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Report and highlights of the dedicated sighting surveys in the western North Pacific Ocean in 2021

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ABSTRACT

Vessel-based sighting surveys were conducted in 2021 by the Institute of Cetacean Research to examine the distribution and abundance of whales in the western North Pacific Ocean. The research area was between 30°N–53°N and 150°E–155°W. The surveys were conducted between 4 August and 30 September, and two research vessels, *Yushin-Maru* and *Kaiyo-Maru* No.7, were engaged in the surveys. A total of 3,713.8 n.miles was searched by the passing mode in the research area. Coverage of the searching efforts on the planned cruise track line was 70.4%. In total, seven large whale species, including blue (17 schools/20 individuals), fin (78/124), sei (102/156), Bryde's (57/72), common minke (1/1), humpback (13/16) and sperm (94/193) whales were sighted during the research period. Photo-ID images were collected from blue (12 individuals), humpback (5 individuals) and sperm (1 individual) whales. Biopsy skin samples using a Larsen system were collected from blue (n=1), fin (n=5), sei (n=15) and humpback (n=3) whales. The density indices of blue and fin whales have increased notably since the last survey in the same research area 10 years ago. Furthermore, Bryde's and humpback whales, which were not detected in the previous surveys, were sighted in the 2021 surveys.

INTRODUCTION

Dedicated cetacean sighting surveys in the western North Pacific have been conducted in the 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) (Anon, 2008). Based on the data collected from those surveys, 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 Scientific Committee (SC) (IWC, 2001; 2010; 2016).

The Fisheries Resources Institute (FRI) has also conducted dedicated sighting surveys for cetaceans in the North Pacific Ocean since the 1980s (Buckland *et al.*, 1992; Miyashita *et al.*, 1995; Miyashita and Kato, 2004; 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 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 the management and conservation of large whales by the IWC SC (IWC, 2016).

This paper reports the results of the latest Japanese dedicated sighting surveys conducted by the Institute of Cetacean Research (ICR) between 4 August and 30 September 2021.

SURVEY DESIGN

Research vessels

The surveys in 2021 were conducted by the research vessels *Kaiyo-Maru* No.7 (*KY7*) and *Yushin-Maru* (*YS1*). The vessels were equipped with a top barrel platform (TOP), IO barrel platform (IOP) and upper bridge. Specifications of these vessels are shown in Figure 1.

Research period and area

In 2021, surveys were conducted in late summer (August to September), and the research areas were between 30°N–40°N and 150°E–180°for *KY7*, and between 40°N–53°N and 180°–155°W for *YS1* (Figure 2).

Track line design

The pre-determined track lines in the research area are

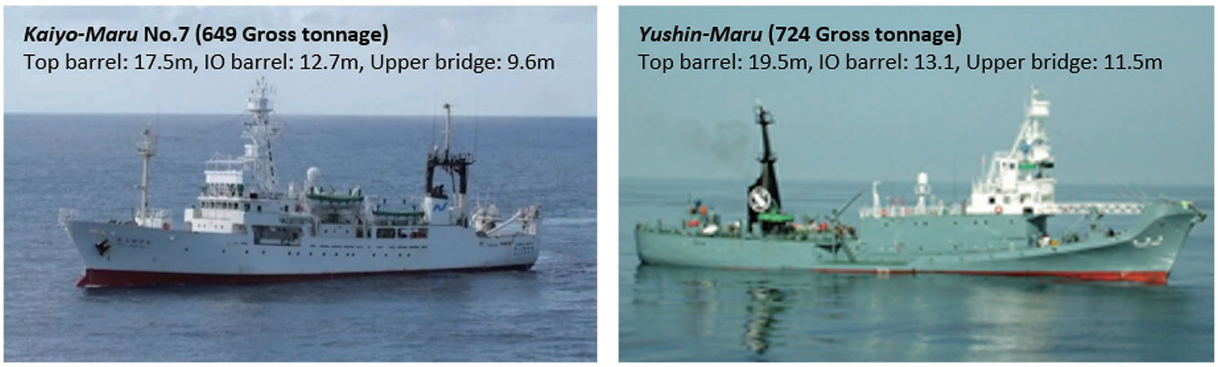

Figure 1. Research vessels *Kaiyo-Maru* No.7 (*KY7*) (left) and *Yushin-Maru* (*YS1*) (right).

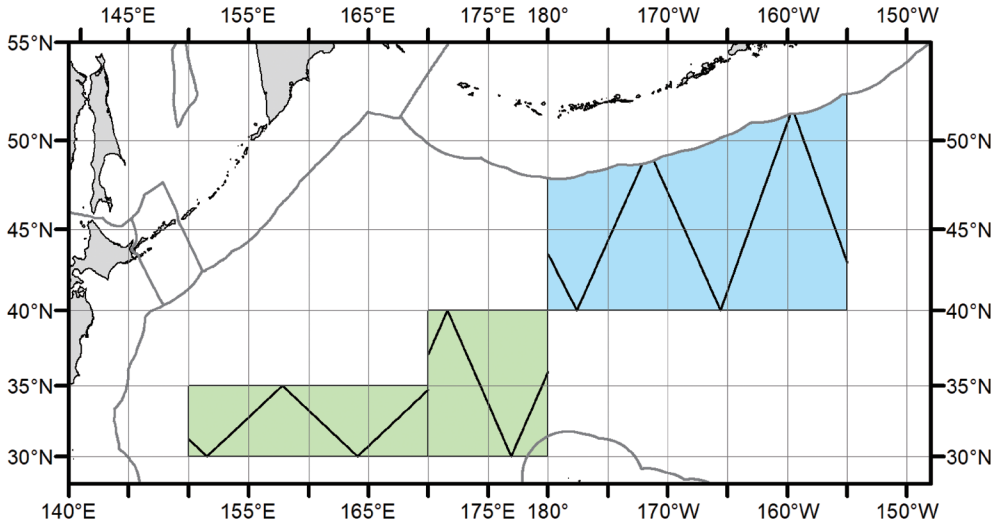

Figure 2. Research areas of the 2021 sighting survey held from August to September. *KY7* covered the green area, and *YS1* covered the blue area.

shown in Figure 2. The start point of the track lines were decided randomly using the "Distance program ver. 7.0" (Thomas *et al.*, 2010), and the number of the line transects was decided by considering the research schedule and based on the IWC survey guidelines (IWC, 2012).

Sighting procedures

The sighting survey was conducted using (1) Normal Passing mode (NSP) and (2) Passing with Independent Observer mode (IO). Data obtained under the IO mode are useful for future estimations of $g(0)$. Both survey modes followed the protocol endorsed for the SOWER surveys (e.g. Matsuoka *et al.*, 2003; Anon, 2008; IWC, 2012).

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

For IO mode, there were two primary observers on the TOP and two on the IO barrel platform (IOP). These observers conducted the searching activity for cetaceans by using 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 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 sighting survey effort began 60 minutes after sunrise and ended 60 minutes before sunset, with a maximum of 12 hours per day when the weather conditions were acceptable for observations: visibility better than 2.0 n.miles and wind speed less than 21 knots. The searching speed was planned to be 10.5 to 11.5 knots with slight adjustments to avoid vibration of the vessel.

Experiments

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

Table 1
Summary of the survey periods and searching effort in each 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 (%)
KY7	2021/08/11–08/21	1,226.1	455.1	470.7	925.8	75.5
	2021/08/30–09/09	1,392.5	533.1	534.4	1,067.5	76.7
YS1	2021/08/18–09/20	2,658.6	752.3	968.2	1,720.5	64.7
Total	–	5,277.2	1,740.5	1,973.3	3,713.8	70.4

Table 2
Numbers of sightings of large cetaceans, by species and research vessel in the 2021 surveys.

Vessel	Transit (Including both vessels)				*KY7* (150°E–180°)				*YS1* (180°–155°W)				Total			
Species	Prim.		Second.		Prim.		Second.		Prim.		Second.		Prim.		Second.	
	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.
Blue whale	0	0	0	0	0	0	0	0	17	20	0	0	17	20	0	0
Fin whale	8	13	0	0	1	1	0	0	66	107	3	3	75	121	3	3
Sei whale	1	1	0	0	0	0	0	0	98	146	3	9	99	147	3	9
Bryde's whale	12	20	1	1	20	25	0	0	24	26	0	0	56	71	1	1
Common minke whale	0	0	0	0	0	0	0	0	1	1	0	0	1	1	0	0
Humpback whale	0	0	0	0	0	0	0	0	11	13	2	3	11	13	2	3
Sperm whale	32	72	3	5	34	90	0	0	24	25	1	1	90	187	4	6

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

(IWC, 2012).

When large cetaceans such as blue and humpback whales were found, 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 system (Larsen, 1998) was conducted when blue, fin, sei, humpback whales were sighted. A satellite tagging experiment using the Air Rocket Transmitter System (LK-ARTS) was also conducted for fin and sei whales.

RESULTS

Brief narrative of the surveys

KY7 departed Shiogama, Miyagi, Japan on 4 August, and started the transit survey on 5 August. *KY7* began the survey in the research area from the east on 11 August. *KY7* paused the survey at 170°E on 21 August for a scheduled port call, and entered Kushiro, Hokkaido, Japan, on 26 August for refueling and disembarkation of researchers. On 27 August, *KY7* departed Kushiro, and reached the resume point at 170°E on 30 August. The survey was completed on 9 September. *KY7* arrived in Shiogama, Miyagi on 17 September.

YS1 departed Shimonoseki, Yamaguchi, Japan on 4 August, and started the transit survey on 6 August. On 18 August, *YS1* reached the start point at 155°W, and completed the survey on 20 September. *YS1* and arrived in Shiogama, Miyagi, on 30 September.

Searching effort

A summary of searching effort and coverage by each research vessel is shown in Table 1. A total of 3,713.8 n.miles (6,878.0 km) were searched. The total searching effort by *KY7* was 925.8 n.miles (1,714.6 km) (75.5% coverage) in the eastern part, and 1,067.5 n.miles (1,977.0 km) (76.7% coverage) in the western part. The total searching effort by *YS1* was 1,720.5 n.miles (3,186.4 km) (64.7% coverage).

Sightings

Overall

Sightings were summarized by each research vessel in Table 2 for large cetaceans and in Table 3 for small cetaceans.

There was a total of 349 schools sighted of seven large whale species, involving 560 individual whales. The largest number of sightings was for sperm whales (in terms of

Table 3
Numbers of sightings of small cetaceans, by species and research vessel in the 2021 surveys.

Vessel	Transit (Including both vessels)				*KY7* (150°E–180°)				*YS1* (180°–155°W)				Total			
Species	Prim.		Second.		Prim.		Second.		Prim.		Second.		Prim.		Second.	
	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.
Killer whale	0	0	0	0	0	0	0	0	7	18	0	0	7	18	0	0
Melon-headed whale	0	0	0	0	1	105	0	0	0	0	0	0	1	105	0	0
Risso's dolphin	3	45	0	0	3	21	0	0	1	3	0	0	7	69	0	0
Striped dolphin	11	1,549	0	0	3	225	0	0	0	0	0	0	14	1,774	0	0
Common dolphin	0	0	0	0	1	6	0	0	7	288	0	0	8	294	0	0
Pacific white-sided dolphin	1	12	0	0	0	0	0	0	14	392	1	13	15	404	1	13
Northern right whale dolphin	3	14	0	0	0	0	0	0	2	223	0	0	5	237	0	0
True type Dall's porpoise	0	0	0	0	0	0	0	0	2	4	0	0	2	4	0	0
Dalli type Dall's porpoise	0	0	0	0	0	0	0	0	11	74	0	0	11	74	0	0
Unid. type Dall's porpoise	0	0	0	0	0	0	0	0	7	27	0	0	7	27	0	0
Ziphiidae	4	16	0	0	21	44	0	0	3	4	0	0	28	64	0	0
Mesoplodon spp.	1	1	0	0	2	3	0	0	1	3	0	0	4	7	0	0

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

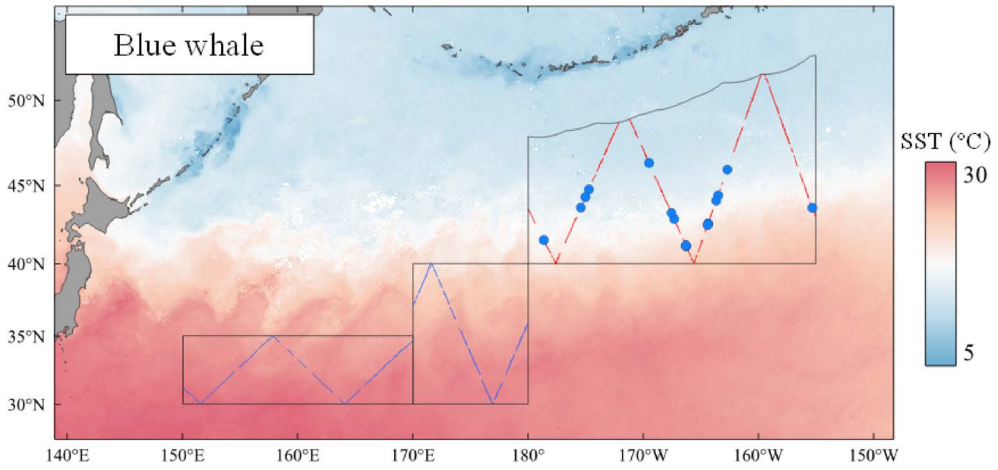

Figure 3. The sighting distribution of blue whales (blue circle) with the searching track of *KY7* (blue line) and *YS1* (red line). Rolling 32 days average sea surface temperature from 13 August to 13 September 2021 was observed by MODIS-Aqua (Original data: Ocean color web, from https://oceancolor.gsfc.nasa.gov/ (Accessed 2022-7-18)).

number of individuals) and the smallest was for common minke whales. The largest number of sightings in baleen whales was for sei whales (Table 2).

In terms of small cetaceans, seven species were identified in the family Delphinidae, and one species was identified in the family Phocoenidae. No species were identified in the family Ziphiidae because of their elusive behavior. The most common species sighted were striped dolphins (14/1,774), followed by Pacific white-sided dolphins (16/417) (Table 3).

Geographical distribution of sightings by cetacean species

Blue whale

The geographical distribution of the sightings is shown in Figure 3 together with sea surface temperature. In total, one mother and calf pair was sighted at position 44°45'N, 174°43'W. The mean school size was 1.2 and the range of sea surface temperature (SST) at the sighting positions was 11.5–19.7°C (mean SST: 16.3°C).

The density index (DI: schools sighted/100 n.miles searching distance) based on primary sightings in the research area for *YS1* was 0.99. The DIs were 0.15 and 0.48

in the 2010 and 2011 IWC-POWER cruises, respectively, which were conducted north of 40°N. The longitudinal ranges of those cruises were 170°E–170°W and 170°W–150°W, respectively (Matsuoka *et al.*, 2011; 2012). It should be noted that the survey period in 2021 was about one month later than in the previous IWC-POWER surveys. The DIs suggest that the population of blue whales in the North Pacific is increasing. A photograph of a blue whale is shown in Figure 4.

Figure 4. A blue whale observed in the research area on 10 September 2021.

Fin whale

The geographical distribution of the sightings is shown in Figure 5 together with sea surface temperature. In total, one mother and calf pair was sighted at position 45°53'N, 174°00'W. Fin whales were distributed mainly throughout the research area surveyed by the *YS1*. The observed mean school size was 1.6 and the range of SST at the sighting positions was 11.0–20.3°C (mean SST: 14.9°C).

The DI of *YS1* was 3.84. The DI in the previous 2010 and 2011 IWC-POWER surveys were 0.53 and 1.79, respectively (Matsuoka *et al.*, 2011; 2012). As in the case of blue whales, the DIs suggest that the fin whale population in the North Pacific is increasing.

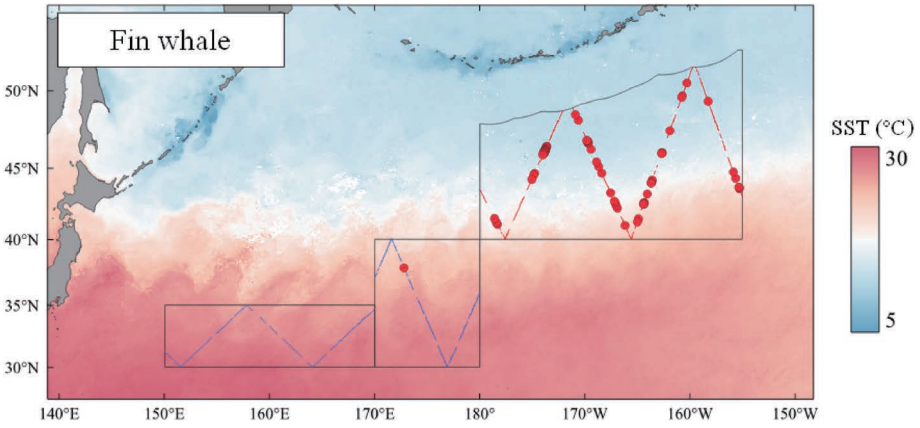

Figure 5. The sighting distribution of fin whales (red circle) with the searching track of *KY7* (blue line) and *YS1* (red line). Rolling 32 days average sea surface temperature from 13 August to 13 September 2021 was observed by MODIS-Aqua.

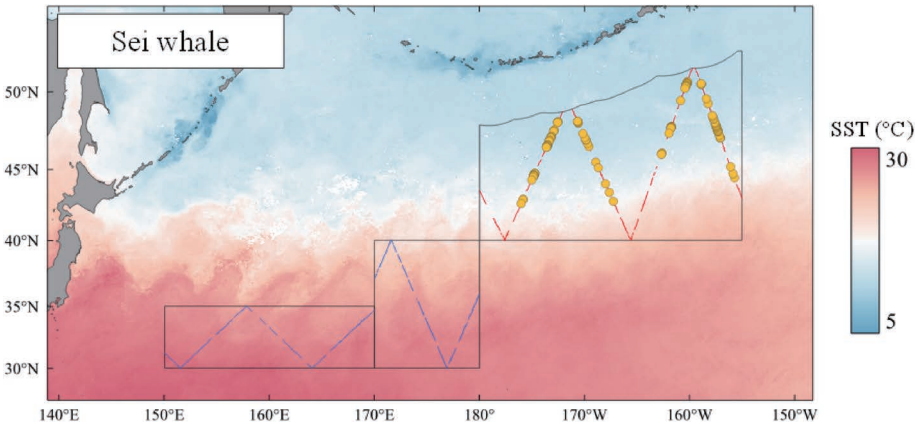

Figure 6. The sighting distribution of sei whales (orange circle) with the searching track of *KY7* (blue line) and *YS1* (red line). Rolling 32 days average sea surface temperature from 13 August to 13 September 2021 was observed by MODIS-Aqua.

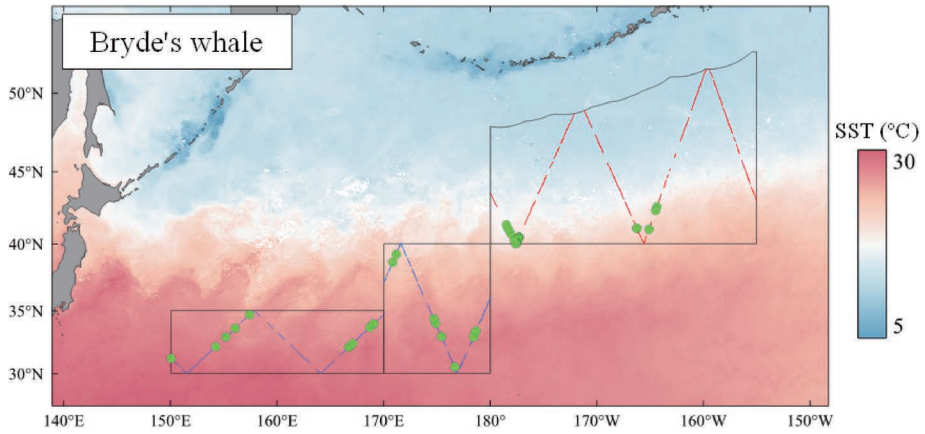

Figure 7. The sighting distribution of Bryde's whales (green circle) with the searching track of *KY7* (blue line) and *YS1* (red line). Rolling 32 days average sea surface temperature from 13 August to 13 September 2021 was observed by MODIS-Aqua.

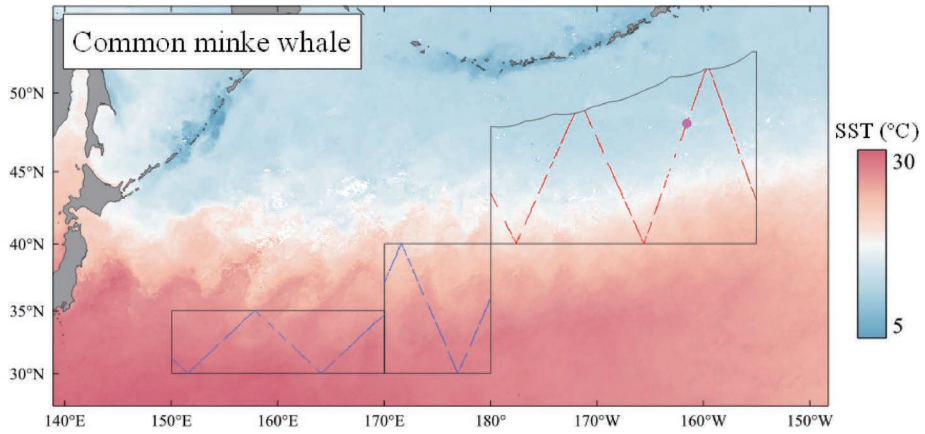

Figure 8. The sighting distribution of common minke whales (pink circle) with the searching track of *KY7* (blue line) and *YS1* (red line). Rolling 32 days average sea surface temperature from 13 August to 13 September 2021 was observed by MODIS-Aqua.

Sei whale

The geographical distribution of the sightings is shown in Figure 6 together with sea surface temperature. This species was sighted north of 42°N in the survey area of the *YS1*. No mother and calf pairs were observed. High density was observed in the latitudinal band between 47°N and 49°N (Figure 6). The observed mean school size was 1.5 and the range of SST at the sighting positions was 10.9–17.4°C (mean SST: 12.6°C).

The DI of *YS1* was 5.70. The DIs of the 2010 and 2011 IWC-POWER surveys were 3.55 and 2.21, respectively (Matsuoka *et al.*, 2011; 2012). These values were smaller than those found in the 2021 surveys.

Bryde's whale

The geographical distribution of the sightings is shown in Figure 7 together with sea surface temperature. One mother and calf pair was observed at position 41°03'N, 178°18'W. Bryde's whales were widely distributed longitudinally north of 30°N, which is similar to the pattern found in previous surveys (Shimada, 2004; Hakamada *et al.*, 2017). Based on sighting data by *KY7*, the observed mean school size was 1.3, and the range of SST at the sighting positions was 21.4–29.7°C (mean SST: 27.2°C). Based on sighting data by *YS1*, the observed mean school size was 1.1, and the range of SST at the sighting positions was 17.5–20.7°C (mean SST: 20.1°C).

The DIs were 1.00 and 1.39 by the *KY7* and *YS1*, respectively. Bryde's whales were not sighted north of 40°N in the previous IWC-POWER surveys (Matsuoka *et al.*, 2011; 2012), however in the 2021 surveys some sightings were made north of that latitude (Figure 7) The northern most sighting position in these surveys was 42°36'N.

Common minke whale

The geographical distribution of the sightings is shown in Figure 8 together with sea surface temperature. Only one school (one individual) was sighted at 48°07'N, 161°34'W

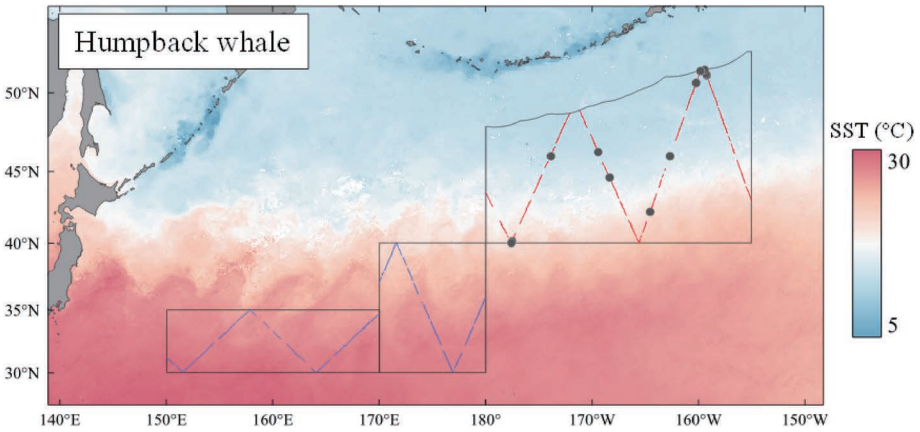

Figure 9. The sighting distribution of humpback whales (black circle) with the searching track of *KY7* (blue line) and *YS1* (red line). Rolling 32 days average sea surface temperature from 13 August to 13 September 2021 was observed by MODIS-Aqua.

Figure 10. A humpback whale sighted at 40°N on 18 September, 2021.

in calm weather conditions. The SST at the sighting position was 12.5°C. Common minke whales are hard to find under harsh sea surface conditions because their small blows are difficult to detect in such conditions.

Humpback whale

The geographical distribution of the sightings is shown in Figure 9 together with sea surface temperature. No mother and calf pair of this species were sighted. Sightings were made north of 40°N only in the area surveyed by *YS1* (Figure 9). The range of SST at the sighting positions was 10.7–20.7°C (mean SST: 13.8°C).

The DI based on primary sightings of *YS1* was 0.64. In previous surveys, humpback whales were not sighted south of 47°N (Matsuoka *et al.*, 2011; 2012). In the 2021 surveys, two schools were sighted around 40°N, and one individual was photographed (Figure 10). A biopsy sample was collected from this individual.

Sperm whale

The geographical distribution of the sightings is shown in Figure 11 together with sea surface temperature. This species was distributed widely in the research areas (Figure 11). The observed mean school size differed markedly between the research areas covered by the two vessels: 2.6 in the area covered by *KY7* and 1.0 by the area covered by *YS1*.

Small cetaceans

The geographical distribution of the sightings of small cetaceans is shown in Figures 12a and 12b together with sea surface temperature. Killer whales, Pacific white-sided dolphins and Dall's porpoises were mainly sighted north of 42°N, while common dolphins were sighted primarily in the 40°N–42°N latitudinal band. Striped dolphins were not sighted north of 40°N. These distribution patterns of small cetaceans were consistent with those found in the previous IWC-POWER surveys conducted ten years ago (Matsuoka *et al.*, 2011; 2012).

Duplicate sightings

A total of 31 and 96 duplicates of large cetaceans were recorded during IO mode surveys by *KY7* and *YS1*, respectively.

Experiments

Sighting distance and angle experiment

The Estimated Angle and Distance Training Exercise was conducted during the surveys using a buoy that resembles a blow with a reflector. During the exercise, the observers familiarized themselves with distance estimates from the TOP, IO and Upper Bridge. The Estimated Angle and Distance Experiment was conducted on 23 September by *YS1* on 14 August by *KY7*. The results of this experiment will be used for the calculation of abundance estimates.

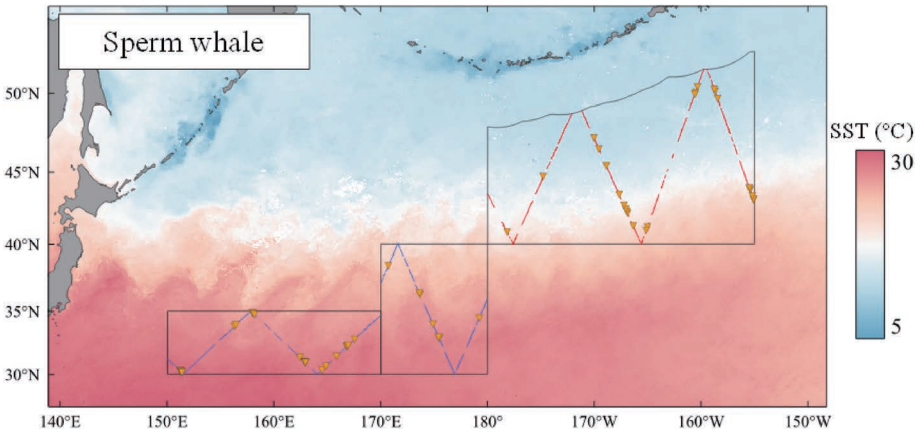

Figure 11. The sighting distribution of sperm whales (inverted brown triangle) with the searching track of *KY7* (blue line) and *YS1* (red line). Rolling 32 days average sea surface temperature from 13 August to 13 September 2021 was observed by MODIS-Aqua.

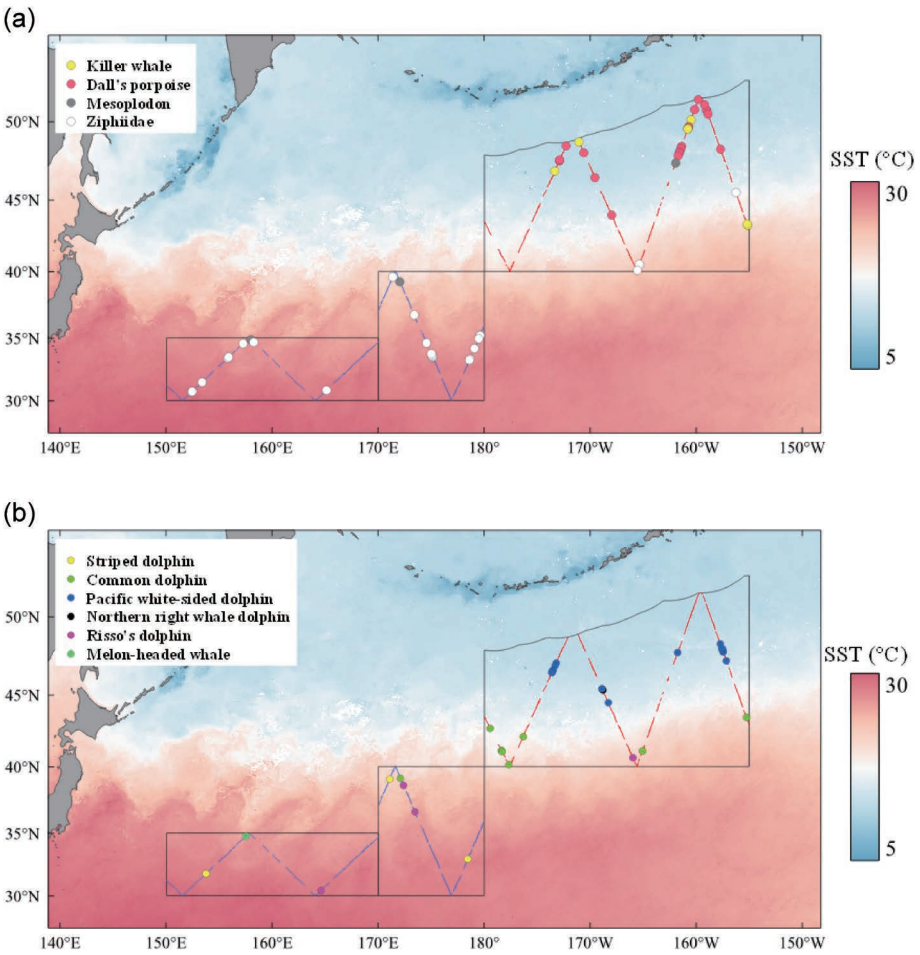

Figure 12. (a) The sighting distribution of killer whales, Dall's porpoise, unidentified *Mesoplodon* spp., and Ziphiidae with the searching track of *KY7* (blue line) and *YS1* (red line). Rolling 32 days average sea surface temperature from 13 August to 13 September 2021 was observed by MODIS-Aqua. (b) The sighting distribution of striped, common, Pacific white-sided, northern right whale, Risso's dolphin and melon-headed whale with the searching track of *KY7* (blue line) and *YS1* (red line). Rolling 32 days average sea surface temperature from 13 August to 13 September 2021 was observed by MODIS-Aqua.

Photo-ID

Photographs were taken of blue (*n*=12), humpback (*n*=5) and sperm (*n*=1) whales. All photographs were stored in the ICR catalog and will be used for investigating stock structure and movement of these species in the future.

Biopsy sampling

A total of 24 biopsy samples were collected from blue (*n*=1), fin (*n*=5), sei (*n*=15) and humpback (*n*=3) whales. All samples were stored at the ICR laboratory and will be used in genetic analyses to investigate stock structure of these species in the future.

Satellite tagging

Two fin and nine sei whales were successfully tagged and tracked. Results of this experiment are shown in Konishi and Isoda (2022).

HIGHLIGHTS OF THE SURVEY

The sighting surveys conducted in 2021 were completed successfully. They provided unique data for summer months, as information on cetacean distribution and abundance during summer have been very scarce. Some main characteristics of the surveys are summarized below.

The surveys in August–September covered the northern part of the central Pacific, and provided important summer sighting data for, fin, sei, Bryde's and sperm whales. These data will be used for the abundance estimation of those species. At the same time, it was confirmed that blue, humpback and common minke whales were also distributed in these areas, although in small numbers.

The DI of blue, fin and sei whales increased significantly compared with previous IWC-POWER surveys conducted ten years ago. The distribution pattern of these three species overlapped in terms of the latitudinal band and SSTs (Figures 3, 5 and 6). The distribution pattern of these three species were consistent with those in the previous surveys from ten years ago. On the other hand, the distribution of Bryde's and humpback whales were different. Ten years ago, Bryde's whales were not sighted and humpback whales were sighted only north of 47°N. The result of the 2021 surveys showed that Bryde's whale distribution either expanded or shifted northward, and humpback whale distribution expanded or shifted southward.

As with the previous surveys, the 2021 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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