

Prey consumption and feeding habits of common minke, sei and Bryde's whales in the western North Pacific

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ABSTRACT

The stomach contents of common minke whale *Balaenoptera acutorostrata*, sei whale *B. borealis* and Bryde's whale *B. edeni* sampled in the western North Pacific from May to September in 2000-2007 JARPN II were analyzed. The purposes of this study are to estimate the amount of fish resources consumed by the three whale species. Prey species of whales were identified by examining their stomach contents, and the amount of prey consumed in the research area was estimated by extrapolation using information on prey consumption per individuals and abundance of whales. The main prey species of common minke whale consisted of one copepod, two krill, two squids and eight fish. The main prey species of sei whale consisted of two copepods, three krill and four fish. The main prey species of Bryde's whale consisted of five krill, one squid and four fish. There were seasonal and geographical changes of prey species. The total prey consumption by three baleen whales during the feeding season was 1.6 million tons per year. The prey consumption of Japanese anchovy, mackerels and Pacific saury by three baleen whales were estimated as 739 thousands tons, 140 thousands tons and 43 thousands tons per year, respectively. The consumption of Japanese anchovy, mackerels and Pacific saury were equivalent to 15.4 %, 13.9 % and 1.0 % of their biomass, respectively. The consumption of Japanese anchovy, mackerels and Pacific saury were equivalent to 224.1 %, 33.3 % and 10.6 % of fisheries catch in each year by Japan, respectively.

KEYWORDS: COMMON MINKE WHALE; BRYDE'S WHALE, SEI WHALE, NORTH PACIFIC; SCIENTIFIC PERMIT

Introduction

Use of marine living resources must be done with sustainable way, so that people have responsibility to examine and evaluate the interactions between top predators and fisheries. However, historical fishery industry showed many cases of depletions in exploited species all over the world. Some species of large baleen whale are examples of the depleted resources by some countries, and then IWC has developed the RMP and RMS for sustainable commercial whaling without depletion. Recent ecosystem based management is alternative management procedure which conserve "ecosystem" not one species, therefore species interactions in management area are becoming important.

Baleen whales generally feed on variety size of prey from small zooplankton to fish, playing an important role in the food web in the Western North Pacific because of their large biomass (Hakamada in this meeting). The Second Phase of Japanese Whale Research Program in the Western North Pacific (JARPN II) conducted samplings of common minke, sei and Bryde's whales that abundantly occur off the coast of Japan and are important compartments of the ecosystem in their feeding grounds.

Although these three baleen whales occur in the JARPN II research area, their feeding habits and distribution differ. Minke whale feed on zooplankton to large sized fish such as Pacific saury, Japanese flying squid and mackerel, indicating wide range of prey size (Kasamatsu and Hata, 1985; Kasamatsu and Tanaka, 1992; Tamura and Fujise, 2002).

The sei whale is known to feed on a wide spectrum of marine animals such as krill, Japanese anchovy, chub mackerel, Pacific saury and Japanese common squid. According to Nemoto (1962), sei whales feed mainly copepods in the northern part of the North Pacific, but they likely feed on fishes and squids off the Pacific coast of northern Japan. In the southern Aleutian waters, Pacific saury was also reported as important prey for sei whales (Nemoto, 1959; Kawamura, 1982).

The information of feeding in Bryde's whales was available from commercial whaling period, showing krill, Japanese anchovy (*Engraulis japonicus*) and Chub mackerel (*Scomber japonicus*), Japanese sardine (*Sardinops melanostictus*), and horse mackerel (*Trachurus japonicus*) as prey.

The overall goal of the JARPN II was to contribute to the conservation and sustainable use of marine living resources including whales in the western North Pacific, especially within Japan's EEZ. This study examined the prey consumption of common minke, Bryde's, sei whales which contribute to the objectives in JARPN II, using up-dated whale abundance estimates obtained by JARPN II sighting survey.

Material and Methods

Research area, year and sample size

The research area of the JARPN II was a part of sub-areas 7, 8 and 9, which were established by the IWC/SC (IWC, 1994) (Fig. 1). The survey months, years and sample size in each sub-area are shown in Table 1. A total of 740 minke whales, 489 sei whales and 393 Bryde's whales were examined in this study (Table 1).

Sampling and treatment of stomach contents from whales

Baleen whales have four chambered stomach system (Hosokawa and Kamiya, 1971; Olsen *et al.*, 1994). The stomach contents remain in the forestomach (1st. stomach) and fundus (2nd. stomach). Therefore, this study was based on contents from forestomach and fundus.

In the JARPN II surveys, the stomach contents were removed on the ship's flensing deck after capture. Then, contents were weighed to the nearest 0.1 kg. A sub-sample (1-5 kg) of stomach contents was removed and frozen and/or fixed with 10 % formalin water for later analyses. The stomach contents were transferred to a system consisting of three sieves (20 mm, 5 mm and 1 mm), which were applied in the Norwegian scientific research to filter off liquid from the rest of the material (Haug *et al.* 1995). The sub-sample (3-4 kg) included all undigested fish skulls, free otoliths and squid beaks, which were kept frozen for later analyses in the laboratory.

Data analyses

Prey species identification and restoring stomach contents weight

In the laboratory prey species in the sub-samples were identified to the lowest taxonomic level as possible. Undigested preys were identified using morphological characteristic, copepods (Brodskii, 1950), euphausiacea (Baker *et al.*, 1990), squids (Kubodera and Furuhashi, 1987) and fish (Masuda *et al.*, 1988; Chihara *et al.*, 1997). The otoliths and jaw plate were used to identify the fish with advanced stage of digestion (Morrow, 1979; Ohe, 1984; Kubodera and Furuhashi, 1987; Arai, 1993).

When undigested fish and squid were found, fork length, mantle length and the weights were measured to the nearest 1 mm and 1 g, respectively. This data were used for restoring their stomach contents with advanced stage of digestion.

The total number of each fish and squid species in the sub-sample were calculated by adding to the number of undigested fish or squid, undigested skulls and half the total number of free otoliths. The total weight of each prey species in the sub-sample was estimated by multiplying the average weight of fresh specimens by the number of individuals. The total number and weight of each prey species in the stomach contents were estimated by using the figures obtained from the sub-sample and the total weight of stomach contents. The total weight of each zooplankton was estimated by using an assimilation efficiency of 84 % (Lockyer, 1981a).

Prey composition in each month and sub area

In order to simplify the comparison of feeding indices, prey species were divided into the following prey groups: copepods (*Neocalanus cristatus*, *N. plumchrus*, *Calanus* sp.), krill (*Euphausia pacifica*, *E. similes*, *E. gibboides*, *Thysanoessa gregaria*, *Nematoscelis difficilis*), Japanese flying squid (*Todarodes pacificus*), Japanese anchovy (*Engraulis japonicus*), Japanese sardine (*Sardinops melanostictus*), Pacific saury (*Cololabis saira*), walleye pollock (*Theragra chalcogramma*), Mackerels (*Scomber japonicus*, *S. australasicus*), Japanese pomfret (*Brama japonica*), Atka mackerel (*Pleurogrammus monopterygius*), oceanic lightfish (*Vinciguerrria nimbaria*), minimal armhook squid (*Berryteuthis anonychus*), Salmonidae, other squids and other fishes.

The relative prey composition (%) in weight of each prey species (*RW*) in each month and sub area was calculated as follows:

$$RW = (W_i / W_{all}) \times 100$$

W_i = the weight of contents containing prey group *i*

W_{all} = the total weight of contents analyzed.

Estimation of daily and seasonal prey consumption in each whale species

The daily consumption of each prey species (*D*) by different maturity stages of minke, sei and Bryde's whale were calculated from the following equations (Sigurjónsson and Víkingsson, 1997):

$$D = 206.25M^{0.783}; F = D/E$$

D : Daily prey consumption (kcal day⁻¹)

M: Mean body weight of whales (kg)

F : Daily prey consumption (kg day⁻¹)

E : Caloric value of prey species (kcal kg⁻¹)

The following assumptions were made for this method.

A: Mean body weight (*M*)

The mean body weight of 2,600 kg and 2,200 kg for immature male and female of minke whale were calculated, respectively. For mature male and female of minke whale were 4,900 kg and 6,500 kg, respectively. The mean body weight of 13,700 kg and 15,400 kg for immature male and female of sei whale were calculated, respectively. For mature male and female of sei whale were 19,900 kg and 24,800 kg, respectively. The mean body weight of 9,600 kg and 9,300 kg for immature male and female of Bryde's whale were calculated, respectively. For mature male and female of Bryde's whale were 15,500 kg and 17,800 kg, respectively. These weights were obtained from JARPN II survey data (Table 2).

B: Caloric value of prey species (*E*)

Stomach contents analyses show large variations in the diet of baleen whales in the western North Pacific

(Kasamatsu and Tanaka, 1992; Tamura *et al.*, 1998). In the North Atlantic, the energy contents of the prey species varies from 900 kcal kg⁻¹ when feeding on *Parathemisto* spp. to as high as 3,000 kcal kg⁻¹ when feeding on herring (Markussen *et al.*, 1992). In this study, the mean caloric value of copepods, krill, Japanese anchovy, Pacific saury, walleye pollock and Japanese flying squid were calculated using bomb calorimeter (Table 3).

C: Residence time in the western North Pacific (*D*)

It was assumed that the minke whales, sei whale and Bryde's whale spend about 150 days (research season) in the feeding areas in the western North Pacific. Lockyer (1981a) indicated that around 83% of the annual energy intake in southern Hemisphere baleenopterid species is ingested during the summer season, corresponding to approximately ten times higher feeding rates during feeding season of summer than non-feeding season of winter.

Based on this assumption, the average daily prey consumption during feeding season (*SF*) (From May to September), and during non-feeding season (*NF*) (From October to April) were made for the baleen whales by the following equations:

$$SF = 2.020 F$$

$$NF = 0.289 F$$

D: The total prey consumption during feeding period

The feeding period were divided up early period (May-June; 60days) and late period (July-September; 90days). The total prey consumption during feeding period per individual was estimated in each month and sub-area using the composition of prey species in JARPNII results.

E: The composition of maturity stages of whales

The composition of maturity stages of whales is shown in Table 4. Males of minke, Bryde's and sei whales were defined as sexually mature by testis weight (larger side) of more than 290g, 560g and 1,090g, respectively (Bando *et al.*, unpublished data). Female were defined as sexually mature by the occurrence of at least one corpus luteum or albicans in their ovaries. The rate of mature males in minke whales was higher in each season and sub area. For sei whales, the rate of mature males and females were higher. The rate of mature females in Bryde's whales was higher than other in each season and sub area.

F: The seasonal abundance of whales in each sexual maturity stage and area

Based on the abundance of whales in each area and season by Hakamada *et al.* (2009) and the above composition of maturity stages of whales (Table 4), the seasonal abundance of whales in each sexual maturity stage and area is shown in Table5.

Results

Diversity of prey species

Minke whales

A total of fourteen prey species, including 1 copepods, 2 euphausiids, 2 squids and 9 fishes were identified in the 740 stomachs of minke whales (Table 6).

Sei whales

A total of twelve prey species, including 3 copepods, 3 euphausiids, 1 squid and 5 fishes were identified in the 489 stomachs of sei whales (Table 6).

Bryde's whales

A total of eighteen prey species, including 5 euphausiids, 1 squid and 12 fishes were identified in the 393 stomachs of Bryde's whales (Table 6).

Composition of prey species

Minke whales

Most minke whales (88 %) had fed upon one single prey species at a time. Animal of 11 % had fed upon two species and only 0.6 had more than two prey species in the stomach (Table 7-1).

Sei whales

Most sei whales (90 %) had fed upon one single prey species at a time. Animal of 10 % had fed upon two species in the stomach (Table 7-2).

Bryde's whales

Most Bryde's (92 %) had fed upon one single prey species at a time. Animal of 8 % had fed upon two species in the stomach (Table 7-3).

Geographical and seasonal changes in dominant prey species

Minke whales

In sub-area 7, Japanese anchovy was the dominant prey species, composing 85.7 and 71.3 % of the total weight ingested in May and July (Table 8-1). In May and June, minke whales consumed Japanese anchovy in the middle part of the research area (38 N° – 40 N°)(Fig. 2-1), while in July and August, minke whales consumed this species in the middle and northern part of the research area (38N° – 42N°) (Fig. 2-1). In September, Pacific saury was the dominant prey species, composing 79.3 % of the total weight ingested around Hokkaido (Table 8-1, Fig. 2-1).

In sub-area 8, the same trend of sub-area 7, in early season (May and June), Japanese anchovy was the dominant prey species, composing 66.6 and 66.1 % of the total weight ingested, while in late season (from July and August), Pacific saury was the dominant prey species, composing 83.5 % and 92.4 % of the total weight ingested. In May and June, minke whales consumed Japanese anchovy in the middle part of the research area (36N° – 40N°)(Fig. 2-1), while in July and August, minke whales consumed this species and Pacific saury in the middle and northern part of the research area (40N° – 45 N°) (Fig. 2-1).

In sub-area 9, copepods and mackerels were the dominant prey species, composing 29.5 and 37.4 % of the total weight ingested in May and July (Table 8-1). Minke whales consumed these preys in the middle part of the research area (36N° – 40N°)(Fig. 2-1). From July to September, minke whales consumed Pacific saury in the middle and northern part of the research area (40N° – 48N°)(Fig. 2-1). In August, Minke whales fed on minimal armhook squid in the North eastern part of sub-area 9.

Sei whales

In sub-area 7, the samples were few numbers. Japanese anchovy was the dominant prey species, composing 100.0 % and 89.5 % of the total weight ingested in June and July (Table 8-2). Sei whales consumed Japanese anchovy in the middle part of the research area (36N° – 40N°)(Fig. 2-2).

In sub-area 8, in May, Mackerels and krill were the dominant prey species, composing 53.0 and 42.0 % of the total weight ingested. Sei whales consumed these preys in the southern part of research area (35 N ° – 40 N °) (Fig. 2-2). While from June to September, Japanese anchovy and krill were the dominant prey species. Sei whales consumed Japanese anchovy in the entire research area (35N° – 45N°)(Fig. 2-2).

In sub-area 9, in May, copepods and krill were the dominant prey species, composing 53.6 and 33.7 % of the total weight ingested. Sei whales consumed these preys in the southern part of research

area (35N° – 40N°)(Fig. 2-2). While from June to September, Japanese anchovy was the dominant prey species. Sei whales consumed Japanese anchovy in the middle and northern part of research area (38N° – 45N°)(Fig. 2-2).

Bryde's whales

In sub-area 7, Krill was the dominant prey species, composing 88.9 and 75.3 % of the total weight ingested in May and June (Table 8-3). Bryde's whales consumed krill in the southern and middle part of the research area (35N° – 40N°)(Fig. 2-3), while from July to September, Bryde's whales consumed this species in the middle part of the research area (38N° – 41N°) (Fig. 2-3).

In sub-area 8, in June, Krill, Mackerels and Japanese anchovy were the dominant prey species, composing 37.0 %, 32.9 % and 30.1 % of the total weight ingested, respectively (Table 8-3). Bryde's whales consumed krill in the southern part of the research area (35N° – 38N°)(Fig. 2-3), while from July to August, Japanese anchovy was the dominant prey species, composing 65.3 % and 100.0 % of the total weight ingested (Table 8-3). Bryde's whales consumed krill in the southern part of the research area (35N° – 38N°)(Fig. 2-3).

In sub-area 9, from June to September, Japanese anchovy was the dominant prey species, composing from 64.5 and 100.0 % of the total weight ingested (Table 8-3). Bryde's whales consumed these preys in the southern part of research area (35N° – 40N°). In August, Bryde's whales fed on oceanic lightfish in the South eastern part of Area 9 (Fig. 2-3).

Yearly changes in dominant prey species

Minke whales

In sub-area 7, the dominant prey was almost Japanese anchovy except 2005 season. In early and late seasons of 2005, krill was dominant prey. In sub-area 8, Japanese anchovy, krill and Pacific saury were dominant prey species in early seasons, though in late seasons, Pacific saury was dominant prey species. In sub-area 9, there is same situation of sub-area 8. Japanese anchovy, krill and Pacific saury were dominant prey species in early seasons, though in late seasons, Pacific saury was dominant prey species except 2000 and 2005 seasons. In late seasons of 2000 and 2005, Japanese anchovy was dominant prey (Figs. 3-1)

Sei whales

In sub-area 7, the dominant prey was Japanese anchovy except early season of 2003. In sub-area 8, the dominant prey was also Japanese anchovy except 2005 and 2007 season. In 2005, krill was dominant prey. In 2007, mackerels was dominant prey in early season, copepods was dominant prey in late season. In sub-area 9, Japanese anchovy and copepods were dominant prey species in early seasons, though in late seasons, Japanese anchovy was dominant prey species except 2002 and 2005 seasons. In late seasons of 2002 and 2005, krill was dominant prey (Figs. 3-2).

Bryde's whales

In sub-area 7, the dominant preys were krill and Japanese anchovy in early season, though in late seasons, Japanese anchovy was dominant prey species except 2003 seasons. In late seasons of 2003, krill was dominant prey. In sub-area 8, the dominant prey was krill in early season except 2004. In early seasons of 2004, mackerels were dominant prey. In late season, Japanese anchovy was dominant prey. In sub-area 9, the dominant prey was krill in early season except 2004. In early seasons of 2004, Japanese anchovy was dominant prey. In late season, Japanese anchovy was dominant prey except 2006 seasons. In late seasons of 2006, krill and oceanic light fish were dominant prey (Figs. 3-3).

The size distribution of three main fish sizes consumed by three baleen whales

Japanese anchovy

The size distributions of Japanese anchovy in the stomach of three baleen whales are shown in Fig. 4-1. Minke whale feed on most large sized anchovy, the fork length ranged from 54 to 155 mm with a single mode at 120-130 mm. The fork length of Japanese anchovy ingested by sei whales ranged from 24 to 143 mm with a single mode at 120 mm. The length of 120 mm of anchovy is mature size. Bryde's whale obviously feed on smaller size of anchovy than other whale's feeding. The fork length ranged from 20 to 153 mm with a single mode at 50-75 mm. The small size anchovy (B.L.<8cm) hatched in this year.

Pacific saury

The size distributions of Pacific saury in the stomach of three baleen whales are shown in Fig. 4-2. We didn't find Pacific saury from the stomach contents of Bryde's whale. We see two modal distributions (B.L: 200-230mm and 300 mm) in minke and sei whales, but minke whale fed on large sized saury.

Mackerels

The size distributions of mackerels in the stomach of three baleen whales are shown in Fig. 4-3. Minke whale fed on largest mackerels, the fork length ranged from 70 to 280 mm with a single mode at 240 mm. The small size mackerel fed by sei whale and Bryde's whales hatched in this year.

Daily and seasonal prey consumption by whales

Minke whales

The daily prey consumption weight of minke whales based on sexual maturity stage (IM, MM, IF and MF) were calculated to be 65-142 kg, 107-234 kg, 57-125 kg and 133-291 kg, respectively (Table 9-1).

The seasonal prey consumption of minke whales was calculated to be 130 thousands tons. The minke whales fed mainly on Japanese anchovy and Pacific saury. The consumption weight of these prey were 67 thousands tons and 28 thousands tons, respectively (Table 11).

Sei whales

The daily prey consumption weight of sei whales based on sexual maturity stage (IM, MM, IF and MF) were calculated to be 475-741 kg, 636-993 kg, 520-812 kg and 756-1,180 kg, respectively (Table 9-2).

The seasonal prey consumption of sei whales was calculated to be 813 thousands tons. The sei whales fed mainly on Japanese anchovy, copepods and krill. The consumption weight of these prey were 273 thousands tons, 269 thousands tons and 228 thousands tons, respectively (Table 11).

Bryde's whales

The daily prey consumption weight of Bryde's whales based on sexual maturity stage (IM, MM, IF and MF) were calculated to be 358-603 kg, 521-877 kg, 349-588 kg and 580-977 kg, respectively (Table 9-3).

The seasonal prey consumption of Bryde's whales was calculated to be 481 thousands tons. The Bryde's whales fed mainly on Japanese anchovy. The consumption weight of this prey was 400 thousands tons (Table 11).

The feeding impact of fisheries resources

Japanese anchovy

The consumption of Japanese anchovy by three baleen whales was estimated to be 739 thousands tons during May to September, equivalent to roughly 2.2 times the total estimated recent Japanese anchovy's catch in the western North Pacific. The biomass of this species is estimated 4.8 million tons. The consumption was equivalent to 15.4 % of their biomass.

Mackerels

The consumption of mackerels by three baleen whales was estimated to be 140 thousands tons during May to September, equivalent to roughly 33.3 % of the total estimated recent mackerel's catch in the western North Pacific. The biomass of this species is estimated 1.0 million tons. The consumption was equivalent to 13.9 % of their biomass.

Pacific saury

The consumption of Pacific saury by two baleen whales (minke and sei whales) was estimated to be 43 thousands tons during May to September, equivalent to roughly 10.6 % of the total estimated recent Pacific saury's catch in the western North Pacific. The biomass of this species is estimated 4.5 million tons. The consumption was equivalent to 1.0 % of their biomass.

Discussion

1. Prey species and feeding type

This study showed that the prey species of three baleen whale species in the western North Pacific during May and September from 2000 to 2007, included various pelagic species of zooplankton, squid and fishes. Prey species of three baleen whale species varied with both geographically and temporally. Minke whales in Northern Hemisphere consume various pelagic prey species of zooplankton, squid and fishes (Kasamatsu and Tanaka, 1992; Haug et al., 1995, 1996; Tamura, 1998; Tamura and Fujise, 2002). We confirmed that three baleen whale species in the western North Pacific are euryphagous, similar to those in Northeast Atlantic. Generally the baleen whales are grouped into two types on the feeding behaviour, that is, swallowing and skimming types (Nemoto, 1959). The former is the group of fin whales, blue whale and humpback whale and the latter is the group of right whale. This study showed most of stomach contents with fish were one single prey species, indicating the aggregation of fish is important factor for whale's feeding habits. Only a few whales had more than two prey species in each sub-area.

2. Geographical, seasonal changes and size difference of prey species

Our results showed that there was geographical and seasonal change of prey species.

In offshore area, minke whales fed on Japanese anchovy during May and June, and changed their prey to Pacific saury during July to September. For this reason, the finding position of minke whales fed on Pacific saury was rather north than whales fed on anchovy, so the movement of minke whale cause spatial overlap with Pacific saury. In the north east part of sub-area 9 over the Emperor Sea Mountains, minke whale abundantly fed on minimal armhook squid in August. This result suggested that the minke whale use the feeding area near Emperor Seamounts where the minimal armhook squid occur in summer (Konishi and Tamura, 2007).

Minke whale also adapted to coastal areas where large whales rarely occur. In sub-area 7, walleye pollock was one of the important prey species in early summer for minke whale in addition to Pacific saury and anchovy off northern Japan. For the size of fish in the stomachs, minke whales fed on large-sized walleye pollock over the continental break and slope around 200-300m water depth.

Sei whale fed on Japanese anchovy and copepods dominantly during survey season in most of years. However they mostly fed on mackerels in 2005 season, and this indicated that sei whale feed on most aggregated prey species near surface. At the off shore area under the effects of Kuroshio-current extension, the prey species fed by large baleen whales depend on what the current carry in early summer.

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 South eastern part of sub-area 9 in August, oceanic lightfish were also important prey species. Kawamura reported that this species was the dominant prey species of Bryde's whales in the North Pacific (Kawamura, 1980). This suggests that the Bryde's whale use the feeding area near Emperor Seamounts where the oceanic lightfish occur in summer.

For three baleen whale species, the most dominant prey species was Japanese anchovy in the JARPN II survey years. Japanese anchovy is distributed shallower than 30 m depth, where it feeds on copepods (Kondo, 1969). The anchovy are distributed widely in temperate waters of the western North Pacific. Japanese anchovy migrate to this research area to feed copepod from June through September (Kondo, 1969). Three baleen whale species probably feed on prey at the surface during their seasonal migration to the feeding area. Differences in the prey might reflect to local and seasonal changes in the relative abundance of these prey species in the research area.

Furthermore, our results showed that there was size difference of prey species. Common minke whale obviously fed on larger size of Japanese anchovy, Pacific saury and mackerels than other whale's feeding. The small size anchovy (B.L.<8cm) and mackerels (B.L.<25cm) hatched in this year. These fishes distributed the southern part of the research area. Differences in the prey size among the stomach contents of three baleen whales might reflect to geographical distribution of prey species in the research area.

3. Yearly change of prey species

Our results showed that there was yearly change of prey species.

For common minke whales, Tamura and Fujise (2001) noted that the Japanese anchovy was the most important prey species in May and June, while Pacific saury was the most important one in July and August in Offshore area. Our results was generally same, but in some seasons, another prey was dominant (*ex.* Krill in early season of 2005, Japanese anchovy in late season of 2000). Kasamatsu and Hata (1985) reported that Chub mackerel was the most important prey species of common minke whales in western Pacific (a northern part of sub-area 8) in August. However, in our surveys, the composition of mackerels was low. This result seems to reflected changes in the abundance of prey species in this area.

Nemoto (1959) reported that Bryde's whales fed on krill, Japanese anchovy and Chub mackerel in the Pacific coast of Japan. Our results were also same. In only some season, however, they fed mainly on mackerels and/or oceanic lightfish.

The sei whale is known to feed on a wide spectrum of marine animals such as krill, Japanese anchovy, chub mackerel, Pacific saury and Japanese flying squid. According to Nemoto (1959 and 1962) and Nemoto and Kawamura (1977), sei whales feed mainly copepods in the northern part of the North Pacific, but they likely feed on fishes and squids in the Sanriku and Hokkaido coastal waters of Japan. Our results were also same. In only some season, they fed mainly on mackerels and/or krill. The fluctuation of prey species of sei whales seems to reflect that sei whales are opportunistic feeders with a broad diet and with flexible feeding habits.

4. Daily and seasonal prey consumption by whales

Our estimates of the daily prey consumption was similar to by Nordøy et al. (1995), which investigated the eastern North Atlantic minke whales and these obtained by Lockyer (1981a,b), which investigated the large baleen whales.

In western North Pacific, the prey consumption of Japanese anchovy by three baleen whale species was 739 thousands tons during May to September. This value was equivalent to roughly 2.2 times the total estimated recent Japanese anchovy's catch in the western North Pacific. The biomass of this species is estimated 4.8 million tons. The consumption was equivalent to 15.4 % of their biomass.

Mackerels were important fish of commercial catch in the western North Pacific. The prey consumption of mackerels by three baleen whale species was 140 thousands tons during May to September. This value was equivalent to roughly 33.3 % of the total estimated recent mackerels catch in the western North Pacific. The biomass of this species is estimated 1.0 million tons. The consumption was equivalent to 13.9 % of their biomass.

The consumption of Pacific saury by two baleen whales (minke and sei whales) was estimated to be 43 thousands tons during May to September, equivalent to roughly 10.6 % of the total estimated recent Pacific saury's catch in the western North Pacific. The biomass of this species is estimated 4.5 million tons. The consumption was equivalent to 1.0 % of their biomass.

Our results show, consumption by three baleen whales should be taken into account for fishery management of these fishes in the future.

It was occurred to replacement from Japanese sardine to Japanese anchovy from 1980's in Pacific region of Japan. Kasamatsu and Tanaka (1992) examined annual changes of prey species based on the catch records of small type whaling in the seven whaling grounds off Japan from 1948 to 1987. In Pacific coast of Hokkaido (a part of sub-area 7W) from April to October, prey species recorded were krill, squid, Japanese sardine, Japanese anchovy, chub mackerel, walleye pollock, cod, sand lance, Pacific saury and so on. They noted that the change of prey of common minke whales from Chub mackerel to Japanese sardine in 1977 corresponded with a change of the dominant species taken by commercial fisheries in the same area in 1976. In addition, the change of prey species of common minke whales from chub mackerel to Japanese sardine in 1977, from Japanese sardine to Pacific saury in 1996 corresponded with a change of the dominant species taken by commercial fisheries in the same area in 1976, 1996, respectively (Tamura and Fujise, 2001).

Night or dawn sampling in order to determine how long food remained in the stomach is important for estimate night feeding behavior, however this resolution is not easy physically. The seasonal movements of whales that affects total consumption in restricted area is also important, and this information can be achieved by spatial modelling in Konishi *et al.* (2009).

To evaluate the interaction between whale and fisheries, long-term information of accurate abundance in prey species and each whale, and the accurate resident period of each whale are needed. Furthermore, there is a need to understand the potential for each whale to have an impact on commercial fisheries, either directly or indirectly using simulation models for specific geographical regions.

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Table 1. Sampling numbers of whales**Common minke whales (2000-2007)**

| Sub-area | Sampling number | | | | | Total |
|----------|-----------------|------|------|--------|-----------|-------|
| | May | June | July | August | September | |
| 7 | 16 | 155 | 49 | 15 | 88 | 323 |
| 8 | 30 | 59 | 37 | 7 | 1 | 134 |
| 9 | 11 | 28 | 86 | 152 | 6 | 283 |
| Total | 57 | 242 | 172 | 174 | 95 | 740 |

Sei whales (2002-2007)

| Sub-area | Sampling number | | | | | Total |
|----------|-----------------|------|------|--------|-----------|-------|
| | May | June | July | August | September | |
| 7 | 0 | 4 | 12 | 0 | 0 | 16 |
| 8 | 31 | 42 | 59 | 0 | 3 | 135 |
| 9 | 27 | 103 | 114 | 68 | 26 | 338 |
| Total | 58 | 149 | 185 | 68 | 29 | 489 |

Bryde's whales (2000-2007)

| Sub-area | Sampling number | | | | | Total |
|----------|-----------------|------|------|--------|-----------|-------|
| | May | June | July | August | September | |
| 7 | 7 | 59 | 60 | 39 | 19 | 184 |
| 8 | 0 | 34 | 39 | 36 | 0 | 109 |
| 9 | 0 | 46 | 33 | 15 | 6 | 100 |
| Total | 7 | 139 | 132 | 90 | 25 | 393 |

Table 2. Mean body weight in each sexual maturity of whales

| Whale species | Sexual maturity | Mean body weight (kg) |
|---------------|-----------------|-----------------------|
| Common minke | IM | 2,600 |
| | MM | 4,900 |
| | IF | 2,200 |
| | MF | 6,500 |
| Sei | IM | 13,700 |
| | MM | 19,900 |
| | IF | 15,400 |
| | MF | 24,800 |
| Bryde's | IM | 9,600 |
| | MM | 15,500 |
| | IF | 9,300 |
| | MF | 17,800 |
| Sperm | IM | 14,300 |
| | MM | 35,500 |
| | IF | 9,400 |
| | MF | 16,800 |

Table 3. Results of caloric value of dominant prey species in western North Pacific.

| Species | Size | Body length | Body weight | Energy Kcal/kg |
|--|-------|-------------|-------------|----------------|
| Copepoda (<i>Neocalanus cristatus</i>) | | | | 920 |
| Krill (<i>Euphausia pacifica</i>) | | | | 850 |
| Sand lance | | | | 1,840 |
| Japanese anchovy | | | | |
| | Small | 86 mm | 7 g | 1,320 |
| | Large | 125 mm | 18 g | 1,530 |
| Pacific saury | | | | |
| | Small | 158 mm | 16 g | 1,260 |
| | Large | 300 mm | 145 g | 3,140 |
| Walleye pollock | | 192 mm | 66 g | 1,490 |
| | | 430 mm | 624 g | 1,480 |
| Japanese flying squid | | 206 mm | 200 g | 1,580 |
| Deep-sea squid | | 6,700 mm | 6,930 g | 650 |

Table 4. Results of sexual maturity composition of whales in western North Pacific.**Common minke**

| Sex maturity | Sub-area 7 | | Sub-area 8 | | Sub-area 9 | |
|--------------|------------|------|------------|------|------------|------|
| | Early | Late | Early | Late | Early | Late |
| IM | 24.2 | 19.7 | 13.3 | 10.9 | 13.2 | 6.4 |
| MM | 64.0 | 61.4 | 75.9 | 80.4 | 73.7 | 86.8 |
| IF | 7.5 | 10.2 | 7.2 | 0.0 | 5.3 | 0.5 |
| MF | 4.3 | 8.7 | 3.6 | 8.7 | 7.9 | 6.4 |
| N | 186 | 127 | 83 | 46 | 38 | 220 |

Sei

| Sex maturity | Sub-area 7 | | Sub-area 8 | | Sub-area 9 | |
|--------------|------------|------|------------|------|------------|------|
| | Early | Late | Early | Late | Early | Late |
| IM | 25.0 | 16.7 | 15.1 | 10.3 | 15.4 | 14.6 |
| MM | 25.0 | 50.0 | 27.4 | 32.8 | 32.3 | 37.3 |
| IF | 50.0 | 8.3 | 8.2 | 13.8 | 14.6 | 13.7 |
| MF | 0.0 | 25.0 | 49.3 | 43.1 | 37.7 | 34.4 |
| N | 4 | 12 | 73 | 58 | 130 | 212 |

Bryde's

| Sex maturity | Sub-area 7 | | Sub-area 8 | | Sub-area 9 | |
|--------------|------------|------|------------|------|------------|------|
| | Early | Late | Early | Late | Early | Late |
| IM | 18.2 | 25.0 | 20.6 | 27.3 | 10.9 | 16.7 |
| MM | 9.1 | 26.7 | 20.6 | 24.7 | 23.9 | 16.7 |
| IF | 25.8 | 19.0 | 14.7 | 13.0 | 21.7 | 13.0 |
| MF | 47.0 | 29.3 | 44.1 | 35.1 | 43.5 | 53.7 |
| N | 66 | 116 | 34 | 77 | 46 | 54 |

Table 5. Results of abundance of whales in each sub-area.

| Species | Period | Sex maturity | Area 7 | Area 8 | Area 9 | Total |
|---------|--------|--------------|--------|--------|--------|-------|
| Minke | Early | IM | 1,026 | 102 | 211 | 1,338 |
| | | MM | 2,713 | 584 | 1,179 | 4,475 |
| | | IF | 319 | 56 | 84 | 459 |
| | | MF | 182 | 28 | 126 | 336 |
| | Late | IM | 112 | 25 | 305 | 441 |
| | | MM | 348 | 182 | 777 | 1,307 |
| | | IF | 58 | 0 | 285 | 343 |
| | | MF | 49 | 20 | 718 | 787 |
| Sei | Early | IM | 143 | 353 | 728 | 1,224 |
| | | MM | 143 | 641 | 1,530 | 2,314 |
| | | IF | 285 | 192 | 692 | 1,169 |
| | | MF | 0 | 1,154 | 1,785 | 2,939 |
| | Late | IM | 34 | 145 | 551 | 730 |
| | | MM | 103 | 459 | 1,403 | 1,964 |
| | | IF | 17 | 193 | 515 | 725 |
| | | MF | 51 | 603 | 1,296 | 1,951 |
| Bryde's | Early | IM | 125 | 110 | 37 | 272 |
| | | MM | 62 | 110 | 81 | 253 |
| | | IF | 177 | 79 | 73 | 329 |
| | | MF | 322 | 236 | 147 | 705 |
| | Late | IM | 659 | 796 | 632 | 2,087 |
| | | MM | 705 | 720 | 632 | 2,056 |
| | | IF | 500 | 379 | 491 | 1,370 |
| | | MF | 773 | 1,023 | 2,035 | 3,831 |

Table 6. Prey species of whales sampled in JARPN II.

Minke

| Species | | |
|-------------------|-------------------------------------|-----------------------|
| Main prey | | |
| Copepods | <i>Calanus</i> sp. | |
| Krill | <i>Euphausia pacifica</i> | |
| | <i>Thysanoessa gregaria</i> | |
| Pisces | <i>Engraulis japonicus</i> | Japanese anchovy |
| | <i>Cololabis saira</i> | Pacific saury |
| | <i>Scomber japonicus</i> | Chub mackerel |
| | <i>Theragra chalcogramma</i> | Walleye pollocke |
| | <i>Brama japonica</i> | Japanese pomfret |
| | <i>Oncorhynchus gorbusha</i> | Pink salmon |
| | <i>O. keta</i> | Chum salmon |
| | <i>Pleurogrammus monoptyerygius</i> | Atka mackerel |
| Squids | <i>Todarodes pacificus</i> | Japanese flying squid |
| | <i>Berryteuthis anonychus</i> | Minimal armhook squid |
| Miner prey | | |
| Pisces | <i>Paralepis atlantica</i> | Duckbill barracudina |

Sei

| species | | |
|-------------------|--------------------------------|-----------------------|
| Main prey | | |
| Copepods | <i>Neocalanus cristatus</i> | |
| | <i>N. plumchrus</i> | |
| | <i>Calanus</i> sp. | |
| Krill | <i>Euphausia pacifica</i> | |
| | <i>E. similis</i> | |
| | <i>Thysanoessa gregaria</i> | |
| Pisces | <i>Engraulis japonicus</i> | Japanese anchovy |
| | <i>Cololabis saira</i> | Pacific saury |
| | <i>Scomber japonicus</i> | Chub mackerel |
| | <i>S. australasicus</i> | Spotted mackerel |
| Miner prey | | |
| Pisces | <i>Sardinops melanostictus</i> | Japanese sardine |
| Squids | <i>Todarodes pacificus</i> | Japanese flying squid |

Bryde's

| species | | |
|-------------------|--------------------------------|-----------------------|
| Main prey | | |
| Krill | <i>Euphausia pacifica</i> | |
| | <i>E. similis</i> | |
| | <i>E. gibboides</i> | |
| | <i>Thysanoessa gregaria</i> | |
| | <i>Nematoscelis difficilis</i> | |
| Pisces | <i>Engraulis japonicus</i> | Japanese anchovy |
| | <i>Scomber japonicus</i> | Chub mackerel |
| | <i>S. australasicus</i> | Spotted mackerel |
| | <i>Vinciguerrria nimbaria</i> | Oceanic lightfish |
| | <i>Auxis rochei</i> | |
| Squids | <i>Todarodes pacificus</i> | Japanese flying squid |
| Miner prey | | |
| Pisces | <i>Arothron firmamentum</i> | Starry toado |
| | <i>Decapterus russelli</i> | Russell's scad |
| | <i>Diaphus theta</i> | Lantern fish |
| | <i>Tarletonbeania taylori</i> | Lantern fish |
| | <i>Starry toado</i> | Arothron firmamentum |
| | <i>Nemichthys scolopaceus</i> | Snipe eel |
| | <i>Lestidiops jayakari</i> | |

Table 7-1. Prey composition of common minke whales sampled in JARPN II.

| Number of prey species | Prey species | 7 | | 8 | | 9 | | Total | | |
|--|--|---|-------------|-------------|-------------|-------------|-------------|------------|-------------|-------------|
| | | N | % | N | % | N | % | N | % | |
| 1 | Copepoda | 0 | 0.0 | 0 | 0.0 | 5 | 2.1 | 5 | 0.8 | |
| | Krill | 38 | 14.1 | 12 | 11.2 | 7 | 2.9 | 57 | 9.2 | |
| | Japanese anchovy | 162 | 60.0 | 40 | 37.4 | 30 | 12.3 | 232 | 37.4 | |
| | Pacific saury | 13 | 4.8 | 39 | 36.4 | 157 | 64.6 | 209 | 33.7 | |
| | Walleye pollock | 21 | 7.8 | 0 | 0.0 | 0 | 0.0 | 21 | 3.4 | |
| | Japanese flying squid | 3 | 1.1 | 0 | 0.0 | 0 | 0.0 | 3 | 0.5 | |
| | Minimal armhook squid | 0 | 0.0 | 0 | 0.0 | 12 | 4.9 | 12 | 1.9 | |
| | Japanese pomfret | 0 | 0.0 | 0 | 0.0 | 2 | 0.8 | 2 | 0.3 | |
| | Atka mackerel | 0 | 0.0 | 0 | 0.0 | 1 | 0.4 | 1 | 0.2 | |
| | Chub mackerel | 1 | 0.4 | 3 | 2.8 | 2 | 0.8 | 6 | 1.0 | |
| | Total | 238 | 88.1 | 94 | 87.9 | 216 | 88.9 | 548 | 88.4 | |
| 2 | Copepoda+Pacific saury | 0 | 0.0 | 0 | 0.0 | 1 | 0.4 | 1 | 0.2 | |
| | Krill+Japanese anchovy | 3 | 1.1 | 0 | 0.0 | 1 | 0.4 | 4 | 0.6 | |
| | Krill+Pacific saury | 2 | 0.7 | 0 | 0.0 | 3 | 1.2 | 5 | 0.8 | |
| | Krill+Japanese flying squid | 1 | 0.4 | 0 | 0.0 | 0 | 0.0 | 1 | 0.2 | |
| | Krill+Barracudas | 0 | 0.0 | 0 | 0.0 | 1 | 0.4 | 1 | 0.2 | |
| | Japanese anchovy+Krill | 4 | 1.5 | 0 | 0.0 | 0 | 0.0 | 4 | 0.6 | |
| | Japanese anchovy+Pacific saury | 1 | 0.4 | 2 | 1.9 | 3 | 1.2 | 6 | 1.0 | |
| | Japanese anchovy+mackerels | 0 | 0.0 | 0 | 0.0 | 1 | 0.4 | 1 | 0.2 | |
| | Japanese anchovy+Walleye pollock | 4 | 1.5 | 0 | 0.0 | 0 | 0.0 | 4 | 0.6 | |
| | Japanese anchovy+Japanese flying squid | 1 | 0.4 | 0 | 0.0 | 0 | 0.0 | 1 | 0.2 | |
| | Japanese anchovy+Pink salmon | 0 | 0.0 | 1 | 0.9 | 0 | 0.0 | 1 | 0.2 | |
| | Pacific saury+Copepoda | 0 | 0.0 | 0 | 0.0 | 1 | 0.4 | 1 | 0.2 | |
| | Pacific saury+Krill | 1 | 0.4 | 4 | 3.7 | 4 | 1.6 | 9 | 1.5 | |
| | Pacific saury+Japanese anchovy | 2 | 0.7 | 2 | 1.9 | 2 | 0.8 | 6 | 1.0 | |
| | Pacific saury+Japanese flying squid | 2 | 0.7 | 2 | 1.9 | 0 | 0.0 | 4 | 0.6 | |
| | Pacific saury+Minimal armhook squid | 0 | 0.0 | 0 | 0.0 | 1 | 0.4 | 1 | 0.2 | |
| | Pacific saury+Japanese pomfret | 0 | 0.0 | 0 | 0.0 | 1 | 0.4 | 1 | 0.2 | |
| | Pacific saury+Walleye pollock | 0 | 0.0 | 0 | 0.0 | 1 | 0.4 | 1 | 0.2 | |
| | Pacific saury+Chum salmon | 0 | 0.0 | 0 | 0.0 | 2 | 0.8 | 2 | 0.3 | |
| | Pacific saury+Other squid | 0 | 0.0 | 1 | 0.9 | 0 | 0.0 | 1 | 0.2 | |
| | Japanese flying squid+Japanese anchovy | 2 | 0.7 | 0 | 0.0 | 0 | 0.0 | 2 | 0.3 | |
| | Japanese flying squid+Pacific saury | 2 | 0.7 | 1 | 0.9 | 0 | 0.0 | 3 | 0.5 | |
| | Japanese flying squid+Walleye pollock | 1 | 0.4 | 0 | 0.0 | 0 | 0.0 | 1 | 0.2 | |
| | Minimal armhook squid+Pacific saury | 0 | 0.0 | 0 | 0.0 | 1 | 0.4 | 1 | 0.2 | |
| | Walleye pollock+Krill | 3 | 1.1 | 0 | 0.0 | 0 | 0.0 | 3 | 0.5 | |
| | Walleye pollock+Japanese anchovy | 2 | 0.7 | 0 | 0.0 | 0 | 0.0 | 2 | 0.3 | |
| | Walleye pollock+Pacific saury | 1 | 0.4 | 0 | 0.0 | 0 | 0.0 | 1 | 0.2 | |
| | | Total | 32 | 11.9 | 13 | 12.1 | 23 | 9.5 | 68 | 11.0 |
| | 3 | Krill+Pacific saury+Barracudas | 0 | 0.0 | 0 | 0.0 | 1 | 0.4 | 1 | 0.2 |
| | | Japanese pomfret+Pacific saury+Japanese anchovy | 0 | 0.0 | 0 | 0.0 | 1 | 0.4 | 1 | 0.2 |
| Chum salmon+Japanese pomfret+Pacific saury | | 0 | 0.0 | 0 | 0.0 | 1 | 0.4 | 1 | 0.2 | |
| Pacific saury+Japanese pomfret+Minimal armhook squid | | 0 | 0.0 | 0 | 0.0 | 1 | 0.4 | 1 | 0.2 | |
| | Total | 0 | 0.0 | 0 | 0.0 | 4 | 1.6 | 4 | 0.6 | |
| No. whales Observed | | 270 | | 107 | | 243 | | 620 | | |

Table 7-2. Prey composition of sei whales sampled in JARPN II.

| Number of prey species | Prey species | 7 | | 8 | | 9 | | Total | |
|---------------------------|-----------------------------------|----|------|----|------|-----|------|-------|------|
| | | N | % | N | % | N | % | N | % |
| 1 | Copepoda | 2 | 15.4 | 5 | 5.6 | 118 | 46.3 | 125 | 35.0 |
| | Krill | 1 | 7.7 | 32 | 36.0 | 33 | 12.9 | 66 | 18.5 |
| | Japanese anchovy | 8 | 61.5 | 37 | 41.6 | 48 | 18.8 | 93 | 26.1 |
| | Pacific saury | 0 | 0.0 | 0 | 0.0 | 20 | 7.8 | 20 | 5.6 |
| | Mackerels | 0 | 0.0 | 11 | 12.4 | 6 | 2.4 | 17 | 4.8 |
| | Total | 11 | 84.6 | 85 | 95.5 | 225 | 88.2 | 321 | 89.9 |
| 2 | Copepoda+Krill | 1 | 7.7 | 0 | 0.0 | 1 | 0.4 | 2 | 0.6 |
| | Copepoda+Pacific saury | 1 | 7.7 | 1 | 1.1 | 7 | 2.7 | 9 | 2.5 |
| | Copepoda+Japanese anchovy | 0 | 0.0 | 0 | 0.0 | 4 | 1.6 | 4 | 1.1 |
| | Krill+Copepoda | 0 | 0.0 | 0 | 0.0 | 2 | 0.8 | 2 | 0.6 |
| | Krill+Japanese anchovy | 0 | 0.0 | 1 | 1.1 | 1 | 0.4 | 2 | 0.6 |
| | Krill+Pacific saury | 0 | 0.0 | 0 | 0.0 | 1 | 0.4 | 1 | 0.3 |
| | Krill+Japanese flyong squid | 0 | 0.0 | 0 | 0.0 | 2 | 0.8 | 2 | 0.6 |
| | Japanese anchovy+Japanese sardine | 0 | 0.0 | 0 | 0.0 | 1 | 0.4 | 1 | 0.3 |
| | Japanese anchovy+mackerels | 0 | 0.0 | 1 | 1.1 | 5 | 2.0 | 6 | 1.7 |
| | Pacific saury+Copepoda | 0 | 0.0 | 0 | 0.0 | 1 | 0.4 | 1 | 0.3 |
| | Pacific saury+Krill | 0 | 0.0 | 1 | 1.1 | 2 | 0.8 | 3 | 0.8 |
| | Pacific saury+Japanese anchovy | 0 | 0.0 | 0 | 0.0 | 1 | 0.4 | 1 | 0.3 |
| | Pacific saury+mackerels | 0 | 0.0 | 0 | 0.0 | 1 | 0.4 | 1 | 0.3 |
| | Mackerels+Copepoda | 0 | 0.0 | 0 | 0.0 | 1 | 0.4 | 1 | 0.3 |
| | Total | 2 | 15.4 | 4 | 4.5 | 30 | 11.8 | 34 | 10.1 |
| No. whales Observed | | 13 | | 89 | | 255 | | | |

Table 7-3. Prey composition of Bryde's whales sampled in JARPN II.

| Number of prey species | Prey species | 7 | | 8 | | 9 | | Total | |
|---------------------------|--|-----|------|----|------|----|------|-------|------|
| | | N | % | N | % | N | % | N | % |
| 1 | Krill | 73 | 43.2 | 14 | 26.9 | 16 | 24.2 | 103 | 35.9 |
| | Japanese anchovy | 89 | 52.7 | 30 | 57.7 | 30 | 45.5 | 149 | 51.9 |
| | Mackerels | 1 | 0.6 | 4 | 7.7 | 0 | 0.0 | 5 | 1.7 |
| | Oceanic lightfish | 0 | 0.0 | 0 | 0.0 | 8 | 12.1 | 8 | 2.8 |
| | Total | 163 | 96.4 | 48 | 92.3 | 54 | 81.8 | 265 | 92.3 |
| 2 | Krill+Oceanic lightfish | 0 | 0.0 | 0 | 0.0 | 1 | 1.5 | 1 | 0.3 |
| | Japanese anchovy+Krill | 5 | 3.0 | 2 | 3.8 | 1 | 1.5 | 8 | 2.8 |
| | Japanese anchovy+mackerels | 0 | 0.0 | 1 | 1.9 | 8 | 12.1 | 9 | 3.1 |
| | Mackerels+Krill | 1 | 0.6 | 0 | 0.0 | 0 | 0.0 | 1 | 0.3 |
| | Mackerels+Japanese anchovy | 0 | 0.0 | 0 | 0.0 | 2 | 3.0 | 2 | 0.7 |
| | Japanese flying squid+Japanese anchovy | 0 | 0.0 | 1 | 1.9 | 0 | 0.0 | 1 | 0.3 |
| | Total | 6 | 3.6 | 4 | 7.7 | 12 | 18.2 | 22 | 7.7 |
| No. whales Observed | | 169 | | 52 | | 66 | | 287 | |

Table 8-1. Prey composition (% of weight) and stomach contents weight (average \pm S.D.) of common minke whales sampled in each sub-area.

Sub-area 7

| Number | May N=52 | | | June N=47 | | | July N=15 | | | August N=3 | | | September N=31 | | |
|-----------------------|-------------|---------------|-------------------|--------------|---------------|---------------------|--------------|---------------|-------------------|---------------|---------------|------------------|-------------------|---------------|-------------------|
| | Broken | | | Broken | | | Broken | | | Broken | | | Broken | | |
| | Empty | 8 2 (3.8%) | | Empty | 5 1 (2.1%) | | Empty | 2 0 (0.0%) | | Empty | 0 0 (0.0%) | | Empty | 5 1 (3.2%) | |
| Species | N | W% | kg \pm S.D | N | W% | kg \pm S.D | N | W% | kg \pm S.D | N | W% | kg \pm S.D | N | W% | kg \pm S.D |
| Copepods | - | - | - | - | - | - | 1 | 0.01 | 0.01 | - | - | - | - | - | - |
| Krill | 4 | 14.3 | 47.98 \pm 76.92 | 15 | 16.7 | 28.58 \pm 30.93 | - | - | - | 1 | 59.7 | 29.85 | 4 | 1.9 | 4.70 \pm 1.31 |
| Anchovy | 40 | 85.7 | 30.15 \pm 32.49 | 26 | 24.4 | 24.15 \pm 21.36 | 7 | 71.3 | 16.78 \pm 18.51 | - | - | - | 9 | 12.5 | 13.89 \pm 13.61 |
| B.L < 80 mm | - | - | 0.0% | - | - | 0.0% | - | - | 0.0% | - | - | - | - | - | 2.8% |
| B.L > 80 mm | - | - | 100.0% | - | - | 100.0% | - | - | 100.0% | - | - | - | - | - | 97.2% |
| Saury | - | - | - | - | - | - | 1 | 0.05 | 0.08 | 2 | 39.4 | 9.85 \pm 12.34 | 17 | 79.3 | 46.61 \pm 70.15 |
| Mackerels | - | - | - | - | - | - | 1 | 18.4 | 30.3 | - | - | - | - | - | - |
| Walleye pollock | - | - | - | 7 | 58.9 | 216.60 \pm 521.70 | 5 | 10.3 | 3.39 \pm 4.04 | - | - | - | - | - | - |
| Japanese flying squid | - | - | - | - | - | - | - | - | - | - | - | - | 5 | 6.3 | 12.65 \pm 8.89 |
| Sardine | 1 | 0.01 | 0.09 | - | - | - | 1 | 0.01 | 0.02 | - | - | - | 1 | 0.02 | 0.18 |
| Other fish | - | - | - | - | - | - | - | - | - | 1 | 0.9 | 0.44 | - | - | - |

Sub-area 8

| Number | May N=30 | | | June N=59 | | | July N=37 | | | August N=7 | | | September N=1 | | |
|-----------------------|-------------|----------------|-------------------|--------------|---------------|-------------------|--------------|---------------|-------------------|---------------|---------------|-------------------|------------------|---------------|--------------|
| | Broken | | | Broken | | | Broken | | | Broken | | | Broken | | |
| | Empty | 4 5 (16.7%) | | Empty | 7 0 (0.0%) | | Empty | 6 1 (3.2%) | | Empty | 1 0 (0.0%) | | Empty | 1 0 (0.0%) | |
| Species | N | W% | kg \pm S.D | N | W% | kg \pm S.D | N | W% | kg \pm S.D | N | W% | kg \pm S.D | N | W% | kg \pm S.D |
| Copepods | - | - | - | 1 | 0.3 | 2.26 | - | - | - | - | - | - | - | - | - |
| Krill | 7 | 24.9 | 8.57 \pm 11.15 | 4 | 0.6 | 1.26 \pm 1.26 | 4 | 2.2 | 3.96 \pm 1.61 | - | - | - | - | - | - |
| Anchovy | 14 | 66.6 | 11.89 \pm 19.30 | 29 | 66.1 | 18.59 \pm 25.19 | 5 | 12.8 | 18.94 \pm 13.69 | - | - | - | - | - | - |
| B.L < 80 mm | - | - | 0.0% | - | - | 0.0% | - | - | 0.0% | - | - | - | - | - | - |
| B.L > 80 mm | - | - | 100.0% | - | - | 100.0% | - | - | 100.0% | - | - | - | - | - | - |
| Saury | 2 | 1.3 | 1.59 \pm 0.99 | 23 | 32.8 | 11.65 \pm 12.30 | 25 | 83.5 | 24.68 \pm 19.60 | 6 | 92.4 | 36.69 \pm 38.34 | - | - | - |
| Mackerels | 1 | 5.4 | 12.93 | 2 | 0.1 | 0.32 \pm 0.42 | - | - | - | - | - | - | - | - | - |
| Japanese flying squid | - | - | - | - | - | - | 1 | 1.3 | 9.70 | 2 | 7.6 | 9.08 \pm 6.78 | - | - | - |
| Sardine | - | - | - | 1 | 0.01 | 0.04 | - | - | - | - | - | - | - | - | - |
| Salmonids | 1 | 1.9 | 4.49 | - | - | - | - | - | - | - | - | - | - | - | - |
| Other fish | - | - | - | - | - | - | 1 | 0.2 | 1.32 | - | - | - | - | - | - |
| Other squid | - | - | - | 1 | 0.1 | 1.06 | - | - | - | - | - | - | - | - | - |

Sub-area 9

| Number | May N=11 | | | June N=28 | | | July N=86 | | | August N=152 | | | September N=6 | | |
|-----------------------|-------------|---------------|-----------------|--------------|----------------|-------------------|--------------|---------------|-------------------|-----------------|----------------|-------------------|------------------|---------------|-------------------|
| | Broken | | | Broken | | | Broken | | | Broken | | | Broken | | |
| | Empty | 0 1 (9.1%) | | Empty | 1 4 (14.3%) | | Empty | 9 0 (0.0%) | | Empty | 24 0 (0.0%) | | Empty | 0 0 (0.0%) | |
| Species | N | W% | kg \pm S.D | N | W% | kg \pm S.D | N | W% | kg \pm S.D | N | W% | kg \pm S.D | N | W% | kg \pm S.D |
| Copepods | 2 | 29.5 | 1.01 \pm 1.38 | 1 | 6.8 | 42.68 | - | - | - | - | - | - | - | - | - |
| Krill | 3 | 7.7 | 2.58 \pm 2.32 | 2 | 2.3 | 7.17 \pm 10.10 | 13 | 10.5 | 18.15 \pm 20.75 | 6 | 0.8 | 5.69 \pm 4.80 | - | - | - |
| Anchovy | - | - | - | 6 | 31.0 | 32.59 \pm 57.66 | 2 | 0.4 | 4.72 \pm 6.57 | 33 | 24.9 | 33.62 \pm 58.14 | 1 | 8.5 | 19.37 |
| B.L < 80 mm | - | - | - | - | - | 0.0% | - | - | - | - | - | 5.4% | - | - | - |
| B.L > 80 mm | - | - | - | - | - | 100.0% | - | - | - | - | - | 94.6% | - | - | - |
| Saury | 2 | 18.6 | 2.44 \pm 0.55 | 17 | 59.9 | 22.22 \pm 25.96 | 72 | 85.1 | 26.46 \pm 26.74 | 94 | 56.8 | 27.00 \pm 27.08 | 5 | 91.5 | 41.73 \pm 47.54 |
| Mackerels | 1 | 37.4 | 9.82 | - | - | - | - | - | - | 5 | 0.2 | 1.90 \pm 3.53 | - | - | - |
| Walleye pollock | - | - | - | - | - | - | 1 | 0.1 | 1.68 | 1 | 0.01 | 0.40 | - | - | - |
| Japanese flying squid | - | - | - | - | - | - | - | - | - | 1 | 0.002 | 0.10 | - | - | - |
| Sardine | - | - | - | - | - | - | - | - | - | 1 | 0.001 | 0.02 | - | - | - |
| Pacific pomfret | - | - | - | - | - | - | 3 | 3.7 | 27.69 \pm 8.43 | 3 | 0.4 | 5.87 \pm 7.11 | - | - | - |
| Salmonids | 1 | 5.6 | 1.47 | - | - | - | - | - | - | 2 | 0.5 | 10.35 \pm 7.91 | - | - | - |
| Min. armed squi | - | - | - | - | - | - | - | - | - | 16 | 15.6 | 43.41 \pm 27.87 | - | - | - |
| Attka mackerel | - | - | - | - | - | - | - | - | - | 1 | 0.8 | 36.30 | - | - | - |
| Other fish | 2 | 1.3 | 0.17 \pm 0.08 | - | - | - | 5 | 0.2 | 0.92 \pm 1.00 | 1 | 0.1 | 3.97 | - | - | - |

Table 8-2. Prey composition (% of weight) and stomach contents weight (average \pm S.D.) of sei whales sampled in each sub-area.

Sub-area 7

| Number | May | | | June | | | July | | | August | | | September | | |
|-------------|--------|----------|--------------|--------|-----------|---------------------|--------|-----------|---------------------|--------|----------|--------------|-----------|----------|--------------|
| | N=0 | | | N=4 | | | N=12 | | | N=0 | | | N=0 | | |
| | Broken | 0 | | Broken | 0 | | Broken | 0 | | Broken | 0 | | Broken | 0 | |
| | Empty | 0 (0.0%) | | Empty | 1 (25.0%) | | Empty | 4 (33.3%) | | Empty | 0 (0.0%) | | Empty | 0 (0.0%) | |
| Species | N | W% | kg \pm S.D | N | W% | kg \pm S.D | N | W% | kg \pm S.D | N | W% | kg \pm S.D | N | W% | kg \pm S.D |
| Copepods | - | - | - | - | - | - | 3 | 9.7 | 18.32 \pm 13.32 | - | - | - | - | - | - |
| Anchovy | - | - | - | 3 | 99.99 | 332.32 \pm 250.94 | 5 | 89.5 | 101.77 \pm 211.55 | - | - | - | - | - | - |
| B.L < 80 mm | - | - | - | - | - | 99.0% | - | - | 100.0% | - | - | - | - | - | - |
| B.L > 80 mm | - | - | - | - | - | 1.0% | - | - | 0.0% | - | - | - | - | - | - |
| Sardine | - | - | - | 1 | 0.01 | 0.03 | - | - | - | - | - | - | - | - | - |
| Saury | - | - | - | - | - | - | 2 | 0.8 | 2.34 \pm 1.07 | - | - | - | - | - | - |
| Mackerels | - | - | - | 1 | 0.003 | 0.10 | - | - | - | - | - | - | - | - | - |

Sub-area 8

| Number | May | | | June | | | July | | | August | | | September | | |
|-----------------------|--------|-----------|---------------------|--------|------------|---------------------|--------|------------|---------------------|--------|----------|--------------|-----------|-----------|---------------------|
| | N=31 | | | N=42 | | | N=59 | | | N=0 | | | N=3 | | |
| | Broken | 2 | | Broken | 0 | | Broken | 3 | | Broken | 0 | | Broken | 0 | |
| | Empty | 5 (17.2%) | | Empty | 11 (26.2%) | | Empty | 18 (30.5%) | | Empty | 0 (0.0%) | | Empty | 1 (33.3%) | |
| Species | N | W% | kg \pm S.D | N | W% | kg \pm S.D | N | W% | kg \pm S.D | N | W% | kg \pm S.D | N | W% | kg \pm S.D |
| Copepods | 1 | 0.1 | 3.79 | 4 | 2.1 | 16.37 \pm 14.96 | 2 | 2.8 | 65.82 \pm 12.00 | - | - | - | - | - | - |
| Krill | 9 | 42.0 | 226.78 \pm 160.27 | 8 | 25.1 | 96.17 \pm 163.96 | 20 | 53.3 | 125.72 \pm 136.51 | - | - | - | - | - | - |
| Anchovy | 4 | 4.8 | 58.61 \pm 115.27 | 19 | 70.1 | 113.14 \pm 115.10 | 15 | 43.2 | 135.86 \pm 158.30 | - | - | - | 2 | 100.0 | 398.40 \pm 562.55 |
| B.L < 80 mm | - | - | - | - | - | 23.5% | - | - | 0.0% | - | - | - | - | - | 4.0% |
| B.L > 80 mm | - | - | - | - | - | 76.5% | - | - | 100.0% | - | - | - | - | - | 96.0% |
| Saury | 1 | 0.1 | 2.44 | 2 | 0.8 | 12.27 \pm 15.83 | 3 | 0.7 | 11.34 \pm 19.33 | - | - | - | - | - | - |
| Mackerels | 12 | 53.0 | 216.00 \pm 201.59 | 1 | 1.9 | 56.91 | - | - | - | - | - | - | - | - | - |
| Japanese flying squid | - | - | - | - | - | - | 1 | 0.01 | 0.46 | - | - | - | - | - | - |

Sub-area 9

| Number | May | | | June | | | July | | | August | | | September | | |
|-----------------------|--------|------------|--------------------|--------|------------|---------------------|--------|------------|---------------------|--------|-----------|---------------------|-----------|------------|-----------------|
| | N=27 | | | N=103 | | | N=110 | | | N=68 | | | N=26 | | |
| | Broken | 1 | | Broken | 8 | | Broken | 7 | | Broken | 6 | | Broken | 1 | |
| | Empty | 11 (42.3%) | | Empty | 22 (21.4%) | | Empty | 19 (17.3%) | | Empty | 7 (10.3%) | | Empty | 19 (76.0%) | |
| Species | N | W% | kg \pm S.D | N | W% | kg \pm S.D | N | W% | kg \pm S.D | N | W% | kg \pm S.D | N | W% | kg \pm S.D |
| Copepods | 11 | 53.6 | 73.41 \pm 68.02 | 51 | 30.8 | 63.97 \pm 97.05 | 35 | 16.7 | 35.54 \pm 81.29 | 24 | 11.4 | 22.17 \pm 26.18 | 5 | 69.7 | 4.30 \pm 3.58 |
| Krill | 2 | 33.7 | 253.78 \pm 49.02 | 8 | 6.8 | 89.75 \pm 104.42 | 20 | 30.1 | 112.36 \pm 155.37 | 8 | 11.8 | 69.10 \pm 106.32 | - | - | - |
| Anchovy | 3 | 4.9 | 24.72 \pm 42.72 | 12 | 58.7 | 518.08 \pm 811.70 | 24 | 44.5 | 138.48 \pm 240.82 | 14 | 62.0 | 207.45 \pm 257.19 | 1 | 1.3 | 0.39 |
| B.L < 80 mm | - | - | - | - | - | - | - | - | 9.3% | - | - | 0.1% | - | - | - |
| B.L > 80 mm | - | - | - | - | - | - | - | - | 90.7% | - | - | 99.9% | - | - | - |
| Sardine | - | - | - | - | - | - | - | - | - | 1 | 1.1 | 53.05 | - | - | - |
| Saury | 1 | 0.1 | 1.24 | 8 | 2.9 | 38.12 \pm 57.33 | 13 | 2.9 | 16.66 \pm 22.03 | 16 | 13.7 | 40.11 \pm 70.95 | - | - | - |
| Mackerels | 3 | 7.7 | 38.53 \pm 34.71 | 2 | 0.6 | 31.99 \pm 45.19 | 7 | 5.4 | 57.42 \pm 110.16 | - | - | - | 1 | 29.0 | 8.95 |
| Japanese flying squid | - | - | - | 1 | 0.3 | 27.38 | 1 | 0.5 | 34.95 | - | - | - | - | - | - |

Table 8-3. Prey composition (% of weight) and stomach contents weight (average \pm S.D.) of Bryde's whales sampled in each sub-area.

Sub-area 7

| Number | May | | | June | | | July | | | August | | | September | | |
|-----------------|----------|------|-------------------|----------|-------|--------------------|----------|-------|---------------------|----------|-------|---------------------|-----------|-------|---------------------|
| | N=7 | | | N=59 | | | N=60 | | | N=39 | | | N=19 | | |
| | Broken 0 | | | Broken 0 | | | Broken 5 | | | Broken 2 | | | Broken 2 | | |
| Empty 2 (28.6%) | | | Empty 18 (30.5%) | | | Empty 19 (34.5%) | | | Empty 11 (28.2%) | | | Empty 8 (42.1%) | | | |
| Species | N | W% | kg \pm S.D | N | W% | kg \pm S.D | N | W% | kg \pm S.D | N | W% | kg \pm S.D | N | W% | kg \pm S.D |
| Krill | 4 | 88.9 | 86.10 \pm 92.87 | 33 | 75.3 | 83.09 \pm 97.20 | 18 | 35.0 | 70.18 \pm 105.42 | 3 | 6.5 | 95.39 \pm 77.95 | 2 | 5.6 | 89.50 \pm 52.56 |
| Anchovy | 1 | 11.1 | 43.09 | 7 | 22.0 | 121.24 \pm 91.41 | 20 | 61.6 | 111.07 \pm 233.85 | 17 | 93.5 | 313.77 \pm 285.15 | 6 | 94.4 | 379.30 \pm 312.28 |
| B.L < 80 mm | | | | | 77.4% | | | 55.6% | | | 45.1% | | | 90.8% | |
| B.L > 80 mm | | | | | 22.6% | | | 44.4% | | | 54.9% | | | 9.3% | |
| Mackerel | - | - | - | 1 | 2.8 | 107.15 | 1 | 3.4 | 123.19 | - | - | - | - | - | - |

Sub-area 8

| Number | May | | | June | | | July | | | August | | | September | | |
|-----------------------|----------|----|------------------|----------|-------|---------------------|----------|-------|-------------------|----------|-------|---------------------|-----------|----|--------------|
| | N=0 | | | N=34 | | | N=39 | | | N=36 | | | N=0 | | |
| | Broken 0 | | | Broken 1 | | | Broken 0 | | | Broken 1 | | | Broken 0 | | |
| Empty 0 (0.0%) | | | Empty 14 (42.4%) | | | Empty 11 (28.2%) | | | Empty 5 (14.3%) | | | Empty 0 (0.0%) | | | |
| Species | N | W% | kg \pm S.D | N | W% | kg \pm S.D | N | W% | kg \pm S.D | N | W% | kg \pm S.D | N | W% | kg \pm S.D |
| Krill | - | - | - | 9 | 37.0 | 53.56 \pm 65.75 | 5 | 34.6 | 96.10 \pm 86.20 | - | - | - | - | - | - |
| Anchovy | - | - | - | 10 | 30.1 | 39.20 \pm 76.61 | 23 | 65.3 | 39.45 \pm 64.52 | 30 | 100.0 | 187.92 \pm 238.26 | - | - | - |
| B.L < 80 mm | | | | | 95.6% | | | 71.8% | | | 53.0% | | | | |
| B.L > 80 mm | | | | | 4.4% | | | 28.2% | | | 47.0% | | | | |
| Mackerel | - | - | - | 3 | 32.9 | 142.61 \pm 158.56 | 1 | 0.1 | 1.13 | - | - | - | - | - | - |
| Japanese flying squid | - | - | - | 1 | 0.002 | 0.03 | - | - | - | - | - | - | - | - | - |

Sub-area 9

| Number | May | | | June | | | July | | | August | | | September | | |
|-------------------|----------|----|-----------------|----------|-------|---------------------|----------|-------|---------------------|----------|-------|--------------------|-----------|-------|--------------|
| | N=0 | | | N=46 | | | N=32 | | | N=16 | | | N=6 | | |
| | Broken 0 | | | Broken 2 | | | Broken 6 | | | Broken 0 | | | Broken 0 | | |
| Empty 0 (0.0%) | | | Empty 7 (15.9%) | | | Empty 3 (11.5%) | | | Empty 5 (31.3%) | | | Empty 5 (83.3%) | | | |
| Species | N | W% | kg \pm S.D | N | W% | kg \pm S.D | N | W% | kg \pm S.D | N | W% | kg \pm S.D | N | W% | kg \pm S.D |
| Krill | - | - | - | 12 | 17.7 | 88.05 \pm 120.01 | 5 | 4.9 | 30.77 \pm 40.45 | 1 | 6.9 | 39.75 | - | - | - |
| Anchovy | - | - | - | 23 | 73.2 | 190.26 \pm 181.85 | 19 | 95.1 | 157.15 \pm 167.28 | 3 | 64.5 | 98.11 \pm 138.97 | 1 | 100.0 | 42.28 |
| B.L < 80 mm | | | | | 46.0% | | | 58.3% | | | 1.0% | | | | |
| B.L > 80 mm | | | | | 54.0% | | | 41.8% | | | 99.0% | | | | |
| Mackerel | - | - | - | 10 | 9.1 | 54.49 \pm 78.66 | - | - | - | - | - | - | - | - | - |
| Oceanic lightfish | - | - | - | 3 | 0.02 | 0.32 \pm 0.22 | - | - | - | 6 | 28.7 | 27.69 \pm 34.32 | - | - | - |

Table 9-1. Daily prey consumption (kg) of common minke whales sampled in each month, sexual maturity stage and sub-area.

Sub-area 7

| Month | May | | | | June | | | | July | | | | August | | | | September | | | |
|-------------------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------|------------|-----------|------------|-----------|------------|
| | IM | MM | IF | MF | IM | MM | IF | MF | IM | MM | IF | MF | IM | MM | IF | MF | IM | MM | IF | MF |
| Prey / Consumption (kg) | | | | | | | | | | | | | | | | | | | | |
| Copepods | - | - | - | - | - | - | - | - | 0.01 | 0.02 | 0.01 | 0.03 | - | - | - | - | - | - | - | - |
| Krill | 20 | 32 | 17 | 40 | 23 | 38 | 20 | 48 | - | - | - | - | 67 | 110 | 59 | 137 | 1 | 2 | 1 | 3 |
| Anchovy | | | | | | | | | | | | | | | | | | | | |
| B.L < 80 mm | | | | | | | | | | | | | | | | | 0.2 | 0.4 | 0.2 | 0.5 |
| B.L > 80 mm | 118 | 193 | 103 | 241 | 36 | 59 | 32 | 74 | 92 | 151 | 81 | 188 | | | | | 8 | 14 | 7 | 17 |
| Saury | - | - | - | - | - | - | - | - | 0.06 | 0.1 | 0.06 | 0.1 | 44 | 72 | 39 | 90 | 55 | 91 | 49 | 113 |
| Mackerels | - | - | - | - | - | - | - | - | 24 | 39 | 21 | 48 | - | - | - | - | - | - | - | - |
| Walleye pollock | - | - | - | - | 82 | 135 | 72 | 169 | 13 | 22 | 12 | 27 | - | - | - | - | - | - | - | - |
| Japanese flying squid | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 4 | 7 | 4 | 9 |
| Sardine | 0.01 | 0.02 | 0.01 | 0.03 | - | - | - | - | 0.01 | 0.02 | 0.01 | 0.03 | - | - | - | - | 0.01 | 0.02 | 0.01 | 0.03 |
| Other fish | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 2 | 1 | 2 | - | - | - | - |
| Total | 137 | 225 | 120 | 281 | 142 | 233 | 124 | 290 | 129 | 212 | 113 | 264 | 112 | 184 | 98 | 229 | 70 | 115 | 61 | 143 |

Sub-area 8

| Month | May | | | | June | | | | July | | | | August | | | | September | | | |
|-------------------------|------------|------------|------------|------------|-----------|------------|-----------|------------|-----------|------------|-----------|------------|-----------|------------|-----------|------------|-----------|------------|-----------|------------|
| | IM | MM | IF | MF | IM | MM | IF | MF | IM | MM | IF | MF | IM | MM | IF | MF | IM | MM | IF | MF |
| Prey / Consumption (kg) | | | | | | | | | | | | | | | | | | | | |
| Copepods | - | - | - | - | 0.3 | 0.4 | 0.2 | 0.5 | - | - | - | - | - | - | - | - | - | - | - | - |
| Krill | 35 | 58 | 31 | 72 | 0.6 | 1.0 | 0.5 | 1.2 | 1 | 2 | 1 | 3 | - | - | - | - | - | - | - | - |
| Anchovy | 95 | 156 | 83 | 194 | 63 | 104 | 56 | 130 | 9 | 14 | 8 | 18 | - | - | - | - | - | - | - | - |
| B.L < 80 mm | | | | | | | | | | | | | | | | | | | | |
| B.L > 80 mm | 95 | 156 | 83 | 194 | 63 | 104 | 56 | 130 | 9 | 14 | 8 | 18 | | | | | | | | |
| Saury | 2 | 3 | 2 | 4 | 31 | 52 | 28 | 64 | 57 | 94 | 50 | 118 | 60 | 99 | 53 | 123 | 60 | 99 | 53 | 123 |
| Mackerels | 8 | 13 | 7 | 16 | 0.07 | 0.1 | 0.06 | 0.2 | - | - | - | - | - | - | - | - | - | - | - | - |
| Japanese flying squid | - | - | - | - | - | - | - | - | 1 | 1 | 1 | 2 | 5 | 8 | 4 | 10 | 5 | 8 | 4 | 10 |
| Sardine | - | - | - | - | 0.005 | 0.008 | 0.004 | 0.010 | - | - | - | - | - | - | - | - | - | - | - | - |
| Salmonids | 3 | 4 | 2 | 5 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Other fish | - | - | - | - | - | - | - | - | 0.1 | 0.2 | 0.1 | 0.3 | - | - | - | - | - | - | - | - |
| Other squid | - | - | - | - | 0.1 | 0.2 | 0.1 | 0.3 | - | - | - | - | - | - | - | - | - | - | - | - |
| Total | 142 | 234 | 125 | 291 | 96 | 157 | 84 | 196 | 69 | 113 | 60 | 141 | 65 | 107 | 57 | 133 | 65 | 107 | 57 | 133 |

Table 9-1. Continued.

Sub-area 9

| Month | May | | | | June | | | | July | | | | August | | | | September | | | |
|-------------------------|------------|------------|------------|------------|-----------|------------|-----------|------------|-----------|------------|-----------|------------|-----------|------------|-----------|------------|-----------|------------|-----------|------------|
| | IM | MM | IF | MF | IM | MM | IF | MF | IM | MM | IF | MF | IM | MM | IF | MF | IM | MM | IF | MF |
| Prey / Consumption (kg) | | | | | | | | | | | | | | | | | | | | |
| Copepods | 36 | 60 | 32 | 74 | 5 | 9 | 5 | 11 | - | - | - | - | - | - | - | - | - | - | - | - |
| Krill | 9 | 15 | 8 | 19 | 2 | 3 | 2 | 4 | 7 | 12 | 6 | 15 | 0.6 | 1.0 | 0.5 | 1.3 | - | - | - | - |
| Anchovy | | | | | | | | | | | | | | | | | | | | |
| B.L < 80 mm | | | | | | | | | 0.02 | 0.03 | 0.01 | 0.03 | 1 | 2 | 1 | 2 | 0.3 | 0.5 | 0.3 | 0.6 |
| B.L > 80 mm | | | | | 25 | 41 | 22 | 51 | 0.3 | 0.5 | 0.2 | 0.6 | 19 | 31 | 17 | 39 | 5 | 9 | 5 | 11 |
| Saury | 23 | 23 | 23 | 23 | 48 | 79 | 42 | 99 | 59 | 97 | 52 | 121 | 46 | 75 | 40 | 94 | 60 | 98 | 53 | 123 |
| Mackerels | 46 | 76 | 40 | 94 | - | - | - | - | - | - | - | - | 0.2 | 0.3 | 0.1 | 0.3 | - | - | - | - |
| Walleye pollock | - | - | - | - | - | - | - | - | 0.05 | 0.08 | 0.04 | 0.10 | 0.008 | 0.01 | 0.01 | 0.02 | - | - | - | - |
| Japanese flying squid | - | - | - | - | - | - | - | - | - | - | - | - | 0.002 | 0.003 | 0.001 | 0.003 | - | - | - | - |
| Sardine | - | - | - | - | - | - | - | - | - | - | - | - | 0.000 | 0.001 | 0.000 | 0.001 | - | - | - | - |
| Pacific pomfret | - | - | - | - | - | - | - | - | 3 | 4 | 2 | 5 | 0.3 | 0.5 | 0.3 | 0.6 | - | - | - | - |
| Salmonids | 7 | 11 | 6 | 14 | - | - | - | - | - | - | - | - | 0.4 | 0.6 | 0.3 | 0.8 | - | - | - | - |
| Min. armed squid | - | - | - | - | - | - | - | - | - | - | - | - | 13 | 21 | 11 | 26 | - | - | - | - |
| Attka mackerel | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 1 | 1 | 1 | - | - | - | - |
| Other fish | 2 | 3 | 1 | 3 | - | - | - | - | 0.1 | 0.2 | 0.1 | 0.3 | 0.07 | 0.1 | 0.06 | 0.1 | - | - | - | - |
| Total | 123 | 202 | 108 | 252 | 81 | 133 | 71 | 165 | 70 | 114 | 61 | 142 | 80 | 132 | 71 | 165 | 65 | 108 | 57 | 134 |

Table 9-2. Daily prey consumption (kg)+ of sei whales sampled in each month, sexual maturity stage and sub-area.

Sub-area 7

| Month | May | | | | June | | | | July | | | | August | | | | September | | | |
|-------------------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|
| Maturity stage | IM | MM | IF | MF | IM | MM | IF | MF | IM | MM | IF | MF | IM | MM | IF | MF | IM | MM | IF | MF |
| Prey / Consumption (kg) | | | | | | | | | | | | | | | | | | | | |
| Copepods | | | | | | | | | 54 | 72 | 59 | 86 | 54 | 72 | 59 | 86 | 54 | 72 | 59 | 86 |
| Anchovy | | | | | | | | | | | | | | | | | | | | |
| B.L < 80 mm | 541 | 725 | 593 | 861 | 541 | 725 | 593 | 861 | 498.8 | 668.2 | 546.7 | 793.8 | 499 | 668 | 547 | 794 | 499 | 668 | 547 | 794 |
| B.L > 80 mm | 5 | 7 | 6 | 9 | 5 | 7 | 6 | 9 | | | | | | | | | | | | |
| Sardine | 0.05 | 0.07 | 0.06 | 0.09 | 0.05 | 0.07 | 0.06 | 0.09 | | | | | | | | | | | | |
| Saury | | | | | | | | | 5 | 6 | 5 | 7 | 5 | 6 | 5 | 7 | 5 | 6 | 5 | 7 |
| Mackerels | 0.02 | 0.02 | 0.02 | 0.03 | 0.02 | 0.02 | 0.02 | 0.03 | | | | | | | | | | | | |
| Total | 546 | 732 | 599 | 870 | 546 | 732 | 599 | 870 | 557 | 746 | 611 | 887 | 557 | 746 | 611 | 887 | 557 | 746 | 611 | 887 |

Sub-area 8

| Month | May | | | | June | | | | July | | | | August | | | | September | | | |
|-------------------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|
| Maturity stage | IM | MM | IF | MF | IM | MM | IF | MF | IM | MM | IF | MF | IM | MM | IF | MF | IM | MM | IF | MF |
| Prey / Consumption (kg) | | | | | | | | | | | | | | | | | | | | |
| Copepods | 0.5 | 0.6 | 0.5 | 0.7 | 12 | 16 | 13 | 19 | 17 | 23 | 19 | 28 | 9 | 12 | 10 | 14 | | | | |
| Krill | 244 | 327 | 268 | 389 | 137 | 183 | 150 | 218 | 331 | 444 | 363 | 527 | 166 | 222 | 182 | 264 | | | | |
| Anchovy | | | | | | | | | | | | | | | | | | | | |
| B.L < 80 mm | 7 | 9 | 7 | 11 | 90 | 120 | 98 | 143 | | | | | 9 | 12 | 10 | 14 | 9 | 13 | 10 | 15 |
| B.L > 80 mm | 22 | 29 | 24 | 34 | 293 | 392 | 321 | 466 | 269 | 360 | 294 | 427 | 436 | 584 | 478 | 694 | 226 | 302 | 247 | 359 |
| Saury | 0.3 | 0.4 | 0.3 | 0.5 | 4 | 6 | 5 | 7 | 4 | 6 | 5 | 7 | 2 | 3 | 2 | 3 | | | | |
| Mackerels | 309 | 413 | 338 | 491 | 10 | 14 | 11 | 16 | | | | | | | | | | | | |
| Japanese flying squid | | | | | | | | | 0.06 | 0.08 | 0.07 | 0.10 | 0.031 | 0.04 | 0.03 | 0.05 | | | | |
| Total | 582 | 779 | 638 | 926 | 545 | 731 | 598 | 868 | 622 | 833 | 681 | 990 | 622 | 833 | 681 | 990 | 475 | 636 | 520 | 756 |

Sub-area 9

| Month | May | | | | June | | | | July | | | | August | | | | September | | | |
|-------------------------|------------|------------|------------|--------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|--------------|
| Maturity stage | IM | MM | IF | MF | IM | MM | IF | MF | IM | MM | IF | MF | IM | MM | IF | MF | IM | MM | IF | MF |
| Prey / Consumption (kg) | | | | | | | | | | | | | | | | | | | | |
| Copepods | 397 | 532 | 436 | 633 | 167 | 224 | 183 | 266 | 95 | 128 | 104 | 152 | 51 | 69 | 56 | 82 | 456 | 611 | 500 | 726 |
| Krill | 250 | 335 | 274 | 398 | 37 | 49 | 40 | 58 | 172 | 231 | 189 | 274 | 53 | 71 | 58 | 85 | | | | |
| Anchovy | | | | | | | | | | | | | | | | | | | | |
| B.L < 80 mm | 3 | 5 | 4 | 5 | 30 | 40 | 32 | 47 | 24 | 32 | 26 | 38 | 0.3 | 0.4 | 0.3 | 0.4 | 0.01 | 0.01 | 0.01 | 0.01 |
| B.L > 80 mm | 33 | 44 | 36 | 53 | 288 | 386 | 316 | 459 | 231 | 309 | 253 | 367 | 280 | 375 | 306 | 445 | 8 | 11 | 9 | 13 |
| Sardine | | | | | | | | | | | | | 5 | 7 | 6 | 8 | | | | |
| Saury | 0.6 | 0.8 | 0.6 | 0.9 | 16 | 21 | 17 | 25 | 17 | 22 | 18 | 26 | 62 | 83 | 68 | 98 | | | | |
| Mackerels | 57 | 76 | 62 | 90 | 3 | 4 | 4 | 5 | 31 | 41 | 34 | 49 | | | | | 190 | 254 | 208 | 302 |
| Japanese flying squid | | | | | 0.4 | 0.6 | 0.5 | 0.7 | 0.4 | 0.6 | 0.5 | 0.7 | | | | | | | | |
| Total | 741 | 993 | 812 | 1,180 | 542 | 726 | 594 | 863 | 572 | 766 | 627 | 910 | 451 | 605 | 495 | 719 | 654 | 876 | 716 | 1,040 |

Table 9-3. Daily prey consumption (kg) of Bryde's whales sampled in each month, sexual maturity stage and sub-area.

Sub-area 7

| Month | May | | | | June | | | | July | | | | August | | | | September | | | |
|-------------------------|-----|-----|-----|-----|------|-----|-----|-----|------|-----|-----|-----|--------|-----|-----|-----|-----------|-----|-----|-----|
| Maturity stage | IM | MM | IF | MF | IM | MM | IF | MF | IM | MM | IF | MF | IM | MM | IF | MF | IM | MM | IF | MF |
| Prey / Consumption (kg) | | | | | | | | | | | | | | | | | | | | |
| Krill | 536 | 779 | 522 | 869 | 418 | 609 | 408 | 678 | 157 | 229 | 153 | 255 | 25 | 37 | 25 | 41 | 23 | 34 | 23 | 38 |
| Anchovy | 67 | 98 | 65 | 109 | 122 | 178 | 119 | 198 | 276 | 402 | 269 | 448 | 366 | 533 | 357 | 594 | 393 | 572 | 383 | 637 |
| B.L < 80 mm | 52 | 75 | 51 | 84 | 94 | 137 | 92 | 153 | 154 | 223 | 150 | 249 | 165 | 240 | 161 | 268 | 357 | 519 | 348 | 578 |
| B.L > 80 mm | 15 | 22 | 15 | 25 | 28 | 40 | 27 | 45 | 123 | 178 | 120 | 199 | 201 | 292 | 196 | 326 | 36 | 53 | 35 | 59 |
| Mackerels | | | | | 15 | 22 | 15 | 25 | 15 | 22 | 15 | 25 | | | | | | | | |
| Total | 603 | 877 | 588 | 977 | 556 | 809 | 542 | 901 | 448 | 653 | 437 | 727 | 391 | 570 | 382 | 635 | 416 | 606 | 406 | 675 |

Sub-area 8

| Month | May | | | | June | | | | July | | | | August | | | | September | | | |
|-------------------------|------|------|-------|------|------|------|-------|------|------|-----|-----|-----|--------|-----|-----|-----|-----------|-----|-----|-----|
| Maturity stage | IM | MM | IF | MF | IM | MM | IF | MF | IM | MM | IF | MF | IM | MM | IF | MF | IM | MM | IF | MF |
| Prey / Consumption (kg) | | | | | | | | | | | | | | | | | | | | |
| Krill | 166 | 242 | 162 | 270 | 166 | 242 | 162 | 270 | 157 | 228 | 153 | 254 | | | | | | | | |
| Anchovy | 135 | 197 | 132 | 219 | 135 | 197 | 132 | 219 | 296 | 431 | 289 | 480 | 385 | 561 | 376 | 625 | 385 | 561 | 376 | 625 |
| B.L < 80 mm | 129 | 188 | 126 | 210 | 129 | 188 | 126 | 210 | 212 | 309 | 207 | 345 | 204 | 297 | 199 | 331 | 204 | 297 | 199 | 331 |
| B.L > 80 mm | 6 | 9 | 6 | 10 | 6 | 9 | 6 | 10 | 83 | 121 | 81 | 135 | 181 | 264 | 177 | 294 | 181 | 264 | 177 | 294 |
| Mackerels | 148 | 215 | 144 | 239 | 148 | 215 | 144 | 239 | 0.4 | 0.5 | 0.4 | 0.6 | | | | | | | | |
| Japanese flying squid | 0.01 | 0.02 | 0.010 | 0.02 | 0.01 | 0.02 | 0.010 | 0.02 | | | | | | | | | | | | |
| Total | 449 | 653 | 438 | 728 | 449 | 653 | 438 | 728 | 453 | 659 | 442 | 735 | 385 | 561 | 376 | 625 | 385 | 561 | 376 | 625 |

Sub-area 9

| Month | May | | | | June | | | | July | | | | August | | | | September | | | |
|-------------------------|-----|-----|-----|-----|------|-----|-----|-----|------|-----|-----|-----|--------|-----|-----|-----|-----------|-----|-----|-----|
| Maturity stage | IM | MM | IF | MF | IM | MM | IF | MF | IM | MM | IF | MF | IM | MM | IF | MF | IM | MM | IF | MF |
| Prey / Consumption (kg) | | | | | | | | | | | | | | | | | | | | |
| Krill | 72 | 105 | 70 | 117 | 72 | 105 | 70 | 117 | 19 | 28 | 19 | 31 | 25 | 37 | 25 | 41 | | | | |
| Anchovy | 299 | 435 | 292 | 485 | 299 | 435 | 292 | 485 | 376 | 548 | 367 | 610 | 238 | 346 | 232 | 385 | 332 | 483 | 324 | 538 |
| B.L < 80 mm | 137 | 200 | 134 | 223 | 137 | 200 | 134 | 223 | 219 | 319 | 214 | 356 | 2 | 3 | 2 | 4 | 3 | 5 | 3 | 5 |
| B.L > 80 mm | 161 | 235 | 157 | 262 | 161 | 235 | 157 | 262 | 157 | 229 | 153 | 255 | 235 | 342 | 229 | 382 | 329 | 478 | 321 | 533 |
| Mackerels | 37 | 54 | 36 | 60 | 37 | 54 | 36 | 60 | | | | | | | | | | | | |
| Oceanic lightfish | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | 106 | 154 | 103 | 171 | | | | |
| Total | 408 | 594 | 398 | 662 | 408 | 594 | 398 | 662 | 396 | 576 | 386 | 642 | 369 | 536 | 359 | 598 | 358 | 521 | 349 | 580 |

Table 10. Seasonal prey consumption (tons) of whales sampled in each sexual maturity stage and sub-area.

Sub-area 7

| Prey species | Common minke whale | | | | | Sei whale | | | | | Bryde's whale | | | | | Total (t) |
|-----------------------|--------------------|--------|-------|-------|--------|-----------|--------|--------|-------|--------|---------------|--------|--------|--------|--------|-----------|
| | IM | MM | IF | MF | Total | IM | MM | IF | MF | Total | IM | MM | IF | MF | Total | |
| Copepods | 0.04 | 0.2 | 0.02 | 0.04 | 0.3 | 169 | 681 | 93 | 404 | 1,347 | 0 | 0 | 0 | 0 | 0 | 1,348 |
| Krill | 2,182 | 9,661 | 639 | 921 | 13,403 | | | | | | 9,828 | 10,617 | 10,893 | 31,591 | 62,929 | 76,332 |
| Anchovy | | | | | | | | | | | | | | | | |
| B.L < 80 mm | 1 | 4 | 0.4 | 1 | 6 | 7,414 | 14,132 | 13,674 | 3,743 | 38,963 | 14,314 | 21,646 | 11,072 | 28,926 | 75,958 | 114,927 |
| B.L > 80 mm | 8,812 | 38,546 | 2,469 | 3,396 | 53,223 | 59 | 79 | 129 | 0 | 268 | 7,550 | 11,564 | 5,727 | 14,855 | 39,696 | 93,187 |
| Saury | 338 | 1,732 | 154 | 305 | 2,529 | 14 | 58 | 8 | 34 | 114 | 0 | 0 | 0 | 0 | 0 | 2,643 |
| Mackerels | 82 | 420 | 37 | 74 | 613 | 0.2 | 0.2 | 0.4 | 0 | 1 | 370 | 528 | 311 | 836 | 2,045 | 2,658 |
| Walleye pollock | 2,581 | 11,245 | 713 | 965 | 15,504 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 15,504 |
| Japanese flying squid | 15 | 76 | 7 | 13 | 111 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 111 |
| Sardine | 1 | 4 | 0.3 | 0.4 | 6 | 1 | 1 | 1 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 8 |
| Other fish | 3 | 17 | 2 | 3 | 26 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 26 |

Sub-area 8

| Prey species | Common minke whale | | | | | Sei whale | | | | | Bryde's whale | | | | | Total (t) |
|-----------------------|--------------------|-------|------|------|-------|-----------|--------|-------|--------|--------|---------------|--------|-------|--------|--------|-----------|
| | IM | MM | IF | MF | Total | IM | MM | IF | MF | Total | IM | MM | IF | MF | Total | |
| Copepods | 1 | 8 | 0.4 | 0.5 | 9 | 250 | 821 | 251 | 1,471 | 2,794 | 0 | 0 | 0 | 0 | 0 | 2,803 |
| Krill | 223 | 2,099 | 106 | 126 | 2,553 | 8,942 | 25,812 | 7,273 | 49,751 | 91,778 | 5,534 | 7,516 | 2,957 | 13,853 | 29,860 | 124,191 |
| Anchovy | | | | | | | | | | | | | | | | |
| B.L < 80 mm | 0 | 0 | 0 | 0 | 0 | 1,174 | 3,005 | 771 | 6,229 | 11,179 | 13,992 | 18,601 | 6,800 | 30,973 | 70,366 | 81,545 |
| B.L > 80 mm | 789 | 7,440 | 374 | 448 | 9,051 | 7,703 | 26,246 | 8,183 | 46,016 | 88,148 | 8,729 | 11,500 | 4,068 | 18,282 | 42,579 | 139,778 |
| Saury | 242 | 2,640 | 52 | 280 | 3,213 | 82 | 254 | 75 | 471 | 883 | 0 | 0 | 0 | 0 | 0 | 4,096 |
| Mackerels | 48 | 448 | 23 | 27 | 545 | 6,749 | 16,437 | 4,034 | 35,152 | 62,372 | 1,488 | 2,164 | 1,035 | 5,158 | 9,844 | 72,760 |
| Japanese flying squid | 8 | 99 | 0 | 13 | 120 | 0.4 | 2 | 1 | 3 | 6 | 0.1 | 0.2 | 0.07 | 0.4 | 0.7 | 126 |
| Sardine | 0.01 | 0.1 | 0.01 | 0.01 | 0.2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Salmonids | 16 | 155 | 8 | 9 | 188 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 188 |
| Other fish | 0.1 | 1 | 0 | 0.2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Other squid | 0.4 | 4 | 0.2 | 0.2 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |

Sub-area 9

| Prey species | Common minke whale | | | | | Sei whale | | | | | Bryde's whale | | | | | Total (t) |
|-----------------------|--------------------|--------|-------|-------|--------|-----------|--------|--------|---------|---------|---------------|--------|--------|--------|---------|-----------|
| | IM | MM | IF | MF | Total | IM | MM | IF | MF | Total | IM | MM | IF | MF | Total | |
| Copepods | 500 | 4,598 | 175 | 615 | 5,887 | 31,343 | 88,815 | 32,672 | 112,271 | 265,100 | 0 | 0 | 0 | 0 | 0 | 270,988 |
| Krill | 207 | 1,532 | 108 | 525 | 2,372 | 15,751 | 45,434 | 16,381 | 58,979 | 136,545 | 1,116 | 2,045 | 1,134 | 6,134 | 10,429 | 149,347 |
| Anchovy | | | | | | | | | | | | | | | | |
| B.L < 80 mm | 13 | 55 | 11 | 63 | 142 | 1,206 | 2,686 | 1,285 | 3,149 | 8,325 | 4,867 | 7,885 | 4,241 | 26,013 | 43,007 | 51,474 |
| B.L > 80 mm | 387 | 2,414 | 244 | 1,301 | 4,346 | 16,625 | 42,792 | 17,513 | 48,934 | 125,865 | 14,938 | 22,680 | 11,977 | 78,739 | 128,334 | 258,545 |
| Saury | 2,138 | 10,895 | 1,488 | 7,978 | 22,498 | 1,706 | 5,101 | 1,774 | 5,663 | 14,244 | 0 | 0 | 0 | 0 | 0 | 36,743 |
| Mackerels | 592 | 5,439 | 209 | 734 | 6,974 | 6,254 | 19,683 | 6,457 | 23,666 | 56,059 | 124 | 398 | 243 | 807 | 1,573 | 64,605 |
| Walleye pollock | 0.5 | 2 | 0.4 | 3 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 |
| Japanese flying squid | 0.02 | 0.06 | 0.01 | 0.07 | 0.2 | 17 | 39 | 18 | 44 | 118 | 0 | 0 | 0 | 0 | 0 | 118 |
| Sardine | 0.004 | 0.02 | 0.003 | 0.02 | 0.04 | 87 | 297 | 89 | 326 | 800 | 0 | 0 | 0 | 0 | 0 | 800 |
| Pacific pomfret | 27 | 114 | 22 | 132 | 296 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 296 |
| Salmonids | 3 | 15 | 3 | 17 | 38 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 38 |
| Min. armed squid | 118 | 495 | 97 | 571 | 1,281 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1,281 |
| Attka mackerel | 6 | 26 | 5 | 30 | 67 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 67 |
| Oceanic lightfish | 2 | 8 | 2 | 10 | 22 | 0 | 0 | 0 | 0 | 0 | 2,068 | 3,009 | 1,569 | 10,804 | 17,450 | 17,471 |
| Other fish | 2 | 8 | 1 | 9 | 19 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 19 |

Table 11. Seasonal prey consumption (tons) of whales sampled.

| All | | | | | | | | | | | | | |
|--------------------------|--------------------|------------|------------|--------|------------|------------|------------|---------|---------------|------------------|------------|----------|-----------|
| Prey species | Common minke whale | | | | Sei whale | | | | Bryde's whale | | | | Total (t) |
| | Sub-area 7 | Sub-area 8 | Sub-area 9 | Total | Sub-area 7 | Sub-area 8 | Sub-area 9 | Total | Sub-area 7 | Sub-area 8 | Sub-area 9 | Total | |
| Copepods | 0.3 | 9 | 5,887 | 5,897 | 1,347 | 2,794 | 265,100 | 269,241 | 0 | 0 | 0 | 0 | 275,138 |
| Krill | 13,403 | 2,553 | 2,372 | 18,328 | | 91,778 | 136,545 | 228,323 | 62,929 | 29,860 | 10,429 | 103,218 | 349,870 |
| Anchovy | | | | | | | | | | | | | |
| B.L < 80 mm | 6 | 0 | 142 | 148 | 38,963 | 11,179 | 8,325 | 58,468 | 75,958 | 70,366 | 43,007 | 189,330 | 247,946 |
| B.L > 80 mm | 53,223 | 9,051 | 4,346 | 66,620 | 268 | 88,148 | 125,865 | 214,280 | 39,696 | 42,579 | 128,334 | 210,610 | 491,510 |
| Saury | 2,529 | 3,213 | 22,498 | 28,240 | 114 | 883 | 14,244 | 15,241 | 0 | 0 | 0 | 0 | 43,481 |
| Mackerels | 613 | 545 | 6,974 | 8,131 | 1 | 62,372 | 56,059 | 118,432 | 2,045 | 9,844 | 1,573 | 13,461 | 140,023 |
| Walleye pollock | 15,504 | 0 | 6 | 15,510 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 15,510 |
| Japanese flying squid | 111 | 120 | 0.2 | 231 | 0 | 6 | 118 | 123 | 0 | 1 | 0 | 1 | 355 |
| Sardine | 6 | 0.2 | 0.04 | 6 | 3 | 0 | 800 | 803 | 0 | 0 | 0 | 0 | 809 |
| Pacific pomfret | 0 | 0 | 296 | 296 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 296 |
| Salmonids | 0 | 188 | 38 | 226 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 226 |
| Min. armed squid | 0 | 0 | 1,281 | 1,281 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1,281 |
| Attka mackerel | 0 | 0 | 67 | 67 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 67 |
| Oceanic lightfish | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 17,450 | 17,450 | 17,450 |
| Other fish | 26 | 1 | 22 | 48 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 48 |
| Other Squid | 0 | 4 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| Total | 145,033 | | | | 904,911 | | | | 534,069 | | | | |
| Total consumption | | | | | | | | | | 1,584,013 | | t | |

Table 12. The comparison among the prey consumption of three baleen whale species, the catch of fisheries and the resources of fishes.

| Prey species | Prey consumption (tons) | | | | Fisheries | | Resources | |
|------------------|-------------------------|---------|---------|---------|--------------|-------|-----------|------|
| | Minke | Sei | Bryde's | Total | catch (tons) | % | (tons) | % |
| Japanese anchovy | 66,768 | 272,748 | 399,940 | 739,456 | 330,000 | 224.1 | 4,800,000 | 15.4 |
| Mackerels | 8,131 | 118,432 | 13,461 | 140,023 | 420,000 | 33.3 | 1,010,000 | 13.9 |
| Pacific saury | 28,240 | 15,241 | 0 | 43,481 | 410,000 | 10.6 | 4,500,000 | 1.0 |

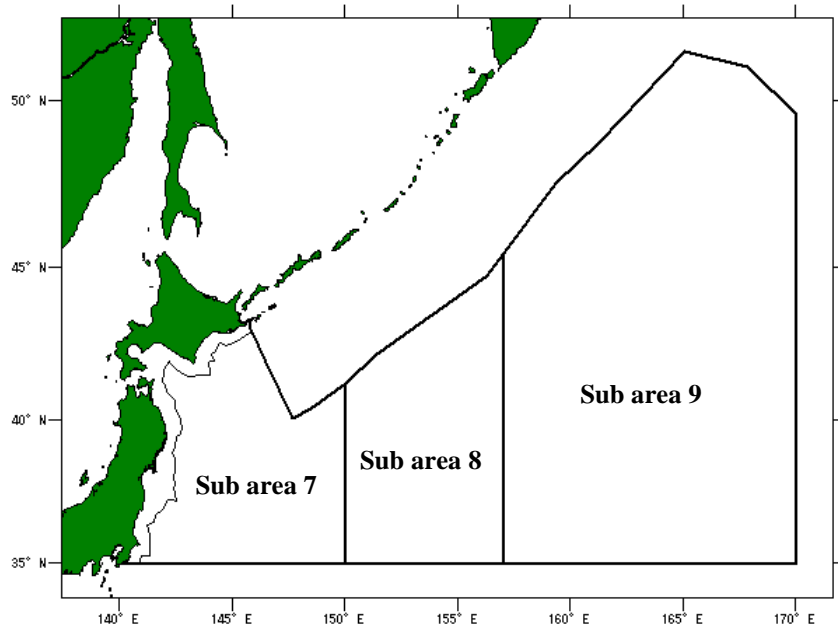
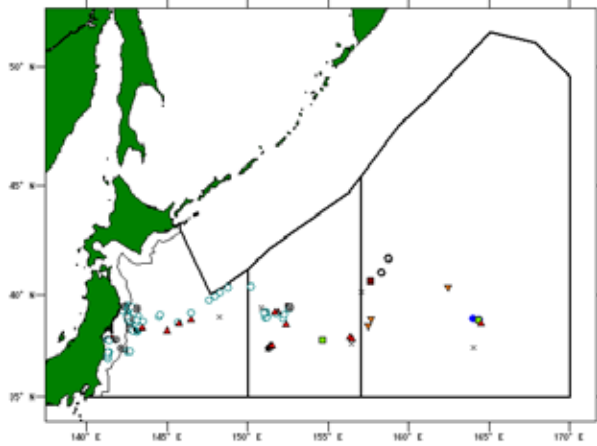
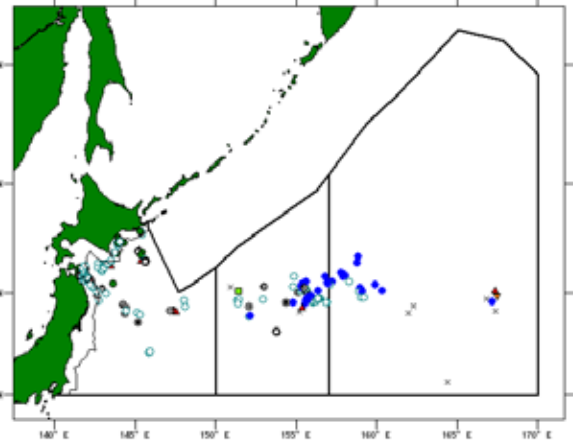


Fig.1 Research area

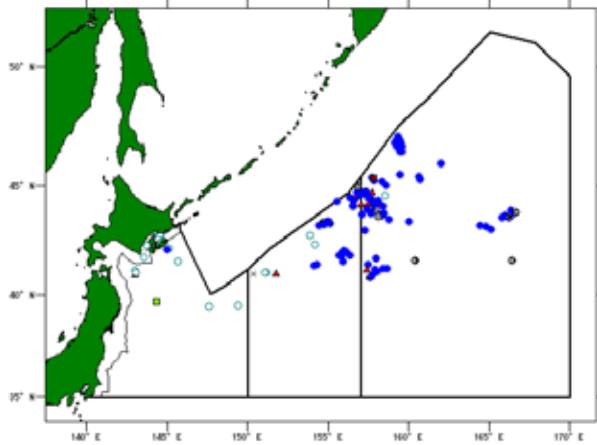
May



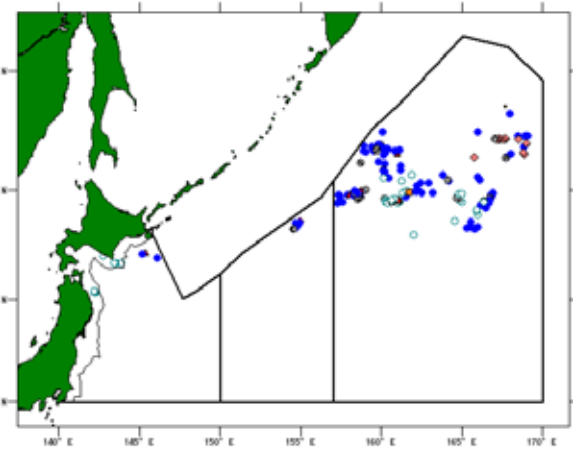
June



July



August



September

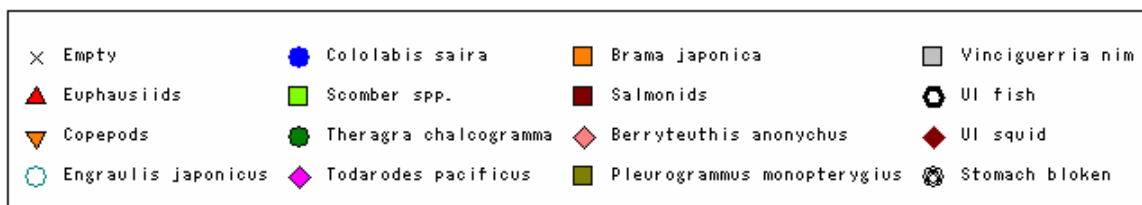
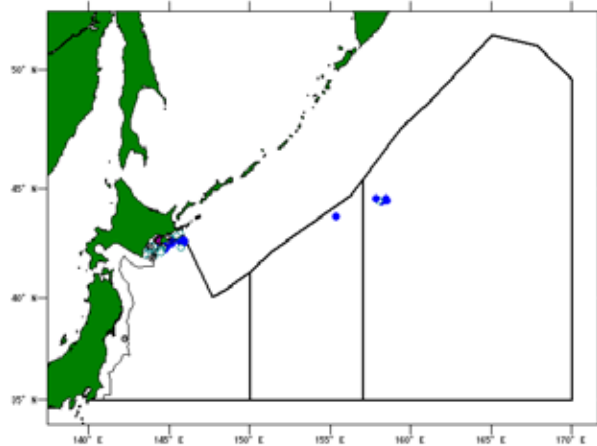
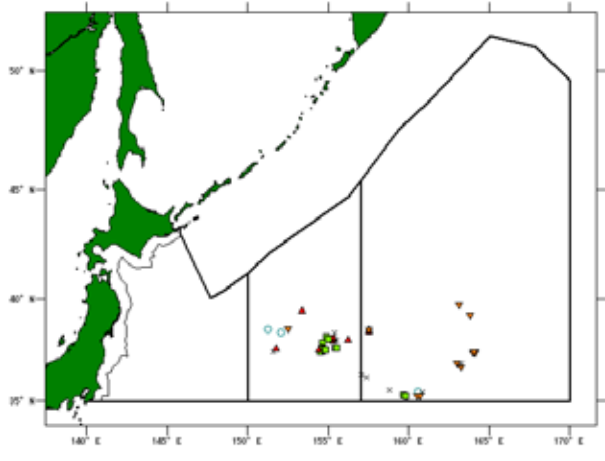
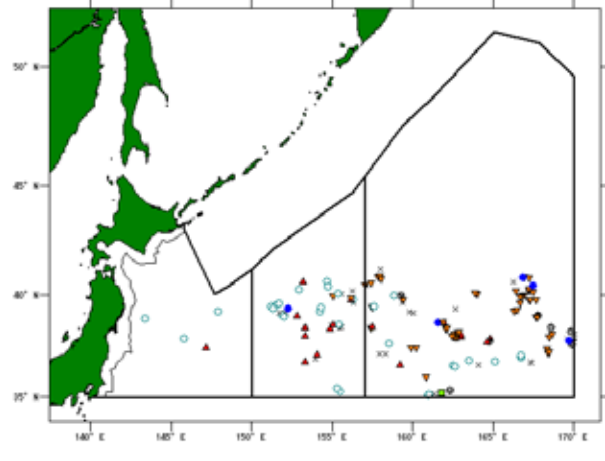


Fig. 2-1. Sighting position of common minke whales sampled and their dominant prey species (2000-2007JARPNI)

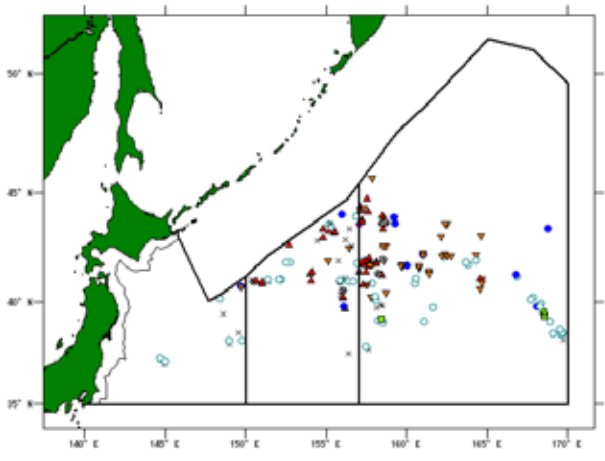
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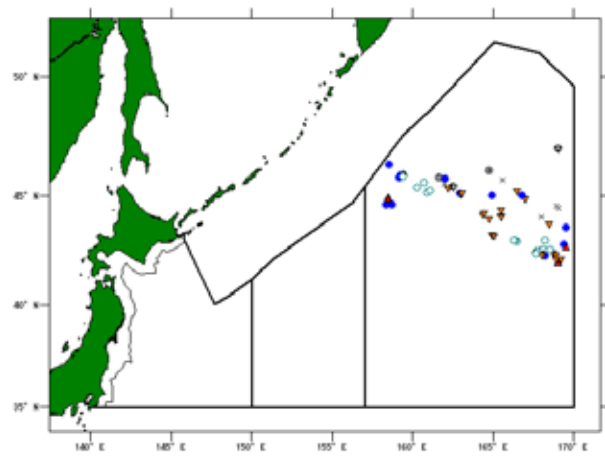
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July



August



September

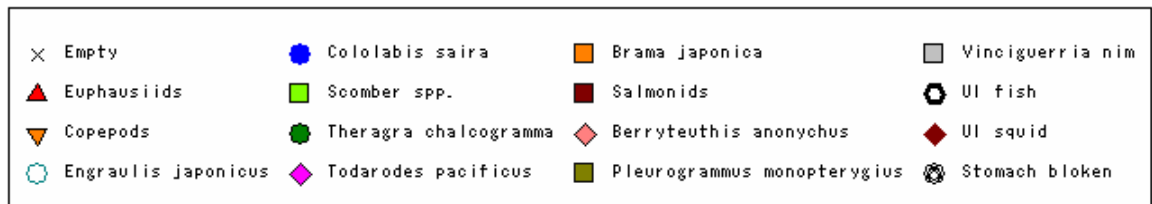
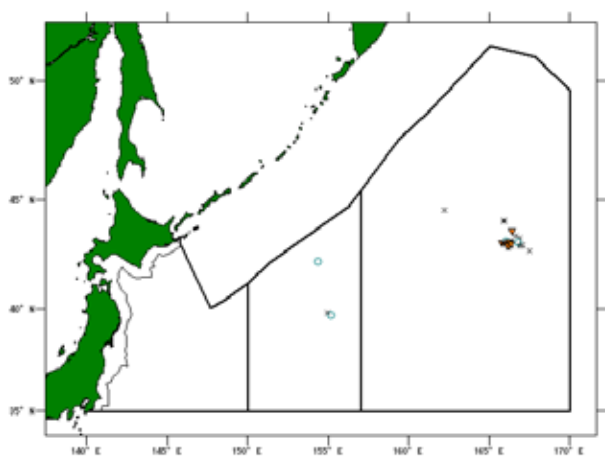
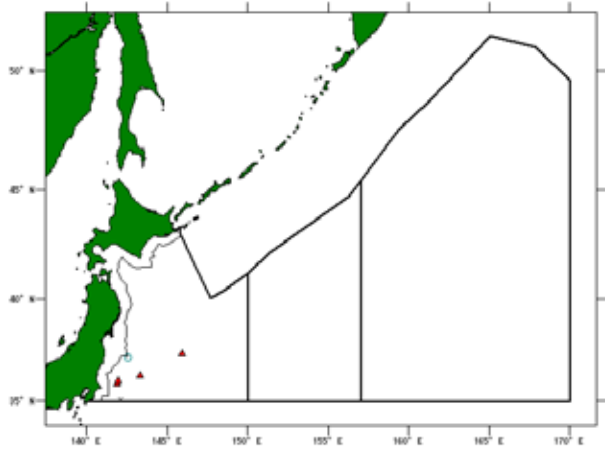
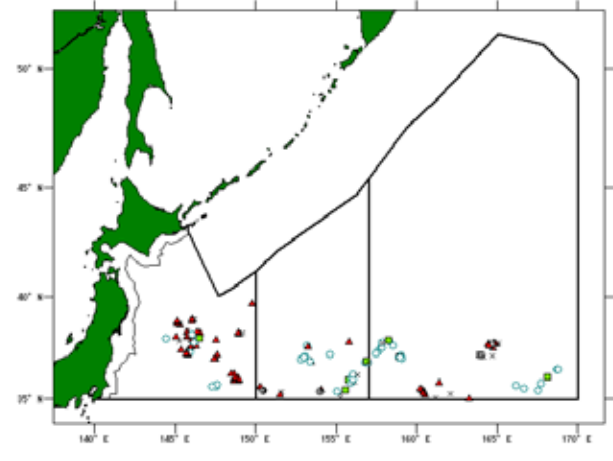


Fig. 2-2. Sighting position of sei whales sampled and their dominant prey species (2002-2007JARPN II)

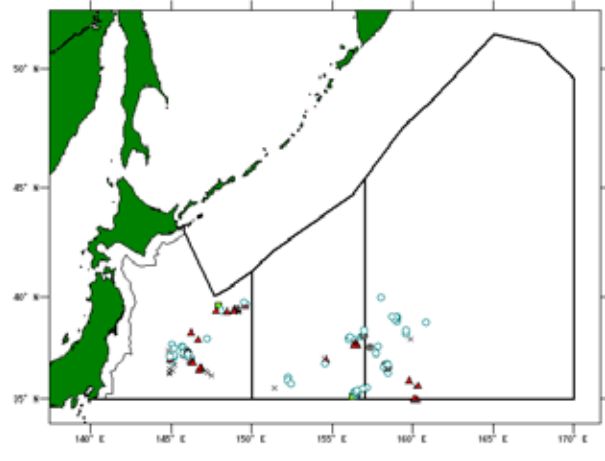
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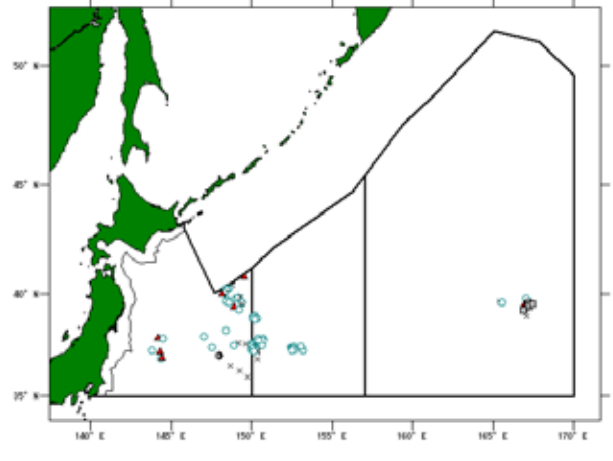
June



July



August



September

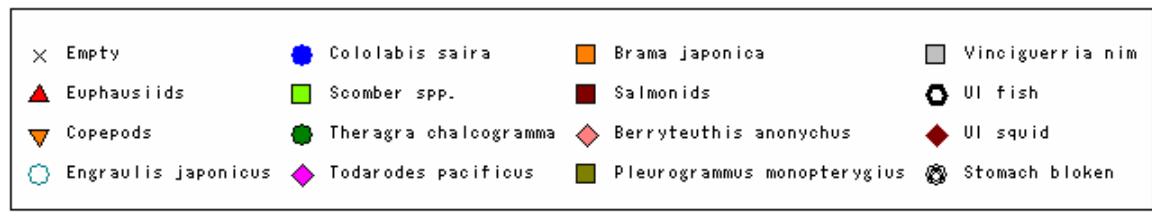
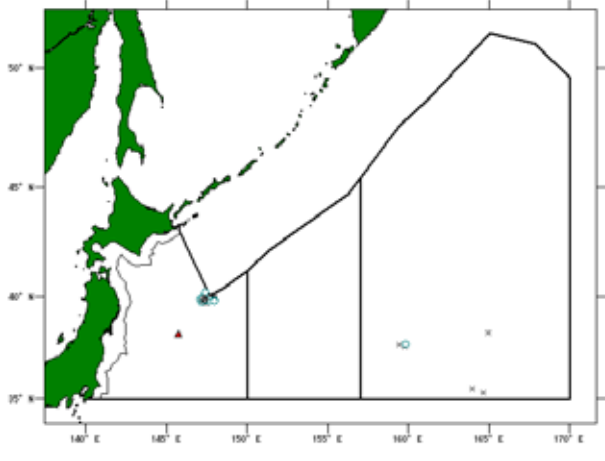
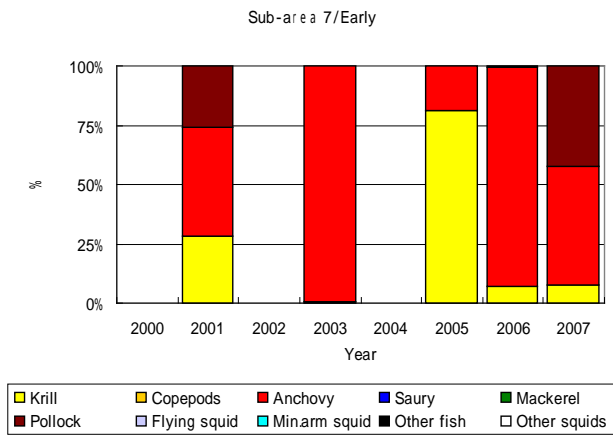


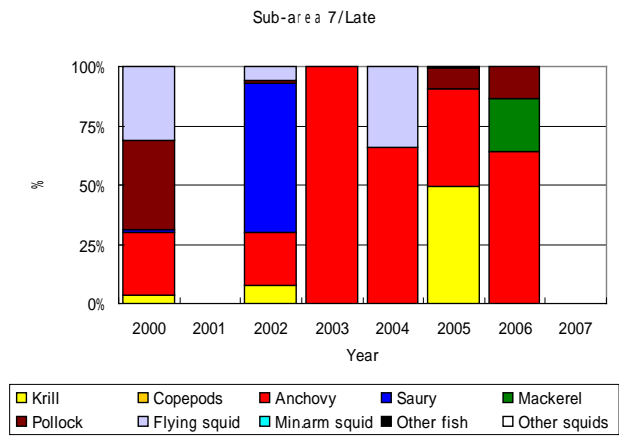
Fig. 2-3. Sighting position of Bryde's whales sampled and their dominant prey species (2000-2007JARP II)

Sub-area 7

Early season

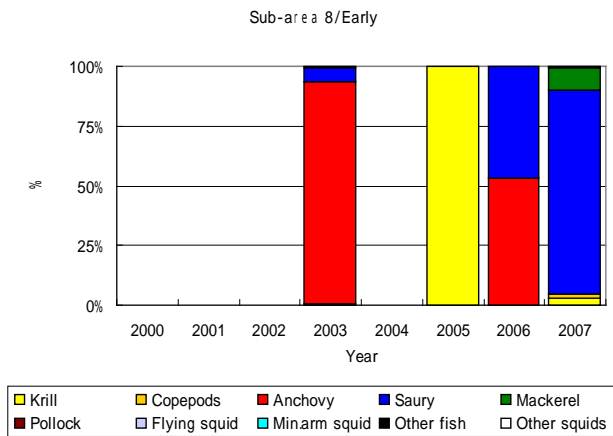


Late season

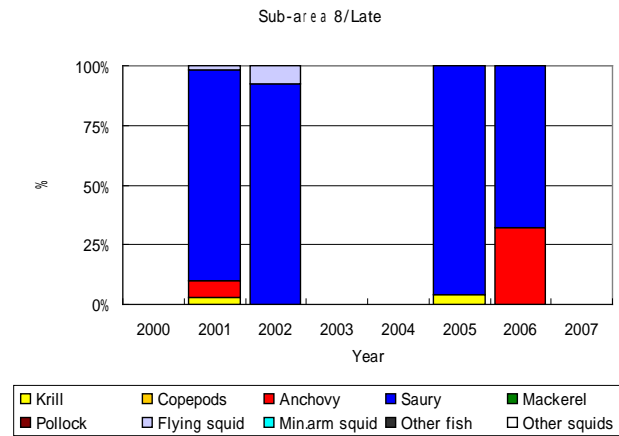


Sub-area 8

Early season

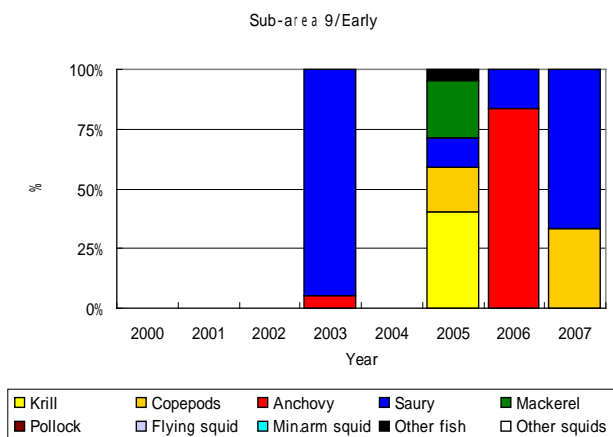


Late season



Sub-area 9

Early season



Late season

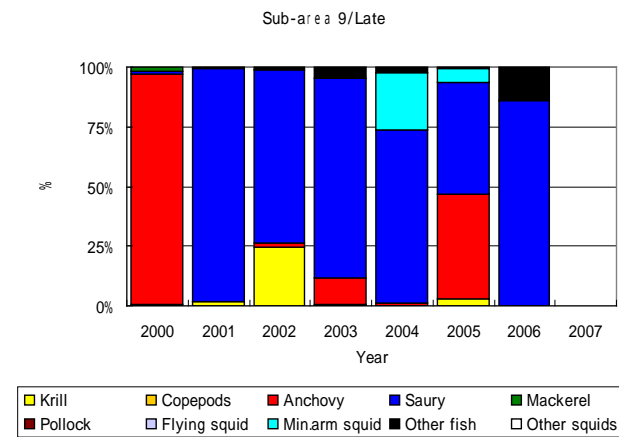
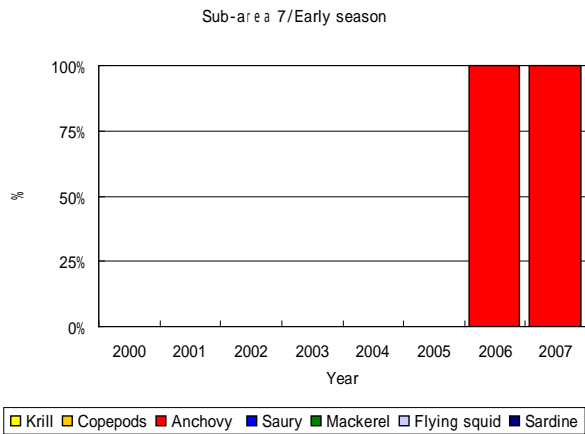


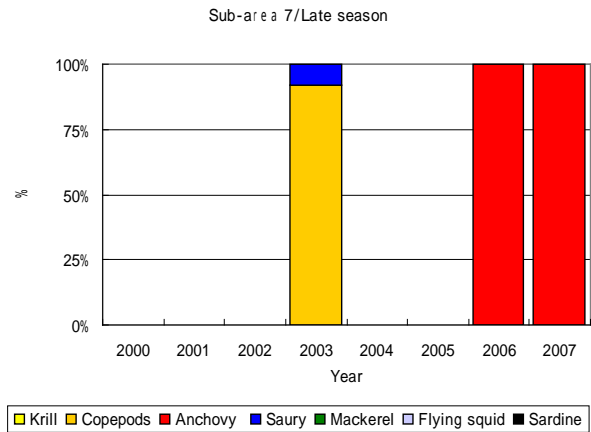
Fig. 3-1. The yearly change of prey species composition of common minke whales sampled in each sub-area

Sub-area 7

Early season

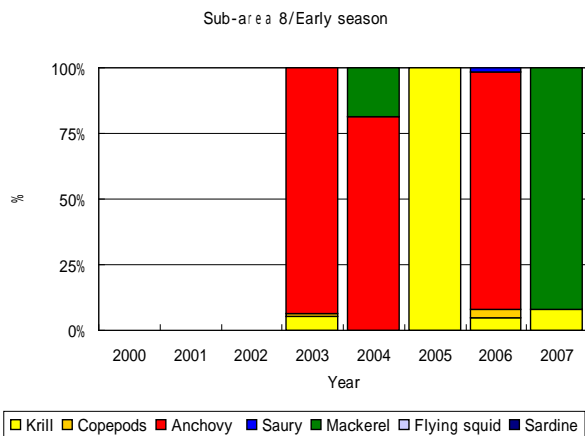


Late season

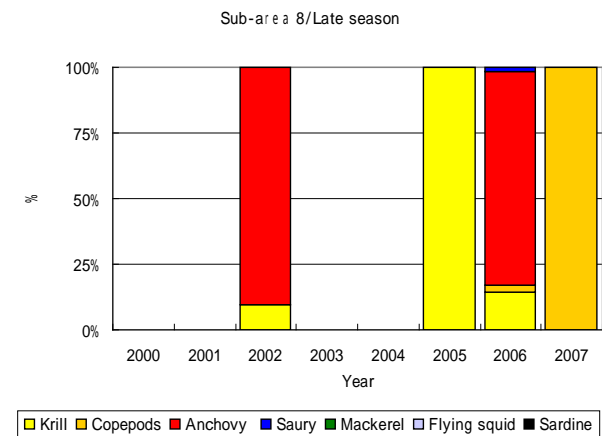


Sub-area 8

Early season

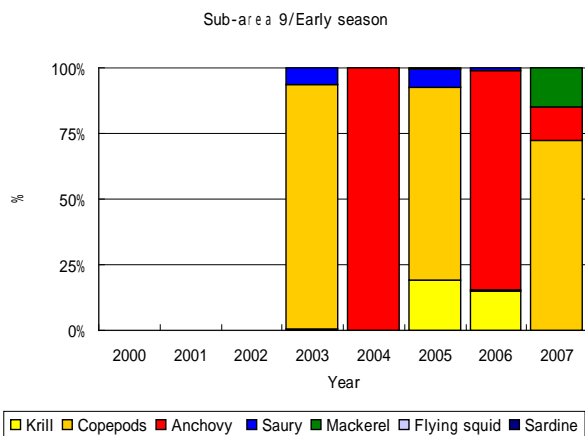


Late season



Sub-area 9

Early season



Late season

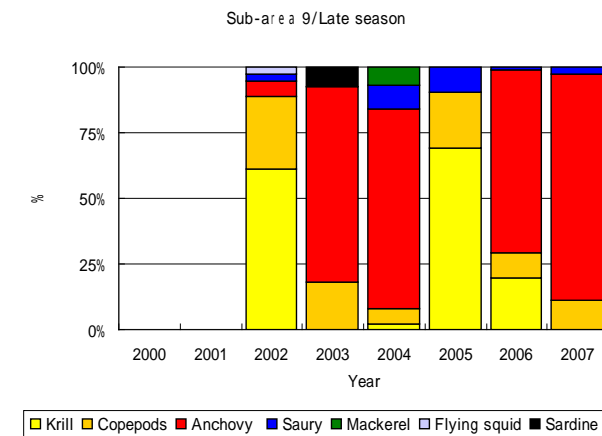
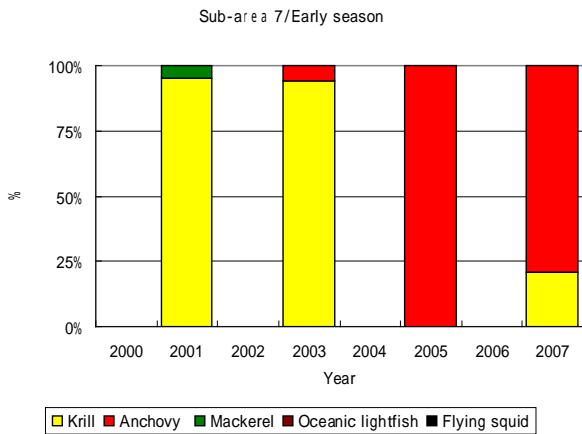


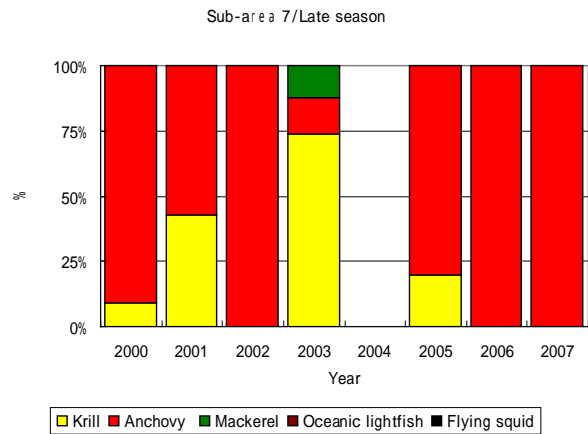
Fig. 3-2. The yearly change of prey species composition of sei whales sampled in each sub-area

Sub-area 7

Early season

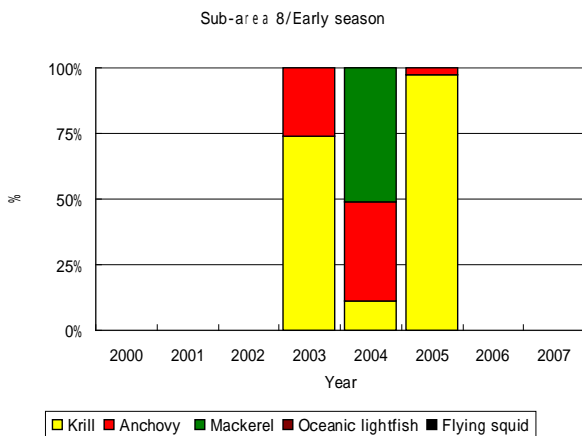


Late season

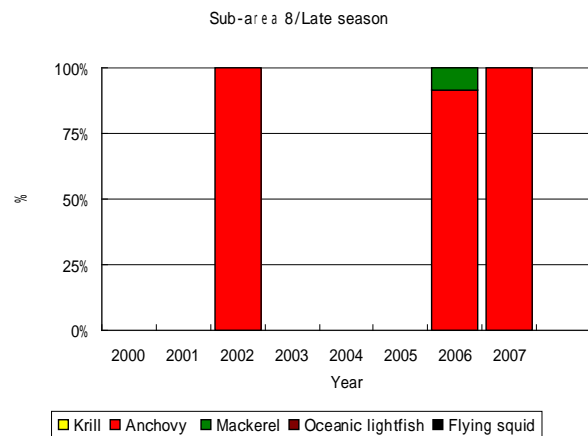


Sub-area 8

Early season

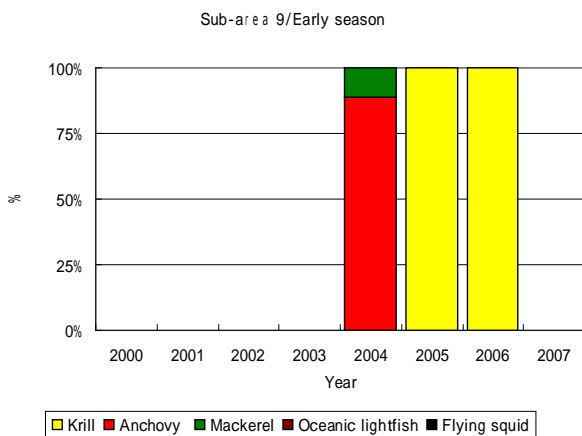


Late season



Sub-area 9

Early season



Late season

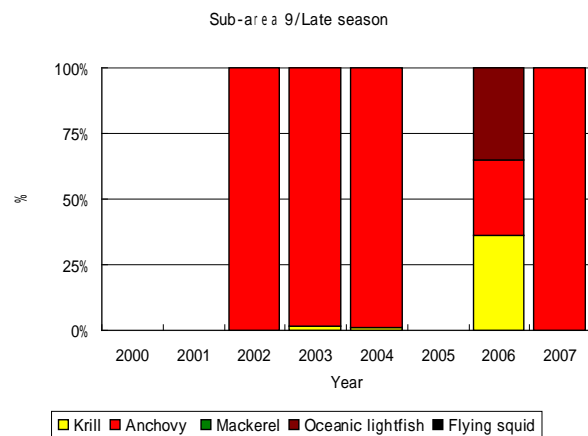


Fig. 3-3. The yearly change of prey species composition of Bryde's whales sampled in each sub-area

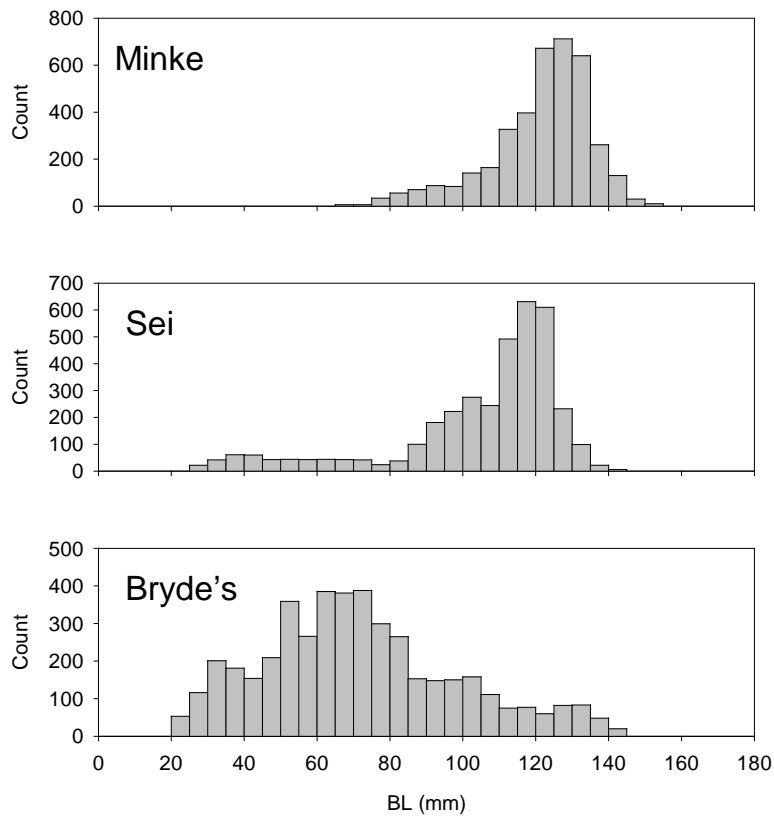


Fig. 4-1. The distribution of Japanese anchovy size in the stomach contents of three baleen whales

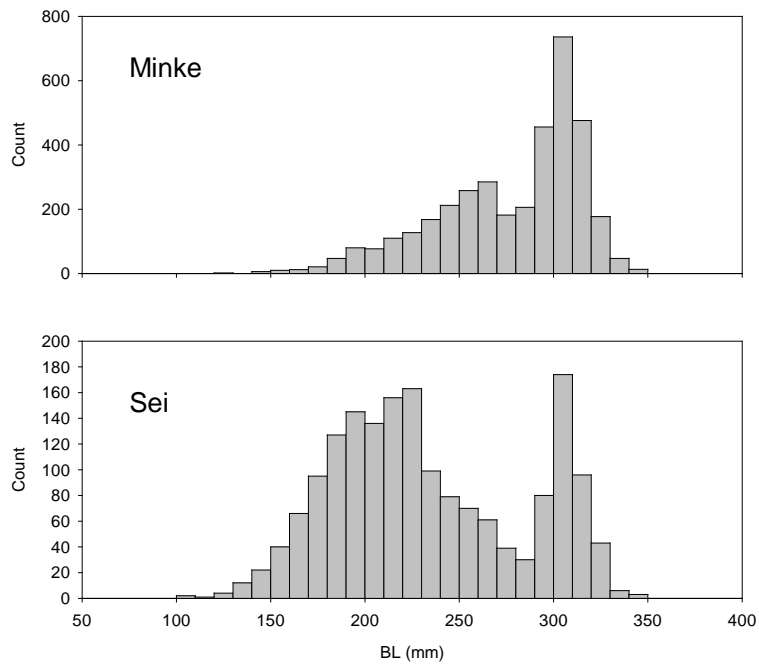


Fig. 4-2. The distribution of Pacific saury size in the stomach contents of three baleen whales

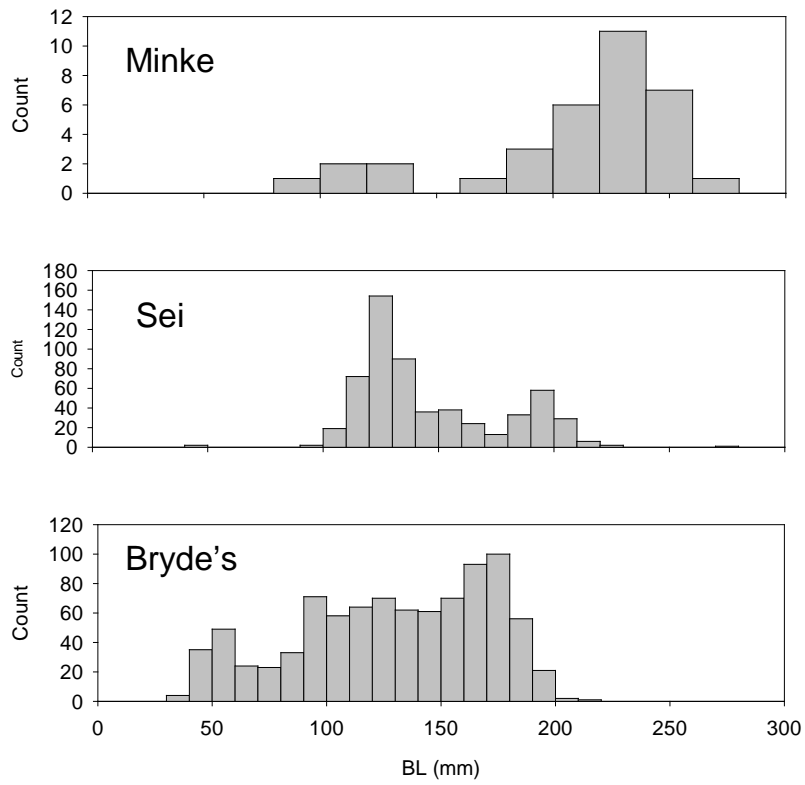


Fig. 4-3. The distribution of mackerels size in the stomach contents of three baleen whales