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Results of the Japanese dedicated cetacean sighting surveys in the western North Pacific in 2019 and 2020

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ABSTRACT

Vessel-based sighting surveys were conducted in 2019/2020 by Japan to examine the distribution and abundance of large whales in the western North Pacific. The research area, set between 25°N–45°N and 128°E–150°E, was covered between 10 May 2019 and 18 March 2020 involving four seasons: early summer, late summer, autumn and winter. Previous surveys in autumn and winter were very scarce. The research vessels *Yushin-Maru*, *Yushin-Maru* No. 2, *Yushin-Maru* No. 3 and *Kaiyo-Maru* No. 7 were engaged in the current surveys. A total of 9,415.9 n.miles was searched in the research area. The coverage of the planned track lines on effort was 94% in the early summer, 86% in the late summer, 75% in the autumn and 70% in the winter surveys. In total, seven large whale species, including blue (7 schools/8 individuals), fin (50/80), sei (44/66), Bryde's (159/202), common minke (39/45), humpback (80/123) and sperm (168/438) whales were sighted over the entire research period. Photo-ID images were collected from blue (8 individuals), humpback (26 individuals), and killer (7 individuals) whales. Biopsy skin samples were collected from blue (n=5), fin (n=7), sei (n=5), common minke (n=1), humpback (n=3), and killer (n=1) whales using a Larsen system. Satellite tags were attached on fin (n=6), sei (n=14) and Bryde's (n=1) whales. Data collected during these surveys will be used in studies on abundance, distribution, movement and stock structure of several species. This information is essential for appropriate management and conservation of cetacean species in the western North Pacific.

INTRODUCTION

Dedicated cetacean sighting surveys in the western North Pacific have been conducted in the summer season since 1995 as a part of the former 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). Those surveys were based on the survey guidelines and procedures of the International Whaling Commission/Southern Ocean Whale and Ecosystem Research (IWC/SOWER) (Anon, 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).

The National Research Institute of Far Seas Fisheries (NRIFSF) has also conducted dedicated sighting surveys for cetaceans in the North Pacific since the 1980s (Buckland *et al.*, 1992; Miyashita *et al.*, 1995., Kanaji *et al.*, 2012). In 2019 and after completing the JARPN/JARPNII and NEWREP-NP, the Government of Japan decided to continue the sighting surveys in the North Pacific (IWC, 2019) based on the rationale 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 May 2019 to March 2020 involving four seasons: early summer, late summer, autumn and winter.

SURVEY DESIGN

Research season and area

In 2019/20, in addition to the usual summer season survey, sighting surveys were also conducted in autumn (October–November) and winter (February–March) seasons. The objective of the extra surveys was to provide basic information on distribution and abundance of large whales from seasons which have been poorly documented. Therefore, surveys in 2019/20 were conducted in four seasons: early summer, late summer, autumn and

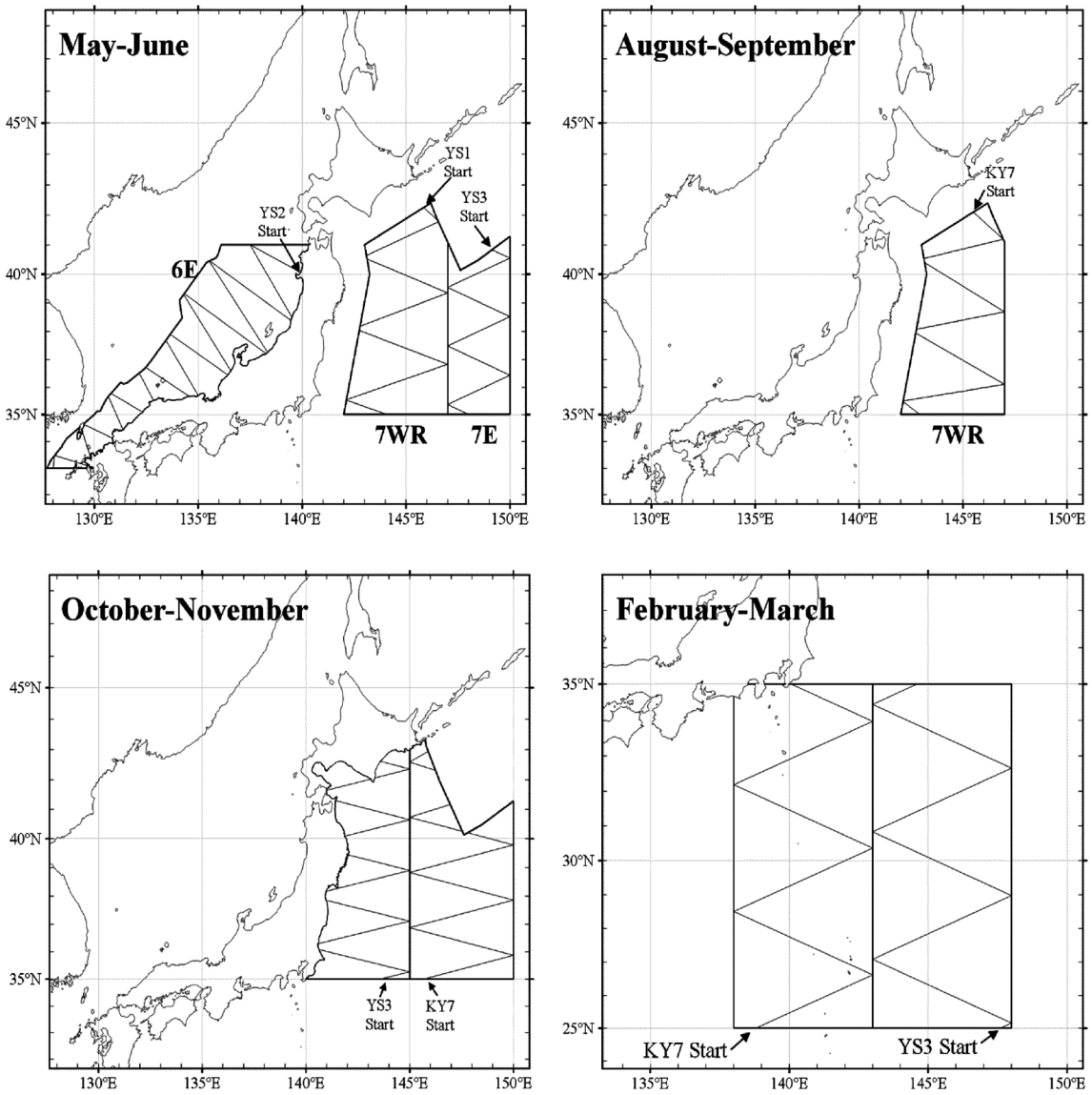

Figure 1. The research area and pre-determined track lines in each season. Upper left: early summer survey (May–June 2019). Upper right: late summer survey (August–September 2019). Lower left: autumn survey (October–November 2019). Lower right: winter survey (February–March 2020).

winter. Figure 1 illustrates the research areas covered in each season.

In early summer (May to June 2019), the research area was set up between 33°N–45°N and 128°E–150°E (for convenience, we name the sub-areas as 6E, 7WR, and 7E from the west).

In late summer (August to September 2019), the research area was set up between 35°N–45°N and 142°E–147°E.

In the autumn season (October to November 2019), the research area was set up between 35°N–45°N and 140°E–150°E. This research area was divided into 'Western part' and 'Eastern part.'

Finally, in the winter season (February to March 2020), the research area was set up between 25°N–35°N and 138°E–148°E and the research area was divided into 'Western' and 'Eastern' parts.

Research vessels

The surveys in 2019/20 were conducted by the research vessels *Yushin-Maru* (*YS1*), *Yushin-Maru* No. 2 (*YS2*), *Yushin-Maru* No. 3 (*YS3*) and *Kaiyo-Maru* No. 7 (*KY7*). The vessels were equipped with a top barrel platform (TOP), independent observer barrel platform (IOP) and upper bridge (Figure 2).

Track line design

The survey blocks and pre-determined track lines are shown in Figure 1. The start point of each track line was decided randomly using the Distance program ver. 7.0

Figure 2. The dedicated sighting vessel that participated in the 2019/20 surveys: *Yushin-Maru* (*YS1*) (upper left), *Yushin-Maru* No. 2 (*YS2*) (upper right), *Yushin-Maru* No. 3 (*YS3*) (lower left), *Kaiyo-Maru* No. 7 (*KY7*) (lower right).

(Thomas *et al.*, 2010), and the number of the lines (width in the longitude) was decided by the research schedule, based on the IWC survey guidelines (IWC, 2012).

Sighting procedure and mode

The sighting survey was conducted using (1) Normal Passing mode (NSP) and (2) Passing with Independent Observer mode (IO) in order to estimate abundance with estimated $g(0)$ for large cetaceans. Both survey modes followed the protocol endorsed for the SOWER surveys (e.g. Matsuoka *et al.*, 2003).

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

For IO mode, there were two primary observers on the TOP and the independent observer platform (IOP), respectively. These observers on TOP and IOP also conducted searching for cetaceans by angle board and scaled binoculars (7×). 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, with the top-men only clarifying information and without distracting the top-men from their normal search procedure. These primary observers reported sighting-information to researchers and other observers on the upper bridge for data recording. For small cetaceans, sightings from the TOP and the upper bridge were recorded.

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 lunch and supper, when surveying in IO mode) when the weather conditions were acceptable for observations: visibility better than 2.0 n.miles and wind speed less than 17 knots in the early and late summer, 21 knots in the autumn and winter season. The searching speed was planned to be 10.5 to 11.5 knots with slight adjustment to avoid vibration of the vessel.

Distance and angle experiments were conducted in the middle of the survey period, using a buoy with a reflector that resembles a blow. The experiment to evaluate measurement error was conducted late in the survey following the protocol of the IWC/SOWER and IWC-POWER surveys (IWC, 2012). The Estimated Angle and Distance Training Exercise were also conducted early in the surveys. During the exercise, the observers familiarized themselves with distance estimates from the TOP and Upper Bridge.

Experiments

For each survey, when large cetaceans such as blue and humpback whales were encountered, photo-ID images were obtained using Canon EOS 7D Mark II (with 100–400 mm lens) from the bow or upper deck. Further, biopsy skin sampling using the Larsen sampling system

(Larsen, 1998) was conducted in early summer, late summer and autumn season survey when blue, fin, sei and humpback whales were sighted. In the early summer, autumn and winter season surveys, a satellite tagging experiment using LK-ARTS was also conducted when fin, sei and common minke whales were sighted. These data collected in different seasons will assist the interpretation of stock structure hypotheses and abundance estimations for these species.

RESULTS OF THE SURVEY

Narrative of the surveys

Early summer 2019

The *YS1* and *YS3* departed Shimonoseki, Yamaguchi prefecture, Japan on 10 May, and the *YS2* departed Shiogama, Miyagi prefecture, Japan, on 11 May. The *YS1* started the survey in sub-area 7WR on 13 May and completed it on 4 June. The *YS2* started the survey in sub-area 6E on 13 May and completed it on 14 June. The YS3 started the survey in sub-area 7E on 14 May and completed it on 2 June. Each vessel surveyed a pre-determined track line from north to south of each stratum, taking into account the seasonal migration of baleen whales to avoid double counting (Figure 1). The *YS1* and *YS3* arrived in Shimonoseki on 8 June, and the *YS2* arrived in Shiogama on 26 June.

Late summer 2019

The *KY7* departed Hachinohe, Aomori prefecture, Japan, on 16 August. The vessel started the survey in sub-area 7WR on 19 August and completed it on 21 September. The vessel arrived in Misaki, Kanagawa prefecture, Japan, on 26 September. The vessel surveyed a pre-determined track line from north to south (Figure 1).

Autumn in 2019

The *YS3* departed Daiba, Tokyo, Japan, and started the survey in the western part of the research area on 8 October. The *KY7* departed Misaki on 10 October and started the survey in the eastern part of the research area on 16 October. The *YS3* completed the survey on 10 November and arrived in Shimonoseki on 15 November. The *KY7* completed the survey on 17 November and arrived in Hachinohe on 20 November. Both vessels surveyed a pre-determined track line from south to north in each stratum (Figure 1).

Winter 2020

The *KY7* departed Shimizu, Shizuoka prefecture, Japan, on 6 February and started the survey in the western part of the research area on 11 February. The *YS3* departed Shimonoseki on 12 February and started the survey in the eastern part of the research area on 16 February. The *KY7* and *YS3* completed the survey on 13 March and arrived in Shiogama on 16 March and Shimonoseki on 17 March, respectively. Both vessels surveyed a pre-determined track line from south to north in each stratum (Figure 1).

The Estimated Angle and Distance Experiments were

Table 1
Summary of the searching effort by each season and area.

Season	Research area	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 (%)
Early summer (May–Jun.)	6E	*YS2*	2019/5/13–6/14	2,021.1	959.4	932.4	1,891.8	94
	7WR	*YS1*	2019/5/13–6/4	1,177.2	566.5	580.1	1,146.6	97
	7E	*YS3*	2019/5/14–6/2	871.8	397.2	408.2	805.4	92
	Sub total	—	2019/5/13–6/14	4,070.1	1,923.2	1,920.7	3,843.8	94
Late summer (Aug.–Sep.)	7WR	*KY7*	2019/8/19–9/21	1,193.0	511.9	518.9	1,030.7	86
Autumn (Oct.–Nov.)	Western	*YS3*	2019/10/8–11/10	1,597.8	635.9	647.4	1,283.3	80
	Eastern	*KY7*	2019/10/16–11/17	1,611.0	578.1	557.8	1,135.8	71
	Sub total	—	2019/10/8–11/17	3,208.8	1,213.9	1,205.1	2,419.1	75
Winter (Feb.–Mar.)	Western	*KY7*	2020/2/11–3/13	1,505.1	450.7	414.3	865.0	58
	Eastern	*YS3*	2020/2/16–3/13	1,522.9	663.7	593.5	1,257.3	83
	Sub total	—	2020/2/11–3/13	3,028.0	1,114.4	1,007.8	2,122.2	70
Total	—	—	—	11,499.9	4,763.4	4,652.5	9,415.9	82

Table 2a
Numbers of sightings of large whales in early summer (May–June), by each sub-area.

Season	Species	6E		7WR		7E		Total	
		Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.
Early summer (May–Jun.)	Blue whale	0	0	0	0	4	5	4	5
	Fin whale	12	21	5	7	6	9	23	37
	Sei whale	0	0	1	2	7	11	8	13
	Bryde's whale	0	0	16	19	32	42	48	61
	Like Bryde's	0	0	0	0	4	4	4	4
	Common minke whale	37	43	1	1	0	0	38	44
	Like minke	0	0	1	1	0	0	1	1
	Humpback whale	1	1	21	29	15	21	37	51
	Sperm whale	0	0	66	165	21	63	87	228
	Unidentified large baleen whale	0	0	1	1	5	5	6	6
	Unidentified large cetacean	1	1	1	1	0	0	2	2

Table 2b
Numbers of sightings of small cetaceans in early summer (May–June), by each sub-area.

Season	Species	6E		7WR		7E		Total	
		Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.
Early summer (May–Jun.)	Cuvier's beaked whale	1	4	0	0	0	0	1	4
	Unidentified Ziphiidae	22	39	6	13	10	20	38	72
	Unidentified *Mesoplodon*	2	4	0	0	2	2	4	6
	Common dolphin	1	200	3	48	9	435	13	683
	Risso's dolphin	5	56	17	143	2	13	24	212
	Pacific white-sided dolphin	8	421	2	170	12	316	22	907
	Dalli type Dall's porpoise	1	4	2	10	1	5	4	19
	Truei type Dall's porpoise	1	1	0	0	2	8	3	9
	Unid. type Dall's porpoise	9	30	4	12	5	51	18	93

conducted on 27 May by *YS1 and YS3*, on 2 June by *YS2* and on 5 September by *KY7*. In winter, the Estimated Angle and Distance Experiments were conducted again on 7 March by *KY7* and *YS3* because there was a change of observers. The results of this experiment will be used in the calculation of abundance estimates.

Research effort in each season and research area

A summary of the searching effort and coverage in each season and research area is shown in Table 1. A total of 9,415.9 n.miles (17,438.2 km) were searched in the whole research area and during all seasons. In early summer, the total searching effort was 3,843.8 n.miles (7,118.7 km), and the coverage exceeded 90% due to continued stable weather conditions. In late summer, the searching effort was 1,030.7 n.miles (1,908.9 km), and the coverage was 86.4%. The percentage dropped slightly in late summer because the survey was interrupted three times in September to avoid typhoons. In the autumn season, the total searching effort was 2,419.1 n.miles (4,480.2 km), and the coverage was relatively low (75.4%) because the available survey hours of the day were only about eight hours due to times of the sunrise and sunset, and also because typhoons were still active around Japan in October. In the winter season, the total searching effort was 2,122.2 n.miles (3,930.3 km), and the coverage was 70.1%. In the western part, the coverage was low (57.5%) because time was lost on a number of occasions in avoiding stormy weather.

Sightings

Sightings were summarized by each season (Tables 2a to 5b). The sighting location of each species in each season

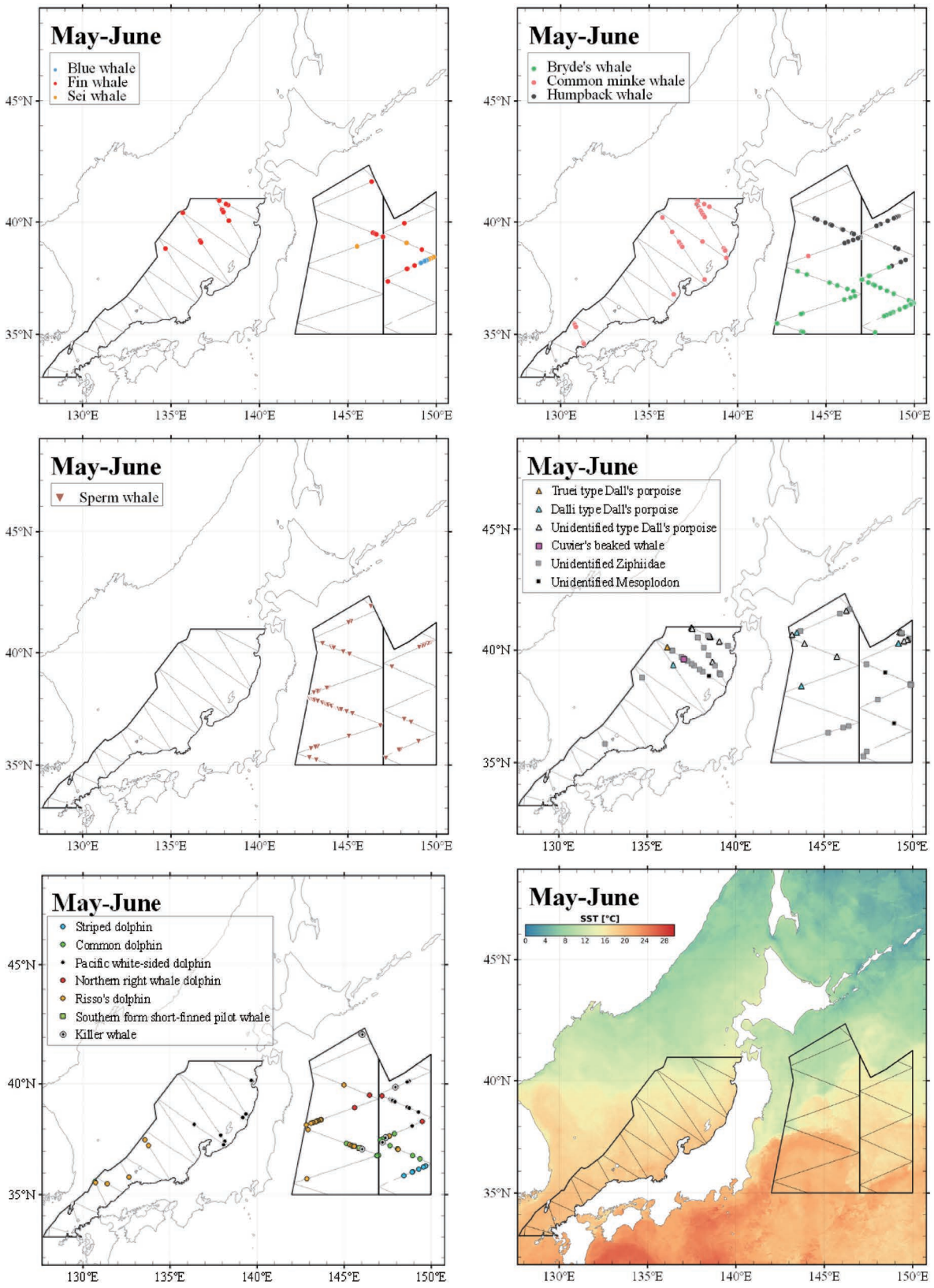

Figure 3. The sighting locations of large and small cetaceans during the early summer (May–June 2019) and information on SST in that season (original data of SST: Ocean color web, from https://oceancolor.gsfc.nasa.gov/).

is shown in Figures 3, 4, 5 and 6, together with sea surface temperature (SST).

Early summer (May–June)

Blue whale

Four schools (five individuals including a mother and

calf pair) were sighted between 38°20'N, 149°27'E and 38°06'N, 148°46'E in sub-area 7E (Table 2a, Figure 3). One blue whale formed a mixed school with a fin whale. The range of SST at the sighting positions was 14.5–15.2°C. All five individuals were photographed, and biopsy samples were collected from four individuals.

Fin whale

Fin whales were sighted in each research area (Table 2a, Figure 3). In sub-area 6E, 12 schools (21 individuals including 2 mother and calf pairs) were sighted. Observed mean school size was 1.75. The range of SST in the sighting positions was 10.0–16.3°C. In sub-areas 7WR and 7E, 11 schools (16 individuals) were sighted. Observed mean school size was 1.45. The range of SST at the sighting positions was 8.4–20.5°C.

Sei whale

Sei whales were sighted in sub-areas 7WR and 7E (Table 2a, Figure 3). A total of eight schools (13 individuals including 2 mother and calf pairs) were sighted. Observed mean school of size was 1.63. The range of SST at the sighting positions was 14.1–16.4°C.

Bryde's whale

A total of 48 schools (61 individuals including 10 mother and calf pairs) were sighted in sub-areas 7WR and 7E (Table 2a, Figure 3). Because the survey was conducted at the beginning of the migration season of this species, they were only sighted in the southern part of sub-areas 7WR and 7E. The observed mean school size was 1.27. The range of the SST at the sighting positions was 15.6–24.2°C.

Common minke whale

This species was the most frequently sighted species in sub-area 6E (37 schools and 43 individuals including 2 mother and calf pairs) (Table 2a, Figure 3). The range of SST at the sighting positions was 10.1–21.9°C, and the observed mean school size was 1.16. In sub-area 7WR, one school (one individual) was sighted. The SST at the sighting position was 16.5°C and the estimated body length was 7.8 m. A picture of a common minke whale is shown in Figure 7.

Humpback whale

Humpback whales were sighted frequently in sub-areas 7WR and 7E (36 schools and 50 individuals) (Table 2a, Figure 3). No mother and calf pair was sighted. They were mainly sighted in the northern part of sub-areas 7WR and 7E. Observed mean school size was 1.38. The range of SST at the sighting positions was 8.6–18.8°C. In sub-area 6E, one individual was sighted. The SST at the sighting position was 10.4°C and the estimated body length was 12.2 m. This individual was photographed and a biopsy sample was obtained.

Sperm whale

A total of 87 schools (228 individuals) of this species were sighted (Table 2a, Figure 3) in the North Pacific sector. A high-density area of sperm whales was observed in the western part of sub-area 7WR. This high-density area was formed across the Japan Trench. The observed mean school size was 2.62. Because the opportunity to approach the schools was limited, there was little information on body length and calves. The range of SST at the sighting positions was 6.8–24.1°C.

Small cetaceans

The species sighted are shown in Table 2b and their distribution in Figure 3. In this season, one species was identified in the family Ziphiidae, three species were identified in the family Delphinidae and one species was identified in the family Phocoenidae. The most common species sighted were Risso's dolphin (24/212), followed by Pacific white-sided dolphin (22/907). There were many sightings of the family Ziphiidae, but it was difficult to identify the species because of their elusive behavior.

Late summer (August–September)

Blue whale

One individual of estimated body length of 24.5 m. was sighted at 40°54'N, 145°13'E (Table 3a, Figure 4). The SST in the sighting position was 22.8°C This individual was photographed and a biopsy sample was obtained (Figure 8).

Fin whale

Two schools (two individuals) were sighted north of 40°N (Table 3a, Figure 4). The estimated body lengths were 20.8 m and 22.8 m. The range of SST at the sighting positions was 22.5–22.8°C.

Sei whale

This species was not sighted in the research area. However, one individual of 14.2 m in body length was sighted during the transit survey between Hachinohe and the starting point of the research area. The SST at the sighting position was 21.5°C.

Bryde's whale

A total of 67 schools (92 individuals include 8 mother and calf pairs) were sighted. In comparison with the distribution of Bryde's whales in early summer, these were widely distributed except the southern part of the research area (Table 3a, Figure 4). In general, Bryde's whales were widely distributed in summer (from July to September) in the western North Pacific, north of 35°N, based on the previous dedicated sighting surveys (Shimada, 2004, Pastene *et al.*, 2009, Hakamada *et al.*, 2017). The observed mean school size was 1.37. The range of the SST at the

Table 3a
Numbers of sightings of large whales in late summer (August–September).

Season	Species	7WR	
		Sch.	Ind.
Late summer (Aug.–Sep.)	Blue whale	1	1
	Fin whale	2	2
	Sei whale	1	1
	Bryde's whale	67	92
	Like Bryde's	5	5
	Like Sei/Bryde's	1	1
	Sperm whale	30	91
	Unidentified large baleen whale	4	5
	Unidentified large cetacean	1	1

Table 3b
Numbers of sightings of small cetaceans in late summer (August–September).

Season	Species	7WR	
		Sch.	Ind.
Late summer (Aug.–Sep.)	Baird's beaked whale	1	2
	Cuvier's beaked whale	1	2
	Unidentified *Mesoplodon* spp.	2	10
	Unidentified Ziphiidae	12	26
	Common dolphin	14	961
	Northern form short-finned pilot whale	1	20
	Risso's dolphin	2	37
	Melon-headed whale	1	96
	Striped dolphin	8	278

sighting positions was 22.0–27.0°C.

Common minke whale

This species was not sighted in the late summer season.

Humpback whale

Humpback whales were not sighted in the research area. It was considered that humpback whales had migrated to the northern area.

Sperm whale

A total of 30 schools (91 individuals) of this species were sighted in the research area (Table 3a, Figure 4). The observed mean school size was 3.09. The range of the estimated body length was 9.1–12.2 m. The range of SST at the sighting positions was 6.8–24.1°C.

Small cetaceans

The species sighted are shown in Table 3b and their distribution in Figure 4. In this season, two species were identified in the family Ziphiidae and five species were identified in the family Delphinidae. The most common species sighted were common dolphins (14/961), followed by striped dolphins (8/278). In comparison with the results of the early summer (May–June), the distribution of the common, Risso's and striped dolphins extended north of 40°N, and the Pacific white-sided dolphin, which was distributed around 40°N in the early summer season, was not sighted in this season. The SST map shows a temperature around 24°C, even near 40°N (Figure 4), suggesting that the distribution of these dolphins is shifting northward as the water temperature rises.

Autumn (October–November)

Blue whale

Two schools (two individuals) with body lengths of 24.3 m and 25.3 m were sighted in the western part (Table 4a, Figure 5). The SST at the sighting positions was 16.7°C and 17.2°C, respectively. These two individuals were photographed.

Fin whale

A total of 22 schools (38 individuals) were sighted in the research area. In this season, fin whales were mainly sighted north of 40°N (Table 4a, Figure 5). The observed mean school size was 1.73. A school of three fin whales sighted at 42°23'N, 145°56'E on 13 November was chased by a solitary adult male killer whale (Figure 9).

Sei whale

A total of 28 schools (38 individuals) were sighted north of 40°N in the research area. Sei whales were concentrated in the northern coastal part of the research area (Table 4a, Figure 5). The observed mean school size was 1.36. The range of the SST at the sighting positions was 9.1–18.1°C.

Bryde's whale

A total of 37 schools (42 individuals including 1 mother and calf pair) were sighted. In this season, Bryde's whales were mainly sighted in the western part of the research area (Table 4a, Figure 5). The observed mean school size was 1.14. Range of the SST in the sighting positions was 16.8–24.3°C.

Common minke whale

One school (one individual) of body length estimated to be 7.2 m was sighted in the most northern part of the western part of the research area (Table 4a, Figure 5). The SST at the sighting position was 11.3°C.

Humpback whale

A total of 26 schools (42 individuals) of this species was sighted. Sightings were concentrated between 41°N and

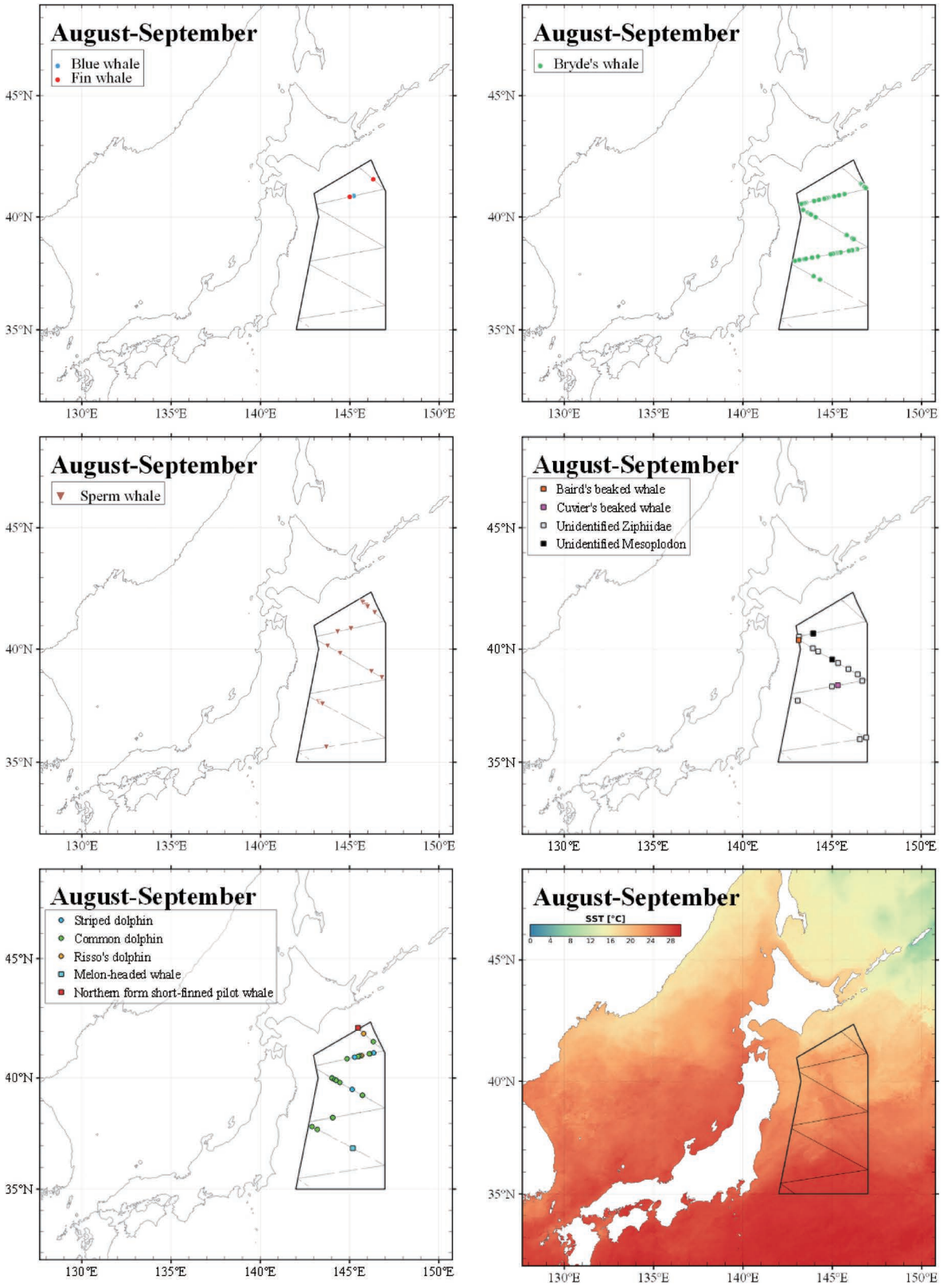

Figure 4. The sighting locations of large and small cetaceans during the late summer (August–September 2019) and information on SST in that season (original data of SST: Ocean color web, from https://oceancolor.gsfc.nasa.gov/).

42°N in the research area (Table 4a, Figure 5). The observed mean school size was 1.62. The range of SST at the sighting position was 8.8–18.8°C. More than half of the schools (65%) were sighted in waters with SST of 11°C.

Sperm whale

A total of 41 schools (107 individuals) of this species were

Table 4a
Numbers of sightings of large whales in autumn (October–November) by each area.

Season	Species	Western part		Eastern part		Total	
		Sch.	Ind.	Sch.	Ind.	Sch.	Ind.
Autumn (Oct.–Nov.)	Blue whale	2	2	0	0	2	2
	Fin whale	10	15	12	23	22	38
	Like fin	0	0	1	2	1	2
	Sei whale	10	11	18	27	28	38
	Bryde's whale	35	39	2	3	37	42
	Common minke whale	0	0	1	1	1	1
	Humpback whale	16	27	10	15	26	42
	Sperm whale	26	52	15	55	41	107
	Unidentified large baleen whale	8	8	1	1	9	9

Table 4b
Numbers of sightings of small cetaceans in autumn (October–November), by each area.

Season	Species	Western part		Eastern part		Total	
		Sch.	Ind.	Sch.	Ind.	Sch.	Ind.
Autumn (Oct.–Nov.)	Baird's beaked whale	3	29	0	0	3	29
	Unidentified Ziphiidae	9	23	4	8	13	31
	Common dolphin	2	70	11	416	13	486
	Southern form short-finned pilot whale	1	4	0	0	1	4
	Risso's dolphin	2	4	0	0	2	4
	Pacific white-sided dolphin	0	0	1	5	1	5
	Killer whale	0	0	3	3	3	3
	Spotted dolphin	0	0	3	75	3	75
	Striped dolphin	1	100	19	537	20	637
	Harbour porpoise	1	4	0	0	1	4
	Dalli type Dall's porpoise	1	15	0	0	1	15
	Truei type Dall's porpoise	2	12	1	25	3	37

sighted (Table 4a, Figure 5). Sightings were concentrated south of 38°N in the research area. The observed mean school size was 2.61. The range of SST at the sighting positions was 11.9–26.7°C.

Small cetaceans

The species sighted are shown in Table 4b and their distribution in Figure 5. In this season, one species was identified in the family Ziphiidae, and seven species were identified in the family Delphinidae and two species were identified in the family Phocoenidae. The most common species sighted were striped dolphins (20/637), followed by common dolphins (13/486). Compared with the late summer (August–September) results, the distribution of the common and striped dolphins shifted to the south and were mainly sighted between 37°N–39°N. The SSTs are decreasing from the north during this season, suggesting that the distribution of these dolphins is moving south as water temperature changes.

Winter (February–March)

Blue whale

This species was not sighted in the winter season.

Fin whale

Three schools (three individuals) were sighted east of 147°E (Table 5a, Figure 6). The range of SST at the sighting positions was 17.3–23.4°C. All four groups were solitary, including one group sighted at 27°47′N, 138°07′E during the transit survey.

Sei whale

A total of 7 schools (14 individuals including 3 mother and

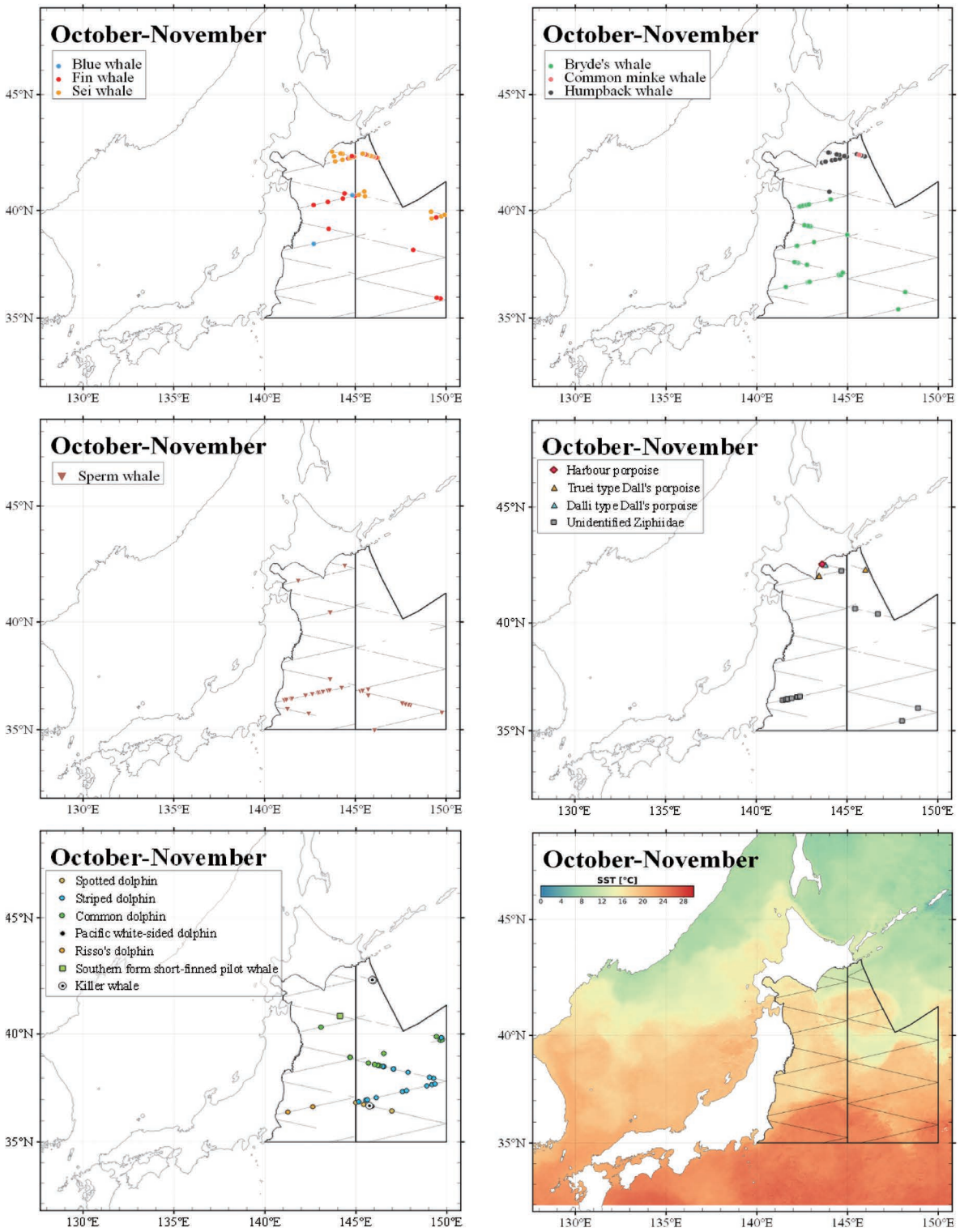

Figure 5. The sighting locations of large and small cetaceans during the autumn (October–November 2019) and information on SST in that season (original data of SST: Ocean color web, from https://oceancolor.gsfc.nasa.gov/).

calf pairs) were sighted in the eastern part of the research area (Table 5a, Figure 6). The range of SST at the sighting positions was 17.4–21.9°C. Sightings occurred only in the eastern part, and the ratio of mother and calf pairs (3/7) was higher than in the other seasons. These data would be useful to identify the breeding ground of sei whales in the North Pacific.

Bryde's whale

A total of seven schools (seven individuals) were sighted in the research area (Table 5a, Figure 6). The range of

Table 5a
Numbers of sightings of large whales in winter (February–March).

Season	Species	Western part		Eastern part		Total	
		Sch.	Ind.	Sch.	Ind.	Sch.	Ind.
Winter (Feb.–Mar.)	Fin whale	0	0	3	3	3	3
	Sei whale	0	0	7	14	7	14
	Like sei	0	0	1	1	1	1
	Bryde's whale	4	4	3	3	7	7
	Humpback whale	13	23	4	7	17	30
	Sperm whale	2	4	8	8	10	12
	Unidentified large baleen whale	1	1	0	0	1	1

Table 5b
Numbers of sightings of small cetaceans in winter (February–March).

Season	Species	Western part		Eastern part		Total	
		Sch.	Ind.	Sch.	Ind.	Sch.	Ind.
Winter (Feb.–Mar.)	Unidentified Ziphiidae	6	10	1	3	7	13
	Common dolphin	1	40	0	0	1	40
	Southern form short-finned pilot whale	2	106	0	0	2	106
	Risso's dolphin	3	20	1	4	4	24
	Killer whale	0	0	1	10	1	10
	Spotted dolphin	1	22	0	0	1	22
	Striped dolphin	1	35	3	270	4	305
	Rough toothed dolphin	1	4	0	0	1	4

SST at the sighting positions was 17.2–22.6°C. All eight groups were solitary. One group was sighted at 26°35'N, 144°52'E during the transit survey.

Common minke whale

This species was not sighted in the winter season.

Humpback whale

A total of 17 schools (30 individuals, including 3 mother and calf pairs) were sighted (Table 5a, Figure 6). Eight of all schools (13 individuals) were sighted in the waters around 27°N, 142°E on 23 February. This area was reported as breeding ground of humpback whales in the western North Pacific (Darling and Mori, 1993). The range of SST at the sighting positions was 17.4–23.6°C. The observed mean school size was 1.76.

Sperm whale

A total of 10 schools (12 individuals) were sighted (Table 5a, Figure 6). The range of SST at the sighting positions was 17.9–22.9°C and the observed mean school size was 1.20. The school size was comparatively smaller than in the other seasons. When the *KY7* entered Suruga Bay on 27 and 28 February in order to shelter from stormy weather, the vessel encountered 11 schools (52 individuals) of sperm whales (secondary sightings). In Suruga Bay, sperm whales were distributed in waters at the center of a submarine canyon (Figure 6). The range of SST at the sighting positions in Suruga Bay was 17.0–18.2°C. The observed mean school size was 4.72.

Small cetaceans

The species sighted are shown in Table 5b and their distribution in Figure 6. No species was identified in the family Ziphiidae because of their elusive behavior. Seven species were identified in the family Delphinidae. Striped (4/305) and Risso's (4/24) dolphins were the most commonly sighted dolphin species.

Duplicate sightings

Duplicate sighting data will be used for analysis of $g(0)$ to accounti for perception bias. A total of 594 re-sightings were recorded during IO mode throughout the whole season involving several species.

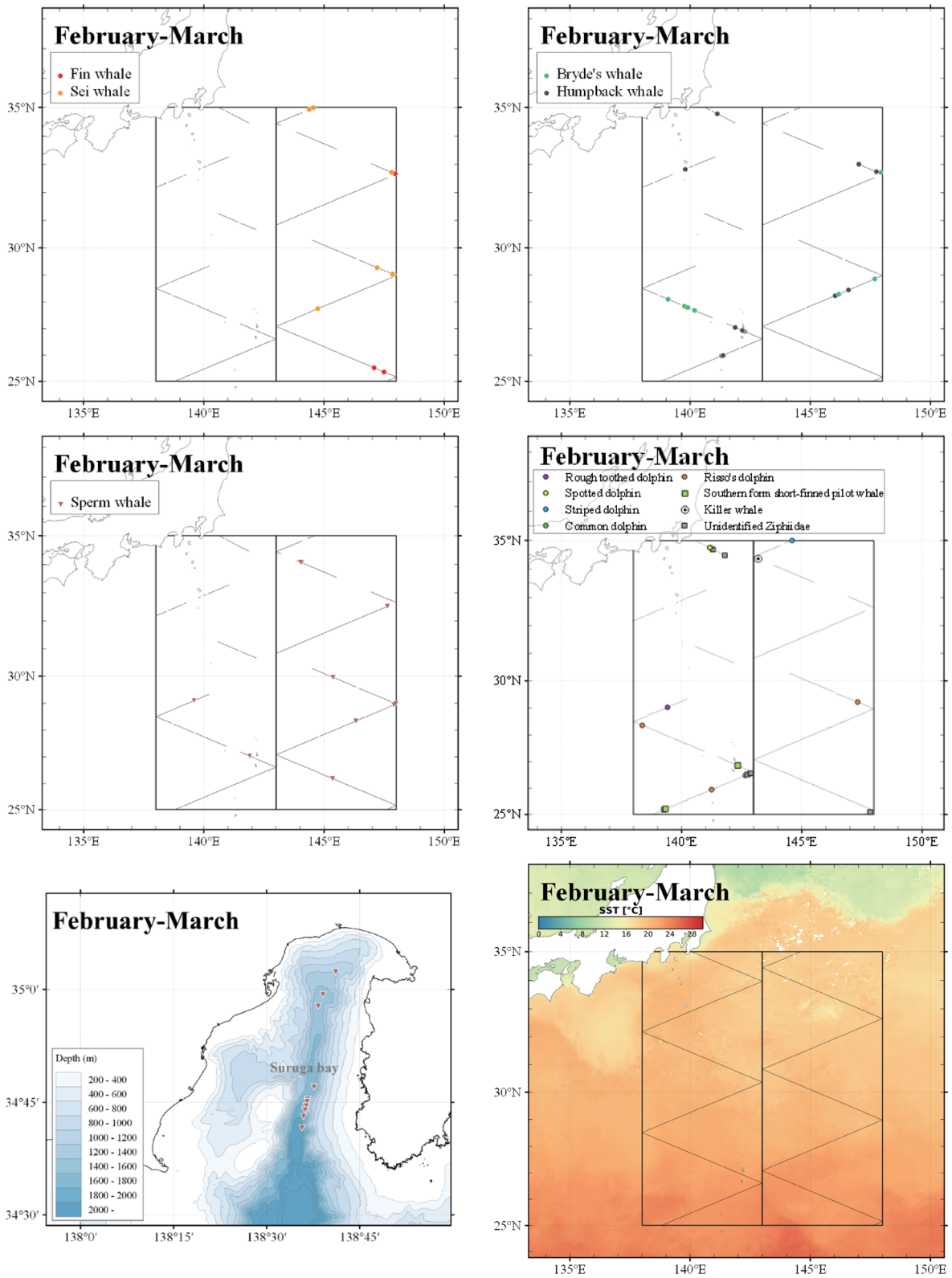

Figure 6. The sighting locations of large and small cetaceans during the winter (February–March 2020) and information on SST in that season (original data of SST: Ocean color web, from https://oceancolor.gsfc.nasa.gov/). Lower left: the sighting locations of sperm whales in Suruga Bay (secondary sightings).

Experiments

Photo-ID

Photo-IDs will be used for investigation of movement, stock structure and site fidelity of cetaceans, and to estimate abundance using the mark-recapture method. Photographs were taken of blue (n=8), humpback (n=26)

Figure 7. A common minke whale surfacing. The white flipper band can be seen below the sea surface.

Table 6
Number of individuals photographed, by each season and sub-area.

Species	Early summer (May–Jun.)			Late summer (Aug.–Sep.)	Autumn (Oct.–Nov.)		Winter (Feb.–Mar.)		Total
	6E	7WR	7E	7WR	Western part	Eastern part	Western part	Eastern part	
Blue whale	0	0	5	1	2	0	0	0	8
Humpback whale	1	0	4	0	5	2	6	8	26
Killer whale	0	2	5	0	0	0	0	0	7
Total	1	2	14	1	7	2	6	8	41

Figure 8. Blow and body of a blue whale.

and killer (n=7) whales throughout the whole season (Table 6). Some small cetaceans were also photographed. All photographs were stored in the Institute of Cetacean Research (ICR) catalogues.

Biopsy sampling

These samples will be used in genetic analyses on stock structure and studies to evaluate the utility of non-lethal techniques for whale biological research. A total of 22 biopsy samples were collected from blue (n=5), fin (n=7), sei (n=5), common minke (n=1), humpback (n=3) and killer (n=1) whales (Table 7). All samples were stored at the ICR laboratory.

Satellite tagging

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 low latitude breeding areas and high latitude feeding areas. Satellite tags were successfully attached on fin (n=6), sei (n=14) and Bryde's (n=1) whales (Table 8).

HIGHLIGHTS OF THE SURVEY

The sighting surveys conducted in 2019/20 were completed successfully. They provided unique data obtained not only in summer, but also in autumn and winter 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 common minke and fin whales were sighted in May–June in the southern part of the Sea of Japan. These data are unique and will be analyzed in combination with available sighting data from the northern

Figure 9. One adult male killer whale chasing a school of three fin whales. Clipped from a video taken from a distance.

Table 7

Number of biopsy samples collected, by each season and research area. The biopsy sampling was conducted in early summer (all areas), late summer (7WR) and autumn (eastern part).

Species	Early summer (May–Jun.)			Late summer (Aug.–Sep.)	Autumn (Oct.–Nov.)	Total
	6E	7WR	7E	7WR	Eastern part	
Blue whale	0	0	4	1	0	5
Fin whale	0	1	3	0	3	7
Sei whale	0	0	2	0	3	5
Common minke whale	1	0	0	0	0	1
Humpback whale	1	0	2	0	0	3
Killer whale	0	1	0	0	0	1
Total	2	2	11	1	6	22

Table 8

Number of individuals attached with satellite tags, by each season and sub-area. The tagging was conducted in early summer (6E and 7E), autumn (whole area) and winter (eastern part).

Species	Early summer (May–Jun.)		Autumn (Oct.–Nov.)		Winter (Feb.–Mar.)	Total
	6E	7E	Western part	Eastern part	Eastern part	
Fin whale	1	1	3	1	0	6
Sei whale	0	2	4	3	5	14
Bryde's whale	0	0	0	0	1	1
Total	1	4	7	4	6	22

part of the Sea of Japan obtained in 2018. The purpose will be to estimate common minke whale abundance in the Sea of Japan, an area where recent information on abundance is scarce.

A large number of Bryde's, humpback and sperm whales were sighted in May–June in the northern part of the Pacific side of Japan. No common minke whales were sighted during this season in this area which suggests that most common minke whales are likely to have already moved north into the Russian EEZ.

The survey in August–September covered the northern part of the Pacific side of Japan, and provided important summer sighting data for Bryde's whales, which will be used for the abundance estimation of this species. It was also confirmed that blue, fin and sperm whales were also distributed in this area, though in small numbers.

A large number of sei and fin whales were sighted in October–November in the coastal area. This area had never been surveyed in this season. These species were sighted north of latitude 40°N. A large number of Bryde's whales and a small number of blue whales were sighted south of 40°N in this season. In addition, it was confirmed

Figure 10. Breaching of a Baird's beaked whale. The long, stout beak and the prominent melon-shaped head identify this species.

that sperm whales are still distributed south of 38°N in this season.

During the February–March survey in the waters around Ogasawara Islands, several fin and sei whales were sighted possibly before their migration to the north. Of particular value are the satellite tags attached on some of these whales. In addition, Bryde's whales and humpback whales were sighted possibly before their migration to the north. Several schools of sperm whales were sighted in the central part of Suruga Bay in waters of 1,000 m depth.

As with the previous surveys, the 2019/20 surveys collected data on small cetaceans in the same way as large whales. The analyses of these data will provide valuable information on the distribution and abundance of small cetaceans in different seasons.

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