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# Cruise Report of the Second Phase of the Japanese Whale Research Program under Special Permit in the Western North Pacific (JARPNII) in 2015 (part I) Offshore component

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# Cruise Report of the Second Phase of the Japanese Whale Research Program under Special Permit in the Western North Pacific (JARPNII) in 2015 (part I) – Offshore component –

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ABSTRACT

The 14th cruise of the full-scale Second Phase of the Japanese Whale Research Program under Special Permit in the Western North Pacific (JARPNII) -offshore component- was conducted in sub-areas 7, 8 and 9 of the western North Pacific. There were two main research components in the 2015 survey: whale sampling survey and dedicated sighting survey. A total of six research vessels was used: two sighting/sampling vessels (*SSVs*) (whale sampling survey component), one research base vessel (Nisshin Maru, *NM*) (whale sampling survey component) and three dedicated sighting vessels (*SVs*) (dedicated sighting survey component). The whale sampling survey was carried out from 11 June to 24 August 2015. A total of 1,762n.miles was surveyed in a period of 67 days by the *SSVs*. A total of three common minke, 265 sei, 156 Bryde's, 128 sperm, 24 blue, 69 fin and one humpback whales were sighted by the *SSVs*. A total of 90 sei and 25 Bryde's whale was sampled by the *SSVs*. All whales sampled were examined on board of *NM*. In July and August, sei whales fed mainly on Japanese sardine followed by mackerels, copepods and krill in sub-areas 8 and 9. Bryde's whales fed mainly on krill in sub-areas 7 and 8. Two dedicated sighting surveys were carried out from 23 April to 6 June and 9 June to 1 August in sub-areas 7, 8 and 9. A total of 2,660 and 2,726n.miles was surveyed during those surveys by the *SVs*, respectively. Data obtained in this research will be used in the elucidation of the role of whales in the marine ecosystem through the study of whale feeding ecology in the western North Pacific.

KEYWORDS: SCIENTIFIC PERMITS; COMMON MINKE WHALE; BRYDE'S WHALE; SEI WHALE; FOOD/PREY; MONITORING

## INTRODUCTION

After the Japanese Whale Research Program under Special Permit in the Western North Pacific (JARPN) was completed in 1999, the second phase of Japanese Whale Research Program under Special Permit in the Western North Pacific (JARPNII) was started in the 2000 summer season as a two-year feasibility study. Based on the success of the feasibility study (Government of Japan, 2002a) and the increasingly strong support from international fisheries organizations, including FAO, for research to improve multi-species approaches to management, JARPNII started as a full-scale research program in 2002. The full-scale study aimed i) to evaluate the feeding ecology and ecosystem studies, ii) to monitor environmental pollutants in cetaceans and the marine ecosystem and iii) to elucidate the stock structure (Government of Japan, 2002b).

The full-scale JARPNII plan involves two survey components: the 'offshore' survey, which is covered by the Nisshin Maru research unit and two 'coastal' surveys (Sanriku and Kushiro), which are covered by small type catcher boats. The coastal component was necessary to cover the temporal and spatial gaps, which could not be covered by the Nisshin Maru unit (Government of Japan, 2002b).

The research area of the offshore component is set in sub-areas 7, 8 and 9, and the target species and sample sizes for the lethal component of the research were set as follows: 100 common minke whales; 100 sei whales, 50 Bryde's whales and 10 sperm whales (Government of Japan, 2002b). The survey is composed of three main components: whale sampling survey, dedicated sighting survey and whale prey surveys.

In January 2009, IWC/SC conducted the Expert Workshop to review the ongoing JARPNII Programme (IWC, 2009) for the first period (2002-2007). The results presented on the three main objectives of JARPNII were discussed by an Experts Panel. Constructive discussions were conducted and some

recommendations were offered by the EP. Some of those recommendations had already been responded to by Japanese scientists (Pastene *et al*., 2010).

An Expert Workshop for the final review on the JARPNII was conducted by the IWC/SC in February 2016. The results from whole JARPNII period were presented and discussed by the Panel. The report of the Expert Panel and Japan's response will be submitted to 66b/IWC/SC.

Following the March 31, 2014 Judgment of the International Court of Justice (ICJ) in the case Whaling in the Antarctic (Australia v. Japan: New Zealand intervening), the Government of Japan voluntarily reviewed the state of JARPNII. The overall research objectives, the research area and research methodology remain the same as those specified in the original JARPNII research plan (SC/56/01). This voluntary review resulted in the reprioritization of the research focus as well as recalculation of sample sizes. The survey concentrated on the study of interactions between whales and fisheries in the coastal area and interactions among whale species in the offshore area as well as a contribution to the management of whales. Sampling of sperm and minke whales in offshore component was suspended because their role in the study of interactions between whales and fisheries in the coastal waters seemed to be limited. Sei whale sample size of 100 (as in the original plan) of which 10 were studied using only non-lethal methods. Bryde's whale sample size of 50 (as in the original plan) of which 25 were studied using only non-lethal methods. A study for verifying the feasibility of using non-lethal methods was carried out.

## MATERIALS AND METHODS

### Whale sampling survey

*Research area*

Sub-areas 7, 8 and 9, excluding the EEZ zones of foreign countries, comprised the research area (Figure 1).

*Research vessels*

Three research vessels were used. The research base vessel *Nisshin Maru* (*NM*: 8,145GT) conducted the research and was the platform for biological examination of whale samples and processing of by-products. The *Yushin Maru* (*YS1*: 724GT) and *Yushin Maru* No.2 (*YS2*: 747GT) were used as the sighting/sampling vessels (*SSVs*), which conducted sighting activities, sampling of targeted whale species and various experiments and observations.

*Methods for setting cruise track line and sighting procedure*

Track lines and allocation of vessels were made as in previous JARPN and JARPNII surveys (Fujise *et al.*, 1995, 1996, 1997, 2000, 2001, 2002, 2003; Ishikawa *et al.*, 1997; Zenitani *et al.*, 1999; Tamura *et al*., 2004, 2005, 2006, 2009a, 2009b, 2012, 2015; Bando *et al.*, 2010, 2013, 2014; Matsuoka *et al.*, 2007; Yasunaga *et al*., 2011). The zigzag-shaped track line was established on an arbitrary basis in each sub-area. Furthermore, some 'special monitoring surveys' (SMS) were conducted in areas where the abundance of Bryde's and sei whales was expected to be high. Track line in the SMS was designed separately from the original track line. Two *SSVs* were allocated to these tracks with the allocation being changed every day. The research course for the *SSVs* consisted of one main track and one parallel track established 7n.miles apart from the main course.

Sighting procedure for the whale sampling survey was similar to the previous surveys of JARPN and JARPNII (Fujise *et al.*, 1995, 1996, 1997, 2000, 2001, 2002, 2003; Ishikawa *et al.*, 1997; Zenitani *et al.*, 1999; Tamura *et al*., 2004, 2005, 2006, 2007, 2009a, 2009b, 2012, 2015; Bando *et al.*, 2010, 2013, 2014; Matsuoka *et al.*, 2008; Yasunaga *et al*., 2011). In the research area, sighting was conducted mainly under closing mode. Furthermore two modalities of sighting in closing mode were adopted, *NSC* and *NSS modes*, by taking into consideration weather and sea conditions. The conditions to conduct surveys under *NSC mode* were similar to those established in Japanese sighting surveys conducted by the National Research Institute of Far Seas Fisheries (*i.e*. visibility of two n.miles or more and wind force of four or below). The *NSS mode* was used under bad weather conditions such as strong wind, heavy rain or fog but the collection of whale samples was still possible. These two modes for surveys were recorded separately for future analysis. Also an *ASP mode* was used (closing mode survey without sampling activities under normal sighting conditions). Closing was performed mainly on sightings of common minke, Bryde's and sei

whales. Furthermore closing was made on sightings of other large baleen whales, such as blue, humpback, right and fin whales. In these cases, closing was done in order to confirm species and school size and to conduct some experiments.

*Sampling numbers and procedure of targeted whales*
The target species and sample sizes in the 2015 JARPNII offshore component were set as follows: 90 sei whales and 25 Bryde's whales. Most of the whales sighted on the track line were approached for sampling. Furthermore sampling effort was applied outside the established research hours (main time: 06:00-18:00 (12 hrs) in local time), if collection of whale samples was considered possible. For schools consisting of two or more animals, all of the whales in the school were numbered to set the sampling order randomly in accordance with the table of random numbers (Kato *et al.*, 1989). Cow and calf pairs were not targeted for sampling. Sampled whales were immediately transported to the research base vessel, where biological measurements and sampling were carried out.

*Experiments*
The following experiments and observations were conducted by the *SV* and *SSVs*:

1. Sighting distance and angle experiments to examine the precision of sighting data.
2. Biopsy sampling on gray, blue, fin, sei, Bryde's, common minke, humpback, right, bowhead and sperm whales. (*SV* and *SSVs*)
3. Photographic records of natural marks on blue, humpback and right whales.
4. Observation of feeding behaviour on blue, fin, sei, Bryde's, common minke, humpback, right and sperm whales.
5. Observation of excretion and vomiting behaviour on sei, Bryde's and common minke whales.

*Observation of marine debris*
Observation of marine debris was conducted from the wheelhouse of the research base vessel (*NM*). Marine debris was also investigated in the stomach contents of Bryde's and sei whales.

**Dedicated Sighting survey**
A report of the dedicated sighting surveys was presented by Matsuoka *et al*. (2016). Here just a brief outline is presented. Two independent surveys were conducted in this season.

*Research area*
First survey: Sub-area 9
Second survey: Sub-areas 7, 8 and 9

*Research vessel*
The *YS1*, *YS2* and *Shonan Maru No.2* (*SM2*: 712GT) were used as dedicated sighting vessel (*SV*).

*Methods for setting cruise track line and sighting procedure*
An independent track line for the dedicated sighting survey was designed in the research area.

*Experiments*
The following experiments and observations were conducted by the *SV*s.

1. Sighting distance and angle experiments to examine the precision of sighting data.
2. Biopsy sampling on gray, blue, fin, sei, Bryde's, common minke, humpback, right, bowhead and sperm whales.
3. Photographic records of natural marks on blue, humpback and right whales.
4. Observation of excretion and vomiting behaviour on sei, Bryde's and common minke whales.

## RESULTS

### Whale sampling survey

*Actual survey periods, track lines and searching distances*
Cruise period: Between 11 June and 24 August (75 days)
Research period: Between 13 June and 18 August (67 days)
Track line: Track line set by the two *SSVs* is shown in Figure 2.
Searching distance: The total searching distance for *SSVs* was 1,762 n.miles

*Sightings of common minke, sei, Bryde's and sperm whales*
A total of three schools (three individuals) of common minke, 198 schools (265 ind.) of sei, 119 schools (156 ind.) of Bryde's and 72 schools (128 ind.) of sperm whales was sighted (Table 1, Figure 2)

*Sightings of other large cetacean species*
Table 1 also shows the number of sightings for other large whale species made by the *SSVs*, such as blue (20 sch./24 ind.), fin (58 sch./69 ind.) and humpback (one sch./one ind.) whales (Figure 2).

*Sampling and biological research on Bryde's and sei whales*
A total of 90 sei whales (male: 29, female: 61 ind.) and 25 Bryde's whales (male: 14, female: 11 ind.) were sampled. Struck and lost did not occur in this survey. Table 2 summarizes the biological data and samples collected from whales. A total of 45 research items was covered. These items are related to the studies conducted under the three main objectives of the JARPNII: study on feeding ecology of whales and marine ecosystem, pollution studies and elucidation of stock structure.

Composition of sex and sexual maturity status of sei and Bryde's whales are shown in Table 3. Statistics of body length of each whale species is shown in Table 4. Mean body length of sei whale was 13.30m and 13.98m for males and females, respectively. For Bryde's whales, those were 12.21m and 12.80m, respectively.

Sighting position of sampled sei and Bryde's whales is shown in Figure 3. Bryde's whales were sampled in southern part of sub-area 7 and 8. Sei whales were sampled in sub-areas 8 and 9.

*Distribution and food habits of whales*
In this survey, dominant prey species of sei whales was Japanese sardine (52.5%) followed by mackerels (11.5%), krill (9.8%) and copepods (8.2%) (Table 5). Bryde's whales only fed on krill (Table 5).

*Experiments*
A detail report of the non-lethal research activity in 2015 JARPNII was presented in Mogoe *et al* (2016). In this section, the summary of the results is described.

Sighting distance and angle experiment
A sighting distance and angle experiment was performed on 10 August by *YS1* and *YS2*. The results of this experiment will be used in calculation of abundance estimates.

Photo-ID
Photo-ID was collected from one blue whale.

Biopsy sampling
Biopsy samples were collected from 16 sei, 33 Bryde's, two common minke, three fin and two blue whales using Larsen gun (Table 6).

Feeding behaviour
No case of feeding was observed during the survey.

Excretion and vomiting behaviour

A total of two common minke, 259 sei and 147 Bryde's whales were observed. As a result, eight cases (six sei and two Bryde's whales) of excretion behaviour were observed during the survey and faeces samples were collected from two sei whales using a hand net. No case of vomiting was observed during the survey.

Observation of marine debris

No large debris was observed in the environment. A small piece of plastic was observed in the stomachs of five Bryde's and 29 sei whales. A small piece of wood was observed in one Bryde's and two sei whales. A small piece of net was observed in five sei whales and a small piece of rope was observed in two sei whales.

**Dedicated Sighting survey**

Here just a brief outline of the results is presented. The details are described in Matsuoka (2016).

*Actual research periods and searching distance*

Cruise period:

First survey : Between 23 April and 6 June (45 days; *YS1, YS2*)
Second survey : Between 9 June and 1 August (60 days; *SM2*)

Searching distance*:*

First survey : 2,660 n.miles (*YS1, YS2*)
Second survey : 2,726 n.miles (*SM2*)

*Sightings of common minke, Bryde's, sei and sperm whales*

Sighting number of large cetacean species during each survey was shown in Table 1. A total of two schools (two individuals) of common minke, 40 schools (46 ind.) of sei and 34 schools (113 ind.) of sperm whales was sighted during first survey. During second survey, a total of 98 schools (190 ind.) of sei, 70 schools (88 ind.) of Bryde's, and 79 schools (125 ind.) of sperm whales was sighted.

*Sightings of other large cetacean species*

Large baleen whales such as fin (19 schools/25 individuals), blue (10 sch./15 ind.), humpback (10 sch./12 ind.) and right (two sch./three ind.) whales were sighted during the first survey. During the second survey, a total of six schools (six ind.) of fin, one school (two ind.) of blue and one school (one ind.) of humpback whales was sighted.

*Experiments*

Photo-ID

A total of eight humpback, 12 blue whales and two right whales were photographed during the first survey. A total of one humpback and two blue whales were photographed during the second survey.

Biopsy sampling

Biopsy samples were collected from one common minke, three fin, six blue, five humpback and two right whales during first survey. During the second survey, biopsy sampling was not carried out for logistical reason.

Feeding behaviour

Two cases of feeding behaviour by sei whales (two sch./45 ind.) were observed during the second survey. Feeding behaviour was not observed during the first survey.

Excretion and vomiting behaviour

A total of 241 sei and 88 Bryde's whales were observed. As a result, four cases (three sei and one Bryde's whales) of excretion behaviour were observed during the second survey. No case of excretion or vomiting was observed during the first survey.

**DISCUSSION**

This year's survey was conducted in mid summer (June - August). Little survey effort was applied to the appropriate temperature zone (10-15 $^{0}$C) for common minke whales and as a result, only a low number of

common minke whales were sighted. Prey species and food habits of sei and Bryde's whales in this survey are discussed below in the context of previous survey results.

**Sei whale**

From our research results of past JARPNII (2002 to 2014), sei whales fed on Japanese anchovy and copepods dominantly during survey season in most years (Figure 4). During the present survey, sei whales were sampled in mid summer in sub-areas 8 and 9. Dominant prey species of sampled sei whales were Japanese sardine followed by mackerels, krill and copepods. Japanese sardine first appeared as the main prey species last year and this year became the most dominant species, which might indicate recovery of this resource and a change of feeding habits of sei whales.

**Bryde's whale**

From our research results of past JARPNII (2000 to 2014), the dominant prey species of Bryde's whale was Japanese anchovy and krill during May to September (Figure 4). There was a seasonal change of prey species. In early season (May and June) the dominant prey species was krill. In late season (from July to September), the dominant prey species was Japanese anchovy in sub-areas 7 and 8. In the south eastern part of sub-area 9, oceanic lightfish were also an important prey species in August. During the present survey, only krill was observed in stomach contents of Bryde's whales in June in sub-area 7 and 8, which does not contradict with results of previous surveys.

**Summary of yearly change of prey species**

In recent years, Japanese sardine increasingly appeared in the stomach contents of sei whales sampled offshore and common minke whales sampled in the Kushiro region (Kishiro *et al*., 2014, 2016; Yoshida *et al*., 2013, 2015). On the other hand, the proportion of Japanese anchovy as prey species of baleen whales has decreased and completely disappeared in present survey. This might indicate fish species replacement from Japanese anchovy to Japanese sardine in the North Pacific. Sei and Bryde's whales might have changed prey species in response to changes in availability of prey species.

Further surveys will be needed to detect possible ongoing changes of dominant pelagic fish species in the North Pacific and changes of feeding strategy of baleen whales.

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Table 1. Whale species and number of sightings in the 2015 JARPN II survey (no. schools/no. individuals)

Whale sampling survey (*YS1* and *YS2*)

| Species | Primary | | Secondary | | Total | |
|---|---|---|---|---|---|---|
| | Sch. | Ind. | Sch. | Ind. | Sch. | Ind. |
| Common minke whale | 2 | 2 | 1 | 1 | 3 | 3 |
| Sei whale | 55 | 72 | 143 | 193 | 198 | 265 |
| Bryde's whale | 67 | 90 | 52 | 66 | 119 | 156 |
| Sperm whale | 46 | 75 | 26 | 53 | 72 | 128 |
| Blue whale | 4 | 4 | 16 | 20 | 20 | 24 |
| Fin whale | 14 | 17 | 44 | 52 | 58 | 69 |
| Humpback whale | 0 | 0 | 1 | 1 | 1 | 1 |

Dedicated sighting surveys (*YS1*, *YS2 and SM2*)

| Species | First survey (*YS1* and *YS2*) | | | | | | Second survey (*SM2*) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Primary | | Secondary | | Total | | Primary | | Secondary | | Total | |
| | Sch. | Ind. | Sch. | Ind. | Sch. | Ind. | Sch. | Ind. | Sch. | Ind. | Sch. | Ind. |
| Common minke whale | 1 | 1 | 1 | 1 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sei whale | 38 | 54 | 2 | 2 | 40 | 56 | 62 | 130 | 36 | 60 | 98 | 190 |
| Bryde's whale | 0 | 0 | 0 | 0 | 0 | 0 | 56 | 69 | 14 | 19 | 70 | 88 |
| Sperm whale | 34 | 113 | 0 | 0 | 34 | 113 | 74 | 117 | 5 | 8 | 79 | 125 |
| Blue whale | 10 | 15 | 0 | 0 | 10 | 15 | 0 | 0 | 1 | 2 | 1 | 2 |
| Fin whale | 19 | 25 | 0 | 0 | 19 | 25 | 5 | 5 | 1 | 1 | 6 | 6 |
| Humpback whale | 9 | 11 | 1 | 1 | 10 | 12 | 0 | 0 | 0 | 0 | 0 | 0 |
| Right whale | 2 | 3 | 0 | 0 | 2 | 3 | 0 | 0 | 0 | 0 | 0 | 0 |

Table 2. Summary of biological data and samples collected during the 2015 JARPN II survey.

| Research items | Sei whale | | | Bryde's whale | | |
|---|---|---|---|---|---|---|
| | F | M | T | F | M | T |
| Measurement of body length | 61 | 29 | 90 | 11 | 14 | 25 |
| Measurement of external body proportion | 61 | 29 | 90 | 11 | 14 | 25 |
| Photographic record of external characters | 61 | 29 | 90 | 11 | 14 | 25 |
| Record of Diatom film | 61 | 29 | 90 | 11 | 14 | 25 |
| Standard measurement of blubber thickness (five points) | 61 | 28 | 89 | 11 | 13 | 24 |
| Detailed measurement of blubber thickness (eleven points) | 0 | 1 | 1 | 0 | 1 | 1 |
| Measurement of body weight | 61 | 29 | 90 | 11 | 14 | 25 |
| Measurement of body weight by parts | 0 | 1 | 1 | 0 | 1 | 1 |
| Collection of skin tissue for genetic study | 61 | 29 | 90 | 11 | 14 | 25 |
| Collection of blubber, muscle, liver and kidney tissues for organochlorines analysis | 61 | 29 | 90 | 11 | 14 | 25 |
| Collection of blubber tissue for fatty acid analysis | 61 | 29 | 90 | 11 | 14 | 25 |
| Collection of blubber tissues for stable isotope ratio analysis | 61 | 29 | 90 | 11 | 14 | 25 |
| Collection of blubber and muscle tissues for nutritional compornent analysis | 3 | 2 | 5 | 2 | 3 | 5 |
| Collection of lung tissue for atmospheric analysis | - | 9 | 9 | - | 9 | 9 |
| Collection of tissues for various analyses | 61 | 29 | 90 | 11 | 14 | 25 |
| Observation of lactation status | 61 | - | 61 | 11 | - | 11 |
| Measurement of mammary gland and collection of histological sample for reproductive study | 61 | - | 61 | 11 | - | 11 |
| Collection of endometrium histological sample for reproductive study | 16 | - | 16 | 5 | - | 5 |
| Collection of ovary | 61 | - | 61 | 11 | - | 11 |
| Photographic record of foetus | 16 | 12 | 29* | 2 | 2 | 4 |
| Identification of foetal sex (by visual observation) | 16 | 12 | 29* | 2 | 2 | 4 |
| Measurement of foetal length and weight | 16 | 12 | 29* | 2 | 2 | 4 |
| Collection of foetal blubber tissue for genetic study | 16 | 12 | 29* | 2 | 2 | 4 |
| Collection of foetal lens for age determination | 16 | 12 | 28 | 2 | 2 | 4 |
| Collection of testis histological sample for reproductive study | - | 29 | 29 | - | 14 | 14 |
| Measurement of testis weight | - | 29 | 29 | - | 14 | 14 |
| Collection of testis for epidemiological study | - | 29 | 29 | - | 14 | 14 |
| Photographic record of testis | - | 29 | 29 | - | 14 | 14 |
| Collection of plasma sample | 61 | 29 | 90 | 11 | 14 | 25 |
| Observation of stomach contents (conventional record) | 61 | 29 | 90 | 11 | 14 | 25 |
| Measurement of stomach content weight in each compartment | 61 | 29 | 90 | 11 | 14 | 25 |
| Collection of stomach contents for feeding study | 44 | 21 | 65 | 6 | 8 | 14 |
| Collection of stomach contents for various analyses | 12 | 8 | 20 | 1 | 4 | 5 |
| Measurement of stomach contents (prey length and weight) | 28 | 16 | 44 | 0 | 0 | 0 |
| Collection of intestines contents for feeding study | 61 | 29 | 90 | 11 | 14 | 25 |
| Observation of appearance of marine debris in stomach | 61 | 29 | 90 | 11 | 14 | 25 |
| Photographic record of marine debris | 21 | 10 | 31 | 4 | 2 | 6 |
| Record of appearance of external parasites | 61 | 29 | 90 | 11 | 14 | 25 |
| Record of appearance of internal parasites | 61 | 29 | 90 | 11 | 14 | 25 |
| Collection of earplug for age determination | 61 | 29 | 90 | 11 | 14 | 25 |
| Collection of lens for age determination | 61 | 29 | 90 | 11 | 14 | 25 |
| Collection of vertebral epiphyses for growth study | 61 | 29 | 90 | 11 | 14 | 25 |
| Counting the number of ribs | 61 | 29 | 90 | 11 | 14 | 25 |
| Measurement of skull length and breadth | 58 | 27 | 85 | 10 | 12 | 22 |
| Collection of testis for sexual maturation study | - | - | - | - | 3 | 3 |

* Including a foetus of already dead and sex unknown

Table 3. Sex and sexual maturity composition of whales sampled during the 2015 JARPN II survey.

| Species | | Male | | | Female | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Imm. | Mat. | Total | Imm. | Mat. | | | | Total | |
| | | | | | | Ovu. | Rest. | Preg. | Lact. | | |
| Sei | SA8 | 0 | 7 | 7 | 1 | 0 | 2 | 7 | 0 | 9 | 10 | 17 |
| | SA9 | 10 | 12 | 22 | 14 | 0 | 10 | 22 | 5 | 37 | 51 | 73 |
| | Combined | 10 | 19 | 29 | 15 | 0 | 12 | 29 | 5 | 46 | 61 | 90 |
| Bryde's | SA7 | 2 | 9 | 11 | 1 | 1 | 2 | 4 | 2 | 9 | 10 | 21 |
| | SA8 | 1 | 2 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 4 |
| | Combined | 3 | 11 | 14 | 2 | 1 | 2 | 4 | 2 | 9 | 11 | 25 |

Table 4. Body length (m) of whales sampled during the 2015 JARPN II survey.

| Species | Sub area | Male | | | | | Female | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | n | mean | S.D. | min | max | n | mean | S.D. | min | max |
| Sei | SA8 | 7 | 13.96 | 0.44 | 13.30 | 14.77 | 10 | 14.31 | 0.85 | 12.70 | 15.20 |
| | SA9 | 22 | 13.08 | 1.20 | 10.32 | 14.95 | 51 | 13.91 | 1.13 | 11.67 | 15.50 |
| | Combined | 29 | 13.30 | 1.13 | 10.32 | 14.95 | 61 | 13.98 | 1.10 | 11.67 | 15.50 |
| Bryde's | SA7 | 11 | 12.26 | 0.66 | 10.42 | 13.10 | 10 | 12.96 | 0.85 | 11.12 | 14.11 |
| | SA8 | 3 | 12.05 | 0.65 | 11.13 | 12.57 | 1 | 11.23 | 0.00 | 11.23 | 11.23 |
| | Combined | 14 | 12.21 | 0.66 | 10.42 | 13.10 | 11 | 12.80 | 0.95 | 11.12 | 14.11 |

Table 5. Prey species and stomach contents weight (1st. + 2nd. stomachs) in whales sampled during the 2015 JARPN II survey.

| Species | Dominant prey species | | N | % | Range of weight (kg) |
|---|---|---|---|---|---|
| Sei | | | | | |
| | Krill | | 6 | 9.8 | 13.20 - 168.73 |
| | Copepods | | 5 | 8.2 | 13.22 - 97.44 |
| | Fish | Japanese sardine | 32 | 52.5 | 0.90 - 915.81 |
| | | Mackerels | 7 | 11.5 | 13.50 - 349.26 |
| | | Pacific saury | 3 | 4.9 | 13.04 - 41.14 |
| | Squids | | 4 | 6.6 | 1.06 - 11.06 |
| | Others | | 4 | 6.6 | 1.14 - 7.45 |
| Bryde's | | | | | |
| | Krill | | 12 | 100.0 | 1.00 - 34.88 |

Table 6. Summary of biopsy skin sampling for some baleen whale species in the 2015 JARPN II offshore component.

| Species | Ship | Number of experiments | Number of targeted individuals | Number of shoots | Number of hits | Number of samples* | Number of sampled individuals | Effort (min) | Biopsy success rate (sample per trial) | Biopsy success rate (sample per shot) | Average sampling time (minute per sample) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | (A) | (B) | | (C) | (D) | (E) | (D)/(A) | (C)/(B) | (E)/(D) |
| Sei | SSVs | 25 | 26 | 44 | 22 | 22 | 16 | 507 | 0.615 | 0.500 | 32 |
| Bryde's | SSVs | 41 | 42 | 90 | 46 | 43 | 33 | 763 | 0.786 | 0.478 | 23 |
| Common minke | SSVs | 2 | 2 | 4 | 2 | 2 | 2 | 53 | 1.000 | 0.500 | 26 |
| Fin | SSVs | 6 | 6 | 6 | 5 | 5 | 3 | 79 | 0.500 | 0.833 | 26 |
| Blue | SSVs | 2 | 2 | 5 | 2 | 2 | 2 | 36 | 1.000 | 0.400 | 18 |

*Including duplicate samples from the same individual

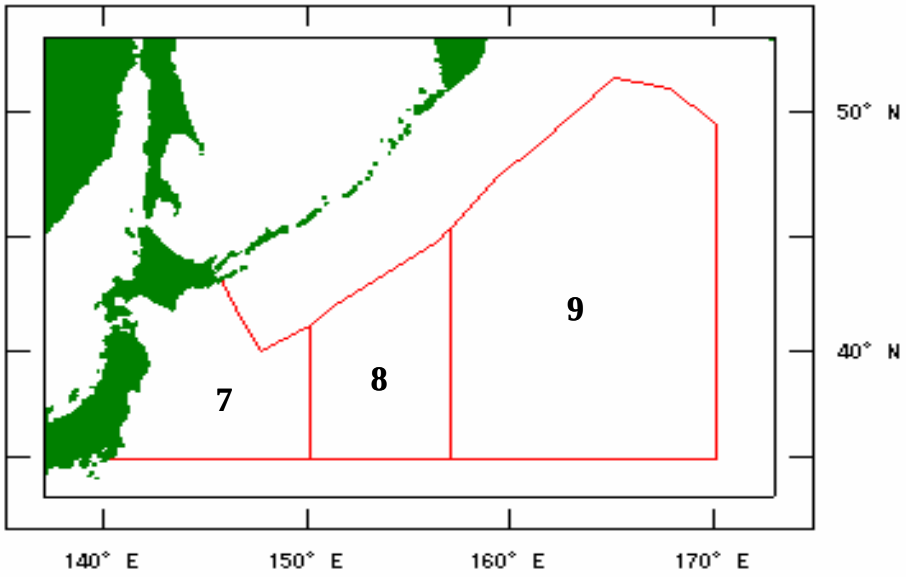


Figure 1. Research area of the JARPN II full-scale program.

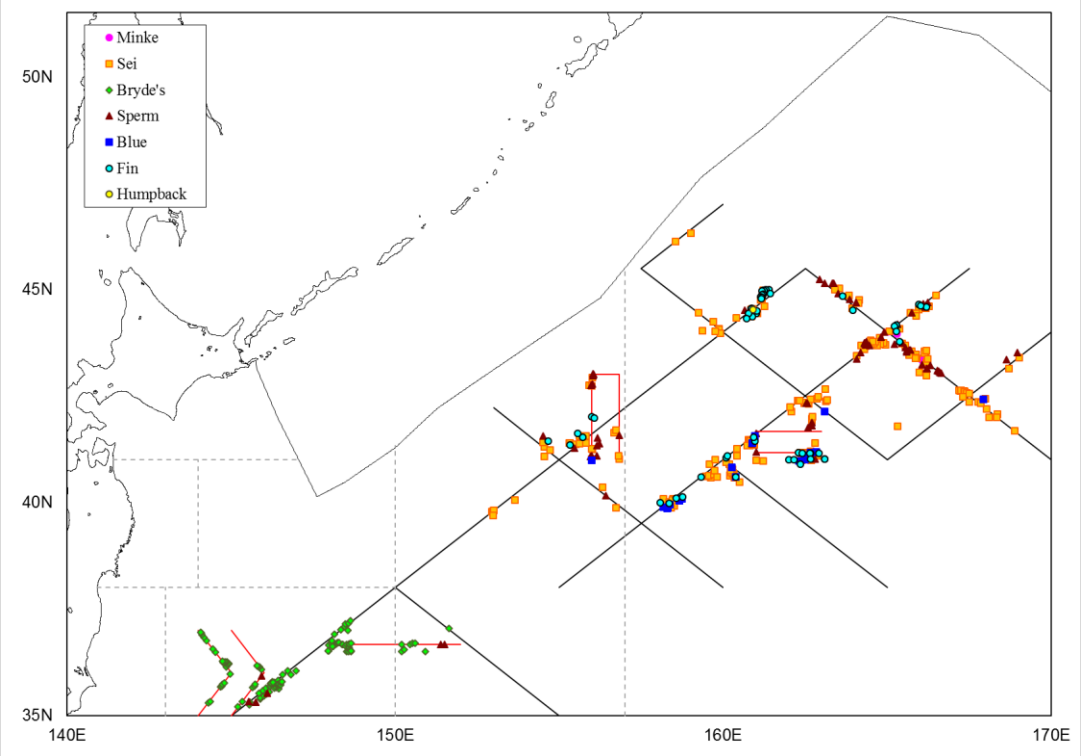


Figure 2. Track-lines and sighting positions of large whales made by the sighting/sampling vessels (*SSVs*).

Black line: Normal survey, Red line: SMS survey

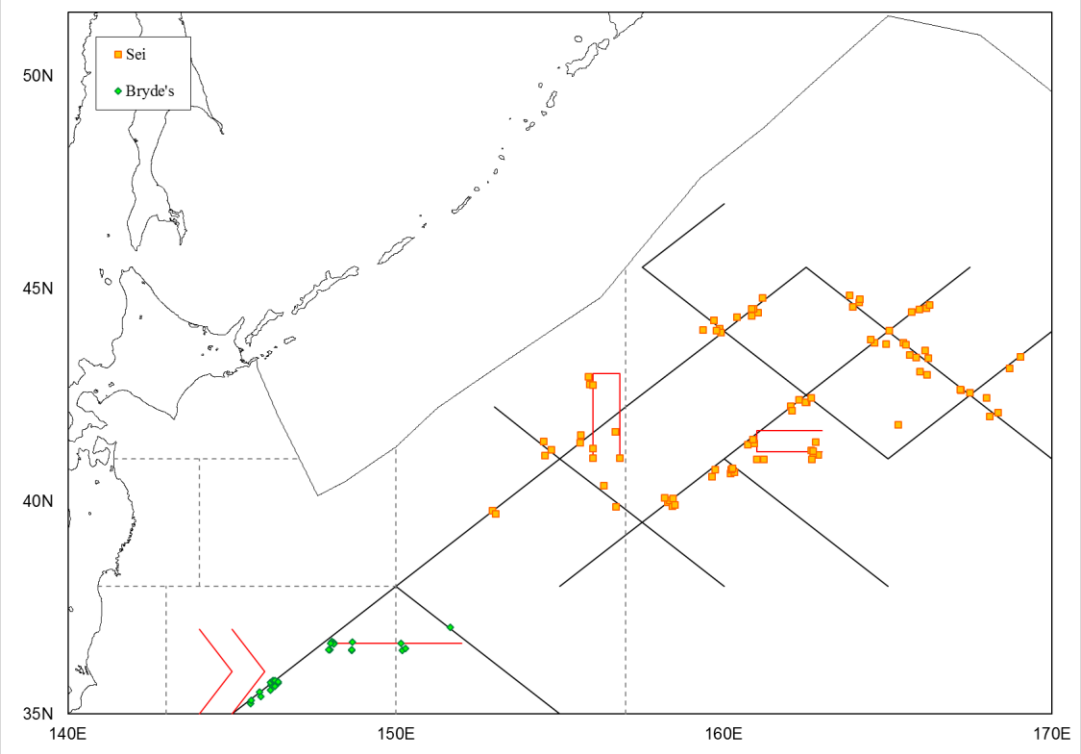


Figure 3. Sighting positions of the sampled sei (orange square) and Bryde's (green diamond) whales.

Black line: Normal survey, Red line: SMS survey

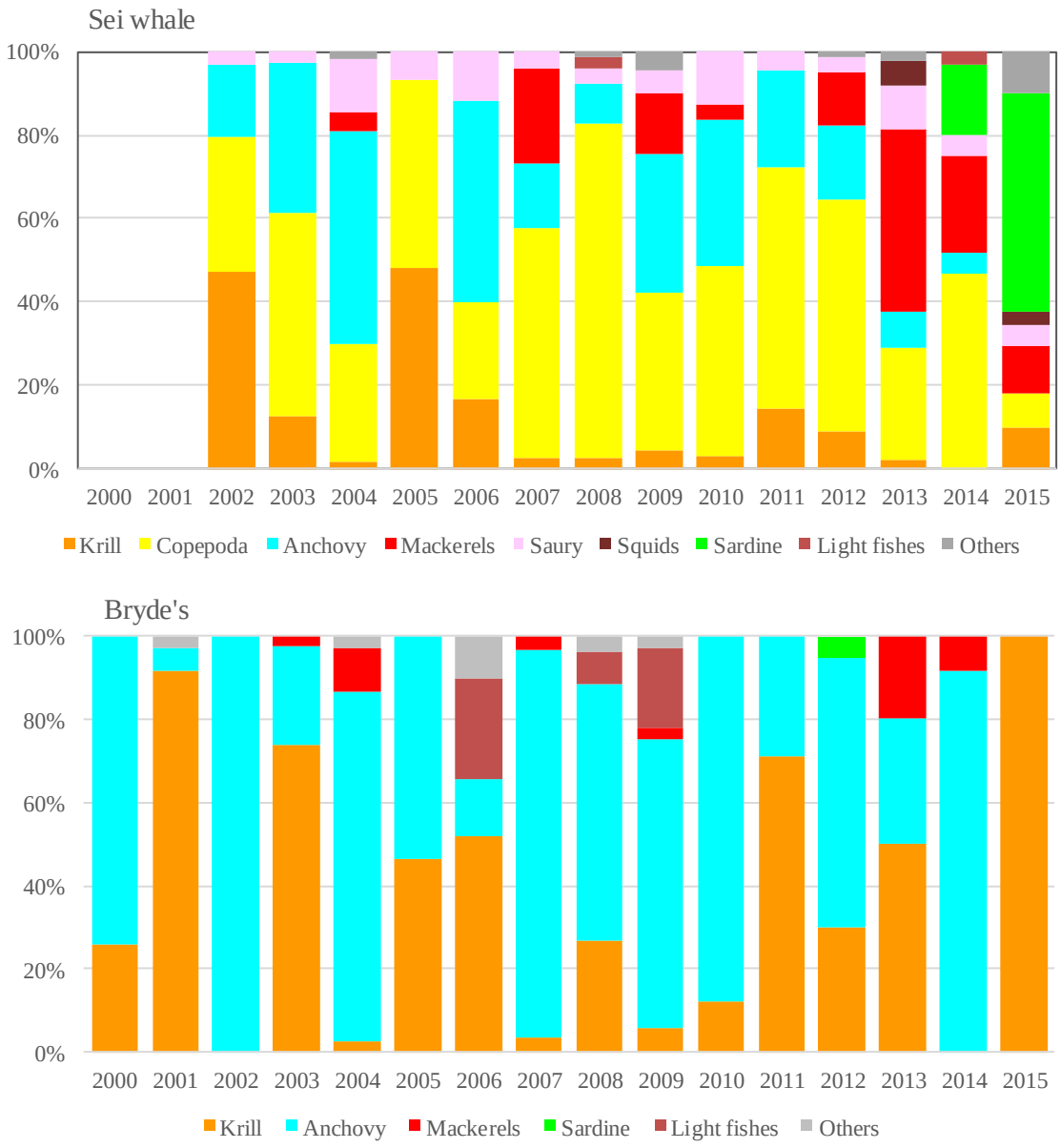


Figure 4. Composition of main prey species of sei (upper) and Bryde's (lower) whales sampled during the 2015 offshore survey, with comparison to the previous surveys.