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Cruise report of the 2014 IWC-Pacific Ocean Whale and Ecosystem Research (IWC-POWER)

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INTERNATIONAL
WHALING COMMISSION

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ABSTRACT

The 5th annual IWC-POWER cruise (successor to the IWC/IDCR-SOWER cruises since 1978/79 in the Antarctic) was successfully conducted between 02 July to 30 August, 2014 in the central North Pacific (north of 30°N, south of 40°N, between 170°E and 160°W) using the Japanese Research Vessel *Yushin-Maru No.3*. The cruise was organised as a joint project between the IWC and Japan. The cruise plan was endorsed at the 65a[th] IWC/Scientific Committee (IWC/SC) meeting. Researchers from Japan, US and UK participated in the survey. The cruise had five main objectives, to: (a) provide information for the proposed future in-depth assessment of sei whales in terms of both abundance and stock structure; (b) provide information relevant to *Implementation Reviews* of whales in terms of both abundance and stock structure; (c) provide baseline information on distribution and abundance for a poorly-known area for several large whale species/populations, including those that were known to have been depleted in the past, but whose status is unclear; (d) provide biopsy samples and photo-identification data to contribute to discussions of stock structure for several large whale species/populations, including those that were known to have been depleted in the past but whose status is unclear, and; (e) provide essential information for the intersessional workshop to plan for a medium-long term international programme in the North Pacific. At the pre-cruise meeting the Captain, crew of the vessel and international researchers agreed on the procedures and objectives of the survey. The sighting survey was conducted using methods based on the guidelines of the IWC/SC. Predetermined transect lines were completed within the anticipated schedule. Survey coverage was 83.4% and a total of 3,233.0 n.miles was surveyed in the research area in the Passing with abeam closing mode (NSP). Additionally, 234.9 and 293.2 n.miles was surveyed during transit to and from the research area respectively. Sightings of: blue (1 school/1 individual), sei (1/1), Bryde's (118/140), sperm (78/155), Cuvier's beaked (6/13), *Mesoplodon* spp. (8/19), *Ziphiidae* (39/86), and southern form short-finned pilot (2/12) whales; Risso's (8/140), bottlenose (3/69), spotted (6/436), striped (5/420) and short-beaked common (4/1,747) dolphins were observed during the cruise. Bryde's and sperm whales were the most frequently sighted large whale species and were widely distributed in the research area. The Estimated Angle and Distance Training Exercises and Experiments were completed as in previous years. Photo-identification data for 1 blue whale, 69 Bryde's whales, 3 killer whales, 2 sperm whales, 14 Risso's dolphins and one pilot whale were collected. A total of 80 biopsy (skin and blubber) samples was collected from 1 blue whale, 78 Bryde's whales and 1 killer whale using the Larsen-gun system. In the case of Bryde's whale, 30 samples (individuals) were collected from Sub-area 1 (170°E-180°E) and 48 samples from Sub-area 2 (180°E- 170°W). These biopsy samples will enable genetic studies on stock structure to be conducted in contribution for the North Pacific Bryde's whale *Implementation Review* to be held in the 2017 SC meeting. A total of 247 objects of marine debris items were observed. The planned survey procedure was in accordance with the guidelines agreed by the SC. The 5[th] annual cruise of the IWC-POWER programme was completed and provided important information on cetacean distribution in an area where no survey had been conducted in recent decades. These results will contribute to the aforementioned objectives of the IWC/SC.

1. INTRODUCTION

1.1 Research objectives

The cruise was organised as a joint project between the International Whaling Commission (IWC) and Japan (IWC, 2012a, 2012b, 2012c, 2013; Kato *et al*., 2011, Matsuoka *et al*., 2011, 2012, 2013, 2014). The 2014 cruise plan was endorsed at the 65[th] IWC/Scientific Committee (IWC/SC) meeting. The cruise had five main objectives, to: (a) provide information for the proposed future in-depth assessment of sei whales in terms of both abundance and stock structure; (b) provide information relevant to Implementation Reviews of whales in terms

of both abundance and stock structure; (c) provide baseline information on distribution and abundance for a poorly known area for several large whale species/populations, including those that were known to have been depleted in the past, but whose status is unclear; (d) provide biopsy samples and photo-identification data to contribute to discussions of stock structure for several large whale species/populations, including those that were known to have been depleted in the past but whose status is unclear, and; (e) provide essential information for the intersessional workshop to plan for a medium-long term international programme in the North Pacific (IWC, 2013).

1.2 Research area, cruise track design and priority of the cruise

The research area was set north of 30°N, south of 40°N between 170°E and 160°W (Figure 1). A randomised start point for survey tracks was used, as for all previous IWC-POWER cruises based on the IWC/SC survey guidelines (IWC, 2005). Every location within the study area had an equal probability of being sampled, as calculated by the software "DISTANCE" (Thomas *et al*., 2010). Figure 1 shows the cruise track design in the research area and Table 1a shows Waypoints (WP) for the pre-determined tracklines. Research hours during the cruise were set at a maximum of 12 hours per day (see section 2.5). Primary search effort was conducted only in acceptable weather conditions, as per guidelines for prior cruises; visibility greater than 2.0 nautical miles (n. miles), wind speed <21 knots and sea state <Beaufort 6. The sighting survey was conducted using Passing with abeam closing mode (NSP) based on discussions at the Tromsø SC meeting; recommendations based on the 2010 cruise; and suggestions from the Technical Advisory Group (TAG) of SC members (IWC, 2013). Two primary observers were in the barrel throughout periods of NSP mode (see section 2.5). Sighting survey procedures are detailed in "Information for Researchers" (Anon. 2014a). For encounters of very rare species (e. g. blue and right whales), it was decided that the vessel would approach whales immediately to avoid losing them due to the delay of closing.

The R/V *Yushin-Maru No.3* (YS3) was used to survey the high seas area during this cruise, including transits between Japan and the research area. Research time was allocated for biopsy sampling of blue, fin, sei, Bryde's, common minke, North Pacific right, humpback, sperm and killer whales, with higher priority given to the former seven species. The Larsen-gun system was used to collect samples. Priority species for photo-ID were blue, North Pacific right and humpback whales, although photos of all other species, including fin, sei, Bryde's and sperm whales would be obtained opportunistically.

2. SHORT NARRATIVE OF THE CRUISE

2.1 The 2014 cruise itinerary

Date	Event
1 July 2014	Pre-cruise meeting
2 July	Researchers board the *Yushin-Maru No. 3*.Vessel departed Shiogama, Japan (10:10)
8 July	Vessel arrives at the research area, starting point 170º00'E (41 days in the research area)
17 August	Vessel completes surveys in the research area at 160º00'W and begins return transit.
27 August	Post-cruise meeting
30 August	Vessel arrives Shiogama, Japan

2.2 Research vessel

The R/V *Yushin-Maru No.3* (742GT) was engaged for this cruise as in 2011, 2012 and 2013. Ship specifications, photo, and a crew list are provided in Appendix A.

2.3 Attending scientists and responsibilities

Four international researchers were nominated by the steering group of the POWER programme: Koji Matsuoka (Cruise leader/Chief Scientist, sighting, photo-ID and video), Sally Mizroch (photo-ID, biopsy and marine debris data), Jessica Taylor (photo-ID, biopsy sample and marine debris data), and Isamu Yoshimura (sighting and biopsy).

Koji Matsuoka (Japan) - Cruise Leader /Chief Scientist, sighting, photo-ID/video
Sally Mizroch (USA) - photo-ID, biopsy and marine debris data
Jessica Taylor (UK/USA) - photo-ID, biopsy and marine debris
Isamu Yoshimura (Japan) – sighting, biopsy

2.4 Pre-cruise meeting

On 1 July, a pre-cruise meeting was held aboard the R/V YS3, chaired by Miyashita (Representation of Convenor for this cruise) of the National Research Institute of Far Seas Fisheries (NRIFSF). Meeting participants were: Miyashita (NRIFSF), Uoya (Fisheries Agency of Japan, FAJ), Matsuoka (The Institute of Cetacean Research, ICR, Cruise Leader), Mizroch (National Oceanic and Atmospheric Administration's (NOAA) Alaska Fisheries Science Center, researcher), Yoshimura (IWC-nominated researcher, Japan), Taylor (IWC-nominated researcher, UK/USA), Yamauchi (Captain), Shimaoka (Chief Operator) and Kasai (Chief Officer). The meeting discussed and confirmed priorities and strategies for the cruise based on the IWC Scientific Committee's planning report (IWC, 2014), and joint IWC-ICR research manual (Anon, 2014a). The pre-cruise meeting report (Anon, 2014b) was distributed to the steering group after review by the Chair. On 2 July, researchers boarded the YS3 with all of the necessary equipment and departed from Shiogama at 10:10.

2.5 Research hours, survey mode and number of observers on effort

The schedule for research hours was consistent with previous SOWER (Southern Ocean Whale and Ecosystem Research) and POWER cruises. Research effort began 60 minutes after sunrise and ended 60 minutes before sunset, with a maximum 12-hour research day (approximately 06:00-18:00). Time-zone changes were in 30-minute intervals, effective from 01:00. Schedules adhered to local 'ship' time which ranged between +9.5 and +12.5 GMT throughout the cruise. Data collected throughout the cruise and all associated reporting were reported in local 'ship' time.

Sighting activities aboard the ship were classified into two principal types: On-effort and Off-effort. In the sightings survey portion of the research, On-effort activities were times when full search effort was being executed and conditions (such as weather and sea state) were within acceptable parameters to conduct research. Off-effort activities were all activities that were not On-effort. All sightings recorded while the ship was On-effort were classified as Primary sightings. All other sightings were considered to be Secondary sightings. Sighting effort was conducted by the bos'un and topmen from the barrel (crow's nest: always two primary observers) and the upper bridge where the helmsman, captain or officer-on-watch, four researchers, and the chief engineer or deputy were also present (always two primary observers and 6 secondary observers). Passing with abeam closing mode (NSP) was used during this cruise. This was in effect Passing Mode. Two topmen were observing from the barrel at all times (maximum 06:00-18:00). There was open communication between the upper bridge and the barrel. The observers on the upper bridge communicated with the topmen only to clarify information and did not distract the topmen from their normal search procedure unless they were directed to do so by the Cruise Leader (Anon. 2013a).

Immediately after a sighting was detected from the barrel, the topman relayed information to observers on the upper bridge. Details of the estimated distance and angle to the sighting (and when possible, the species and number of animals present) were relayed. The topman did not alter his normal searching pattern in order to keep contact with the sighting. Observers on the upper bridge located the sighting made by the topman and decided whether it would be possible to confirm species and count before the sighting passed abeam of the vessel. The topman gave no further information to the upper bridge unless the whale group resurfaced within their normal searching pattern. A designated researcher on the upper bridge recorded the species and estimated number of whales in the school when the sighting passed abeam of the vessel, in consultation with other researchers. When the sighting location was abeam of the vessel, the ship altered course to approach the whale, and speed was increased to 15 knots to hasten the closure. Ship speed was decreased when the group was neared, usually within 0.2 to 0.4 n. miles from the initial sighting position. After the sighting was approached, the species, number of animals in the group, estimated length(s), number of calves present, and behaviour were determined and recorded. Following this, other activities could commence at the discretion of the Cruise Leader, such as natural marking or biopsy experiments. Until the ship resumed full search effort on the trackline, any sightings detected after initial departure from the trackline, were classified as secondary sightings (Anon. 2013a).

2.6 Weather conditions and expected versus realised effort

In the research area, general weather conditions were good due to a strong high pressure system and high sea surface temperature from the south. A total of 3,233.0 n. miles was surveyed in the research area in NSP mode. Survey coverage (searching distance/planned distance (3,878.4 n.miles)) was 83.4% in the research area. A comparison of weather conditions among past cruises is shown in Appendix B.

2.7 Research permit in the US-EEZ

The Japanese and the US Governments issued the necessary permits for exporting samples taken in the high seas and the US EEZ for importation into Japan. These permits are for introducing specimens of CITES-listed

species into Japan from both the high seas and the USA EEZ, including blue, fin, sei, Bryde's, common minke, right, humpback, grey, bowhead, sperm and killer whales. Research in the US EEZ was conducted under the Pacific Islands Fisheries Science Center Marine Mammal Research Permit No. 15240 for Bryde's whales and under the Alaska Fisheries Science Center's Marine Mammal Research Permit No. 14245 for all other cetacean species. A summary of research effort in the US EEZ is provided in Appendix C.

3. SUMMARY OF SIGHTINGS

3.1 Identification of species

Guidelines for species identification were based on the IWC-SOWER and IWC-POWER methods for classification of identification (Anon, 2014a):

Positive identification of species was based on multiple cues and usually required clear observation of the whale's body. Occasionally, repeated observations of the shape of the blow, surfacing and other behavioural patterns were sufficient; this judgement was made only by the Cruise leader or other designated researcher. Identification of species was recorded as 'probable' based on multiple cues, which were nevertheless insufficient to be absolutely confident of identification. This usually occurred when blows and surfacing patterns could be confirmed, but the whale's body could not be clearly seen. Details of recording procedures during sightings can be found in 'Information for Researchers' (Anon, 2014a).

3.2 Determination of group size

The following guidelines were used in determining group size: Schools where the number of animals, or an accurate estimated range of the number of animals was determined, were classified as confirmed schools. Data from the confirmed schools can be used to determine a mean school size. Therefore, it is critical that the confirmed schools accurately represent the size of schools in the survey area. Normally, schools believed to be confirmed for school size are approached to within 1 n. mile for large whales and to within 0.3 n. miles for minke whales. Allowing for context-specific differences (i.e. environmental conditions and animal behaviour), every effort was made to be consistent with regard to the maximum time spent on identification of species and confirmation of numbers. Normally, if the sighting was thought to be minke whales, no more than 20 minutes (after closure has been completed) should be spent on confirmation, this reduces the potential for confusion with other sightings in the vicinity (Anon, 2014a). Counts of individuals provided in the Sighting summary (section 3.3) represent best estimates of school sizes in the research area, except when indicated otherwise.

3.3 Sighting summary

Tabulations of all track line WPs, the searching effort and the sightings recorded in the research area, by species and by effort mode are presented in Tables 1a, 1b and 2a, respectively. Table 2b summarises all sightings observed throughout the cruise including transit to and from the research area. Table 3a shows the sea surface temperature (minimum, maximum and range) for each frequently-sighted species in the research area and provides quartile analysis for the major species observed. Figure 1 illustrates the research area, track line design and location of the searching effort. Figures 2a through e illustrate locations of sightings during the 2014 IWC-POWER cruise. Figure 3a shows the breakdown of research time, in hours by effort code in the research area. Figures 3b and 3c show the breakdown of research time, in hours by wind speed and visibility in the research area, respectively. Recorded sea surface temperature (SST) ranged from 16.6 to 27.6°C during sightings observed in the research area.

Transit survey to the research area

The YS3 departed Shiogama port on schedule (10:10, 2 July) and conducted the transit survey to the research area from 4 July (06:00) through 7 July (17:55) using the passing mode. Weather conditions were generally good, with occasional intervals of rain. The safety instruction meeting and emergency drill were conducted on 3 July. The exercise "experiment of distance & angle estimation" and "test of Larsen-gun" were conducted on 5 July.

A number of Bryde's whales were sighted during the transit survey between 4 and 7 July (Table 2b and Figure 2a). Total searching distance was 854.9 n. miles. Total transit sightings included Bryde's whales (29 schools/41 individuals), sperm whales (7/10), southern-form short finned pilot whales (2/12), Risso's dolphins (2/16) and striped dolphins (1/72) (Table 2b). Biopsy experiments were conducted on 7 July.

The research area

The YS3 finished the transit survey and started the research area survey at Waypoint 101 (Table 1a) position 31˚59.8'N 170˚00'E, on 8 July 06:00. The research vessel followed a south-southeast course (158°) towards

latitude 30˚N, with a north-northeast course change (22°) towards latitude 40 ˚N under acceptable searching conditions. The YS3 arrived at the most easterly WP (WP141), position 31˚59.8'N 160˚00'W on 17 August 15:23, almost on schedule (Table 1b).

Generally, weather conditions were good for the sighting survey allowing for a good portion of passing mode searching (Figures 3a). Wind speed generally ranged between 11 to 17 knots and visibility was usually over 7.0 n.miles (Figures 3b and 3c). There were no strong ocean currents in the research area over the research period.

A total of 3,233.0 n. miles was surveyed in the research area in the Passing with abeam closing mode (NSP) (Table 1b). Survey coverage (searching distance/planned distance (3,878.4 n.miles)) was 83.4% in the research area (Table 1a). Sightings recorded in the research area by species, by survey mode, are presented in Table 2a.

The most dominant large whale species in the research area were Bryde's (88 schools/98 individuals) and sperm (65/137) whales. Total sightings of other species including blue (1 school/1 individual), sei (1/1), Cuvier's beaked (5/8), *Mesoplodon* spp. (7/13), Ziphiidae (other than beaked whale) (35/73), killer (1/3) whales, Risso's (5/72), bottlenose (3/69), spotted (5/401), striped (4/348) dolphins were detected in the research area. Bryde's whales and sperm whales were widely sighted in the research area (Figures 2a and 2b).

Details of sightings by each species; results of photo-identification and biopsy experiments; and marine debris observations are provided in the following paragraphs.

Transit survey to Shiogama

The YS3 departed the research area (15:23, 17 August) and started the transit survey to Japan (Shiogama port) using the passing mode until 28 August (12:00) under intervals of heavy wind and/or rain (Table 1b). Total searching distance was 293.19 n. miles. Total sightings included Bryde's (1 school/1 individual), sperm (6/8), Cuvier's beaked (5/8) whales, *Mesoplodon* spp. (1/6), Ziphiidae (4/13), Risso's (1/52) and spotted (1/35) dolphins. Sightings recorded during the transit sighting survey, by species are presented in Table 2b.

Detailed sightings by each species as follows:

Blue whale

A very small and emaciated solitary blue whale was sighted in the research area on 29 July 2014 at 35˚39'N, 176˚15'E (Figure 2a). Its body length was estimated to be 13.5 m, which is the size of a weanling calf. It is possible that this whale may have separated from its mother too early (pers. comm. Dale W. Rice). A biopsy sample was collected and photo-identification photos were taken. Sea surface temperature in the vicinity of the whale was 22.8 ˚C (Tables 3a and 3b).

Sei whale

One sei whale was sighted during the entire cruise. The solitary individual was seen near the northwest boundary of the research area (near the first northern waypoint) (Figure 2a). Sea surface temperature in the vicinity of the sei whale was 16.9° C (Tables 3a and 3b).

Bryde's whale

Bryde's whales were the most frequently encountered whale species with 118 schools (140 individuals including 13 calves) seen over a wide area (Figure 2a). A total of 29 schools (41 individuals including 4 mothers and calves) was seen during transit to the research area and 88 schools (98 individuals including 9 mothers and calves) were seen in the research area. One individual Bryde's whale was seen during transit from the research area to Japan. Bryde's whales were widely distributed throughout the research area.

Sea surface temperatures in the vicinity of Bryde's whales ranged from a minimum of 18.0˚C to a maximum of 27.3˚C (Table 3a). However, the sea surface temperature range in the vicinity of most of the sightings was 21.33-24.78° C (25^{th} to 75^{th} quartiles) (Table 3a). The sea surface temperature range in the vicinity of most of the mothers and calves was 20.7-22.1° C (25^{th} to 75^{th} quartiles).

Biopsy samples were obtained from 78 Bryde's whales (individuals), including 4 from a mother and calf, 1 from the mother only and 1 from the calf only (Table 4). Bryde's whales were the only baleen whale observed in the US EEZ (25-27 July 2014). All thirteen Bryde's whales that were encountered in the US EEZ were biopsy sampled. (See Appendix C)

Sperm whale

Sperm whales were the most frequently encountered toothed whale species seen during the cruise with 72 sperm whale schools (147 individuals including 1 calf) seen over a wide area (Figure 2b). A total of 7 schools (10 individuals) was seen during transit to the research area and 65 schools of sperm whales (137 individuals, including at least one confirmed calf) were seen in the research area. One sighting in the research area of a school of 4 whales may have included a mother and calf, but our closest approach was about 0.6 miles and the presence of a calf could not be confirmed (Figure 2b). A total of 6 schools of sperm whales (8 individuals) were seen during transit from the research area.

The sea surface temperature in the vicinity of the confirmed mother and calf was 24.4° C. Overall, sperm whales were observed at sea surface temperature ranging from a minimum of 17.8˚C to a maximum of 27.1˚C. However, the sea surface temperature range in the vicinity of most of the sightings was 23.4-26.9° C (25th to 75th quartiles) (Tables 3a and 3b).

Cuvier's beaked whale

Six schools (13 individuals including 1 calf) of Cuvier's beaked whales were seen during the cruise. Five schools (8 individuals) were seen in the research area and one school (5 individuals including one calf) was seen during transit from the research area to Japan (Figure 2c). Cuvier's beaked whales were observed at sea surface temperatures ranging from a minimum of 20.5˚C to a maximum of 26.2˚C (Tables 3a and 3b).

Ziphiidae and *Mesoplodon* spp.

A total of 39 schools (86 individuals including 1 calf) of unidentified Ziphiidae was observed at sea surface temperatures ranging from a minimum of 16.8˚C to a maximum of 27.1˚C (Figure 2c, Table 3a). Thirty-five schools (73 individuals including at least 1 calf) were observed in the research area and four schools (13 individuals) were seen during transit from the research area to Japan (Figure 2c).

A total of 8 schools (19 individuals including 1 calf) of unidentified *Mesoplodon* species were observed at sea surface temperatures ranging from a minimum of 18.4˚C to a maximum of 26.2˚C (Figure 2c, Table 3a). Seven schools (13 individuals and no calves) were observed in the research area (Table 3b) and one school (6 individuals including 1 calf) was seen during transit from the research area to Japan (Figure 2c).

Short-finned pilot whale

Two schools of the southern form of the short-finned pilot whale were observed in close proximity to each other during transit to the research area at sea surface temperatures of 23.4 and 23.5° C (Figure 2d, Table 3a). Four schools of unknown-type pilot whales (115 individuals) were seen in the research area at sea surface temperatures ranging from a minimum of 19.6° C to a maximum of 27.2° C (Figure 2d, Table 3b).

Risso's dolphin

Eight schools of Risso's dolphins (140 individuals including 1 calf) were observed at sea surface temperatures ranging from a minimum of 21.1˚C to a maximum of 24.2˚C (Figure 2d, Table 3a). Two schools (16 individuals) were observed during transit to the research area, five schools (72 individuals) were observed in the research area (Table 3b), and one school of 52 individuals was seen during transit from the research area to Japan (Figure 2d).

Killer whale

One killer whale pod (3 individuals: male, female and juvenile) was observed during the cruise at a sea surface temperature of 18.2° C (Figure 2e, Table 3a). Photo-identification catalogue numbers were assigned to all three individuals (Table 4). One biopsy sample was collected from the male.

Bottlenose dolphin

Three schools of bottlenose dolphins (69 individuals including 3 calves) were observed at sea surface temperatures ranging from a minimum of 24.2˚C to a maximum of 24.9˚C (Figure 2e, Tables 3a and 3b). All sightings were in the research area.

Striped dolphin

Five schools of striped dolphins (420 individuals including 17 calves) were observed at sea surface temperatures ranging from a minimum of 24.5˚C to a maximum of 27.2 ˚C (Figure 2e, Table 3a). One school (72 individuals including 2 calves) was observed during transit to the research area and four schools (348 individuals including 15 calves) were observed in the research area (Figure 2e, Table 3b)

Spotted dolphin

Six schools of spotted dolphins (436 individuals including 29 calves) were observed at sea surface temperatures ranging from a minimum of 21.8˚C to a maximum of 23.3˚C (Figure 2e, Tables 3a and 3b). All sightings were in the research area.

Common dolphin

Forty-two schools of common dolphins (1,747 individuals including 130 calves) were observed at sea surface temperatures ranging from a minimum of 16.7 ˚C to a maximum of 22.2˚C (Figure 2e, Tables 3a and 3b). All sightings were in the research area.

4. PHOTO-IDENTIFICATION

A total of one blue whale, 69 Bryde's whales, two sperm whales (mother and calf), one pilot whale, 14 Risso's dolphins and three killer whales were photo-identified during the 2014 IWC-POWER cruise (Table 4). During transit to the research area, photo-identification data were collected for 10 Bryde's whales, 1 pilot whales, and 3 Risso's dolphins. In the research area, photo-identification data were collected for 1 blue whale, 59 Bryde's whales, 2 sperm whales and 3 killer whales. During transit from the research area, photo-identification data were collected for 11 Risso's dolphins.

4.1 Whale ID numbering protocol for the IWC-POWER cruises

As in 2011 and 2012, annual YS3 Whale ID numbers were assigned to whales only if there were sufficient natural markings showing to assign annual photo-ID catalogue numbers. If sufficient detail was not apparent to re-identify the whale in future sightings, no ID number was assigned. As is standard practice with killer whale identification numbering, pod ID numbers have been assigned to killer whales as well as individual whale ID numbers within each pod. The pod ID number is a unique identifier that includes the date and sighting number of the first sighting of the pod, e.g., 2014_0720_15 based on the date and sighting number of the pod. Biopsy sample numbers have been added to the whale ID numbers when a sampled whale was photo-identified, e.g., 2014_Bryde's_1_14031001. If the whale was biopsied but could not be assigned a photo-ID number because the natural markings were not photographed, the whale ID number is the species, the letter "X" in place of the whale ID number, and the biopsy sample number e.g., 2014_Bryde's_X_14041023. The same pod ID protocol was used for assigning ID numbers to the Risso's dolphin pods.

5. BIOPSY SAMPLING

A total of 80 biopsy samples (individuals) were successfully collected, including 1 blue whale, 78 Bryde's whales, and 1 killer whale (Table 4). Every biopsy encounter was documented photographically. All samples for molecular genetic analysis were frozen. All biopsy samples will be sent to NRIFSF after arrival in Shiogama. Samples are to be divided in half, with one half of the sample for IWC and the other half for Japan. All dividing work will be conducted by NRIFSF, after conclusion of the cruise, before export is arranged.

In the case of Bryde's whale, 30 samples (individuals) were collected from Sub-area 1 (170°E-180°E in Figure 2a) and 48 samples from Sub-area 2 (180°E- 170°W in Figure 2a). These biopsy samples will enable genetic studies on stock structure to be conducted in contribution for the North Pacific Bryde's whale *Implementation Review* to be held in the 2017 SC meeting.

5.1 Biopsy data management

As in past years, biopsy darts were numbered and color-coded and each biopsy shooter used either red or black labelled darts. During setup for each biopsy sampling encounter, photos were taken of each dart before it was loaded into the Larsen gun. After a sample was collected, photos were taken of each dart with the sample. This allowed us to track which whale was sampled. The time of each biopsy hit was captured photographically, and the exact biopsy time of each biopsy hit was written on the foil wrap for each sample before it was taken to the biopsy lab. The biopsy time was also recorded for each sighting by the researcher on the upper bridge.

Each evening, the photos were evaluated to confirm which whale had been biopsied. After analysis of the photographs, biopsy sample numbers were assigned and simultaneously linked to photo-ID data where possible. Information about each encounter was entered into an integrated "PhotoID_Biopsy" database which merged data from the ship's sightings data ".csv" file with the biopsy and photo-ID catalogue and biopsy sample information. After sample numbers were assigned, data were double-checked with the sightings data manager to confirm sighting numbers and biopsy hit times, and then biopsy data sheets were given to the biopsy sample manager for sample processing. Times of biopsy start based on photos taken during setup on bow deck,

document biopsy darts before approach, hitting, retrieval (photo of dart with sample) and/or finish (dart retrieval and photo-documentation of the retrieved date) (no hit or no shot) were entered in the "PhotoID_Biopsy database" based on the exact time in each photo image.

5.2 Biopsy efficiency

Biopsy duration times were evaluated to examine biopsy efficiency (Table 4). Biopsy start time was recorded in the database as the time the Larsen guns were loaded based on the initial photos taken at the start of each biopsy encounter. Every biopsy hit was photo-documented (see section 8.2), so the exact biopsy hit time could be entered into in the database based on the time recorded on the "biopsy hit" photo. Lastly, after the dart was retrieved, each shooter holding the dart with sample was photographed before leaving the bow deck. Time from setup to first hit was evaluated, as well as time from setup to dart retrieval.

Biopsy success rate when approaching Bryde's whales for sampling was very high this year. Of the 83, encounters with Bryde's whales where biopsy sampling was attempted, a sample was obtained in 78 of those encounters (93.3% success rate). Median time from setup to sample retrieval when sampling solitary Bryde's whales was 14:02 minutes (25^{th} to 75^{th} quartiles: 8:04 – 22:37 minutes). When sampling groups of 2 Bryde's whales (including mothers and calves), the median time from setup to sample retrieval was 30:31minutes (25^{th} to 75^{th} quartiles: 12:47 – 50:48 minutes). A biopsy sample was collected from the solitary blue whale encountered during the cruise (biopsy duration: 12:36 minutes) and from one whale in the pod of three killer whales encountered during the cruise (encounter duration 35:27 minutes). Biopsy was briefly attempted during the lone encounter with a sperm whale mother and calf, but the whales dove before we could approach closely enough to sample (encounter duration: 12:10 minutes). During the five encounters with Bryde's whales where the biopsy experiment was initiated but samples were not collected, the whales were surfacing in erratic (not predictable patterns) generally under less than ideal lighting conditions. Table 4 shows the summary of biopsy experiment. Biopsy sampling was attempted as often as conditions permitted.

6. VIDEO-RECORDING

A digital video camera recorder, Sony HDR-PJ800, AVCHD was used to conduct opportunistic video recording. Biopsy events were recorded from the top barrel during thirteen sightings of single Bryde's whales, on six different days. Eighteen separate video clips were recorded, for a total time of 00:28:15, including 00:27:23 of Bryde's whale footage. Video content consists of: one subsurface tracking, two dart pick-up and 15 biopsy events. A quality code was assigned to each clip based on the usefulness of video content i.e. for training or behavioural observations.

7. OTHER EXPERIMENTS

7.1 Estimated Angle and Distance Training Exercise

The Estimated Angle and Distance Training Exercises were conducted in the afternoon of 6 July for 1 hour 29 minutes. During the exercise the observers familiarized themselves with distance estimates from the top barrel and upper bridge.

7.2 Estimated Angle and Distance Experiment

The Estimated Angle and Distance Experiments were conducted on 6 August for 3 hours 17 minutes in the research area, later in the research period. Estimated Angle and Distance Training Exercises and Estimated Angle and Distance Experiments were performed using the same protocol as recent cruises (Anon. 2013a).

7.3 Marine debris observation

During this cruise as in past years, data on floating marine debris were collected to document type and extent of marine debris presence in the North Pacific. As agreed during the pre-cruise meeting in Shiogama, systematic data collection of marine debris was conducted only during the first 15 minutes of each hour, and only as time permitted (not to interfere with marine mammal observations). In addition, per the request of the US researcher, attempts were made to record all observations of marine debris while in the US EEZ. Lastly, opportunistic marine debris data were recorded if the ship passed close enough to an object to collect a good documentation photograph or if an unusual item of marine debris was observed at a distance. The following parameters were recorded for all on-effort observations: angle and distance from vessel at time of initial sighting; description of the marine debris item; size, colour and height above water level of object. In addition, items were photographed when possible to document the type of marine debris or in some cases to confirm observations of a distant sighting. All photographs were geotagged automatically, and therefore the precise location of each object was recorded in the photo EXIF metadata (section 8.2)

Marine debris was sparsely distributed during this cruise, unlike during the 2012 POWER cruise (Matsuoka et al. 2013) and especially during the 2013 POWER cruise (Matsuoka et al. 2014). A total of 247 marine debris objects were observed, of which 118 were recorded "on effort" (i.e., during the first 15 minutes of each hour) (Table 5). A total of 23 objects were recorded in the US EEZ (25-26 July and the morning of 27 July before 10:00) (Appendix Table C3). A total of 156 objects were photographed. Only three natural (not man-made) items, wooden logs, were observed during the entire cruise.

8. TECHNICAL MATTERS OF DATA AND RECOMMENDATIONS

8.1 Whale photo-ID catalogue for the IWC-POWER cruises

Annual catalogues for blue, humpback, killer whale and one right whale produced during the 2011 and 2012 cruises have already been compared to existing North Pacific catalogues. It appears that the 2011 and 2012 blue whales are unique whales (never documented before) and that the right whale photographed in 2012 is a unique individual (never documented before). Two killer whale pods observed during POWER cruises had been photographed in prior years (2004 and 2006). Aside from those two pods, it's likely that most of the killer whale pods observed during the POWER cruises have never been documented before. Five humpback whales had been photographed in prior years (a few as long ago as early as 1990 and 1992). During this cruise, Mizroch obtained full access to the 2010 photo data and began integrating all the annual blue, humpback and killer whale catalogues to produce a fully reconciled 2010-2014 "POWER" catalogue for each of these species (i.e., integrate each annual catalogue and assign sequential catalogue numbers for each individual by species). Taylor assigned ID numbers for the fin whale ID photos taken during the 2010-2012 cruises.

During this cruise, 69 Bryde's whales were catalogued. After the Bryde's whale photographs from the 2013 are evaluated, a reconciled Bryde's whale "POWER" catalogue will be developed. Because no blue whales were photographed during the 2013 POWER cruise, this year's blue whale can be added directly to the reconciled blue whale "POWER" catalogue. Mizroch will distribute the integrated POWER catalogues to managers of the existing North Pacific catalogues in early fall and ask them to conduct another round of matching evaluating all the POWER catalogue photos. Mizroch and Matsuoka will submit a full report on known and any new matches to the 2015 IWC meeting.

8.2 Photography and photo-processing

All photographs were shot using RAW format, which provides the highest resolution image possible from each digital SLR camera. During this cruise, all three photographers used "image-stabilized" lenses, which are highly recommended for shooting moving objects (fast-swimming whales) from a moving object (fast traveling ship sometimes in heavy seas). Matsuoka photographed with Canon 100-400mm lens attached to a camera with a crop-frame sensor (Canon EOS 7D), Taylor photographed with a Tamron 150-600mm lens attached to a camera with a full-frame sensor (Nikon D700) and Mizroch photographed with a Nikon 80-400 lens attached to a camera with a full-frame sensor (Nikon D4).

After evaluating the photographs from this year's cruise, we found that the "extreme" zoom telephoto Tamron 150-600mm lens had good enough resolution to confirm species ID of dolphin groups that were seen at long distances, for example, a group of spotted dolphins seen in the US EEZ at a distance of more than 0.1 mi.

GPS data were geotagged automatically using a GPS logger attached directly to each camera. In addition, photographer's contact information was automatically embedded into the camera's "User comment" field for both Nikon cameras and was "batch entered" into the EXIF metadata as time permitted for the Canon camera. Each night after surveys were completed, all photographs from each camera were transferred to a fast computer (Intel Core i7 processor, 8 Gbytes RAM, 500 Gb solid state hard drive, screen resolution 3200 x 1800) using a high speed card reader with multiple bays that could copy all three cards at the same time. Photos from all three cameras were then integrated and transferred to folders labelled with the date and each day's line transect sighting number.

An informative "encounter number" that included project information and the sighting number was "batch" edited into the "Image Description" EXIF metadata field of each photo in each folder (e.g., 2014_POWER_YS3_20140731_23) every survey day after double-checking sighting number assignments with the sightings data. This information, which is embedded in the photo file's EXIF metadata fields, can be seen viewing the "Properties" of the image file. Many online programs such as Google Earth, Lightroom and Flickr automatically read the GPS information and show the map location where each photo was taken.

At this early stage of labeling (even before photo-ID catalogue and biopsy sample numbers were assigned), each photo can be viewed as an independent data point which documents the sighting number, project information (e.g., POWER_YS3) as well as the exact latitude and longitude where the photograph was taken.

8.3 Evaluating natural markings and analysing biopsy events

All photo-ID and/or biopsy approaches during this cruise were documented by each three cameras from different locations on the ship. Mizroch photographed from the bow deck and shot at 10 frames per second to try to capture the exact "hit" position of each biopsy dart and to capture any photo-ID shots opportunistically. Taylor photographed from the IO platform to capture photo-ID shots and also document biopsy hit positions. Matsuoka photographed from the barrel to capture full body shots of whales, plus to capture biopsy hit location and photo-ID shots. Every night, each photograph was evaluated to see if the detail was sufficient to assign a catalogue number to the individual photographed. For each successful biopsy encounter, photos of each biopsy hit were labelled with the biopsy sample number, shooter name and then evaluated with the biopsy sample manager to determine the "hit position" field in the biopsy data form. All catalogued photographs were labelled with a 2014 YS3 ID number in the "Artist" EXIF metadata field and the identifying part (e.g., LD for left dorsal) was typed into the "Copyright" EXIF metadata field. When all photo labelling was complete, the daily photographs were backed up each night to three hard drives using a high speed hard drive dock (155/Mb sec). Each photographer was able to review everyone's integrated daily photos each day and could adjust camera settings (ISO, shutter speed, zoom level) based on how well their photographs complemented the photographs taken by the other photographers during the cruise.

8.4 Recommendation

Because these surveys cover a broad area and encounter species that are seldom documented, and because encounter times are very short and/or close approaches are sometimes not possible, it is recommended that all future photographs be shot using RAW format using cameras with full-frame sensors and use an "extreme" zoom telephoto lens such as the Tamron 150-600mm lens. Because of the volume of the photographic data and the large file sizes of RAW photos, it is also recommended that high speed, high resolution computers and fast file transfer devices are used for transferring, analysing and backing up all the photographic data.

9. CONCLUSIONS

The 5th annual IWC-POWER cruise was successfully conducted using the Japanese Research Vessel *Yushin-Maru No.3*. Equipment and survey methods were consistent with previous IWC international sighting surveys. Sighting procedures were in accordance with guidelines agreed upon by the SC (IWC, 2005). Survey objectives, methods and procedures were explained in detail and fully understood by the Captain, officers, crew and international researchers prior to survey operations. Throughout the cruise, all participants worked collaboratively to meet the overall research objectives. Data collected, including sighting, photo-ID, daily photographs, biopsy and video, will be sent to the IWC secretariat after arriving at the home port, under the responsibility of the cruise leader. The 5th cruise of this programme provides critical information on the distribution, abundance and stock structure of baleen whale species, in particular the Bryde's whale, in a poorly-known area. Additional information on other cetacean species found to be widely distributed in the research area will contribute to an improved understanding of species/population movements in areas of the North Pacific where there has been little to no survey effort in recent decades. These results will contribute to the objectives of the IWC/SC.

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TABLES AND FIGURES

Table 1a. Way Points (WP) in the research area. The planned cruise track line distance in the research area was 3,878.4 n.miles.

WP	Latitude	Longitude
101	31˚59.8'N	170˚00.0'E
102	30˚00.0'N	170˚59.9'E
103	31˚40.0'N	171˚47.5'E
104	33˚20.0'N	172˚35.9'E
105	35˚00.0'N	173˚25.3'E
106	36˚40.0'N	174˚15.7'E
107	38˚20.0'N	175˚07.2'E
108	40˚00.0'N	175˚59.9'E
109	38˚20.0'N	176˚52.6'E
110	36˚40.0'N	177˚44.1'E
111	35˚00.0'N	178˚34.5'E
112	33˚20.0'N	179˚23.9'E
113	32˚05.7'N	180˚00.0'W
114	31˚40.0'N	179˚47.6'W
115	31˚36.6'N	179˚46.0'W
116	30˚00.0'N	179˚00.1'W
117	31˚40.0'N	178˚12.5'W
118	31˚50.3'N	178˚07.6'W
119	33˚20.0'N	177˚24.1'W
120	35˚00.0'N	176˚34.7'W

WP	Latitude	Longitude
121	36˚40.0'N	175˚44.3'W
122	38˚20.0'N	174˚52.8'W
123	40˚00.0'N	174˚00.1'W
124	38˚20.0'N	173˚07.4'W
125	36˚40.0'N	172˚15.9'W
126	35˚00.0'N	171˚25.5'W
127	33˚20.0'N	170˚36.1'W
128	31˚40.0'N	169˚47.7'W
129	30˚00.0'N	169˚00.1'W
130	31˚40.0'N	168˚12.5'W
131	33˚20.0'N	167˚24.1'W
132	35˚00.0'N	166˚34.7'W
133	36˚40.0'N	165˚44.3'W
134	38˚20.0'N	164˚52.8'W
135	40˚00.0'N	164˚00.1'W
136	38˚40.0'N	163˚18.3'W
137	37˚20.0'N	162˚37.3'W
138	36˚00.0'N	161˚57.0'W
139	34˚40.0'N	161˚17.4'W
140	33˚20.0'N	160˚38.5'W
141	31˚59.8'N	160˚00.0'W

Table 1b. Summary of search effort (time and distance) and experimental time (hours) conducted during the 2014 IWC- POWER Cruise.

Area	Start	End	NSP with abeam closing		Photo-ID, Biopsy	Estimated angle and distance training / experiment
	Date	Date	Time	Dist.	Time	Time
	Time	Time		(n.m.)		
Shiogama to research area	4-Jul. 6:00	7-Jul. 17:55	20:33	234.88	1:03	1:29
Research area	8-Jul. 6:00	17-Aug. 15:21	279:04	3,233.01	32:12	3:17
Research area to Shiogama	17-Aug. 15:21	28-Aug. 12:00	24:52	293.19	0:12	0:00
Total	4-Jul 6:00	28-Aug. 12:00	324:29	3,761.08	33:27	4:46

Table 2a. Number of sightings for all species observed in the research area by effort mode. NSP: Normal Passing with abeam closing Mode; OE: Top down (TD) and drifting (DR). Numbers of calves are shown in parentheses.

Species	NSP		OE		Total	
	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.
Blue whale	1	1	0	0	1	1
Sei whale	1	1	0	0	1	1
Bryde's whale	87	97 (9)	1	1	88	98 (9)
Like Bryde's whale	3	3	0	0	3	3
Sperm whale	65	137 (1)	0	0	65	137 (1)
Cuvier's beaked whale	4	7	1	1	5	8
Mesoplodon spp.	7	13	0	0	7	13
Ziphiidae	35	73 (1)	0	0	35	73 (1)
Killer whale	1	3	0	0	1	3
Risso's dolphin	5	72	0	0	5	72
Bottlenose dolphin	3	69 (6)	0	0	3	69 (6)
Spotted dolphin	5	401 (29)	0	0	5	401 (29)
Striped dolphin	4	348 (15)	0	0	4	348 (15)
Common dolphin	41	1,719 (127)	1	28 (3)	42	1,747 (130)
Unidentified large baleen whale	46	49	0	0	46	49
Unidentified large cetacean	9	9	0	0	9	9
Unidentified pilot whale	4	115	0	0	4	115
Unidentified small cetacean	1	1	0	0	1	1
Unidentified dolphin/porpoise	53	1,592	0	0	53	1,592
Unidentified cetacean	9	10	0	0	9	10
Total	384	4,720 (188)	3	30 (3)	387	4,750 (191)

Table 2b. Number of sightings for all species observed in 2014, including sightings during transits and in the research area (R.A.). Numbers of calves are shown in parentheses.

Species	**Transit to R.A.**		**Research Area (R.A.)**		**Transit from R.A.**		**Total**	
	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.
Blue whale	0	0	1	1	0	0	1	1
Sei whale	0	0	1	1	0	0	1	1
Bryde's whale	29	41 (4)	88	98 (9)	1	1	118	140 (13)
Sperm whale	7	10	65	137 (1)	6	8	78	155 (1)
Like Bryde's whale	0	0	3	3	0	0	3	3
Cuvier's beaked whale	0	0	5	8	1	5 (1)	6	13 (1)
Mesoplodon spp.	0	0	7	13	1	6 (1)	8	19 (1)
Ziphiidae	0	0	35	73 (1)	4	13	39	86 (1)
Killer whale	0	0	1	3	0	0	1	3
Southern form short-finned pilot whale	2	12 (2)	0	0	0	0	2	12 (2)
Risso's dolphin	2	16	5	72	1	52 (1)	8	140 (1)
Bottlenose dolphin	0	0	3	69 (6)	0	0	3	69 (6)
Spotted dolphin	0	0	5	401 (29)	1	35	6	436 (29)
Striped dolphin	1	72 (2)	4	348 (15)	0	0	5	420 (17)
Common dolphin	0	0	42	1,747 (130)	0	0	42	1,747 (130)
Unid. large baleen whale	13	13	46	49	1	1	60	63
Unid. large cetacean	1	1	9	9	1	1	11	11
Unid. pilot whale	0	0	4	115	0	0	4	115
Unid. small cetacean	0	0	1	1	6	6	7	7
Unid. dolphin/porpoise	4	78	53	1,592	3	90	60	1,760
Unid. cetacean	1	1	9	10	0	0	10	11
Total	60	244 (8)	387	4,750 (191)	26	218 (3)	473	5,212 (202)

Table 3a. Minimum, maximum and range of sea surface temperatures in degrees Celsius for each species sighted during the cruise (including transit survey), sorted in order of frequency of sightings. Range of 25th to 75th quartiles are presented for our most frequently encountered cetaceans: Bryde's whales, sperm whales and common dolphins.

Species	Number of sightings	Minimum SST	Maximum SST	Temperature range	25th to 75th Quartile
Blue whale	1	22.8	22.8	0	-
Sei whale	1	16.9	16.9	0	-
Bryde's whale	118	18	27.3	9.3	21.33-24.78
Sperm whale	78	17.8	27.1	9.3	23.4-25.9
Killer whale	1	18.2	18.2	0	-
Risso's dolphin	8	21.1	24.2	3.1	-
Cuvier's beaked whale	6	20.5	26.2	5.7	-
Ziphiidae	39	16.8	27.1	10.3	-
Mesoplodon spp.	8	18.4	26.2	7.8	-
Southern form short finned pilot whale	2	23.4	23.5	0.1	-
Unidentified pilot whale	4	19.6	27.2	7.6	-
Common dolphin	42	16.7	22.2	5.5	17.6-19.5
Striped dolphin	5	21.8	23.3	1.5	-
Spotted dolphin	6	24.5	27.2	2.7	-
Bottlenose dolphin	3	24.2	24.9	0.69	-

Table 3b. Minimum, maximum and range of sea surface temperature (°C) for each species sighted in the research area. A range of 25th to 75th quartiles are presented for the most frequently encountered cetaceans: Bryde's whales, sperm whales and common dolphins.

Species	Number of sightings	Minimum SST	Maximum SST	Temperature range	25th to 75th Quartile
Blue whale	1	22.8	22.8	0	-
Sei whale	1	16.9	16.9	0	-
Bryde's whale	88	18	27.3	9.3	21.15-25.2
Sperm whale	65	17.8	27.1	9.3	24.1-26.1
Killer whale	1	18.2	18.2	0	-
Risso's dolphin	5	21.7	24.2	2.5	-
Cuvier's beaked whale	5	20.5	26.2	5.7	-
Ziphiidae	35	16.8	27.1	10.3	-
Mesoplodon spp.	7	18.4	26.2	7.8	-
Unidentified pilot whale	4	19.6	27.2	7.6	-
Common dolphin	42	16.7	22.2	5.5	17.6-19.5
Striped dolphin	4	22	23.3	1.3	-
Spotted dolphin	5	24.5	27.2	2.7	-
Bottlenose dolphin	3	24.2	24.9	0.69	-

Table 4. Summary of the photo-identification and biopsy data with accompanying photo-ID data and encounter duration (minutes) LD: Left dorsal; RD: Right dorsal. YS3 Whale ID numbers have been assigned to one blue whale, 69 Bryde's whales, 2 sperm whales, 3 killer whales and one pilot whale. Biopsy sample numbers have been added to the whale ID numbers when a sampled whale was photo-identified.

	Common Name	Sighting Number	Group size	Number Photo-ID'd	YS3WhaleID	Photo-ID Part	Encounter duration
7/29/2014	Blue whale	15	1	1	2014_Blue_1_14061048	RD, RL, LD	12
7/4/2014	Brydes whale	9	1	1	2014_Brydes_1	LD, LL	
7/5/2014	Brydes whale	1	2	2	2014_Brydes_2 (calf); 2014_Brydes_3(mother)	RD, LD each	
7/5/2014	Brydes whale	5	2	2	2014_Brydes_4; 2014_Brydes_5	LD of one; LD,LL of the other	
7/5/2014	Brydes whale	23	3	1	2014_Brydes_6	LD, LL	
7/6/2014	Brydes whale	8	2	1	2014_Brydes_7	LD, RD	
7/6/2014	Brydes whale	11	1	1	2014_Brydes_8	LD, LL	
7/7/2014	Brydes whale	2	1	1	2014_Brydes_9_14031001	RD, LD	33
7/7/2014	Brydes whale	3	1	1	2014_Brydes_10_14031002	RD	21

	Common Name	Sighting Number	Group size	Number Photo-ID'd	YS3WhaleID	Photo-ID Part	Encounter duration
7/8/2014	Brydes whale	1	1	0	2014_Brydes_X_14031003		42
7/8/2014	Brydes whale	3	2	2	2014_Brydes_11_14031004 (calf); 2014_Brydes_12 (mother)	LD, RD (calf); LD (mother)	49
7/8/2014	Brydes whale	4	1	0	2014_Brydes_X_14031005		16
7/8/2014	Brydes whale	8	1	0	2014_Brydes_X_14031006		10
7/10/2014	Brydes whale	1	1	1	2014_Brydes_13	LD	45
7/11/2014	Brydes whale	2	1	1	2014_Brydes_14_14031007	RD	11
7/12/2014	Brydes whale	5	1	0	2014_Brydes_X_14031008		9
7/13/2014	Brydes whale	3	1	1	2014_Brydes_15_14031009	LD, LL	7
7/13/2014	Brydes whale	4	1	1	2014_Brydes_16_14031010	RD, LD	19
7/13/2014	Brydes whale	14	1	0	2014_Brydes_X_14031011		10
7/14/2014	Brydes whale	9	1	1	2014_Brydes_17_14031012	LD	14
7/14/2014	Brydes whale	11	1	0	2014_Brydes_X_14031013		14
7/14/2014	Brydes whale	15	1	1	2014_Brydes_18_14031014	RD, LD, LL	31
7/14/2014	Brydes whale	18	2	0	2014_Brydes_X_14031015		15
7/16/2014	Brydes whale	3	2	2	2014_Brydes_19 (calf); 2014_Brydes_20_14031016 (mother)	RD, LD (calf); LD (mother)	52
7/16/2014	Brydes whale	4	2	2	2014_Brydes_21_14031017 (mother); 2014_Brydes_22_14031018 (calf);	RD (mother); RD (calf)	12
7/19/2014	Brydes whale	1	1	0	2014_Brydes_X_14031019		38
7/19/2014	Brydes whale	2	1	0	2014_Brydes_X_14031020		20
7/20/2014	Brydes whale	3	1	0	2014_Brydes_X_14031021		37
7/21/2014	Brydes whale	4	2	2	2014_Brydes_23_14031023 (mother); 2014_Brydes_24_14031024 (calf)	LD (mother); LD, LL (calf)	9
7/21/2014	Brydes whale	7	1	1	2014_Brydes_25_14031025	RD	9
7/21/2014	Brydes whale	11	1	1	2014_Brydes_26_14031026	RD	33
7/21/2014	Brydes whale	12	1	0	2014_Brydes_X_14031027		8
7/22/2014	Brydes whale	1	1	1	2014_Brydes_27_14031028	LD	4
7/23/2014	Brydes whale	4	1	0	2014_Brydes_X_14031029		4
7/23/2014	Brydes whale	5	1	1	2014_Brydes_28	RD, LD	45
7/24/2014	Brydes whale	20	1	1	2014_Brydes_29_14031030	RD, RL	8
7/24/2014	Brydes whale	22	1	1	2014_Brydes_30_14031031	LD	32
7/25/2014	Brydes whale	3	1	1	2014_Brydes_31_14031032	RD	17
7/25/2014	Brydes whale	10	1	0	2014_Brydes_X_14031033		9
7/25/2014	Brydes whale	24	1	1	2014_Brydes_32_14031034	RD, LD	4
7/25/2014	Brydes whale	27	1	1	2014_Brydes_33_14031035	LD	4
7/25/2014	Brydes whale	28	1	0	2014_Brydes_X_14031036		8
7/25/2014	Brydes whale	29	1	1	2014_Brydes_34_14031037	LD	4
7/25/2014	Brydes whale	30	1	0	2014_Brydes_X_14031038		24
7/26/2014	Brydes whale	2	1	0	2014_Brydes_X_14031039		6
7/26/2014	Brydes whale	3	1	1	2014_Brydes_35_14031040	RD, LD	16
7/26/2014	Brydes whale	4	1	0	2014_Brydes_X_14031041		14
7/26/2014	Brydes whale	6	1	1	2014_Brydes_36_14031042	RD, RL	22
7/26/2014	Brydes whale	7	1	1	2014_Brydes_37_14031043	RD	5
7/27/2014	Brydes whale	1	1	1	2014_Brydes_38_14031044	LD	20
7/27/2014	Brydes whale	6	1	1	2014_Brydes_39_14031045	LD	7
7/29/2014	Brydes whale	1	1	1	2014_Brydes_40_14031046	LD	14
7/29/2014	Brydes whale	9	1	1	2014_Brydes_41_14031047	RD	6
7/31/2014	Brydes whale	6	1	0	2014_Brydes_X_14031049		11
7/31/2014	Brydes whale	7	1	1	2014_Brydes_42_14031050	RD	14
8/2/2014	Brydes whale	1	1	1	2014_Brydes_43_14031051	RD, LD, LL	23
8/2/2014	Brydes whale	9	1	1	2014_Brydes_44_14031052	RD, RL	15
8/2/2014	Brydes whale	11	1	1	2014_Brydes_45_14031053	RD, RL	5
8/3/2014	Brydes whale	5	1	0	2014_Brydes_X_14031054		6
8/3/2014	Brydes whale	6	1	1	2014_Brydes_46_14031055	LD	6
8/3/2014	Brydes whale	7	1	0	2014_Brydes_X_14031056		11
8/4/2014	Brydes whale	2	1	1	2014_Brydes_47_14031057	LD, LL	7
8/5/2014	Brydes whale	1	1	1	2014_Brydes_48_14031058	RD, RL, LD, LL	44
8/7/2014	Brydes whale	16	1	1	2014_Brydes_49_14031059	RD, RL	15
8/8/2014	Brydes whale	16	1	1	2014_Brydes_50_14031060	RD, RL, LD, LL	43
8/9/2014	Brydes whale	6	1	1	2014_Brydes_51_14031061	RD, LD	47

	Common Name	Sighting Number	Group size	Number Photo-ID'd	YS3WhaleID	Photo-ID Part	Encounter duration
8/9/2014	Brydes whale	7	1	1	2014_Brydes_52	RD	
8/10/2014	Brydes whale	4	1	0	2014_Brydes_X_14031062		45
8/11/2014	Brydes whale	1	1	0	2014_Brydes_X_14031063		9
8/11/2014	Brydes whale	4	1	1	2014_Brydes_53_14031064	LD	15
8/11/2014	Brydes whale	5	1	0	2014_Brydes_X_14031065		18
8/11/2014	Brydes whale	6	1	1	2014_Brydes_54_14031066	RD	3
8/11/2014	Brydes whale	7	2	2	2014_Brydes_55_14031067 (mother); 2014_Brydes_56_14031068 (calf)	LD, LL (mother); RD, LD (calf)	3
8/12/2014	Brydes whale	4	1	1	2014_Brydes_57_14031069	RD, LD	35
8/12/2014	Brydes whale	8	2	2	2014_Brydes_58_14031070 (mother); 2014_Brydes_59_14031071 (calf)	RD, LD (mother); LD (calf)	30
8/12/2014	Brydes whale	9	1	1	2014_Brydes_60_14031072	RD	5
8/12/2014	Brydes whale	10	1	1	2014_Brydes_61_14031073	RD. LD	3
8/12/2014	Brydes whale	11	1	1	2014_Brydes_62_14031074	LD	21
8/12/2014	Brydes whale	13	1	1	2014_Brydes_63	RD, RL	
8/12/2014	Brydes whale	17	2	2	2014_Brydes_64 (mother); 2014_Brydes_65 (calf)	LD, RD (mother); LD, LL (calf)	
8/13/2014	Brydes whale	1	1	0	2014_Brydes_X_14031075		13
8/13/2014	Brydes whale	3	1	1	2014_Brydes_66_14031076	RD, LD	27
8/13/2014	Brydes whale	6	1	1	2014_Brydes_67_14031077	LD	9
8/14/2014	Brydes whale	2	2	1	2014_Brydes_68	RD	
8/15/2014	Brydes whale	2	1	0	2014_Brydes_X_14031078		10
8/15/2014	Brydes whale	12	1	1	2014_Brydes_69_14031079	RD, LD	48
8/18/2014	Brydes whale	10	1	0	2014_Brydes_X_14031080		8
7/13/2014	Sperm whale	16	4	2	2014_Sperm_1 (calf); 2014_Sperm_2 (mother)	LD of each	12
7/20/2014	Killer whale	15	3	3	2014_720_15_KW_1_14271022 (male); 2014_720_15_KW_2 (female); 2014_720_15_KW_3 (juvenile);	LD, RD of each	35
7/5/2014	Risso's dolphin	11	7	3	2014-705_11_Risso_1; 2014-705_11_Risso_2;2014-705_11_Risso_3	LD	
7/4/2014	Southern form short finned pilot whale	11	7	1	2014_704_11_Pilot_1	RD, RL	

Table 5. Summary of marine debris observations. Codes below 199 correspond to the IWC codes. Codes above 199 were developed based on marine debris observations during the POWER cruises. On-effort observations were during the first 15 minutes each hour while on survey. Off-effort observations were strictly opportunistic.

Marine Debris Code	Description	Total	On-effort	Off-effort
134	single fishing float	142	79	63
134	single fishing float with high flyer	1		1
134	single fishing float with rope	1	1	
134	styrofoam float	15	5	10
134	styrofoam float with rope	1	1	
135	clustered fishing floats (2)	3	1	2
135	clustered fishing floats and net	2	1	1
135	clustered fishing floats, line and rope	1		1
135	clustered fishing floats, rope and net	1		1
135	clustered floats with high flyer	3	3	
137	wood crate, 1 side only	2	1	1
142	metal cannister, 1 litre or less	2	2	
144	metal can, 150-150 litres	1	1	
148	styrofoam piece	5	1	4
148	styrofoam piece, square	1	1	
149	styrofoam piece, 1-3 square metres	1		1
162	piece of plastic	8	4	4
169	garbage, 1 piece	2	2	
169	garbage, 2 pieces	1	1	
304	clustered rope	4	1	3
304	clustered rope and net	6	2	4
304	rope	2		2
402	lightbulb	1		1

Marine Debris Code	Description	Total	On-effort	Off-effort
501	cushion or flotation pad	1	1	
501	life jacket	1		1
502	life ring	2	1	1
601	plastic bottle	4		4
602	plastic box	1		1
602	plastic bucket	1	1	
602	plastic cannister	1		1
602	plastic container	2		2
602	plastic crate	1		1
602	plastic crate, 1 side only	3	2	1
602	plastic crate, 2 sides	1	1	
606	plastic sheet	7	3	4
606	plastic sheet and rope	1		1
607	canvas	1		1
611	plastic lid	1		1
611	plastic lid (from 5gal. bucket)	1		1
611	plastic pot	1		1
612	plastic table	1		1
615	plastic round grate	1	1	
630	plastic drum	1		1
701	tire with barnacles	1		1
801	wooden log	3		3
901	metal gas cannister	1		1
901	steel drum	1	1	
902	metal grate	1		1
902	metal screen	1		1

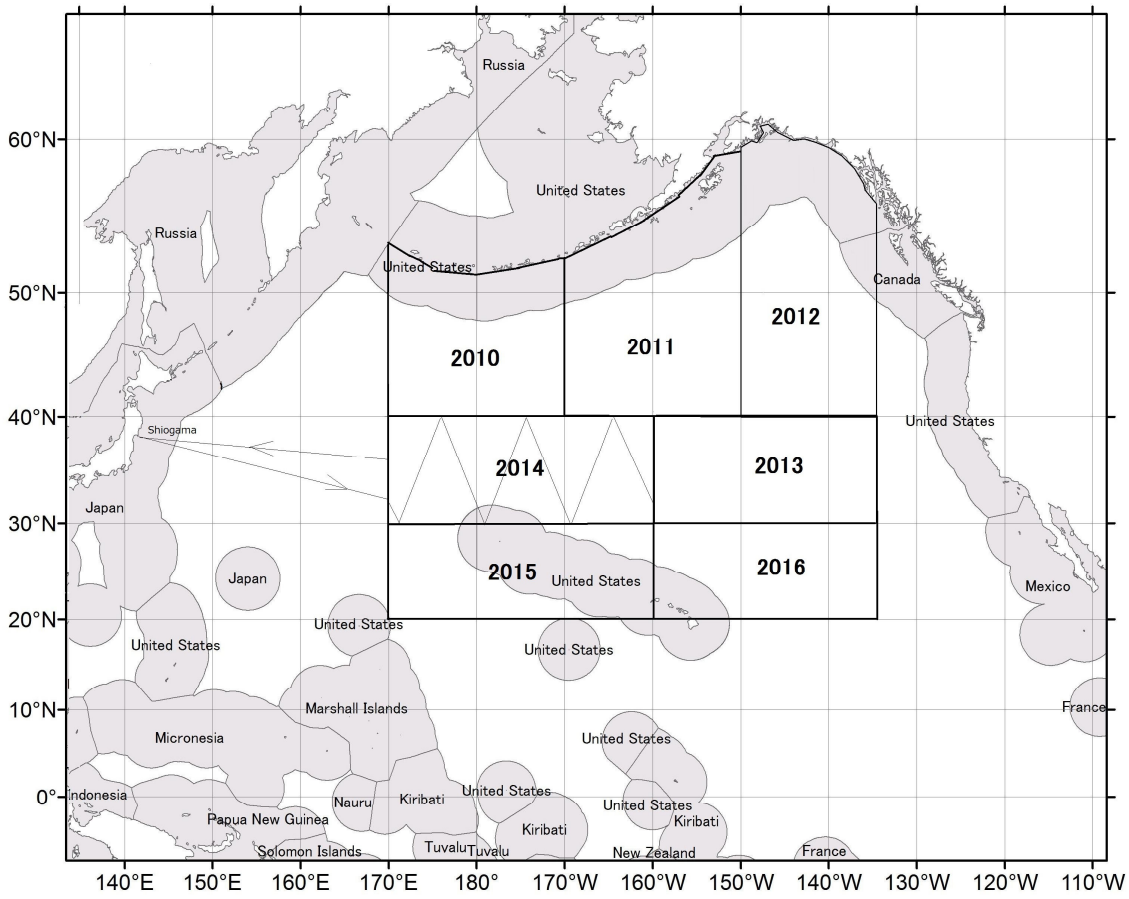

Figure 1. Research area and the trackline design of the 2014 IWC-POWER cruise.

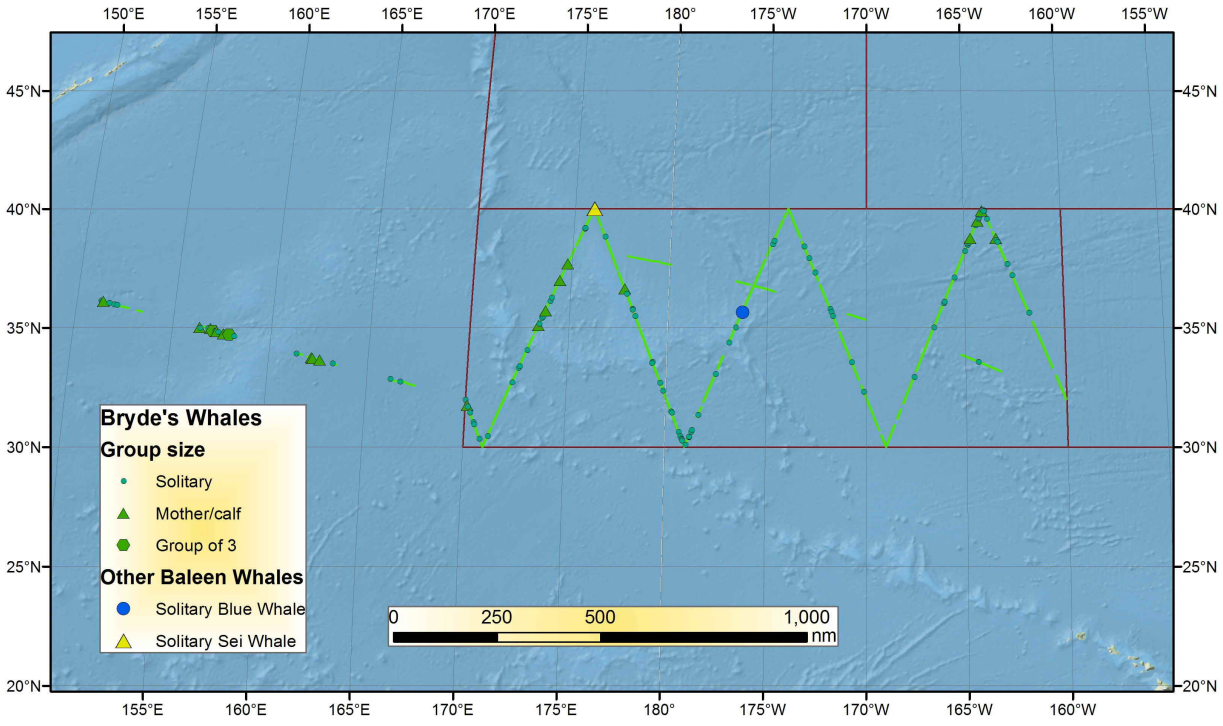

Figure 2a. The searching effort (Green line) and sighting positions of blue (blue circle), sei (yellow triangle) and Bryde's (green circle and triangle) whales during the 2014 POWER cruise.

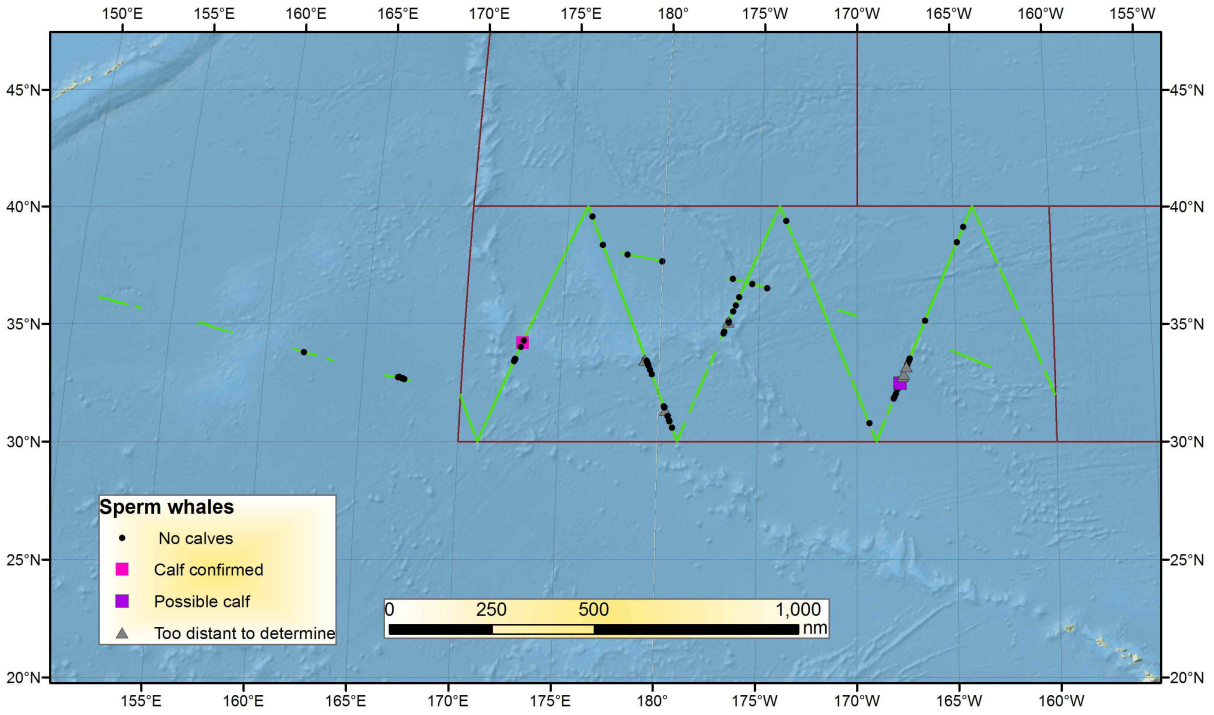

Figure 2b. The searching effort (Green line) and sighting positions of sperm whales during the 2014 POWER cruise.

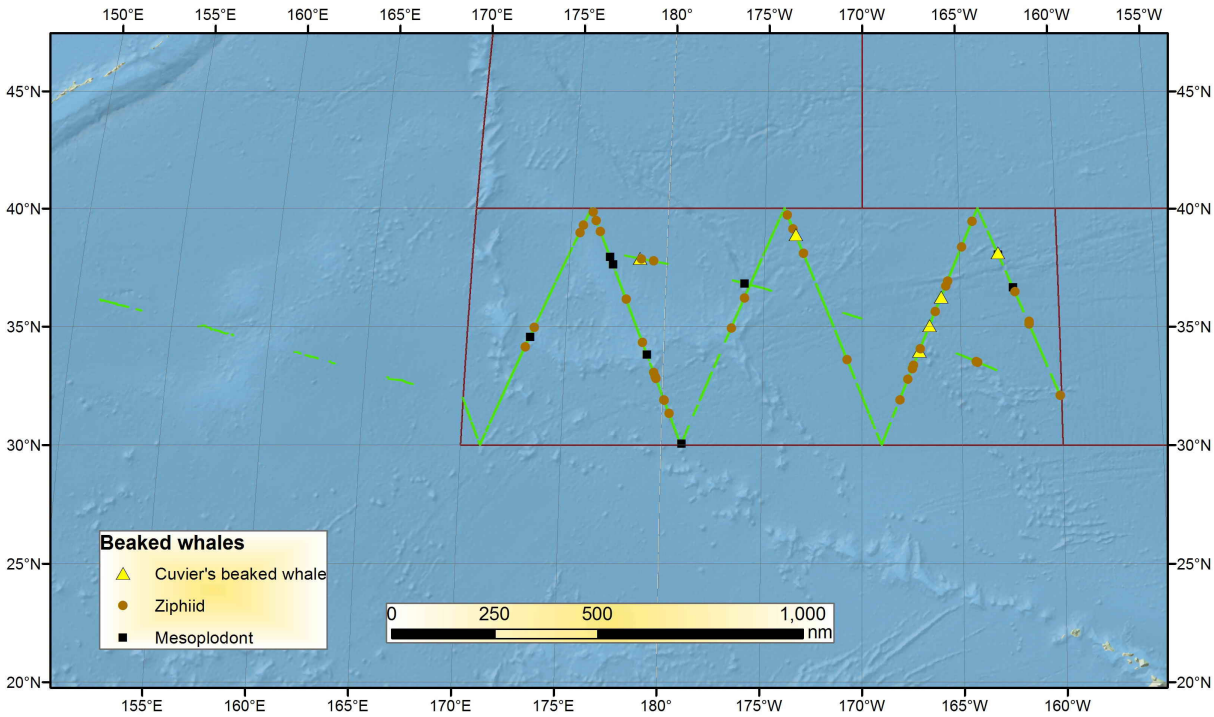

Figure 2c. The searching effort (Green line) and sighting positions of Cuvier's beaked whales (triangle), Ziphiidae (circle) and *Mesoplodon* spp. (square) during the 2014 POWER cruise.

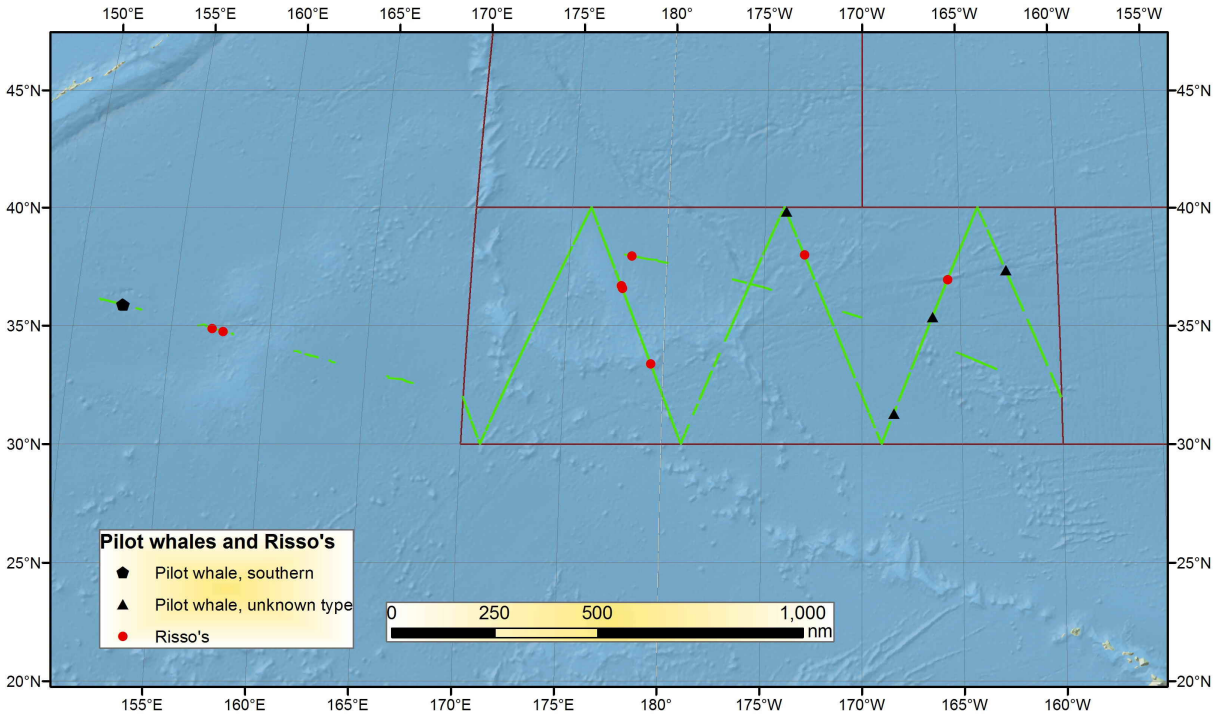

Figure 2d. The searching effort (Green line) and sighting positions of pilot whales and Risso's dolphins during the 2014 POWER cruise.

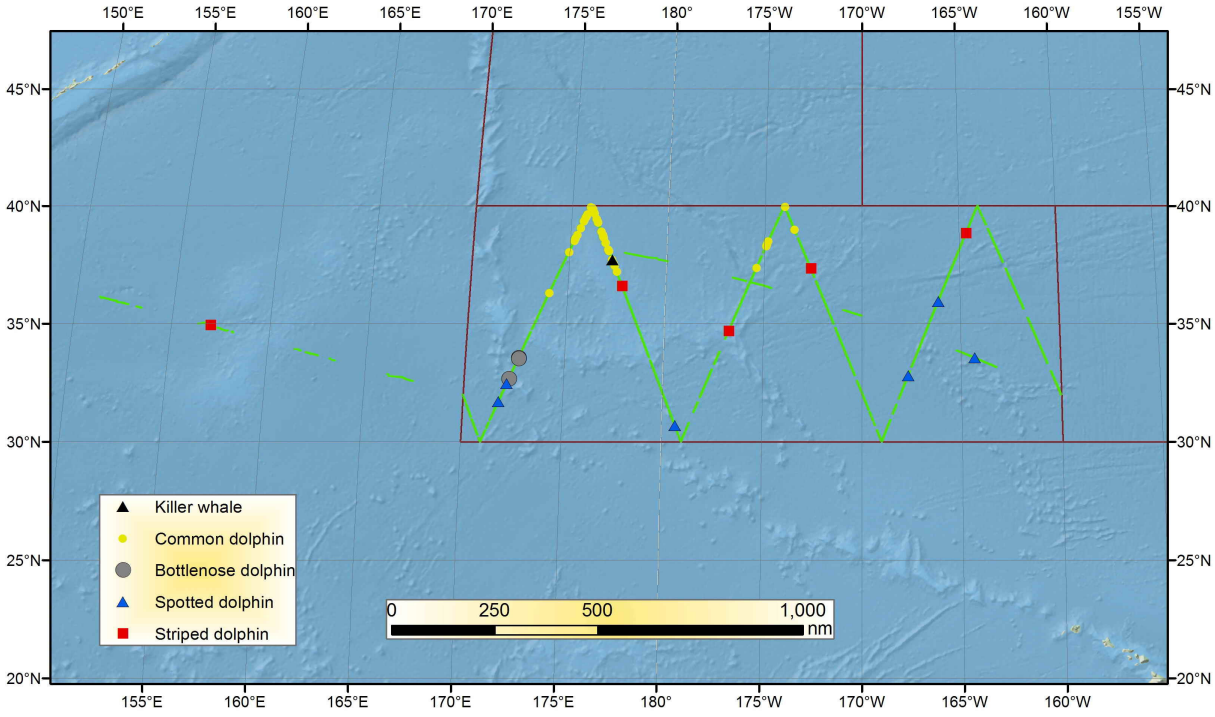

Figure 2e. The searching effort (Green line) and sighting positions of killer whales, common, bottlenose, spotted and striped dolphins during the 2014 POWER cruise.

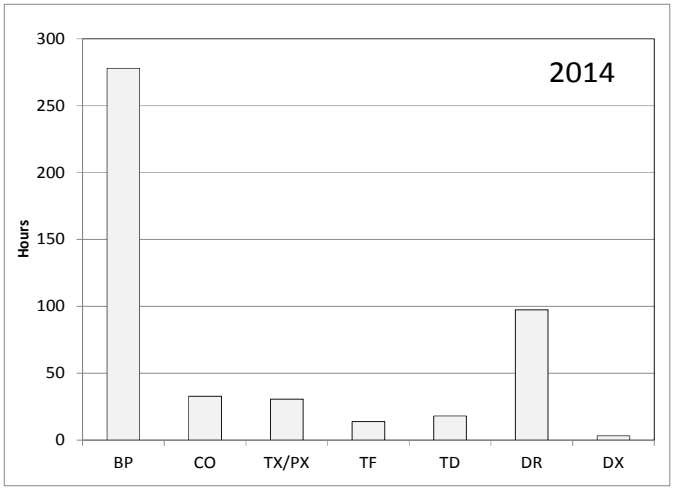

Figure 3a. Breakdown of research time in hours, by effort code in the research area during the 2014 POWER cruise. BP: Passing mode searching, CO: Confirmation of school, TX/PX: Biopsy experiment, TF: Time back to trackline, TD: Top down steaming, DR: Drifting, DX: Distance and angle estimate experiment.

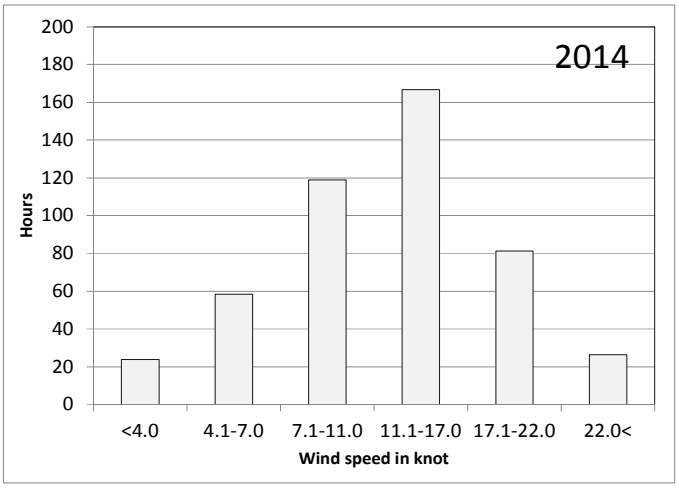

Figure 3b. Breakdown of research time in hours during 2014 surveys in the research area, by wind speed in knots.

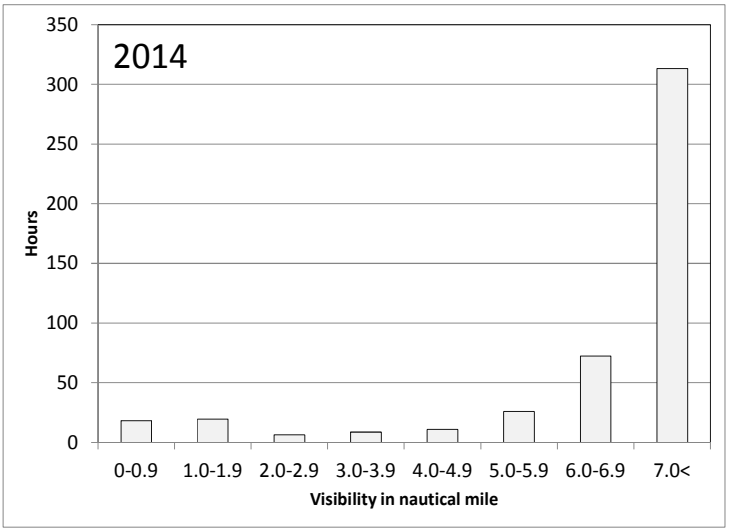

Figure 3c. Breakdown of research time in hours during 2014 surveys in the research area, by visibility in nautical mile.

APPENDICES

Appendix A. Ship specifications and crew list of *Yushin-Maru No.3*.

Ship photo:

Ship specifications:

	Yushin-Maru No.3
Call sign	7JCH
Length overall [m]	69.61
Molded breadth [m]	10.80
Gross tonnage (GT)	742
Barrel height [m]	19.5
Upper bridge height [m]	11.5
Bow height [m]	6.5
Engine power [PS / kW]	5280 / 3900

Crew list:

	Yushin-Maru No.3
Captain	Yoshiyuki Yamauchi
Chief Officer	Hidenori Kasai
Second Officer	Shinya Kawabe
Junior Second Officer	Kensuke Fujii
Chief Engineer	Yoshihiro Oura
First Engineer	Keisuke Mizobuchi
Second Engineer	Kenji Kawamoto
Third Engineer	Yasuhisa Nitta
Chief Operator/Purser	Hitoshi Shimaoka
Operator/Assistant Purser	Takachika Yokomitsu
Boatswain	Masahiko Abe
Quartermaster	Hisashi Katase
Quartermaster	Akihiko Tsuji
Sailor	Naoto Nomakawauchi
Sailor	Naoto Suzuki
Chief Steward	Hironobu Hodokuma
Steward	Wataru Morino

Appendix B. Comparison of weather conditions (wind speed / visibility) among past cruises (2010-2013).

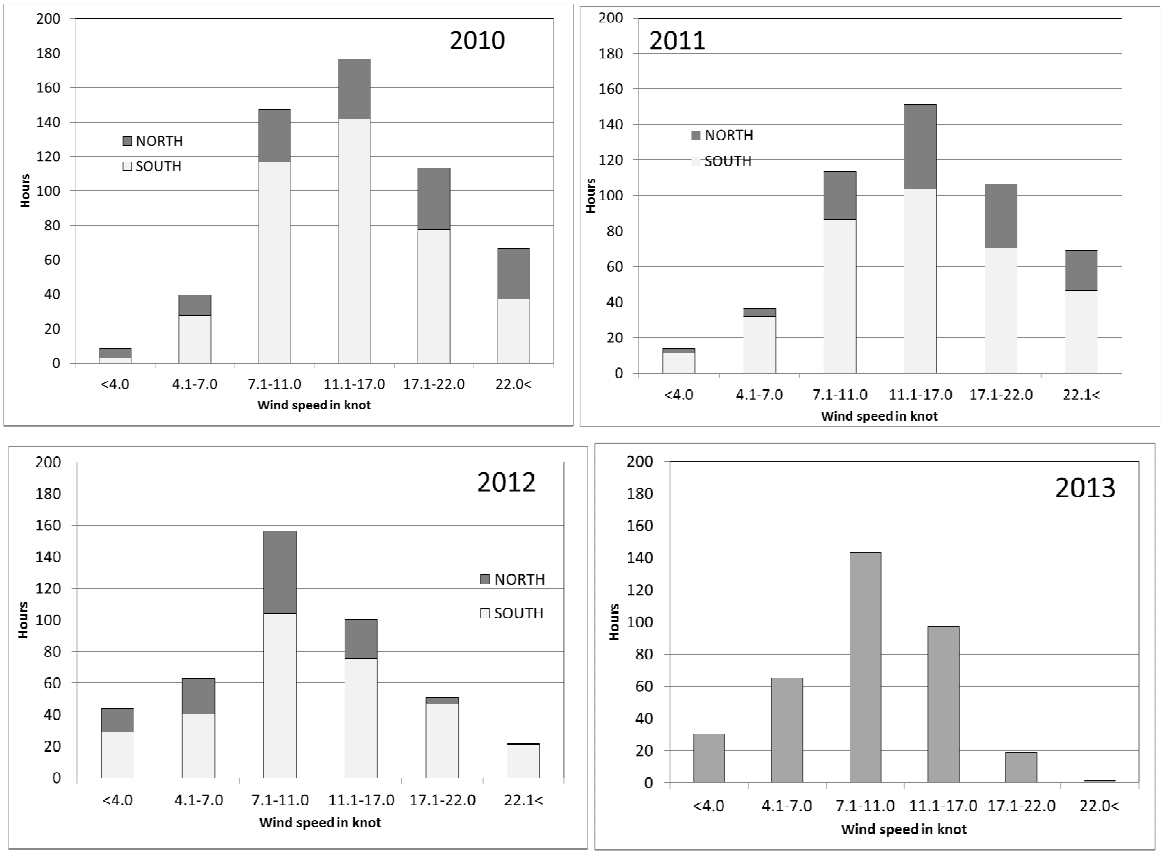

Figure B1. Breakdown of research time in hours during 2010 to 2013 surveys in research area by wind speed.

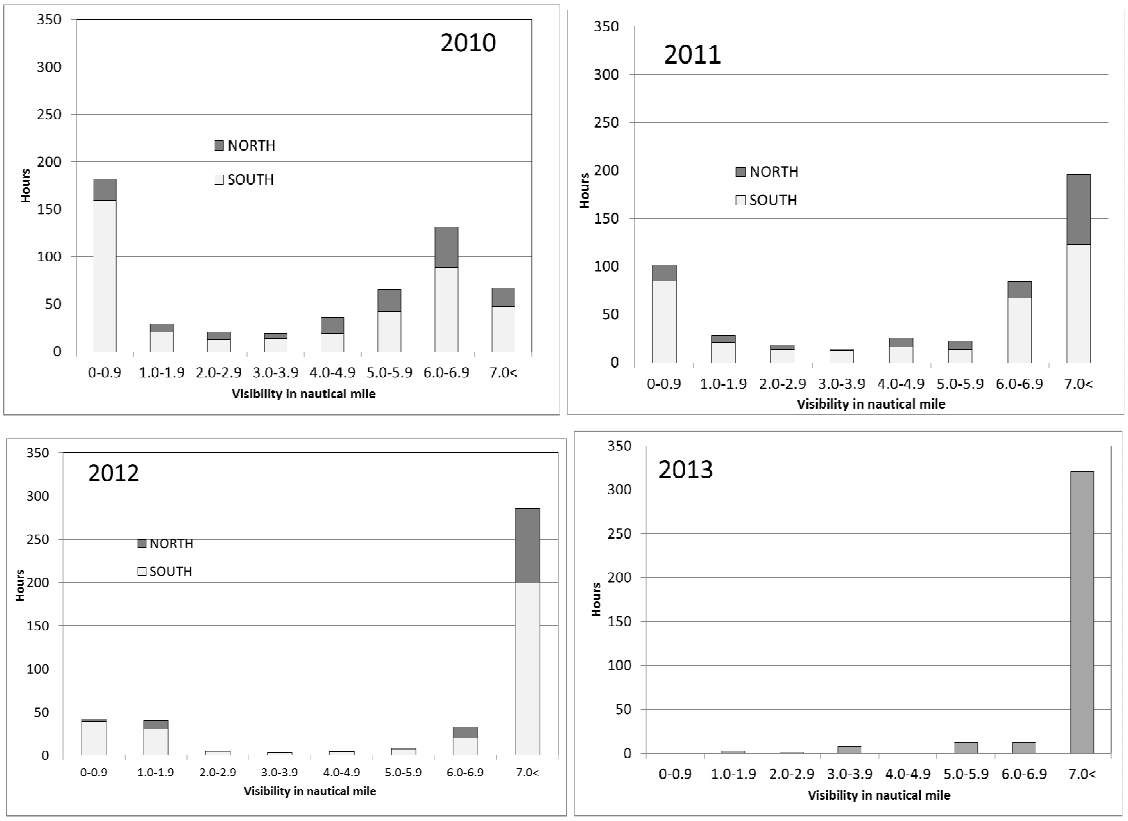

Figure B2. Breakdown of research time in hours during 2010 to 2013 surveys in research area by visibility in nautical mile.

Appendix C. Sightings in the US EEZ

1. Dates and Locations of Survey Effort in US waters

The ship entered the US EEZ at location 31° 36.5' N, 179° 46.0 W on 24 July 2014 at 17:20 SMT (GMT+12) and left the USEEZ at location 31° 50.3' N, 178° 07.6' W on 27 July 2014 at 9:57 SMT (GMT+12). Total searching distance of US EEZ was 149.4 n. miles by the passing with abeam closing mode. Coverage of the research area of US EEZ (total searching distance/planned cruise track distance) was 67.1 %.

2. Sightings

Appendix Table C1 shows total sightings while in the US EEZ. All Bryde's whales sighted were approached for species confirmation and biopsy sampling. The group of spotted dolphins was approached briefly to within 0.1 miles for long distance species confirmation. No other species were approached. A total of 23 objects of marine debris was recorded during surveys in the US EEZ (Appendix Table C3) and 21 of those were photographed.

3. Photo-ID and photo durations

Photographs sufficient for assigning photo-ID catalogue numbers were collected opportunistically during eight of the 13 encounters with Bryde's whales. All 13 whales approached for biopsy sampling were sampled. Biopsy encounter times were exceptionally short. The elapsed time from when Larsen guns were loaded to the retrieval of the sample ranged from a minimum of 4:02 minutes to a maximum of 24:05 minutes, with most samples collected within a time period of 5:52-17:55 minutes (25th to 75th quartiles) (Appendix Table C2).

Appendix Table **C**1. Summary of the all sightings in the US-EEZ. Parentheses indicated the number of calves observed.

Species	Primary		Secondary		Total	
	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.
Bryde's whale	13	13	0	0	13	13
Sperm whale	9	26	1	1	10	27
Mesoplodon spp.	1	3	0	0	1	3
Ziphiidae	1	1	0	0	1	1
Spotted dolphin	1	42 (5)	0	0	1	42 (5)
Unidentified large baleen whale	8	16	0	0	8	16
Unidentified large cetacean	1	1	0	0	1	1
Unidentified dolphin	2	30	0	0	2	30
Unidentified cetacean	2	2	0	0	2	2

Appendix Table C2. Summary of the 13 Bryde's whales encounters in the US EEZ.

Date	Common	Sighting	Best	Number of	YS3WhaleID	Photo-ID Parts	Encounter duration
7/25/2014	Brydes whale	3	1	1	2014 Brydes 31 14031032	RD	17
7/25/2014	Brydes whale	10	1	0	2014 Brydes X 14031033		9
7/25/2014	Brydes whale	24	1	1	2014 Brydes 32 14031034	RD, LD	4
7/25/2014	Brydes whale	27	1	1	2014 Brydes 33 14031035	LD	4
7/25/2014	Brydes whale	28	1	0	2014 Brydes X 14031036		8
7/25/2014	Brydes whale	29	1	1	2014 Brydes 34 14031037	LD	4
7/25/2014	Brydes whale	30	1	0	2014 Brydes X 14031038		24
7/26/2014	Brydes whale	2	1	0	2014 Brydes X 14031039		6
7/26/2014	Brydes whale	3	1	1	2014 Brydes 35 14031040	RD, LD	16
7/26/2014	Brydes whale	4	1	0	2014 Brydes X 14031041		14
7/26/2014	Brydes whale	6	1	1	2014 Brydes 36 14031042	RD, RL	22
7/26/2014	Brydes whale	7	1	1	2014 Brydes 37 14031043	RD	5
7/27/2014	Brydes whale	1	1	1	2014 Brydes 38 14031044	LD	20

Appendix Table C3. Summary of all marine debris observations in the US EEZ.

Marine Debris Code	Description	Total
134	single fishing float	15
134	styrofoam float	1
137	wood crate, 1 side only	1
148	styrofoam piece	2
304	clustered rope and net	1
502	life ring	1
606	plastic sheet	1
901	metal gas cannister	1