Cruise Report of the Second Phase of the Japanese Whale Research Program under Special Permit in the Western North Pacific (JARPN II) in 2013 (part I) – Offshore component –

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ABSTRACT

The twelfth cruise of the full-scale Second Phase of the Japanese Whale Research Program under Special Permit in the Western North Pacific (JARPN II) -offshore component- was conducted in sub-areas 7, 8 and 9 of the western North Pacific. JARPN II was planned to conduct comprehensive review every six years and 2013 was the last survey of second six-year period (2008-2013). There were three main research components in the 2013 survey: whale sampling survey, dedicated sighting survey and whale prey 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), one whale prey survey vessel (whale prey survey component) and four dedicated sighting vessels (SVs) (dedicated sighting survey component). The whale sampling survey was carried out from 25 July to 7 October 2013. A total of 1,846n.miles was surveyed in a period of 65 days by the SSVs. A total of three common minke, 442 sei, 56 Bryde's, 167 sperm, seven blue, 64 fin and one humpback whales were sighted by the SSVs. A total of three common minke, 100 sei, 28 Bryde's and one sperm whale was sampled by the SSVs. All whales sampled were examined on board of NM. In August, common minke whales fed mainly on Japanese anchovy, mackerels and Pacific saury in sub-area 9. Sei whales fed mainly on mackerels followed by copepods from August to September in sub-areas 8 and 9. Bryde's whales fed mainly on krill followed by Japanese anchovy and mackerels in sub-areas 8 and 9 from late July to early October. Dominant prey species in the stomach of the sperm whale was various kinds of squids, which inhabit in mid- and deep-waters. Three dedicated sighting surveys were carried out from 18 May to 26 June in sub-areas 7 and 8, from 20 July to 23 August in sub-area 9 and from 12 September to 7 October in sub-areas 8 and 9. A total of 3,470, 987 and 539n.miles was surveyed during those surveys by the SVs, respectively. The whale prey survey was carried out from 24 July to 22 August. The survey was conducted concurrently with SSVs and *NM* in a part of sub-areas 8 and 9. The main purpose of the prey survey in this year was recording of underwater behaviour of Bryde's and sei whales by using acoustic transmitters. 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; SPERM 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, JARPN II 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 JARPN II 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 JARPN II Programme (IWC, 2009) for the first period (2002-2007). The results presented on the three main objectives of JARPN II were discussed by an Experts Panel. Constructive discussions were conducted and some recommendations were offered by the EP. Some of those recommendations were already responded by Japanese scientists (Pastene, *et al*., 2010).

This paper reports the twelfth full-scale survey of the JARPN II offshore component, carried out in 2013, which completed the second six-year period of JARPN II.

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) commanded the research and was the platform for biological examination of whale samples and processing of by-products. The *Yushin Maru* (*YS1*: 720GT) 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 JARPN II 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; Bando *et al*., 2010, 2013; Matuoka *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 common minke whales, 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 JARPN II (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; Bando *et al*., 2010, 2013; 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 mode 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, sei and sperm whales. Furthermore closing was made on sightings of other large 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 2013 JARPN II offshore component were set as follows: 100 common minke whales, 100 sei whales, 50 Bryde's whales and 10 sperm 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: 06:30-18:30 (12 hrs) in local time), if collection of whale samples was considered possible. For schools consisting of two or more animals, numbering was made for all the whales in the school; to set 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 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.
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, common minke and sperm whales.
6. Observation of underwater behaviour of sei and Bryde's whales by using acoustic transmitters (Co-operative experiment with prey survey component. See Appendix for the details).

Observation of marine debris
Observation of marine debris was conducted from the wheelhouse of the research base vessel (*NM*) during transit from home port to the research area (25 July to 29 July) and from research area to home port (3 October to 6 October). Marine debris was also investigated in the stomach contents of common minke, Bryde's, sei and sperm whales sampled.

Dedicated Sighting survey
A report of the dedicated sighting surveys was presented by Matsuoka *et al*. (2014). Here just a brief outline is presented. Three independent surveys were conducted in this season.

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

Research vessel
The *YS1*, *YS2*, *Yushin Maru* No.3 (*YS3*: 742GT) 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 dedicated sighting survey was designed in the research area.

Experiments

The following experiments and observations were conducted by the SVs.

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.

Whale prey surveys

A brief outline is provided here. The details can be found in the Annex of this paper. The main objective of the survey in this year was to record underwater behaviour of Bryde's and sei whales by using acoustic transmitters.

Research area

Research area was set in sub-areas 8 and 9.

Research vessel

The *Shunyo Maru* (*SHU*: 887GT) was used as the survey vessel.

Methods for setting cruise track line and survey procedure

The survey was conducted concurrently with whale sampling survey.

Experiments

The following experiments and observations were conducted in the prey survey.

1. Observation of underwater behaviour of sei and Bryde's whales by using acoustic transmitters (Co-operative experiment with whale sampling component).
2. Collection of data for the estimation of abundance of prey species: echosounder, mid-water trawl and plankton net surveys.
3. Sighting surveys of cetaceans and seabirds.
4. Recording of oceanographic conditions by CTD and XCTD.

RESULTS

Whale sampling survey

Actual survey periods, track lines and searching distances

Cruise period: Between 25 July and 7 October (75 days)
Research period: Between 30 July and 2 October (65 days)
Track line: Track line set by the two SSVs is shown in Figure 2.
Searching distance: The total searching distance for SSVs was 1,846 n.miles

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

A total of three schools (three individuals) of common minke, 282 schools (442 ind.) of sei, 47 schools (56 ind.) of Bryde's and 123 schools (167 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 (six sch./seven ind.), fin (47 sch./64 ind.) and humpback (one sch./one ind.) whales (Figure 2).

Sampling and biological research on common minke, Bryde's, sei and sperm whales

A total of three common minke whales (three male), 100 sei whales (male: 44, female: 56 ind.), 28 Bryde's whales (male: 13, female: 15 ind.) and one female sperm whale 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 39 research items was covered. These items are related to the studies conducted under the three main objectives of the JARPN II: study on feeding ecology of whales and marine ecosystem, pollution studies and elucidation of stock structure.

Composition of sex and sexual maturity status of common minke, sei, Bryde's and sperm whales are shown in Table 3. Statistics of body length of each whale species is shown in Table 4. Mean body length of three male common minke whales was 7.59m. Mean body length of sei whale was 13.14m and 14.22m for males and females, respectively. For Bryde's whales, those were 12.20m and 12.63m, respectively. For sperm whales, body length of one female was 7.36m.

Geographical distribution of common minke, sei, Bryde's and sperm whale samples is shown in Figure 3 based on the sighting positions.

Distribution and food habits of whales
During the research period, three common minke whales were sampled at western part of sub-area 9 and their main prey species were Japanese anchovy, mackerels and pacific saury (Table 5).

Sei whales distributed widely in the offshore area. In this survey, sei whales were sampled in the sub-areas 8 and 9 and they fed mainly on mackerels (44.7%), followed by copepods (27.7%), Japanese anchovy (8.5%), pacific saury (8.5%) and squids (8.5%) (Table 5).

Bryde's whales distributed in the southern part of sub-areas 8 and 9. In this survey, Bryde's whales were sampled in the sub-areas 8 and 9 and they fed mainly on krill (58.3%), followed by Japanese anchovy (25.0%) and Mackerels (16.7%) (Table 5).

Sperm whales distributed widely in the research area. In this survey, one sperm whale was sampled in the sub-area 9. Main prey species of sampled whale was deep sea squids.

Experiments
Sighting distance and angle experiment
A sighting distance and angle experiment was performed on 8 August 2013 by *YS1* and *YS2*. The results of this experiment will be used in calculation of abundance estimates.

Photo-ID and biopsy sampling
No experiment was conducted by the SSVs.

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

Excretion and vomiting behaviour
No case of excretion or vomiting was observed during the survey.

Observation of marine debris
No large debris was observed in the environment. Small piece of plastic was observed in the stomachs of three Bryde's and 33 sei whales. Small piece of wood was observed in one Bryde's whale. Small piece of net was observed in three sei and one sperm whales. One to five pieces were observed in each individual and sizes were less than 15cm in most cases.

Dedicated Sighting survey
Here just a brief outline of the results is presented. The details are described in Matsuoka (2014).

Actual research periods and searching distance
Cruise period:
First survey : Between 18 May and 26 June (40 days; *YS1* and *YS2*)
Second survey : Between 20 July and 23 August (35 days; *SM2*)
Third survey : Between 12 September and 7 October (26 days; *YS3*)

Searching distance:
First survey : 1,646 n.miles (*YS1*); 1,824 n.miles (*YS2*)
Second survey : 987 n.miles (*SM2*)

Third survey : 539 n.miles (*YS3*)

Co-operative survey with whale sampling component
During 29 September to 2 October, SV (*YS3*) conducted sighting survey in cooperation with whale sampling component. During this period, SV conducted sighting survey on one of the three tracklines established for whale sampling component. The data collected during this period will be treated separately.

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 seven schools (seven individuals) of common minke, 33 schools (56 ind.) of sei, 39 schools (55 ind.) of Bryde's and 75 schools (225 ind.) of sperm whales was sighted during first survey. During second survey, a total of 57 schools (116 ind.) of sei, 11 schools (12 ind.) of Bryde's and 40 schools (66 ind.) of sperm whales was sighted. During third survey, two schools (two ind.) of common minke, 11 schools (14 ind.) of sei, 10 schools (10 ind.) of Bryde's and 49 schools (61 ind.) of sperm whales was sighted.

Sightings of other large cetacean species
Large baleen whales such as fin (25 schools/34 individuals), blue (two sch./two ind.), humpback (66 sch./88 ind.) and right (one sch./one ind.) whales were sighted during the first survey. During the second survey, fin (19 sch./22 ind.), blue (three sch./four ind.) and humpback (two sch./three ind.) whales were sighted. During the third survey, fin (five sch./six ind.), blue (one sch./one ind.) and humpback (one sch./two ind.) whales were sighted.

Experiments
Photo-ID and biopsy sampling
A total of 11 humpback whales, two blue whales and one right whale was photographed during first survey. Biopsy samples were collected from six humpback and one blue whales during first survey.

Whale prey survey
A brief outline of the results is presented here. The details are described in the Appendix of this paper.

Actual research period
Cruise period: Between 24 July and 22 August (30 days)

Recording of whale behaviour
A total of 45 hours 26 minutes of underwater behaviour was recorded from two sei and two Bryde's whales by the acoustic transmitters.

Sightings of common minke, Bryde's, sei and sperm whales
A total of three schools (11 individuals) of sei, eight schools (12 ind.) of Bryde's and 12 schools (16 ind.) of sperm whales was sighted as the primary sightings.

Sightings of other large cetacean species
No other large whale species were observed.

Main experiments
CTD: 8 stations
XCTD: 8 stations
Midwater trawl: 8 stations
NORPAC net survey: 8 stations
Ring net survey: 4 stations

DISCUSSION
In this year, survey was conducted in late summer, which was later than previous surveys. Therefore, samples from late feeding season were collected. High density sei whales distribution area was detected in

eastern part of sub-area 9 where sea surface temperature was high (15℃ to 20℃) compared to general distribution zone (10℃ to 15℃) of this species in summer. Much effort was applied to collect samples from this high density area because feeding information from this newly detected high density area is important to estimate total food consumption of sei whales during feeding season. Common minke whales usually distributes in more cold waters where sea surface temperature was from 10℃ to 15℃ which overlap with that of sei whales in general year. Few survey effort was applied to this temperature zone and as a result, only low number of common minke whales were collected.

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

Common minke whale
From the JARPN and JARPN II surveys from 1994 to 2012, common minke whales fed on various prey species such as Japanese anchovy, Pacific saury *Cololabis saira*, walleye pollock and Japanese common squid *Todarodes pacificus*, and the main prey species changed seasonally and geographically. From the previous analyses for the stomach contents of minke whales taken by JARPN II, they fed on Japanese anchovy in May/June and Pacific saury in July/August in offshore area. In the 2013 survey, only three whales were sampled in August in the sub-area 9. Their main prey species were mackerels, pacific saury and Japanese anchovy, which was commonly found as main prey species in the previous surveys.

Sei whale
From our research results of past JARPN II (2002 to 2012), they fed on Japanese anchovy and copepods dominantly during survey season in most of years. During the present survey, sei whales were sampled in late summer in sub-areas 8 and 9. Main prey species of sampled sei whales were mainly mackerels and copepods. In recent surveys, mackerels were increasingly appeared in stomach contents, which might indicate recovery of this resource and change of available prey species for sei whales.

Bryde's whale
From our research results of past JARPN II (2000 to 2012), the dominant prey species of Bryde's whale was Japanese anchovy and krill during May to September. There was 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 important prey species in August. During the present survey, Bryde's whale fed mainly on krill followed by Japanese anchovy and mackerels in late summer in the sub-areas 8 and 9.

Sperm whale
From our research results of past JARPN II (2000 to 2012), the following information was obtained: (1) sperm whales feed mainly on deep-sea squids. Some of these are reported as prey species of the sperm whale for the first time; (2) Squids found in the sperm whale stomach are relatively fresh suggesting that sperm whale feed on these prey during daytime; (3) At least some fish species (walleye pollock, bottom fishes) was identified in the diet of the sperm whale (Tamura *et al*., 2009d). During the present survey, stomach contents of sampled sperm whale were mainly deep-sea squid which was same as in previous surveys.

Summary of six years surveys

JARPN II was planned to conduct comprehensive review every six years and 2013 cruise was the last survey of the second six year period (2008-2013). The number of samples of three baleen whale species taken by 2008-2013 JARPN II surveys were shown in Table 6. A total of 242 common minke, 595 sei, 262 Bryde's and eleven (three males and eight females) sperm whales was collected during this period. Male ratio of common minke whales was high (82.6%) and mature male dominated in samples. On the other hand, female samples were slightly predominated for sei (53.8%) and Bryde's (55.3%) whales. Investigation of segregation and migration strategy will be conducted from these samples. Apparent pregnancy rate of sei and Bryde's whales was high (0.752 and 0.581 for sei and Bryde's whales, respectively), which indicates high reproductive rate of these species. Analysis of sampled stomach contents is currently in progress, and long-term change of pelagic small fishes has been observed compare to that in the early time of JARPN II. These results will be submitted to next review meeting.

The number of photo-ID and biopsy samples taken by JARPN II during 2008 to 2013 was shown in Table 7. A total of 20 blue, 27 humpback and 26 right whales were photographed and biopsy samples were collected from 15 blue, nine humpback, 19 right, three fin, 14 sei and 43 Bryde's whales. The research results using these data and samples will be submitted to next JARPN II review meeting.

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Table 1. Whale species and number of sightings in the 2013 JARPN II survey (no. schools/no. individuals)

Sighting/Sampling vessels (*YS1* and *YS2*)

Species	Primary		Secondary		Total	
	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.
Common minke whale	0	0	3	3	3	3
Sei whale	49	64	233	378	282	442
Bryde's whale	17	20	30	36	47	56
Sperm whale	49	66	74	101	123	167
Blue whale	1	1	5	6	6	7
Fin whale	17	23	30	41	47	64
Humpback whale	0	0	1	1	1	1

Sighting vessels (*YS1*, *YS2*, *SM2* and *YS3*)

Species	First survey (*YS1* and *YS2*)						Second survey (*SM2*)						Third survey (*YS3*)					
	Primary		Secondary		Total		Primary		Secondary		Total		Primary		Secondary		Total	
	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.
Common minke whale	6	6	1	1	7	7	0	0	0	0	0	0	2	2	0	0	2	2
Sei whale	30	52	3	4	33	56	50	95	7	21	57	116	7	7	4	7	11	14
Bryde's whale	37	53	2	2	39	55	10	11	1	1	11	12	5	5	5	5	10	10
Sperm whale	73	223	2	2	75	225	32	52	8	8	40	60	34	45	15	16	49	61
Blue whale	2	2	0	0	2	2	2	3	1	1	3	4	1	1	0	0	1	1
Fin whale	24	33	1	1	25	34	15	18	4	4	19	22	2	3	3	3	5	6
Humpback whale	60	78	6	10	66	88	2	3	0	0	2	3	0	0	1	2	1	2
Right whale	1	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0

Table 2. Summary of biological data and samples collected during the 2013 JARPN II survey.

Reesearch items	Common minke			Sei whale			Bryde's whale			Sperm whale		
	F	M	T	F	M	T	F	M	T	F	M	T
Body length and sex	0	3	3	56	44	100	15	13	28	1	0	1
External body proportion	0	3	3	56	44	100	15	13	28	1	0	1
Photographic recoed and external character	0	3	3	56	44	100	15	13	28	1	0	1
Diatom film recoed	0	3	3	56	44	100	15	13	28	1	0	1
Standaed measurements of blubber thickness (five points)	0	3	3	56	44	100	15	13	28	1	0	1
Detailed measurements of blubber thickness (eleven points)	0	0	0	1	0	1	0	1	1	1	0	1
Body weight	0	3	3	56	44	100	15	13	28	1	0	1
Body weight by parts	0	0	0	1	0	1	0	1	1	1	0	1
Blubber tissues for DNA study	0	3	3	56	44	100	15	13	28	1	0	1
Blubber, muscle, liver and kidney tissues for organochlorines analysis	0	3	3	56	44	100	15	13	28	1	0	1
Tissue for nutritional compornent analysis	0	3	3	4	2	6	2	3	5	0	0	0
Lung tissue for atmospheric analysis	0	0	0	0	10	10	0	7	7	1	0	1
Muscle tissues for cesium analysis	0	3	3	5	6	11	3	6	9	1	0	1
Tissues for various analysis	0	3	3	56	44	100	15	13	28	1	0	1
Tissues for virus test	-	3	3	-	44	44	-	13	13	-	0	0
Mammary gland; lactation status and measurement	0	-	0	56	-	56	15	-	15	1	-	1
Collection of ovary	0	-	0	56	-	56	15	-	15	1	-	1
Photographic record of foetus	0	0	0	13	18	31	5	2	7	0	0	0
Foetal sex (identified by visual observation)	0	0	0	13	18	31	5	2	7	0	0	0
Foetal length and weight	0	0	0	13	18	31	5	2	7	0	0	0
Foetal blubber tissuyes for DNA study	0	0	0	13	18	31	5	2	7	0	0	0
Testis; weight and histological sample	-	3	3	-	44	44	-	13	13	-	0	0
Collection of plasma sample	0	3	3	55	41	96	15	13	28	1	0	1
Stomach content, conventional record	0	3	3	56	44	100	15	13	28	1	0	1
Weight of stomach content in each compartment	0	3	3	56	44	100	15	13	28	1	0	1
Stomach contents for feeding study	0	3	3	24	24	48	5	5	10	1	0	1
Record of external parasites	0	3	3	56	44	100	15	13	28	1	0	1
Collection of external parasites	0	0	0	1	0	1	0	0	0	0	0	0
Record of internal parasites	0	3	3	56	44	100	15	13	28	1	0	1
Earplug for age determination	0	3	3	56	44	100	15	13	28	0	0	0
Tympanic bulla for age determination	0	0	0	1	0	1	0	1	1	0	0	0
Maxillally teeth for age determination	0	0	0	0	0	0	0	0	0	1	0	1
Lens for age determination	0	3	3	56	44	100	15	13	28	1	0	1
Largest baleen plate for morphologic study and age determination	0	3	3	56	44	100	15	13	28	-	-	-
Vertebral epiphyses sample	0	3	3	56	44	100	15	13	28	1	0	1
Brain weight	0	0	0	1	0	1	0	1	1	1	0	1
Skull measurements (length and breadth)	0	3	3	54	43	97	15	13	28	1	0	1
Pelvic bone	0	0	0	4	6	10	15	13	28	1	0	1
Testis tissues for morphological study	-	0	0	-	0	0	-	1	1	-	0	0

Table 3. Sex and sexual maturity composition of whales sampled during the 2013 JARPN II survey.

Species		Male				Female							Total
		Imm.	Mat.	Uk	Total	Imm.	Mat.				Total		
							Ovu.	Rest.	Preg.	Lact.			
Common minke	SA8	-	-	-	-	-	-	-	-	-	-	-	-
	SA9	0	3	0	3	0	0	0	0	0	-	-	-
	Combined	0	3	0	3	0	0	0	0	0	0	0	3
Sei	SA8	1	2	0	3	0	0	1	5	1	7	7	10
	SA9	15	26	0	41	6	3	13	26	1	43	49	90
	Combined	16	28	0	44	6	3	14	31	2	50	56	100
Bryde's	SA8	1	6	0	7	3	0	2	5	1	8	11	18
	SA9	2	3	1	6	0	2	0	2	0	4	4	10
	Combined	3	9	1	13	3	2	2	7	1	12	15	28
Sperm	SA8	-	-	-	-	-	-	-	-	-	-	-	-
	SA9	0	0	0	0	1	0	0	0	0	0	1	1
	Combined	0	0	0	0	1	0	0	0	0	0	1	1

Table 4. Body length (m) of whales sampled during the 2013 JARPN II survey.

Species	Sub area	Male					Female				
		n	mean	S.D.	min	max	n	mean	S.D.	min	max
Common minke	SA8	0	-	-	-	-	0	-	-	-	-
	SA9	3	7.59	0.18	7.42	7.84	0	-	-	-	-
	Combined	3	7.59	0.18	7.42	7.84	0	-	-	-	-
Sei	SA8	3	13.17	0.91	12.01	14.22	7	14.65	0.47	13.93	15.44
	SA9	41	13.14	1.08	9.88	14.69	49	14.16	1.06	10.74	15.90
	Combined	44	13.14	1.07	9.88	14.69	56	14.22	1.02	10.74	15.90
Bryde's	SA8	7	12.08	1.79	7.72	13.08	11	12.43	1.17	10.34	13.78
	SA9	6	12.34	0.67	11.24	13.53	4	13.19	0.61	12.24	13.92
	Combined	13	12.20	1.39	7.72	13.53	15	12.63	1.10	10.34	13.92
Sperm	SA8	0	-	-	-	-	0	-	-	-	-
	SA9	0	-	-	-	-	1	7.36	-	-	-
	Combined	0	-	-	-	-	1	7.36	-	-	-

Table 5. Prey species and stomach contents weight (1st. + 2nd. stomachs) in whales sampled during the 2013 JARPN II survey.

	Dominant prey species		N	%	Range of weight (kg) min		max
Common minke whale							
	Fish	Japanese anchovy	1	33.3	2.62+		
		Mackerels	1	33.3	4.46		
		Pacific saury	1	33.3	18.64		
Sei whale							
	Krill		1	2.1	1.58		
	Copepods		13	27.7	0.34	-	70.66
	Fish	Japanese anchovy	4	8.5	5.06	-	360.44
		Mackerels	21	44.7	0.66	-	367.93
		Pacific saury	4	8.5	0.32	-	395.12
	Squids		4	8.5	1.84	-	359.74
Bryde's whale							
	Krill		7	58.3	0.42	-	41.66
	Fish	Japanese anchovy	3	25.0	3.22	-	16.74
		Mackerels	2	16.7	25.28	-	218.11

Table 6. The number of samples for each maturity stages taken by second six year periods of JARPNII offshore surveys (2008-2013).

		Maturity stage	2008	2009	2010	2011	2012	2013	Total
Common minke	Male	Immature	3	6	2	11	21	0	43
		Mature	45	24	9	27	30	3	138
		Unknown	5	6	1		7	0	19
	Female	Immature	0	3	1	4	12	0	20
		Resting	1	1	0	3	0	0	5
		Pregnant	5	3	1	4	4	0	17
		Total	59	43	14	49	74	3	242
Sei	Male	Immature	10	12	15	11	13	16	77
		Mature	34	34	28	43	31	28	198
	Female	Immature	17	9	10	13	11	6	66
		Ovulating	0	0	1	0	2	3	6
		Resting	2	10	7	8	5	14	46
		Pregnant	35	33	35	18	36	31	188
		Lactating	1	1	4	2	1	2	11
		Preg & Lact.	1	1	0	0	1	0	3
		Total	100	100	100	95	100	100	595
Bryde's	Male	Immature	6	9	5	10	5	3	38
		Mature	23	8	19	10	6	9	75
		Unknown	1	1	1	0	0	1	4
	Female	Immature	4	14	4	11	4	3	40
		Ovulating	0	0	1	1	0	2	4
		Resting	7	7	5	7	8	2	36
		Pregnant	9	9	15	11	10	7	61
		Lactating	0	2	0	0	1	1	4
		Total	50	50	50	50	34	28	262

Table 7. The number of photo-ID and biopsy samples taken by JARPN II offshore component during second six year periods (2008-2013).

Species	Photo-ID (individuals)	Biopsy (individuals)
Blue	20	15
Humpback	27	9
Right	26	19
Fin		3
Sei		14
Bryde's		43

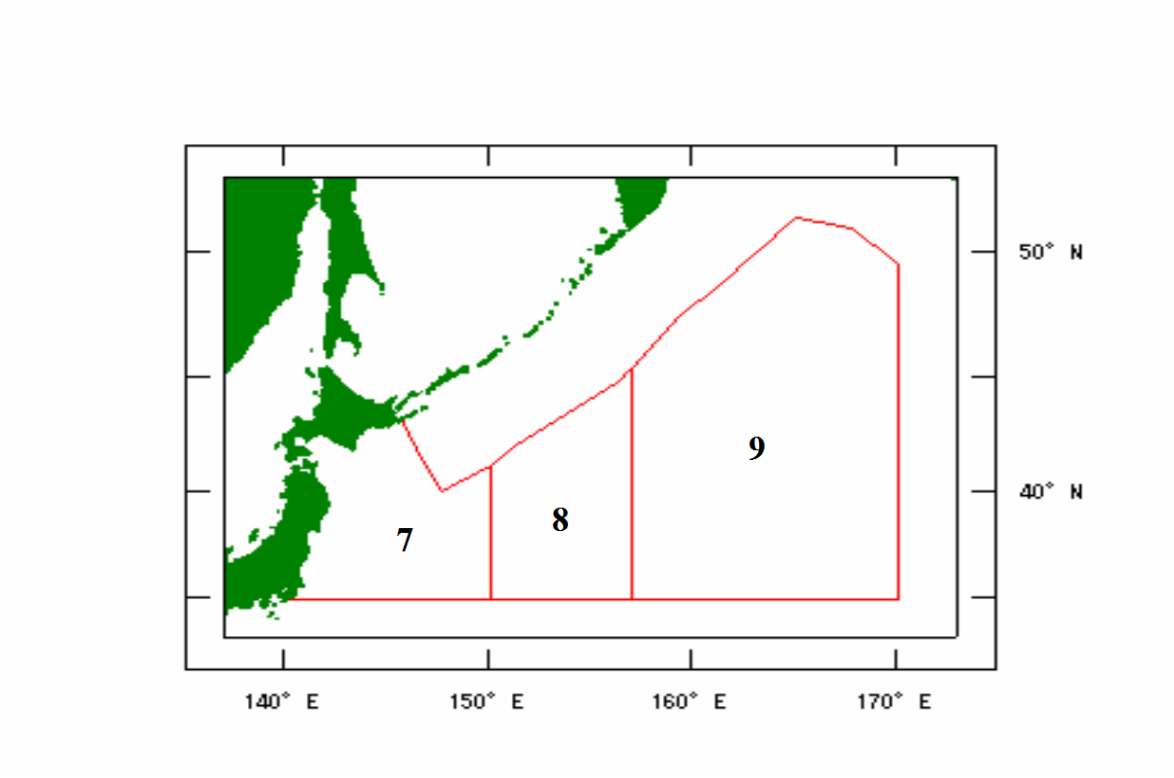

Figure 1. Research area of the JARPN II full-scale program.

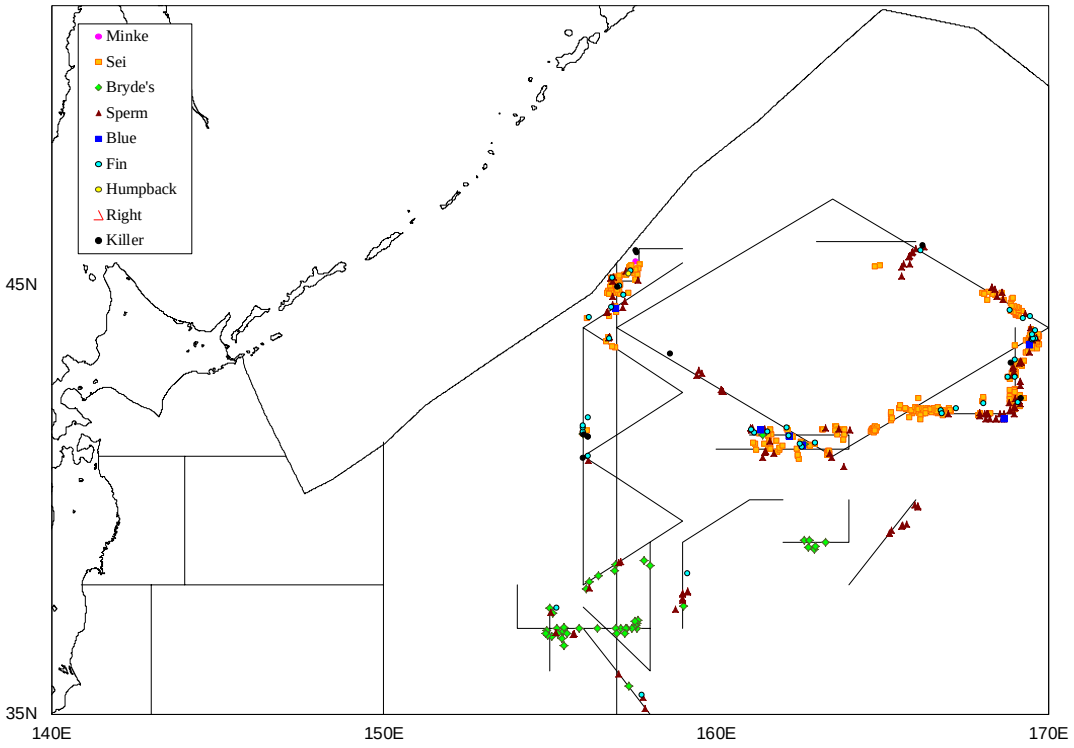

Figure 2. Track-lines and sighting positions of large whales made by the sighting/sampling vessels (SSVs).

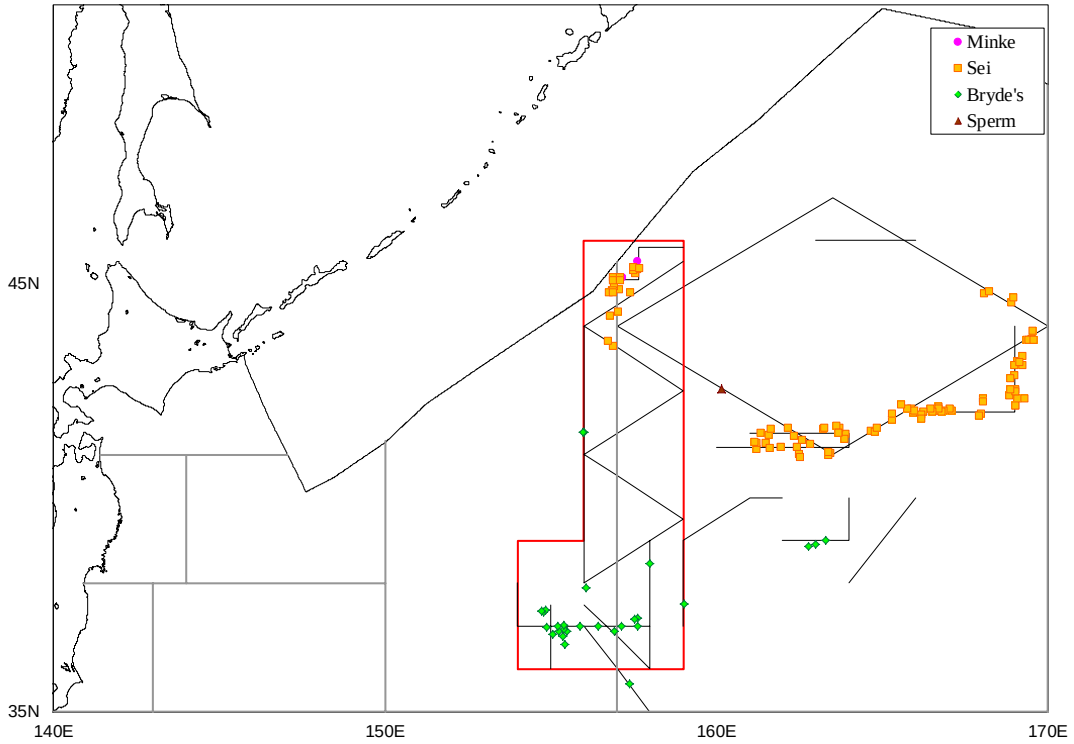

Figure 3. Sighting positions of the sampled common minke (pink circle), sei (orange square), Bryde's (green diamond) and sperm (brown triangle) whales. Red block shows the survey area for the cooperative prey and whale sampling survey.

Appendix

Cruise report of the whale prey survey conducted in the offshore component of the JARPNII in 2013

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ABSTRACT

The whale prey survey was conducted from 24 July to 22 August 2013 as a part of the offshore component of JARPNII. The main objective of the survey was to collect data for analysis of prey preference of whales. To achieve the goal, acoustic transmitters equipped with time, depth and temperature sensors were used in the study to record underwater behaviour of sei and Bryde's whales. Four transmitters were successfully attached to sei and Bryde's whales (two transmitters for each species). A total of 45 hours36 minutes of their behaviour were recorded. These were the first data of underwater behaviour of sei and Bryde's whales in the western North Pacific. Furthermore, this was the first record of underwater behaviour of sei whales in the world. Echosounder data were recorded simultaneously with the observations. Oceanographic observations, trawl and plankton net sampling, and sighting survey of whales and seabirds were conducted around the area of the behaviour observations. The data sets obtained by the survey will be used in the detailed analysis to understand prey preference of whales and their environment. The results will be reported to the IWC/SC in the near future once the analysis is completed.

INTRODUCTION

The Second Phase of Japanese Whale Research Program under Special Permit in the Western North Pacific (JARPNII) has been conducted since 2000 (Government of Japan, 2000; 2002). One of the main objectives of JARPNII is "feeding ecology and ecosystem studies". The whale prey surveys has been conducted since the beginning of the offshore component of JARPNII to provide data sets for these studies and some of the results were published in the scientific literatures (e.g. Murase et al., 2007; 2012; Watanabe et al., 2012). The results of the first six year period of JARPII were reviewed by the expert workshop of the Scientific Committee of the International Whaling Commission (IWC/SC) (IWC, 2010a) and the subsequent the IWC/SC meeting in 2010 (IWC, 2010b). The expert panels recommended that "a proper evaluation of the use of nonlethal and lethal techniques in any long-term programme such as this should occur periodically at appropriate intervals this applies both to the development of new analytical techniques and to technical developments that allow appropriate samples to be collected from free-ranging animals (IWC, 2010a). Biologging techniques are used as a nonlethal technique to monitor feeding behaviour of large whales in recent years (Calambokidis et al., 2008; Friedlaender et al., 2009; Goldbogen et al., 2008; 2011). However, observation of feeding behavior of sei (*Balaenoptera borealis*) and Bryde's (*B. edeni*) whales using data loggers has not been reported although diving profile of Bryde's whales were reported (Alves et al., 2010). To understand their feeding behaviour, underwater behaviour of animals and vertical distribution of their prey should be recorded simultaneously. Use of an acoustic transmitter as a data logger is one of the approach to achieve the goal as in the case of Witteveen et al. (2008).

The priory of the prey survey in 2013 was given to attachment of acoustic transmitters to sei and Bryde's whales. In addition, echosounder data recording, trawl and plankton net sampling, oceanographic observations were conducted in the survey to understand distribution of whale prey. Sighting surveys of

whales and seabirds were also carried in the survey to understand their distributions in the survey area qualitatively. This paper briefly outlines the results of the survey.

MATERIALS AND METHODS

Survey protocol

The whale prey survey was conducted in the western North Pacific from 24 July to 22 August 2013 (Fig. 1). A trawler type fisheries survey vessel, *Shunyo-maru* (SHU, 887 GT), was engaged in the survey. The most of the whale prey survey was conducted concurrently proximate (i.e. within 100 n.miles) to the whale sighting and sampling survey (Bando et al., this meeting).

Recording of whale behaviour

Underwater whale behaviour was recording using the acoustic transmitters, FPXG-1040-60P500T30 (Fusion Inc., Japan). The specifications are summarized in Table 1. The transmitters were tethered to small titanium spearhead using dyneema fishing lines. The transmitters were deployed from the bows of the vessels, either SHU or *Yushin-maru* (YS1, 720 GT), with compound crossbows. Target species were either sei or Bryde's whales. Transmitted signals were received by a transducer and processed by a receiver, FRX-4001 (Fusion Inc., Japan) onboard SHU. The data were stored in a Windows PC. The data were recorded from the time of the attachment to the whales to the time either the attached animals were missed or the battery of the transmitters were flat. Echosounder data were recorded continuously while behaviour of whales was recorded.

Prey survey

Predetermined tracklines for prey surveys were set around the area where behaviour of whales was recorded. The survey hour was from an hour after sunrise to an hour before sunset while the maximum research hours were set at 12 hours. Echosounder data were recorded along the lines at a speed of 10 knots. Trawl and plankton net samplings were also conducted along the lines. In some occasion, the samplings were also conducted after sunset.

Echosounder

A quantitative echo sounder EK60 (Simrad, Norway) with operating frequency at 38, 70 and 120 kHz was used on board SHU to acquire acoustic data. The transducers were hull-mounted at the depth of 4.3 m from the surface. Calibrations were carried out in Suruga Bay using a standard sphere (tungsten carbide, 38.1 mm diameter) prior to the survey.

Trawl sampling

Trawl sampling was conducted by SHU. The midwater trawl net was 84.9 m long with a mouth opening of 42.4×42.4 m and a 8.0 m cod end (NBT-2P-SY, Nitto Seimo Co., Japan). The sampling depth and the height of the mouth of the net were monitored with the Scanmar system (Scamar, Norway). The mouth opening was set 30×30 m while the net was towed. Towing speed of the trawl net was 4-5 knot. Sampling depth was either surface (0-30 m) or midwater (0-90 m). Surface trawls were conducted using the midwater trawls with the floats attached the bridle so that the trawl could be towed at the surface. The samplings were conducted either predetermined (approximately 50 n.mile apart) or target stations. Target trawls were conducted for 0.5 to 1 hour to identify the species and size compositions of biological backscattering detected by the quantitative echosounder. The purpose of the predetermined trawls was to estimate the abundance and distribution patterns of cephalopods and neustnic organisms such as Pacific saury that are difficult to detect by the echosounder. Nighttime trawls were conducted to examine day-night difference of prey species composition. Daytime trawls were towed before nighttime trawls were towed at the same positions on the same day. Midwater predetermined trawl was towed for 20 minutes at each depth layer, 0-30 m, 30-60 m, and 60-90 m whereas surface predetermined trawl was towed for 30 minutes. All samples were identified to the species as much as possible and wet weight of each species was measured aboard the ship. For the major species, length of 100 individuals was measured to examine their size composition.

Plankton sampling

A small plankton net, the North Pacific standard net (NORPAC), equipped with flow meter was towed by SHU at most of trawl stations. The mouth opening of NORPAC is 45 cm. Two sizes of meshes (0.01 and

0.33 mm) were used. Two nets were mounted on the same net frame and towed from 150 m to surface. Two casts were made at each station. One sample set was preserved in formalin-buffered seawater for species identification by using microscope while the other was preserved in methanol for DNA analysis. A ring net with the mouth opening of 80cm was towed at several stations to obtain krill samples to calculate the theoretical target strength.

Oceanographic observations

Oceanographic observations were conducted by SHU using either Conductivity-Temperature-Depth profiler (CTD, SBE-9, Seabird, USA) or expendable CTD (XCTD, Tsurumi Seiki Co., Japan). CTD and XCTD casts were conducted down to 500 m and 1000 m, respectively.

Cetacean sighting survey

Cetacean sighting survey was conducted by SHU as a part of the whale prey survey. Primary purpose of the survey was to find target animals of behaviour observations. Passing mode surveys were also conducted on the predetermined tracklines during the prey survey. Two observers were allocated to the top barrel while one researcher was allocated to the upper bridge.

Seabird sighting survey

Seabird sighting survey was conducted by SHU opportunistically. The survey was conducted for 15 minutes every hour. A researcher on the upper bridge identified seabird species and counted number of seabird within 0.5 n.miles of a 90 degree segment in either port or starboard side from the ship's bow.

RESULTS AND DISCUSSION

A total of 45 hours26 minutes of observation of behaviour of sei and Bryde's whales (2 individuals for each species) was obtained by the acoustic transmitters (Table 2). These were the first data of underwater behaviour of sei and Bryde's whales in the western North Pacific. Furthermore, this was the first record of underwater behaviour of sei whales in the world. A summary of the surveys conducted at each stations is shown in Table 3. The trawl samplings were conducted at 8 stations. Species compositions at each station were summarized in Table 4. The NORPAC and ring net were towed at 8 and 4 stations, respectively. A total of 16 casts were made using CTD and XCTD (8 stations each). A total of 146 individuals of 90 schools of cetaceans were sighted during the survey (Table 5). A total of 2,727 individuals of seabirds were recorded during the survey (Table 6). The data sets obtained by the survey will be used in the detailed analysis to understand prey preference of whales and their environment. The results will be reported to the IWC/SC in the near future once the analysis is completed.

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Table 1. Specification of the acoustic transmitters, FPXG-1040-60P500T30 (Fusion Inc., Japan).

Frequancy		62.5 kHz
Transmission Interval		1sec
Source level		155 dbuPa at 1m
Dimension		
	Length	45.6mm
	Diameter	10mm
Weight (in air)		6g
Sensors		
		Time
		Depth
		Temperature
Maximum Detection range		
	Horizontal distance	900m
	Vertical distance	500m
Battery longevity		2 days

Table 2. Summary of behaviour observations of whales using acoustic transmitters.

Date	Tagged positions		Species	Estimated body length	Duration of observation
	Latitude	Longitude			
2-Aug	37-00.06N	157-27.41E	Bryde's whale	10.7m	1:03
5-Aug	36-45.37N	155-22.13E	Bryde's whale	11.8m	1:47
13-Aug	44-56.99N	156-49.59E	Sei whale	13.2m	10:46
14-Aug	45-06.25N	156-59.43E	Sei whale	13.9m	31:59

Table 3. Summary of the surveys at observation stations.

Station	Latitude	Longitude	Day / night	Type						
				CTD	XCTD	NORPAC	Ring net	Trawl		
								0-90m	0-30m	Targeting
St-01	37-07N	154-00E	Day		Y					
St-02	37-05N	154-45E	Day	Y		Y	Y			
St-03	37-07N	155-23E	Day		Y		Y			
St-04	37-07N	155-47E	Day		Y					
St-05	37-07N	156-22E	Day	Y		Y				Y
St-06	37-07N	157-03E	Day	Y		Y				
St-07	37-07N	158-00E	Day	Y		Y		Y		
St-08	37-07N	158-00E	Night				Y	Y		
St-09	43-48N	156-42E	Day	Y		Y		Y		
St-10	43-47N	156-40E	Night				Y	Y		
St-11	43-48N	156-00E	Day		Y					
St-12	44-39N	157-00E	Day		Y					
St-13	45-02N	157-46E	Day	Y		Y			Y	
St-14	45-25N	158-33E	Day	Y		Y			Y	
St-15	45-25N	158-53E	Day	Y		Y			Y	
St-16	45-07N	157-00E	Day		Y					
St-17	45-18N	157-32E	Day		Y					
St-18	45-25N	157-36E	Day		Y					

Table 4. Summary of samples of the trawling.

St. no.	5	7	8	9	10	13	14	15
Date	7-Aug	8-Aug	8-Aug	10-Aug	10-Aug	11-Aug	12-Aug	12-Aug
Start time	10:04	10:04	20:27	13:38	20:20	17:29	10:29	16:11
Start latitude (N)	37-06.2	37-07.9	37-08.8	43-44.8	43-44.8	44-57.9	45-23.7	45-33.4
Start longitude (E)	156-20.1	157-57.8	158-00.1	156-38.2	156-37.9	157-42.1	158-32.8	158-51.8
End time	7-Aug	8-Aug	8-Aug	10-Aug	10-Aug	11-Aug	12-Aug	12-Aug
End latitude (N)	37-07.9	37-10.4	37-12.7	43-39.9	43-40.0	44-56.1	45-21.6	45-31.6
End longitude (E)	156-20.2	157-53.0	157-56.2	156-34.4	156-33.9	157-40.6	158-31.7	158-49.4
Time zone	daytime	daytime	night	daytime	night	daytime	daytime	daytime
Depths of trawling	0-30m	0-30m, 30-60m, 60-90m	0-30m, 30-60m, 60-90m	0-30m, 30-60m, 60-90m	0-30m, 30-60m, 60-90m	0-30m	0-30m	0-30m
Trawling time of several depths (minute)	30	15	15	15	15	30	30	30
Time difference	+10:30	+10:30	+10:30	+10:30	+10:30	+10:30	+10:30	+10:30
Distance of trawling (km)	2.9	4.5	5.9	6.8	6.4	4.2	4.0	4.2
Trawl net mouth (m)	30	30	30	30	30	30	30	30
Total wet weight (kg)	15.2	3.482	64.35	1.1	355.05	2.158	5.216	1.409
Total trawling area (km^2)	0.09	0.14	0.18	0.20	0.19	0.13	0.12	0.13
	weight(kg)	weight(kg)	weight(kg)	weight(kg)	weight(kg)	weight(kg)	weight(kg)	weight(kg)
Fish								
Engraulis japonicus	12.87			0.55	226.49	0.10		
Engraulis japonicus (Larva)								0.01
Scomber japonicus					7.17			
Scomber australasicus						0.06		
Nealotus tripes		0.01	2.39					
Myctophum asperum			0.73					
Notoscopelus resplendens			7.95					
Ceratoscopelus warmingii			24.71					
Diaphus perspicillatus			0.26					
Diaphus gigas			1.11					
Diaphus watasei			0.16					
Diaphus theta					22.32			
Hygophum reinhardti			0.08		39.88			
Lobianchia gemellarii			0.06					
Myctophidae spp.			0.91		1.88			
Tetragonurus cuvieri		0.02						
Leuroglossus schmidti					20.67			
Scopelosaurus hoedti			0.53					
Cubiceps pauciradiatus			0.93					
Lipolagus ochotensis			0.09					
Paralepididae spp.		<0.01	0.25					
Trachipteridae spp.		<0.01						
Unidentified fish		<0.01			0.43			
Onychoteuthidae								
Eucleoteuthis Luminosa		0.02	1.42					
Todarodes pacificus							0.23	0.06
Gonatopsis borealis			0.79					
Onychoteuthis borealijaponica					1.25			
Onychoteuthidae spp.			3.71					
Watasenia scintillans					16.08			
Crustacea								
Unidentified amphipod		<0.01						
Other								
Unidentified	0.61		0.69	0.55		2.00	4.99	1.10

Table 5. Summary of cetacean sightings.

Species	Primary		Secondary	
	Sch.	Ind.	Sch.	Ind.
Sei whale	3	11	-	-
Bryde's whale	8	12	-	-
Sperm whale	12	16	7	30
Unidentified large whale	30	41	27	33
Unidentified whale	-	-	3	3

Table 6. Summary of seabird sightings.

Common name	Scientific name	Ind.
Sooty Shearwater	*Puffinus griseus*	904
Streaked Shearwater	*Calonectris leucomelas*	468
Leach's Storm-petrel	*Oceanodroma leucorhoa*	400
Northern Fulmar	*Fulmarus glacialis*	217
Sooty Storm-petrel	*Oceanodroma tristrami*	145
Laysan Albatross	*Diomedea immutabilis*	99
Bonin Petrel	*Pterodroma hypoleuca*	84
Black-footed Albatross	*Diomedea nigripes*	50
Bulwer’s Petrel	*Bulweria bulwerii*	29
Providence Petrel	*Pterodroma solandri*	23
Stejneger’s Petrel	*Pterodroma longirostris*	19
White-necked Petrel	*Pterodroma cervicalis*	9
Mottled Petrel	*Pterodroma inexpectata*	8
Wedge-tailed Shearwater	*Puffinus pacificus*	3
South Polar Skua	*Catharacta maccormicki*	1
Kermadec Petrel	*Pterodroma neglecta*	1
Black-winged Petrel	*Pterodroma nigripennis*	1
Buller’s Shearwater	*Puffinus bulleri*	1
-	Procellariidae spp.	139
-	Hydrobatidae spp.	97
-	Stercorariidae spp.	22
-	Sterninae sp.	1

Fig. 1. The area of the whale prey survey.