# Cruise Report of the Feasibility Study of the Japanese Whales Research Program under Special Permit in the western North Pacific-Phase II (JARPN II) in 2001

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## ABSTRACT

The second phase of the Japanese Whale Research Program under Special Permit in the North Pacific (JARPNII) was planed with the aim to study the feeding ecology and ecosystem of common minke whale *Balaenoptera acutorostrata*, Bryde's whale *B. edeni* and sperm whale *Physeter macrocephalus*. JARPN II started with two feasibility surveys in 2000 and 2001 and several studies have been conducted using samples and data obtained in these surveys. While most of these studies are within the 'feasibility' category some others are a continuation of the studies initiated under JARPN. The second survey of the feasibility study was conducted from 14 May to 3 August 2001 in the sub-areas 7, 8 and 9 of the western North Pacific. The research period in the 2001 survey was about 2.5 months (82 days) earlier than in the 2000 survey. Same as in the 2000 survey a total of six research vessels were used: one scientific echo sounder survey vessel (ESSV), one trawl survey vessel (TSV), three sighting/sampling vessels (SSVs) and one research base vessel. Due to availability consideration, the TSV in 2001 was the *Torishima*, which replaced the *Syunyo Maru* used in 2000. In the 2001 survey five small blocks were defined in sub-area 7 for the cooperative survey on ecosystem research. A total of 17,435n.miles was surveyed for whale searching in a period of 82 days. During that period 153 common minke, 128 Bryde's and 1,184 sperm whales were sighted by the SSVs and ESSV. A total of 100 common minke, 50 Bryde's and 8 sperm whales were sampled by the SSVs. One sei whale was accidentally sampled. The whales sampled were examined on board the research base vessel. Regarding minke whales mature males were dominant. In the case of the Bryde's whales female was dominated in the first period and male was dominated in the second period. Major prey species of minke whales were Japanese anchovy *Engraulis japonicus* in sub-area 7, Pacific saury *Cololabis saira* in sub-areas 8 and 9 and walleye poilock *Theragra chalcogramma* in the coastal area of Pacific side of Hokkaido (northern part of sub-area 7). Krill and small-sized Japanese anchovy were found in the stomach of Bryde's whales. Dominant preys in the stomach of eight sperm whales were different kinds of squids which inhabit in the mid- and deep-waters. The stomach content of the sei whale was krill only. The acoustic survey using a Simrad EK500 echo sounder operating frequencies at 38, 120 and 200 kHz was carried out to quantify prey abundance as well as to reveal the distribution of prey species. The TSV conducted sampling of prey species based on the initial information provided by the ESSV. In this way prey species could be identified. In addition, trawling was made at predetermined stations independently from the acoustic survey. Three types of plankton nets (IKMT, Maruchi and Bongo) were used to collect zooplanktons. Oceanographic observations were made with CTD down to 500m. Cetacean sighting survey was also conducted from one of the prey survey vessels. A total of 2,702 nautical miles acoustic data were acquired. Trawling was made at 63 points. Japanese anchovy, walleye pollock and krill were abundant with the distribution patterns reflecting the oceanographic structure and bottom topography. Most of the night time trawl catches consisted of fishes dominated by lantern fishes. As in the case of the 2000 survey, the concurrent whale and prey species surveys were conducted successfully.

## INTRODUCTION

After the Japanese Whale Research Program under Special Permit in the North Pacific (JARPN) from 1994 to 1999, the meeting to review the survey results and data availability was held on February 2000. In that meeting, the member agreed that no sub-stock scenario was exist within the O stock (Government of Japan, 1994) for common minke whale *Balaenoptera acutorostrata* in western North Pacific but the hypothesis of whether the W-stock exist (western part of sub-area 9) was not solved. Regarding to the feasibility studies on feeding ecology, the workshop considered them as successful. The results showed that the main prey species of minke whale changed seasonally and geographically. As most of these prey species are also the target species of Japanese commercial fisheries, a possible competition between minke whales and fisheries was postulated. The Workshop agreed that, if ecological studies are to be conducted in the area, the sampling regime must be designed to allow for a more quantitative estimation of temporal and geographical variation in diet. It was also recommended that acoustic and trawl surveys should be conducted concurrently with future whale surveys, if possible (IWC, 2001).

The second phase of Japanese Whale Research Program under Special Permit in the North Pacific (JARPNII) was started in 2000 summer season as a two-year feasibility study. One of major objectives of this plan is to study on feeding ecology of whales and marine ecosystem. During the previous JARPN surveys, it was revealed the minke whales consumed various commercial fish species such as Pacific saury *Cololabis saira*, Japanese anchovy *Engraulis japonicus*. Japanese common squids *Todarodes pacificus* and walleye pollock *Theragra chalcogramma*, and they ate considerable amount of these prey species. Tamura and Ohsumi (1999) estimated that the large amount of marine fish resources were consumed by cetaceans in the world's ocean, and they empathized the further examination of prey consumption by cetacean. Second objective of the feasibility survey of JARPNII is related to stock structure issues, and third one is related to pollution studies.

The two-year feasibility study aimed mainly i) to evaluate the performance of the concurrent prey and whale surveys and ii) to evaluate whether or not information on feeding ecology can be obtained for the new target species (Bryde's whale *B. edeni* and sperm whale *Physeter macrocephalus*) in the same way as it had been obtained for the minke whale under JARPN.

In this paper, we present an outline of the second feasibility survey of the JARPNII survey, which was conducted from 14 May to 3 August 2001.

## MATERIALS AND METHOD

### Research area

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

In the co-operative survey on ecosystem research, five small blocks were determined for several type of oceanographic structure using by satellite information on water temperature. The source of this information was getting from the homepage of National Fisheries Research Institute in Tohoku Region. Furthermore, a 'special monitoring survey' (SMS) was conducted in an area where the number of minke and Bryde's whales were expected to be large (Special blocks A, B and C) (Fig. 2).

### Research vessels

Six research vessels were used. The research base vessel *Nisshin Maru* (NM: 7,575GT) commanded the research and was engaged in the biological examination of whale samples and of by-products. *Yushin Maru* (YS1: 720GT), *Kyo Maru* No.1 (K01: 812.08GT) and *Toshi Maru* No. 25 (T25: 739.92GT) were used as the sighting/sampling vessels (SSVs), which conducted sighting activities, sampling of targeted whale species and various experiments and observations. One of the SSVs (YS1) was also engaged in oceanographic observations using CTD and EPCS.

The *Kyoshin Maru* No. 2 (KS2: 368GT) was engaged as an echo sounder survey vessel as well as a dedicated sighting vessel (SV). This vessel was also conducted plankton net sampling and the oceanographic observations using EPCS (Electric particle counting and sizing system).

The *Torishima* (TOR: 426GT) was engaged as a trawl survey vessel. This vessel was also conducted the oceanographic observations using CTD.

**Research type**
In this survey, two main components (the co-operative survey and the whale surveys) were consisted as follows:

*Co-operative survey on the prey species and whale sampling*
Vessels: Six research vessels (NM, YS1, K01, T25, KS2 and TOR)

Research area: Five small blocks within sub-area 7 designed by taking into consideration previous data on temperature. Furthermore, a 'special monitoring survey' (SMS) was conducted in an area where the abundance of minke and Bryde's whales were expected to be high (Fig. 2).

Research periods:

First period: Between 14 May and 23 June for small blocks 1, 2, 3, 4 and 5 and Special Monitoring Survey A and B.

Second period: Between 11 and 13 July for Special Monitoring Survey C (Table 1).

*Whale survey*
Vessels: Five research vessels (NM, YS1, K01, T25 and KS2)

Research area: Sub-areas 8 and 9 (Fig. 1)

Research period: First period between 23 June and 10 July in sub-area 7, 8, 9 and second period between 13 July and 3 August in sub-areas 8 and 9 (Table 1).

**Cruise track line**
In the whale survey, the survey was conducted in similar setting manner of the cruise track line and allocation of vessels in previous JARPN surveys (Fujise *et al.*, 1995, 1996, 1997, 2000; Ishikawa *et al.*, 1997, Zenitani *et al.*, 1999). The zigzag-shaped track line was established on an arbitrary basis in each sub-area and month, taking into consideration previous sighting information of minke whales and sea conditions. Furthermore, a 'special monitoring survey' (SMS) was conducted in an area where the abundance of minke whales and Bryde's were expected to be high. Track line in the SMS was designed separately from the original track line. Three SSVs were allocated to these tracks with the allocation being changed every day. The track line of the SV was also similar to those of the SSVs.

Allocation of the vessels in the co-operative survey was determined in the following manner. On the predetermined survey track line, the KS2 were surveying using the echo sounder as well as conducting the sighting survey under passing mode. The TOR followed to the KS2. If the KS2 detected the existing of the prey species by response of echo sounder, the TOR conducted the trawl survey for the target depth to identify these prey species.

After several ten or hundred n.miles from these two prey survey vessels, the whale research fleet surveyed as the following manner: the research course consisted of one main track and two parallel tracks established six n.miles apart from both sides. In the SMS the distance between the main and parallel tracks was set at four n.miles, for better efficiency of sampling.

**Sighting surveys**
Sighting procedure was similar to the previous surveys of JARPN (Fujise *et al.*, 1995, 1996, 1997, 2000; Ishikawa *et al.*, 1997; Zenitani *et al.*, 1999). In the research area sighting was conducted mainly under closing mode. Furthermore two modalities of sighting in closing mode were adopted, *NSC* and *NSS modes*, by taking into consideration weather and sea conditions mainly. The *NSC* and *NSS modes* were the same as *BC* and *BS modes* in the previous JARPN surveys, respectively. The conditions to conduct surveys under *NSC mode* were similar to those established in Japanese sighting surveys conducted by the National Research Institute of Far Seas Fisheries (*i.e.* visibility of 2 n.miles or more and wind speed of 4 or below). The *NSS mode* was used under more critical weather conditions but under these condition the collection of whale samples was possible. These two mode surveys were recorded separately for future analysis. Also an *ASP mode* was used (closing mode survey without sampling activities under normal sighting conditions).

During the transit from homeport (HP) to research area (RA) and from RA to HP, the *NSP mode* was adopted (passing mode without sampling activities under normal sighting conditions).

Closing was made mainly on sightings of minke, Bryde's and sperm whales or on schools that looked like those whales. Furthermore it was planned that closing was made on large whales species sightings, such as blue, sei,

humpback, right and fin whales. In these cases, closing were made in order to confirm species and school size and in order to conduct some experiments.

### Sampling of minke, Bryde's and sperm whales

Sampling activities were conducted with the aim to take 100 minke whales, 50 Bryde's whales and 10 sperm whales. Most of these whale species sighted on the trackline were approached for sampling. Furthermore sampling effort was applied outside the established research hours (06:00-19:00), if collection of whale samples was considered as possible.

For schools consisting of two or more animals, numbering was made to all the whales in the school, to set sampling order randomly in accordance with the table of random numbers (Kato *et al.*, 1989). As in a previous JARPN survey the sampling was made in co-operation with three sighting/sampling vessels in this survey (Fujise *et al.*, 1996, 2000).

### Prey species survey

A quantitative echo sounder (Simrad EK500 with software version 5.30) was used on board KS2 to obtain acoustic data with operating frequency at 38, 120 and 200 kHz. The transducers were hull-mounted at the depth of 4.3 m from the surface. Each transducer was covered with a 40 mm polycarbonate acoustic and the hydraulic oil filled the space between the transducer surfaces and the acoustic windows. Calibrations were carried out at Sendai-bay (17 July 2001) using the copper sphere technique described in EK 500 operation manual (Simrad, 1997). Data were stored with the aid of Sonar Data Echoview version 2.10.51. Acoustic data were analyzed with the aid of Sonar Data Echoview (version 2.10.51) software at the laboratory. In principle, marks on the echo sounder were identified based on the trawl catches especially from targeting trawling. For fishes, data collected at 38 kHz were used with the threshold set at -60dB and the depth range from 0m to 250m was analyzed. For Japanese anchovy that was the most common fish, shape and intensity of marks were also used for species identification. The integration was made at an interval of one nautical mile by 50 m depth zones. For krill, data collected at 120 kHz were used with the threshold set at –80 dB. The analyzed depth range was from 12m to 250m (maximum depth at 120 kHz). Echo marks were identified as krill if ΔSv (the difference of Sv between 38 and 120) falls between 10 and 15 dB (Miyashita *et al.* 1997). Because most of krill species in the survey area have the body length similar to *isada* krill (*Euphausia pacifica*), this ΔSv value was applied to. Species identification was based on ΔSv for preliminary analysis. The integration was made at an interval of one nautical mile by 50 m depth zones.

There are three type of trawl survey, normal, target and night trawling. The normal trawling was conducted at the scheduled time or point. The target trawling was conducted for 0.5 to 1 hour if the KS2 detect an echo for the prey species in the echo sounder, and then the TOR conducted the trawling in the target depth which was detected for prey species. The species are determined by the catches of the trawling. The night trawling was conducted at one hour after sunset on the same point of the normal trawling in daytime. The trawl net was 86.3 m long with a mouth opening of ca. 900 $m^2$ and a 6.0 m cod end with a 17.5 x 17.5 mm mesh. The sampling depth and the height of the mouth of the net were monitored with data logger (SBT-500R, Murayama Co.) attached to the head and bottom rope of the trawl. Towing speed of the trawl net was 3-4 knots. This survey was conducted to examine the abundance and distribution pattern of cephalopods and neustonic organisms such as Pacific saury that are difficult to determine by the eco sounder and also to examine day-night difference of prey species composition in the 0 to 100-m layer of each small block. This predetermined trawl was towed for 20 minutes at each depth layer, 0-30 m, 30-60 m, and 60-100 m. All samples were identified to the species and wet weight of each species was measured aboard the ship. For the major species, length of 100 individuals was measured to examine their size composition. A part of samples were frozen at –30°C for further analysis in the laboratory.

Two plankton nets were used to collect zooplankton. The *Maruchi* net (0.334 mm mesh at the cod end) and the twin-bongo net (0.335 mm mesh). Plankton net samplings were made at depths down to 100m in concordance with the trawling. The *Maruchi* net was towed vertically at the speed of 40cm/s. The bongo net was towed at a depth where biological scatter was recorded on the echo sounder, or obliquely from the depth to the surface. Samples were preserved in 10 % formalin for species identification at the laboratory.

### Oceanographic observations

CTD (Model SBE911 Plus, Seabird Co.) were casted down to 500 m at each sampling station to measure the temperature and salinity profiles in the study area by TOR. Salinity compensation for CTD data and analysis of oceanographic conditions were made at the laboratory.

The EPCS system (Nippon Kaiyo Co., Ltd.) on board of KS2 was running during survey, and recorded continuously at interval each 1 minute of ship's position (from GPS), sea surface temperature & salinity (from Sea-bird SBE-21), chlorophyll-a concentration (from Turner 10-AU fluorometer), and dissolved oxygen, *etc.*

### Experiments

The following experiments and observations were conducted on board the sighting/sampling vessels:

1. Sighting distance and angle experiments to examine the precision of sighting data (YS1, K01 and T25).
2. Satellite tagging on minke whales.
3. Biopsy sampling on blue, fin, humpback, right, Bryde's, minke and sperm whales.
4. Photographic records of natural marks in blue, humpback and right whales.
5. Feasibility study for sampling prey species of minke and other large whale species.
6. Preliminary examination on attachment of data logger for Bryde's whales.

On board the SV (KS2), the following experiments and observations were conducted:

1. Sighting distance and angle experiment to examine the precision of sighting data.
2. Biopsy sampling trial on minke whales.
3. Biopsy sampling on blue, fin, humpback, right, Bryde's, minke and sperm whales.
4. Photographic records of natural marks in blue, humpback and right whales.
5. Feeding behaviour patterns of blue, fin and sperm whales.
6. Feasibility study to estimate abundance of prey species of minke and other large whale species using an echo sounder system.
7. Feasibility study for sampling prey species of minke and other large whale species.
8. Sea water sampling for pollution study

On board the research base vessel (*NM*), observations of marine debris in the research area were conducted from the wheelhouse (mainly during transit cruises). Marine debris was also investigated in the stomach contents of the minke, Bryde's and sperm whales sampled. And, air was sampled for pollution study in research area.

Experiments on killing method were conducted onboard of both the research base vessel and the SSVs.

## RESULTS

### Searching distance

Track line covered by the three sighting/sampling vessels (SSVs) during the 2001 JARPN II survey was shown in Fig. 3. The total searching distance for SSVs and dedicated sighting vessel (SV) were 14,359.6 n.miles and 3,075.4 n.miles in sub-areas 7, 8 and 9, respectively (Table 2).

In the co-operative survey on ecosystem research, the survey was conducted from May to July with two periods; first from 14 May to 23 June 2001, and second from 11 to 13 July 2001 (43 days) (Table 1).

### Sightings of minke, Bryde's and sperm whales

*Sighting and sampling vessels (SSVs)*

During the research cruise, 133 schools (136 individuals) of minke whales were sighted, consisting of 73 schools (75 individuals) of primary and 60 schools (61 individuals) of secondary sightings. For Bryde's whale, 64 schools (77 individuals) were sighted, consisting of 34 schools (42 individuals) of primary sightings and 30 schools (35 individuals) of secondary sightings. For sperm whale, 326 schools (948 individuals) were made, consisting of 224 schools (506 individuals) of primary sightings and 102 schools (442 individuals) of secondary sightings (Table 3). Figs. 4 and 5 show the distribution of minke and Bryde's whales sighted by the SSVs in the sub-areas 7, 8 and 9. Minke whales were usually sighted in sub-areas 7, 8 and 9, but Bryde's whales were

sighted mainly in offshore area in the sub-area 7. In the sub-area 7, some segregation was observed between minke and Bryde's whales. In minke whales, the sightings were made in northern part of sub-area 7 where water temperature was below 20°C. In contrast, sightings of Bryde's were made in southern part of the sub-area where the water temperature was higher than 20°C.Fig. 6 shows the distribution of sperm whale sightings in sub-area 7. This species were found in the whole the sub-area 7 except the coastal area such as small blocks 1 and 2.

*Dedicated sighting vessel (SV)*
During the research cruise, 15 schools (17 individuals) of minke whales were sighted, consisting of 14 schools (16 individuals) of primary and 1 schools (1 individuals) of secondary sightings. For Bryde's whale, sightings for 38 schools (51 individuals) were sighted, consisting of 36 schools (48 individuals) of primary sightings and 2 schools (3 individuals) of secondary sightings. For sperm whale, sightings 43 schools (236 individuals) were sighted, consisting of 37 schools (210 individuals) of primary sightings and 6 schools (26 individuals) of secondary sightings (Table 4).

In the co-operative survey on ecosystem research, during small block survey, 15 schools (17 individuals) of minke whales were primary sighted. For Bryde's whale, primary sightings of 4 schools (6 individuals) were sighted. For sperm whale, primary sightings of 20 schools (75 individuals) were sighted. During special monitoring survey' (SMS), minke whales were not primary sighted. For Bryde's whale, primary sightings of 34 schools (45 individuals) were sighted. For sperm whale, primary sightings of 23 schools (161 individuals) were sighted (Table 4).

## Sightings of other large cetacean species

*Sighting and sampling vessels (SSVs)*
Table 3 also shows the sightings for other cetacean species made by the SSVs. Large baleen whales such as blue (23 sch./31 ind.: Fig.7), fin (15 sch./23 ind.: Fig.8), sei (110 sch./148 ind.: Fig.9), humpback (15 sch./18 ind.: Fig.10) and right whales (2 sch./3 ind.: Fig.11) were found in the sub-areas 7, 8 and 9.

*Dedicated sighting vessel (SV)*
Table 4 also show the sightings for other cetacean species made by the SV. Large baleen whales such as sei (6 sch./ 17 ind.) and humpback whales (7 sch./ 9 ind.) were found in the sub-areas 7, 8 and 9.

## Sampling of minke, Bryde's and sperm whales
Table 6 shows the number of whales sampled in each sub-area or small block for each research component and period.

A total of 100 minke whales was sampled, 50 during the whale survey component and 50 during the co-operative survey component. If we consider the sub-areas, 50 were sampled in sub-area 7, 21 in sub-area 8 and 29 in sub-area 9. The whale samples are consisted of 93 males and 7 females.

A total of 50 Bryde's whales were sampled in sub-area 7 during the co-operative survey component. The figure of 50 whales consisted of 17 males and 33 females, including eight mother/calf pair.

A total of eight sperm whales were sampled in sub-area 7 during the co-operative survey component. The figure of eight animals consisted of two males and six females.

Geographical distribution of minke and Bryde's whale samples is shown in Figs 12 and 13 based on the sighting positions. Fig. 14 shows the distribution of sperm whale samples based on the sighting positions. The sampling of sperm whales covered only sub-area 7.

## Biological research for minke, Bryde's and sperm whales sampled
Table 7 summarizes the biological data and samples obtained from the minke, Bryde's and sperm whales sampled. A total of 54 research items were covered. These items are related to the studies conducted under the three main objectives of the JARPN II: study on feeding ecology of whales and marine ecosystem, elucidation of stock structure and pollution studies.

## Experiments

*Biopsy sampling trial for Bryde's, sperm, minke and blue whales*
Table 8 shows the result of biopsy skin sampling for Bryde's, sperm, minke and blue whales. A total of five Bryde's, 16 sperm, 2 minke and 2 blue whales were targeted for biopsy sampling by the SSVs and SV. As a result, five, eleven, two and one biopsy skin samples were collected from these species, respectively.

*Sea water and air sampling*
For organochlorines analysis, air samplings were conducted on the upper deck of the *NM*. A total of three and one air samples were collected from sub-area 7 and 8, respectively during May 15 and Jun 30 in 2001. Surface seawater samplings were also conducted by pumping from a seawater faucet in the *KS2*. A total of two and one surface seawater samples were collected from sub-area 7 and 9, respectively during May 24 and Jun 29 in 2001.

## Accidental take of a sei whale

On 5 June, a sei whale was accidentally sampled. In that day, the special monitoring survey (SMS) had been conducted in an area of high density of Bryde's whales. The sei whale was sighted as a primary sighting at 06:32 (local time as JST+1) by one of the SSVs (K01). Position of the sighting was 37°57'N, 146°07'E and water temperature was 19.1°C. The cue of the sighting was body. According to the field notes, the SSV began to close the whale immediately after sighting was made.

After the vessel arrived at the location where the whale had been sighted, the topman identified it as a school composed of two animals. At the surfacing of the one of these whales, the topman misidentified the sei whale as a Bryde's whale by the observation of three likely ridges on the rostrum. Considering that the whale was a Bryde's whale, the animal was chased and sampled at 7:28. During chasing and towing nobody noticed that the whale was not a Bryde's whale. The sampled whale was retrieved on the deck of research base at 8:40, where the whale was identified by a researcher for the first time as a sei whale. This accidental sampling was informed immediately to an inspector, all researchers and crews of three SSVs and the research base.

In order to avoid a similar accident all research activities were suspended on that day and the crews from all SSVs were called on board the research base. After observing the body of the sei whale accidentally sampled, they received a lecture on whale identification by a specialist on board. After then, detailed biological research was conducted on the sei whale. This included morphological record by photographs, detailed external measurements and sampling of biological materials. This individual was confirmed as a mature male with body length of 14.3m and body weight of 21.3t. The subsequent mtDNA analyses confirmed this individual as a sei whale (M. Goto, pers. comm.).

The whale was processed after the biological research was completed. The weight of by-products from this whale was 13.9t (including 9.4t of red meat). However these by-products were not sold at the market but used in other non-commercial events such as whaling-related cultural events in Japan.

## Preliminary analyses of biological data

*Sex ratio and maturity status*
The sex ratio, maturity rate and maturity composition of minke whales in each sub-area were shown in Table 9. Proportion of males is high in all sub-areas. Composition of maturity was also high in all of sub-areas 7, 8 and 9. Immature animals was found in sub-area 7.

Table 10 shows those for Bryde's whales in the sub-area 7. Female was dominated in the first period (23.1% males) and male was dominated in the second period (72.7% males). Immature animal was found in both sexes, and maturity rate ranged between 22.2% - 25.0% and 60.0% - 100% for males and females, respectively.

*Body length and weight*
The body length distributions of minke whales are shown in Fig. 15. Mean body length of males tended to be high in the sub-area 8 and 9 than those in sub-area 7. Similar trends were shown for their body weight (Table 11 and Fig. 16).

For Bryde's whales, the distribution of body length and weight are shown in Figs 17 and 18. Mean body length of Bryde's whales is 10.4 m and 11.5m for males and females, respectively (Table 12). Those for body weight are 9.4 ton for males and 12.7 ton for females.

For sperm whale, the distribution of body length and weight are shown in Figs 19 and 20.

*Anomaly testis tissues of sampled whales*
In previous JARPN surveys, anomaly testis of mature minke whales was accounted to 20.3% in frequency. In the present survey, 39 of 82 mature minke whales are revealed to have anomaly testes. The rate 47.6% is remarkably higher than those in the previous one. One immature animal was shown to be this anomaly. Of 17 male Bryde's whales, no animal reveals anomaly in his testes.

*Prey species of minke, Bryde's and sperm whale*
The summary of stomach contents of minke, Bryde's and sperm whales was shown on Table 13. Minke whale fed on six prey species consisting of 1 krill, 1 squid and 4 fish species. They fed mainly on Pacific saury in sub-area 8 and 9. On the other hand, in sub-area 7, they fed on Walleye Pollock and Japanese anchovy.

Bryde's whale fed on seven prey species consisting of 3 krill and 4 fish species. They fed mainly on Krill and Japanese anchovy.

Sperm whale fed mainly on deep-sea squids. Twenty-one squids species and 1 fish species were identified.

*Forestomach contents weight and % of body weight*
**MINKE WHALE**
The range of forestomach contents weight was from 0.0 kg to 108 kg. The maximum of % of body weight was 2.5 % (Figs 21 and 22; Table 14).

**BRYDE'S WHALE**
The range of forestomach contents weight was from 0.0 kg to 395 kg. The maximum of % of body weight was 2.5 % (Figs 23 and 24; Table 14).

*The stomach contents of sperm whales*
Table 13 shows the summary of stomach contents of eight sperm whales. They fed mainly on deep-sea squids during daytime. The range of stomach contents was from 0 kg to 30.3kg. The maximum of % of body weight was 0.3 % (Table 15).

*Mother and calf pairs of Bryde's whale*
According to sampling scheme of JARPNII, all individuals for Bryde's whales sighted were targeted for the sampling as well as minke whales. Order of sampling was determined randomly, if the school consist of two or more individuals (Kato *et al.*, 1988). However, if mother or calf was chosen by random selection in the school, the order of sampling was fixed that calf is targeted first and then her mother next for avoiding calf alone. As a result, eight mothers and nine calves were sampled. Table 16 shows the biological information on the Bryde's whale including these mother and calf pairs. Lengths of these calf ranged from 6.70m to 8.19m and those of her mother ranged from 12.39m to 13.71m having lactating mammary grounds. Body length of other 22 individuals ranged from 8.12m to14.03m having two small individuals (8.12m and 8.51m) and two lactating females (not associated with calf). Most of stomach contents were milk for the calves which were 8m or small of body length, and krill for calves over 8m. Similar trends were observed for individuals sampled as non-mother-calf pairs. This suggests that juveniles begin to eat krill around 8m of body length, and weaning of calf occurred at that time (summer) in the research area.

## Prey species survey (Co-operative survey on the prey species and ecosystem research)

*Hydroacoustic survey and plankton net sampling*
Table 17 shows the summary of Hydroacoustic survey and plankton net sampling. A total of 2,702 n.miles data was surveyed by KS2. Forty-four Maruchi net and sixty bongo net tows were conducted by KS2. Time difference between the whale and prey surveys was less than a week at most so that results of prey and cetacean surveys were seemed to be comparable.

*Mid-water trawling*
A total of 63 trawl hauls were conducted in 5 small blocks and 3 special blocks in subtropical, transitional, and sub arctic waters of the western North Pacific off Japan between 16 May and 12 July 2001, by the mid water trawl (Fig. 25, Table 17). The sampling area covered the area bounded by 35-43°N and 141-150°E. Locality of the small blocks 3 and B and the small block 4 and C largely overlapped, but sampling period of the small blocks B and C were about one and half month later than that of the small block 3 and 4, respectively.

Predetermined trawl samplings were conducted at 44 stations in the 8 small blocks during the daytime (Table 18). In the small block 1 located off Hokkaido, walleye pollock was the most abundant in the slope water region shallower than 200 m depth while Japanese common squid was dominant in the offshore region. Japanese anchovy was the most abundant species both in the small block 2 and in the western area west of 145°E of the small block 3 off Tohoku. In the small block 2 other commercial fish species such as chub mackerel *Scomber japonicus* and Japanese horse mackerel *Trachurus japonicus* were also distributed although these species were minor components. In the eastern area east of 145°E of the small block 3, Japanese common squid was relatively abundant. Japanese pilchard *Sardinops melanostictus* and Round herring *Etrumeus teres* were sometimes collected in the small blocks 2 and 3. Pacific saury was only collected in the northern part of the small block 3. In the small block B, Japanese anchovy and chub mackerel were rarely collected and no Japanese common squid was collected although this squid were often collected in the same area (small block 3) about 2 weeks ago. In other small blocks except for special block C, the total catch was very small and chub mackerel, Japanese horse mackerel, and Japanese anchovy were rarely collected. In the special block C, it was remarkable that Japanese anchovy was often collected although this species was not collected in this region (small block 4) about 1 month ago.

Night-time trawl samplings were conducted at 6 stations of the 5 small blocks (Table 19). In these stations, Stns. 1-11 were located in the slope water region shallower than 200 m depth in the small block 1 and other 5 stations are located in the offshore region. The highest and the lowest catches were observed in the offshore region of the small block 1 (Stn 1-9) and in the small block 5 located in the Kuroshio extension region, respectively. Most of the catches consisted of fishes and the most abundant fish was myctophids except for slope water region of the small block 1 (Stn 1-11). At Stn 1-11 slope water species walleye pollock was the most abundant species. The species composition of myctophid fishes was well reflected the oceanographic condition in the studied area. In the offshore region of the small block 1 (Stn 1-9) and small blocks 2 and 3 located in the northern part of the studied area, *Notoscopelus japonocus* (transitional species) was the most common species. The next most common was subarctic species in these 3 small blocks, i.e. *Tarletonbeania taylori* in the small block 1, *Diaphus theta* in the small block 2, and *Stenobrachus leucopsarus* in the small block 3. Besides, variety of the subtropical myctophid fish species were collected in the small blocks 4 and 5 located southern part of the studied area and *Ceratoscopelus warmingii* was the most abundant species in these 2 small blocks. For squid species, Japanese common squid was distributed in the offshore region of the small block 1 (Stn1-11) and small block 3 where this species was commonly collected during the daytime.

*Plankton sampling*
Total of 46 and 62 hauls were made with *Maruchi* and Twin Bongo nets, respectively (Table 18).

*Distribution of prey species suggested by the echo-sounder survey*
Figs 26-30 show the distribution of prey species suggested by the echo-sounder survey. Total of 2,702 nautical miles acoustic data was obtained. Targeting trawling of 23 times confirmed that Japanese anchovy was abundant in small block 2,and in special C (Figs 26 and 29). The distribution was sporadic in small blocks 1, 3 and 4, and special B). Those blocks were located south of Oyashio front except small block 1. In small block 1, Japanese anchovy was concentrated in a small area. Walleye pollock was abundant on the continental shelf zone in small block 1 (Fig 27). Krill were widely distribution in all small blocks and special blocks (Figs 28 and 30). Those three preys formed large schools (swarm in the case of krill) and therefore easy to detect using echo sounder.

*Length frequency of prey from trawl catch*
Length frequency of Japanese anchovy in each small block and special block was shown on Figs 31 and 32. Large size classes (9-14cm) were dominant in small blocks 2 and 3, and whereas small size classes (3-6cm) was dominate in special block C. Two size classes (14-19cm and 31-40cm) of walleye pollock were observed in small block 1 (Fig. 33). Small size classes (3-5cm) of Japanese common squid were dominant in small block 1 and 3, and special block B and C (Figs 34 and 35).

*Length frequency of prey species from stomach contents*
Length frequency of Japanese anchovy in the stomachs of minke and Bryde's whales was shown in Figs 36, 37 and 38. Minke whale fed on large size classes (12-15cm) of Japanese anchovy. Small size classes of Japanese anchovy were found in Bryde's whale stomach.

Large size classes (31-40cm) of walleye pollock were mainly found in minke whale stomach contents (Fig. 39).

Size classes between 15-20 mm of *Euphausia pacifica* were mainly found in both minke and Bryde's whale stomachs (Figs 40, 41, 42 and 43).

## DISCUSSION

### Prey species of common minke, Bryde's and sperm whales

*Minke whale*
From the JARPN surveys from 1994 to 1999, it was revealed that Japanese anchovy was the most important prey species of minke whales in May and June, while Pacific saury was the most important one in July and August (Tamura and Fujise, 2000a).

In the 2000 JARPN II feasibility survey, conducted during August and September, the dominant prey species for minke whales in the offshore area were the Japanese anchovy. Walleye pollock and Japanese common squid were the dominant species in the coastal area of sub-area 7.

In 2001 JARPN II survey, Pacific saury was the dominant prey species in sub-areas 8 and 9 and walleye pollock was the dominant prey species in the coastal area as same as in the previous survey.

In sub-areas 8 and 9 Pacific saury was the most important prey species and this results is the same as those obtained from 1994 to 1999. These results suggest that not only yearly changes but also temporal variation within a year of the prey species of minke whale.

*Bryde's whale*
Previously, krill and some small schooling fish such as Japanese anchovy and Japanese pilchard have been reported as prey species of the Bryde's whale in the North Pacific (Nemoto, 1959; Kawamura, 1980). The prey species identified during the 2000 feasibility survey were the Japanese anchovy (main) and some krill in August. The dominant prey species was krill during May and June in 2001. There are seasonal changes of prey species of Bryde's whales in the research area.

*Sperm whale*
Previous studies have indicated that the prey species of the sperm whale are mainly mesopelagic squids, which are not targeted by commercial fishery (Kawakami, 1976, 1980; Okutani *et al.*, 1976; Okutani and Satake, 1978). However, sardines, salmon (*Onchorhynchus gorbusha*), Pacific saury and Chub mackerel, which are important commercial fishes in the western North Pacific, have been also reported as prey species of the sperm whale (Kawakami, 1980).

From the 2000 and 2001 JARPN II feasibility surveys, the following information was obtained: (1) sperm whales feed mainly on deep-sea squids. Some of these are reported as prey species of the sperm whale for the first time; (2) Squids found in the sperm whale stomach are relatively fresh suggesting that sperm whale feed on these prey during daytime; (3) At least two fish species (walleye pollock and king of salmon) was identified in the diet of the sperm whale. However, the information on feeding ecology of the sperm whale is limited by the small sample size.

### Prey preference of cetaceans

Minke whales fed on dominant Pisces such as Japanese anchovy and walleye pollock that formed large schools in a given geographic area. It seems that krill was avoided by minke whales when fish were present even though minke whales fed on krill in occasion. This situation was similar to that in the Norwegian water (Skaug *et al.*, 1997; Lindstrøm and Haug, 2000). Walleye pollock was dominant prey in small block 1 in this survey while Japanese anchovy was dominant prey of minke whale based on past data (Tamura and Fujise, 2000b). Japanese anchovy was abundant in small block 1 in June 1999 (Murase unpublished data) but it was less abundant in this survey. It seems that dominant prey of minke whale reflects the abundance of the prey in a spatio/temporal scale. At this stage and based only on qualitative analysis, we are not able to determine the fish preference of minke whales when more than one fish species is present in a same geographical area. Size classes of Japanese anchovy from trawl samples and minke whale stomach contents were largely overlapped except in the case of block B. In this block a minke whale fed on large-sized classes that was not sampled in the trawling. Size class proportion of walleye pollock from minke whale stomach contents differed from the proportion in the trawl samples. In both cases, given the small sample size, it is difficult to conclude whether or not minke whale has prey size preference.

At the early stage of the survey (small blocks 3, 4 and 5, and special blocks A and B surveyed from end of May to mid June) Bryde's whales fed mainly on krill. At this stage, Japanese anchovies were mainly juveniles in the surveyed blocks. There was no sign of juvenile Japanese anchovy in the stomach contents of Bryde's whales. Bryde's whale may not feed on juvenile Japanese anchovy for some unknown reason. At the late stage of the survey (in special block C in early July), Bryde's whale fed on both Japanese anchovy and krill. Based on qualitative analysis we can not determine prey preference of Bryde's whales when more than one species were present in a same geographic area. Size classes of Japanese anchovy from trawl samples and Bryde's whale stomach contents were largely overlapped.

As same as last year, minke and Bryde's whales did not feed on meso-pelagic fishes and squids which migrate into the upper layer at night and are important prey of many marine mammals (Ohizumi, 1998). This can be explained by the fact that minke and Bryde's whales usually do not feed at night.

Prey preference is the key parameter in most ecosystem models. As diets of minke whales varied spatially and temporally (Haug *et. al.*, 1995; Tamura and Fujise, 2000a), the cooperative whale and prey surveys should be continued at least for several years to estimate the prey preference of cetaceans quantitatively.

### Feasibility of the concurrent whale and prey species surveys

There were no serious practical problems in the conduction of the concurrent prey and whale surveys. As mentioned above, preliminary analysis suggests that the data obtained from these concurrent surveys are useful to determine the prey preference of cetaceans. Information on feeding ecology of Bryde's and sperm whales could be obtained in the same way as it has been obtained for minke whale.

### Interaction between whales and fisheries

In 2001 JARPNII feasibility survey, we did not find evidence of direct interaction between minke whales and fisheries. A possible explanation is that the period of this survey did not coincide with the peak of fisheries activities such as that on Pacific saury. However, minke whales fed on some fish species targeted by commercial fisheries such as Pacific saury and walleye pollock. Further research might be necessary to clear their interaction between minke whales and walleye pollock especially in the coastal areas.

Most of the Bryde's whale sightings occurred close to the fishing grounds of skipjack tuna in July, as same as in the 2000 JARPNII survey. However, we were unable to collect samples in this area. Therefore, further research might be necessary in the future to understand this interaction.

### The sightings of large baleen whales in the sub-area 9

In the 2001 feasibility survey large number of large baleen whales are found in sub-area 9 (Figs 7-10) and wider surveys are need to investigate further the occurrence and distribution of large whale species in this sub-area.

### Sampling of cow and calf of Bryde's whales

Differences in diet between mother and calf were observed. Most of the individuals under 8.0m of body length did not feed on solid food. They feed mainly on mother's milk. However, the individuals who are over 8.0 m of body length feed on krill. A total of nine calves of Bryde's whale were collected with cows. The examination of these individuals for feeding ecology showed that the stomach contents of cows were not different from other samples and calves only had milk in the stomach. Consequently, calf samples are of less value for the studies of feeding ecology.

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## Table 1. Outline of 2001 JARPN II survey.

| Research | Research periods | Days | Sub-area | small block | Research ships |
|---|---|---|---|---|---|
| Cooperative survey (first period) | 14, May-23, June | 40.5 | 7 | | NM, YS1, K01, T25, TOR. KS2 |
| | 14-22, May | 8.5 | | 2 | |
| | 22-27, May | 5.5 | | 3 | |
| | 28, May-2, June | 5.5 | | 5 | |
| | 2-9, June | 7.5 | | between 3 and 4 | |
| | 10-13, June | 4 | | 4 | |
| | 14-18, June | 5 | | nearly 3 | |
| | 19-23, June | 4.5 | | 1 | |
| Whale survey (first period) | 23, June-10, July | 17.5 | 7,8,9 | | NM, YS1, K01, T25 |
| | 23-24, June | 1 | 7 | | |
| | 24-25, June | 1 | 8 | | |
| | 25, June-9, July | 14.5 | 9 | | |
| | 10, July | 1 | 8 | | |
| Cooperative survey (second period) | 11-13, July | 2.5 | 7 | nearly 4 | NM, YS1, K01, T25, TOR. KS2 |
| Whale survey (second period) | 13, July-3, Aug. | 21.5 | 8,9 | | NM, YS1, K01, T25 |
| | 13-20, July | 7 | 8 | | |
| | 20-30, July | 10 | 9 | | |
| | 30-31, July | 1 | 8 | | |
| | 31, July-2, Aug. | 2 | 9 | | |
| | 2-3, Aug | 1.5 | 8 | | |
| Total | 14, May-3, Aug. | 82 | | | NM, YS1, K01, T25, TOR. KS2 |

Research base ship: Nisshin Maru (NM)
Sighting and Sampling vessels (SSVs) : Yushin Maru (YS1), Kyo Maru No.1 (K01) and Toshi Maru No.25 (T25)
Sighting vessel (SV) : Kyoshin Maru No.2 (KS2)
Trawl survey vessel : Torishima Maru (TOR)

## Table 2. Searching distances made by the three sighting/sampling vessels (YS1, K01 and T25) and dedicated sighting vessel (KS2) in the 2001 JARPN II survey.

| Sub-area | Period | Searching distance (n.miles) | | | | |
|---|---|---|---|---|---|---|
| | | NSC | ASP | NSS | NSP | Combined |
| SSVs | | | | | | |
| 7 | 14, May-24, June | 3,699.0 | 196.5 | 1,851.2 | 425.3 | 6,172.0 |
| | 11-13, July | 59.9 | 0.0 | 203.9 | 0.0 | 263.8 |
| | | 3,758.9 | 196.5 | 2,055.1 | 425.3 | 6,435.8 |
| 8 | 24-25, June | 0.0 | 0.0 | 0.0 | 235.0 | 235.0 |
| | 10-Jul | 0.0 | 153.5 | 0.0 | 0.0 | 153.5 |
| | 13, July-3, Aug. | 1,382.7 | 76.2 | 299.5 | 0.0 | 1,758.4 |
| | | 1,382.7 | 229.7 | 299.5 | 235.0 | 2,146.9 |
| 9 | 25, June-9, July | 1,383.0 | 528.9 | 1,157.3 | 0.0 | 3,069.2 |
| | 20, July-2, Aug. | 1,822.2 | 0.0 | 885.5 | 0.0 | 2,707.7 |
| | | 3,205.2 | 528.9 | 2,042.8 | 0.0 | 5,776.9 |
| Combined | 14, May-3, Aug. | 8,346.8 | 955.1 | 4,397.4 | 660.3 | 14,359.6 |
| SV(KS2) | | | | | | |
| 7 | 11, May-24, June; 7-15, July | 0.0 | 733.2 | 0.0 | 1,976.0 | 2,709.2 |
| 9 | 27, June -5, July | 0.0 | 348.6 | 0.0 | 17.6 | 366.2 |
| Combined | | 0.0 | 1,081.8 | 0.0 | 1,993.6 | 3,075.4 |

**Table 3. List of cetacean species and number of sightings (no. schools/no. individuals) were made by three sighting/sampling vessels in the 2001 JARPN II survey (Total area: 5/14-8/3).**

| Species | Primary | | Secondary | | Total | |
|---|---|---|---|---|---|---|
| | Sch. | Ind. | Sch. | Ind. | Sch. | Ind. |
| Common minke whale | 73 | 75 | 60 | 61 | 133 | 136 |
| Like minke whale | 6 | 6 | 15 | 15 | 21 | 21 |
| Blue whale | 20 | 28 | 3 | 3 | 23 | 31 |
| Fin whale | 11 | 17 | 4 | 6 | 15 | 23 |
| Sei whale | 96 | 130 | 14 | 18 | 110 | 148 |
| Bryde's whale | 34 | 42 | 30 | 35 | 64 | 77 |
| Humpback whale | 9 | 12 | 6 | 6 | 15 | 18 |
| Right whale | 1 | 2 | 1 | 1 | 2 | 3 |
| Sperm whale | 224 | 506 | 102 | 442 | 326 | 948 |
| Unidentified large cetacean | 10 | 11 | 8 | 8 | 18 | 19 |

**Table 4. List of cetacean species and number of sightings (no. schools/no. individuals) were made by dedicated sighting vessel (KS2) in the 2001 JARPN II survey (Total area: 5/10-7/16).**

| Species | Primary | | Secondary | | Total | |
|---|---|---|---|---|---|---|
| | Sch. | Ind. | Sch. | Ind. | Sch. | Ind. |
| Common minke whale | 14 | 16 | 1 | 1 | 15 | 17 |
| Like minke whale | 2 | 2 | 1 | 1 | 3 | 3 |
| Bryde's whale | 36 | 48 | 2 | 3 | 38 | 51 |
| Sei whale | 6 | 17 | 0 | 0 | 6 | 17 |
| Humpback whale | 7 | 9 | 0 | 0 | 7 | 9 |
| Sperm whale | 37 | 210 | 6 | 26 | 43 | 236 |
| Unidentified large cetacean | 10 | 20 | 4 | 4 | 14 | 24 |

**Table 5. Summary of prey species surveys in 2001 JARPNII survey.**

| Research Items | type | effort |
|---|---|---|
| **<KS2>** | | |
| Echo-sounder survey | | 2,702 n.miles |
| Net sampling | Bongo | 60 points |
| | Maruchi | 44 points |
| EPCS | | 1,185 hours |
| **<TOR>** | | |
| CTD | | 64 points |
| Trowl | Target | 13 points |
| | Normal | 43 points |
| | Night | 6 points |

**Table 6. Summary of whale sampling in the 2001 JARPN II survey.**

| Research | Research periods | Sub-area (small block) | Whale samples | | |
|---|---|---|---|---|---|
| | | | Common minke | Bryde's | Sperm |
| **Cooperative survey (first period)** | **14, May-23, June** | **7 (1, 2, 3, 4, 5)** | **50** | **39** | **8** |
| | 14-22, May | 7 (2) | 24 | | 1 |
| | 22-27, May | 7 (3) | 4 | 2 | |
| | 28, May-2, June | 7 (5) | | 4 | 3 |
| | 2-9, June | 7 (SMS A) | 2 | 10 | 3 |
| | 10-13, June | 7 (4) | | 4 | |
| | 14-18, June | 7 (SMS B) | 10 | 19 | 1 |
| | 19-23, June | 7 (1) | 10 | | |
| **Whale survey (first period)** | **23, June-10, July** | **7,8,9** | **11** | | |
| | 23-24, June | 7 | | | |
| | 24-25, June | 8 | | | |
| | 25, June-9, July | 9 | 11 | | |
| | 10, July | 8 | | | |
| **Cooperative survey (second period)** | **11-13, July** | **7 (SMS C)** | | 11 | |
| **Whale survey (second period)** | **13, July-3, Aug.** | **8,9** | **39** | | |
| | 13-20, July | 8 | 18 | | |
| | 20-30, July | 9 | 9 | | |
| | 30-31, July | 8 | 3 | | |
| | 31, July-2, Aug. | 9 | 9 | | |
| | 2-3, Aug | 8 | | | |
| **Total** | **14, May-3, Aug.** | **82** | **100** | **50** | **8** |

**Table 7. Summary of biological data and samples collected during the 2001 JARPN II survey.**

| Samples and data | Common minke | | | Bryde's whale | | | Sperm whale | | |
|---|---|---|---|---|---|---|---|---|---|
| | M | F | T | M | F | T | M | F | T |
| Body length and sex | 93 | 7 | 100 | 17 | 33 | 50 | 2 | 6 | 8 |
| External body proportion | 93 | 7 | 100 | 17 | 33 | 50 | 2 | 6 | 8 |
| Photographic record and external character | 93 | 7 | 100 | 17 | 33 | 50 | 2 | 6 | 8 |
| Diatom film record and sampling | 93 | 7 | 100 | 17 | 33 | 50 | 2 | 6 | 8 |
| Standard measurements of blubber thickness (eleven points) | 93 | 7 | 100 | 17 | 33 | 50 | 2 | 6 | 8 |
| Detailed measurements of blubber thickness (fourteen points) | 29 | 3 | 32 | 3 | 13 | 16 | 0 | 0 | 0 |
| Body weight | 93 | 7 | 100 | 17 | 33 | 50 | 2 | 6 | 8 |
| Body weight by parts | 29 | 3 | 32 | 3 | 13 | 16 | 2 | 4 | 6 |
| Blubber, muscle, liver and heart tissues for DNA study | 93 | 7 | 100 | 17 | 33 | 50 | 2 | 6 | 8 |
| Muscle, liver and heart tissues for isozyme analysis | 93 | 7 | 100 | 17 | 33 | 50 | 2 | 6 | 8 |
| Muscle, liver and kidney tissues for heavy metal analysis | 93 | 7 | 100 | 17 | 33 | 50 | 2 | 6 | 8 |
| Blubber, muscle, liver and kidney tissues for organochlorine analysis | 93 | 7 | 100 | 17 | 33 | 50 | 2 | 6 | 8 |
| Tissues for lipid analysis | 29 | 3 | 32 | 3 | 13 | 16 | 2 | 6 | 8 |
| Tissues for endocrine disrupters analysis | 93 | 7 | 100 | 17 | 33 | 50 | 2 | 6 | 8 |
| Muscle and liver for chemical analysis | 93 | 7 | 100 | 17 | 33 | 50 | 2 | 6 | 8 |
| Muscle, blubber and intestin content for energy flow analysis | 30 | 3 | 33 | 17 | 33 | 50 | 2 | 5 | 7 |
| Spleen and testis for virus test | 93 | 7 | 100 | 17 | 33 | 50 | 2 | 6 | 8 |
| Mammary grand; lactation status, measurement and histological sample | 0 | 7 | 7 | 0 | 33 | 33 | 0 | 6 | 6 |
| Collection of maternal milk sample | 0 | 0 | 0 | 0 | 6 | 6 | 0 | 0 | 0 |
| Uterine horn; measurement and endometrium sample | 0 | 7 | 7 | 0 | 33 | 33 | 0 | 6 | 6 |
| Uterine mucus for sperm detection | 0 | 0 | 0 | 0 | 30 | 30 | 0 | 6 | 6 |
| Collection of ovary | 0 | 7 | 7 | 0 | 33 | 33 | 0 | 6 | 6 |
| Photographic record of foetus | 0 | 3 | 3 | 3 | 7 | 11[*1] | 0 | 4 | 4 |
| Foetal sex (identified by visual observation) | 0 | 3 | 3 | 3 | 7 | 10 | 0 | 4 | 4 |
| Foetal length and weight | 0 | 3 | 3 | 3 | 7 | 11[*1] | 0 | 4 | 4 |
| External measurements of foetus | 0 | 3 | 3 | 3 | 7 | 10 | 0 | 4 | 4 |
| Collection of foetus | 0 | 3 | 3 | 3 | 7 | 11[*1] | 0 | 4 | 4 |
| Testis and epididymis; weight and histological sample | 93 | 0 | 93 | 17 | 0 | 17 | 2 | 0 | 2 |
| Smear samples from testis and epididymis tissues | 0 | 0 | 0 | 17 | 0 | 17 | 2 | 0 | 2 |
| Urine sample for sperm detection | 0 | 0 | 0 | 5 | 0 | 5 | 1 | 0 | 1 |
| Collection of serum sample | 93 | 7 | 100 | 17 | 33 | 50 | 2 | 6 | 8 |
| Whole blood samples from umbilical cord | 0 | 0 | 0 | 0 | 5 | 5 | 0 | 4 | 4 |
| Serum samples from umbilical cord | 0 | 0 | 0 | 0 | 5 | 5 | 0 | 4 | 4 |
| Stomach content, conventional record | 93 | 7 | 100 | 17 | 33 | 50 | 2 | 6 | 8 |
| Volume and weight of stomach content in each compartment | 93 | 7 | 100 | 17 | 33 | 50 | 2 | 6 | 8 |
| Measurement of gastric juice pH | 24 | 2 | 26 | 0 | 6 | 6 | 1 | 3 | 4 |
| Stomach contents for feeding study | 90 | 7 | 97 | 14 | 28 | 42 | 2 | 6 | 8 |
| Record of external parasites | 93 | 7 | 100 | 17 | 33 | 50 | 2 | 6 | 8 |
| Collection of external parasites | 19 | 2 | 21 | 16 | 29 | 45 | 2 | 5 | 7 |
| Record of internal parasites | 93 | 7 | 100 | 17 | 33 | 50 | 2 | 6 | 8 |
| Collection of internal parasites | 1 | 0 | 1 | 4 | 4 | 8 | 2 | 3 | 5 |
| Earplug for age determination | 93 | 7 | 100 | 17 | 33 | 50 | 0 | 0 | 0 |
| Tympanic bulla for age determination | 93 | 7 | 100 | 17 | 33 | 50 | 2 | 5 | 7 |
| Maxillally teeth for age determination | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 6 | 8 |
| Largest baleen plate for morphologic study and age determination | 93 | 7 | 100 | 17 | 33 | 50 | 0 | 0 | 0 |
| Largest baleen plate for stable isotopes | 93 | 7 | 100 | 17 | 33 | 50 | 0 | 0 | 0 |
| Baleen plate measurements (length and breadth) | 93 | 7 | 100 | 17 | 33 | 50 | 0 | 0 | 0 |
| Length of each baleen plate series | 93 | 7 | 100 | 17 | 33 | 50 | 0 | 0 | 0 |
| Vertebral epiphyses sample | 93 | 7 | 100 | 17 | 33 | 50 | 2 | 6 | 8 |
| Number of vertebrae | 93 | 7 | 100 | 17 | 33 | 50 | 2 | 6 | 8 |
| Number of ribs | 93 | 7 | 100 | 17 | 33 | 50 | 2 | 6 | 8 |
| Brain weight | 29 | 3 | 32 | 3 | 13 | 16 | 2 | 3 | 5 |
| Skull measurement (length and breadth) | 93 | 7 | 100 | 17 | 33 | 50 | 2 | 4 | 6 |
| Collection of skull | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Collection of whole skeleton | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

[*1]including fetuses of sex unidentified

**Table 8. Summary of biopsy skin sampling for Bryde's, sperm whales, common minke whales and blue whales in the 2001 JARPN II survey.**

| Date | Vessel | Sub area | Sighting No. | Species | Sch. Size | Samples | Sample number |
|---|---|---|---|---|---|---|---|
| 2001/5/29 | YS1 | 7 | 7003 | Sperm | 18 | 1 | J0015YS1S1 |
| 2001/6/2 | YS1 | 7 | 7003 | Sperm | 5 | 1 | J0015YS1S2 |
| 2001/6/5 | YS1 | 7 | 7004 | Sperm | 4 | 1 | J0015YS1S3 |
| 2001/6/17 | YS1 | 7 | 7006 | Minke | 1 | 1 | J0015YS1M4 |
| 2001/6/17 | YS1 | 7 | 5013 | Bryde's | 2 | 1 | J0015YS1Br5 |
| 2001/6/17 | YS1 | 7 | 5013 | Bryde's | 2 | 1 | J0015YS1Br6 |
| 2001/7/9 | YS1 | 9 | 7001 | Blue | 2 | 1 | J0015YS1B7 |
| 2001/5/21 | K01 | 7 | 1002 | Sperm | 25 | 0 | |
| 2001/5/21 | K01 | 7 | 1006 | Sperm | 25 | 1 | J01NK01S01 |
| 2001/6/3 | K01 | 7 | 1001 | Sperm | 09 | 1 | J01NK01S02 |
| 2001/6/3 | K01 | 7 | 5008 | Sperm | 17 | 1 | J01NK01S03 |
| 2001/6/18 | K01 | 7 | 1002 | Bryde's | 01 | 1 | J01NK01BR01 |
| 2001/6/18 | K01 | 7 | 1003 | Bryde's | 01 | 1 | J01NK01BR02 |
| 2001/6/18 | K01 | 7 | 1004 | Bryde's | 01 | 1 | J01NK01BR03 |
| 2001/5/14 | T25 | 7 | 5002 | Sperm | 6 | 0 | |
| 2001/5/28 | T25 | 7 | 5004 | Sperm | 1 | 0 | |
| 2001/5/28 | T25 | 7 | 5005 | Sperm | 7 | 1 | J00NT25S01 |
| 2001/5/29 | T25 | 7 | 5005 | Sperm | 2 | 0 | |
| 2001/6/2 | T25 | 7 | 5002 | Sperm | 9 | 1 | J00NT25S02 |
| 2001/6/2 | T25 | 7 | 5003 | Sperm | 7 | 1 | J00NT25S03 |
| 2001/6/11 | T25 | 7 | 5002 | Sperm | 2 | 0 | |
| 2001/6/17 | T25 | 7 | 5009 | Minke | 1 | 1 | J00NT25M04 |
| 2001/6/30 | T25 | 9 | 5004 | Blue | 1 | 0 | |
| 2001/6/28 | KS2 | 7 | 2001 | Sperm | 1 | 1 | J01NKS2S01 |
| 2001/6/28 | KS2 | 7 | 2001 | Sperm | 1 | 1 | J01NKS2S02 |

**Table 9. Composition of sex and sexual maturity of common minke whales collected by the 2001 JARPN II survey.**

| Sub-area | Male | | | Female | | | | Sex ratio | Maturity | | Pregnancy |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Imm. | Mat. | Total | Imm | Rest. | Preg. | Total | (% males) | Male | Female | rate*) |
| 7 | 11 (22.0) | 36 (72.0) | 47 (94.0) | 3 (6.0) | 0 (0.0) | 0 (0.0) | 3 (6.0) | 94.0 | 76.6 | 0.0 | - |
| 8 | 0 (0.0) | 20 (95.2) | 20 (95.2) | 0 (0.0) | 0 (0.0) | 1 (4.8) | 1 (4.8) | 95.2 | 100.0 | 100.0 | 100.0 |
| 9 | 0 (0.0) | 26 (89.7) | 26 (89.7) | 1 (3.4) | 0 (0.0) | 2 (6.9) | 3 (10.3) | 89.7 | 100.0 | 66.7 | 100.0 |
| Combined | 11 (11.0) | 82 (82.0) | 93 (93.0) | 4 (4.0) | 0 (0.0) | 3 (3.0) | 7 (7.0) | 93.0 | 88.2 | 42.9 | 100.0 |

*) Apparent pregnancy rate

**Table 10. Composition of sex and sexual maturity of Bryde's whales collected by the 2001 JARPN II survey.**

| Sub-area | Male | | | Female | | | | | | | Sex ratio | Maturity | | Pregnancy |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Imm. | Mat. | Total | Imm | Ovu. | Rest. | Preg. | Lact. | P&L | Total | (% males) | Male | Female | rate*) |
| 7 First | 7 (17.9) | 2 (5.1) | 9 (23.1) | 12 (30.8) | 2 (5.1) | 0 (0.0) | 8 (20.5) | 8 (20.5) | 0 (0.0) | 30 (76.9) | 23.1 | 22.2 | 60.0 | 44.4 |
| 7 Second | 6 (54.5) | 2 (18.2) | 8 (72.7) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 2 (18.2) | 1 (9.1) | 0 (0.0) | 3 (27.3) | 72.7 | 25.0 | 100.0 | 66.7 |
| Combined | 13 (26.0) | 4 (8.0) | 17 (34.0) | 12 (24.0) | 2 (4.0) | 0 (0.0) | 10 (20.0) | 9 (18.0) | 0 (0.0) | 33 (66.0) | 34.0 | 23.5 | 63.6 | 47.6 |

*) Apparent pregnancy rate

**Table 11. Statistics of body length (m) and body weight (ton) of common minke whales in each sub-area.**

A. Body length (m)

| Sub | Male | | | | | Female | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| area | Mean | S.D. | Min | Max | n | Mean | S.D. | Min | Max | n |
| 7 | 7.01 | 0.89 | 4.44 | 8.29 | 47 | 4.84 | 0.47 | 4.35 | 5.28 | 3 |
| 8 | 7.72 | 0.32 | 7.25 | 8.62 | 20 | 8.75 | | 8.75 | 8.75 | 1 |
| 9 | 7.63 | 0.31 | 6.87 | 8.24 | 26 | 8.21 | 0.59 | 7.57 | 8.73 | 3 |

B. Body weight (ton)

| Sub | Male | | | | | Female | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| area | Mean | S.D. | Min | Max | n | Mean | S.D. | Min | Max | n |
| 7 | 4.06 | 1.20 | 1.20 | 5.70 | 47 | 1.26 | 0.23 | 1.00 | 1.44 | 3 |
| 8 | 4.99 | 0.47 | 4.20 | 6.15 | 20 | 6.95 | | 6.95 | 6.95 | 1 |
| 9 | 4.87 | 0.49 | 3.70 | 5.75 | 26 | 5.74 | 1.46 | 4.05 | 6.61 | 3 |

**Table 12. Statistics of body length (m) and body weight (ton) of Bryde's whales in each sub-area.**

A. Body length (m)

| Sub | | Male | | | | | Female | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| area | | Mean | S.D. | Min | Max | n | Mean | S.D. | Min | Max | n |
| 7 | First | 9.98 | 2.07 | 7.57 | 13.30 | 9 | 11.33 | 2.27 | 6.70 | 14.03 | 30 |
| 7 | Second | 10.79 | 1.34 | 8.19 | 12.33 | 8 | 12.80 | 0.21 | 12.61 | 13.02 | 3 |
| Combined | | 10.36 | 1.76 | 7.57 | 13.30 | 17 | 11.46 | 2.21 | 6.70 | 14.03 | 33 |

B. Body weight (ton)

| Sub | | Male | | | | | Female | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| area | | Mean | S.D. | Min | Max | n | Mean | S.D. | Min | Max | n |
| 7 | First | 8.67 | 5.21 | 4.00 | 17.65 | 9 | 12.29 | 5.72 | 2.80 | 20.99 | 30 |
| 7 | Second | 10.24 | 3.15 | 5.00 | 13.60 | 8 | 17.02 | 2.26 | 14.45 | 18.75 | 3 |
| Combined | | 9.41 | 4.31 | 4.00 | 17.65 | 17 | 12.72 | 5.65 | 2.80 | 20.99 | 33 |

**Table 13. Prey species found in stomach of common minke, Bryde's and sperm whales sampled by the JARPN II surveys in 2001.**

**Common minke whale**

| | | |
|---|---|---|
| Krill | | *Euphausia pacifica* |
| Squid | Japanese common squid | *Todarodes pacificus* |
| Pisces | Japanese anchovy | *Engraulis japonicus* |
| | Japanese pilchard | *Sardinops melanostictus* |
| | Pacific saury | *Colorais saira* |
| | Walleye pollock | *Theragra chalcogramma* |

**Bryde's whale**

| | | |
|---|---|---|
| Krill | | *Euphausia pacifica* |
| | | *E. similis* |
| | | *Thysanoessa inspinata* |
| Pisces | Japanese anchovy | *Engraulis japonicus* |
| | | *Taletonbeania taylori* |
| | | *Diaphus theta* |
| | | *Vinciguerria nimbaria* |

**Sperm whale**

| | |
|---|---|
| Squid | *Gonatus pyros* |
| | *G.* spp. |
| | *Chiroteuthis imperator* |
| | *C. calyx* |
| | *Ancistrocheirus lesueuri* |
| | *Galiteuthis pacifica* |
| | *Taonius pacifica borealis* |
| | *Megalocranchia* sp. |
| | *Moroteuthis loennbergi* |
| | *Histioteuthis dofleini* |
| | *Histioteuthis corona inermis* |
| | *Discoteuthis discus* |
| | *Cycloteuthis akimushkini* |
| | *Taningia danae* |
| | *Octopoteuthis deletron* |
| | *O. megaptera* |
| | *O.* sp. |
| | *O.* sp. |
| | *Ommastrephes bartrami* |
| | *Asperoteuthis acanthoderma* |
| | *Pholodoteuthis boschmai* |
| Pisces | *Trachipterus ishikawae* |

**Table 14. Frequencies of major prey species and their weight during observation for stomachs of common minke and Bryde's whales.**

**a. Common minke whales**

| | Sub-area 7 | | | | Sub-area 8 | | | | Sub-area 9 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | n | Mean | Min | Max | n | Mean | Min | Max | n | Mean | Min | Max |
| Krill | 8 | 24.9 | 0.0 | 40.9 | | | | | | | | |
| Japanese anchovy | 25 | 30.4 | 0.1 | 107.7 | 1 | 56.5 | | | | | | |
| Pacific saury | | | | | 12 | 23.4 | 3.0 | 56.4 | 23 | 31.1 | 1.8 | 94.8 |
| Walleye pollock | 3 | 40.8 | 26.2 | 51.6 | | | | | | | | |
| Krill + Japanese anchovy | 2 | 31.7 | 27.8 | 35.6 | | | | | | | | |
| Krill + Pacific saury | | | | | 3 | 32.2 | 13.0 | 45.5 | 4 | 28.9 | 25.2 | 32.1 |
| Krill + W. pollock | 1 | 15.6 | | | | | | | | | | |
| J. anchovy + W. pollock | 5 | 37.3 | 9.1 | 61.2 | | | | | | | | |
| P. saury + Common squid | | | | | 1 | 80.9 | | | | | | |
| P. saury + Other fish | | | | | 1 | 38.2 | | | | | | |
| Blank | 0 | | | | 0 | | | | 1 | | | |
| Broken | 6 | | | | 3 | | | | 1 | | | |
| Total | 50 | | | | 21 | | | | 29 | | | |

**b. Bryde's whale**

| | Sub-area 7 | | | |
|---|---|---|---|---|
| | n | Mean | Min | Max |
| Krill | 31 | 54.6 | 1.0 | 394.5 |
| Krill (Calf) | (4) | 0.9 | 1.0 | 2.5 |
| Japanse anchovy | 2 | 20.5 | 19.4 | 21.7 |
| Other | 1 | 95.8 | | |
| J. anchovy + Krill | 1 | 20.4 | | |
| Blank | 13 | | | |
| Blank (Calf) | (4) | | | |
| Broken | 2 | | | |
| Total | 50 | | | |

## Table 15. Data on sperm whales of which stomach contents were examined.

| No. | Small block | Sampling date | Sighting time | Sighting position N. Lat. | | E. Long. | | Length (m) | Weight (t) | Sex | Weight of s. c. (kg)* | Ratio of body weight (%) | Freshness of s. c. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 5.14 | 13.01 | 37 | 37.0 | 142 | 30.1 | 9.2 | 10.9 | F | 3.1 | 0.03 | f |
| 2 | 5 | 5.28 | 9.15 | 36 | 28.0 | 142 | 58.4 | 10.2 | 14.4 | M | 1.4 | 0.01 | f |
| 3 | 5 | 5.28 | 16.31 | 35 | 32.4 | 142 | 29.9 | 10.2 | 16.2 | F | 27.4 | 0.17 | fff |
| 4 | 5 | 6.01 | 11.04 | 35 | 9.4 | 144 | 14.6 | 9.7 | 11.8 | F | 15.4 | 0.13 | fff |
| 5 | 4-5 | 6.02 | 12.23 | 36 | 51.4 | 145 | 30.7 | 9.0 | 10.8 | M | 30.3 | 0.28 | ff |
| 6 | 4-5 | 6.09 | 6.43 | 37 | 36.9 | 146 | 27.3 | 10.2 | 15.5 | F | 0.0 | 0.00 | |
| 7 | 4-5 | 6.09 | 17.50 | 37 | 16.0 | 146 | 50.0 | 9.1 | 11.8 | F | 2.9 | 0.02 | f |
| 8 | 4-3 | 6.14 | 7.39 | 38 | 43.6 | 146 | 43.4 | 11.0 | 21.9 | F | 5.4 | 0.02 | f |

* : Including forestomach, fundas and third stomach contents

s. c.: : stomach contents

## Table 16. Data on cow and calf of Bryde's whale in the 2000 and 2001 JARPN II surveys.

| | | | Sampling date | Body length (m) | Body weight (t) | Sex | Stomach contents* Species | Volume | Size (Eu) | Digestion stage | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Cow and calf** | | | | | | | | | | | |
| **Small** | | | | | | | | | | | |
| 2001 | B001 | Calf? | 2001/5/27 | 6.70 | 2.80 | F | | 0 | | | Like-milk in 3rd. stomach |
| 2001 | B028 | Calf? | 2001/6/15 | 7.47 | 4.25 | F | | 0 | | | Like-milk and krill in 3rd. stomach |
| 2001 | B031 | Calf? | 2001/6/16 | 7.57 | 4.50 | M | | 0 | | | Like-milk in 1st.-4th. stomach |
| 2001 | B010 | Calf? | 2001/6/3 | 7.80 | 4.00 | M | | 0 | | | Like-milk in 3rd. stomach |
| 2001 | B015 | Calf? | 2001/6/6 | 8.07 | 4.44 | F | Eu | 1 | S | 3 | Krill only |
| 2001 | B025 | Calf? | 2001/6/15 | 8.20 | 5.39 | M | Eu | 1 | S | 4 | Krill only |
| 2001 | B029 | Calf? | 2001/6/16 | 8.57 | 6.00 | F | Eu | 1 | S | 3 | Krill only |
| 2001 | B046 | Calf? | 2001/7/12 | 8.19 | 5.00 | M | Eu | 1 | S | 3 | Like-milk in 3rd. stomach, Like-milk and krill in 4th stomach |
| **Large** | | | | | | | | | | | |
| 2001 | B002 | Cow? | 2001/5/27 | 12.39 | 14.30 | F | Eu | 1 | S | 2 | Lactation (B001, B002) |
| 2001 | B011 | Cow? | 2001/6/3 | 13.77 | 16.45 | F | | 0 | | | Lactation (B010, B011) |
| 2001 | B016 | Cow? | 2001/6/6 | 13.11 | 16.40 | F | Eu | 2 | S | 3 | Lactation (B015, B016) |
| 2001 | B026 | Cow? | 2001/6/15 | 13.14 | 17.30 | F | Eu | 1 | S | 4 | Lactation (B025, B026) |
| 2001 | B030 | Cow? | 2001/6/16 | 12.55 | 14.25 | F | Eu | 1 | S | 3 | Lactation (B029, B030) |
| 2001 | B032 | Cow? | 2001/6/16 | 13.71 | 18.60 | F | | 0 | | | Lactation (B031, B032) |
| 2001 | B047 | Cow? | 2001/7/12 | 12.61 | 14.45 | F | Fish | 5 | | 2 | Lactation (B046, B047) |
| **Independent individual** | | | | | | | | | | | |
| 2001 | B035 | | 2001/6/17 | 8.12 | 4.30 | F | Eu | 1 | S | 4 | Imm. |
| 2001 | B006 | | 2001/5/30 | 8.51 | 4.65 | F | Eu | 1 | S | 3 | Imm |
| 2001 | B009 | | 2001/6/3 | 8.65 | 5.45 | F | Eu | 1 | S | 4 | Imm |
| 2001 | B021 | | 2001/6/14 | 8.74 | 5.34 | F | Eu | 1 | S | 3 | Imm. |
| 2001 | B008 | | 2001/6/3 | 9.24 | 5.80 | M | Eu | 1 | S | 2 | Imm. |
| 2001 | B007 | | 2001/6/3 | 9.65 | 7.60 | F | Eu | 2 | S | 2 | Imm. |
| 2001 | B022 | | 2001/6/14 | 9.70 | 5.75 | M | Eu | 4 | S | 1 | Imm. |
| 2001 | B034 | | 2001/6/16 | 9.76 | 7.35 | F | Eu | 1 | S | 2 | Imm. |
| 2001 | B005 | | 2001/5/29 | 10.12 | 7.85 | M | Eu | 2 | S | 1 | Imm. |
| 2001 | B003 | | 2001/5/29 | 11.24 | 10.20 | M | | 0 | | | Imm. |
| 2001 | B004 | | 2001/5/29 | 11.61 | 11.10 | F | Eu | 3 | S | 2 | Preg. (Foetus =20.5cm F) |
| 2001 | B033 | | 2001/6/16 | 11.70 | 11.76 | F | Eu | 2 | S | 2 | Imm. |
| 2001 | B027 | | 2001/6/15 | 12.06 | 15.45 | F | Eu | 1 | S | 4 | Rest. |
| 2001 | B024 | | 2001/6/15 | 12.54 | 17.00 | F | Eu | 1 | S | 4 | Rest. |
| 2001 | B019 | | 2001/6/11 | 12.67 | 16.85 | M | Eu | 1 | S | 4 | Mat |
| 2001 | B020 | | 2001/6/11 | 13.30 | 17.65 | M | | 0 | | | Mat |
| 2001 | B013 | | 2001/6/4 | 13.31 | 19.35 | F | Fish | 4 | | 2 | Preg. (Foetuses =178cmM, 187cmM) |
| 2001 | B017 | | 2001/6/10 | 13.50 | 18.05 | F | Eu | 1 | S | 3 | Preg. (Foetus = 156cm F) |
| 2001 | B014 | | 2001/6/5 | 13.99 | 20.75 | F | Eu | 3 | S | 2 | Preg. (Foetus = 202cm F) |
| 2001 | B018 | | 2001/6/11 | 14.03 | 20.99 | F | Eu | 2 | S | 2 | Preg. (Foetus = 333cm F) |
| 2001 | B012 | | 2001/6/3 | 13.10 | 14.60 | F | | 0 | | | Lactation |
| 2001 | B023 | | 2001/6/14 | 12.75 | 16.20 | F | Eu | 4 | S | 1 | Lactation |
| **Mother and calf (00NP)** | | | | | | | | | | | |
| 2000 | B039 | Calf? | 2000/9/10 | 8.54 | 6.35 | F | | 0 | | | |
| 2000 | B040 | Cow? | 2000/9/10 | 13.51 | 19.96 | F | | 0 | | | Lactation |

*: Species: Eu=Euphausiacea, Ot=Other

Volume: 0=Empty, 1=<25%, 2=25-50%, 3=50-75%, 4=75-100%, 5=Broken

Size: L=large size, M=Middle size, S= Small size

Digestion stage: 4=Fresh, 3=Lightly degested, 2=Moderately digested, 1=Heavily digested

## Table 17. Summary of prey survey

| Small Block | Prey survey period | Cetacean survey period | No. of trackline | Fixed distance (n.mile) | Distance covered by echo sounder (n.mile) | Cetacean survey searching distance(KS 2) (n.mile) | No. of taget trawl point | No. of daytime trawl station | No. of nighttime trawl station | No. of sampled minke whale (ind.) | No. of sampled Bryde's whale (ind.) | No. of sampled sperm whale (ind.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 19-24 Jun. | 19-23 Jun. | 4 | 322 | 334 | 267.8 | 4 | 6 | 2 | 10 | 0 | 0 |
| 2 | 17-21 May | 14-18 May& 21-22 May | 5 | 400 | 414 | 276.6 | 4 | 7 | 1 | 24 | 0 | 1 |
| 3 | 22-26 May | 22-27 May | 2 | 222.4 | 224 | 113.7 | 1 | 4 | 1 | 4 | 2 | 0 |
| 4 | 3 Jun.* | — | 2 | — | 193 | 67.9 | 0 | 2 | 0 | 0 | 0 | 0 |
| | 11-13 Jun. | 10-13 Jun. | | 223.5 | | 209.9 | 1 | 4 | 1 | 0 | 4 | |
| 5 | 28 May-2 Jun. | 28-29 May & 31 May-2 Jun. | 4 | 397.3 | 195 | 261.8 | 1 | 10 | 1 | 0 | 4 | 3 |
| Sub Total | | | 17 | 1565.2 | 1360 | 1197.7 | 11 | 33 | 6 | 38 | 10 | 4 |
| Special-A | 4-10 Jun. | 4-10 Jun. | 8 | 402.1 | 249 | 228.6 | 1 | 4 | 0 | 2 | 10 | 3 |
| Special-B ** | — | 13-18 Jun. | 5 | 340.4 | — | — | — | — | — | 10 | 19 | 1 |
| | 15-18 Jun. | — | 11 | 470.6 | 425 | 346.8 | 0 | 1 | 0 | 0 | 0 | 0 |
| Special-C | 7-12 Jul. | 11-13 Jul. | 4 | 448.2 | 668 | 522.4 | 1 | 6 | 0 | 0 | 11 | 0 |
| | 13-15 Jul.*** | — | 2 | 222.4 | | | — | — | — | 0 | 0 | 0 |
| Sub Total | | | 30 | 1883.7 | 1342 | 1097.8 | 2 | 11 | 0 | 12 | 40 | 4 |
| Total | | | 47 | 3448.9 | 2702 | 2295.5 | 13 | 44 | 6 | 50 | 50 | 8 |

* *Not for analysis (duplication survey).*

** *Prey survey's transect was different from cetacean sampling & survey vessels'.*

*** *Only KS2 (Acoustic & Sighting survey).*

**Table 18. Summary of results of trawling during prey survey. Catch weight (kg) at each sampling station was shown. Target trawling stations were in bold face. "+" represent >0.1kg.**

Day-time survey

| Sta no. | Date, 2001 | Time (horizontal tow) | Locality | Sampling depth (m) | *Engraulis japonicus* | *Etrumeus teres* | *Sardinops melanostictus* | *Coilabia muro* | *Scomber japonicus* | *Trachurus japonicus* | *Theragra chalcogramma* | Myctophids | Other fish species | *Todarodes pacificus* | Other squid species | Jelly fish | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Small block 2** | | | | | | | | | | | | | | | | | |
| 1 | 16-May | 16:02-17:16 | 37-32.4N, 142-30.0E | 0-100 | 0 | 0.1 | 0 | 0 | 0 | + | 0 | 0 | + | 0 | 0 | 0.5 | 0.6 |
| 2 | 17-May | 11:08-12:41 | 37-46.1N, 141-59.7E | 0-30 | 400.8 | + | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 400.9 |
| 3 | 17-May | 17:06-18:18 | 38-04.1N, 141-45.8E | 0-100 | 0.1 | 0.7 | 0.2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.1 | 0.5 | 5.6 |
| 4 | 18-May | 10:00-10:30 | 38-21.6N, 141-56.5E | 0-30 | 50.0 | 0.2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 50.2 |
| 5 | 18-May | 13:31-14:01 | 38-28.2N, 142-22.0E | 0-30 | 749.2 | 0 | 9.6 | 0 | + | 0 | 0 | 0 | + | 3.4 | 0 | 0 | 762.3 |
| 6 | 19-May | 05:55-07:05 | 38-47.0N, 142-58.4E | 0-100 | 9.7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.2 | 0 | 0 | 9.9 |
| 7 | 19-May | 16:29-17:32 | 39-22.2N, 142-23.0E | 0-100 | 0.1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.2 | 0 | + | 0.1 | 0.4 |
| 9 | 20-May | 09:09-10:23 | 39-37.4N, 143-02.9E | 0-100 | 2.9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | + | 0.2 | + | 0 | 3.3 |
| 10 | 20-May | 15:59-17:12 | 40-00.4N, 143-58.2E | 0-100 | 0 | 0 | 0 | 0 | + | 0 | 0 | + | 0.2 | + | 0.6 | 0.9 |
| 11 | 21-May | 11:21-12:51 | 40-12.8N, 143-07.9E | 30-60 | 1.0 | 0 | 0 | 0 | 0 | 0 | 0 | + | 0 | 0 | 0 | 1.1 |
| 12 | 21-May | 14:25-15:35 | 40-18.9N, 142-44.4E | 0-100 | 2.0 | 0 | 0 | 0 | 0 | 0 | 0 | + | + | + | 0.4 | 2.6 |
| **Small block 3** | | | | | | | | | | | | | | | | | |
| 1 | 22-May | 07:18-08:37 | 39-51.7N, 144-46.7E | 0-100 | 77.2 | 0 | 0.1 | 1.3 | 0 | 0 | 0 | 0 | + | 1.4 | 0 | 0 | 79.0 |
| 2 | 22-May | 15:43-17:00 | 39-11.0N, 146-08.1E | 0-100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1.9 | 0.7 | 0 | 0.7 | 3.3 |
| 4 | 23-May | 09:03-10:03 | 38-52.0N, 146-14.6E | 30-60 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 23-May | 15:00-16:13 | 38-38.6N, 145-26.8E | 0-100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | + | 0.3 | + | + | 0.4 |
| 6 | 24-May | 08:05-09:18 | 38-01.8N, 144-33.8E | 0-100 | 22.3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | + | 0 | + | + | 22.6 |
| **Small block 5** | | | | | | | | | | | | | | | | | |
| 1 | 28-May | 05:44-06:57 | 36-28.8N, 142-59.2E | 0-100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | + | 0 | + | 0.3 | 0.3 |
| 2 | 28-May | 12:15-13:27 | 36-05.2N, 142-43.6E | 0-100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | + | 0 | + | + | 0.1 |
| 3 | 29-May | 05:46-06:59 | 35-35.2N, 142-23.6E | 0-100 | 0 | 0 | 0 | 0 | + | 0 | 0 | + | 0 | + | 0.3 | 0.4 | |
| 4 | 29-May | 09:16-10:16 | 35-20.5N, 142-14.1E | 0-30 | 0 | 0 | 0 | 0 | + | 0 | 0 | + | 0 | 13.0 | 0 | 13.1 | |
| 5 | 29-May | 13:31-14:44 | 35-02.0N, 142-00.1E | 0-100 | 0 | 0 | 0 | 0 | 0 | + | 0 | 0 | + | 0 | 0 | + | + |
| 6 | 30-May | 05:41-06:53 | 35-36.9N, 142-00.2E | 0-100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.3 | 0 | + | + | 0.4 |
| 7 | 30-May | 10:42-12:14 | 36-12.5N, 141-59.9E | 0-100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.2 | 0 | 0.2 | 0.2 | 0.6 |
| 8 | 1-Jun | 08:21-09:34 | 35-36.9N, 143-35.6E | 0-100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | + | 0 | + | 0.1 | 0.2 |
| 9 | 1-Jun | 15:18-16:32 | 35-05.3N, 144-03.2E | 0-100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7.9 | 0 | 0 | + | 7.9 |
| 11 | 2-Jun | 09:15-10:32 | 35-37.4N, 144-25.1E | 0-100 | 0 | 0 | 0 | 0 | 0 | + | 0 | 0 | + | 0 | 0 | 0 | + |
| 12 | 2-Jun | 15:16-16:29 | 36-13.4N, 144-49.1E | 0-100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | + | 0 | 0 | 0 | + |
| **Small block 4** | | | | | | | | | | | | | | 0 | 0 | 0 | 0 |
| 1 | 3-Jun | 07:43-08:57 | 37-31.3N, 147-32.0E | 0-100 | 0 | 0 | 0 | 0 | + | 0 | 0 | 0 | + | 0 | + | 0 | + |
| 2 | 3-Jun | 14:15-15:27 | 37-58.0N, 148-26.1E | 0-100 | 0 | 0 | 0 | 0 | + | 0 | 0 | + | 0 | + | 0.3 | 0.3 | |
| **Special block A** | | | | | | | | | | | | | | | | | |
| 1 | 4-Jun | 05:33-06:45 | 37-59.9N, 146-29.0E | 0-100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | + | 0 | 0 | 0 | + |
| 2 | 4-Jun | 09:13-10:13 | 37-50.1N, 146-00.2E | 0-30 | 0 | 0 | 0 | 0 | 0 | 0.2 | 0 | 0 | + | 5.5 | + | + | 5.8 |
| 3 | 5-Jun | 13:13-14:25 | 36-59.2N, 145-28.0E | 0-100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | + | 0 | 0 | 0.1 | 0.1 |
| 4 | 6-Jun | 05:29-06:43 | 37-00.8N, 145-00.9E | 0-100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.3 | 0 | 0 | 0 | 0.3 |
| 5 | 6-Jun | 11:20-12:32 | 37-36.9N, 145-59.8E | 0-100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | + | 0 | 0 | + | + |
| **Small block 4** | | | | | | | | | | | | | | | | | |
| 3 | 11-Jun | 08:30-09:42 | 39-29.3N, 147-31.3E | 0-100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | + | 0 | + | 0.1 | 0.3 |
| 4 | 12-Jun | 13:42-14:12 | 39-09.8N, 148-10.9E | 30-60 | 0 | 0 | 0 | 0 | + | + | 0 | 0 | + | 0 | + | + | 0.1 |
| 5 | 12-Jun | 08:46-09:58 | 38-32.0N, 149-36.0E | 0-100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.1 | 0 | 0 | + | 0.2 |
| 6 | 12-Jun | 15:20-16:32 | 38-07.3N, 149-44.6E | 0-100 | 0 | 0 | 0 | 0 | 0 | + | 0 | 0 | 0.6 | 0 | 0 | 0.3 | 0.9 |
| 8 | 13-Jun | 12:13-13:26 | 37-32.5N, 147-34.6E | 0-100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | + | 0 | 0 | + | + |
| **Special block B** | | | | | | | | | | | | | | | | | |
| 1 | 15-Jun | 06:43-07:54 | 38-45.2N, 145-47.1E | 0-100 | + | 0 | 0 | 0 | + | 0 | 0 | 0 | + | 0 | 0 | + | 0.3 |
| **Small block 1** | | | | | | | | | | | | | | | | | |
| 1 | 19-Jun | 05:40-06:53 | 41-01.9N, 144-00.1E | 0-100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | + | + | + | 0 | 0.3 |
| 2 | 19-Jun | 11:48-12:18 | 41-20.3N, 144-00.0E | 0-30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | + | 7.0 | 0 | + | 7.0 |
| 3 | 21-Jun | 05:18-06:30 | 42-00.6N, 143-59.5E | 0-100 | 0 | 0 | 0 | 0 | 0 | 0 | 2.2 | 0 | 0 | 0.1 | 0.3 | 0 | 2.6 |
| 4 | 21-Jun | 08:50-09:20 | 42-15.4N, 144-00.5E | 0-30 | 0 | 0 | 0 | 0 | 0 | 0 | 1.2 | 0 | + | 4.2 | 0 | 0.4 | 5.8 |
| 5 | 21-Jun | 13:08-13:39 | 42-38.3N, 144-01.1E | 70-100 | 0 | 0 | 0 | 0 | 0 | 0 | 94.6 | 0 | 0 | + | + | 0 | 94.6 |
| 6 | 21-Jun | 16:48-17:18 | 42-58.4N, 144-01.7E | 0-30 | 0 | 0 | 0 | 0 | 0 | 0 | 12.4 | 0 | + | 2.0 | 0 | 3.8 | 18.2 |
| 7 | 22-Jun | 08:24-08:54 | 42-00.8N, 144-35.1E | 0-30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.2 | 0.2 | 0 | 3.0 | 3.4 |
| 8 | 22-Jun | 13:15-14:28 | 41-51.8N, 143-02.7E | 0-100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | + | + | 0.5 | 2.2 | 2.7 |
| 10 | 23-Jun | 12:12-12:56 | 42-51.9N, 143-07.1E | 0-70 | + | 0 | 0 | 0 | 0 | 0 | 151.5 | 0 | + | 0 | 0 | 0.1 | 151.7 |
| 12 | 24-Jun | 09:16-10:29 | 42-48.1N, 143-20.8E | 0-100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Special block C** | | | | | | | | | | | | | | | | | |
| 1 | 7-Jul | 05:18-05:30 | 39-58.7N, 149-59.2E | 0-100 | 0 | 0 | 0 | 0 | 0 | 0.1 | 0 | 0 | + | 2.5 | 0 | + | 2.6 |
| 2 | 8-Jul | 11:06-12:18 | 39-30.5N, 149-01.1E | 0-100 | 0.6 | 0 | 0 | 0 | 0 | + | 0 | 0 | + | 0 | + | 0.2 | 0.9 |
| 3 | 9-Jul | 09:18-09:48 | 39-07.8N, 148-34.9E | 0-30 | 0.9 | 0 | 0 | 0 | + | + | 0 | 0 | + | 0 | 0 | 0 | 1.0 |
| 4 | 9-Jul | 13:35-14:47 | 38-43.1N, 148-33.7E | 0-100 | + | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.1 | 0 | + | 0.2 | 0.3 |
| 5 | 10-Jul | 15:46-16:58 | 38-01.8N, 149-06.5E | 0-100 | 3.4 | 0 | 0 | 0 | 0.1 | + | 0 | 0 | 0.2 | 0 | + | 0.1 | 3.9 |
| 6 | 11-Jul | 11:45-12:57 | 37-31.3N, 149-02.1E | 0-100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.5 | 0 | 0.1 | + | 0.6 |
| 7 | 12-Jul | 06:45-07:57 | 37-00.8N, 147-58.5E | 0-100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.3 | 0 | + | + | 0.4 |

Nighttime survey

| Sta no. | Date, 2001 | Time (horizontal tow) | Locality | Sampling depth (m) | *Engraulis japonicus* | *Etrumeus teres* | *Sardinops melanostictus* | *Coilabia muro* | *Scomber japonicus* | *Trachurus japonicus* | *Theragra chalcogramma* | Myctophids | Other fish species | *Todarodes pacificus* | Other squid species | Jelly fish | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Small block 2** | | | | | | | | | | | | | | | | | |
| 8 | 19-May | 19:56-21:10 | 39-21.4N, 142-21.4E | 0-100 | 2.5 | 0 | 0 | 0 | 0 | 0 | 0 | 44.2 | 5.3 | 0 | 3.0 | 1.2 | 56.2 |
| **Small block 3** | | | | | | | | | | | | | | | | | |
| 3 | 22-May | 19:56-21:10 | 39-11.0N, 146-08.0E | 0-100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 27.9 | 3.1 | 0.3 | 2.2 | 0.1 | 33.4 |
| **Small block 5** | | | | | | | | | | | | | | | | | |
| 10 | 1-Jun | 19:58-21:10 | 35-05.1N, 144-03.2E | 0-100 | + | 0 | 0 | 0 | 0 | 0 | 0 | 16.9 | 4.1 | 0 | 1.4 | 0.4 | 22.8 |
| **Small block 4** | | | | | | | | | | | | | | | | | |
| 7 | 12-Jun | 20:01-21:13 | 38-06.8N, 145-43.6E | 0-100 | 0 | 0 | 0 | 0 | 0 | 0.1 | 0 | 14.6 | 16.6 | 0 | 1.7 | 0.7 | 33.6 |
| **Small block 1** | | | | | | | | | | | | | | | | | |
| 9 | 22-Jun | 20:16-21:28 | 41-53.0N, 143-02.8E | 0-100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 189.4 | 2.9 | 1.8 | 4.4 | 0.1 | 198.6 |
| 11 | 23-Jun | 20:17-21:00 | 42-51.8N, 143-07.1E | 0-70 | 0 | 0 | 0 | 0 | 0 | 0 | 44.5 | 0 | 2.1 | 0 | 0 | 2.6 | 49.2 |

# Table 19. Summary of plankton net sampling (except IKMT).

| St.# | | Date | Local Time | Lat. | | Long. | | SST | Hauling Method (Marichi) | Sampling Depth (Marichi) | Hauling Method (Bongo) | Sampling Depth (Bongo) | Note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Small Block 1** | | | | | | | | | | | | | |
| 1-1 | pre-det. | Jun. 19 | 06:14 | 41 | 00 | 144 | 00 | 9.2 | Vertical | 100-0 | Oblique | 100-0 | |
| 1-2 | Target | Jun. 19 | 12:39 | 41 | 22 | 144 | 00 | 10.6 | *** | (no cast) | Horizontal | 20-30 | |
| 1-3 | pre-det. | Jun. 21 | 06:01 | 42 | 00 | 144 | 00 | 6.9 | Vertical | 100-0 | Oblique | 100-0 | |
| 1-4 | Target | Jun. 21 | 09:40 | 42 | 16 | 144 | 00 | 7.8 | *** | (no cast) | Horizontal | 15-20 | |
| 1-5 | Target | Jun. 21 | 14:05 | 42 | 38 | 144 | 02 | 8.3 | Vertical | 200-0 | Horizontal | 120 | |
| 1-6 | Target | Jun. 21 | 17:56 | 42 | 28 | 144 | 09 | 8.2 | Vertical | 100-0 | Horizontal | 40 | |
| 1-7 | Target | Jun. 22 | 09:20 | 42 | 00 | 144 | 34 | 7.8 | Vertical | 100-0 | Horizontal | 20 | |
| 1-8 | pre-det. | Jun. 22 | 16:28 | 41 | 54 | 145 | 03 | 9.0 | *** | (no cast) | Oblique | 100-0 | |
| 1-9 | Night | Jun. 22 | 21:20 | 41 | 55 | 145 | 02 | 9.2 | *** | (no cast) | Oblique | 100-0 | |
| 1-10 | Target | Jun. 23 | 17:09 | 42 | 50 | 145 | 09 | 8.4 | *** | (no cast) | Horizontal | 65 | |
| 1-11 | Night | Jun. 23 | 21:20 | 42 | 50 | 145 | 09 | 8.2 | *** | (no cast) | Horizontal | 65 | |
| 1-12 | pre-det. | Jun. 24 | 10:39 | 42 | 47 | 145 | 23 | 8.2 | Vertical | 100-0 | Oblique | 100-0 | |
| **Small Block 2** | | | | | | | | | | | | | |
| 2-1 | pre-det. | May. 17 | 06:24 | 37 | 31 | 142 | 31 | 19.3 | Vertical | 100-0 | *** | (no cast) | |
| 2-2 | Target | May. 17 | 11:59 | 37 | 44 | 141 | 59 | 10.3 | *** | (no cast) | Horizontal | 30-25 | |
| 2-3 | pre-det. | May. 17 | 17:25 | 38 | 04 | 141 | 46 | 11.6 | Vertical | 140-0 | *** | (no cast) | |
| 2-4 | Target | May. 18 | 10:30 | 38 | 21 | 142 | 56 | 8.8 | Vertical | 50-0 | Horizontal | 200 | |
| 2-5 | Target | May. 18 | 13:50 | 38 | 28 | 143 | 22 | 15.9 | Vertical | 150-0 | *** | 15 | |
| 2-6 | pre-det. | May. 19 | 06:23 | 38 | 46 | 143 | 00 | 15.6 | Vertical | 100-0 | *** | (no cast) | |
| 2-7 | pre-det. | May. 19 | 16:40 | 39 | 23 | 142 | 24 | 10.6 | Vertical | 100-0 | *** | (no cast) | |
| 2-8 | Night | May. 19 | 20:30 | 39 | 21 | 142 | 24 | 10.2 | Vertical | 100-0 | *** | (no cast) | |
| 2-9 | pre-det. | May. 20 | 09:22 | 39 | 38 | 143 | 03 | 10.2 | Vertical | 100-0 | Horizontal | 200 | |
| 2-10 | pre-det. | May. 20 | 16:05 | 40 | 00 | 144 | 00 | 12.7 | Vertical | 100-0 | Oblique | 100-0 | |
| 2-11 | Target | May. 21 | 12:02 | 40 | 13 | 143 | 10 | 13.7 | *** | (no cast) | Horizontal | 35-40 | |
| 2-12 | pre-det. | May. 21 | 15:04 | 40 | 20 | 142 | 40 | 9.2 | Vertical | 100-0 | Oblique | 100-0 | |
| **Small Block 3** | | | | | | | | | | | | | |
| 3-1 | pre-det. | May. 22 | 07:37 | 39 | 51 | 144 | 48 | 15.3 | Vertical | 100-0 | *** | (no cast) | |
| 3-2 | pre-det. | May. 22 | 16:07 | 39 | 11 | 146 | 09 | 10.9 | Vertical | 100-0 | Oblique | 100-0 | |
| 3-3 | Night | May. 22 | 20:20 | 39 | 10 | 146 | 09 | 11.0 | Vertical | 100-0 | Oblique | 100-0 | |
| 3-4 | Target | May. 23 | 09:27 | 38 | 51 | 146 | 15 | 14.8 | *** | (no cast) | Horizontal | 30-50 | |
| 3-5 | pre-det. | May. 23 | 15:17 | 38 | 28 | 145 | 27 | 16.2 | *** | (no cast) | Oblique | 100-0 | |
| 3-6 | pre-det. | May 26 | 08:42 | 38 | 00 | 144 | 30 | 16.3 | *** | (no cast) | Oblique | 100-0 | |
| **Small Block 4** | | | | | | | | | | | | | |
| *4-1* | *pre-det.* | *Jun. 3* | *08:51* | *37* | *30* | *147* | *30* | *20.6* | *Vertical* | *100-0* | *Oblique* | *100-0* | ***Not for Analysis (duplicate transect)*** |
| *4-2* | *Target* | *Jun. 3* | *15:42* | *37* | *59* | *148* | *29* | *17.8* | *Vertical* | *100-0* | *Horizontal* | *40* | ***Not for Analysis (duplicate transect)*** |
| 4-3 | pre-det. | Jun. 11 | 10:10 | 39 | 30 | 147 | 30 | 12.5 | *** | (no cast) | Oblique | 100-0 | |
| 4-4 | Target | Jun. 11 | 14:28 | 39 | 10 | 148 | 11 | 19.0 | *** | (no cast) | Horizontal | 20-30 | |
| 4-5 | pre-det. | Jun. 12 | 09:56 | 38 | 30 | 149 | 30 | 20.7 | Vertical | 100-0 | Oblique | 100-0 | |
| 4-6 | pre-det. | Jun. 12 | 16:25 | 38 | 08 | 148 | 43 | 20.1 | *** | (no cast) | Oblique | 100-0 | |
| 4-7 | Night | Jun. 12 | 20:37 | 38 | 08 | 148 | 43 | 20.1 | *** | (no cast) | Oblique | 100-0 | |
| 4-8 | pre-det. | Jun. 13 | 12:52 | 37 | 30 | 147 | 30 | 23.3 | Vertical | 100-0 | Oblique | 100-0 | |
| **Small Block 5** | | | | | | | | | | | | | |
| 5-1 | pre-det. | May. 28 | 06:25 | 36 | 30 | 143 | 00 | 20.5 | Vertical | 100-0 | Oblique | 100-0 | |
| 5-2 | pre-det. | May. 28 | 13:30 | 36 | 00 | 142 | 40 | 23.0 | *** | (no cast) | Oblique | 100-0 | |
| 5-3 | pre-det. | May. 29 | 06:28 | 35 | 34 | 142 | 22 | 24.1 | Vertical | 100-0 | Oblique | 100-0 | |
| 5-4 | Target | May. 29 | 10:02 | 35 | 19 | 142 | 13 | 24.5 | *** | (no cast) | Horizontal | 20 | |
| 5-5 | pre-det. | May. 29 | 13:50 | 35 | 00 | 142 | 00 | 24.6 | Vertical | 100-0 | Oblique | 100-0 | |
| 5-6 | pre-det. | May. 30 | 06:37 | 35 | 40 | 142 | 00 | 23.1 | Vertical | 100-0 | Oblique | 100-0 | |
| 5-7 | Target | May. 30 | 11:24 | 36 | 10 | 142 | 00 | 21.3 | Vertical | 160-0 | Oblique | 130-0 | |
| | | May 30 | 12:42 | 36 | 13 | 142 | 00 | 20.9 | *** | (no cast) | Horizontal | 250 | ***Bongo 2nd Cast.*** |
| 5-8 | pre-det. | Jun. 1 | 09:08 | 35 | 36 | 143 | 36 | 20.6 | Vertical | 100-0 | *** | (no cast) | |
| 5-9 | pre-det. | Jun. 1 | 17:10 | 35 | 06 | 144 | 04 | 22.3 | Vertical | 100-0 | Oblique | 100-0 | |
| 5-10 | Night | Jun. 1 | 20:36 | 35 | 07 | 144 | 04 | 22.0 | Vertical | 100-0 | Oblique | 100-0 | |
| 5-11 | pre-det. | Jun. 2 | 10:10 | 35 | 40 | 144 | 26 | 20.3 | Vertical | 100-0 | Oblique | 100-0 | |
| 5-12 | pre-det. | Jun. 2 | 16:08 | 36 | 15 | 144 | 50 | 20.7 | Vertical | 100-0 | Oblique | 100-0 | |
| **Special Research / Area - A** | | | | | | | | | | | | | |
| A-1 | pre-det. | Jun. 4 | 06:00 | 38 | 00 | 146 | 30 | 20.6 | Vertical | 100-0 | Oblique | 100-0 | |
| A-2 | pre-det. | Jun. 5 | 10:10 | 37 | 30 | 146 | 00 | 18.0 | Vertical | 100-0 | Horizontal | 30 | |
| A-3 | pre-det. | Jun. 5 | 15:45 | 37 | 00 | 145 | 30 | 17.5 | Vertical | 100-0 | Horizontal | 200 | |
| A-4 | pre-det. | Jun. 6 | 06:48 | 37 | 00 | 145 | 00 | 23.7 | Vertical | 100-0 | Oblique | 100-0 | |
| A-5 | pre-det. | Jun. 8 | 12:19 | 38 | 00 | 146 | 00 | 17.6 | Vertical | 100-0 | Oblique | 100-0 | |
| A-6 | Target | Jun. 9 | | | | | | | *** | (no cast) | *** | (no cast) | ***TOR's IKMT only.*** |
| A-7 | pre-det. | Jun. 10 | 06:03 | 38 | 00 | 147 | 30 | 20.4 | Vertical | 100-0 | Oblique | 100-0 | |
| A-8 | Target | Jun. 10 | 14:29 | 36 | 59 | 146 | 31 | 18.3 | Vertical | 100-0 | Horizontal | 25 | |
| **Special Research / Area - B** | | | | | | | | | | | | | |
| B-1 | Target | Jun. 15 | 07:33 | 38 | 45 | 145 | 48 | 21.9 | Vertical | 100-0 | Horizontal | 200 | |
| B-2 | Target | Jun. 15 | 17:41 | 39 | 15 | 146 | 46 | 21.8 | *** | (no cast) | Horizontal | 70-80 | |
| B-3 | Target | Jun. 16 | 08:13 | 39 | 15 | 146 | 35 | 21.6 | *** | (no cast) | Horizontal | 70 | |
| B-4 | Target | Jun. 16 | 15:41 | 39 | 02 | 145 | 30 | 11.1 | *** | (no cast) | Horizontal | 40-50 | |
| B-5 | Target | Jun. 18 | 09:48 | 38 | 46 | 145 | 14 | 18.9 | *** | (no cast) | Horizontal | 20-30 | |
| **Special Research / Area - C** | | | | | | | | | | | | | |
| C-1 | pre-det. | Jul. 7 | 06:06 | 40 | 00 | 150 | 00 | 16.5 | Vertical | 100-0 | Oblique | 100-0 | |
| C-2 | pre-det. | Jul. 8 | 12:02 | 39 | 30 | 149 | 01 | 20.2 | Vertical | 100-0 | Oblique | 100-0 | |
| C-3 | Target | Jul. 9 | 10:07 | 39 | 06 | 148 | 12 | 22.1 | *** | (no cast) | Horizontal | 30-40 | |
| C-4 | pre-det. | Jul. 9 | 17:02 | 38 | 43 | 148 | 36 | 22.8 | Vertical | 100-0 | Oblique | 100-0 | |
| C-5 | pre-det. | Jul. 10 | 17:50 | 38 | 00 | 150 | 00 | 21.4 | *** | (no cast) | Oblique | 100-0 | |
| C-6 | pre-det. | Jul. 11 | 13:42 | 37 | 30 | 149 | 00 | 23.4 | Vertical | 100-0 | Oblique | 100-0 | |
| C-7 | pre-det. | Jul. 12 | 07:54 | 37 | 00 | 148 | 00 | 23.1 | Vertical | 100-0 | Oblique | 100-0 | |

**pre-det.: pre-determined stations.*

**Table 20. Summary of plankton net sampling (IKMT).**

| St. # | Date | Time | Locality | Sampling depth range (m) | Depth of horizontal tow (m) | Remarks |
|---|---|---|---|---|---|---|
| Special block A | | | | | | |
| 6 | 5-Jun | 0701-0721 | 38-00.4N, 146-04.3E | 0-150 | 0-70 | |
| 7 | 9-Jun | 0500-0521 | 37-59.7N, 147-29.7E | 0-100 | 0-65 | |
| 8 | 9-Jun | 1336-1402 | 40-12.8N, 143-07.9E | 0-50 | 20-25, 45-50 | 2 layer |
| Special block B | | | | | | |
| 2 | 14-Jun | 1639-1705 | 39-14.9N, 146-48.4E | 0-90 | 80-85 | |
| 3 | 15-Jun | 0658-0717 | 39-15.0N, 146-35.7E | 0-80 | 60-80 | |
| 4 | 15-Jun | 1438-1455 | 39-04.8N, 145-29.9E | 0-50 | 40-50 | |
| 5 | 17-Jun | 0846-0900 | 38-44.6N, 145-15.6E | 0-25 | 20-25 | |

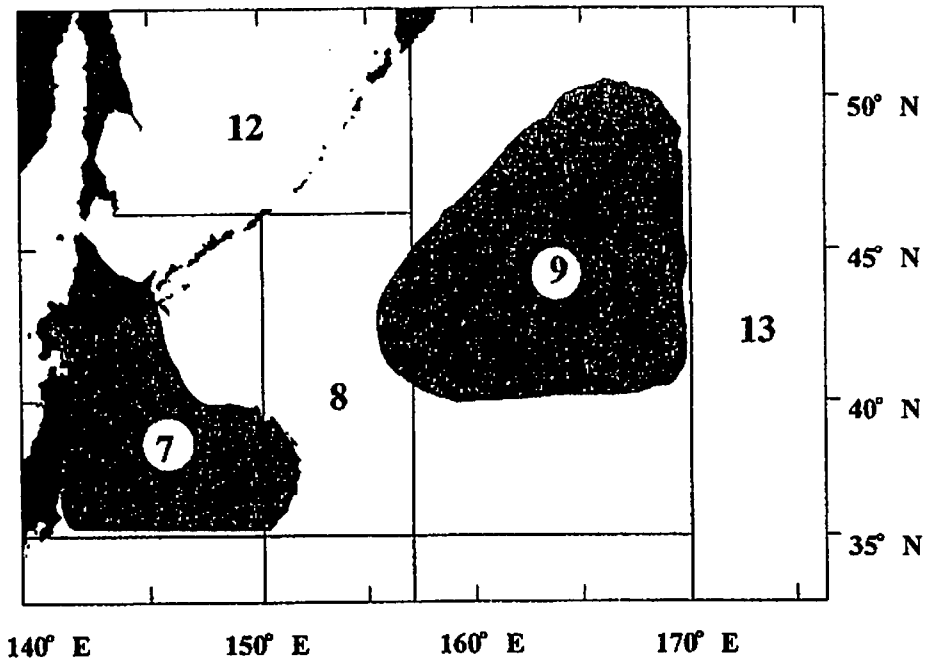



**Fig. 1. Map showing the IWC sub-areas and the general research area of the 2001 JARPN II survey.**

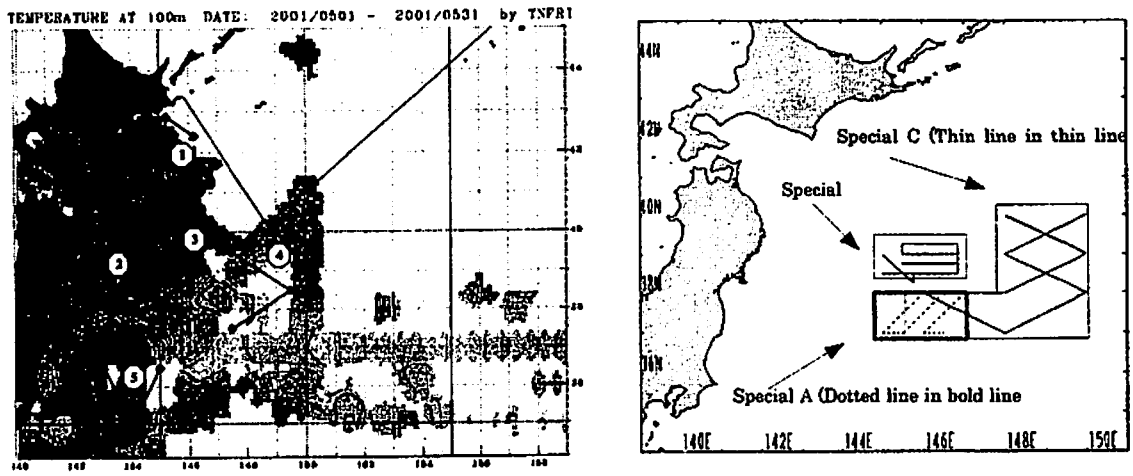



**Fig. 2. Five small blocks (Left) and three special blocks (Right) designed for the co-operative study of 2001 JARPN II survey.**

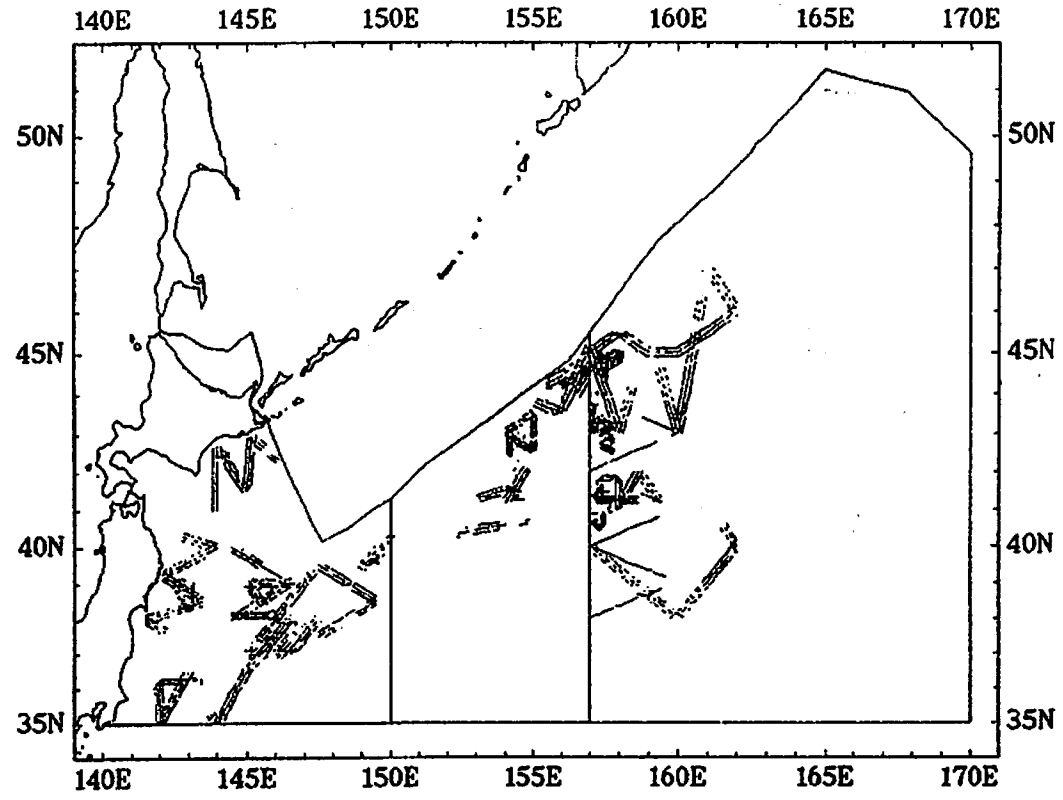



**Fig. 3. Track – line covered by the three sighting/sampling vessels (SSVs) during the 2001 JARPN II survey (- : NSC, ASP and NSP mode; ・・: NSS mode).**

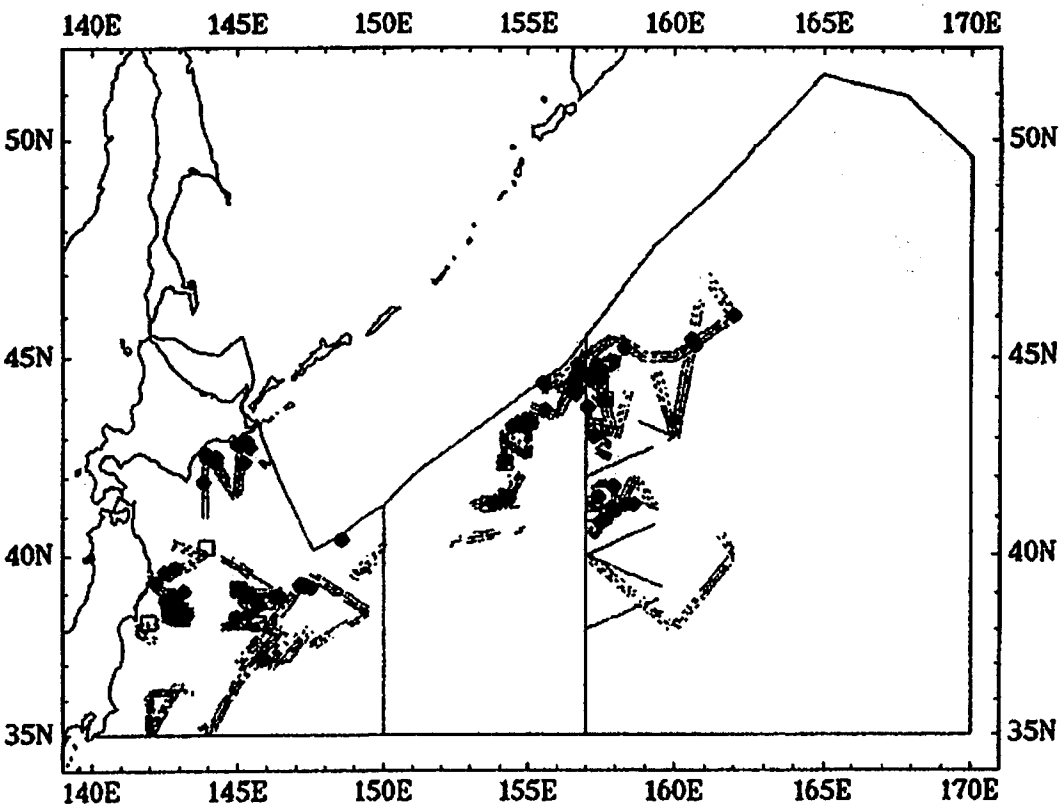



**Fig. 4. Position of the sightings of the common minke whales (●).**

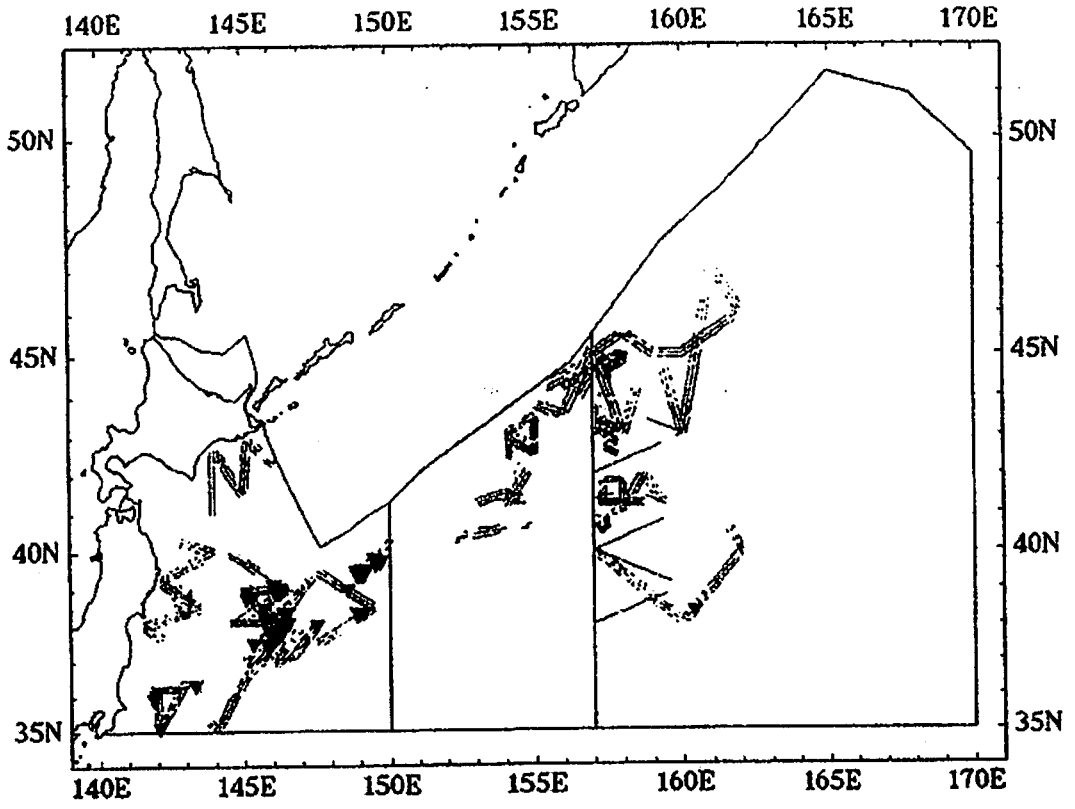



**Fig. 5. Position of the sightings of the Bryde's whales (▼).**

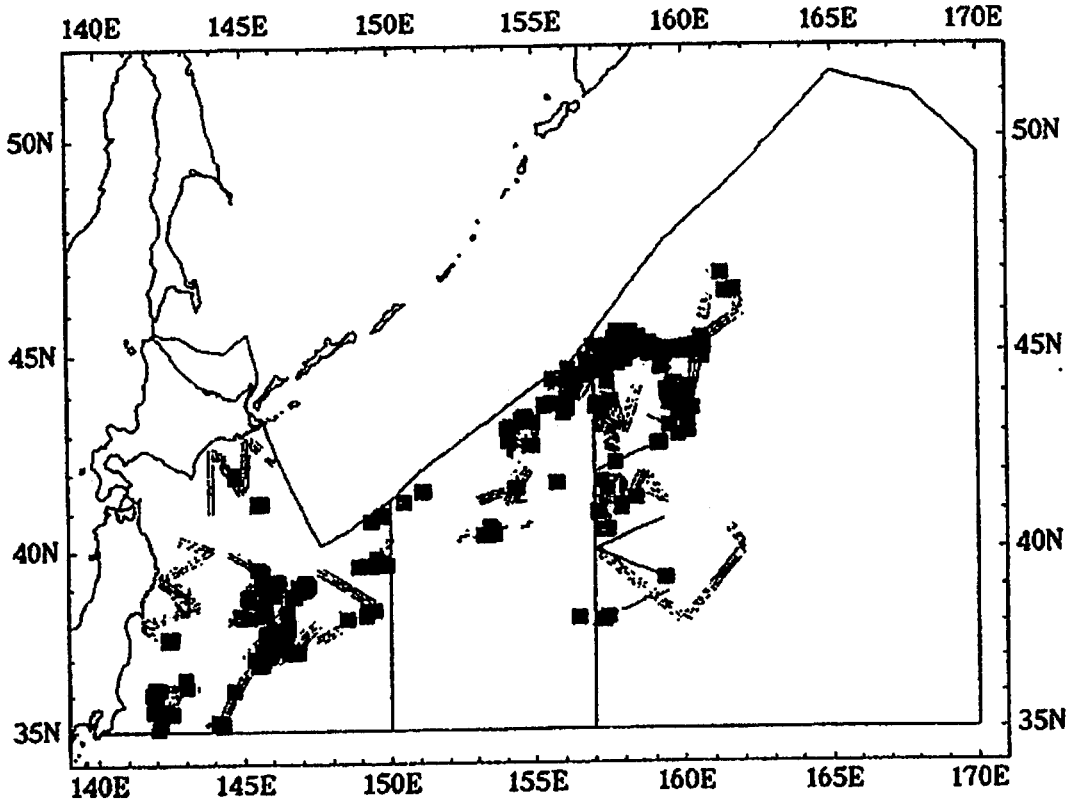



**Fig. 6. Position of the sightings of the Sperm whales (■).**

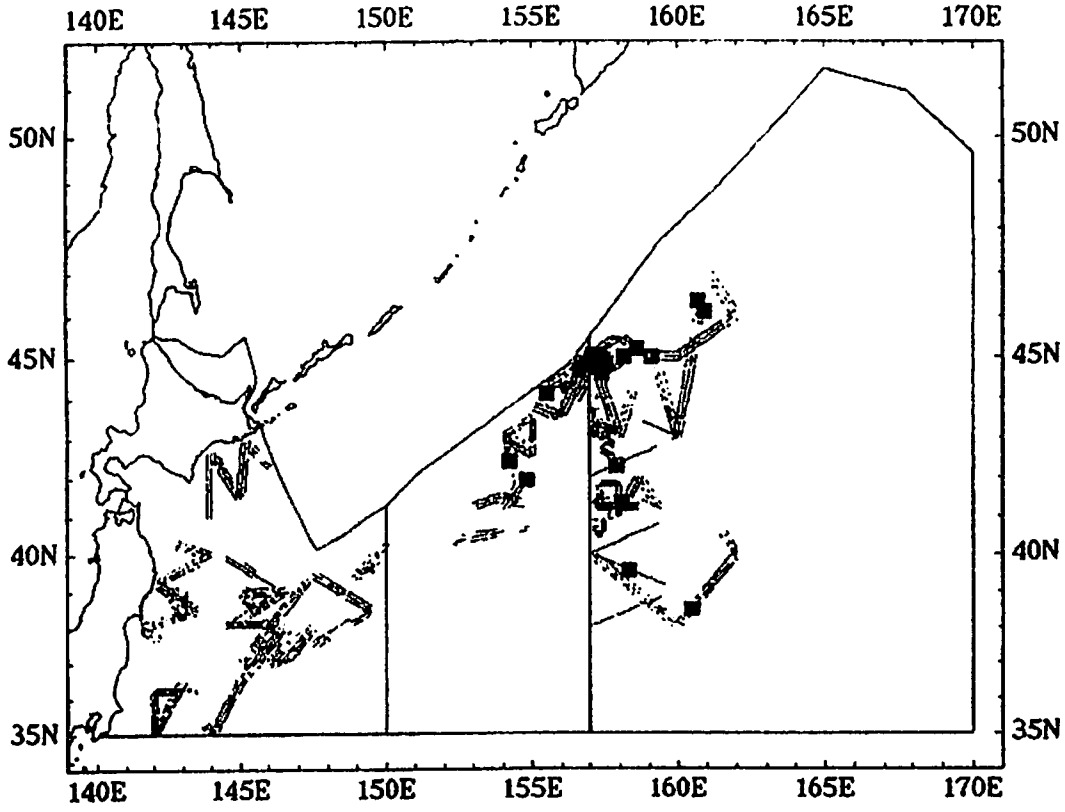



Fig. 7. Position of the sightings of the Blue whales (■).

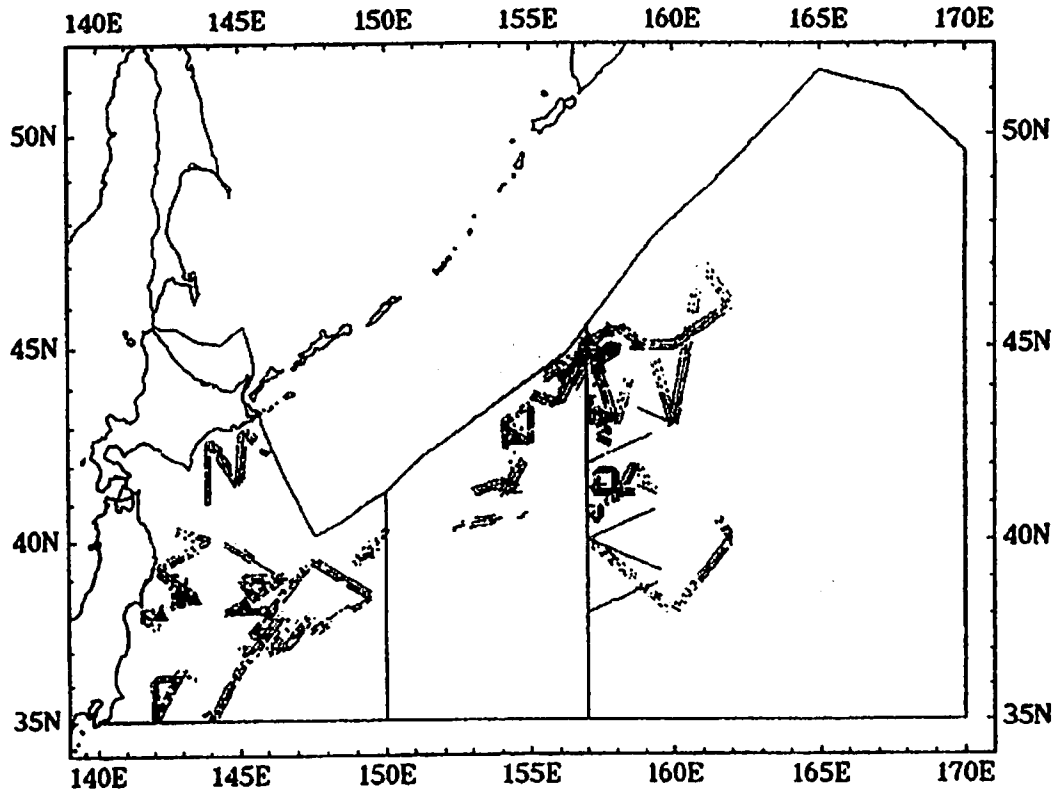



Fig. 8. Position of the sightings of the fin whales (▲).

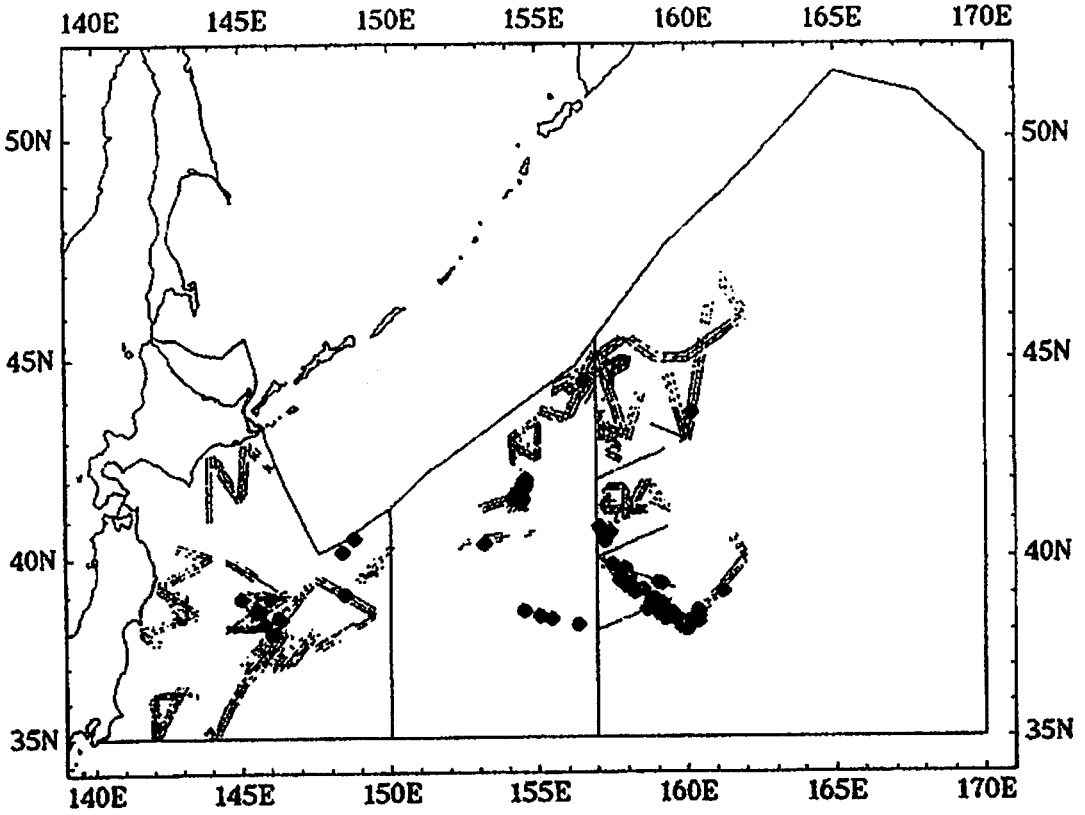



**Fig. 9. Position of the sightings of the Sei whales (●).**

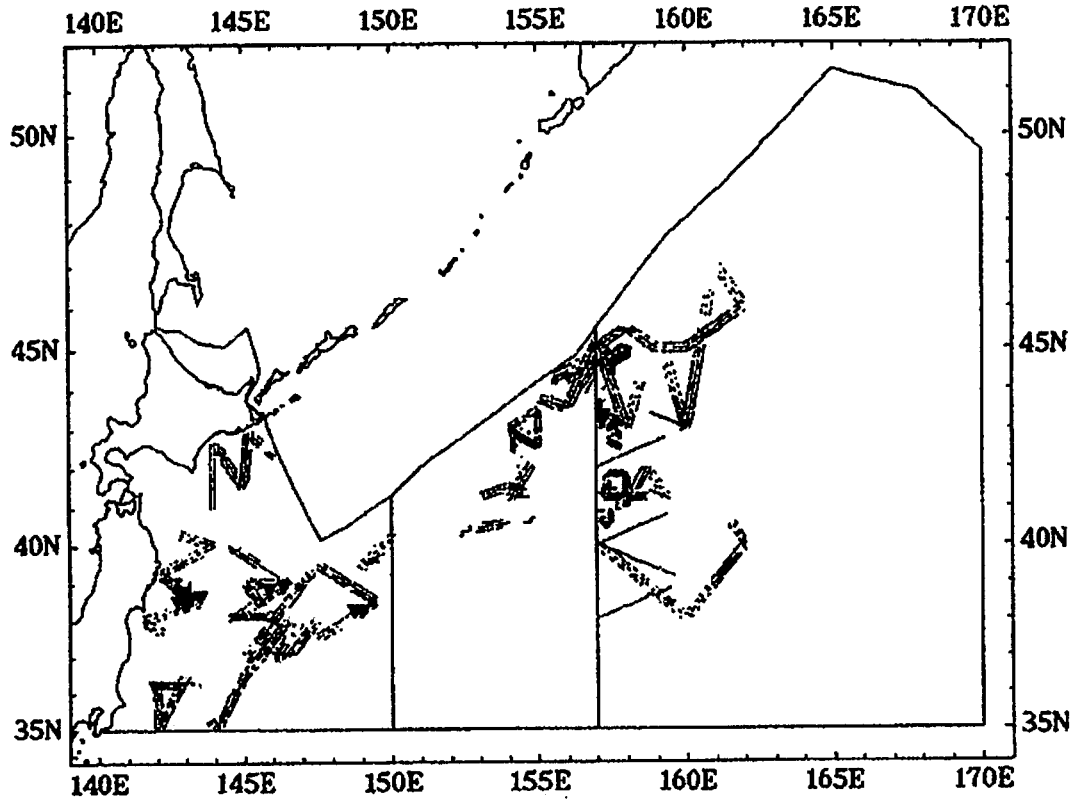



**Fig. 10. Position of the sightings of the humpback whales (▼).**

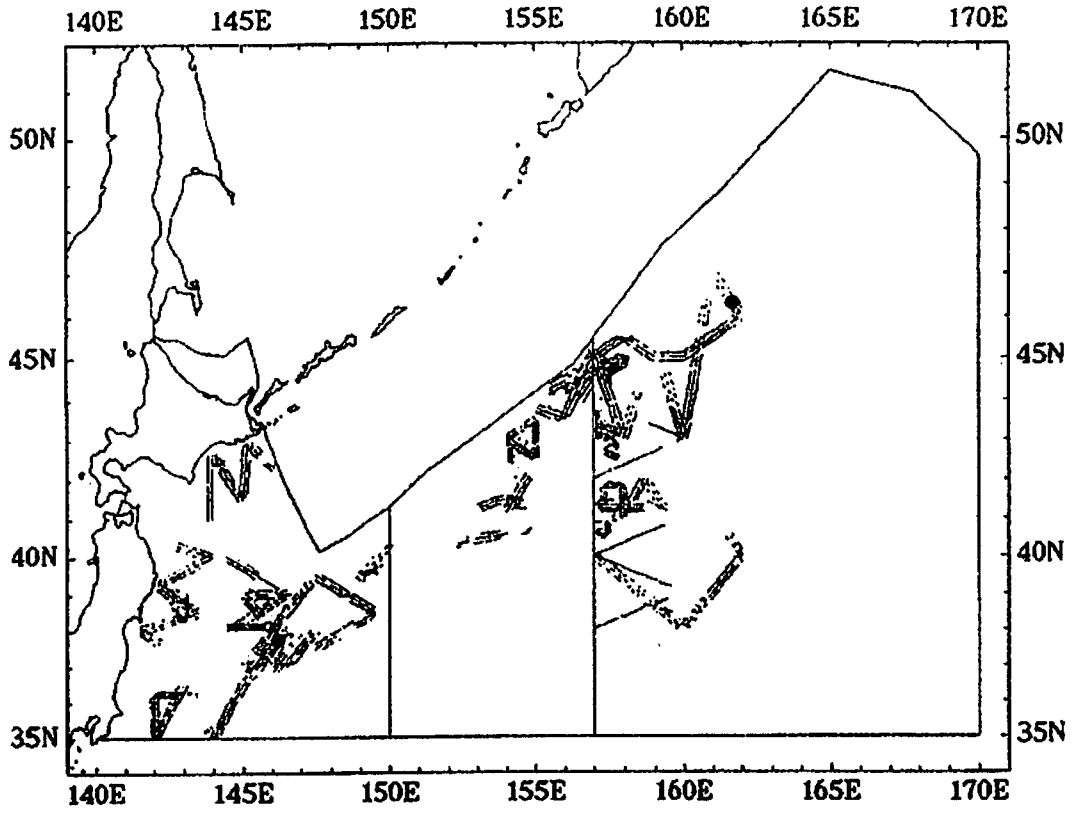



**Fig. 11. Position of the sightings of the northern right whales (●).**

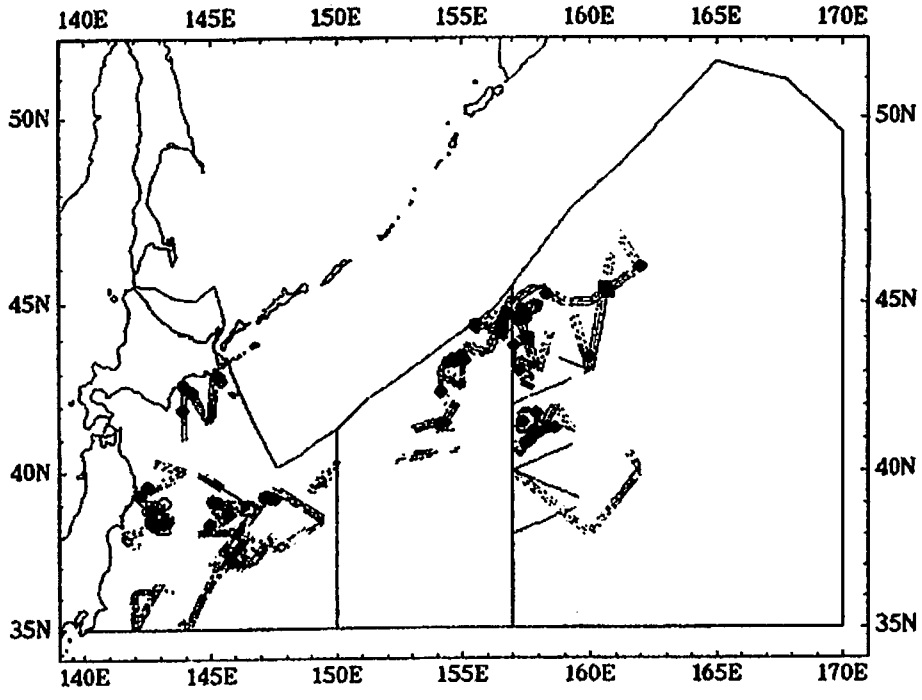



**Fig. 12. Geographical position of common minke whales sampled in the 2001 JARPN II survey, based on the sighting position (○: Immature male; ●: Mature male; □: Immature female; ■: Mature female).**

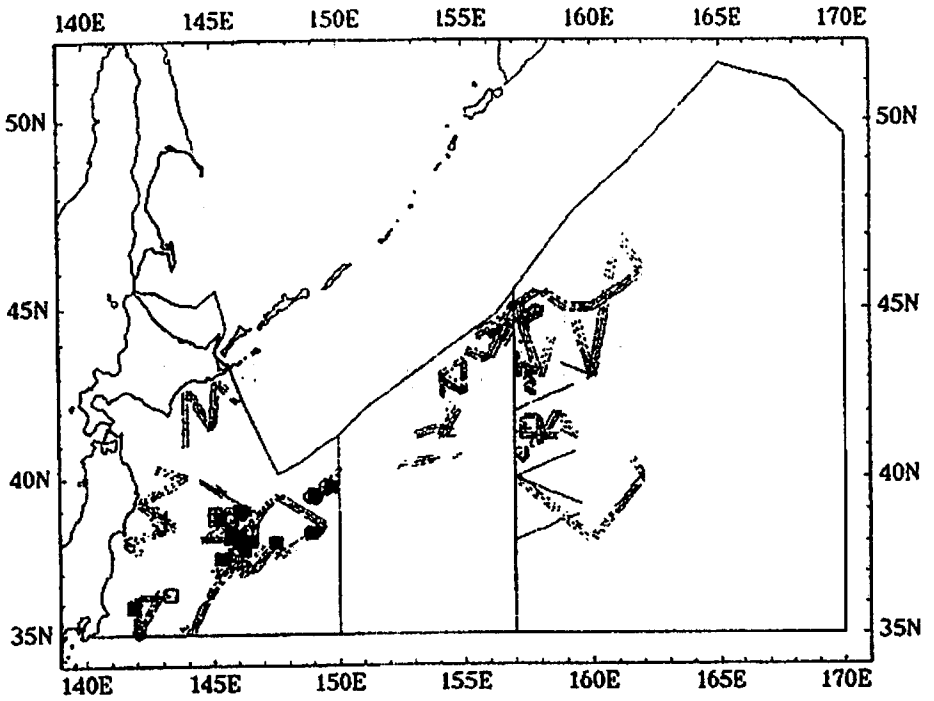



**Fig. 13. Geographical position of Bryde's whales sampled in the 2001 JARPN II survey, based on the sighting position (○: Immature male; ●: Mature male; □: Immature female; ■: Mature female).**

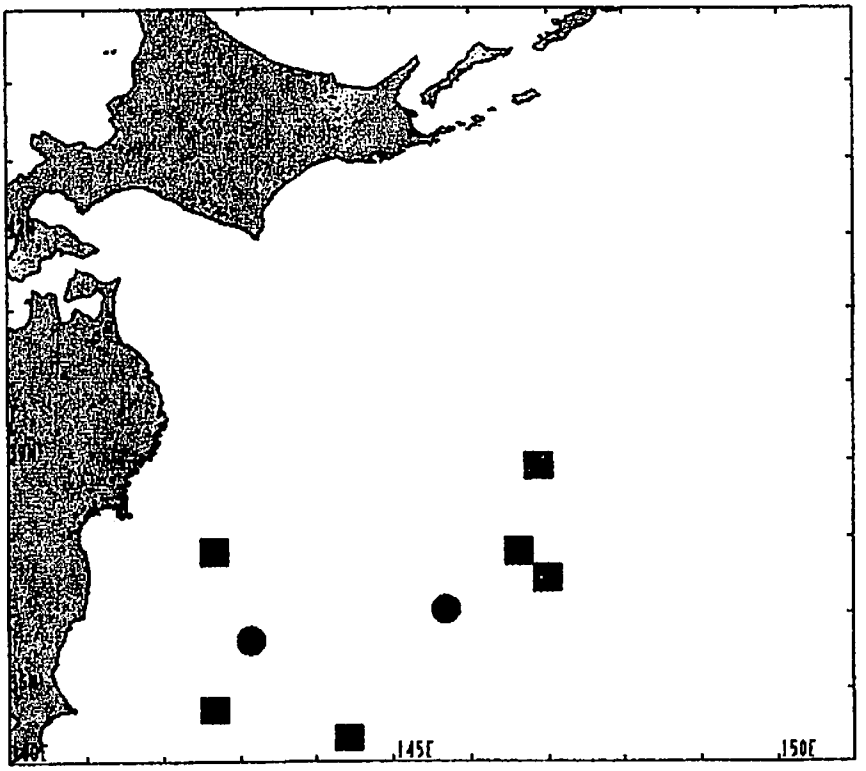
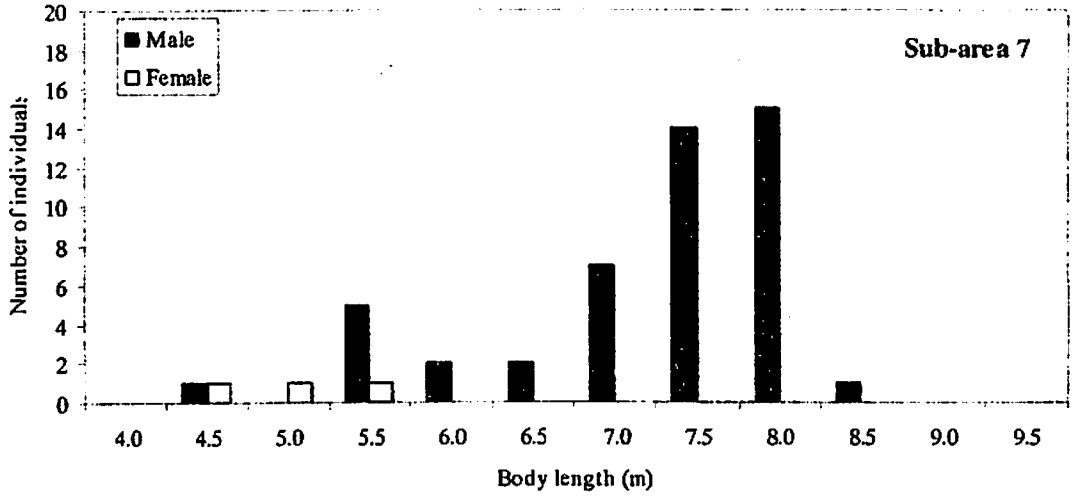
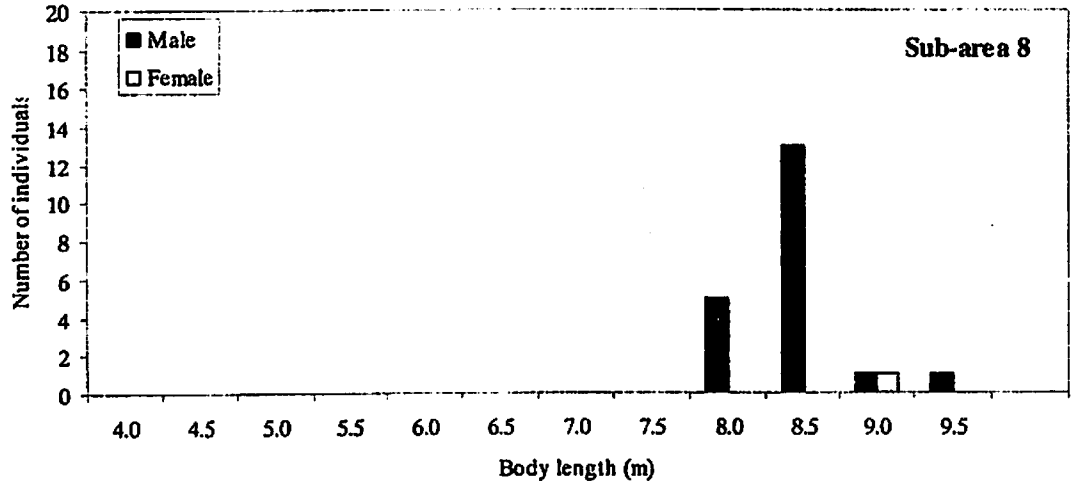



**Fig. 14. Geographical position of sperm whales sampled in the 2001 JARPN II survey, based on the sighting position (●: Male;■: Female).**



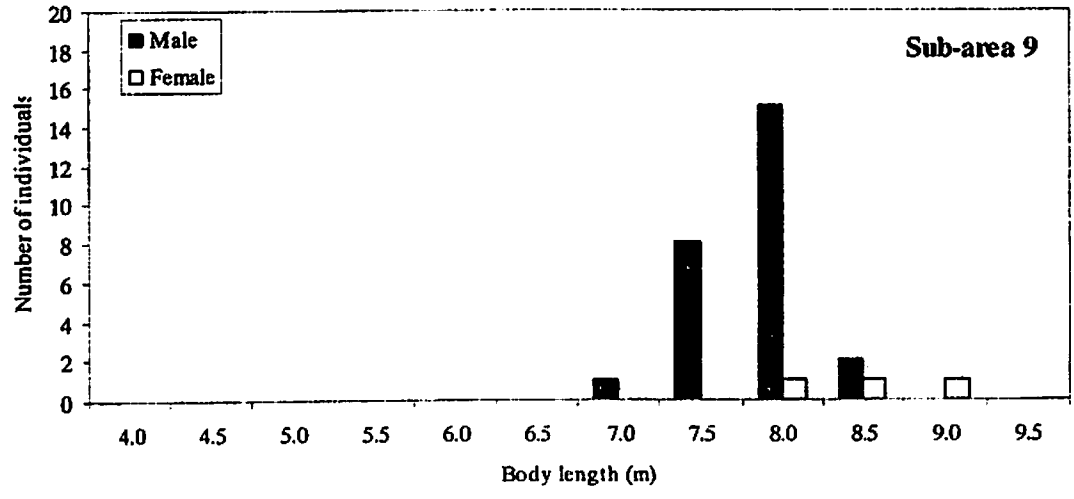




**Fig. 15. Body length frequency of the samples of common minke whales taken in the 2001 JARPN II survey.**

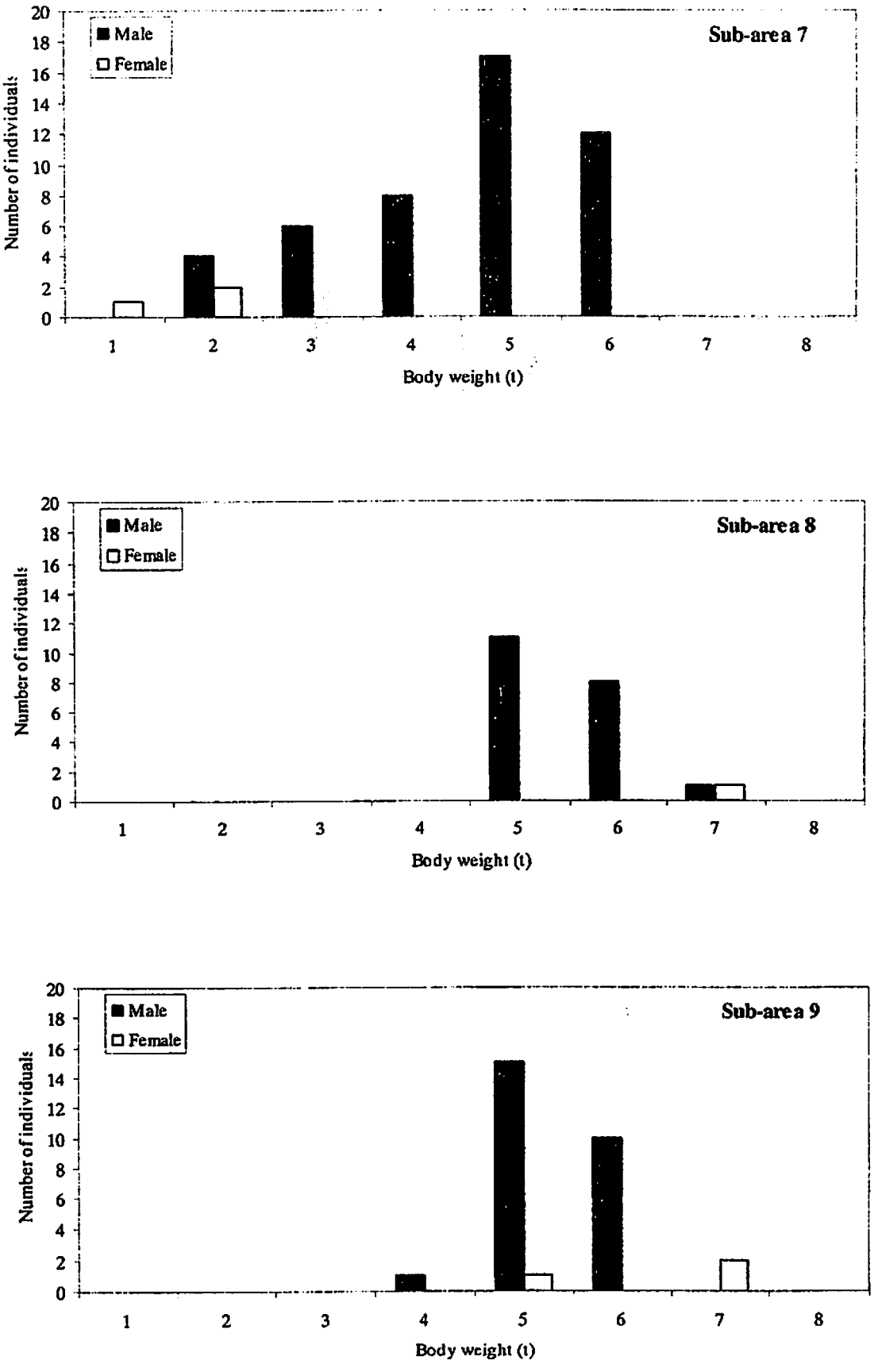



**Fig. 16. Body weight frequency of the samples of common minke whales taken in the 2001 JARPN II survey.**

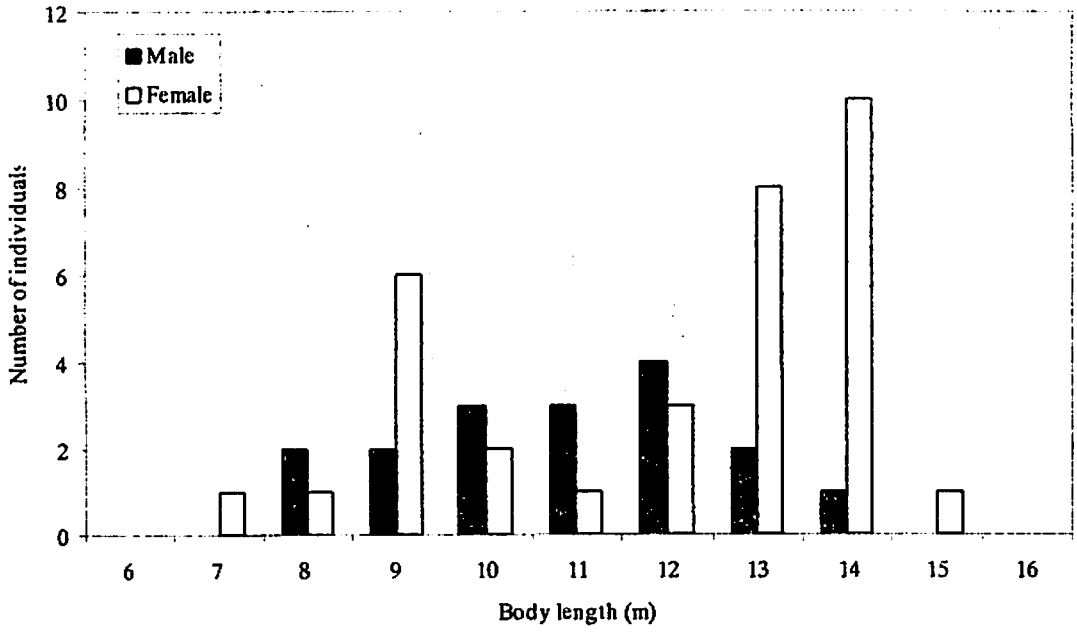



**Fig. 17. Body length frequency of the samples of Bryde's whales taken in the 2001 JARPN II survey.**

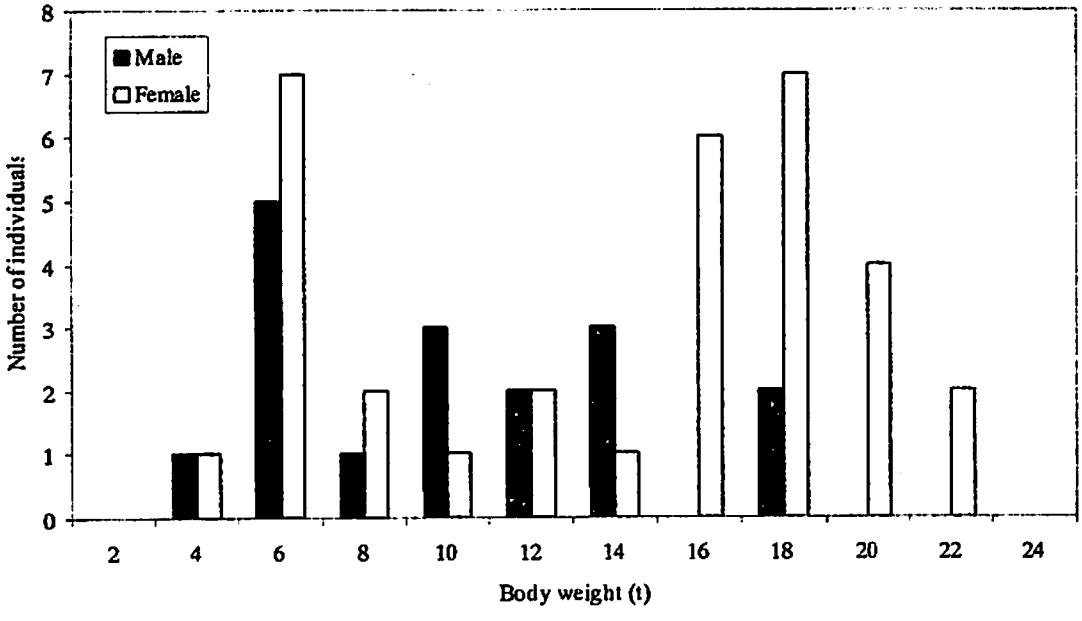



**Fig. 18. Body weight frequency of the samples of Bryde's whales taken in the 2001 JARPN II survey.**

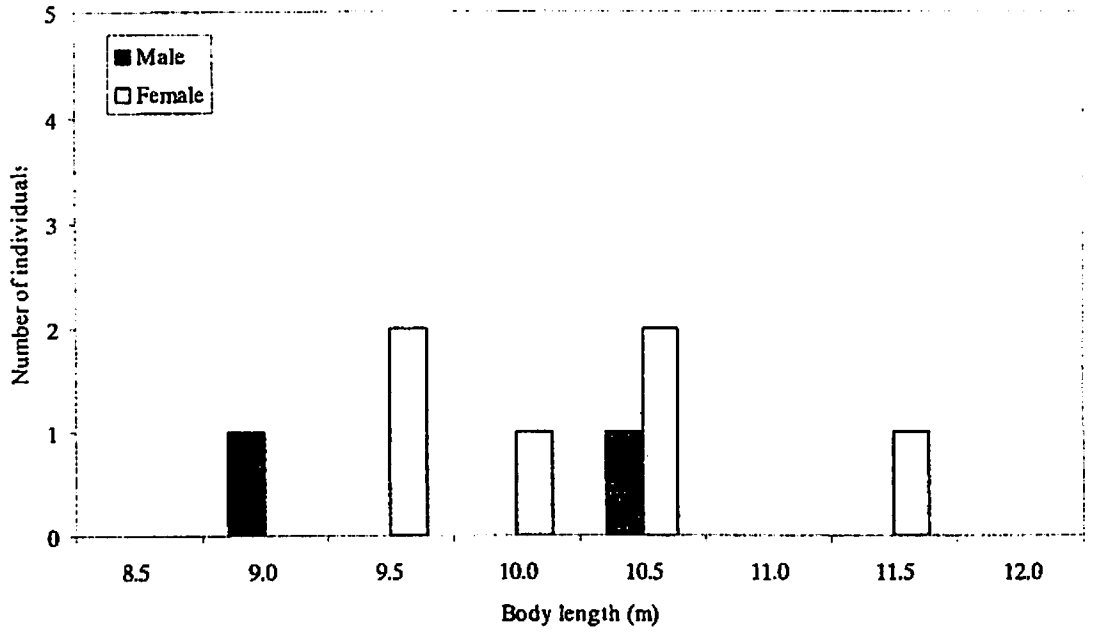



**Fig. 19. Body length frequency of the samples of sperm whales taken in the 2001 JARPN II survey.**

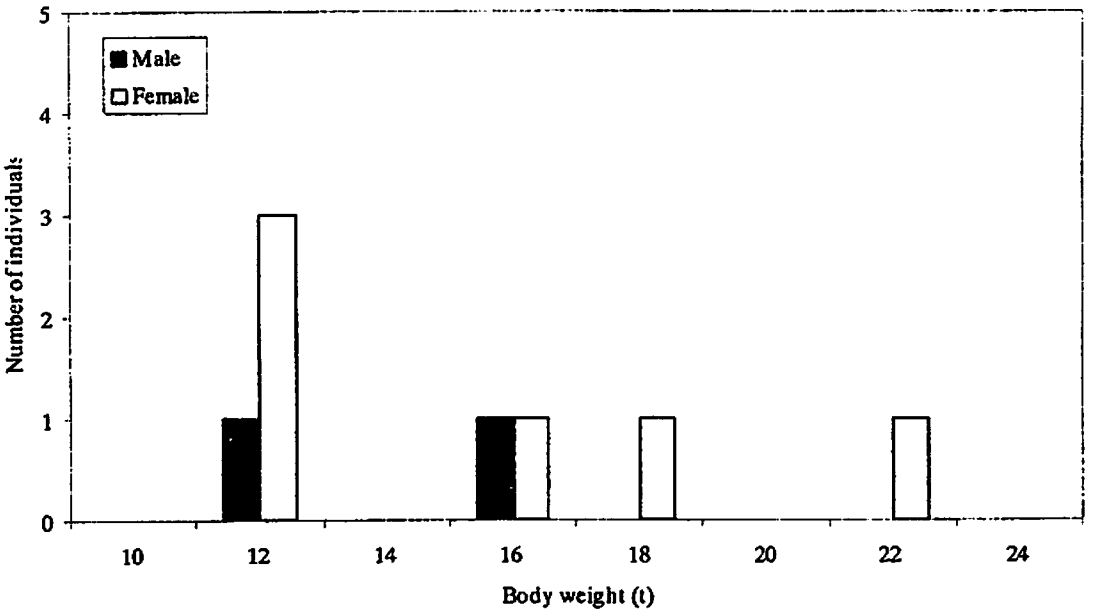



**Fig. 20. Body weight frequency of the samples of sperm whales taken in the 2001 JARPN II survey.**

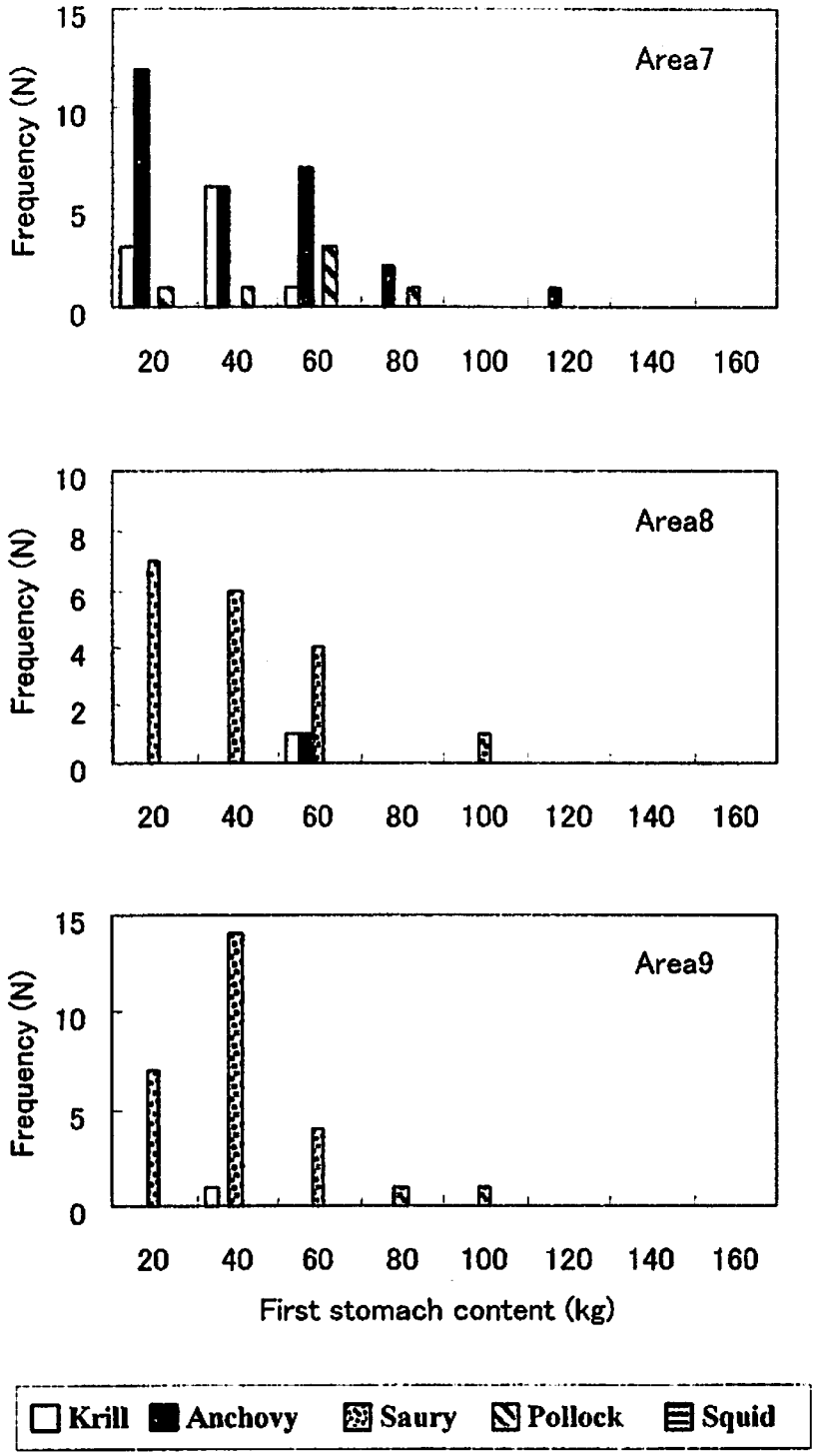



**Fig. 21. Distribution of the stomach contents weight (First stomach) in the samples of common minke whale taken in the 2001JARPN II survey, by prey species.**

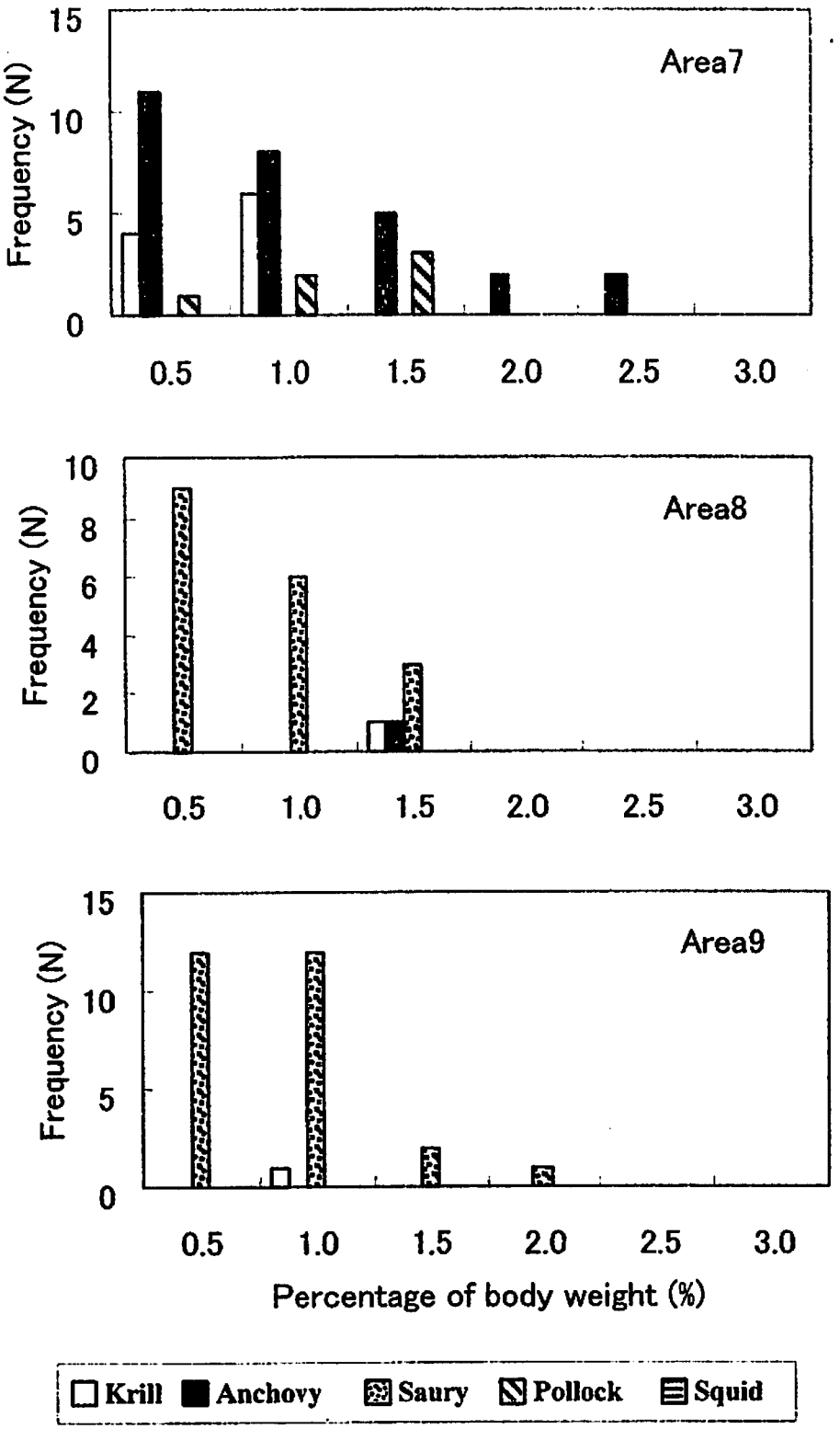



**Fig. 22. Distribution of the feeding rate (weight of first stomach contents / body weight ×100) in the samples of common minke whale taken in the 2001JARPN II survey, by prey species.**

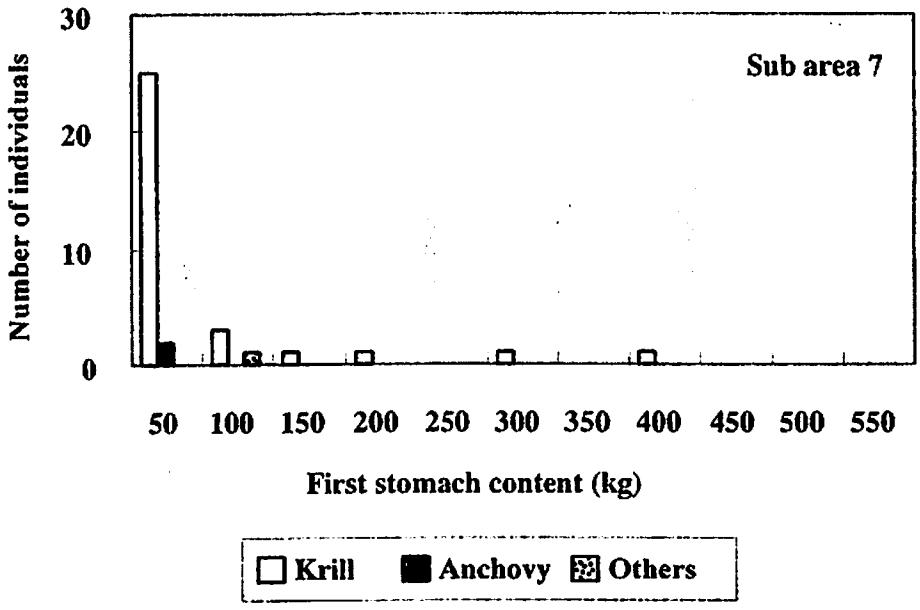



Fig. 23. Distribution of the stomach contents weight (First stomach) in the samples of Bryde's whale taken in the 2001JARPN II survey, by prey species.

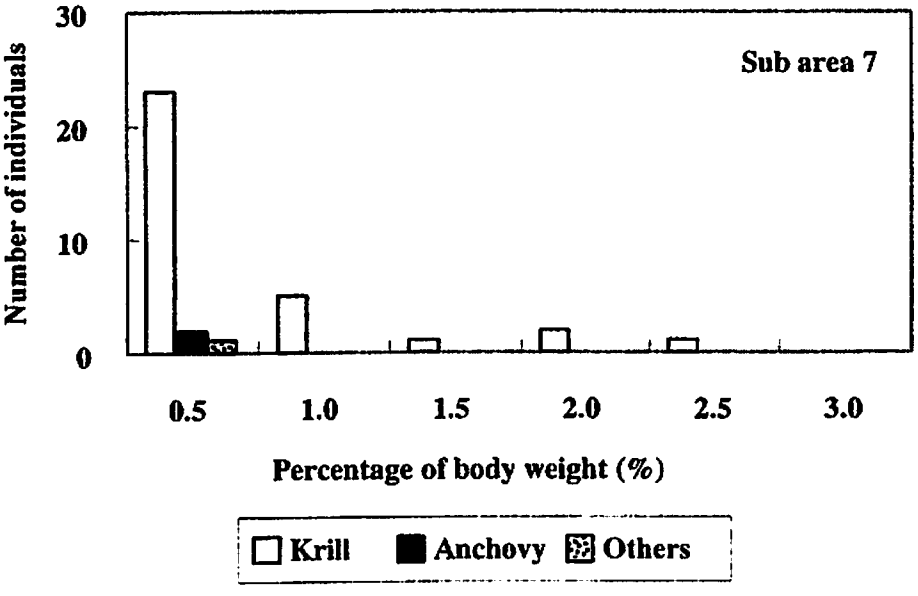



Fig. 24. Distribution of the feeding rate (weight of first stomach contents / body weight ×100) in the samples of Bryde's whale taken in the 2001JARPN II survey, by prey species.

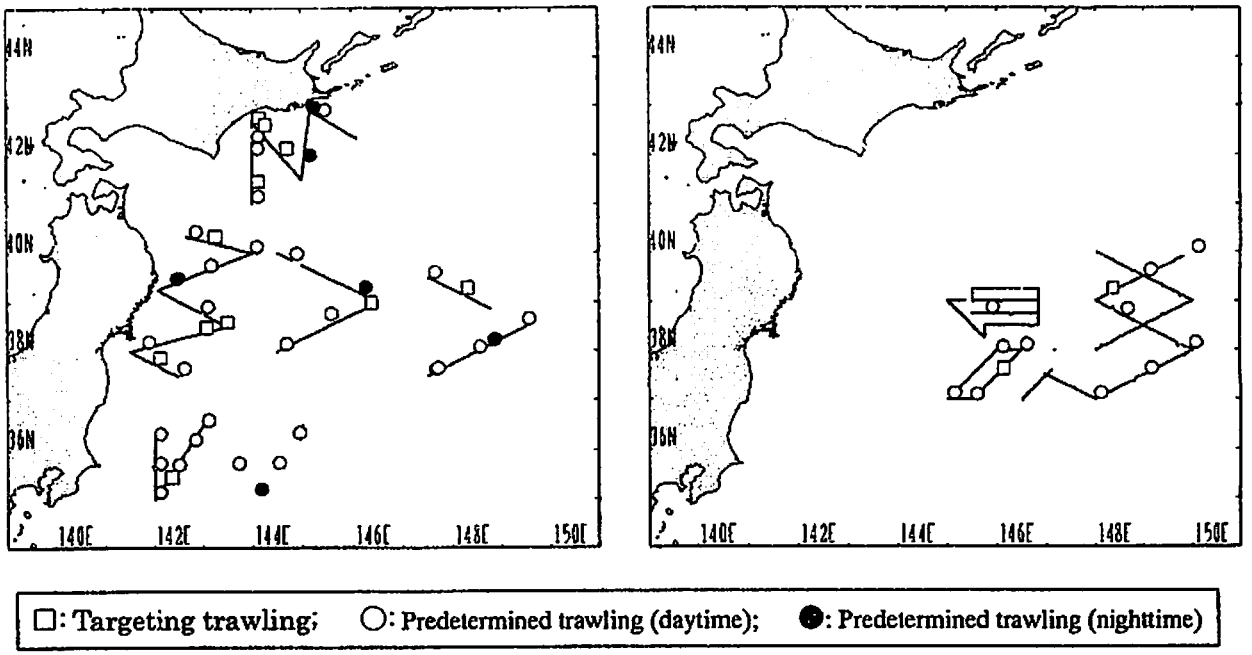



**Fig. 25. Echosounder surveyed lines and trawling positions in the survey of small blocks and special blocks.**

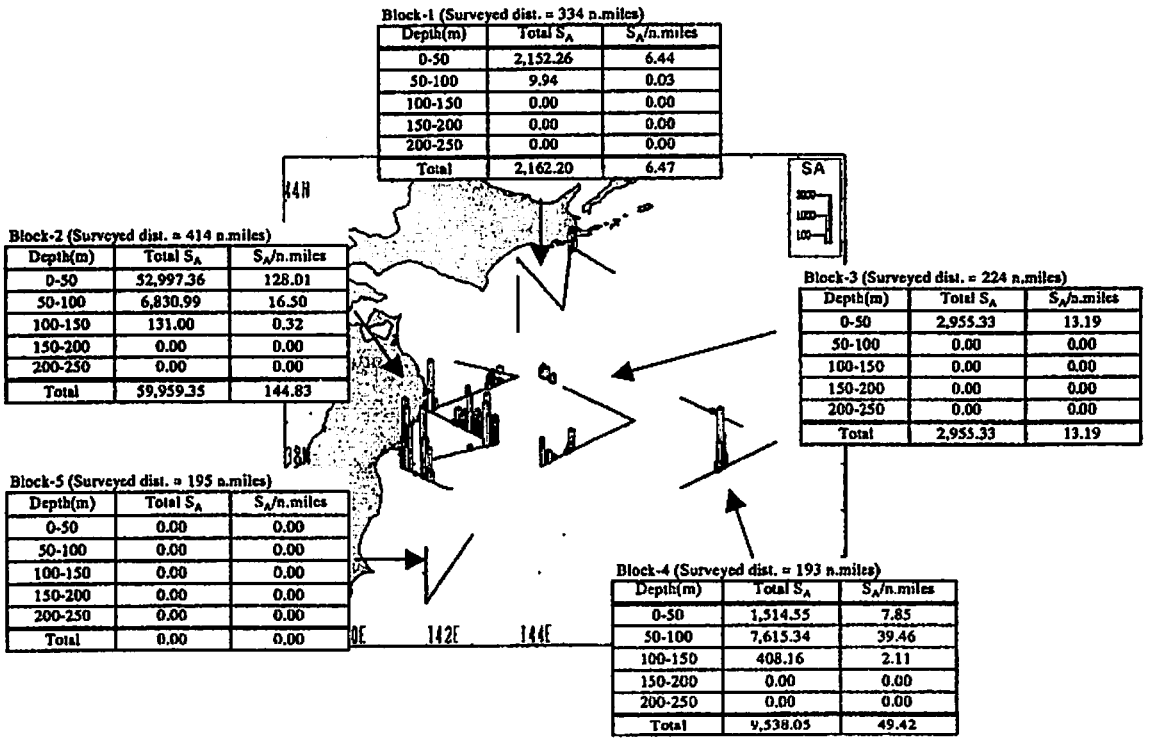



**Fig. 26. SA of Japanese anchovy in each small block. Bars denoting magnitude of SA.**

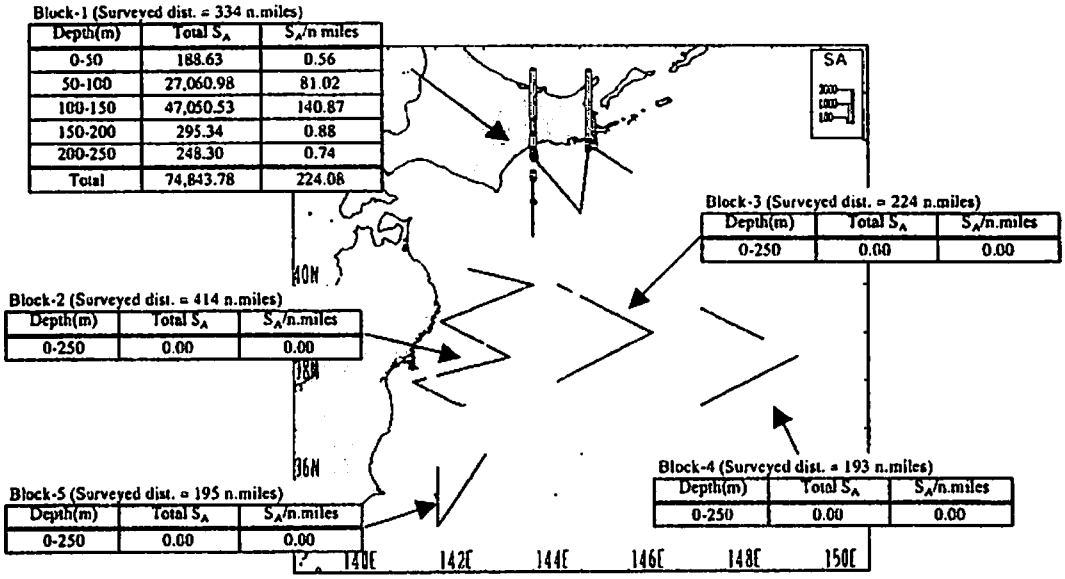



**Fig. 27. SA of Walleye pollock in each small block. Bars denoting magnitude of SA.**

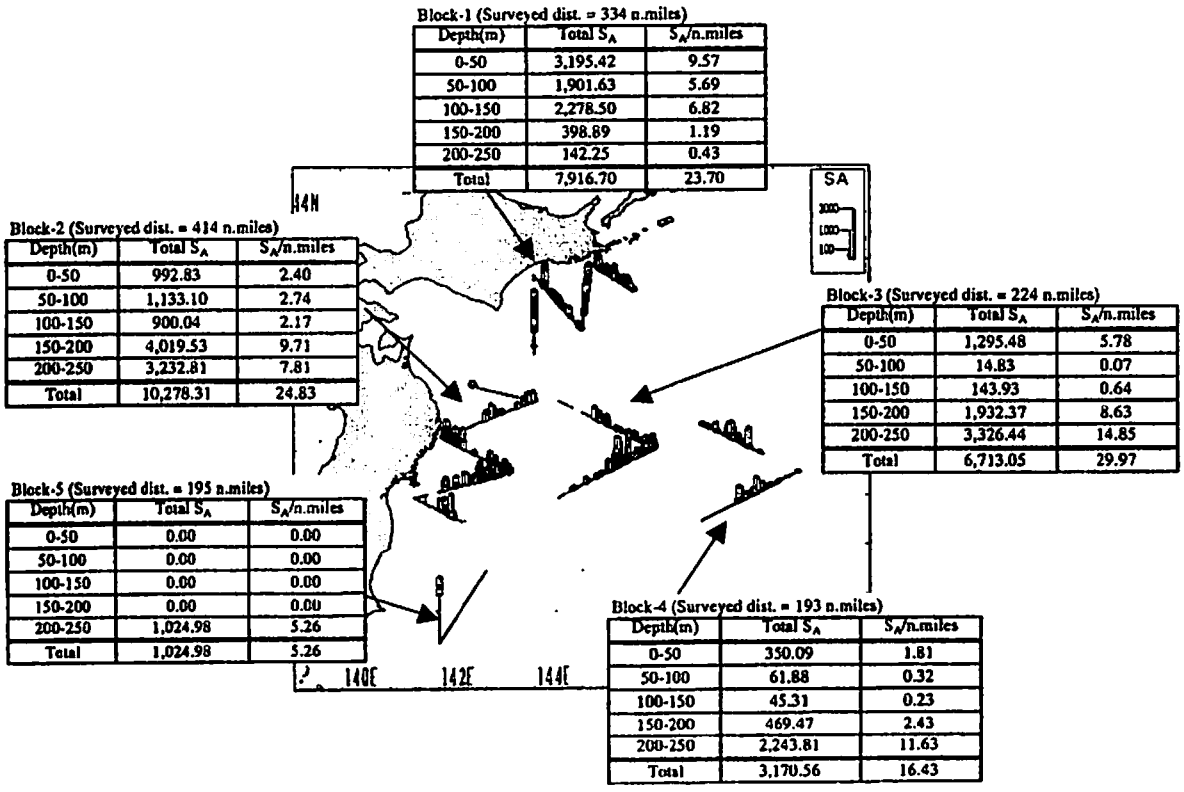
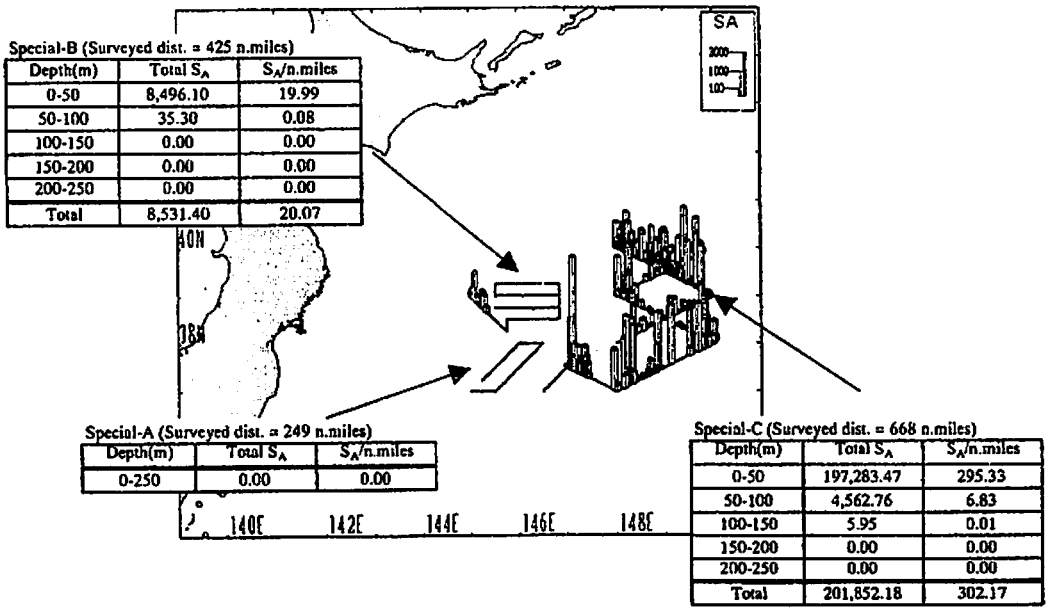



**Fig. 28. SA of krills in each small block. Bars denoting magnitude of SA.**

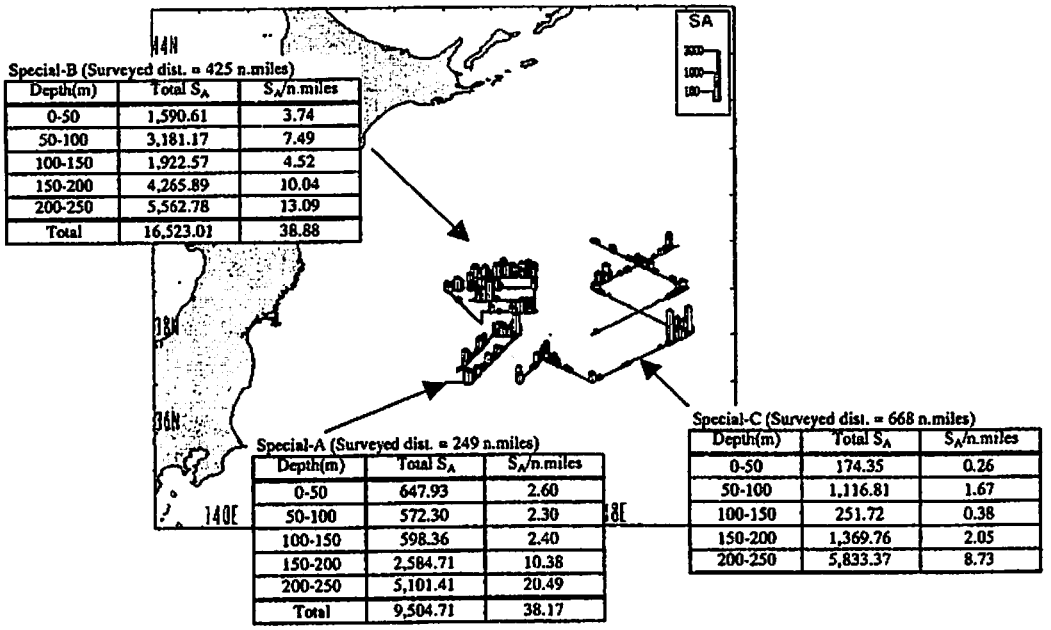



| Depth(m) | Total $S_A$ | $S_A$/n.miles |
|---|---|---|
| 0-50 | 8,496.10 | 19.99 |
| 50-100 | 35.30 | 0.08 |
| 100-150 | 0.00 | 0.00 |
| 150-200 | 0.00 | 0.00 |
| 200-250 | 0.00 | 0.00 |
| Total | 8,531.40 | 20.07 |

| Depth(m) | Total $S_A$ | $S_A$/n.miles |
|---|---|---|
| 0-250 | 0.00 | 0.00 |

| Depth(m) | Total $S_A$ | $S_A$/n.miles |
|---|---|---|
| 0-50 | 197,283.47 | 295.33 |
| 50-100 | 4,562.76 | 6.83 |
| 100-150 | 5.95 | 0.01 |
| 150-200 | 0.00 | 0.00 |
| 200-250 | 0.00 | 0.00 |
| Total | 201,852.18 | 302.17 |

**Fig. 29. SA of Japanese anchovy in each special block. Bars denoting magnitude of SA.**




| Depth(m) | Total $S_A$ | $S_A$/n.miles |
|---|---|---|
| 0-50 | 1,590.61 | 3.74 |
| 50-100 | 3,181.17 | 7.49 |
| 100-150 | 1,922.57 | 4.52 |
| 150-200 | 4,265.89 | 10.04 |
| 200-250 | 5,562.78 | 13.09 |
| Total | 16,523.01 | 38.88 |

| Depth(m) | Total $S_A$ | $S_A$/n.miles |
|---|---|---|
| 0-50 | 647.93 | 2.60 |
| 50-100 | 572.30 | 2.30 |
| 100-150 | 598.36 | 2.40 |
| 150-200 | 2,584.71 | 10.38 |
| 200-250 | 5,101.41 | 20.49 |
| Total | 9,504.71 | 38.17 |

| Depth(m) | Total $S_A$ | $S_A$/n.miles |
|---|---|---|
| 0-50 | 174.35 | 0.26 |
| 50-100 | 1,116.81 | 1.67 |
| 100-150 | 251.72 | 0.38 |
| 150-200 | 1,369.76 | 2.05 |
| 200-250 | 5,833.37 | 8.73 |

**Fig. 30. SA of Krills in each special block. Bars denoting magnitude of SA.**

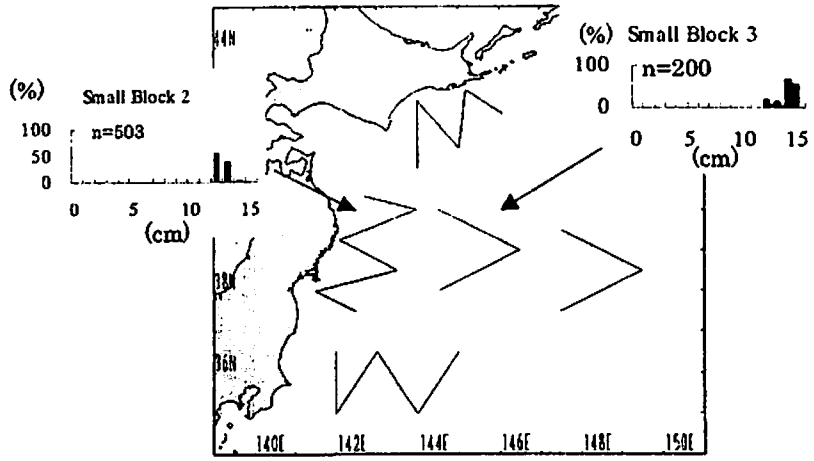



**Fig. 31. Length frequency of Japanese anchovy in each small block. (trawling samples).**

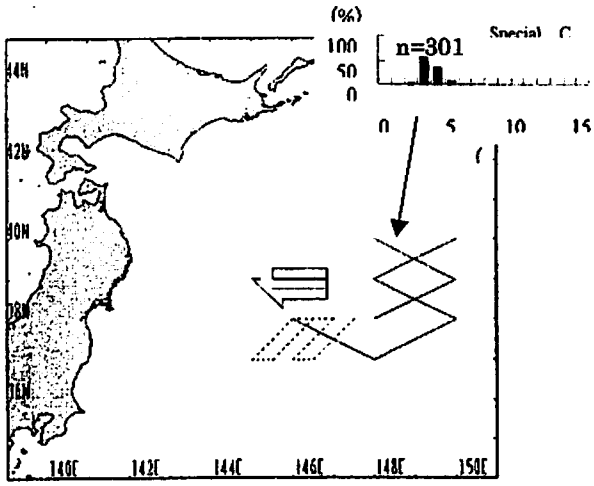



**Fig. 32. Length frequency of Japanese anchovy in each special block. (trawling samples).**

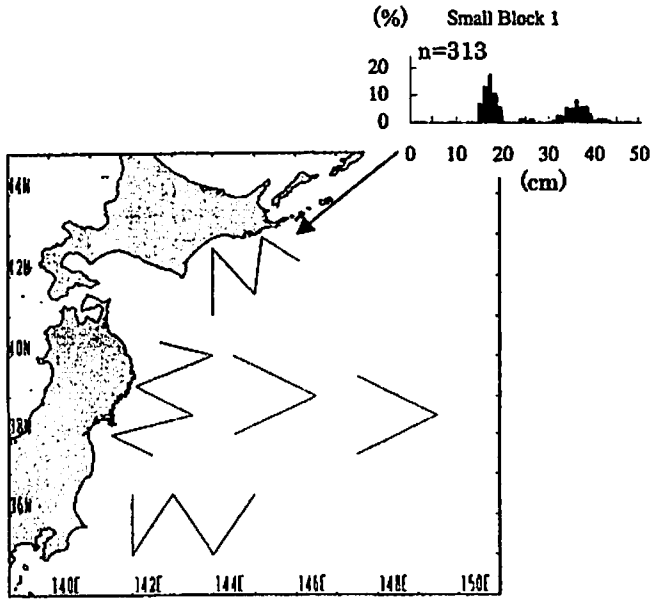



**Fig. 33. Length frequency of walleye pollock in each small block. (trawling samples).**

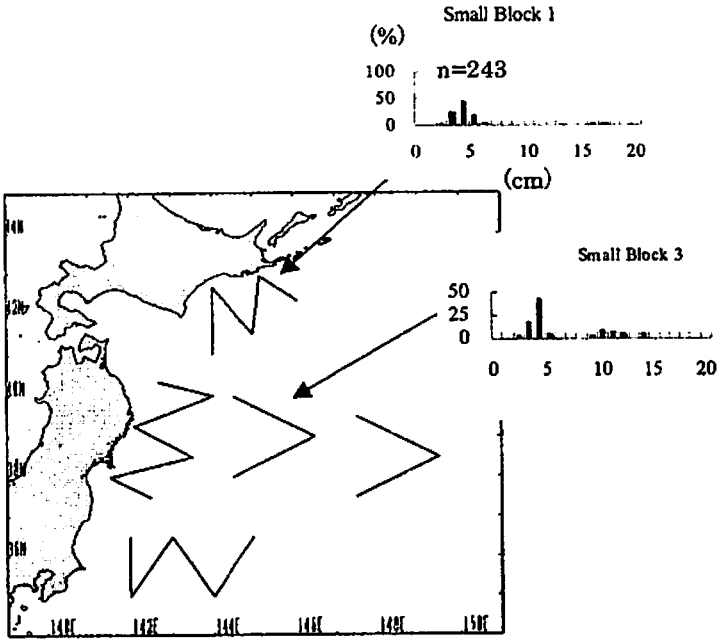



**Fig. 34. Length frequency of Japanese common squid in each small block. (trawling samples).**

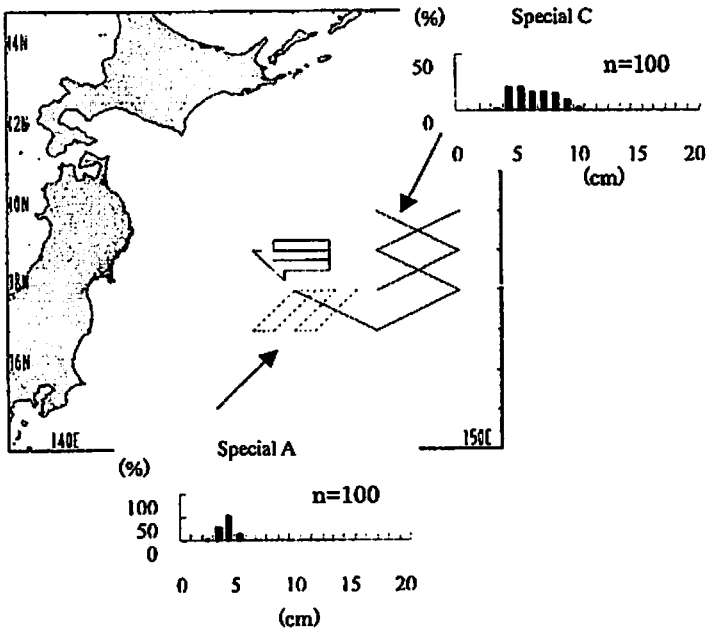



**Fig. 35. Length frequency of Japanese common squid in each special block. (trawling samples).**

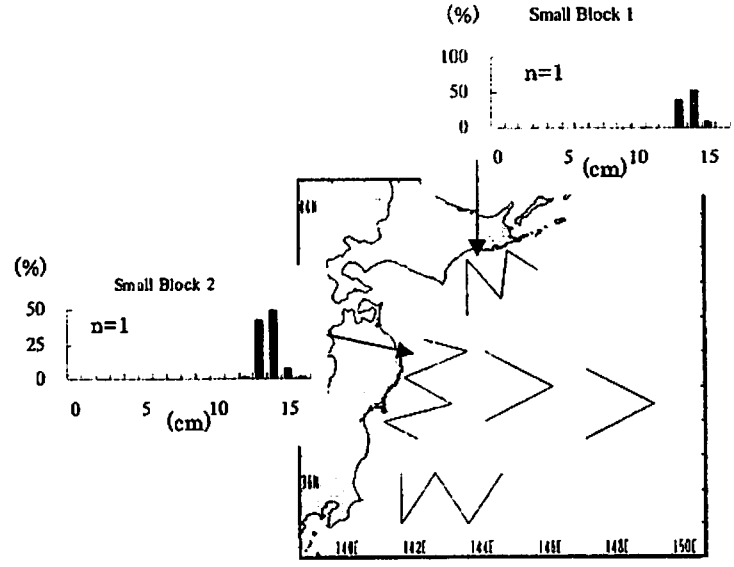



**Fig. 36. Length frequency of Japanese anchovy from minke whales (Small blocks).**

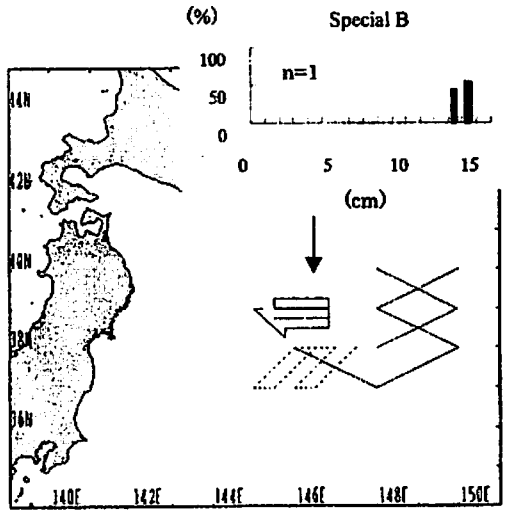



**Fig. 37. Length frequency of Japanese anchovy from minke whales (Special block).**

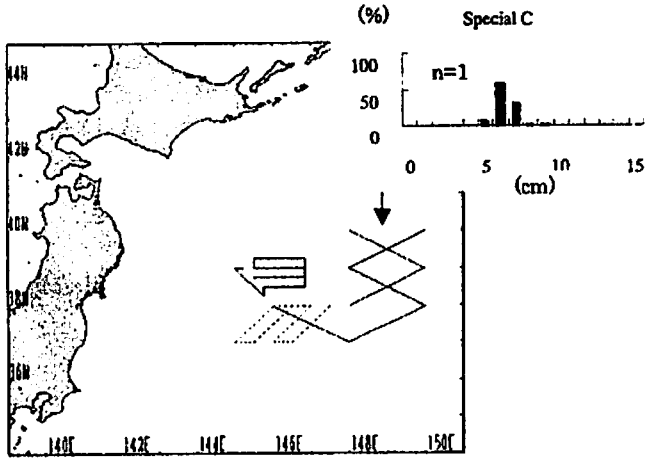



**Fig. 38. Length frequency of Japanese anchovy from Bryde's whales (Special block).**

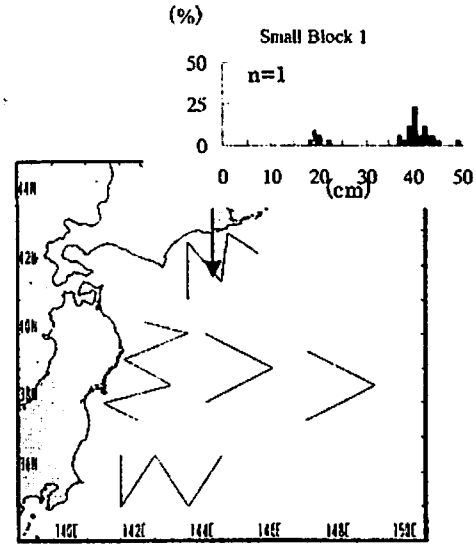



**Fig. 39. Length frequency of walleye pollock from minke whales (Small block).**

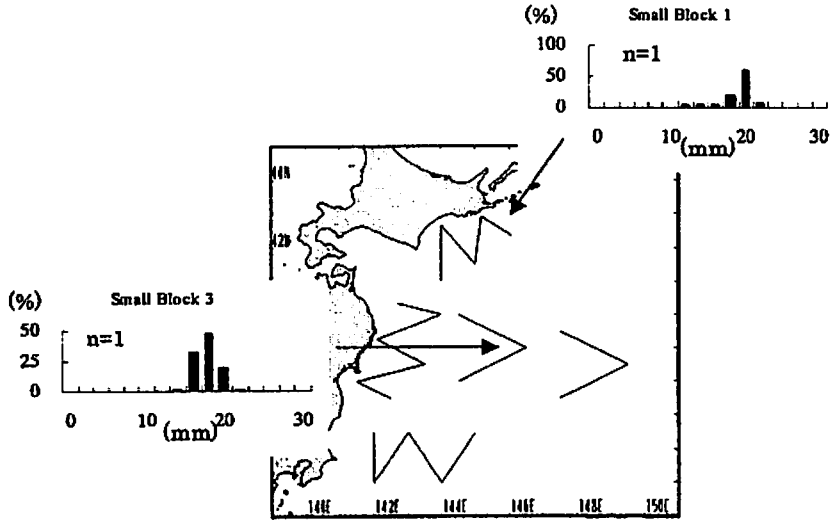



**Fig. 40. Length frequency of *Euphausia pacifica* from minke whales (Small blocks).**

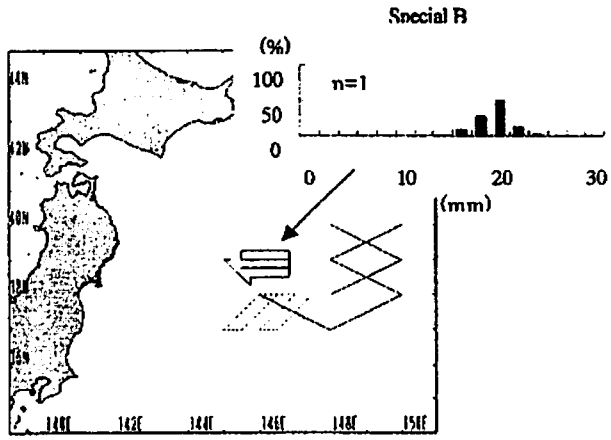



**Fig. 41. Length frequency of *Euphausia pacifica* from minke whales (Special block).**

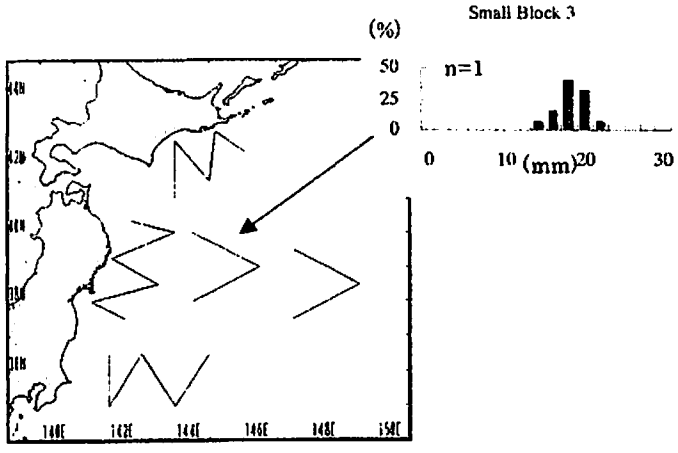



**Fig. 42. Length frequency of *Euphausia pacifica* from Bryde's whales (Small block).**

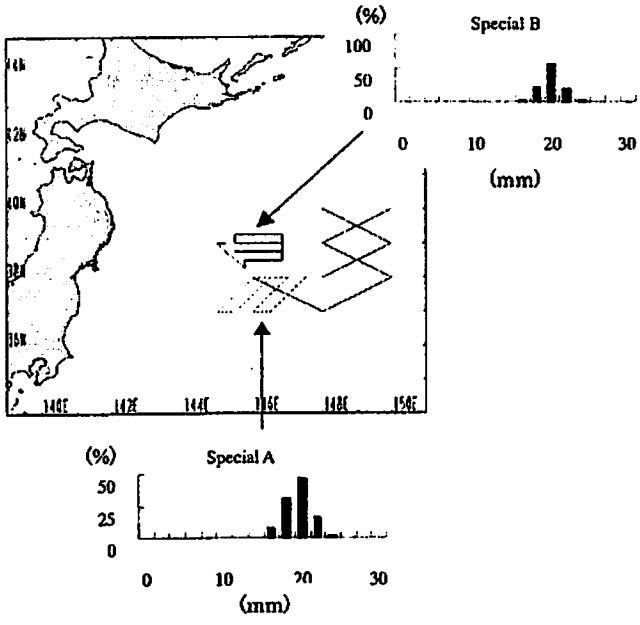



**Fig. 43. Length frequency of *Euphausia pacifica* from Bryde's whales (Special blocks).**

Appendix I

# Oceanographic conditions in the Kuroshio-Oyashio Inter-frontal zone around June 2001

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## INTRODUCTION

There are a lot of oceanic fronts and water masses in the Kuroshio-Oyashio Inter-frontal zone. Oceanographic conditions around June 2001 (JARPNII-2001), when the concurrent whale and prey surveys of JARPN II were conducted, are described comparing with those in August 2000 (JARPNII-2000; Inagake and Uehara, 2001).

## METHODS

Hydrographic observations with a conductivity-temperature-depth profiler (CTD; SBE 9plus) were carried out from 16th May to 10th July 2001 in the Kuroshio-Oyashio Inter-frontal Zone on board *Torisima*. Salinity compensation for CTD data was done using water sampling data at three CTD stations.

The oceanographic conditions in June 2001 were presented by the Tohoku National Fisheries Research Institute (TNFRI), who used quasi-real-time data from several cooperative organizations and prefectures, that was Fisheries Agency, Meteorological Agency, Hydrographic Department and Fisheries Experiment Stations, etc.TNFRI published temperature maps and schematic hydrographic maps using World Wide Web (http://ss.myg.affrc.go.jp/kaiyo/temp/temp.html). Oceanic fronts and water masses are usually detected by subsurface temperature map, because they are obscure in sea surface temperature distributions in warming seasons and the Oyashio water spreads into the subsurface layer. The Kuroshio Extension is defined by the 14℃ isotherm at the depth of 200m (Kawai, 1969). The Kuroshio warm-core rings and cold rings are defined by the closed isothermal lines on a 200 m temperature map. The warm water spreading from Kuroshio Extension is defined by temperature more than 10℃ at the depth of 100 m. The Tsugaru warm water is defined by an oceanic front in a 100 m temperature map. The first and the second Oyashio Intrusions are defined by temperature lass than 5℃ at the depth of 100 m (Murakami, 1994).

## OCEANOGRAPHIC CONDITIONS IN 2001

Fig. 1 shows Temperature-Salinity (T-S) diagrams using CTD station data in May to July 2001. Water masses in the research area have characteristics of warm high-salinity water (the Kuroshio water in the right read part of Fig. 1), cold low-salinity water (the Oyashio water in the lower blue part of Fig. 1) and the mixed water of the Kuroshio and Oyashio water. The T-S points were distributed in these water masses characterized by the Kuroshio water to the Oyashio water. The Kuroshio water mass was observed in twelve stations and more dominant in 2001 than in 2000. The low-salinity Intermediate waters (North Pacific Intermediate Water) were observed in the mid-layer under the depth of 300 m of the Kuroshio area. The low-salinity water less than 34 psu shows that the Oyashio water mass spread into the mid-layer of the Kuroshio water directly. These phenomena were observed more typically at JARPNII-2001 than JARPN-2000.

Fig. 2 shows the 200 m depth temperature map and the schematic hydrographic map in June 2001, presented by TNFRI. The Kuroshio Extension northern limit at the first crest was

37 ° 40'N (upper panel in Fig. 2). The Kuroshio warm-core ring off Sanriku was located at 39 ° 30'N and 144 ° 30'E with 200 m temperature of 6℃ (upper panel in Fig. 2).

The northern limit of the warm water spread from the Kuroshio Extension usually shifts northward from March to November, but from April to September 2001 the northern limit in near-coastal area was stable in 39 ° N-40 ° N and its position in June 2001 was at 39 ° 20'N on 146 ° 40'E, 40 ° 20'N at 153 ° E line (yellow area in lower panel of Fig. 2), which is the almost same position observed in JARPN-2000.

Tsugaru warm water spread eastward to 142 ° 50'E along 42 ° N line in June 2001 (eastern part of green area in lower panel of Fig. 2). This water changes itself from a coastal mode in winter and spring to a gyre mode in summer and fall. So, the east limit of the Tsugaru water in JARPN-2001 was more east than the limit in JARPN-2000.

The southern limit of the first Oyashio Intrusion was located at 39 ° 20'N and 142 ° 30'E in JARPN-2001 (blue area in lower panel of Fig. 2), which was approximately mean location of its fluctuation same as JARPNII-2000 period. The southern limit of the second Oyashio Intrusion was 39 ° 20'N and 146 ° E which was approximately in the mean location.

Red diamond, green triangle, light blue star and blue square on the lower panel in Fig. 2 denote CTD stations observed from *Torisima* in the Kuroshio area, warm area (100 m temperature was over 10℃ and 200 m temperature was less than 14℃), cold area (100 m temperature was over 5℃ and less than 10℃) and the Oyashio area, respectively. This schematic map was decided by observation data in June but these CTD stations were observed from May 16 to July 12, so same CTD stations were distributed different water masses, for example, the light blue star at 40° N and 143° 52'E was in the Oyashio area. Although some stations looks in different water mass in this figure because of time rag and different data sources, we can easy to see where these stations were distributed in each water mass. The blue square stations in the area southeast of Hokkaido and between 145° E and 150° E from 39° N to 40° N were distributed in the Oyashio area. Red diamond stations in 142° -145° E and 35° -37° N were in the first crest of Kuroshio Extension. Red diamonds also observed in 147° -150° E and 37° -39° N, and shows that the second crest of the Kuroshio Extension flowed in this area. Light blue star and green triangle were distributed between the Kuroshio area and the Oyashio area. The Oyashio area was not so different, but the Kuroshio area was wider. Thus the Kuroshio water was dominant in JARPNII-2001.

Fig. 3 shows the vertical temperature sections along 142-143° E, 144-145° E and 148-150° E. Southern part of each section corresponded with the Kuroshio area that was indicated by a typical slope of sharp thermocline. This Kuroshio front at the first crest lied at more northern area (north of 36° 30'N along 142-143° E and 144-145° E) than JARPNII-2000 when the Kuroshio Extension flowed at south of 36° N along 144-146° E. The Kuroshio warm-core ring was indicated by the deeper thermocline structure like a bowl shape around the 39° N along the 142-143° E section and around 39° 30'N along 144-145° E. Another Kuroshio warm-core ring was also shown around 38° 30'N in the 148-150° E section (upper right panel in Fig. 3) with a bowl shape thermocline structure and a mixed layer in the mid-depth of 150-280m (temperature was 12-13℃). In the northern area of 40° N along each section, there was the Oyashio water shown by the cold water less than 5℃ in the upper layer shallower than 200 m depth. The shallow cold water less than 5℃ was also observed around 38° 30'N along 142-143° E, but this water was separated from the Oyashio area. At the layer deeper than 300 meter, cold water less than 3℃ was observed to the north of the Kuroshio front along 142° -143° E and 144° -145° E sections. It indicated that pure Oyashio water exerted a substantial influence on the intermediate water of the Kuroshio.

Thus the Kuroshio water was dominant in JARPNII-2001 than in JARPNII-2000. But, other waters are distributed in almost normal position. Therefore less differences between JARPN-2000 and JARPN-2001 were observed except for the seasonal changes.

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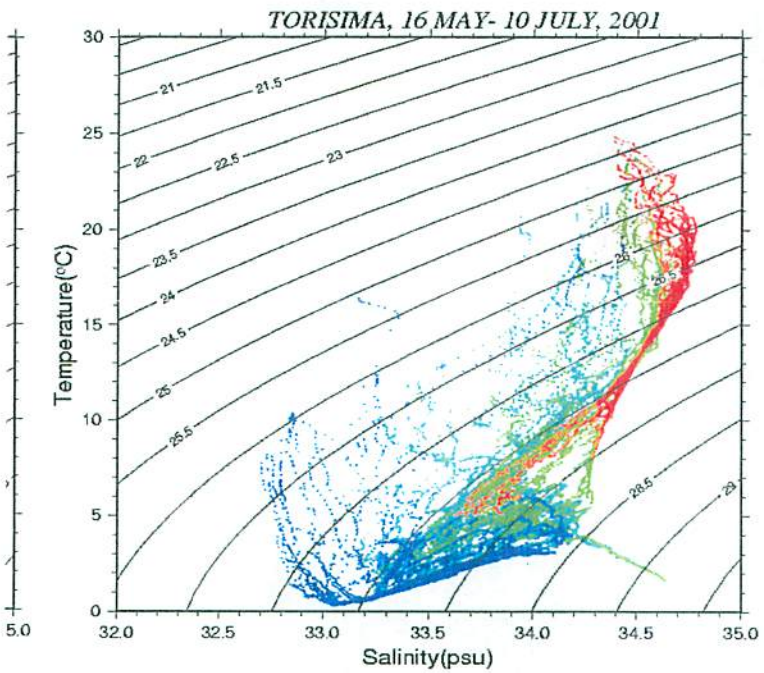


Fig. 1. Temperature-Salinity diagrams using CTD station data from *Torisima* from May to July 2001. Each thin line in this figure denotes a density line of sigma-t. Red, green, light blue and blue points corresponded to the Kuroshio area, warm area, cold area and the Oyashio area, respectively.

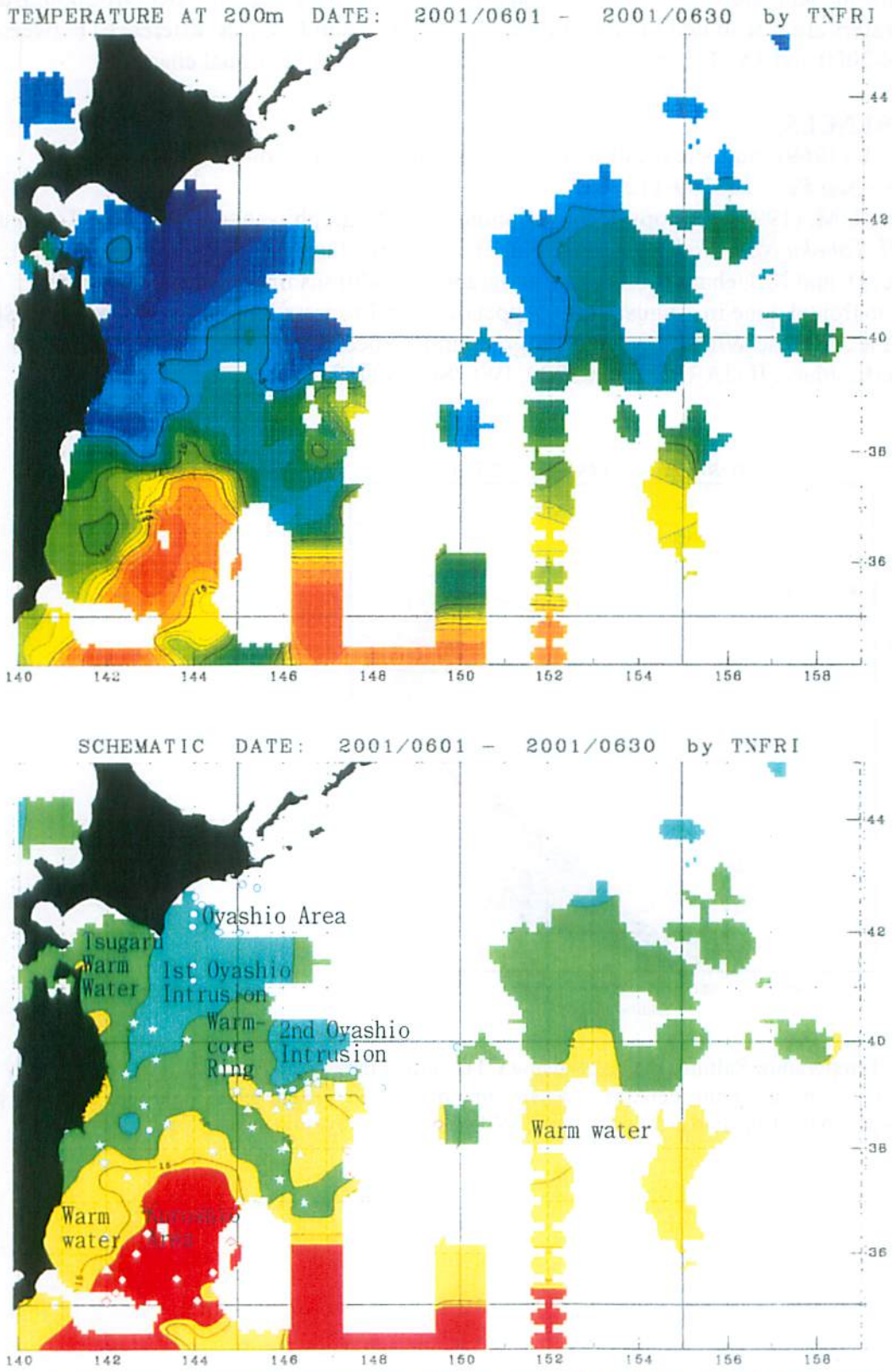


Fig. 2. 200 m temperature map (upper panel) and schematic hydrographic map (lower panel) in June 2001 (presented by the Tohoku National Research Institute). Red diamond, green triangle, light blue star and blue square on the lower panel denote CTD stations in the Kuroshio area, warm area, cold area and the Oyashio area, respectively. In the lower panel, blue, yellow and red area show the Oyashio, the warm water spreading from the Kuroshio Extension and the Kuroshio Extension, respectively.

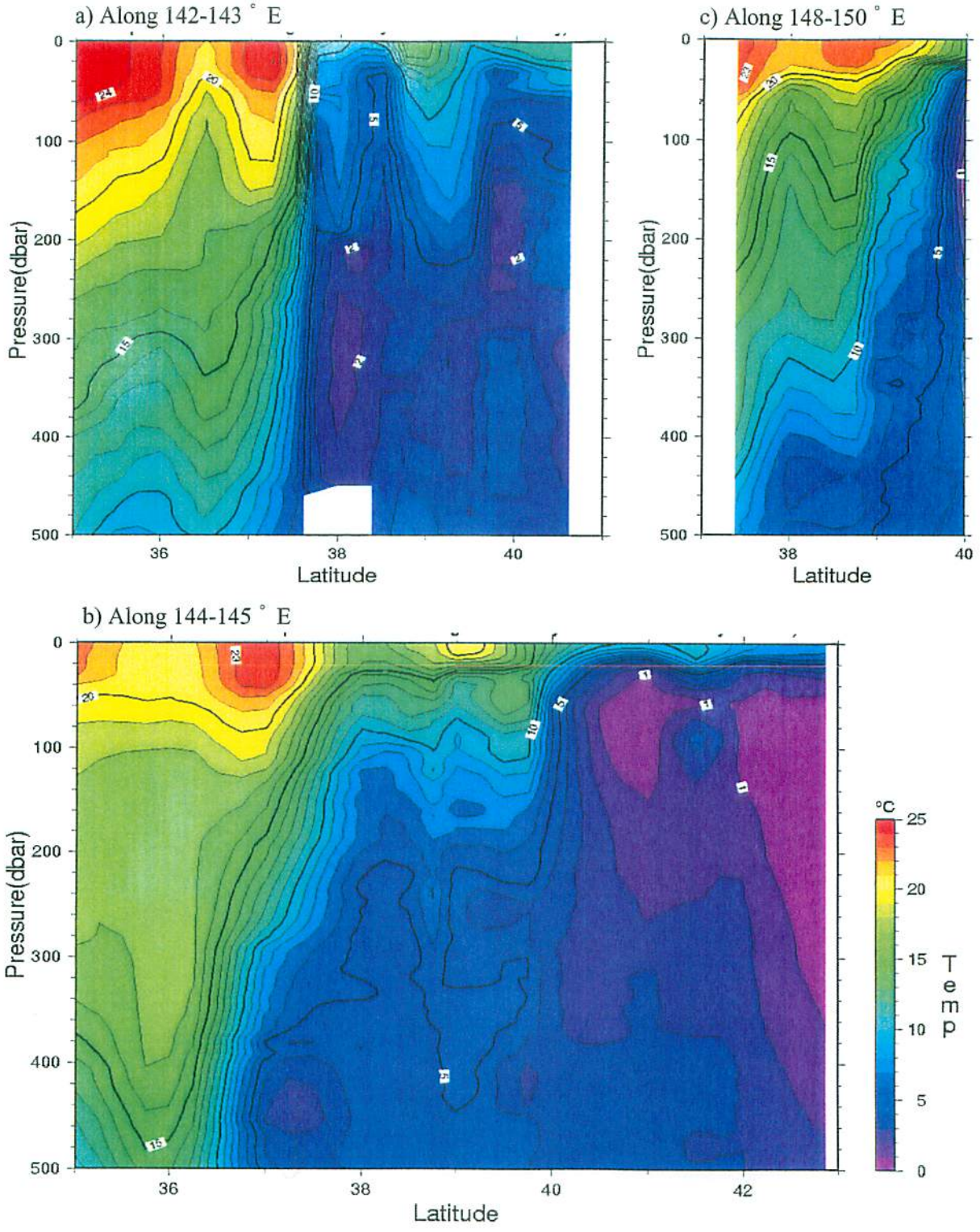


Fig. 3. Temperature sections along 142 °-143 ° E (upper left panel), 144 °-145 ° E (lower panel) and 148-150 ° E (upper right panel), observed from May to July 2001.