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Taiki Katsumata, Isamu Yoshimura, Masaomi Tsunekawa, Shinya Kawabe, Koji Matsuoka

INTERNATIONAL WHALING COMMISSION

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TAIKI KATSUMATA [1], ISAMU YOSHIMURA [2], MASAOMI TSUNEKAWA [2], SHINYA KAWABE [2] AND KOJI MATSUOKA[1],

[1]*Institute of Cetacean Research, Toyomi 4-5, Chuo-ku Tokyo 104-0055, JAPAN*
[2]*Kyodo Senpaku Co. Ltd., Toyomi 4-5, Chuo-ku Tokyo 104-0055, JAPAN*

Contact e-mail: katsumata@cetacean.jp

ABSTRACT

A systematic large-scale vessel-based sighting survey was conducted in 2019 by Japan to examine the distribution and abundance of large whales in the western North Pacific. In this year, as a first attempt, the survey was also conducted in autumn and winter season, which information was very poor so far. The research area was set between 25ºN-45ºN and 128ºE-150ºE (a part of sub-areas 2, 6E and 7 for common minke whale's RMP *Implementation*). The survey was conducted between 10th May, 2019, and 18th March, 2020, divided into four seasons (Early summer, Late summer, Autumn and Winter season). The research vessels *Yushin-Maru, Yushin-Maru No.2, Yushin-Maru No.3* and *Kaiyo-Maru No.7* were engaged in the surveys. A total of 9,415.9 n.miles was searched by the passing mode in the research area. Coverage of the searching efforts of the planned cruise track line was 94% for early summer, 86% for late summer, 75% for autumn and 70% for winter survey. In total, seven large whale species including blue (7 schools/8 individuals), fin (51/81), sei (34/66), Bryde's (161/204), common minke (43/49), humpback (86/130) and sperm (182/481) whales were sighted during whole research. Photo-ID images were collected from blue (8 individuals), humpback (26 individuals), killer (7 individuals) whales. Biopsy skin samples using a Larsen system were collected from blue (n=5), fin (n=7), sei (n=5), common minke (n=1), humpback (n=3) and killer (n=1) whales. Satellite tags were attached on blue (n=1), fin (n=6), sei (n=14) and Bryde's (n=1) whales. The sighting data will contribute to the work on management and conservation of large whales.

KEYWORDS: BLUE WHALE, FIN WHALE, BRYDE'S WHALE, SEI WHALE, COMMON MINKE WHALE, HUMPBACK WHALE, SPERM WHALE, SURVEY VESSEL, NORTH PACIFIC, SEA OF JAPAN

INTRODUCTION

In the western North Pacific dedicated cetacean sighting surveys have been conducted in the summer 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). 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, Pastene *et al*., 2009, Hakamada *et al.*, 2009, Matsuoka *et al*., 2014, 2016, Murase *et al*., 2009). 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., Miyashita and Kato, 2004; 2005, Shimada, 2004, Kanaji, 2012). In 2017 the Government of Japan planned to continue the sighting surveys in the North Pacific. The collection of sighting data to estimate abundance and biopsy/photo-identification data to examine stock structure have contributed to the work on management and conservation of large whales by the IWC SC (IWC, 2010, 2016).

In this year in addition to the usual summer survey season, sighting surveys were also conducted in the autumn (October-November) and the winter (February-March) seasons. The objective of the extra surveys was to provide basic information on distribution and abundance of large whales in poorly documented seasons. In the autumn, assuming that baleen whales migrate from the feeding area to the wintering area, the survey area was set between 35°N-42°N experimentally. In winter, assuming baleen whales (especially Bryde's whale) stay in temperate waters as a wintering area, the survey area was set between 25°N -35°N experimentally. On the other hand, the research areas of the early and late summer survey were set based on a survey plan covering the western North Pacific in several years.

This paper reports the result of the Japanese dedicated sighting surveys conducted during May 2019 to March 2020 divided into four seasons (early summer, late summer, autumn and winter). The plan for the survey of early summer (May-June) and late summer (August-September) had been presented to the 2019 IWC/SC meeting (Hakamada *et al*., 2019) and endorsed by the SC (IWC, 2019).

MATERIALS AND METHODS

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), IO barrel platform (IOP) and upper bridge. Specifications of these vessels are shown in Appendix A.

Research period and area

In 2019, surveys were conducted in four seasons. First in early summer (May to June), and the research area was set up between 33ºN-45ºN and 128ºE-150ºE (a part of sub-area 6E, 7WR and 7E for common minke whale's RMP *Implementation*).

Second, in late summer (August to September), and the research area was set up between 35ºN-42ºN and 142ºE-147ºE (sub-area 7WR for common minke whale's RMP *Implementation*).

Third, in the autumn season (October to November), and the research area was set up between 35ºN-42ºN and 140ºE-150ºE (sub-area 7 for common minke whale's RMP *Implementation*). The research area was divided into "Western part" and "Eastern part".

Finally, in the winter season (February to March), and the research area was set up between 25ºN-35ºN and 138ºE-148ºE (a part of sub-area 2 for common minke whale's RMP *Implementation*) and the research area was divided into as "West" and "East" parts. Figure 1 illustrates the research areas in each season.

Track line design

The survey blocks and pre-determined track lines are shown in Tables from 2a to 2h and Figure 1. 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 (width in the longitude) was decided by the research schedule based on the IWC survey guidelines (IWC, 2012).

Sighting procedure

The sighting survey was conducted using (1) Normal Passing mode (NSP) and (2) Passing with Independent Observer mode (IO) in order to estimate whale abundance considering estimated g(0). Both survey modes followed the protocol endorsed for the SOWER surveys (e.g. Matsuoka *et al*., 2003; IWC, 2008, 2012).

For NSP mode, there were two primary observers in the top barrel (TOP) and 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 the independent observer platform (IOP), respectively. These observers on TOP and IOP also conducted searching for cetaceans by 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, with the top-men only to clarify information and did not distract the top-men from their normal search 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: visibility better than 2.0 n.miles and wind speed less than 17 knots in the early and late summer, 21knots in the autumn and winter season. The searching speed was planned to be 10.5 to 11.5knots with slight adjustment to avoid vibration of the vessel.

Research personnel

One or two researchers were on board of each research vessel. The researchers had considerable experience in whale line-transect surveys in the North Pacific and the Antarctic as well as experience conducting photo-ID and biopsy experiments through participation in the IWC/POWER and NEWREP-NP programs.

Early Summer

Yushin-Maru (YS1)
- Masaomi Tsunekawa (Japan) – sighting data, photo-ID, biopsy
- Yu Ueda (Japan) – sighting data, photo-ID, biopsy

Yushin-Maru No.2 (YS2)
- Isamu Yoshimura (Japan)– sighting data, photo-ID, biopsy, satellite tag

Kensuke Fujii (Japan) – sighting data, photo-ID, biopsy
Yushin-Maru No.3 (YS3)
Taiki Katsumata (Japan)– sighting data, photo-ID, biopsy, satellite tag
Shinya Kawabe (Japan) – sighting data, photo-ID, biopsy

Late Summer
Kaiyo-Maru No.7 (KY7)
Taiki Katsumata (Japan) – sighting data, photo-ID, biopsy
Kensuke Fujii (Japan) – sighting data, photo-ID, biopsy

Autumn
Yushin-Maru No.3 (YS3)
Shinya Kawabe (Japan)– sighting data, photo-ID, satellite tag
Riki Omukai (Japan) – sighting data, photo-ID
Kaiyo-Maru No.7 (KY7)
Taiki Katsumata (Japan) – sighting data, photo-ID, biopsy, satellite tag
Futoshi Yamaguchi (Japan) – sighting data, photo-ID, biopsy

Winter
Yushin-Maru No.3 (YS3)
Riki Omukai (Japan)– sighting data, photo-ID, satellite tag
Kaiyo-Maru No.7 (KY7)
Isamu Yoshimura (Japan)– sighting data, photo-ID

Experiments

Distance and angle experiments were conducted in the middle of the survey period. 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).

When encountered large cetaceans such as blue and humpback whales, 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 in early summer, late summer and autumn season survey when blue, fin, sei, humpback whales were sighted. In the early summer, autumn and winter season survey, a satellite tagging experiment using LK-ARTS was also conducted when blue, fin, sei and common minke whales were sighted.

RESULTS AND DISCUSSION

Brief narrative of the surveys

The survey was conducted between 10th May 2019, and 18th March 2020, divided into four seasons (Early summer, Late summer, Autumn and Winter season). Table 1 shows details of the itinerary of each seasonal survey.

Early summer

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

Late summer

The *KY7* departed Hachinohe, Aomori, Japan, on 16th August. The vessel started the survey in sub-area 7WR on 19th August and completed it on 21st September. The vessel arrived at Misaki, Kanagawa, Japan, on 26th September. The vessel surveyed on a pre-determined track-lines from north to south (Table 2d, Figure 1).

Autumn

The *YS3* departed fDaiba, Tokyo, Japan, and started the survey in the western part of sub-area 7 on 8th October. The *KY7* departed Misaki on 10th October and started the survey in the eastern part of sub-area 7 on 16th October. The *YS3* completed the survey on 10th November and arrived at Shimonoseki on 15th November. The *KY7* completed the survey on 17th November and arrived at Hachinohe on 20th November. Both vessels surveyed on a pre-determined track-lines from south to north of each stratum (Tables 2e, 2f and Figure 1).

Winter

The *KY7* departed Shimizu, Shizuoka, Japan, on 6th February, 2020, and started the survey in the western part of

sub-area 2 on 11th February. The *YS3* departed Shimonoseki on 12th February and started the survey in the eastern part of sub-area 2 on 16th February. The *KY7* and *YS3* completed the survey on 13th March and arrived at Shiogama on 16th March and Shimonoseki on 17th March, respectively. The northward migration of Bryde's whales was considered from May to August (see the recent result of Bryde's whale sightings (Hakamada *et al*., 2009 and 2017). We assumed Bryde's whales stay temperate waters at the winter season, both vessels surveyed on a pre-determined track-lines from south to north of each stratum (Tables 2g, 2h and Figure 1).

Searching effort

A summary of searching effort and coverage in each survey is shown in Table 3. A total of 9,415.9 n.miles (17,438.2 km) were searched in the whole research area and seasons. In early summer, the total searching effort was 3,843.8 n.miles (7,118.7 km), and the coverage exceeded 90% in all areas due to stable weather conditions continued. In late summer, searching effort was 1,030.7 n.miles (1,908.9 km), and the coverage was 86.4 %. It has dropped slightly in the second half of the survey because the survey was interrupted three times in September to avoid the 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 survey hours of the day was only about for 8 hours (due to times of the sunrise and sunset), and also because October was still a typhoon season around Japan. 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 west area, coverage was low (57.5 %) because it took days to escape from stormy weather.

Sightings

Sightings were summarized by each season (Tables 4a to 4d). Tables 5a to 5d shows the identification of duplicate sightings observed when surveying in IO mode. The sighting location of each species in each season is shown in Figures 2a to 2d, and sea surface temperature (SST) of the western North Pacific in the middle date of each survey season is illustrated in the lower right picture of those figures .

Sightings by each species

Blue whale

In early summer, 4 schools (5 individuals including a mother & calf pair) were sighted between 38°-20'N, 149°-27'E and 38°-06'N, 148°- 46'E in sub-area 7E (Figure 2a). One blue whale formed a mixed school with one fin whale. Range of SST in the sighting positions was 14.5°C – 15.2°C. All 5 individuals were photographed, biopsy samples were collected from 4 individuals, and satellite tag was attached to one individual.

In late summer, 1 individual was sighted at 40°-54'N, 145°-13'E. The SST in the sighting position was 22.8°C and the estimated body length was 24.5m. This individual was photographed and a biopsy sample was obtained.

In the autumn season, 2 schools (2 individuals) were sighted in the western part of sub-area 7. The SST in the sighting position was 16.7°C and 17.2°C, respectively. Estimated body length was 24.3m and 25.3m. These two individuals were photographed.

This species was not sighted in the winter season.

Fin whale

In early summer, this species was sighted in each research area. In sub-area 6E, 12 schools (21 individuals including 2 mother & calf pairs) were sighted. Observed mean school size was 1.75. Range of SST in the sighting positions was 10.0°C – 16.3°C. In sub-areas 7WR and 7E, 11 schools (16 individuals and no calves) were sighted. Observed mean school size was 1.45. Range of SST in the sighting positions was 8.4°C – 20.5°C.

In late summer, 2 schools (2 individuals) were sighted north of 40°N (Figure 2b). The estimated body length was 20.8m and 22.8m. Range of SST in the sighting positions was 22.5°C – 22.8°C.

In the autumn season, 22 schools (38 individuals) were sighted in sub-area 7. In this season, fin whales were mainly sighted north of 40°N (Figure 2c). However, in the eastern part of sub-area 7, 2 schools were sighted around 36°N, locationconsidered as Kuroshio basin because temperate and fast current water. Observed mean school size was 1.73. The school of three fin whales sighted at 42°-23'N, 145°-56'E in 13th November was chased by a solitary adult male killer whale.

In the winter season, 3 schools (3 individuals) were sighted in the east of 147°E. Range of SST in the sighting positions was 17.3°C – 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

In early summer, this species was sighted in sub-areas 7WR and 7E. A total of 8 schools (13 individuals including 2 mother & calf pairs) were sighted (Figure 2a). Observed mean school of size was 1.63. Range of SST in the sighting positions was 14.1°C – 16.4°C.

In late summer, 1 individual was sighted during the transit survey between Hachinohe and the starting point of the research area. The SST in the sighting position was 21.5°C, and the estimated body length was 14.2m.

In the autumn season, 28 schools (38 individuals and no mother & calf pair) were sighted north of 40°N in the sub-area 7. Sei whales were concentrated in the northern, coastal part of the research area (Figure 2c). Observed mean school size was 1.36. Range of the SST in the sighting positions was 9.1°C – 18.1°C.

In the winter season, 7 schools (14 individuals including 3 mother & calf pairs) were sighted in the eastern part of sub-area 2. Range of SST in the sighting positions was 17.4°C – 21.9°C. Sightings occurred only in the eastern part, and the ratio of mother & calf pair was higher than in the other season. These results would be useful to identify the breeding ground of sei whales in the North Pacific.

Bryde's whale

In early summer, a total of 48 schools (61 individuals including 10 mother & calf pairs) were sighted in sub-areas 7WR and 7E (Table 4a and Figure 2a). 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. Observed mean school size was 1.27. Range of the SST in the the sighting positions was 15.6°C – 24.2°C.

In late summer, a total of 67 schools (92 individuals include 8 mother & 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 where the Kuroshio current flows into (Figure 2b). In general, Bryde's whales were widely distributed in summer (from July to September) in the western North Pacific north of 35ºN based on the previous dedicated sighting surveys (Shimada, 2004; Pastene *et al*., 2009; Hakamada *et al.*, 2017). Observed mean school size was 1.37. Range of the SST in the sighting positions was 22.0°C – 27.0°C.

In the autumn season, a total of 37 schools (42 individuals including 1 mother & calf pair) were sighted. In this season, Bryde's whales were mainly sighted in the western part of sub-area 7 (Figure 2c). Observed mean school size was 1.14. Range of the SST in the sighting positions was 16.8°C – 24.3°C.

In the winter season, 7 schools (7 individuals and no mother & calf pair) were sighted in both parts of sub-area 2 (Figure 2d). Range of SST in the sighting positions was 17.2°C – 22.6°C. All 8 groups were solitary. One group was sighted at 26°-35'N, 144°-52'E during the transit survey.

Common minke whale

In early summer, this species was the most frequently sighted species in sub-area 6E (37 schools and 43 individuals including 2 mother & calf pairs). Range of SST in the sighting positions was 10.1°C – 21.9°C and the observed mean school size was 1.16. In sub-area 7WR, 1 school (1 individual) was sighted. SST in the sighting position was 16.5 °C and the estimated body length was 7.8m.

In late summer, common minke whales were not sighted in the research area. In this season, the water temperature at a depth 100m south of 41°N in the research area was higher than 6°C according to daily 100m temperatures profiles from the Japan Meteorological Agency (JMA; https://www.jma.go.jp/jma/index.html, Figure 3). According to Watanabe *et al.* (2012), in the western North Pacific, common minke whales were distributed in waters where the water temperature at a depth 100m was lower than 6°C during summer. These high-temperature waters seem to have affected the distribution of common minke whales in the research area.

In the autumn season, 1 school (1 individual) was sighted in the most northern part of the western part of sub-area 7. SST in the sighting position was 11.3 °C and the estimated body length was 7.2m.

This species was not sighted in the winter season.

Humpback whale

In early summer, humpback whales were sighted frequentlyin sub-areas 7WR and 7E (36 schools and 50 individuals). No mother & calf pair were sighted. They were mainly sighted in the northern part of sub-areas 7WR and 7E (Figure 2a). Observed mean school size was 1.38. Range of SST in the sighting positions was 8.6°C – 18.8°C. In sub-area 6E,

1 individual was sighted. The SST in the sighting position was 10.4°C and the estimated body length was 12.2m. This individual was photographed and a biopsy sample was obtained.

In late summer, humpback whales were not sighted in the research area. It was considered that humpback whales had migrated to northern area.

In the autumn season, 26 schools (42 individuals and no mother & calf pair) of this species were sighted. Sightings were concentrated between 41°N and 42°N in the research area (Figure 2c). Observed mean school size was 1.62. Range of SST in the sighting position was 8.8°C – 18.8°C, but more than half of the schools (65%) were sighted in waters with SST of 11°C.

In the winter season, 17 schools (30 individuals, including 3 mother & calf pairs) were sighted (Figure 2d). 8 of all schools (13 individuals and no mother & calf pair) were sighted in the waters around 27°N, 142°E on 23rd February. This area was reported as breeding ground of humpback whales in the western North Pacific (Darling and Mori, 1993). Range of SST in the sighting positions was 17.4°C – 23.6°C.The observed mean school size was 1.76.

Sperm whale

In early summer, a total of 87 schools (228 individuals) of this species were sighted (Figure 2a) in the North Pacific side. 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. Observed mean school size was 2.62. Because of limited approaching to the schools, there was little information on body length and calves. Range of SST in the sighting positions was 6.8°C – 24.1°C.

In late summer, a total of 33 schools (102 individuals) of this species were sighted (Figure 2b) in the research area. Observed mean school size was 3.09. Range of the estimated body length was 9.1– 12.2 m. Range of SST in the sighting positions was 6.8°C – 24.1°C.

In the autumn season, a total of 41 schools (107 individuals) of this species were sighted (Figure 2c) in the research area. Sightings were concentrated south of 38° in both research areas. Observed mean school size was 2.61. Range of SST in the sighting positions was 11.9°C – 26.7°C.

In the winter season, 10 schools (12 individuals) were sighted (Figure 2d). Range of SST in the sighting positions was 17.9°C – 22.9°C, and observed mean school size was 1.20. The school size was comparatively smaller than in the other season. When the *KY7* entered Suruga Bay on 27th and 28th February to escape from stormy weather, the vessel encountered 11 schools (52 individuals) of sperm whales. In the Suruga bay, sperm whales were distributed in waters at the centre of a submarine canyon. Range of SST in the sighting positions in Suruga Bay was 17.0°C – 18.2°C The observed mean school size was 4.72. The sightings of Suruga Bay were secondary sighting.

Resighting during IO Mode

A total of 594 resightings were recorded during IO mode throughout the all season. Tables 5a to 5d shows the duplicates by each season based on the number of sightings made by the IOP and TOP.

For fin whales, there were 26 school sightings made by TOP and IOP and 14 schools made by IOP throughout the all survey seasons. This included 8 “definite duplicate” and 6 “not duplicate”. For sei whales, there were 23 school sightings made by TOP and IOP and 11 schools made by IOP throughout the all survey seasons. This included include 7 “definite duplicate” and 4 “not duplicate”. For Bryde’s whales, there were 104 school sightings made by TOP and IOP and 48 schools made by IOP throughout the all survey seasons. This included 30 “definite duplicate”, 1 “probably duplicate” and 17 “not duplicate”. For common minke whales, there were 26 school sightings made by TOP and IOP and 15 schools made by IOP throughout the all survey seasons. This included 6 “definite duplicate” and 9 “not duplicate”. For humpback whales, there were 44 school sightings made by TOP and IOP and 21 schools made by IOP throughout the all survey seasons. This included 17 “definite duplicate” and 4 “not duplicate”.

The data obtained during the IO survey mode will be valuable when the estimations of g(0) are made for those species.

Experiments

Sighting distance and angle experiment

The Estimated Angle and Distance Training Exercise were conducted using a buoy that resembles a blow with a reflector early in the surveys. During the exercise, the observers familiarized themselves with distance estimates from the TOP and Upper Bridge. The Estimated Angle and Distance Experiment were conducted on 27th May by *YS1 and*

YS3, on 2nd June by *YS2* and on 5th September by *KY7*. In winter survey, the Estimated Angle and Distance Experiment were conducted again on 7th March by *KY7* and *YS3* because observers of the winter survey has changed significantly. The results of this experiment will be used for the calculation of abundance estimates.

Photo-ID

Photographs were taken of blue (n=8), humpback (n=26) and killer (n=7) whales (Table 6a). All photographs were stored in the ICR catalogues and will be used for investigating their stock structure and movement in the future.

Biopsy sampling

. Allocation of research time to biopsy sampling was initially restricted with the aim of maximizing the sighting searching effort to cover the research area. 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 (Tables 6b). Details of all attempts are summarized in the table 6c. All samples were stored at the ICR laboratory and will be used for investigating their stock structure in the future.

Satellite tagging

Satellite tags were successfully attached on blue (n=1), fin (n=6), sei (n=14) and Bryde's (n=1) whales (Table 6d). This result will be used for investigating their pattern of distribution and migration in the future.

Report of the IWC oversight

Detailed report of the IWC oversight is shown in Appendix B. All equipment and the survey method were the same as in the past sighting surveys. The design of the survey blocks and track lines was improved to cover each survey block based on the IWC guidelines. The planned sighting procedure was in accordance with the guidelines agreed by the SC (IWC, 2012). Objectives and procedures of the survey were explained to the captains, officers, crew and researchers in advance.

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Table 1. Outline of the dedicated sighting survey in 2019.

Season	Date	Event
Early summer (May-June)	7-May-19	Pre-cruise meeting at Shimonoseki, Yamaguchi, Japan (YS1,YS3)
	8-May-19	Pre-cruise meeting at Shiogama, Miyagi, Japan (YS2)
	10-May-19	YS1,YS3 departed at Shimonoseki, Japan. And started transit survey to research area
	11-May-19	YS2 departed at Shiogama, Japan. And started transit survey to research area
	13-May-19	YS1,YS2 arrived at the starting point in the research area (7WR,6E)
	14-May-19	YS3 arrived at the starting point in the research area (7E)
	2-Jun-19	YS3 completed survey in the research area (7E)
	4-Jun-19	YS1 completed survey in the research area (7WR)
	8-Jun-19	YS1,3 arrived, and post-cruise meeting was held at Shimonoseki
	14-Jun-19	YS2 completed survey in the research area (6E) and started a transit survey to Shiogama
	25-Jun-19	YS2 finished transit survey to Shiogama
	26-Jun-19	YS2 arrived, and post-cruise meeting was held at Shiogama
Late summer (August-September)	15-Aug-19	Pre-cruise meeting at Hachinohe, Aomori, Japan (KY7)
	16-Aug-19	KY7 departed at Hachinohe
	18-Aug-19	Started transit survey to research area
	19-Aug-19	Arrived at the starting point in the research area (7WR)
	21-Sep-19	Completed survey in the research area (7WR)
	26-Sep-19	Arrived and post-cruise meeting was held at Misaki, Kanagawa, Japan
Autumn (October-November)	7-Oct-19	Pre-cruise meeting and YS3 departed at Daiba, Tokyo, Japan
	8-Oct-19	YS3 arrived at the starting point in the research area (Western part of sub-area 7)
	9-Oct-19	Pre-cruise meeting at Misaki, Japan
	10-Oct-19	KY7 departed at Misaki
	16-Oct-19	KY7 arrived at the starting point in the research area (Eastern part of sub-area 7)
	10-Nov-19	YS3 completed survey in the research area (Western part of sub-area 7)
	15-Nov-19	YS3 arrived, and post-cruise meeting was held at Shimonoseki
	17-Nov-19	KY7 completed survey in the research area (Eastern part of sub-area 7)
	20-Nov-19	KY7 arrived, and post-cruise meeting was held at Misaki
Winter (Febryary-March)	5-Feb-20	Pre-cruise meeting at Shimizu, Shizuoka, Japan (KY7)
	6-Feb-20	KY7 departed at Shimizu.
	11-Feb-20	KY7 arrived at the starting point in the research area (West area)
	12-Feb-20	Pre-cruise meeting and YS3 departed at Shimonoseki
	16-Feb-20	YS3 arrived at the starting point in the research area (East area)
	13-Mar-20	KY7 and YS3 completed survey in the research area
	16-Mar-20	KY7 arrived at Shiogama
	17-Mar-20	YS3 arrived and post-cruise meeting was held at Shimonoseki
	18-Mar-20	Post-cruise meeting was held at Shiogama (KY7)

Table 2a. Waypoints (WP) and each survey mode in the research area(6E) in early summer (May-June). The planned original cruise track line distance in the research area was 2,021.1 n.miles.

Sub-area 6E- Early summer (May-Jun)											
WP	Latitude	Longitude	Co.	Distance	Mode	WP	Latitude	Longitude	Co.	Distance	Mode
101	40˚03.1'N	139˚55.9'E	297˚	62.65	NSP	133	37˚40.8'N	133˚26.1'E	148˚	35.15	NSP
102	40˚31.6'N	138˚42.8'E	297˚	62.65	IO	134	37˚11.0'N	133˚49.6'E	148˚	35.15	IO
103	41˚00.0'N	137˚29.2'E	148˚	44.25	NSP	135	36˚41.1'N	134˚13.0'E	148˚	35.15	NSP
104	40˚22.3'N	138˚00.0'E	148˚	44.25	IO	136	36˚11.3'N	134˚36.3'E	148˚	35.15	IO
105	39˚44.7'N	138˚30.5'E	148˚	44.25	NSP	137	35˚41.4'N	134˚59.4'E	-	-	-
106	39˚07.0'N	139˚00.7'E	148˚	44.25	IO	138	35˚39.5'N	134˚35.0'E	302˚	60.20	NSP
107	38˚29.3'N	139˚30.7'E	-	-	-	139	36˚11.3'N	133˚31.8'E	302˚	60.20	IO
108	38˚22.6'N	139˚27.5'E	304˚	55.05	NSP	140	36˚43.0'N	132˚28.3'E	-	-	-
109	38˚53.7'N	138˚29.3'E	304˚	55.05	IO	141	36˚30.6'N	132˚09.5'E	151˚	34.40	NSP
110	39˚24.7'N	137˚30.7'E	304˚	55.05	NSP	142	36˚00.5'N	132˚30.4'E	151˚	34.40	IO
111	39˚55.8'N	136˚31.7'E	304˚	55.05	IO	143	35˚30.5'N	132˚51.2'E	-	-	-
112	40˚26.9'N	135˚32.2'E	-	-	-	144	35˚05.3'N	132˚19.4'E	299˚	42.65	NSP
113	40˚26.4'N	135˚31.0'E	145˚	58.12	NSP	145	35˚25.9'N	131˚33.7'E	299˚	42.65	IO
114	39˚38.4'N	136˚14.0'E	145˚	58.13	IO	146	35˚46.5'N	130˚47.7'E	-	-	-
115	38˚50.4'N	136˚56.5'E	145˚	58.12	NSP	147	35˚39.4'N	130˚39.8'E	155˚	40.90	NSP
116	38˚02.4'N	137˚38.6'E	145˚	58.13	IO	148	35˚02.3'N	131˚01.3'E	155˚	40.90	IO
117	37˚14.4'N	138˚20.2'E	-	-	-	149	34˚25.3'N	131˚22.6'E	-	-	-
118	37˚11.7'N	138˚16.3'E	304˚	56.45	NSP	150	34˚06.9'N	130˚51.9'E	294˚	37.55	NSP
119	37˚43.6'N	137˚17.6'E	304˚	56.45	IO	151	34˚22.4'N	130˚10.5'E	294˚	37.55	IO

Table 2a. continued.

120	38˚15.5'N	136˚18.5'E	304˚	56.45	NSP	152	34˚37.9'N	129˚29.1'E	-	-	-
121	38˚47.3'N	135˚18.9'E	304˚	56.45	IO	153	34˚27.4'N	129˚23.1'E	161˚	19.15	NSP
122	39˚19.2'N	134˚19.0'E	-	-	-	154	34˚09.2'N	129˚30.5'E	161˚	19.15	IO
123	39˚17.9'N	134˚17.7'E	146˚	48.75	NSP	155	33˚51.0'N	129˚37.9'E	-	-	-
124	38˚37.2'N	134˚52.4'E	146˚	48.75	IO	156	33˚15.1'N	129˚00.0'E	286˚	24.00	NSP
125	37˚56.5'N	135˚26.7'E	146˚	48.75	NSP	157	33˚21.8'N	128˚32.4'E	286˚	24.00	IO
126	37˚15.8'N	136˚00.8'E	146˚	48.75	IO	158	33˚28.6'N	128˚04.9'E	-	-	-
127	36˚35.1'N	136˚34.5'E	-	-	-	159	33˚27.7'N	128˚04.1'E	185˚	13.85	NSP
128	36˚25.8'N	136˚25.5'E	303˚	39.82	NSP	160	33˚13.8'N	128˚02.7'E	185˚	13.85	IO
129	36˚47.7'N	135˚44.1'E	303˚	39.83	IO	161	33˚00.0'N	128˚01.3'E	-	-	-
130	37˚09.7'N	135˚02.5'E	303˚	39.82	NSP						
131	37˚31.6'N	134˚20.6'E	303˚	39.83	IO						
132	37˚53.5'N	133˚38.6'E	-	-	-						

Table 2b. Way Points (WP) and each survey mode in the research area (7WR) in early summer (May-June). The planned original cruise track line distance in the sub-area 7WR was 1,177.2 n.miles.

Sub-area 7WR- Early summer (May-Jun)											
WP	Latitude	Longitude	Co.	Distance	Mode	WP	Latitude	Longitude	Co.	Distance	Mode
201	42˚15.4N	145˚51.6E	132˚	20.20	NSP	216	38˚28.1N	143˚49.9E	250˚	52.41	IO
202	42˚02.0N	146˚11.9E	132˚	20.20	IO	217	38˚10.5N	142˚47.0E	-	-	-
203	41˚48.5N	146˚32.2E	-	-	-	218	38˚01.8N	142˚44.8E	110˚	53.82	NSP
204	41˚46.6N	146˚33.5E	246˚	42.77	NSP	219	37˚43.7N	143˚49.0E	110˚	53.82	IO
205	41˚29.4N	145˚41.2E	246˚	42.77	IO	220	37˚25.7N	144˚52.9E	110˚	53.82	NSP
206	41˚12.3N	144˚49.1E	246˚	42.77	NSP	221	37˚07.6N	145˚56.6E	110˚	53.82	IO
207	40˚55.1N	143˚57.2E	246˚	42.77	IO	222	36˚49.5N	147˚00.0E	252˚	62.05	NSP
208	40˚37.9N	143˚05.6E	-	-	-	223	36˚30.3N	145˚46.5E	252˚	62.05	IO
209	40˚31.1N	143˚07.3E	111˚	47.98	NSP	224	36˚11.0N	144˚33.3E	252˚	62.05	NSP
210	40˚13.6N	144˚05.9E	111˚	47.98	IO	225	35˚51.8N	143˚20.4E	252˚	62.05	IO
211	39˚56.0N	145˚04.2E	111˚	47.98	NSP	226	35˚32.6N	142˚07.9E	-	-	-
212	39˚38.5N	146˚02.2E	111˚	47.98	IO	227	35˚31.2N	142˚07.6E	108˚	50.36	NSP
213	39˚20.9N	147˚00.0E	250˚	52.41	NSP	228	35˚15.6N	143˚06.3E	108˚	50.36	IO
214	39˚03.3N	145˚56.4E	250˚	52.41	IO	229	35˚00.0N	144˚04.8E	-	-	-
215	38˚45.7N	144˚53.0E	250˚	52.41	NSP						

Table 2c. Way Points (WP) and each survey mode in the research area (7E) in early summer (May-June). The planned original cruise track line distance in the sub-area 7E was 871.8 n.miles.

Sub-area 7E- Early summer (May-Jun)											
WP	Latitude	Longitude	Co.	Distance	Mode	WP	Latitude	Longitude	Co.	Distance	Mode
301	40˚49.9N	149˚08.5E	114˚	21.33	NSP	314	37˚44.4N	147˚44.7E	246˚	38.74	IO
302	40˚41.4N	149˚34.2E	114˚	21.33	IO	315	37˚28.9N	147˚00.0E	114˚	39.29	NSP
303	40˚32.8N	150˚00.0E	246˚	37.64	NSP	316	37˚13.1N	147˚45.3E	114˚	39.29	IO
304	40˚17.7N	149˚14.7E	246˚	37.64	IO	317	36˚57.4N	148˚30.3E	114˚	39.29	NSP
305	40˚02.6N	148˚29.7E	246˚	37.64	NSP	318	36˚41.6N	149˚15.2E	114˚	39.29	IO
306	39˚47.5N	147˚44.7E	246˚	37.64	IO	319	36˚25.8N	150˚00.0E	246˚	39.83	NSP
307	39˚32.4N	147˚00.0E	114˚	38.19	NSP	320	36˚09.8N	149˚14.8E	246˚	39.83	IO
308	39˚17.1N	147˚45.3E	114˚	38.19	IO	321	35˚53.8N	148˚29.7E	246˚	39.83	NSP
309	39˚01.7N	148˚30.3E	114˚	38.19	NSP	322	35˚37.8N	147˚44.8E	246˚	39.83	IO
310	38˚46.4N	149˚15.3E	114˚	38.19	IO	323	35˚21.8N	147˚00.0E	114˚	27.18	NSP
311	38˚31.1N	150˚00.0E	246˚	38.74	NSP	324	35˚10.9N	147˚30.5E	114˚	27.18	IO
312	38˚15.6N	149˚14.8E	246˚	38.74	IO	325	35˚00.0N	148˚00.9E	-	-	-
313	38˚00.0N	148˚29.7E	246˚	38.74	NSP						

Table 2d. Way Points (WP) and each survey mode in the research area (7WR) in late summer (August-September). The planned original cruise track line distance in the sub-area 7WR was 1,193.0 n.miles.

Sub-area 7WR- Late summer (Aug-Sep)											
WP	Latitude	Longitude	Co.	Distance	Mode	WP	Latitude	Longitude	Co.	Distance	Mode
401	42˚06.1N	145˚30.2E	130	42.13	NSP	417	38˚04.4N	142˚45.5E	-	-	-
402	41˚38.9N	146˚13.4E	130	42.13	IO	418	37˚56.3N	142˚43.5E	118	38.80	NSP
403	41˚11.6N	146˚56.2E	-	-	-	419	37˚37.9N	143˚26.7E	118	38.80	IO
404	41˚11.3N	146˚56.4E	257	44.55	NSP	420	37˚19.5N	144˚09.7E	118	38.80	NSP
405	41˚01.5N	145˚58.8E	257	44.55	IO	421	37˚01.2N	144˚52.5E	118	38.80	IO
406	40˚51.7N	145˚01.4E	257	44.55	NSP	422	36˚42.8N	145˚35.2E	118	38.80	NSP
407	40˚41.8N	144˚04.1E	257	44.55	IO	423	36˚24.4N	146˚17.7E	118	38.80	IO
408	40˚32.0N	143˚07.0E	-	-	-	424	36˚06.0N	147˚00.0E	261	60.13	NSP
409	40˚23.6N	143˚09.1E	120	51.40	NSP	425	35˚56.9N	145˚46.6E	261	60.13	IO
410	39˚58.0N	144˚07.4E	120	51.40	IO	426	35˚47.8N	144˚33.3E	261	60.13	NSP

Table 2d. continued.

411	39°32.4N	145°05.3E	120	51.40	NSP	427	35°38.6N	143°20.2E	261	60.13	IO
412	39°06.8N	146°02.8E	120	51.40	IO	428	35°29.5N	142°07.2E	-	-	-
413	38°41.2N	147°00.0E	260	50.78	NSP	429	35°28.0N	142°06.8E	125	24.26	NSP
414	38°32.0N	145°56.2E	260	50.78	IO	430	35°14.0N	142°31.1E	125	24.30	IO
415	38°22.8N	144°52.5E	260	50.78	NSP	431	35°00.0N	142°55.4E	-	-	-
416	38°13.6N	143°48.9E	260	50.78	IO						

Table 2e. Way Points (WP) and each survey mode in the research area (Western part of sub-area 7) in autumn (October-November). The planned original cruise track line distance in the Western part of sub-area 7 was 1,597.9 n.miles.

Western part of sub-area 7- Autumn (Oct-Nov)

WP	Latitude	Longitude	Co.	Distance	Mode	WP	Latitude	Longitude	Co.	Distance	Mode
101	35°00.0N	143°37.1E	077	34.80	NSP	126	38°31.7N	142°58.5E	077	32.50	IO
102	35°07.7N	144°18.5E	077	34.80	IO	127	38°39.1N	143°38.9E	077	32.50	NSP
103	35°15.4N	145°00.0E	283	36.60	NSP	128	38°46.4N	144°19.4E	077	32.50	IO
104	35°23.6N	144°16.3E	283	36.60	IO	129	38°53.8N	145°00.0E	283	35.40	NSP
105	35°31.8N	143°32.6E	283	36.60	NSP	130	39°01.9N	144°15.7E	283	35.40	IO
106	35°40.0N	142°48.8E	283	36.60	IO	131	39°10.1N	143°31.4E	283	35.40	NSP
107	35°48.2N	142°04.9E	283	36.60	NSP	132	39°18.2N	142°47.0E	283	35.30	IO
108	35°56.4N	141°20.9E	283	36.30	IO	133	39°26.3N	142°02.6E	-	-	-
109	36°04.5N	140°37.2E	-	-	-	134	40°04.8N	141°50.2E	077	37.20	NSP
110	36°17.0N	140°34.0E	077	36.50	NSP	135	40°13.4N	142°37.5E	077	37.20	IO
111	36°25.2N	141°18.1E	077	36.50	IO	136	40°21.9N	143°24.9E	077	37.20	NSP
112	36°33.3N	142°02.3E	077	36.50	NSP	137	40°30.5N	144°12.4E	077	37.20	IO
113	36°41.5N	142°46.6E	077	36.50	IO	138	40°39.0N	145°00.0E	283	41.60	NSP
114	36°49.7N	143°31.0E	077	36.50	NSP	139	40°48.7N	144°06.7E	283	41.60	IO
115	36°57.8N	144°15.4E	077	36.60	IO	140	40°58.4N	143°13.3E	283	41.60	NSP
116	37°06.0N	145°00.0E	283	33.00	NSP	141	41°08.1N	142°19.7E	283	41.60	IO
117	37°13.5N	144°19.7E	283	33.00	IO	142	41°17.8N	141°26.0E	-	-	-
118	37°20.9N	143°39.3E	283	33.00	NSP	143	41°38.7N	141°00.0E	077	49.10	NSP
119	37°28.4N	142°58.9E	283	33.00	IO	144	41°50.1N	142°03.9E	077	49.10	IO
120	37°35.9N	142°18.4E	283	33.00	NSP	145	42°01.5N	143°08.0E	-	-	-
121	37°43.3N	141°37.8E	283	32.90	IO	146	42°03.5N	143°19.0E	077	38.50	NSP
122	37°50.8N	140°57.3E	-	-	-	147	42°12.5N	144°09.4E	077	38.50	IO
123	38°09.6N	140°57.6E	077	32.50	NSP	148	42°21.4N	145°00.0E	284	32.50	NSP
124	38°17.0N	141°37.8E	077	32.50	IO	149	42°29.1N	144°17.3E	284	32.60	IO
125	38°24.3N	142°18.1E	077	32.50	NSP	150	42°36.8N	143°34.4E	-	-	-

Table 2f. Way Points (WP) and each survey mode in the research area (Eastern part of sub-area 7) in autumn (October-November). The planned original cruise track line distance in the Eastern part of sub-area 7 was 1,611.0 n.miles.

Eastern part of sub-area 7- Autumn (Oct-Nov)

WP	Latitude	Longitude	Co.	Distance	Mode	WP	Latitude	Longitude	Co.	Distance	Mode
751	35°00.0N	145°43.5E	076	35.92	NSP	776	38°49.4N	145°00.0E	-	-	-
752	35°08.7N	146°26.1E	076	35.92	IO	777	38°49.6N	145°00.0E	076	39.90	NSP
753	35°17.3N	147°08.7E	076	35.92	NSP	778	38°59.2N	145°49.7E	076	39.90	IO
754	35°26.0N	147°51.4E	076	35.92	IO	779	39°08.8N	146°39.5E	076	39.90	NSP
755	35°34.6N	148°34.2E	076	35.92	NSP	780	39°18.4N	147°29.5E	076	39.90	IO
756	35°43.3N	149°17.1E	076	35.92	IO	781	39°27.9N	148°19.5E	076	39.90	NSP
757	35°51.9N	150°00.0E	284	41.52	NSP	782	39°37.5N	149°09.7E	076	39.90	IO
758	36°01.9N	149°10.3E	284	41.52	IO	783	39°47.1N	150°00.0E	284	34.87	NSP
759	36°11.9N	148°20.4E	284	41.52	NSP	784	39°55.5N	149°16.0E	284	34.87	IO
760	36°21.9N	147°30.5E	284	41.52	IO	785	40°03.8N	148°31.8E	284	34.87	NSP
761	36°31.8N	146°40.4E	284	41.52	NSP	786	40°12.2N	147°47.6E	-	-	-
762	36°41.8N	145°50.3E	284	41.52	IO	787	40°15.1N	147°32.5E	284	39.87	IO
763	36°51.8N	145°00.0E	-	-	-	788	40°24.7N	146°41.8E	284	39.87	NSP
764	36°51.9N	145°00.0E	076	40.99	NSP	789	40°34.2N	145°51.0E	284	39.87	IO
765	37°01.8N	145°49.7E	076	40.99	IO	790	40°43.8N	145°00.0E	-	-	-
766	37°11.6N	146°39.6E	076	40.99	NSP	791	40°44.0N	145°00.0E	074	46.18	NSP
767	37°21.5N	147°29.5E	076	40.99	IO	792	40°57.0N	145°58.5E	074	46.18	IO
768	37°31.4N	148°19.6E	076	40.99	NSP	793	41°10.0N	146°57.2E	-	-	-
769	37°41.2N	149°09.7E	076	40.99	IO	794	42°18.9N	146°14.3E	286	28.60	NSP
770	37°51.1N	150°00.0E	284	40.45	NSP	795	42°27.0N	145°37.2E	286	28.60	IO
771	38°00.8N	149°10.3E	284	40.45	IO	796	42°35.0N	145°00.0E	-	-	-
772	38°10.5N	148°20.5E	284	40.45	NSP	797	42°35.4N	145°00.0E	062	22.25	NSP
773	38°20.3N	147°30.5E	284	40.45	IO	798	42°45.9N	145°26.7E	062	22.25	IO
774	38°30.0N	146°40.5E	284	40.45	NSP	799	42°56.4N	145°53.4E	-	-	-
775	38°39.7N	145°50.3E	284	40.45	IO						

Table 2g. Way Points (WP) and each survey mode in the research area (West area) in winter (February-March). The planned original cruise track line distance was 1,505.1 n.miles.

Wset part- Winter (Feb-Mar)											
WP	Latitude	Longitude	Co.	Distance	Mode	WP	Latitude	Longitude	Co.	Distance	Mode
101	25˚00.0N	138˚48.3E	067	41.00	NSP	119	30˚21.5N	143˚00.0E	293	46.50	NSP
102	25˚16.1N	139˚30.0E	067	41.00	IO	120	30˚39.7N	142˚10.4E	293	46.50	IO
103	25˚32.2N	140˚11.8E	067	41.10	NSP	121	30˚58.0N	141˚20.6E	293	46.40	NSP
104	25˚48.4N	140˚53.7E	067	41.00	IO	122	31˚16.2N	140˚30.7E	293	46.40	IO
105	26˚04.5N	141˚35.7E	067	41.10	NSP	123	31˚34.4N	139˚40.7E	293	46.50	NSP
106	26˚20.6N	142˚17.8E	067	41.10	IO	124	31˚52.7N	138˚50.4E	293	46.50	IO
107	26˚36.7N	143˚00.0E	293	48.10	NSP	125	32˚10.9N	138˚00.0E	067	45.60	NSP
108	26˚55.6N	142˚10.4E	293	48.20	IO	126	32˚28.8N	138˚49.6E	067	45.50	IO
109	27˚14.5N	141˚20.6E	293	48.20	NSP	127	32˚46.6N	139˚39.3E	067	45.60	NSP
110	27˚33.4N	140˚30.7E	293	48.20	IO	128	33˚04.5N	140˚29.2E	067	45.50	IO
111	27˚52.3N	139˚40.6E	293	48.20	NSP	129	33˚22.3N	141˚19.3E	067	45.60	NSP
112	28˚11.2N	138˚50.4E	293	48.20	IO	130	33˚40.2N	142˚09.6E	067	45.50	IO
113	28˚30.1N	138˚00.0E	067	47.40	NSP	131	33˚58.0N	143˚00.0E	298	33.50	NSP
114	28˚48.7N	138˚49.7E	067	47.30	IO	132	34˚13.5N	142˚24.2E	298	33.40	IO
115	29˚07.2N	139˚39.4E	067	47.30	NSP	133	34˚29.0N	141˚48.4E	298	33.40	NSP
116	29˚25.8N	140˚29.3E	067	47.40	IO	134	34˚44.5N	141˚12.5E	298	33.40	IO
117	29˚44.4N	141˚19.4E	067	47.30	NSP	135	35˚00.0N	140˚36.4E	-	-	-
118	30˚02.9N	142˚09.6E	067	47.40	IO						

Table 2h. Way Points (WP) and each survey mode in the research area (East area) in winter (February-March). The planned original cruise track line distance was 1,522.9 n.miles.

Wset part- Winter (Feb-Mar)											
WP	Latitude	Longitude	Co.	Distance	Mode	WP	Latitude	Longitude	Co.	Distance	Mode
201	25˚00.0N	147˚36.4E	067	11.60	NSP	219	30˚12.6N	144˚40.6E	292	47.10	NSP
202	25˚04.2N	147˚48.2E	067	11.60	IO	220	30˚31.4N	143˚50.4E	292	47.20	IO
203	25˚09.0N	148˚00.0E	292	48.80	NSP	221	30˚49.0N	143˚00.0E	065	46.30	NSP
204	25˚28.4N	147˚10.4E	292	48.80	IO	222	31˚07.6N	143˚49.6E	065	46.30	IO
205	25˚47.6N	146˚20.6E	292	48.90	NSP	223	31˚26.3N	144˚39.3E	065	46.20	NSP
206	26˚06.6N	145˚30.6E	292	48.80	IO	224	31˚44.2N	145˚29.2E	065	46.30	IO
207	26˚26.6N	144˚40.6E	292	48.80	NSP	225	32˚02.3N	146˚19.3E	065	46.30	NSP
208	26˚45.4N	143˚50.4E	292	48.90	IO	226	32˚20.6N	147˚09.6E	065	46.20	IO
209	27˚04.0N	143˚00.0E	066	48.00	NSP	227	32˚39.0N	148˚00.0E	292	45.40	NSP
210	27˚23.6N	143˚49.6E	066	48.10	IO	228	32˚57.4N	147˚10.4E	292	45.30	IO
211	27˚42.4N	144˚39.4E	066	48.00	NSP	229	33˚14.7N	146˚20.7E	292	45.40	NSP
212	28˚01.3N	145˚29.3E	066	48.00	IO	230	33˚32.8N	145˚30.8E	292	45.30	IO
213	28˚20.4N	146˚19.4E	066	48.00	NSP	231	33˚50.7N	144˚40.7E	292	45.40	NSP
214	28˚39.6N	147˚09.6E	066	48.00	IO	232	34˚08.4N	143˚50.4E	292	45.30	IO
215	28˚58.0N	148˚00.0E	292	47.20	NSP	233	34˚26.0N	143˚00.0E	066	42.90	NSP
216	29˚16.4N	147˚10.4E	292	47.20	IO	234	34˚43.9N	143˚47.9E	066	42.90	IO
217	29˚35.6N	146˚20.6E	292	47.20	NSP	235	35˚00.9N	144˚35.9E	-	-	-
218	29˚54.7N	145˚30.7E	292	47.20	IO						

Table 3. Summary of the survey periods and searching effort by each season. (n.miles)

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-June)	Sub-area 6E	YS2	2019/5/13-6/14	2,021.1	959.4	932.4	1,891.8	93.6%
	Sub-area 7WR	YS1	2019/5/13-6/4	1,177.2	566.5	580.1	1,146.6	97.4%
	Sub-area 7E	YS3	2019/5/14-6/2	871.8	397.2	408.2	805.4	92.4%
	Sub total	-	2019/5/13-6/14	4,070.1	1,923.2	1,920.7	3,843.8	94.4%
Late summer (August-September)	Sub-area 7WR	KY7	2019/8/19-9/21	1,193.0	511.9	518.9	1,030.7	86.4%
Autumn (October-November)	Western part	YS3	2019/10/8-11/10	1,597.8	635.9	647.4	1,283.3	80.3%
	Eastern part	KY7	2019/10/16-11/17	1,611.0	578.1	557.8	1,135.8	70.5%
	Sub total	-	2019/10/8-11/17	3,208.8	1,213.9	1,205.1	2,419.1	75.4%
Winter (February-November)	West area	KY7	2020/2/11-3/13	1,505.1	450.7	414.3	865.0	57.5%
	East area	YS3	2020/2/16-3/13	1,522.9	663.7	593.5	1,257.3	82.6%
	Sub total	-	2020/2/11-3/13	3,028.0	1,114.4	1,007.8	2,122.2	70.1%
Total	-	-	-	11,499.9	4,763.4	4,652.5	9,415.9	81.9%

Table 4a. Numbers of sightings in early summer (May-June) by species and by each sub-areas including transit survey between port and the research area.

Early summer (May-Jun)	Transit to R.A.		Sub-area 6E		Sub-area 7WR		Sub-area 7E		Transit from R.A.		Total	
	sch.	Ind.	sch.	Ind.	sch.	Ind.	sch.	Ind.	sch.	Ind.	sch.	Ind.
Blue whale	0	0	0	0	0	0	4	5	0	0	4	5
Fin whale	0	0	12	21	5	7	6	9	0	0	23	37
Sei whale	0	0	0	0	1	2	7	11	0	0	8	13
Bryde's whale	0	0	0	0	16	19	32	42	0	0	48	61
Like Bryde's	0	0	0	0	0	0	4	4	0	0	4	4
Common minke whale	2	2	37	43	1	1	0	0	2	2	42	48
Like Common minke	1	1	0	0	1	1	0	0	0	0	2	2
Humpback whale	4	5	1	1	21	29	15	21	0	0	41	56
Sperm whale	8	31	0	0	66	165	21	63	0	0	95	259
Unidentified large baleen whale	0	0	0	0	1	1	5	5	0	0	6	6
Unidentified large cetacean	0	0	1	1	1	1	0	0	0	0	2	2

Table 4b. Numbers of sightings in late summer (August-September) by species and by each sub-area including transit survey between port and the research area.

Late summer (Aug-Sep)	Transit to R.A.		Sub-area 7WR		Total	
	sch.	Ind.	sch.	Ind.	sch.	Ind.
Blue whale	0	0	1	1	1	1
Fin whale	0	0	2	2	2	2
Sei whale	1	1	0	0	1	1
Bryde's whale	1	1	67	92	68	93
Like Bryde's	0	0	5	5	5	5
Like Sei/Bryde's	0	0	1	1	1	1
Sperm whale	5	9	30	91	35	100
Unidentified large baleen whale	1	1	4	5	5	6
Unidentified large cetacean	0	0	1	1	1	1

Table 4c. Numbers of sightings in autumn (October-November) by species and by each sub-area including transit survey between port and the research area.

Autumn (Oct-Nov)	Transit to R.A.		Western part of Sub-area 7		Eastern part of Sub-area 7		Total	
	sch.	Ind.	sch.	Ind.	sch.	Ind.	sch.	Ind.
Blue whale	0	0	2	2	0	0	2	2
Fin whale	0	0	10	15	12	23	22	38
Like fin	0	0	0	0	1	2	1	2
Sei whale	0	0	10	11	18	27	28	38
Bryde's whale	0	0	35	39	2	3	37	42
Common minke whale	0	0	0	0	1	1	1	1
Humpback whale	0	0	16	27	10	15	26	42
Sperm whale	0	0	26	52	15	55	41	107
Unidentified large baleen	0	0	8	8	1	1	9	9

Table 4d. Numbers of sightings in winter (February-March) by species and by each sub-area including transit survey between port and the research area.

Winter (Feb-Mar)	Transit to R.A.		West area		East area		Total	
	sch.	Ind.	sch.	Ind.	sch.	Ind.	sch.	Ind.
Fin whale	1	1	0	0	3	3	4	4
Sei whale	0	0	0	0	7	14	7	14
Like sei	0	0	0	0	1	1	1	1
Bryde's whale	1	1	4	4	3	3	8	8
Humpback whale	2	2	13	23	4	7	19	32
Sperm whale	1	3	2	4	8	8	11	15
Unidentified large baleen	0	0	1	1	0	0	1	1

Table 5a. Identification of duplicate sightings (main species) observed during early summer (May-June) survey in Independent Observer (IO) mode. Duplicate status was based on the number of sightings made by the Independent Observer Platform (IOP) that were also observed by the Topmen in the Standard TOP Barrel. Status codes: D - Definite duplicate, P - Possible duplicate, R - Remote duplicate, N - No duplicate. Top: Sub-area 6E, Middle: Sub-area 7WR, Bottom: Sub-area 7E.

Sub-area 6E Early summer (May-Jun)	Number of all schools sighted made by TOP & IOP	Number of schools made by IOP	Duplicate Status			
			D	P	R	N
Fin whale	13	7	5	0	0	2
Common minke whale	26	15	6	0	0	9

Sub-area 7WR Early summer (May-Jun)	Number of all schools sighted made by TOP & IOP	Number of schools made by IOP	Duplicate Status			
			D	P	R	N
Fin whale	4	3	2	0	0	1
Sei whale	1	1	0	0	0	1
Bryde's whale	6	2	0	1	0	1
Humpback whale	4	1	0	0	0	1
Sperm whale	58	29	20	0	0	9
Killer whale	2	1	1	0	0	0

Sub-area 7E Early summer (May-Jun)	Number of all schools sighted made by TOP & IOP	Number of schools made by IOP	Duplicate Status			
			D	P	R	N
Blue whale	2	1	1	0	0	0
Fin whale	1	0	0	0	0	0
Bryde's whale	22	9	5	0	0	4
Like Bryde's	2	1	0	0	0	1
Humpback whale	11	5	5	0	0	0
Sperm whale	9	5	2	1	0	2
Killer whale	3	2	1	0	0	1

Table 5b. Identification of duplicate sightings (main species) observed during late summer (August-September) survey in Independent Observer (IO) mode. Duplicate status was based on the number of sightings made by the Independent Observer Platform (IOP) that were observed also by the Topmen in the Standard TOP Barrel. Status codes: D – Definite duplicate, P - Possible duplicate, R - Remote duplicate, N - No duplicate.

Sub-area 7WR Late summer (Aug-Sep)	Number of all schools sighted made by TOP & IOP	Number of schools made by IOP	Duplicate Status			
			D	P	R	N
Blue whale	2	1	1	0	0	0
Fin whale	1	1	0	0	0	1
Bryde's whale	54	27	19	0	0	8
Sperm whale	24	11	9	0	0	2
Like Bryde’s	2	1	1	0	0	0
Like sei / Bryde’s	1	1	0	0	0	1

Table 5c. Identification of duplicate sightings (main species) observed during autumn (October-November) survey in Independent Observer (IO) mode. Duplicate status was based on the number of sightings made by the Independent Observer Platform (IOP) that were also observed by the Topmen in the Standard TOP Barrel. Status codes: D – Definite duplicate, P - Possible duplicate, R - Remote duplicate, N - No duplicate. Top: Western part of sub-area 7, Bottom: Eastern part of sub-area 7.

Western part of sub-area 7 Autumn (Oct-Nov)	Number of all schools sighted made by TOP & IOP	Number of schools made by IOP	Duplicate Status			
			D	P	R	N
Fin whale	4	1	0	0	0	1
Sei whale	5	2	1	0	0	1
Bryde's whale	16	7	4	0	0	3
Common minke whale	0	0	0	0	0	0
Humpback whale	10	5	4	0	0	1
Sperm whale	17	9	4	1	0	4

Eastern part of sub-area 7 Autumn (Oct-Nov)	Number of all schools sighted made by TOP & IOP	Number of schools made by IOP	Duplicate Status			
			D	P	R	N
Fin whale	1	1	0	0	0	1
Sei whale	15	6	6	0	0	0
Bryde's whale	0	0	0	0	0	0
Common minke whale	0	0	0	0	0	0
Humpback whale	8	5	3	0	0	2
Sperm whale	2	1	1	0	0	0

Table 5d. Identification of duplicate sightings (main species) observed during winter (February-March) survey in Independent Observer (IO) mode. Duplicate status was based on the number of sightings made by the Independent Observer Platform (IOP) that were also observed by the Topmen in the Standard TOP Barrel. Status codes: D – Definite duplicate, P - Possible duplicate, R - Remote duplicate, N - No duplicate. Top: West area, Bottom: East area.

West area Winter (Feb-Mar)	Number of all schools sighted made by TOP & IOP	Number of schools made by IOP	Duplicate Status			
			D	P	R	N
Bryde's whale	5	2	2	0	0	0
Humpback whale	7	3	3	0	0	0
Sperm whale	3	1	1	0	0	0

East area Winter (Feb-Mar)	Number of all schools sighted made by TOP & IOP	Number of schools made by IOP	Duplicate Status			
			D	P	R	N
Fin whale	2	1	1	0	0	0
Sei whale	2	2	0	0	0	2
Bryde's whale	1	1	0	0	0	1
Humpback whale	4	2	2	0	0	0
Sperm whale	5	1	1	0	0	0

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

Season	Early summer (May-Jun)			Late summer (Aug-Sep)	Autumn (Oct-Nov)		Winter (Feb-Mar)		Total
Area	Sub-area 6E	Sub-area 7WR	Sub-area 7E	Sub-area 7WR	Western part of sub-area 7	Eastern part of sub-area 7	West area	East area	
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

Table 6b. Number of individuals biopsy samples collected, by each season and each sub-area. The biopsy sampling was conducted in early summer (all areas), late summer (7WR) and autumn (Eastern part of sub-area 7).

Season	Early summer (May-Jun)			Late summer (Aug-Sep)	Autumn	Total
	Sub-area 6E	Sub-area 7WR	Sub-area 7E	Sub-area 7WR	Eastern part of sub-area 7	
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 6c. Results of all biopsy sampling experiments throughout all survey seasons.

Season	Vesl.	Sheet number	Date	Sight No.	Sp.	Scl. size	Area	Est. body length of target ind. [m]	Position struck	number of sample	Sample No.
Early summer	YS2	BY201	20190514	1	F	3	6E	17.8	-	-	-
	YS2	BY202	20190514	18	H	1	6E	12.2	RC1, RC2	1	J19NYS2H001
	YS2	BY203	20190515	6	F	2	6E	20.8, 9.3	-	-	-
	YS2	BY204	20190516	1	M	2	6E	6.1, 5.8	-	-	-
	YS2	BY205	20190516	3	M	1	6E	6.9	-	-	-
	YS2	BY206	20190516	5	M	1	6E	6.2	RB1	1	J19NYS2M001
	YS1	BY101	20190514	2	F	3	7WR	21.5	LA	1	J19NYS1F001
	YS1	BY102	20190526	1	Ki	3	7WR	7.6	C1	1	J19NYS1K001
	YS3	BY301	20190515	18	H	2	7E	12.8	-	0	-
	YS3	BY302	20190516	2	F	1	7E	20.3	-	0	-
	YS3	BY303	20190518	1	SE	1	7E	12.7	LC1	1	J19NYS3SE001
	YS3	BY304	20190519	1	H	1	7E	10.8	D1	1	J19NYS3H001
	YS3	BY305	20190519	2	H	1	7E	11.2	RC2	1	J19NYS3H002
	YS3	BY306	20190519	3	F	1	7E	18.3	B1p	1	J19NYS3F001
	YS3	BY307	20190520	5	SE	1	7E	12.7	RC1	1	J19NYS3SE002
	YS3	BY308	20190524	8	B	1	7E	24.6	B1p	1	J19NYS3B001
	YS3	BY309	20190524	9	B	1	7E	24.1	-	0	-
	YS3	BY310	20190525	3	B	2	7E	25.7, 14.2	LB1, RB1	2	J19NYS3B002 J19NYS3B003
	YS3	BY311	20190525	6	F, B	2	7E	20.2, 25.7	RA, B1p	2	J19NYS3B004 J19NYS3F002
	YS3	BY312	20190526	15	F	4	7E	22.5	RC1	1	J19NYS3F003
Late summer	KY7	BY701	20190827	5	B	1	7WR	24.5	C1	1	J19NKY7B001
	KY7	BY702	20190827	10	F	1	7WR	22.8	-	0	-
Autumn	KY7	BY703	20191019	1	F	2	7	20.2	-	0	-
	KY7	BY704	20191019	2	F	1	7	22.3	-	0	-
	KY7	BY705	20191107	1	SE	2	7	12.1	-	0	-
	KY7	BY706	20191107	4	F	1	7	19.8	-	0	-
	KY7	BY707	20191107	6	SE	1	7	14.4	RB1p	1	J19NKY7SE001
	KY7	BY708	20191111	1	SE	2	7	14.1	RC1	1	J19NKY7SE002
	KY7	BY709	20191113	1	F	1	7	16.8	RC1	1	J19NKY7F001
	KY7	BY710	20191113	3	F	5	7	20.6	RC1	1	J19NKY7F002
	KY7	BY711	20191113	5	F	3	7	20.8	RC1	1	J19NKY7F003
	KY7	BY712	20191113	19	SE	1	7	14.3	LC1	1	J19NKY7SE003

Table 6c. Number of individuals satellite tag attached, by each season and each sub-area. The tagging was conducted in early summer (6E and 7E), autumn (both area) and winter (East area).

Season	Early summer (May-Jun)		Autumn (Oct-Nov)		Winter (Feb-Mar)	Total
Area	Sub-area 6E	Sub-area 7E	Western part of sub-area 7	Eastern part of sub-area 7	East area	
Blue whale	0	1	0	0	0	1
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

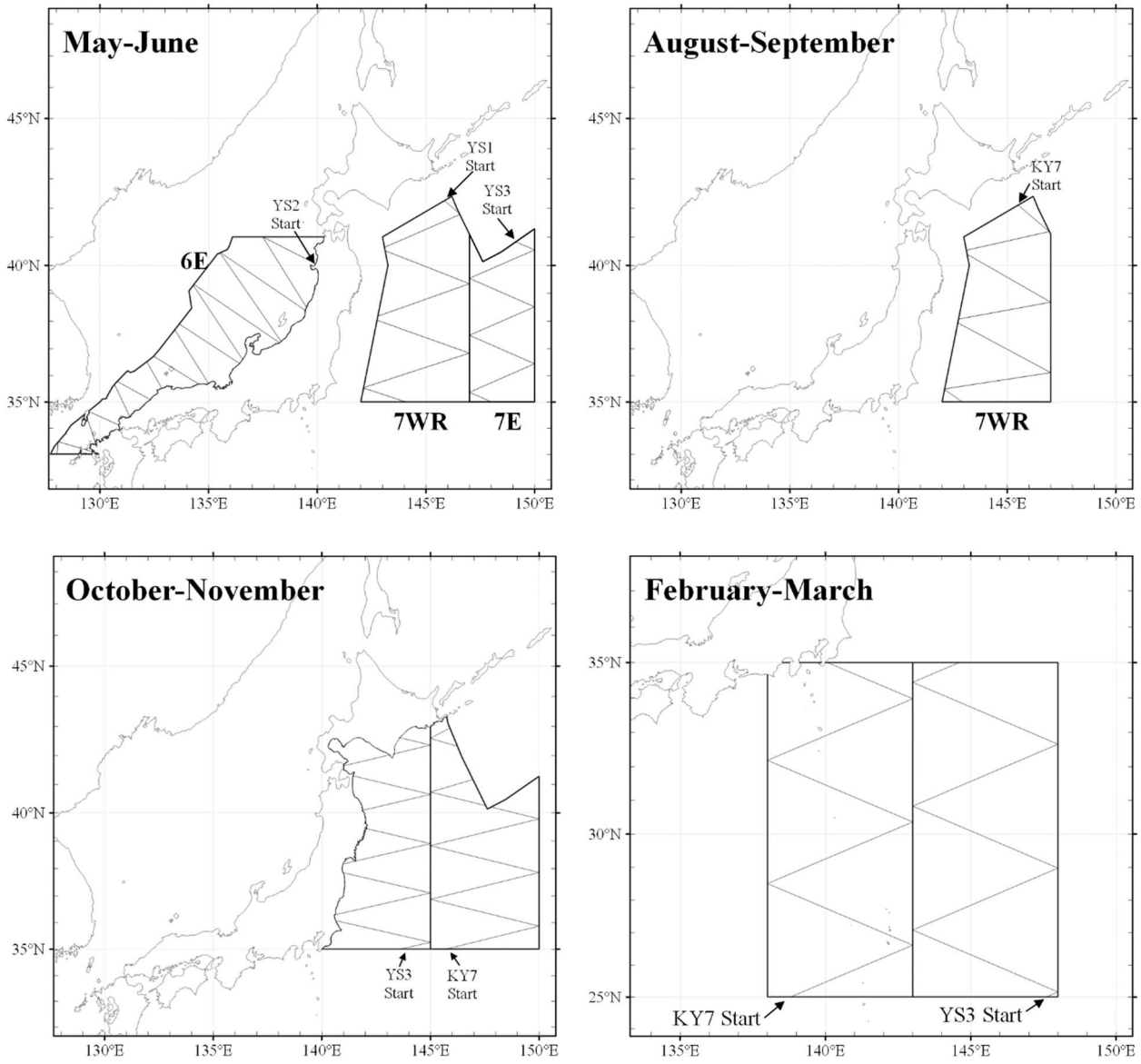

Figure 1. The research area and pre-determined track lines of each season.. Upper left: The research area of early summer survey (May-June). Upper right: The research area of late summer survey (August-September). Lower left: The research area of autumn survey (October-November). Lower right: The research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

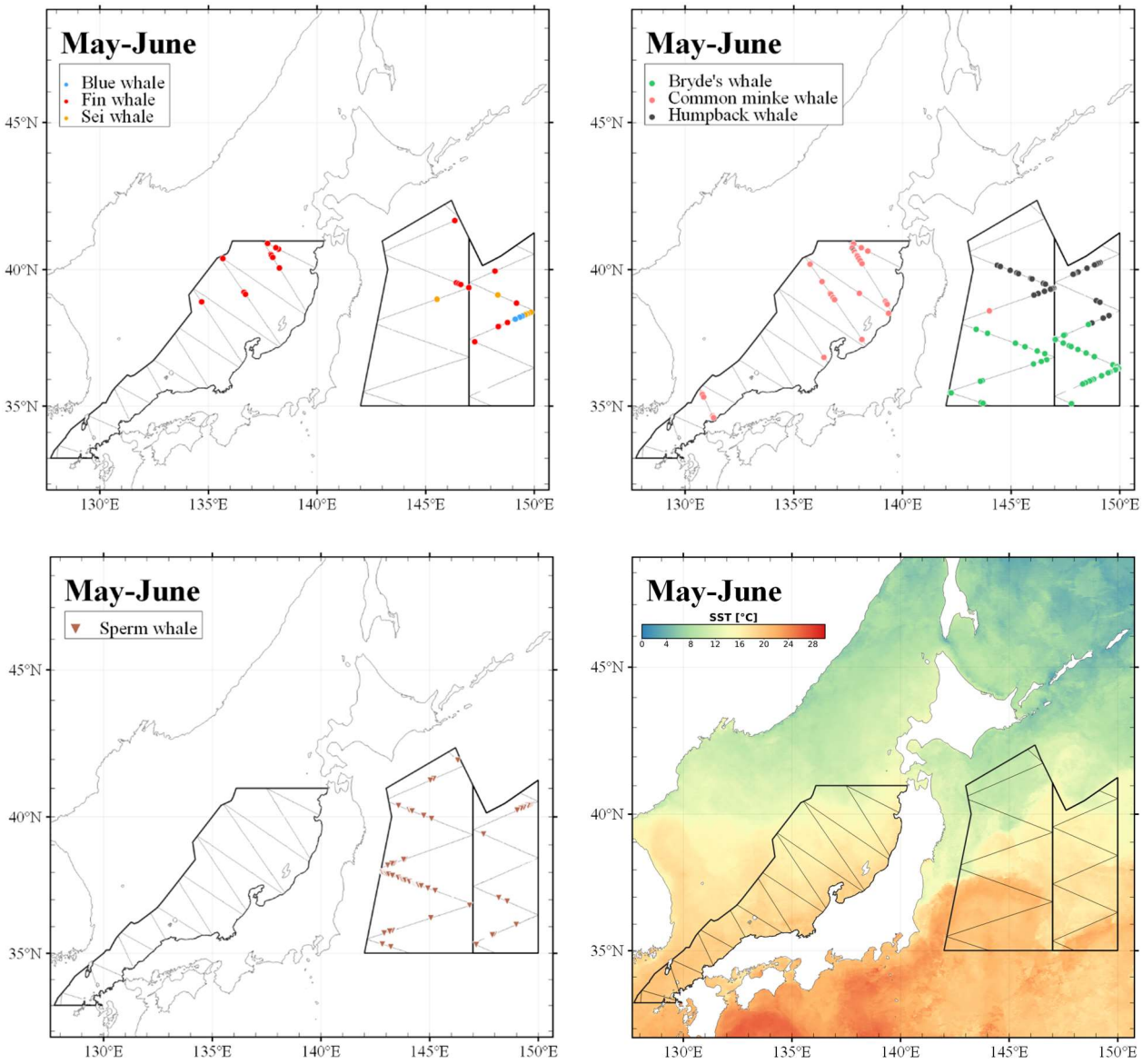

Figure 2a. The sighting locations of large whales and sea surface temperature in the middle date of survey period in early summer (May-June) 2019. Upper left: sighting locations of blue (blue dot), fin (red dot) and sei (orange dot) whales. Upper right: sighting locations of Bryde's (green dot), common minke (pink dot) and humpback (black dot) whales. Lower left: sighting locations of sperm whales (brown inverted triangle). Lower right: the average sea surface temperature of western north pacific between 9th May, and 9th June, 2019 (original data: Ocean color web , from https://oceancolor.gsfc.nasa.gov/).

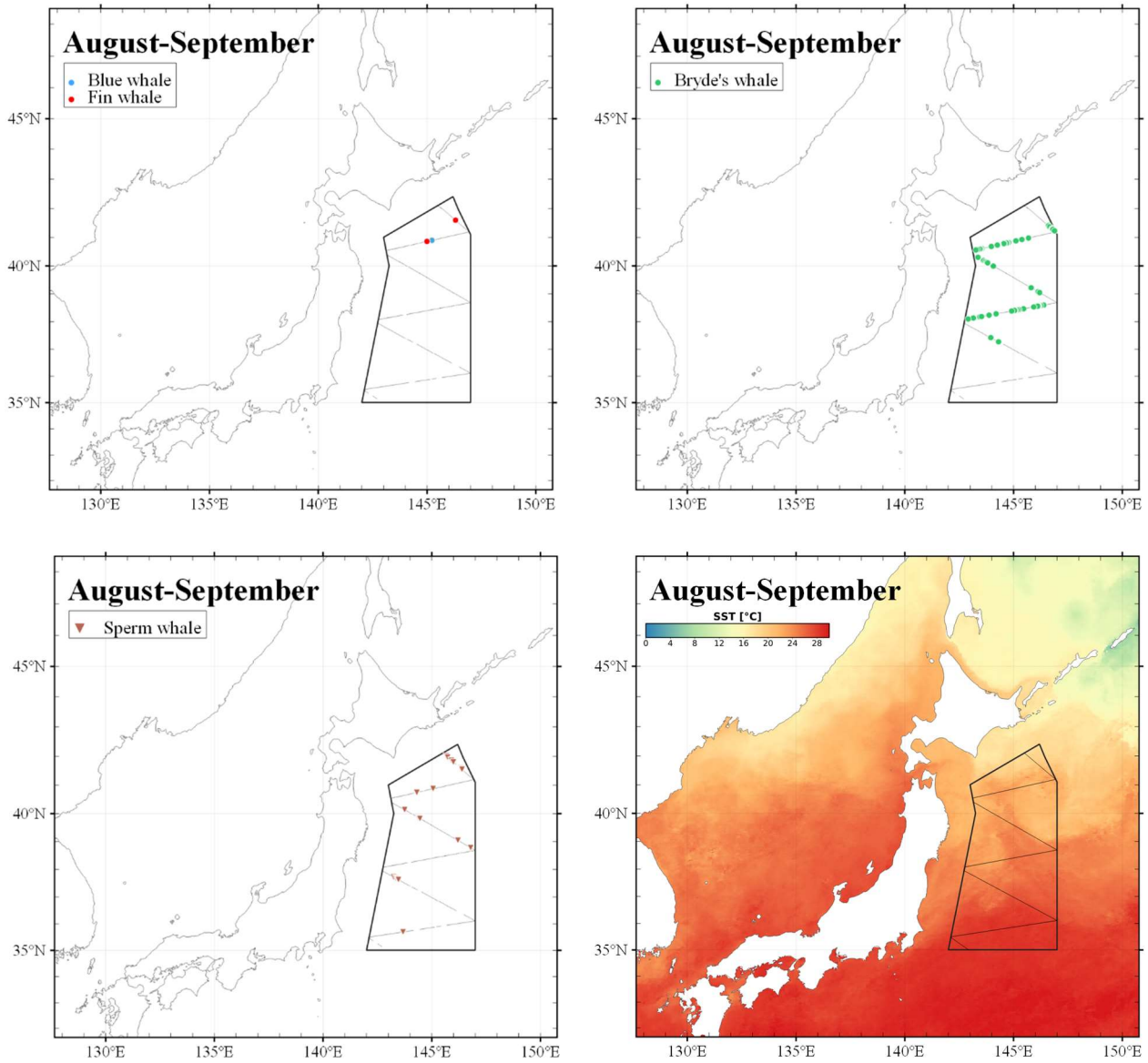

Figure 2b. The sighting locations of large whales and sea surface temperature in the middle date of survey period in late summer (August-September) 2019. Upper left: sighting locations of blue (blue dot) and fin (red dot) whales. Upper right: sighting locations of Bryde's (green dot) whales. Lower left: sighting locations of sperm whales (brown inverted triangle). Lower right: the average sea surface temperature of western north pacific between 21st August, and 21st September, 2019 (original data: Ocean color web , from https://oceancolor.gsfc.nasa.gov/).

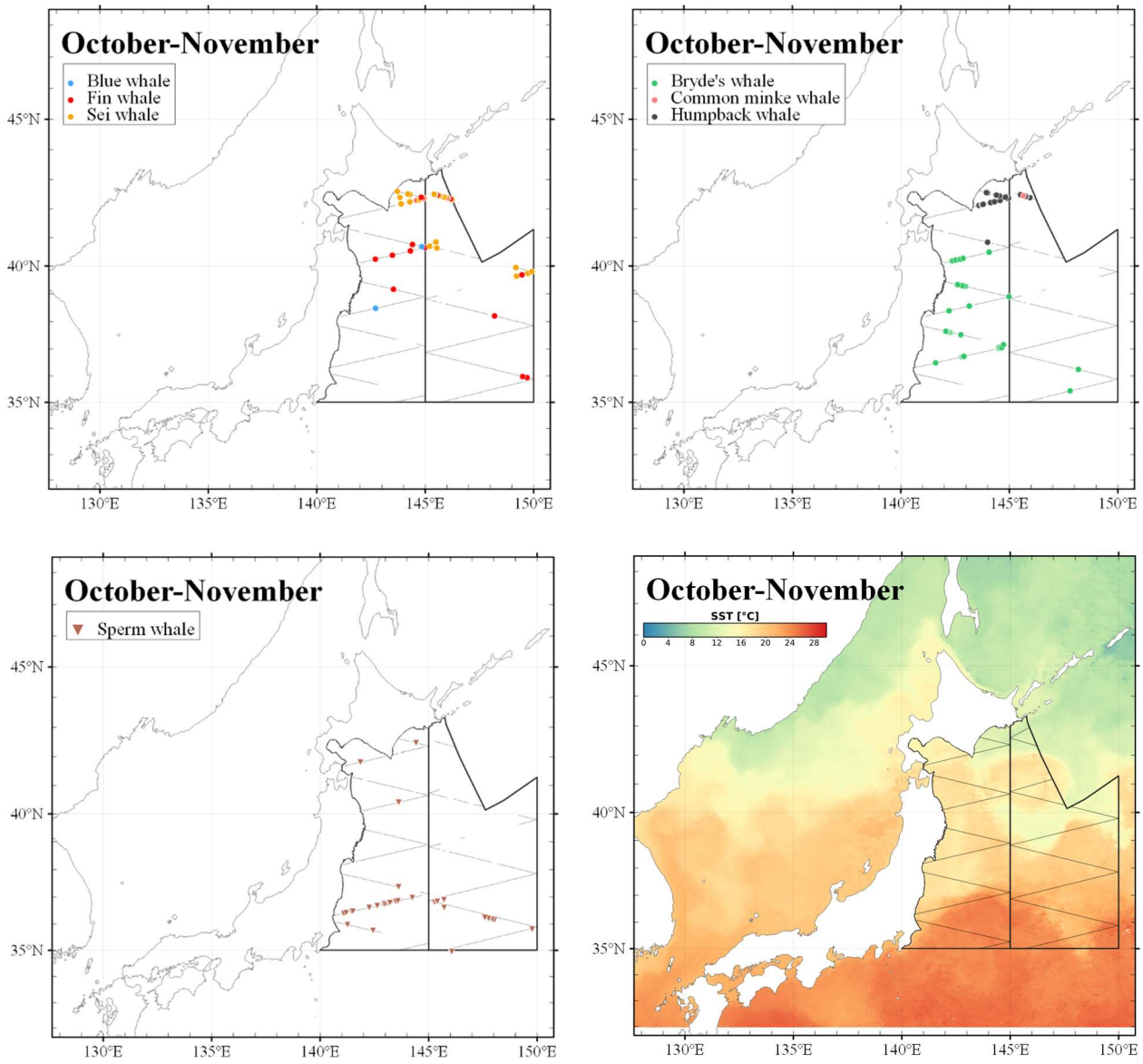

Figure 2c. The sighting locations of large whales and sea surface temperature in the middle date of survey period in autumn (October-November) 2019. Upper left: sighting locations of blue (blue dot), fin (red dot) and sei (orange dot) whales. Upper right: sighting locations of Bryde's (green dot), common minke (pink dot) and humpback (black dot) whales. Lower left: sighting locations of sperm whales (brown inverted triangle). Lower right: the average sea surface temperature of western north pacific between 16th October, and 16th November, 2019 (original data: Ocean color web , from https://oceancolor.gsfc.nasa.gov/).

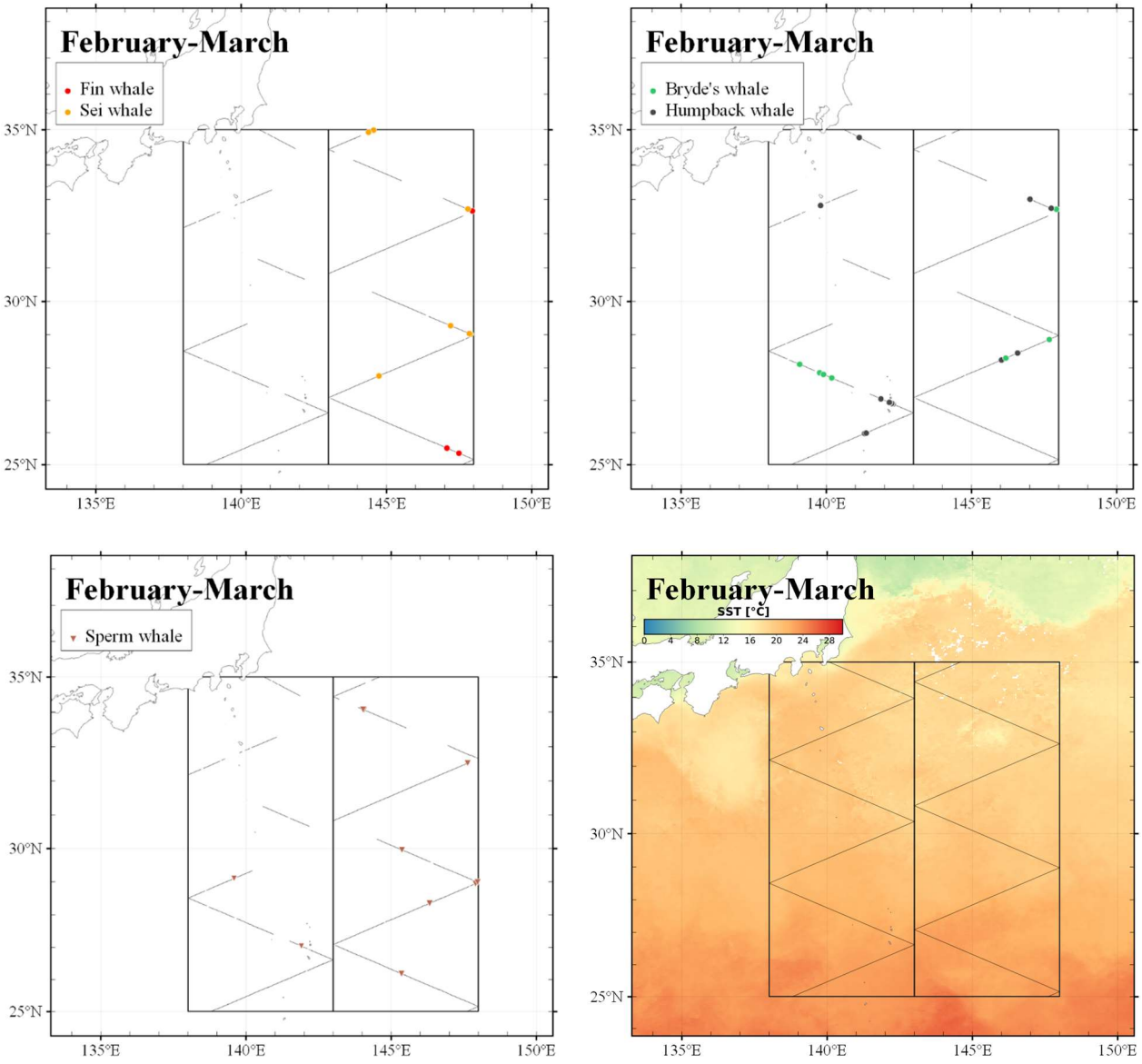

Figure 2d. The sighting locations of large whales and sea surface temperature in the middle date of survey period in winter (February-March) 2020. Upper left: sighting locations of fin (red dot) and sei (orange dot) whales. Upper right: sighting locations of Bryde's (green dot), and humpback (black dot) whales. Lower left: sighting locations of sperm whales (brown inverted triangle). Lower right: the average sea surface temperature of western north pacific between 25thth January, and 25th February, 2019 (original data: Ocean color web , from https://oceancolor.gsfc.nasa.gov/).

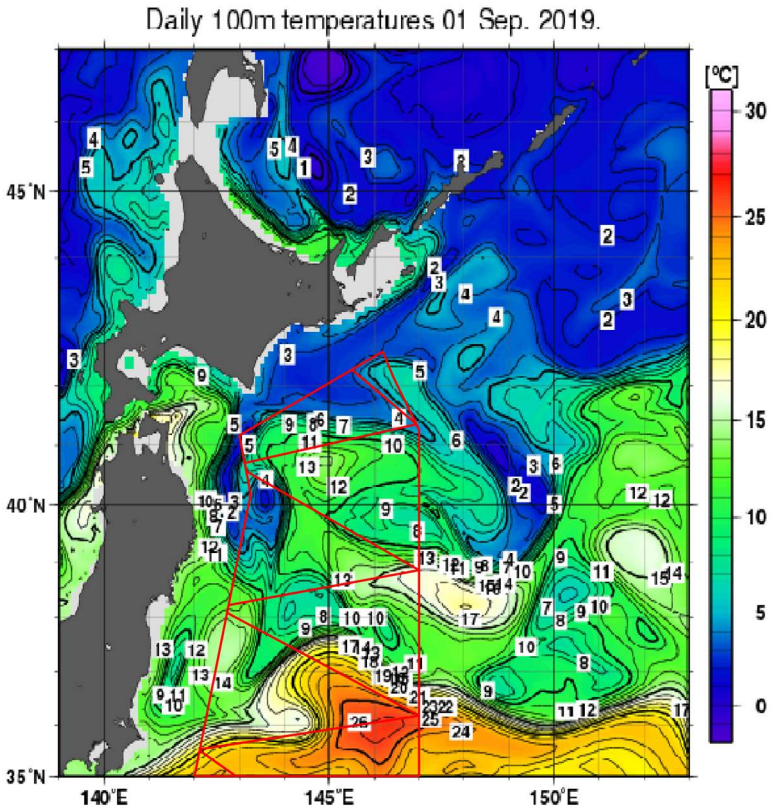

Figure 3. The water temperature at a depth 100m of the western North Pacific in the middle date of survey period (1st September, 2019) in late summer (August-September) 2019 (Modified from JMA website, on 20th December, 2019, from https://www.jma.go.jp/jma/index.html). The red lines indicate the research area and track line of the survey.

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Appendix A. Ship specifications of Yushin-Maru, Yushin-Maru No.2, Yushin-Maru No.3 and Kaiyo-Maru No.7.

Ship photos: Upper left: *Yushin-Maru*, Upper right: *Yushin-Maru No.2*, Lower left: *Yush in-Maru No.3*, Lower right: *Kaiyo-Maru No.7*

Ship specifications:

	Yushin-Maru	*Yushin-Maru No.2*	*Yushin-Maru No.3*	*Kaiyo-Maru No.7*
Call sign	JLZS	JPPV	7JCH	JECL
Length overall [m]	69.61	69.61	69.61	60.02
Gross tonnage (GT)	724	747	742	649
TOP barrel height [m]	19.5	19.5	19.5	17.5
IO barrel height [m]	13.5	13.5	13.5	12.7
Upper bridge height [m]	11.5	11.5	11.5	9.6
Bow height [m]	6.5	6.5	6.5	4.5
Engine power [PS / kW]	5280/3900	5280 / 3900	5280/3900	2100 / 1544

Appendix B. Oversight for the 2019 Japanese dedicated sighting survey in the western North Pacific

Koji Matsuoka
Institute of Cetacean Research
4-5, Toyomi, Chuo, Tokyo, 104-0055, JAPAN

The plan of early and late summer surveys were presented to the 2019 IWC/SC meeting (Hakamada *et al*., 2019) and endorsed by the Scientific Committee (IWC, 2019). On behalf of the IWC Scientific Committee, I carried out the oversight work during the 2019 Japanese dedicated sighting survey in the western North Pacific. This is a brief report of the oversight activities conducted on that survey.

Preparatory work and pre-cruise meeting

The pre-cruise meetings carried out at Shimonoseki on 7th May and at Shiogama on 8th May and at Hachinohe on 15th August 2019. The survey organizers, researchers and crewmembers also participated in that meeting. During the meeting, the organizers explained the objective of the survey and the procedure to be used for both sightings and experiments. The planned sighting procedure was in order with that agreed by the Scientific Committee. The research vessels *Yushin-Maru, Yushin-Maru* No.2, *Yushin-Maru* No.3 and *Kaiyo-Maru* No.7 were engaged for this survey.

The research area was set between 33°N and 45°N and between 128°E and 150°E. The survey was conducted between 13th May and 14th June in early summer and between 18th August and 21st September in late summer. The vessels were assigned to cover pre-determined transects in these areas by the passing with abeam closing mode (NSP) and the independent observer mode (IO). Two experienced researchers were assigned to work onboard each vessel.

Oversight method and period

The research activities of the vessels were oversight by e-mail communication and by examining the daily report prepared by each researcher on board. In some instances, Inmarsat satellite telephone calls were made for further clarification of the activities, procedure and sightings made. Further, geographical positions and weather information of each vessel were tracked each other per day. Oversight activities were carried between 10th May and 26th June and between 15th August and 26th September.

Brief narrative of the oversight vessel

The *YS1, YS2* and *YS3* departed Japan on 10th or 11th May and started the survey in the research area on 13 or 14 May. The *YS1* surveyed in the sub-area 7WR, the *YS2* surveyed in the sub-area 6E and *YS3* surveyed in the sub-area 7E. The vessels left the research area and arrived at their port on 8th or 26th June. *KY7* departed Japan on 16th August and started the survey in the research area (sub-area 7WR) on 18th August. The *KY7* left the research area and arrived at the port on 26th September.

Post-cruise meeting

I participated in a post-cruise meetings held on 8th June at Shimonoseki, 26th June at Shiogama and on 26th September 2019 at Misaki, respectively. Survey organizers, researchers and the Captain also participated in that meeting. Apart to discuss and assess the results of the surveys, the researchers engaged in the verification and checking of data.

Conclusion

All equipment and the survey method of each vessel were the same as in the past sighting surveys. The design of the survey strata and track lines were improved to cover each stratum completely. The planned sighting procedure was in accordance with the guideline agreed by the SC (IWC, 2012). Objectives and procedure of the survey were explained to the captains, officers, crew and researcher in advance. I then endorse the information and data obtained during the 2019 Japanese dedicated sighting survey in the western North Pacific.

Reference

IWC. 2012. Requirements and Guidelines for Conducting Surveys and Analysing Data within the Revised Management Scheme. *J. Cetacean Res. Manage. (Suppl2.)* 11:507-18.

IWC. 2019. Report of the Scientific Committee. Annex Q. 41pp. Nairobi, Kenya, 2019. [Paper available at the IWC Office].

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