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Report and highlights of the Japanese dedicated sighting surveys in the North Pacific in 2023

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ABSTRACT

This paper presents the results of vessel-based sighting surveys conducted in 2023 by the Institute of Cetacean Research in the North Pacific. The research area was set between 20°N–50°N and 140°E–160°W. The surveys were conducted between 6 April and 6 November involving three seasons: spring, summer and autumn. The spring and summer surveys were conducted to examine the distribution and abundance of whales. Part of spring and autumn surveys were conducted to investigate the migration of whales using satellite tags. The research vessels *Yushin-Maru, Yushin-Maru* No.2 and *Kaiyo-Maru* No.7 were engaged in the surveys. A total of 10,778.7 n.miles were searched in the research area. Coverage of the searching efforts on the planned cruise track line was 81.3%. In total, eight large whale species, including blue (30 schools/34 individuals), fin (268/450), sei (160/243), Bryde's (75/84), common minke (72/84), humpback (55/77), North Pacific right (1/1) and sperm (78/172) whales were sighted during the whole research. Photo-ID images were collected from blue (n=28), humpback (n=18), North Pacific right (n=1) and killer (n=66) whales. Biopsy skin samples using a Larsen system were collected from blue (n=4), fin (n=27), sei (n=47), common minke (n=1) and North Pacific right (n=1) whales. Satellite tags were attached on fin (n=22) and sei (n=44) whales. Data collected during these surveys will be used in studies on abundance, distribution, movement, and stock structure of several whale species.

INTRODUCTION

Dedicated cetacean sighting surveys in the western North Pacific were conducted in the late summer season since 1995 as a part of the Japanese Whale Research Program under Special Permit in the western North Pacific (JARPN/JARPNII) and the New Scientific Whale Research Program in the western North Pacific (NEWREP-NP) based on the survey procedures of the International Whaling Commission/Southern Ocean Whale and Ecosystem Research (IWC/SOWER) (IWC, 2008). Based on the collected data, the distribution patterns of large whales such as blue, fin, sei, Bryde's, common minke, humpback, North Pacific right and sperm whales, and abundance estimates of common minke, sei and Bryde's whales were investigated and reported to the IWC SC (IWC, 2001; 2010; 2016; Hakamada *et al.*, 2009; Murase *et al.*, 2009; Pastene *et al.*, 2009; Matsuoka *et al.*, 2014; 2015).

The Fisheries Resources Institute (FRI) has also conducted dedicated sighting surveys for cetaceans in the North Pacific since the 1980s (Buckland *et al.*, 1992; Miyashita *et al.*, 1995; Miyashita and Kato, 2004; 2005; Shimada, 2004; Kanaji *et al.*, 2012). In 2019 the Government of Japan decided to continue the sighting surveys in the North Pacific (IWC, 2019) under the rational that the collection of sighting data to estimate abundance and biopsy/photo-identification data to examine stock structure have contributed in the past to the work on management and conservation of large whales by the IWC SC (IWC, 2016).

This paper reports the results of the Japanese dedicated sighting surveys conducted during 6 April and 6 November 2023 involving three seasons: spring, summer and autumn.

SURVEY DESIGN

Research period and area

In 2023, the surveys were conducted in three seasons: spring, summer and autumn. The objective of spring and summer surveys was the study of distribution and abundance of large whales from poorly documented seasons. The surveys during part of spring and autumn were designed to study the movement and migration of fin, sei and common minke whales using satellite tags. Figure 1

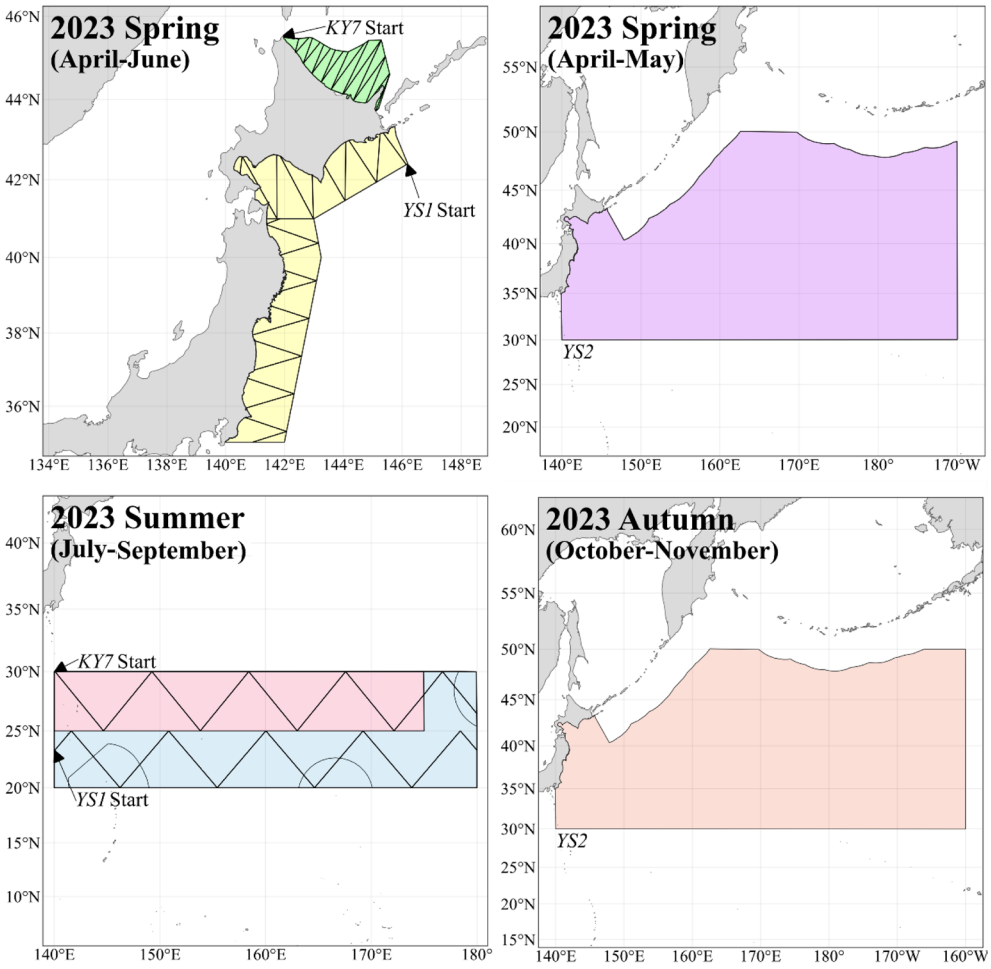

Figure 1. Research areas covered by the 2023 dedicated sighting surveys in each season. Upper left: spring survey. *Kaiyo-Maru* No.7 (*KY7*) covered the green area, and *Yushin-Maru* (*YS1*) covered the yellow area. Upper right: spring survey. *Yushin-Maru* No.2 (*YS2*) covered the purple area. Lower left: summer survey. *KY7* covered the pink area, and *YS1* covered the blue area. Lower right: autumn survey. *YS2* covered the orange area. The spring and autumn surveys conducted by *YS2* did not have a pre-determined track line.

illustrates the research areas covered in each season.

In the spring (April to June), the research area was set up between 30°N–50°N and 140°E–170°W; in the summer (July to September), between 20°N–30°N and 140°E–180°; and in the autumn (October to November), between 30°N–50°N and 140°E–160°W.

Research vessels

The sighting surveys in 2023 were conducted by the research vessels *Yushin-Maru* (*YS1*), *Yushin-Maru* No.2 (*YS2*) and *Kaiyo-Maru* No.7 (*KY7*). The vessels were equipped with a top barrel platform (TOP), IO barrel platform (IOP) and upper bridge (Figure 2).

Track line design

The pre-determined track lines in the spring and summer surveys are shown in Figure 1. The start points of the track lines were decided randomly using the 'Distance program ver. 7.3' (Thomas *et al.*, 2010) and the number of the line (width in the longitude) was decided by the research schedule based on the IWC survey guidelines (IWC, 2012). The spring and autumn surveys conducted by *YS2* did not set track lines because the objective was not to estimate abundance but to satellite tag of whales.

Sighting procedure

The sighting surveys were conducted using (1) Normal Passing mode (NSP), (2) Normal Closing mode (ASP) and (3) Passing with Independent Observer mode (IO). The latter mode was conducted to estimate whale abundance considering estimated $g(0)$. The survey modes adopted for each survey are shown in Table 1. The three survey modes followed the protocol endorsed for the SOWER surveys (e.g. Matsuoka *et al.*, 2003; IWC, 2008; 2012). As data from summer surveys are used to estimate the abundance of large whales, the IO mode was also adopt-

Figure 2. Research vessels participating in the 2023 dedicated sighting surveys: *Yushin-Maru* (*YS1*) (upper left), *Yushin-Maru* No.2 (*YS2*) (upper right) and *Kaiyo-Maru* No.7 (*KY7*) (lower left).

Table 1

Summary of the survey modes and searching conditions by each seasonal survey during the 2023 dedicated sighting surveys.

Season	Vessel	Survey mode	Searching conditions		
			Visibility (n.miles)	Wind speed (kt)	Searching speed (kt)
Spring	*KY7, YS1*	Normal Passing mode	≥2.0	17.0>	10.0
	YS2	Normal Closing mode	≥2.0	17.0>	11.5
Summer	*KY7, YS1*	Normal Passing mode Passing with Independent Observer mode	≥2.0	21.0>	10.5
Autumn	*YS2*	Normal Closing mode	≥2.0	21.0>	11.5

ed for this survey, as this survey can provide important data to calculate *g*(0).

For NSP and ASP mode, there were two primary observers in the top barrel (TOP) and two in the upper bridge (captain and helmsman). All primary observers conducted searching for cetaceans by using angle board and scaled binoculars (7x).

For IO mode, there were two primary observers on the TOP and two in the independent observer platform (IOP). These observers conducted searching for cetaceans by using angle board and scaled binoculars (7x). There was no open communication between the IOP and the TOP. The observers and researchers on the upper bridge communicated to the TOP (or IOP) independently, only to clarify information and did not distract the top-men from their normal searching procedure. These primary observers report sighting-information to researchers and other observers on the upper bridge for data recording.

The survey effort began 60 minutes after sunrise and ended 60 minutes before sunset, with a maximum of 12 hours per day (maximum 06:00–19:00, including 30 minutes for mealtime for lunch and supper, when surveying in IO mode) when the weather conditions were acceptable for observations. Detailed search conditions for each survey are shown in Table 1.

Experiments

Table 2 describes the details of the planned experiments for each survey. Distance and angle experiments were conducted in the middle of the survey period. The experiment was conducted to evaluate measurement error and followed the protocol of the IWC/SOWER and IWC-POWER surveys (IWC, 2012).

When large cetaceans such as blue and humpback whales were found, photo-id images were obtained using Canon EOS R6 Mark II (with 100–500 mm lens) from the

Table 2
Experiments planned in each seasonal survey during the 2023 dedicated sighting surveys.

Season	Vessel	Planned experiments
Spring	*KY7, YS1*	Photo-ID, biopsy, satellite tagging, distance and angle experiments
	YS2	Photo-ID, biopsy, satellite tagging
Summer	*KY7, YS1*	Photo-ID, biopsy, distance and angle experiments
Autumn	*YS2*	Photo-ID, biopsy, satellite tagging

bow or upper deck. Further, biopsy skin sampling using the Larsen system (Larsen, 1998) was conducted when blue, fin, sei and common minke whales were sighted. The satellite tagging experiment using the Air Rocket Transmitter System (LK-ARTS) was also conducted for fin, sei and common minke whales.

RESULTS

Brief narrative of the surveys

Spring (April–June)

KY7 departed Hakodate, Hokkaido, Japan on 6 April, and started the survey in the research area on 8 April. *KY7* paused the survey on 2 May for a scheduled port call, and entered Otaru, Hokkaido, Japan, on 5 May for refueling and disembarkation of researchers. On 8 May, *KY7* departed Otaru, and resumed the survey on 9 May. The survey was completed on 3 June. *KY7* arrived in Kushiro, Hokkaido, Japan on 6 June.

YS1 and *YS2* departed Shiogama, Miyagi, Japan on 7 April and 12 April, respectively. *YS1* started the survey in the research area on 9 April and completed it on 20 May. On 13 April, *YS2* started the survey, which was completed on 29 May. *YS1* and *YS2* arrived in Shiogama on 22 May and 31 May, respectively.

Summer (July–September)

KY7 departed Kurihama, Kanagawa, Japan on 29 July and began the survey on 31 July. *KY7* suspended the survey on 25 August and entered Shiogama for refueling on 1 September. *KY7* departed Shiogama on 4 September and resumed the survey on 9 September. *KY7* completed the survey on 24 September and arrived in Kushiro on 5 October.

YS1 departed Shimonoseki, Yamaguchi, Japan on 28 July. *YS1* started the survey on 31 July and paused the survey on 21 August for refueling and disembarkation

Table 3
Summary of the survey periods and searching effort by each seasonal survey in the 2023 dedicated sighting surveys.

Season	Vessel	Research period	Planned cruise track (n.miles)	Searching effort NSP (n.miles)	Searching effort IO (n.miles)	Searching effort Total (n.miles)	Coverage of effort
Spring	*KY7**	2023/04/08–05/02	1,019.2	820.8	—	820.8	80.5%
		2023/05/09–06/03	1,019.2	794.2	—	794.2	77.9%
	YS1	2023/04/09–05/20	1,648.0	1,242.2	—	1,242.2	75.4%
	YS2	2023/04/13–05/29	—	1,678.9**	—	1,678.9	—
	Sub total	—	3,686.4	4,536.1	—	4,536.1	77.5%
Summer	*KY7*	2023/07/31–08/25	1,868.7	901.9	941.7	1,843.6	98.7%
		2023/09/09–09/24	1,076.6	551.0	514.9	1,065.9	99.0%
	YS1	2023/07/31–08/21	1,706.7	624.0	650.7	1,274.7	74.7%
		2023/09/04–09/21	2,121.0	735.2	712.2	1,447.4	68.2%
	Sub total	—	6,773.0	2,812.1	2,819.5	5,631.6	83.1%
Autumn	*YS2*	2023/10/12–11/05	—	611.0**	—	611.0	—
Total		—	10,459.4	7,959.2	2,819.5	10,778.7	81.3%

* The pre-determined track line was surveyed twice at different times.

** Searching effort ASP (n.miles).

of researchers, and entered Sendai, Miyagi, Japan on 26 August. *YS1* restarted the survey on 4 September and completed it on 21 September. *YS1* arrived in Shiogama on 2 October.

Autumn (October–November)

YS2 departed Shiogama on 12 October and began the survey on 12 October. The vessel completed the survey on 5 November and arrived in Shiogama on 6 November.

Searching effort

A summary of searching effort and coverage in each seasonal survey is shown in Table 3. A total of 10,778.7 n. miles (19,962.2 km) were searched in all seasonal surveys.

Sightings

Spring

Tables 4a and 4b show the total sightings for large and small cetacean species, respectively, made in the spring season. The sighting locations of each species are shown in Figure 3a and 3b together with sea surface temperature (SST).

Blue whale

A total of 28 schools (32 individuals two mother and calf pairs) were sighted in this season (Figure 3a, 3b). The range of SST in the sighting positions was 15.8°C–21.0°C (mean SST 17.0°C), and the mean school size was 1.14. The Density Index (DI: schools of primary sighted/100 n. miles searching distance) of *YS1* was 0.08. A total of 26

Table 4a

Total number of sightings of large whales made in the spring season 2023, by research vessel and species.

Season	Species	*KY7* (Apr.)		*KY7* (May)		*YS1*		*YS2*		Total	
		Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.
Spring	Blue whale	0	0	0	0	1	1	27	31	28	32
	Fin whale	62	90	152	289	4	5	15	17	233	401
	Sei whale	0	0	0	0	0	0	93	155	93	155
	Bryde's whale	0	0	0	0	11	14	8	8	19	22
	Common minke whale	31	41	36	38	3	3	2	2	72	84
	Humpback whale	2	2	1	1	26	37	5	8	34	48
	North Pacific right whale	0	0	0	0	1	1	0	0	1	1
	Sperm whale	0	0	3	3	19	61	8	19	30	83

Table 4b

Total number of sightings of small cetaceans made in the spring season 2023, by research vessel and species.

Season	Species	*KY7* (Apr.)		*KY7* (May)		*YS1*		*YS2*		Total	
		Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.
Spring	Baird's beaked whale	8	33	12	45	2	11	0	0	22	89
	Bottlenose dolphin	0	0	0	0	1	8	0	0	1	8
	Striped dolphin	0	0	0	0	1	11	0	0	1	11
	Common dolphin	0	0	0	0	0	0	4	104	4	104
	Pacific white sided dolphin	0	0	0	0	3	40	0	0	3	40
	Risso's dolphin	0	0	0	0	7	74	3	13	10	87
	Southern form short-finned pilot whale	0	0	0	0	1	2	0	0	1	2
	Northern form short-finned pilot whale	0	0	0	0	1	35	0	0	1	35
	Killer whale	13	51	15	135	6	17	3	11	37	214
	Harbour porpoise	3	6	3	3	0	0	0	0	6	9
	Truei type Dall's porpoise	0	0	0	0	9	68	0	0	9	68
	Dalli type Dall's porpoise	0	0	2	7	1	44	0	0	3	51
	Unidentified type Dall's porpoise	0	0	4	10	3	20	0	0	7	30
	Black type Dall's porpoise	0	0	1	3	0	0	0	0	1	3
	Ziphiidae	0	0	0	0	0	0	8	16	8	16
	Mesoplodon	0	0	0	0	1	4	0	0	1	4

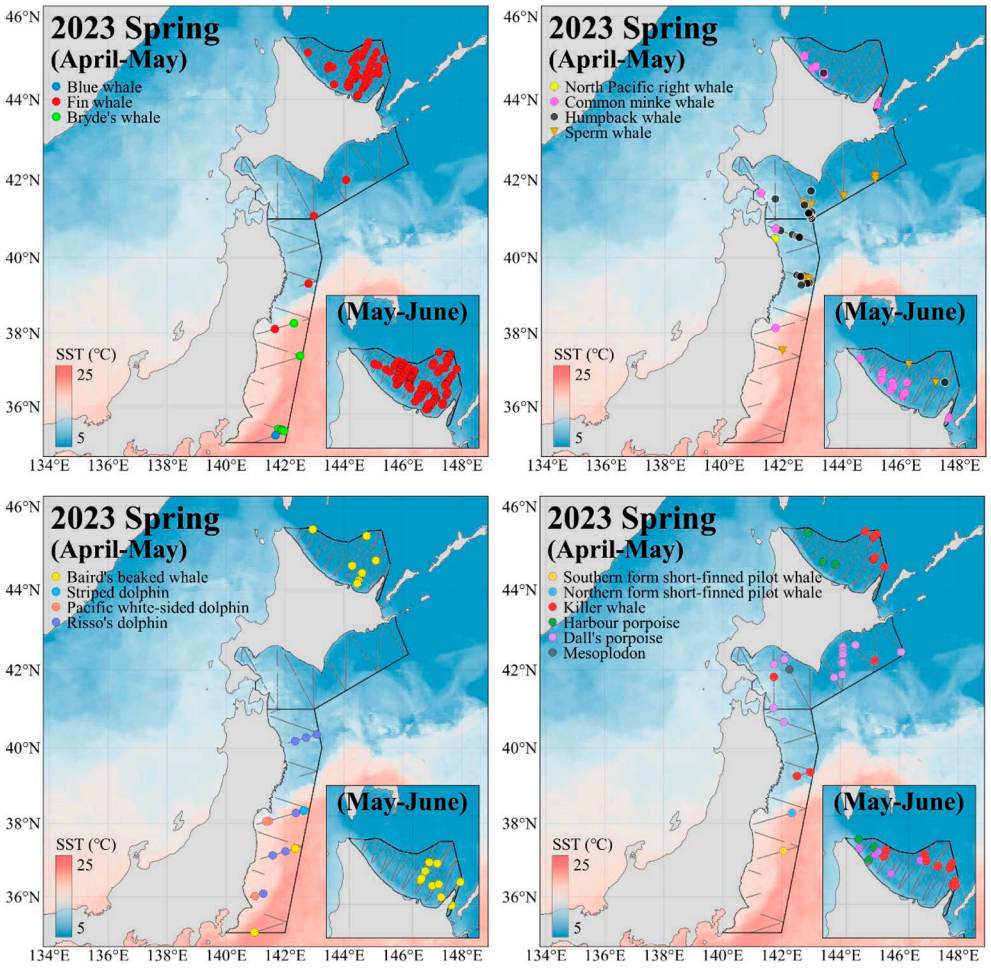

Figure 3a. The locations of large and small cetaceans sighted by *YS1* and *KY7* during the spring season 2023. Rolling 32 days average sea surface temperature data from 23 April to 24 May and 1 May to 1 June 2023 obtained by MODIS-Aqua (Original data: Ocean color web, from https://oceancolor.gsfc.nasa.gov/, accessed on 2024-04-01), are also shown.

individuals were photographed and four biopsy samples were collected.

Fin whale

This species was the most frequently sighted species in the spring season (233 schools and 401 individuals) (Figure 3a, 3b). No mother and calf pairs were sighted. The range of SST in the sighting positions was 0.6°C–18.1°C (mean SST 6.4°C), and the mean school size was 1.72. The DIs differed considerably between the seasonal surveys, 5.24 for *KY7* in April, 16.1 for *KY7* in May and 0.32 for *YS1*. A total of 11 biopsy samples were collected and seven satellite tags were attached to seven individuals.

Sei whale

A total of 93 schools (155 individuals including 8 mother and calf pairs) were sighted (Figure 3a, 3b). The mean SST at the sighting position was 16.6°C (14.7°C–19.9°C). The mean school size was 1.67. A total of 47 biopsy samples were collected and satellite tag were attached to 44 individuals.

Bryde's whale

A total of 19 schools (22 individuals with no mother and calf pair) were sighted (Figure 3a, 3b). The range of SST at the sighting positions was 10.5°C–21.0°C (mean SST 19.3°C). Observed mean school size was 1.15. The DI was 0.72 for *YS1*.

Common minke whale

A total of 72 schools (84 individuals with no mother and calf pair) were sighted (Figure 3a, 3b). The mean school size was 1.17 and the range of SST at the sighting positions was 1.9°C–16.9°C (mean SST 8.4°C). The DIs of *KY7* in April and May were 1.34 and 1.89, respectively. The DI of *YS1* was 0.24. One biopsy sample was collected.

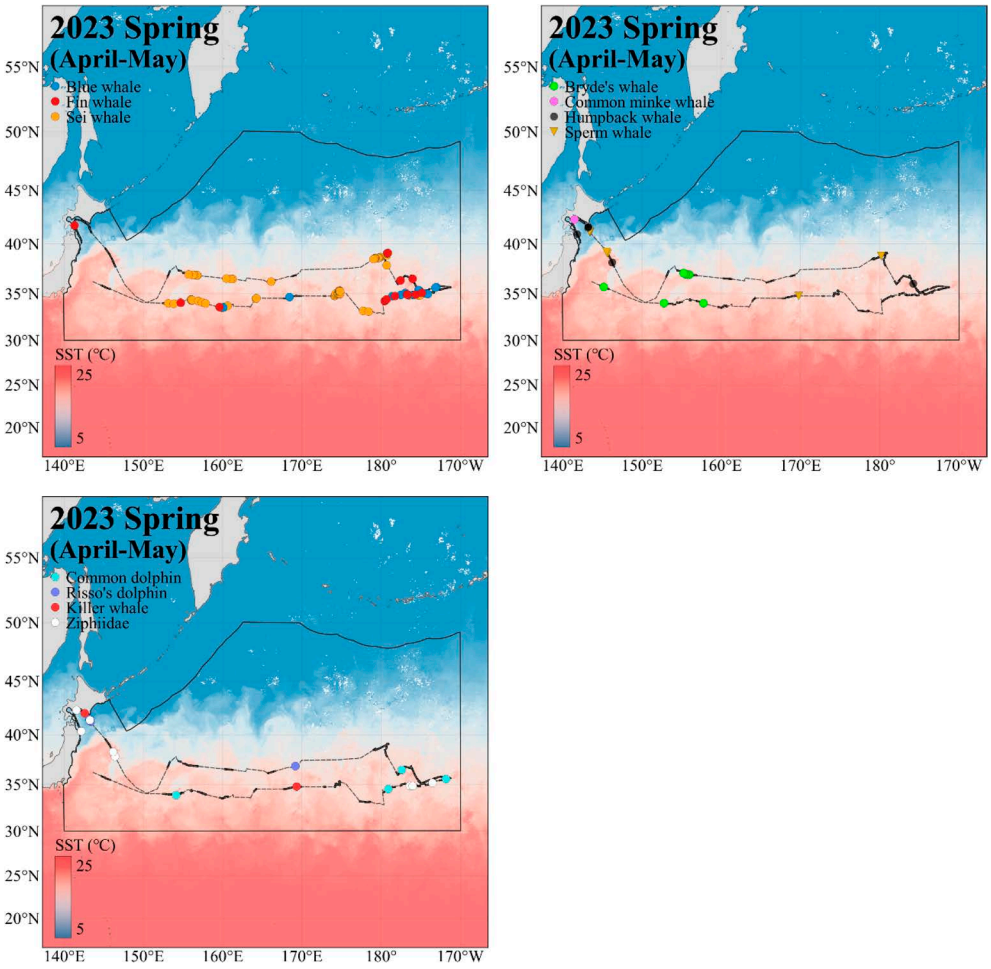

Figure 3b. The locations of large and small cetaceans sighted by *YS2* during the spring season 2023. Rolling 32 days average sea surface temperature data from 23 April to 24 May 2023 obtained by MODIS-Aqua (Original data: Ocean color web, from https://oceancolor.gsfc.nasa.gov/, accessed on 2024-04-01), are also shown.

Humpback whale

A total of 34 schools (48 individuals including two mother and calf pairs) were sighted (Figure 3a, 3b). The observed mean school size was 1.41. The range of SST in the sighting positions was 3.1°C–20.6°C (mean SST 8.4°C). The DIs of *KY7* in April, May and *YS1* were 0.12, 0.13 and 1.85, respectively. Photo-ID images were collected from nine individuals.

North Pacific right whale

One school (one individual) of estimated body length of 13.7 m was sighted at 40°30'N, 141°44'E (Figures 3a and 4). The SST at the sighting position was 9.4°C. This individual was photographed, and a biopsy sample was obtained. As the whale was sighted secondarily, not during a search, no DI was calculated for this species.

Sperm whale

A total of 30 schools (83 individuals) were sighted (Figure 3a, 3b). The range of SST in the sighting positions was 2.1°C–21.7°C (mean SST 9.9°C). Because the opportunity to approach the schools was limited, there was little information on school size, body length and calves. The mean school size was 2.77 when the school size was confirmed. The DIs were 0.38 for *KY7* in May and 1.45 for *YS1*.

Figure 4. A North Pacific right whale sighted in the spring (16 May) during the 2023 dedicated sighting surveys.

Small cetaceans

In the spring season, eight species of the family Delphinidae, five species of the family Phocoenidae and three species of the family Ziphiidae were sighted (Table 4b). The most common species sighted was the killer whale (37 schools/214 individuals), followed by Baird's beaked whale (22/89). Killer whales and Baird's beaked whales were primarily sighted north of 44°N, but were also sighted at 35°N, the southernmost point of the seasonal research area (Figures 3a, 3b).

Summer

Tables 5a and 5b show the total sightings for large and small cetacean species, respectively, made in the summer season. The sighting locations of each species are shown in Figure 5 together with SSTs.

Bryde's whale

Bryde's whales were the only baleen whales sighted in the summer season. A total of 32 schools (33 individuals with no mother and calf pair) were sighted (Figure 5). The observed mean school size was 1.03. The range of SST at the sighting positions was 27.4°C–30.6°C (mean SST 28.8°C). The DIs were 0.52 and 0.62 for *KY7* and *YS1*, respectively.

Sperm whale

A total of 26 schools (54 individuals) were sighted (Figure 5). This species was not sighted east of 160°E. Mean school size was 2.08. The range of the SST at the sighting position was 27.5°C–31.5°C (mean SST 29.4°C). The DIs were 0.58 for *KY7* and 0.33 for *YS1*.

Small cetaceans

In this season, eight species of the family Delphinidae, two species of the family Ziphiidae and one species of the family Kogiidae were sighted (Table 5b). Species of the family Ziphiidae were the most common species sighted (20 schools/44 individuals) and were mainly sighted north of 25°N (Figure 5). One school of killer whale was sighted at 28°46'N, 148°06'E.

Duplicate sightings

A total of 16 and 14 re-sightings of large whales were recorded in IO mode during this season in *KY7* and *YS1*, respectively.

Autumn

Tables 6a and 6b show the total sightings for large and small cetacean species, made in the autumn season. The sighting locations of each species are shown in Figure 6

Table 5a

Total number of sightings of large whales made in the summer season 2023, by research vessel and species.

Season	Species	*KY7*		*YS1*		Total	
		Sch.	Ind.	Sch.	Ind.	Sch.	Ind.
Summer	Bryde's whale	15	15	17	18	32	33
	Sperm whale	17	40	9	14	26	54

Table 5b

Total number of sightings of small cetaceans made in the summer season 2023, by research vessel and species.

Season	Species	*KY7*		*YS1*		Total	
		Sch.	Ind.	Sch.	Ind.	Sch.	Ind.
Summer	Bottlenose dolphin	1	60	0	0	1	60
	Spotted dolphin	2	50	1	45	3	95
	Striped dolphin	2	88	0	0	2	88
	Fraser's dolphin	1	43	1	70	2	113
	Risso's dolphin	1	7	3	60	4	67
	False killer whale	2	6	1	25	3	31
	Melon-headed whale	0	0	1	540	1	540
	Killer whale	1	2	0	0	1	2
	Ziphiidae	8	12	3	7	11	19
	Mesoplodon	9	25	0	0	9	25
	Kogia	2	4	0	0	2	4

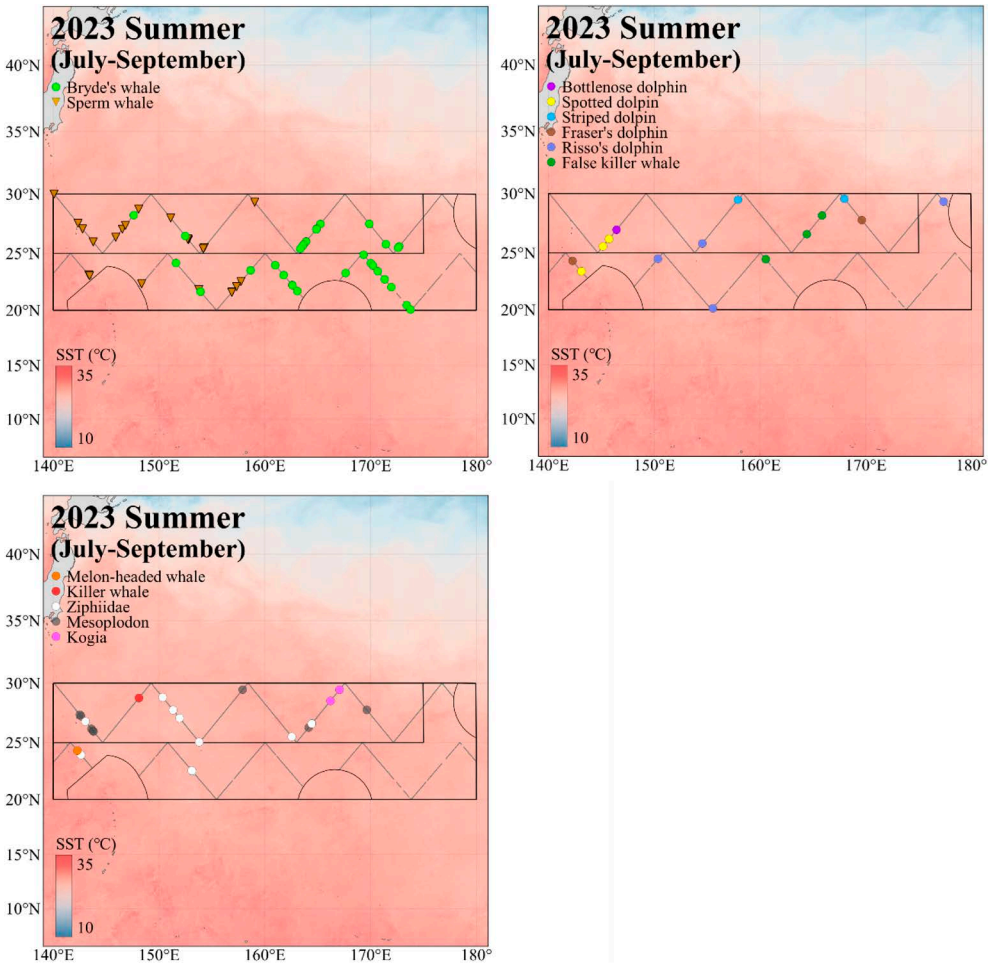

Figure 5. The locations of large and small cetaceans sighted during the summer season 2023. Rolling 32 days average sea surface temperature data from 21 August to 21 September 2023 obtained by MODIS-Aqua (Original data: Ocean color web, from https://oceancolor.gsfc.nasa.gov/, accessed 2024-04-01), are also shown.

together with SSTs.

Blue whale

Two schools (two individuals) with estimated body lengths of 18.4 m and 20.1 m were sighted (Figure 6). The range of SST was 14.0°C–15.7°C (mean SST 14.9°C). Photo-ID images were collected from two individuals.

Fin whale

A total of 35 schools (49 individuals with no mother and calf pair) were sighted (Figure 6). This species was mainly sighted north of 40°N and west of 150°E. Observed mean school size was 1.40. The mean SST at the sighting positions was 14.2°C (9.9°C–17.9°C). A total of 16 biopsy samples were collected, and satellite tags were attached on 15 individuals.

Sei whale

Sei whales were the most common species sighted during the autumn season. A total of 67 schools (88 individuals with no mother and calf pair) were sighted (Figure 6). Mean school size was 1.31. The range of SST at the sighting positions was 9.9°C–18.2°C (mean SST 11.4°C). This species was sighted in high densities east of 150°E.

Bryde's whale

A total of 24 schools (29 individuals) were sighted (Figure 6). A mother and calf pair was sighted at 41°50'N, 143°58'E. This species was the only baleen whale species sighted south of 40°N. The range of SST at the sighting positions was 13.8°C–24.5°C (mean 16.2°C) and mean school size was 1.21.

Humpback whale

A total of 21 schools (29 individuals including two mother and calf pairs) were sighted (Figure 6). The mean SST at the sighting position was 14.3°C (11.8°C–16.3°C). The observed mean school size was 1.38. Nine individuals were photographed.

Table 6a
Total number of sightings of large whales made in the autumn season 2023, by research vessel and species.

Season	Species	*YS2*	
		Sch.	Ind.
Autumn	Blue whale	2	2
	Fin whale	35	49
	Sei whale	67	88
	Bryde's whale	24	29
	Humpback whale	21	29
	Sperm whale	22	35

Table 6b
Total number of sightings of small cetaceans made in autumn season 2023, by research vessel and species.

Season	Species	*YS2*	
		Sch.	Ind.
Autumn	Baird's beaked whale	2	12
	Common dolphin	4	102
	Pacific white sided dolphin	2	93
	Northern right whale dolphin	2	19
	Risso's dolphin	1	8
	Killer whale	3	17
	Truei type Dall's porpoise	5	45
	Unidentified type Dall's porpoise	5	20
	Ziphiidae	3	6

Sperm whale

In total, 22 schools (35 individuals) were sighted (Figure 6). Mean school size was 2.45. The range of SST was 9.6°C–17.8°C (mean SST 13.2°C).

Small cetaceans

In this season, five species of the family Delphinidae, two species of the family Phocoenidae and two species of the family Ziphiidae were sighted (Table 6b). Dall's porpoises were sighted primarily in the 42°–44°N latitudinal band.

Experiments

Sighting distance and angle experiment

In the spring, the Estimated Angle and Distance Experiment was conducted by *KY7* on 29 April. It was conducted on 18 May by *YS1*. In the summer, the experiment was conducted on 27 August by *KY7* and on 25 September by *YS1*. The results of this experiment will be used for calibrating the sighting distances and angle data used for the calculation of abundance estimates.

Photo-ID

The number of individuals photographed by species is shown in Table 7. All photographs were stored in the Institute of Cetacean Research (ICR) catalogs and will be used for investigating the stock structure and movement of those cetacean species in the future.

Biopsy sampling

A total of 80 biopsy samples were collected during the 2023 dedicated sighting surveys. Table 8 shows the number of biopsy samples, by seasonal survey, research vessels and species. All samples were stored at the ICR laboratory and will be used in genetic analyses for investigating the stock structure of those species in the future.

Satellite tagging

Satellite tags were deployed in the spring and autumn surveys and deployment was successful in both seasons. The number of individuals tagged is shown in Table 9, by seasonal survey, research vessel and species. A total of 22 and 44 satellite tags were deployed for fin and sei whales, respectively. All the deployments to sei whales taken place in the spring. These were evenly deployed among the sightings (Figure 7). Tracking data obtained from satellite tags will contribute to the elucidation of the movement of whales in each season and the timing of the start of migration between high latitude feeding areas and low latitude breeding areas.

HIGHLIGHTS OF THE SURVEY

The sighting surveys conducted in 2023 were completed successfully. They provided unique data obtained not only in the summer, but also in the spring and autumn seasons for which information on cetacean distribution and abundance have been very scarce. Some main characteristics of the surveys are summarized below.

A large number of blue and sei whales were sighted during the spring season. Blue whales were more densely distributed east of 180°, while sei whales were distributed throughout the pelagic area (outside the Japanese EEZ). Sei whales are known to migrate north from the breeding areas in January and February, reaching feeding areas around 30°N by March, and reaching feeding areas north of 35°N by May and early June (Mizroch *et al.*, 2016; Konishi *et al.*, 2024). This species was also concentrated around 35°N, between April and June 2023. Although no direct feeding behaviour of this species was observed during these surveys, many patches of prey species such as small fish were observed at the sighting positions. These numerous sightings of sei whales and

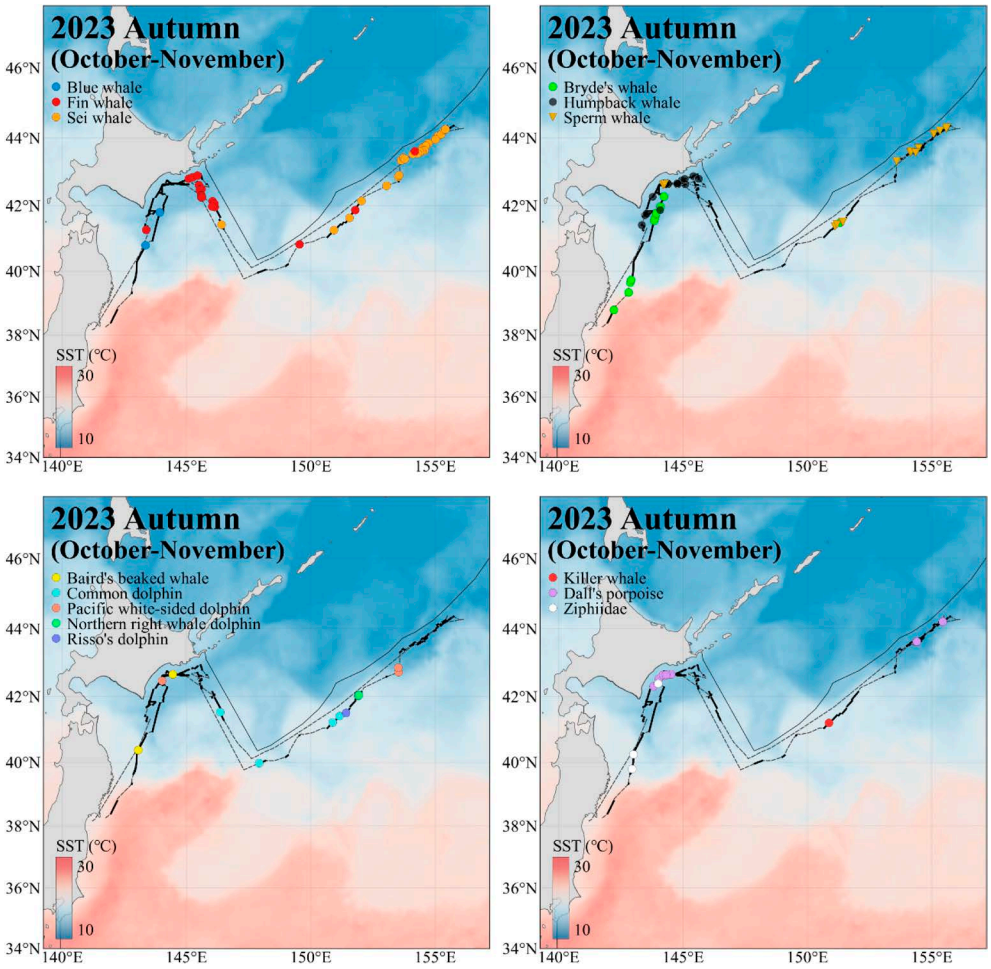

Figure 6. The locations of large and small cetaceans sighted during the autumn season 2023. Rolling 32-days average sea surface temperature data from 8 October to 8 November 2023 obtained by MODIS-Aqua (Original data: Ocean color web, from https://oceancolor.gsfc.nasa.gov/, accessed on 2024-04-01), are also shown.

Table 7

Number of individuals photographed during the 2023 dedicated sighting surveys, by seasonal survey, research vessel and species.

Species	Spring				Summer		Autumn	Total
	KY7 (Apr.)	*KY7* (May)	*YS1*	*YS2*	*KY7*	*YS1*	*YS2*	
Blue whale	0	0	1	25	0	0	2	28
Humpback whale	0	0	1	8	0	0	9	18
North Pacific right whale	0	0	1	0	0	0	0	1
Killer whale	3	39	13	9	2	0	0	66
Total	3	39	16	42	2	0	11	113

observations of prey species support the migration pattern to feeding areas around 35°N during the spring season suggested by previous studies (Mizroch *et al.*, 2016; Konishi *et al.*, 2024).

In April–June, fin and common minke whales were distributed in high densities on the Japanese side of the Sea of Okhotsk. Compared to previous surveys conducted during the same seasons and in the same research area (Kim *et al.*, 2023), sightings in April confirmed that fin whales were distributed east of 144°E, the same as in 2022, but in May the distribution extended further west of 144°E. Common minke whales were distributed west of 144°E and east of the Shiretoko Peninsula, the same as in 2022. Based on the results of the previous surveys, these two species had separate distributions in the Sea of Okhotsk during the spring feeding season from April to June (Kim *et al.*, 2023), but in 2023 they were mixed in one area (west of 144°E). One of the reasons for the

Table 8
Number of biopsy samples collected during the 2023 dedicated sighting surveys, by seasonal survey, research vessel and species.

Species	Spring				Summer		Autumn	Total
	KY7 (Apr.)	*KY7* (May)	*YS1*	*YS2*	*KY7*	*YS1*	*YS2*	
Blue whale	0	0	0	4	0	0	0	4
Fin whale	0	0	2	9	0	0	16	27
Sei whale	0	0	0	47	0	0	0	47
Common minke whale	0	0	0	1	0	0	0	1
North Pacific right whale	0	0	1	0	0	0	0	1
Total	0	0	3	61	0	0	16	80

Table 9
Number of individuals attached with satellite tags, by each season and research vessel in 2023.

Species	Spring		Autumn	Total
	YS1	*YS2*	*YS2*	
Fin whale	1	6	15	22
Sei whale	0	44	0	44
Total	1	50	15	66

westward expansion of the distribution of fin whales may be that the number of whales visiting this area during the same period has increased compared to previous surveys. The number of sightings of this species between April and June more than doubled compared to 2022 (Kim *et al.*, 2023). Further research is needed to determine what is driving the increase in number of whales visiting this area during the spring season.

A large number of humpback whales were sighted in the coastal area (within the Japanese EEZ) from April to June. Most of these sightings were between 39°N and 42°N. Compared to previous surveys (Kim *et al.*, 2023), large numbers of this species were sighted south of 40°N in 2022, while whales were sighted further north in 2023. This suggests that the northward migration of humpback whales started earlier in 2023 than in 2022. In the spring seasons, Bryde's whales were distributed in south of the coastal area and west of the pelagic area, with a concentration of sightings around 35°N and 142°E in the coastal area and 37°N and 156°E in the pelagic area.

The summer survey covered the North Pacific between 20°N–30°N and 140°E–180° and provided important summer sighting data for Bryde's and sperm whales. In the previous survey in 2014, a total of 56 schools (72 individuals) including 9 mother and calf pairs of Bryde's whales were sighted in this area (Matsuoka *et al.*, 2015), while no mother and calf pair was sighted in 2023. The monthly mean SST in 2023 was lower than 30°C (Figure 5), but in 2014, the monthly mean SST in this area was higher than 30°C. Changes in SST in this area could be a contributing factor to changes in the distribution trend of Bryde's whales. However, SST at the sighting positions averaged 29.1°C (range 27.8°C–30.1°C) in 2014 (Matsuoka *et al.*, 2015) and 28.8°C (range 27.4°C–30.6°C) in 2023, indicating that there was no significant difference in SST between the two years. The distribution trend of this species needs to be analyzed in more detail, considering other information such as prey species. No sperm whales were sighted east of 160°E during this season. However, this species was sighted further east than 160°E during previous surveys in 2014 (Matsuoka *et al.*, 2015). The mean SST at the sighting position in the previous survey in 2014 was 28.5°C (range 26.8°C–29.7°C) (Matsuoka *et al.*, 2015), lower than in 2023.

In October–November, most of the baleen whales (blue, fin, Bryde's and humpback whales) were distributed on the Japanese side of the North Pacific, particularly off Kushiro. In contrast, sei whales were distributed in high densities further east than 150°E. These trends in the distribution of baleen whales also differed in SST. The mean SST at the sighting positions where blue, fin, Bryde's and humpback whales were sighted was higher than 14°C, while for sei whales it was lower at 11.4°C. During this season, feeding behaviours such as multiple defecations by fin and Bryde's whales and a single prey chase by sei whales have been observed. These behaviours indicate that these waters are one of the whales' feeding grounds for this season.

Satellite tags were deployed during the part of spring and autumn surveys to study the movements and migrations of fin, sei and common minke whales. In the spring survey, 7 and 44 satellite tags were successfully deployed on fin and sei whales, respectively. In the autumn survey, 15 satellite tags were deployed on fin whales. Common minke whales were not tagged in either the spring or autumn surveys due to the low number of sightings.

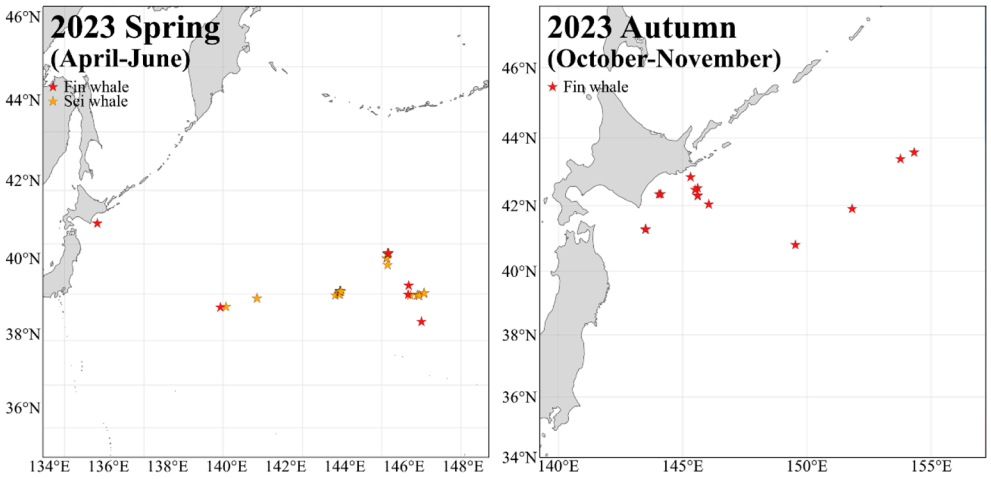

Figure 7. The locations of tagged fin and sei whales during the 2023 dedicated sighting surveys. Locations were obtained from photographs taken at the time of the tagging.

Tracking data from satellite tags deployed during sighting surveys conducted between 2017 and 2023 were used to study the seasonal migration patterns of sei whales between feeding and breeding areas (Konishi *et al.*, 2024). These studies of the migration using satellite tags will contribute to resource management by assisting the interpretation of the genetic analyses of stock structure of sei and other large whales.

As in the previous surveys, the 2023 surveys collected data on small cetaceans in the same way as large cetaceans. The analyses of these data will provide valuable information on the distribution and abundance of small cetaceans in different seasons.

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