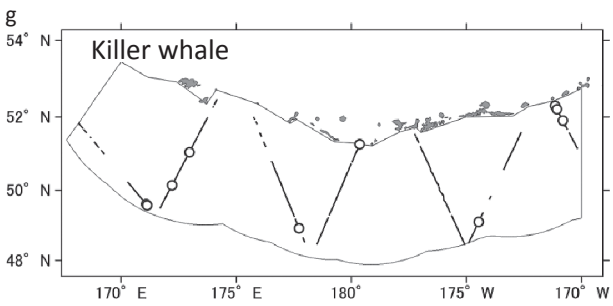

Figure 3g. The searching effort (thin line) and sighting positions (white circles) of killer whales during the 2022 IWC-POWER survey.

associated SSTs at the sighting positions ranging between 6.8°C and 10.8°C (25th to 75th quartiles: 7.9–10.1°C) which was lower than the range for sei whales (Table 5).

Fin whale (Balaenoptera physalus)

Fin whales were widely distributed throughout the survey area. Several high-density areas were observed along the most east transect and through Samalga Pass during the transit to Dutch Harbor from the survey area (Figure 3b). Sea temperatures ranged from 5.4°C to 11.2°C (25th to 75th quartiles: 8.7–9.6°C) (Table 5).

Sei whale (Balaenoptera borealis)

Sei whales were the second most frequently encountered baleen whale species through this survey. Sei whales were widely distributed but appeared to be spatially separated from blue whales with associated SST differences (Figure 3c). SSTs ranged from 9.3°C to 12.0°C (25th to 75th quartiles: 10.0–11.6°C), which was higher than the range for blue whales (Table 5).

Common minke whale (Balaenoptera acutorostrata)

Common minke whales were the rarest baleen whale species in the research area and were only sighted west of 180° (Figure 3d). A total of 3 schools (3 individuals) were observed. SSTs at the sighting locations ranged from 8.0°C to 9.9°C (25th to 75th quartiles: 8.7–9.6°C) (Table 5). During this survey, sea states averaged 4–5 on the Beaufort scale, which is assumed to be too rough for sighting common minke whales.

Humpback whale (Megaptera novaeangliae)

Humpback whales were sporadically distributed in the research area (Figure 3e). SSTs at the sighting positions ranged from 6.5°C to 12.0°C (25th to 75th quartiles: 7.2–9.3°C) (Table 5).

Sperm whale (Physeter macrocephalus)

Sperm whales were widely distributed throughout the research area, with the highest densities observed between 175°E and 175°W (Figure 3f). All schools were observed as solitary individuals (probably large males). Sperm whales were recorded in waters with SSTs ranging from 5.7°C to 11.2°C (25th to 75th quartiles: 8.9–10.2°C) (Table 5).

Killer whale (Orcinus Orca)

Killer whales were widely distributed in the research area

Table 6

Identification of duplicate sightings (main species) observed during the Independent Observer (IO) mode survey (original track line). Duplicate status was based on the number of sightings made by the Independent Observer Platform (IOP) that were observed also by the Topmen in the Standard TOP Barrel. Status codes D: Definite duplicate, P: Possible duplicate, R: Remote duplicate, N: Not duplicate.

Species	Number of all schools sighted by TOP and IOP	Number of all schools sighted by IOP	Duplicate Status			
			D	P	R	N
Blue whale	12	5	5	0	0	0
Fin whale	21	10	6	0	0	4
Sei whale	10	5	2	0	0	3
Common minke whale	1	0	0	0	0	0
Humpback whale	3	3	0	0	0	3
Sperm whale	21	11	7	0	0	4
Killer whale	13	4	4	0	0	0

Table 7a

Summary of the information on photo-ID experiments during the 2022 IWC-POWER survey, by species.

Photo-ID	Blue whale	Fin whale	Sei whale	Humpback whale	Killer whale	Total
Research area	14	7	7	2	8	38
Transit	2	0	1	4	0	7
Total	16	7	8	6	8	45

Table 7b

Summary of the number of biopsy samples collected during the 2022 IWC-POWER survey, by species.

Biopsy samples	Blue whale	Fin whale	Sei whale	Humpback whale	Total
Research area	4	4	5	2	15
Transit	0	0	1	0	1
Total	4	4	6	2	16

(Figure 3g). They were sighted in waters with SSTs ranging from 3.4°C to 11.9°C (25th to 75th quartiles: 6.8–10.1°C) (Table 5).

Summary of Acoustic monitoring

A total of 34 sonobuoys were deployed during the cruise. Of these, 33 were deployed and transmitted successfully for an overall success rate of 97.05%. A total of 211.46 hours of acoustic monitoring occurred during the survey. The most common species detected were sperm and fin whales, both detected on 31 of 33 buoys (93.9%), followed by killer whales (23, 69.6%), blue whales (18, 54.5%) and humpback whales (7, 21.2%). More detailed results are described in Morse *et al.* (2023).

Identification of duplicated sightings

Resight data were recorded for a total of 68 sightings during IO Mode involving several baleen whale species (Table 6). These data will be used to estimate $g(0)$, which in turn will be used to adjust abundance estimates.

Photo-ID experiments

Photo-ID experiments were conducted on blue (16 individuals), fin (7), sei (8), humpback (6) and killer (8) whales (Table 7a).

Biopsy sampling

Biopsy samples were collected from 4 blue, 4 fin, 6 sei and 2 humpback whales (Table 7b). Every biopsy encounter was documented photographically. All biopsy samples were catalogued and stored on the vessel in cryo-vials frozen at a temperature of −30°C.

Estimated Angle and Distance Experiment

The Estimated Angle and Distance Experiment was conducted on 1 September for 7 hours 51 minutes whilst in the research area. A total of 84 trials were conducted for each platform (TOP and IO barrels and upper bridge).

Table 8
The diving and surfacing durations of a sei whale tagged during the 2022 IWC-POWER survey.

PTT ID	Number of days with data obtained	type	*n*	duration mean (sec.)	SD	Duration minimum (sec.)	Duration maximum (sec.)	Duration range (sec.)
207833	4.6	Dive	573	83.48	144.57	4	772	768
		Surfacing	570	60.60	185.28	2	2728	2726

Figure 4. International researchers and crew of the 2022 IWC-POWER survey with *Yushin-Maru* No. 2. The picture was taken at the end of the survey in Dutch Harbor (date: 18 September 2022).

Both the Estimated Angle and Distance Training Exercises and Experiments were performed using the improved protocol (IWC, 2017).

Marine debris observations

A total of eight marine debris were observed. A total of seven items were recorded 'on effort' (i.e. during the first 15 minutes of each hour) and one item was recorded during 'off effort'. Marine debris were scarce and sparsely distributed in the survey area, compared to previous years (Matsuoka *et al.*, 2013; 2014).

Satellite tagging studies

During the transit survey on the high sea, satellite-linked dive behavior tags were experimentally deployed as a feasibility study at the discretion of Japan. The tag was attached to one sei whale on 24 September. The diving and surfacing duration obtained by 1 October are summarised in Table 8. The obtained data could be used to correct availability bias in future abundance estimation work.

HIGHLIGHT OF THE SURVEY

The 2022 annual IWC-POWER survey was successfully conducted by a group of international scientists using the Japanese R/V *Yushin-Maru* No. 2 (Figure 4), and valuable data were collected for several cetacean species. Such data will allow for further studies on the distribution, abundance and stock structure of large cetaceans in this particular area of the North Pacific.

This survey provided critical information on seasonal distribution and abundance of baleen whales. The research area of the 2022 survey was also surveyed in 2010 (Matsuoka *et al.*, 2011). Some differences were noted between the two surveys. Sei whales are moving northward, indicating they are distributed at higher latitudes in August–September. In addition, the 2010 survey had poor coverage of 34% due to bad weather. On the other hand, the coverage was 62% in 2022, which provides sufficient data for abundance estimation. Furthermore, it should be noted that biopsy samples were collected for the first time in this area. These samples will be used for molecular genetics analyses on stock identification.

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