Cruise Report of the Japanese Whale Research Program under a Special Permit in the North Pacific in 1998

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ABSTRACT

The Japanese Whale Research Program under Special Permit in the North Pacific (JARPN) survey in 1998 was conducted in the eastern half of sub-areas 7 (7E) and 8 from 26 April to 21 June. The 1998 JARPN survey was carried out using one research base ship, three sighting/sampling vessels (SSVs) and one sighting vessel (SV). The SV searched a total of 2,762.5 n.miles and 15 schools/17 individual minke whales were sighted during the survey. The SSVs searched a total of 4,944.5 n.miles and 155 schools/165 individual minke whales were sighted. Many minke whales were sighted in the latitudinal zone from 38° N to 40° N in both sub-areas. The sampling activities were conducted on 119 schools/126 individual minke whales, resulting in the catch of 100 animals, 89 males and 11 females. As in previous surveys, mature males were dominant and few immature animals and mature females were distributed in the sub-areas 7E and 8. The peak of frequency of body length for male was 7.6m in both sub-areas and body length distribution of two sub-areas were similar. With regard to the feeding ecology of the minke whale, Japanese anchovy (*Engraulis japonicus*) was the dominant prey species in the early summer season in sub-areas 7E and 8.

INTRODUCTION

The Japanese Whale Research Program under Special Permit in the North Pacific (JARPN) was designed by the Government of Japan (Government of Japan, 1994). The first survey was conducted in 1994 as a feasibility study, and the regular survey started in 1995. The research program has two objectives; the elucidation of the stock structure of the western North Pacific minke whales and, the elucidation of the feeding ecology of the western North Pacific minke whales. Elucidation of the feeding ecology of the western North Pacific minke whales was incorporated as a new objective beginning with the 1996 JARPN survey (Government of Japan, 1996).

Previous studies, identified two stocks of minke whales around Japan, i.e. the Okhotsk Sea-West Pacific Stock (O Stock) and the Sea of Japan-Yellow Sea-East China Sea Stock (J Stock). However, at the meeting of the working Group on North Pacific minke whale management trials of the IWC/SC in 1993, two additional hypotheses were proposed by some SC members; "existence of the other stock 'W-Stock'" and, "existence of sub-stocks within the these two stocks" (IWC, 1994). Therefore the JARPN survey was designed in order to examine these two hypotheses (Government of Japan, 1994).

The minke whales in the western North Pacific widely consumed zooplankton and pelagic fish species, and it was clear that Pacific saury (*Cololabis saira*) was the dominant prey species (Fujise *et al.*, 1995, 1996). Pacific saury and Japanese anchovy (*Engraulis japonicus*) the minke

whales feed on, are also caught in the coastal fisheries of Japan. Therefore the feeding ecology of minke whales became a component of the research plan for the 1996 JARPN (Government of Japan, 1996). In Norway, the studies of feeding ecology have been carried out for several years, therefore, a Norwegian scientist with experience in feeding ecology studies on the North Atlantic minke whale participated in the 1996 JARPN survey.

In 1994-1995, the surveys were conducted in the mid summer in the offshore sub-area 9 to examine the hypothesis concerning the existence of the W Stock (Fujise *et al.*, 1995, 1996). In 1996, the survey was conducted in the mid summer season in the sub-areas 7, 8 and 11 in order to elucidate whether sub-stocks exist within the O Stock (Fujise *et al.*, 1997). Results of the genetic analyses (Goto and Pastene, 1996; Wada, 1996) and the biological preliminary analysis (Fujise *et al.*, 1996) from data collected in previous surveys provide no evidence to support the existence of the W Stock. However, during the working group meeting in 1996, it was agreed that these results were not conclusive because they were obtained from surveys conducted in the mid summer season and there was no information for the early migration season during April and May (IWC, 1997). Therefore, the 1997 JARPN survey was conducted in the early migration season (May to early July) in sub-areas 7E, 8 and 9. It was not possible to identify differences in a number of biological parameters from the samples collected in the early summer season (May to June) and those collected from the mid summer season (June to September) (Fujise *et al.*, 1998).

In 1998 also, the entry to the sub-area 12 which is the major feeding area of minke whales in the mid summer season, most of this area is in Russian waters was not permitted. Therefore the 1998 survey was conducted in sub-areas 7E and 8 in order to obtain samples from sub-area 7E and sub-area 8 (especially western part) in the early migrate season (May to June). Furthermore, the survey was also designed to be conducted in the sub-area 11 in order to obtain the sufficient samples in July to provide information on the mixing of J and O Stock animals in this sub-area. The surveys in sub-areas 7E and 8 were conducted under good weather and sea conditions and many minke whales were sighted in both sub-areas. Accordingly, the survey in sub-area 11 which was planned for the latter half of the research period was postponed and emphasis was put on securing samples in sub-area 7E and western part of sub-area 8, taking into account that the numbers of samples obtained through the previous surveys were only 3 and 7 in the sub-area 7E and western part of sub-area 8, respectively. This paper provides a description of the fifth cruise of the JARPN, which was conducted from 26 April to 21 June and reports the results of preliminary analysis of biological data obtained in this survey.

RESEARCH METHODS

1. Research area

The Western North Pacific was divided into 13 sub-area by the IWC. The research area was defined as parts of sub-areas 7 and 8 established by the IWC, excluding the EEZ zones of foreign countries. In sub-area 7, the research area was eastern half of the area (7E) as in the previous surveys (Fujise *et al.*, 1997; Ishikawa *et al.*, 1997).

2. Research vessels

As in the previous surveys, the *Nisshin Maru* (7,575GT) was used as a research base ship. The base played the roles of the command center for the research, the platform for the biological examination of whale samples and processing of by-products. Three vessels, *Kyo Maru No.1* (812.08GT), *Toshi Maru No. 25* (739.92GT) and *Toshi Maru No. 18* (758.33GT) (sighting/sampling vessels:SSVs) were engaged in sighting and sampling activities, various experiments and observations as mentioned below. *Kyoshin Maru No. 2* (sighting vessel:SV) was engaged in the sighting survey independently and conducted various experiments and observations as mentioned below.

3. Cruise trackline

The sighting survey conducted by the SV

The cruise track of the SV is shown in Fig.1. As the main survey, the zigzag-shaped trackline was established in each sub-area 7E and 8. In addition, in sub-area 7E, a 'special monitoring survey (SMS)' was conducted in a latitudinal zone which was chosen taking into consideration the sighting information on minke whales and surface temperature.

The sighting and sampling surveys conducted by the three SSVs and the research base ship

The sighting and sampling surveys constituted three types of surveys including a pre-survey, a main survey and a SMS. As the most of the minke whales were sighted in the area with a surface temperature range from 12° C to 13° C in the previous surveys, the pre-survey was conducted in order to obtain information on water temperature and minke whales distribution in May which was the early migration season. The zigzag-shaped trackline was set from east to west in the latitudinal zone from 37°N to 40°N in sub-area 7E taking into consideration information such as the sighting of minke whales and surface temperature obtained during the SV which was conducted earlier in research period. The zigzag-shaped trackline was divided into three sections, and the three SSVs were each allocated one section.

For the main survey, the zigzag-shaped trackline was established from north to south in an area which included sub-area 7E and the western part of sub-area 8 (to 153° -30'E). The SMS was conducted in the area where the sightings of minke whales were expected based on information such as sighting minke whales and surface temperature in the pre-survey and the main survey. The trackline in the SMS was designed to be separated from the trackline in the pre-survey and the main survey. The cruise tracks of the three type of surveys are shown in Fig.2.

As in the previous JARPN survey (Fujise *et al.*, 1995, 1996, 1997 ; Ishikawa *et al.*, 1997), the research course consisted of three tracks, one main track established as in the above procedure and two parallel sub-tracks established 6 n.miles apart on both sides. In the SMS, the distance between the tracks was set at 4 n.miles considering efficiency of sampling. The three SSVs were assigned to these three tracks, and the assignment was changed every research day.

4. Sighting surveys

The searching procedure was same as in the previous JARPN surveys (Fujise *et al.*, 1996, 1997; Ishikawa *et al.*, 1997). Searching was conducted under a closing mode. Furthermore, two modes of sighting surveys were adopted (*BC* and *BS mode* surveys) by taking into consideration the sea condition at the time of the searching. The conditions under which surveys were conducted using the *BC mode* are 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 velocity 4 or below). The *BS mode* survey was conducted in conditions different from these indicated for the *BC mode* but under which, the collection of whale samples was possible. These two mode surveys were recorded separately for future analyses. Closing was made mainly on minke whale sightings or on schools which looked like minke whales. Closing was also made on large whales species sightings, such as blue, humpback, right, fin and sperm whales. In these cases, closing was made in order to confirm species and school size, and in order to conduct some experiments.

5. Sampling of minke whales

As in the previous survey, all minke whales sighted on the trackline were approached for sampling and the sampling was made in co-operation with the three SSVs according to circumstance, and in addition, sampling effort was expanded outside the regular research hours (06:00-19:00), when collection of whale sample was considered to be possible (Fujise *et al.*, 1996, 1997; Ishikawa *et al.*, 1997).

In case of schools of at least two animals, all minke whales were numbered so that sampling could be conducted randomly in accordance with the table of random numbers (Kato *et al.*, 1989).

6. Experiments

On board the SV, the following experiments were conducted and observations made:

1. Estimation of distances and angles for examination of the precision of sighting data,
2. Biopsy sampling on minke, blue, fin, humpback and right whales,
3. Photographing of natural marks for blue, humpback and right whales,
4. Observation of behaviour patterns of blue, fin and sperm whales,
5. Oceanographic survey by means of XCTD.

On board the three SSVs, the following experiments were conducted and observations made:

1. Estimation of distances and angles for examination of the precision of sighting data,
2. Photographing of natural marks for blue, humpback and right whales.

Furthermore, killing methods experiments were conducted onboard of both the research base ship and the SSVs.

OUTLINE OF THE RESEARCH

1. Sighting survey conducted by the SV

Navigation and research periods were as follows;

navigation period : Apr. 24–June 23 (61 days)
research period : Apr. 26–June 21 (57 days)

The main survey in sub-area 7E was started on 26 April from northern part of the zigzag-shaped trackline toward southward and finished on 7 May when the SV reached at southern limit of the zigzag-shaped trackline. The SMSs were conducted two times in the latitudinal zone from 38° N to 40° N in sub-area 7E . One was on 28 April and the others was from 8 May to 12 May. After the all surveys in sub-area 7E were finished, the main survey in sub-area 8 was started on 18 May from northern part of the zigzag-shaped trackline toward southward. This sighting survey using the SV was completed on 21 June.

2. Sighting and sampling survey conducted by the three SSVs and the research base ship

Navigation and research periods were as follows;

navigation period : May 1–June 19 (50 days)
research period : May 2–June 15 (45 days)

The pre-survey was conducted in the latitudinal zone between 37°N and 40°N in sub-area 7E from 2 May to 6 May. After that, taking into consideration the information such as sighting minke whales and surface temperature in the pre-survey, the SMS was conducted in sub-area 7E from 7 May to 17 May. The main survey was started on 18 May and finished in the northern part of the zigzag-shaped trackline on 27 May. Then, the SMS was conducted in the latitudinal zone from 39°N to 40°N in sub-area 8E from 28 May to 13 June. The sampling activity was finished on 13 June because the number of whales sampled reached 100. Thereafter, on the remaining research course of the main survey, only the sighting survey was conducted. The remaining research course was divided into three sections, and each of the three SSVs surveyed one section. All sighting and sampling surveys in 1998 completed on 15 June.

RESULTS

1. Searching distance

The total searching distance by the SV was 2,762.5 n.miles, and searching distances in each sub-area were 1,258.9 n.miles for the sub-area 7E and 1,503.6 n.miles for the sub-area 8.

The total searching distance by the three SSVs was 4,944.5 n.miles (under *BC mode*: 2,721.2 n.miles and under *BS mode*:2,721.2 n.miles). Searching distance in the sub-area 7E was 3,024.4 n.miles and 59 % of the distance was made under *BC mode*. Those in sub-area 8 were 1,920.1 n.miles and 23% of distance made under *BC mode*. Therefore proportion of searching distance under BS mode in sub-area 8 was higher.

2. Distribution of minke whales

Table 1 shows the cetacean species sighted by the SV during the 1998 JARPN survey, by sub-area. A total of 15 schools/17 individual minke whales (primary:13 schools/14 individuals; secondary:2 schools/3 individuals) and 3 schools/3 individuals of 'like minke whales' (primary) were sighted. Five schools (5 individuals) of minke whales were primary sighted in sub-area 7E and 10 schools/12 individuals (primary:8 schools/9 individuals; secondary:2 schools/3 individuals) were sighted in sub-area 8. Only two schools included two whales while the other schools were composed of a solitary whale. In most cases the cue of sightings was the body. Many minke whales and 'like minke whales' were sighted in the latitudinal zone from 40° N to 42° N in both sub-areas (Fig.3).

Table 2 shows the cetacean species sighted by the SSVs, by sub-area. A total of 155 schools/165 individual minke whales (primary: 69 schools/71 individuals; secondary: 86 schools/94 individuals) and 25 schools/25 individuals of 'like minke whales' (primary: 6

schools/6 individuals; secondary: 19 schools/19 individuals) were sighted. The 94 schools/100 individuals (primary: 47 schools/48 individuals; secondary: 47 schools/52 individuals) of minke whales were sighted in sub-area 7E and 61 schools/65 individuals (primary: 22 schools/23 individuals; secondary: 39 schools/42 individuals) were sighted in sub-area 8. Most of schools consisted of a solitary whale (the schools of two whales were only 10) and in most cases the cue of sighting was the body. The distribution of minke whales and 'like minke whales' sighted during the 1998 survey is shown in Fig. 4. Many minke whales and 'like minke whales' were sighted in the latitudinal zone from 39° N to 41° N in both sub-areas.

Fig 5 shows the relationship between sea surface temperature and number of schools of minke whales sighted, by sub-area. Sightings of minke whales were concentrated in the temperature range from 8° C to 9° C in the sub-area 7E in which the survey conducted on May, and at 11° C in the sub-area 8 in which the survey conducted on June.

3. Distribution of other whale species

The species most frequently sighted by the SV was Dall's porpoise (*dalli* type:31 schools/206 animals, *truei* type:3 schools/14 animals, unidentified type:63 schools/288 animals). The second most frequently sighted species was the sperm whale (38 schools/68 animals) (Table 1). With regard to the sighting distribution of large baleen whales, two schools of right whales (three animals) and one school of fin whale (one animal) were found in sub-area 7E and sei (7 schools/8 animals), fin (4 schools/4 animals), blue (1 schools/2 animals) and humpback (1 schools/1 animals) whales were found in the sub-area 8 (Fig. 6).

For the three SSVs, the most frequently sighted species was the sperm whale (99 schools/248 animals), and the second most frequently sighted species (excluding minke whales) was the killer whale (38 schools/144 animals) (Table 2.). Fig.7 shows the distribution of large baleen whales. Some large baleen whales were sighted in the research area. Sei (2 schools/2 animals), Bryde's (one animal), humpback (6 schools/6 animals) and right whales (2 schools/3 animals) were found in the latitudinal zone from 39°N to 41°N in both sub-areas.

4. Sampling of minke whales

Table 3 shows the number of minke whales sighted and sampled and their efficiencies by sub-area. Of 155 schools/165 minke whales sighted 119 schools/126 animals were targeted for sampling. As a result 100 minke whales were sampled. Fig. 8 shows the geographical location of sampled minke whales. In the sub-area 7E, 64 schools /67 minke whales were targeted for sampling resulting in 56 animals were sampled. Technical sampling efficiency (the rate of sampling of targeted individuals) was 0.84 (true sampling efficiency : the percentage of sampled individuals in all the sighted individuals was 0.56). In the sub-area 8, 55 schools/59 animals were targeted for sampling resulting in 44 sampled. Technical sampling efficiency was 0.75 (true sampling efficiency was 0.68). In most cases the reasons for missing whales during chasing were due to whale behaviours such as long diving and/or quick mobile behaviours.

5. Experiments and oceanographic surveys

5.1 Experiments to estimate distance and angle

The experiments were conducted on board of the SV on 10 June and on board the three SSVs on 13 June after a rehearsal of the experiment.

5.2 Biopsy sampling experiment

A biopsy sampling experiment was conducted on board the SV. One school of blue (2 animals), humpback (1 animal) and right (2 animals) whales were targeted for biopsy sampling. Though a total of 93 minutes for blue whales, 53 minutes for humpback whales and 42 minutes for right whales were spent in this experiment, biopsy skin samples were not collected.

5.3 Recording of natural marks

Photographs of natural marks on blue, humpback and right whales were taken by the SV and the three SSVs which was sighted for these target species as primary sighting. This experiment was conducted in consideration of the research time itinerary. As the result, photographs of natural marks were obtained from one school of blue (2 animals), three schools of humpback (3 animals) and three schools of right (5 animals) whales.

5.4 Observation of behaviour in large whale species

Behaviour patterns of blue, fin and sperm whales sighted were observed for their swimming direction, diving time and feeding activities by the SV. These observations were recorded for 2 animals of blue whales during 44 minutes, for 3 animals of fin whales during 121 minutes and for one animal of sperm whale during 39 minutes.

5.5 XCTD observation

On board of the SV, XCTD observations were conducted at points which established every 15 n.miles along the trackline in sub-area 7E. In sub-area 8, these observations were conducted once a day. As a result, XCTD observations were conducted at a total of 51 points in both sub-areas.

5.6 Killing methods

The killing methods experiments were conducted by both the research base ship and the three SSVs. Data were made and data collected on the performance of rifle and harpoons as secondary methods for killing the animal.

6. Biological research

The minke whales sampled were retrieved into the research base ship and biological research (such as external measurements and tissue samples) was conducted for these whales. Table 5 shows the summery of biological research that indicated research items and the number of animals examined. Although a parasitologist was participated on board the research base ship in order to conduct special parasitological examination in the previous three JARPN surveys, any parasitologist was not on board in this cruise due to logistic. The minke whales sampled in the sub-area 7E included 49 males and 7 females, and in the sub-area 8, 40 males and 4 females.

7. By-products

After biological research was completed, all the whales were processed according to the International Convention for the regulation of whaling, Article VIII. Table 6 shows the list of by-product. Total production including red meat, blubber and viscera (kidney, heart, pancreas, etc.) from all of the 100 sampled minke whales was 281,190.5 kg.

8. Preliminary analyses of biological information

Data and samples collected during the 1998 JARPN survey are analysed by experts in each field after the fleet returned to Japan. Some of the results of these studies are presented separately in this meeting . In this section, some preliminary analyses of biological data obtained from the 1998 JARPN survey such as maturity, body length, foetal length, stomach contents and parasites are presented.

8.1 Sex ratio and maturity status

Table 8 shows the sex ratio, the maturity rate and maturity composition of samples collected in this survey. At present time, histological examination of gonads has not been completed therefore these animals were classified as either mature or immature by taking into consideration the weight of testis. In both sub-areas 7E and 8, the male to female ratio was high, and the maturity rate in males was high. For females, sample size was small in both sub-areas. The maturity rate in the sub-area 7E was 42.9% and in the sub-area 8, 50.0%. Most mature females were pregnant. Comparison of the sex ratio and maturity status of samples between sub-areas, shows a dominance of mature males with few immature animals and mature females distributed in both sub-areas.

8.2 Body length and length distribution

Table 7 shows the values of body length of minke whales sampled in this survey by sex and sub-area. The mean body length of males were 7.13m (range:5.19-7.53m) and 7.29m (range:5.28-8.10m) in the sub-areas 7E and 8, respectively. Those of females were 6.61m (range:5.54-8.23m) and 7.31m (range:5.62-8.63m) in the sub-areas 7E and 8, respectively.

Fig. 9 shows the frequency of body length by sex and the sub-area. The peak of these frequencies for male was 7.6m in both sub-areas. Further a relatively high proportion of small male animals were observed in both sub-areas, and body length distribution of two sub-areas were similar. On the other hand, though body length distribution of females was not clearly because of the small number of samples, females seem to have a wider range of body length in the sub-areas 7E and 8.

8.3 Foetus size (conception date)

In this survey, a total of 11 females were sampled of which five were sexually mature. Of these, two pregnant females were sampled from each sub-area. Table 9 shows the summery of pregnant females and their foetuses collected by this survey. The body length of the foetuses were in the range of 3.7 to 47.3cm. Fig.10 shows the relations between the sampling date and the body length of these foetuses, with those sampled during the JARPN surveys in 1994-1998 and during the past Japanese coastal whaling. As well as the results suggested from foetuses collected in the JARPN surveys, the four foetuses in the this survey were considered to have been conceived at roughly the same time as the Okhotsk-Western North Pacific Stock (O Stock).

8.4 Parasites

Table 10 shows the preliminary results for parasite species in this survey. The parasitic worms observed were Pennella, Cirripedia and Cyamus at the skin, Nematode in the stomachs, Acanthocephala and Cestoda in the small intestines and Trematode in the livers of whales sampled in this survey. Pennella infected the skin of minke whales sampled with an infection rate of more than 80% in the sub-areas 7E and 8. In both sub-areas, Nematodes (*Anisakis simplex*) were observed in the stomachs of almost all of the minke whales sampled (range of infection rate: 97.7-100%). Acanthocephala infected the small intestine of all whales sampled (infection rate was 100%). The infection rate in livers by Trematoda was about 65-75% in the sub-areas 7E and 8. There was no difference in the infection rate of external and endo parasitic worms between Sub-areas 7E and 8. The parasitic worms collected in this survey have been analysing in detail by parasitologists (T. Kuramachi, pers. comm.) and further information will be presented in near future.

8.5 Anomaly in gonadal tissues of sampled whales

It has already been reported that anomalous tissues were observed in testes of some male minke whales (Fujise *et al.*, 1996, 1997, 1998 ; Ishikawa *et al.*, 1997). The same anomaly was observed in testes tissues collected in this survey. Table 11 shows the frequency of the anomaly for immature and mature males sampled in the 1998 survey. Anomaly in both or either side of testes was observed in testes of 13 mature males of 89 males sampled in 1998. The percentage of anomalous testes in mature males were 15.4% and 20.0% in the sub-areas 7E and 8, respectively. The cause of the anomaly in gonadal tissues has not been confiemed.

8.6 Feeding habit

Table 12 shows the main prey species in the forestomach and their frequency of occurrence in samples taken in this survey. Euphausiids (*Euphausia pacifica*), Pacific saury (*Cololabis saira*), Japanese anchovy (*Engraulis japonicus*) and unidentified salmon were observed to be the main food species of sampled minke whales. The dominant prey species was Japanese anchovy (*Engraulis japonicus*) (94.3-97.7%) in both sub-areas 7E and 8.

Further when marine debris (artifact) was found in the stomach contents of the sampled minke whales, it were collected and photographed. During this survey, one or more artifacts were observed in the stomach contents of 21 animals. Collected artifacts were plastic fragments (11 animals), piece of wood (7 animals), pebbles (5 animals) and fishhook (1 animal).

9. Mistake sampling of Bryde's whale

During sampling activities, a Bryde's whale was mistakenly sampled on 9 May. In that day, the special monitoring survey (SMS) was conducted in an area where it was expected a high density of minke whales. During the searching that day, no other large whales had been sighted (primarily or secondarily) except that Bryde's whale. The cue when this Bryde's whale was sighted was a pale blow (same as the minke whale). The surface temperature where this whale was sampled was 8.3° C and it was considerably lower than the surface temperature range (18-26° C) where the Bryde's whales are usually sighted. Within 0.5 n.miles, the researcher and captain identified the whale as a minke whale by the following characters: dark gray body coloration, sickle shape of dorsal fin and shade pattern of bright and dark. After this whale was sampled, it was noticed that this whale was actually a Bryde's whale. This mistaken sampling was informed immediately to all researchers and crews of the all SSVs as well to the all crews of the research base ship. In order to avoid to repeat this mistake, all crews from all SSVs were called on board the research base ship. Then, they received a lecture by specialists on whale identification using actual the whale body. After

that, detailed biological research was conducted on the Bryde's whale. This included morphological record by photographs, detailed external measurements, and sampling of biological materials as shown in Tables 13 and 14. This individual was confirmed to be an immature female with body length of 8.52m and with weight of 4.66t. After the mtDNA analysis at the laboratory, the whale was also re-confirmed as a Bryde's whale (offshore form) (M. Goto, pers. comm.). After the biological research was completed, the whale was processed and all the by-products were burnt under supervision of the Fisheries Agency after returning to the port.

DISCUSSION

In response to the comments of the working group meeting in 1996 (IWC, 1997), the 1997 JARPN survey was conducted in the early migration season (May to June) in the sub-area 9, and the 1998 survey was conducted in the early migrate season (May to June) in the sub-areas 7E and 8.

Result of preliminary analyses of biological data obtained during the 1998 survey (from May to June which is the early migration season of minke whales) shows that similar to the previous offshore surveys, mature males were dominant and few immature animals and mature females were distributed in sub-areas 7E and 8 (Fujise *et al.*, 1995, 1996, 1997 ; Ishikawa *et al.*, 1997). However the proportion of immature animals in this survey was higher than those of the previous mid summer season (July to September) in the 1994-1996 surveys. This trend was similar to the results of the 1997 survey which was carried out in the early summer season (Ishikawa *et al.*, 1997). These data and previous research results make it difficult to assume that the minke whales distributed in these research areas formed only one biological group. Although immature animals tend to distribute in the coastal area compared with the offshore area, the proportion of immature animals tend to be relatively high in the spring to early summer season compared with the mid summer season. Furthermore, in the 1994-1998 surveys, few pregnant females were distributed in the offshore area from the sub-area 7E to the sub-area 9 in the spring to mid summer. It appears that most of the pregnant females have already moved to the northward in the period the JARPN surveys were conducted. The migration routes of the mature females appears to differ from that of males. It is thought that the migration and distribution pattern of the western North Pacific minke whales differs by sex and the stage of sexual maturity. These differences could be clarified by conducting surveys in the offshore areas earlier in the season and in the coastal area from the spring to the early summer season, and in the sub-area 12 (Okhotsk sea) which is regarded as the main distribution area of O Stock during the mid summer season. Result of preliminary analysis of the body length distribution, the foetus size (conception date), the infection rate for parasite species show no difference between the sub-areas 7E and 8. These results provide no evidence to support the existence of the W Stock, and it is considered that the O Stock is widely distribute from the coastal area to the offshore area.

With regard to the feeding habits, previous surveys conducted in mid summer seasons in 1994-1996 show clearly that the Pacific saury (*Cololabis saira*) was the dominant prey species of minke whales in the western part of North Pacific (Fujise *et al.*, 1995, 1996, 1997). However, Japanese anchovy (*Engraulis japonicus*) was the dominant prey species in this survey. This result was similar to the result obtained in the early summer season in the 1997 survey (Ishikawa *et al.*, 1997). This shows that the main food species were different by season and that the main prey species of the minke whales was the Japanese anchovy from the spring to the early summer, and that thereafter, from the early summer to the mid summer, the main prey species changed to the Pacific saury.

ACKNOWLEDGEMENTS

We are greatly indebted to Yasuhiko Shimadzu, project leader of the JARPN survey (Director of the National Research Institute of Far Seas Fisheries; NRIFSF), and Hiroshi Hatanaka, Director of the National Research Institute of Fisheries Science (NRIFS). We are also greatly indebted to Seiji Ohsumi, Director general of the Institute of Cetacean Research (ICR), and Nobuyuki Yagi, former the Fisheries Agency, the Government of Japan. We are also indebted to all of the crew and the colleagues from the ICR, the NRIFSF and other related institutions who participated to planing of the research. We also thank Dan Goodman and Luis A. Pastene of the ICR for valuable suggestions in preparing this manuscript. The present research project was funded under the

subsidy of the Ministry of Agriculture, Forestry and Fisheries, Government of Japan.

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Table 1. List of cetacean species sighted by sighting vessel (*Kyoshin Maru No.2*) during the 1998 JARPN

Species	Sub-area 7E		Sub-area 8		Combined	
	Primary	Secondary	Primary	Secondary	Primary	Secondary
	Sch / Ind.	Sch / Ind.	Sch / Ind.	Sch / Ind.	Sch / Ind.	Sch / Ind.
Minke whale	5 / 5		8 / 9	2 / 3	13 / 14	2 / 3
Like minke whale			3 / 3		3 / 3	
Sei whale			4 / 4	3 / 4	4 / 4	3 / 4
Fin whale		1 / 1	4 / 4		4 / 4	1 / 1
Blue whale			1 / 2		1 / 2	
Humpback whale				1 / 1		1 / 1
Right whale	2 / 3				2 / 3	
Sperm whale	20 / 31	3 / 8	10 / 24	5 / 5	30 / 55	8 / 13
Risso's dolphin			1 / 36		1 / 36	
Killer whale	1 / 1		3 / 7	1 / 5	4 / 8	1 / 5
Blainville's beaked whale			1 / 5		1 / 5	
Unidentified Ziphiidae	4 / 11	2 / 3	4 / 6		8 / 17	2 / 3
Dall's porpoise (*dalli* type)	2 / 28		24 / 149	5 / 29	26 / 177	5 / 29
Dall's porpoise (*truei* type)	3 / 14				3 / 14	
Dall's porpoise (unidentified type)	18 / 84	2 / 15	37 / 166	6 / 23	55 / 250	8 / 38
Pacific white-sided dolphin	1 / 5	2 / 40	5 / 33	2 / 10	6 / 38	4 / 50
Common dolphin	1 / 130			5 / 189	1 / 130	5 / 189
Unidentified large cetacean	2 / 2		4 / 4		6 / 6	
Unidentified small cetacean	3 / 5	2 / 6	3 / 3	1 / 4	6 / 8	3 / 10
Unidentified dolphin	16 / 87	4 / 17	18 / 141	7 / 170	34 / 228	11 / 187
Unidentified cetacean	6 / 8	1 / 3	4 / 5		10 / 13	1 / 3

Table 2. List of cetacean species sighted by three sighting / sampling vessels during the 1998 JARPN surv

Species	Sub-area 7E		Sub-area 8		Combined	
	Primary	Secondary	Primary	Secondary	Primary	Secondary
	Sch / Ind.	Sch / Ind.	Sch / Ind.	Sch / Ind.	Sch / Ind.	Sch / Ind.
Minke whale	47 / 48	47 / 52 [1]	22 / 23	39 / 42 [2]	69 / 71	86 / 94
Like minke whale	5 / 5	9 / 9 [3]	1 / 1	10 / 10 [4]	6 / 6	19 / 19
Bryde's whale		1 / 1				1 / 1
Sei whale	1 / 1		1 / 1		2 / 2	
Humpback whale	3 / 3		2 / 2	1 / 1	5 / 5	1 / 1
Right whale	2 / 3				2 / 3	
Sperm whale	56 / 184	13 / 20	22 / 34	8 / 10	78 / 218	21 / 30
Risso's dolphin	1 / 10	1 / 6	1 / 50		2 / 60	1 / 6
Killer whale	13 / 42	5 / 19	12 / 45	8 / 38	25 / 87	13 / 57
Unidentified Mesoplodon	6 / 8	1 / 2	2 / 2		8 / 10	1 / 2
Unidentified Hyperoodon	1 / 4				1 / 4	
Unidentified Ziphiidae	14 / 32	2 / 2	10 / 20	3 / 5	24 / 52	5 / 7
Dall's porpoise (*dalli* type)	1 / 5		3 / 24		4 / 29	
Dall's porpoise (*truei* type)	2 / 7				2 / 7	
Dall's porpoise (unidentified type)	7 / 37		2 / 12		9 / 49	
Unidentified pilot whales	1 / 3		0 / 0		1 / 3	
Unidentified large cetacean	1 / 1	1 / 1	2 / 2	1 / 1	3 / 3	2 / 2
Unidentified dolphin	5 / 24				5 / 24	
Unidentified cetacean	32 / 32	7 / 7	21 / 21	12 / 12	53 / 53	19 / 19

1) : including 3 secondary sightings (3 whales) by research base
2) : including 3 secondary sightings (3 whales) by research base
3) : including 1 secondary sightings (1 whales) by research base
4) : including 3 secondary sightings (3 whales) by research base

Table 3. Number of minke whales sighted, targeted and sampled by the sighting / sampling vessels and their sampling efficiencies.

	Sighted		Targeted		Sampled	Sampling efficiencies	
	Sch. / Ind.		Sch. / Ind.		Ind.	Technical	True
Sub-area	(A)	(B)	(C)	(D)	(E)	(E/D)	(E/B)
7E	94 /	100	64 /	67	56	0.84	0.56
8	61 /	65	55 /	59	44	0.75	0.68
Total	155 /	165	119 /	126	100	0.79	0.61

Table 4. Cause of failure to collect samples targeted by sub-area.
A : quick mobile behavior; B : long diving; C : technical problem;
D : missing of the targeted animal before chasing; E : other

	Reason why whales could not be sampled					Total
Sub-area	A	B	C	D	E	
7E	0	2	2	3	2	9
8	2	6	1	2	3	14
Combined	2	8	3	5	5	23

Table 5. List of biological samples and data from the minke whales sampled during the 1998 JARPN survey.

Samples and data	Number of whales		
	Male	Female	Total
Body length and sex	89	11	100
External body proportion	89	11	100
Photographic record and external character	89	11	100
Diatom film record and sampling	89	11	100
Standard measurements of blubber thickness (three points)	89	11	100
Detailed measurements of blubber thickness	19	0	19
Body weight	89	11	100
Body weight by parts	19	0	19
Blubber, muscle, liver and kidney tissues for DNA study	89	11	100
Muscle, liver and heart tissues for isozyme analysis	89	11	100
Muscle, liver and kidney tissues for heavy metal analysis	89	11	100
Blubber, muscle, liver and kidney tissues for organochlorine analysis	89	11	100
Tissues for lipid analysis	19	0	19
Muscle tissue for hormone analysis	89	11	100
Testis tissue for hormone analysis	89	-	89
Muscle, liver tissues and baleen plate for stable isotopes	89	11	100
Mammary grand ; lactation status , measurements and histlogical sample	-	11	11
Uterine horn ; measurement and endometrium sample	-	11	11
Uterine mucus for sperm detection	-	11	11
Collection of ovary	-	11	11
Photographic record of foetus	(1)	(2)	(4)*
Foetal sex (identified by visual observation)	(1)	(2)	(3)
Foetal length and weight	(1)	(2)	(3)
External measurements of foetus	(1)	(1)	(2)
Foetal tissues for genetic study	(1)	(0)	(1)
Collection of foetus	(0)	(2)	(3)*
Testis and epididymis ; weight and histological sample	89	-	89
Smear samples from testis and epididymis tissues	89	-	89
Urine sample for sperm detection	59	-	59
Serum sample for physiological study	89	11	100
Stomach content, conventional record	89	11	100
Weight of stomach content in each compartment	89	11	100
Collection of stomach contents for heavy metal analysis	16	1	17
Collection of stomach contents for lipid analysis	2	0	2
Record of external parasites	89	11	100
Collection of external parasites	7	0	7
Record of parasites in 1st stomach	89	11	100
Record of parasites in 2nd stomach	89	11	100
Record of parasites in 3rd stomach	89	11	100
Record of parasites in 4th stomach	89	11	100
Record of parasites in intestine	89	11	100
Record of parasites in liver	89	11	100
Earplug for age determination	89	11	100
Tympanic bulla for age determination	89	11	100
Largest baleen plate for morphologic study	89	11	100
Vertebral ephiphysis sample	88	11	99
Skull measurement (length and breadth)	88	10	98
Detailed measurement of skull	0	1	1

* : including fetuses of sex unidentified

Table 6. List of by-products in the 1998 JARPN survey.

Name of by-product	Amount (kg)	Name of by-product	Amount (kg)
O-niku*	45.0	Throat mottled meat	1,725.5
O-niku* (regular)	45.0	Bacon (grade 1)	9,868.5
Ventral blubber (neck)	60.0	Bacon (grade 2)	13.5
Jaw skin (mottled)	240.0	Bacon (small pieces)	3,901.5
Jaw skin (regular)	195.0	Ventral blubber	1,026.0
Red meat (premium)	840.0	Blubber (grade 1)	14,066.0
Red meat	76,065.0	Kidney	714.0
Red meat (regular)	1,845.0	Heart	784.0
Small pieces	15,720.0	Pancreas	148.0
Small pieces (process)	9,930.0	Esophagus	169.0
Breast meat	16,560.0	Mandibular ligaments (hard)	429.0
Breast meat (grade 2)	18,120.0	Mandibular ligaments (soft)	143.0
Breast meat (grade 3)	54,255.0	Tongue (mottled)	481.0
Breast meat (regular)	1,485.0	Tongue	3,510.0
Diaphragm	1,305.0	First stomach	403.0
Blubber (regular)	12,700.0	Intestine	2,860.0
Posterior ventral blubber	12,350.0	Underside of blubber	3,380.0
Nasal plug	525.0	Lining of meat	2,912.0
Tail flukes	4,225.0	Testis	48.0
Tail flukes (regular)	625.0	Caudal tendon	882.0
Maxillary cartilage	300.0	Tendon	6,216.0

*: Muscles associated with caudal vertebra.

Table 7. Mean body length of minke whales collected by the 1998 JARPN survey.

	Male				Female			
Sub-area	Mean	S.D.	Range	n	Mean	S.D.	Range	n
7E	7.13	± 0.74	(5.19 - 7.53)	49	6.61	± 0.95	(5.54 - 8.23)	7
8	7.29	± 0.64	(5.28 - 8.10)	40	7.31	± 1.14	(5.62 - 8.63)	4
Combined	7.20	± 0.70	(5.19 - 8.10)	89	6.86	± 1.08	(5.54 - 8.63)	11

Table 8. Sex and sexual maturity of minke whales collected by the 1998 JARPN survey.

Sub-	Sample	Male			Female				Sex ratio	Maturity rate (%)		Pregnancy
area	size	Imm.	Mat.	Total	Imm.	Mat.*	[Preg.]	Total	(% males)	Male	Female	rate (%)
7E	56	10	39	49	4	3	[2]	7	87.5	79.6	42.9	66.7
		(17.9)	(69.6)		(7.1)	(5.4)						
8	44	5	35	40	2	2	[2]	4	90.9	87.5	50.0	100.0
		(11.4)	(79.5)		(4.5)	(4.5)						
Total	100	15	74	89	6	5	[4]	11	89.0	83.1	45.5	80.0
		(13.6)	(67.3)		(5.5)	(4.5)						

*: Mature females including pregnant females.

Table 9. Summary of pregnant females and their foetuses collected by the 1998 JARPN surveys.

Sampling date	Sub-area	Body length (m)	Blubber thickness (cm)	Foetus		
				Length (cm)	Weight (kg)	Sex
1998/5/5	7E	8.23	2.2	3.7	0.003	U
1998/5/11	7E	7.23	3.3	15.7	0.054	F
1998/6/3	8	8.03	4.5	47.3	1.40	M
1998/6/7	8	8.63	4.1	21.7	0.172	F

Table 10. Infection rate of parasitic worm in minke whale collected by the 1998 JARPN survey.

Parasitic worm	Body part	Sub-area 7E		Sub-area 8	
		Infected/ exmained	%	Infected/ exmained	%
External parasite					
Pennella	Skin	45 / 56	80.4	36 / 44	81.8
Cirripedia	Skin	4 / 56	7.1	2 / 44	4.5
Cyamus	Skin	1 / 56	1.8	0 / 44	0.0
Endo parasite					
Nematode	Stomach	54 / 54	100.0	43 / 44	97.7
Acanthocephala	Small intestine	48 / 48	100.0	41 / 41	100.0
Cestoda	Small intestine	6 / 45	13.3	3 / 39	7.7
Trematode	Liver	36 / 56	64.3	33 / 44	75.0

Table 11. Freqencies of male whales with anomalous testes tissues, by maturity of animals in the 1998 JARPN survey.

Sub-area	Maturity	n	Normal	Anomalous			
				Both side	One side	Combined n	(%)
7E	Imm.	10	10	0	0	0	(0.0)
	Mat.	39	33	0	6	6	(15.4)
	Combined	49	43	0	6	6	(12.2)
8	Imm.	5	5	0	0	0	(0.0)
	Mat.	35	28	3	4	7	(20.0)
	Combined	40	33	3	4	7	(17.5)
Total	Imm.	15	15	0	0	0	(0.0)
	Mat.	74	61	3	10	13	(17.6)
	Combined	89	76	3	10	13	(14.6)

Table 12. Food species of minke whales collected by the 1998 JARPN survey and their frequency of occurrence.

Food species		Sub-area 7E		Sub-area 8		Combined	
		n	(%)	n	(%)	n	(%)
Euphausiacea	Euphausiids (*Euphausia pacifica*)			1	(2.9)	1	(1.3)
Sauries	Pacific saury (*Cololabis saira*)			1	(2.9)	1	(1.3)
Anchovies	Japanese anchovy (*Engraulis japonicus*)	43	(97.7)	33	(94.3)	76	(96.2)
Salmonids	Unidentified salmon	1	(2.3)			1	(1.3)
No. whales observed		44	(100.0)	35	(100.0)	79	(100.0)

Table 13. Biological research items of Bryde's whale collected in the 1998 JARPN survey.

Biological research items
Observation of external characters and photographic record (13 points)
Sexual record
Observation and record of Jacobson's organ
Observation and record of notch flukes
Observation and record of diatom film
Observation and record of external parasites
Conventional record of stomach content
Observation and record of endo parasites
Photographic record of internal organs (16 points)
Record of number of ventral grooves
Measurement of body length
Measurements of external body proportions (54 points)
Measurement of body weight
Measurements of body weight by parts
Detailed measurements of blubber thickness (14 points)
The maximum breadth and thicknes measurements of mammary grand
The breadth measurement of uterine horn
Measurement of stomach content capacity in each compartment
Measurement of stomach content weight in each compartment (including water)
Measurement of stomach content weight in each compartment (excluding water)
The minor and major axes measurement of row of baleen plates
Measurement of row of baleen plates (each right and left)
Skull measurement (length and breadth)
Record of number of ribs

Table 14. Samples list of Bryde's whale collected in the 1998 JARPN survey.

Sampling items	Samples
Reproduction	mammary grand, endometrium, uterine forn, ovary, uterine mucus for sperm detection
Age determination	ear plug (right and left)
Diatom film	a part of angle of gape (left)
Serum	serum sample from the back of maxilla
Parasite	external parasites (Cirripedia, Pennella) parasite from small intestine
Stomach content	1st, 2nd, 3rd stomach contents
Tissues	
(Genetic analysis)	blubber, muscle, liver, heart, kidney
(Heavy metal analysis)	muscle, liver, kidney
(Organochlorine analysis)	blubber, muscle, liver, kidney
(Hormone analysis)	muscle
(Stable isotope analysis)	muscle, liver
(Lipid analysis)	blubber, muscle, liver, heart, kidney, 1st stomach, small intestine
(Chemical analysis)	blubber, muscle, liver, heart, kidney, lungs, pancreas, spleen, small and large intestine, cerebrum, cerebellum, diaphragm, thyroid gland, samall and large intestine contents, blood
Tissues specimen	kidney, liver, lungs, heart, 1st-4th stomach, pancreas, spleen, small and large intestine,cerebrum, cerebellum, diaphragm, blood, thyroid gland, mammary grand, lymphonoidi mesenteric

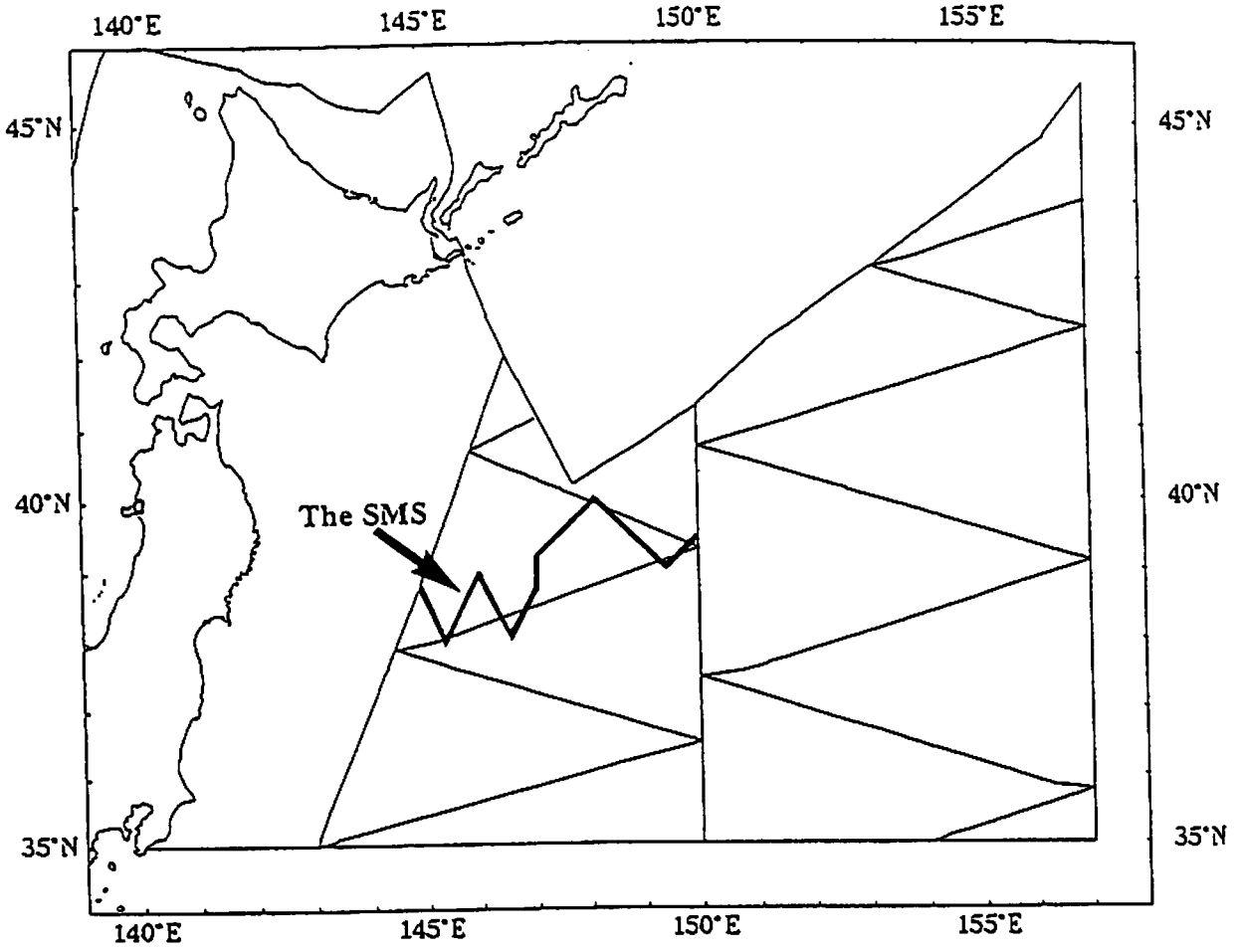

Fig. 1. Cruise track line of the sighting vessel (SV) for the JARPN survey in 1998.

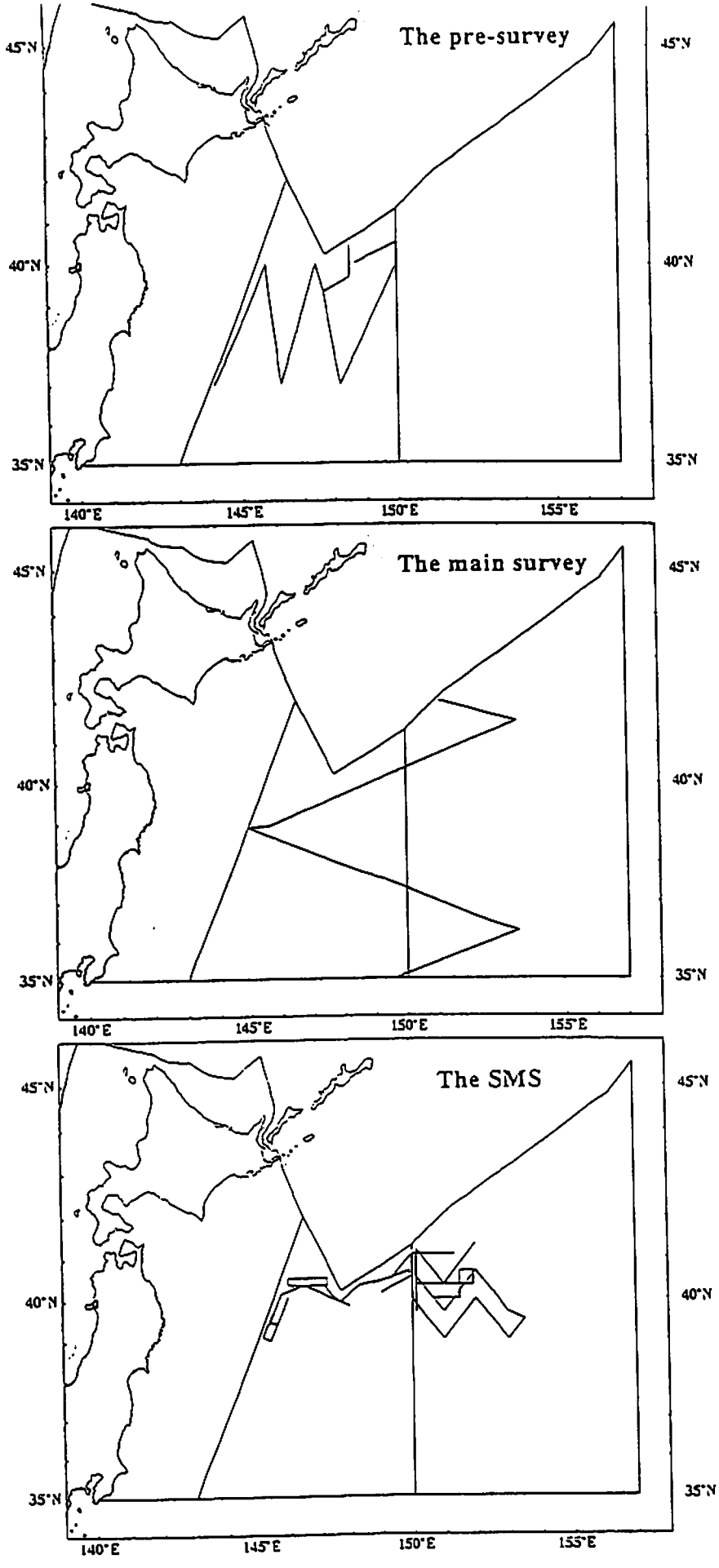

Fig. 2. Cruise track line of the sighting/sampling vessels (SSVs) for the JARPN survey in 1998.

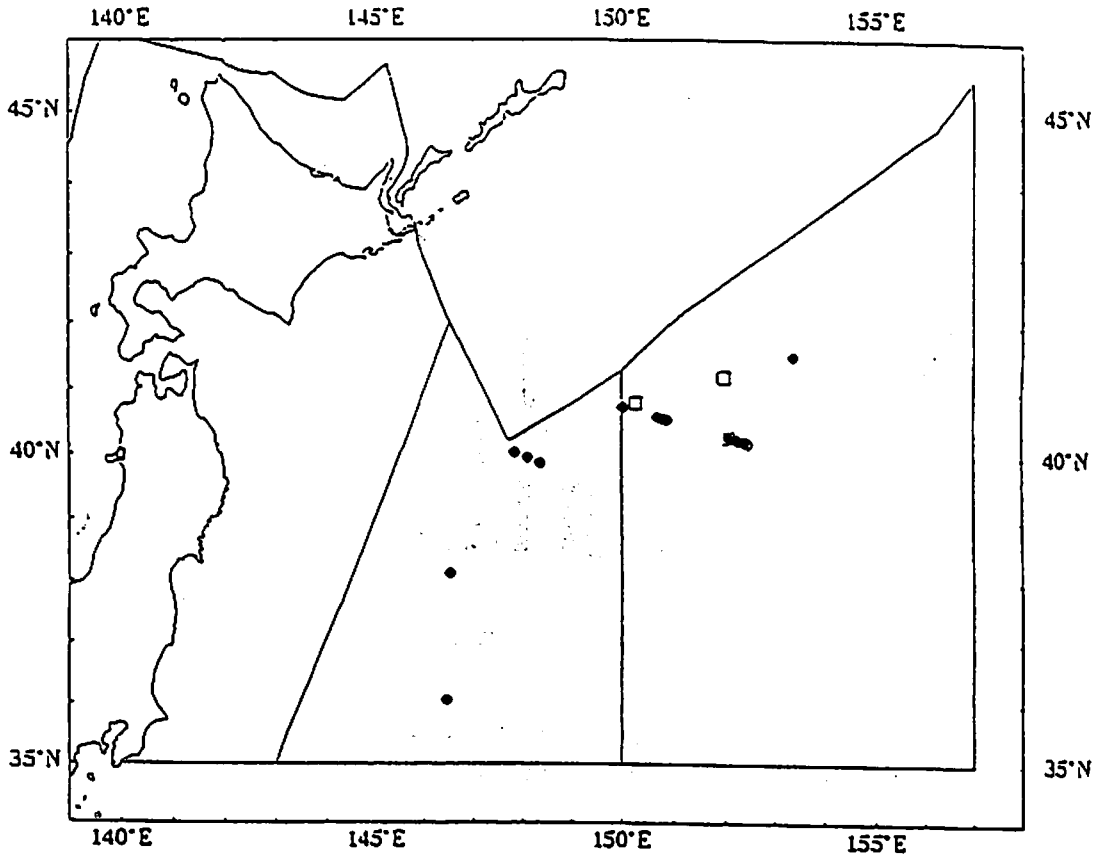

Fig. 3. Distribution of minke whales sighted by the SV during the 1998 JARPN survey. Minke whale:●primary,○secondary; 'like minke whale':■primary,□secondary.

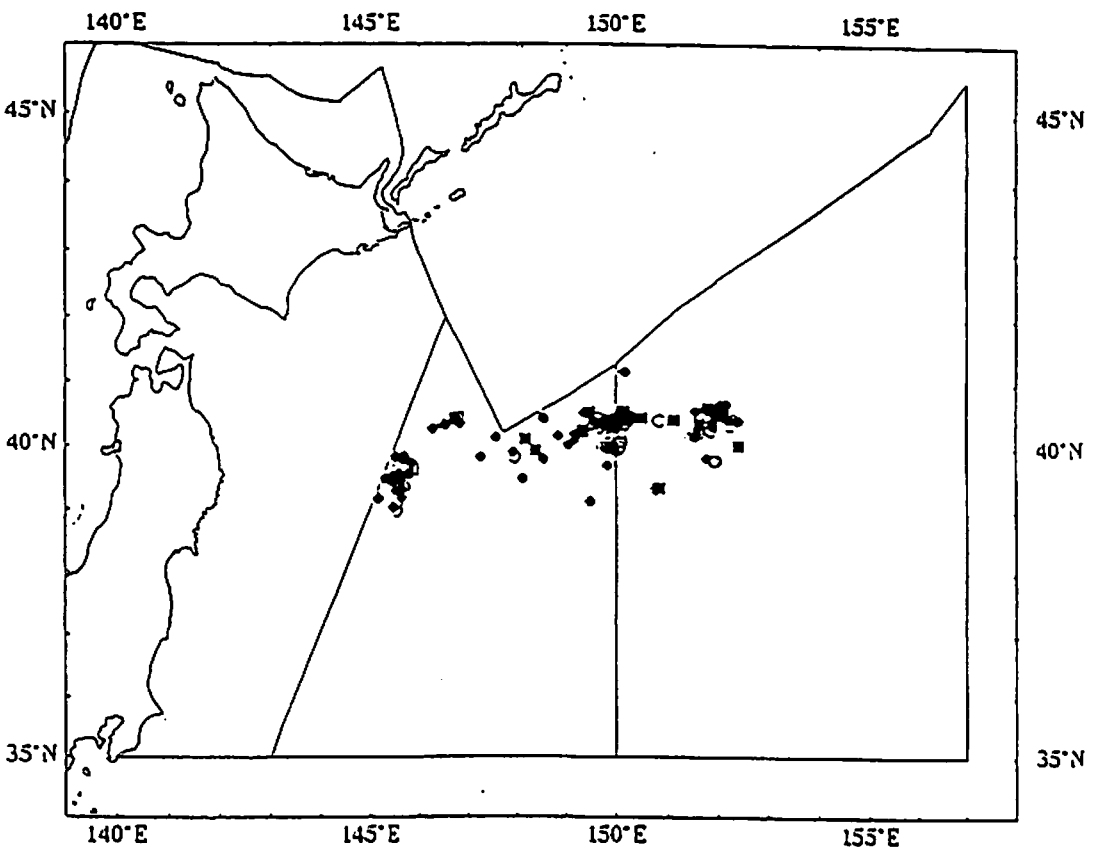

Fig. 4. Distribution of minke whales sighted by the three SSVs during the 1998 JARPN survey. Minke whale:●primary,○secondary; 'like minke whale':■primary, □secondary.

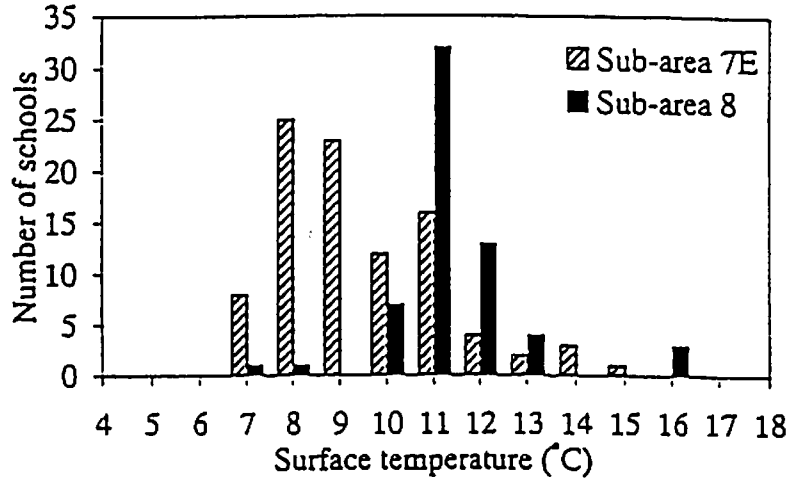

Fig. 5. Frequency distribution of sea surface temperature where minke whales sighted.

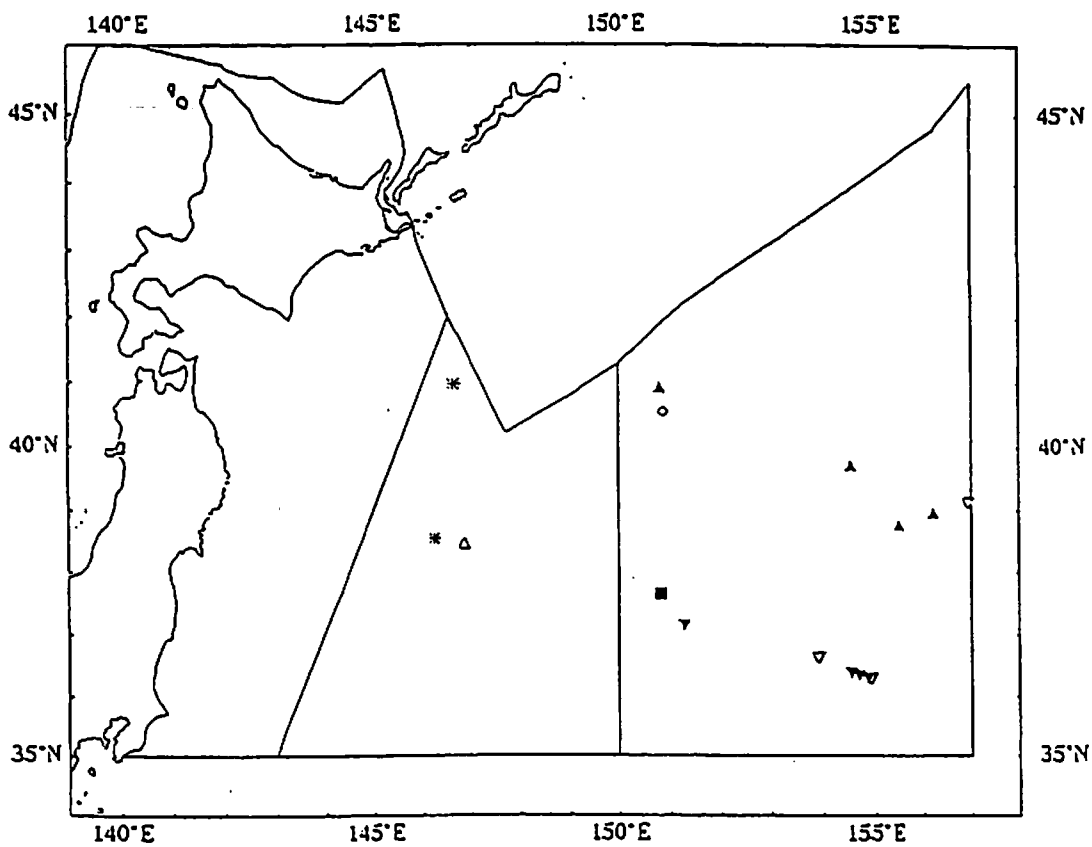

Fig. 6. Distribution of large baleen whales sighted by the SV during the 1998 JARPN survey. Blue whale: ■primary; right whale: * primary; humpback whale: ◇secondary; fin whale: ▲primary, △secondary; sei whale: ▼primary, ▽secondary.

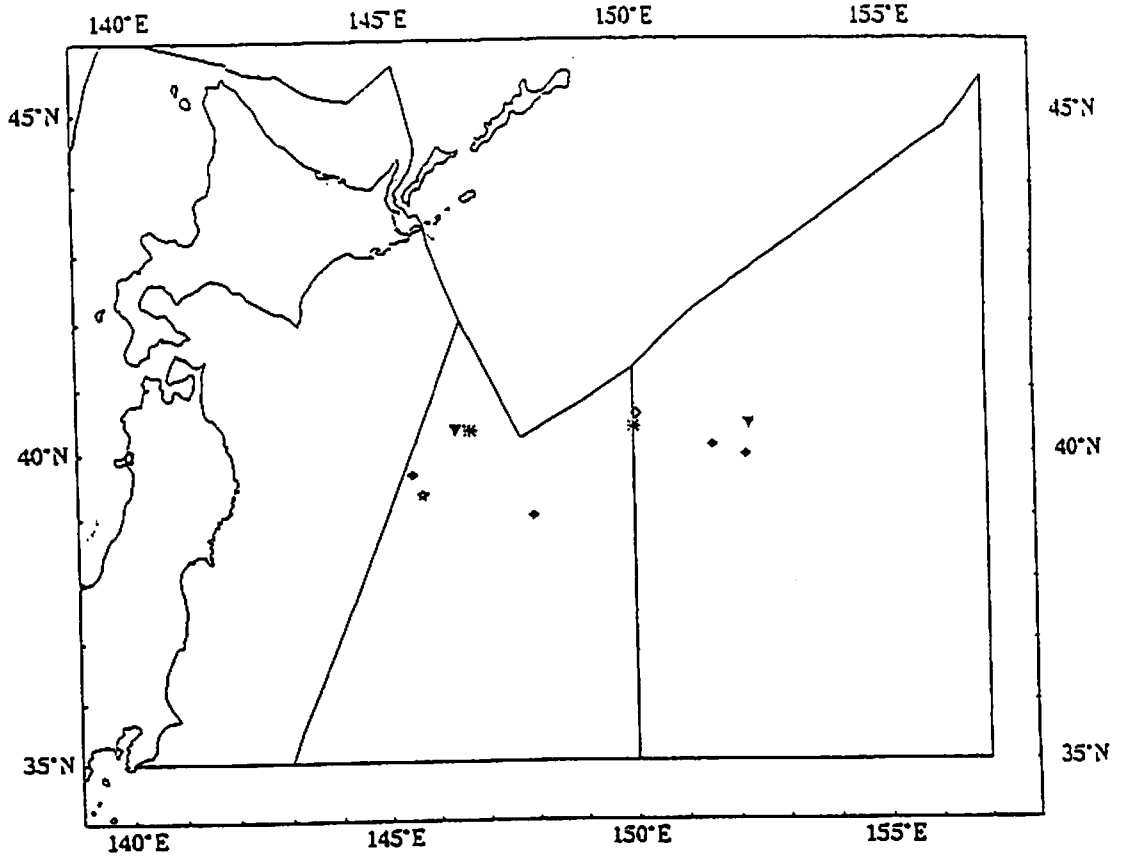

Fig. 7. Distribution of large baleen whales sighted by the three SSVs during the 1998 JARPN survey. Humpback whale: ◆primary, ◇secondary; sei whale: ▼primary; Bryde's whale: ■secondary; right whale: * primary.

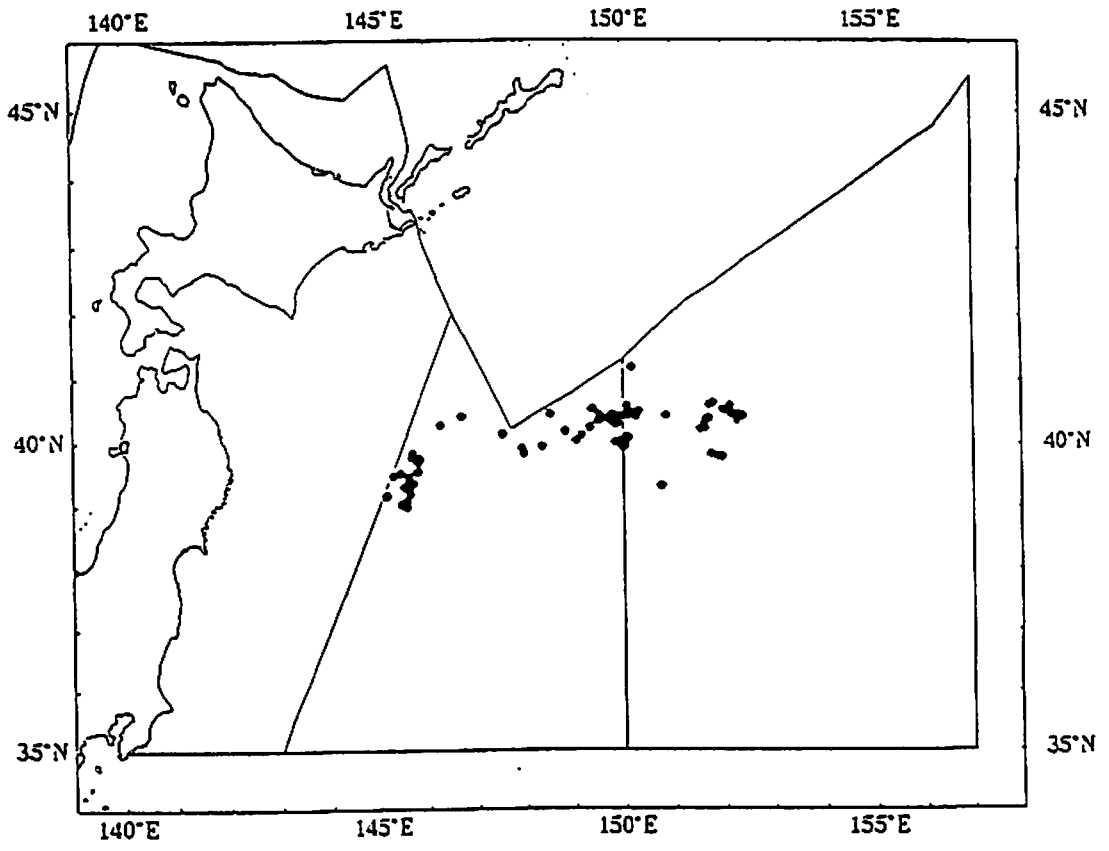

Fig. 8. Distribution of minke whales sampled in the 1998 JARPN survey, based on their sighting position.

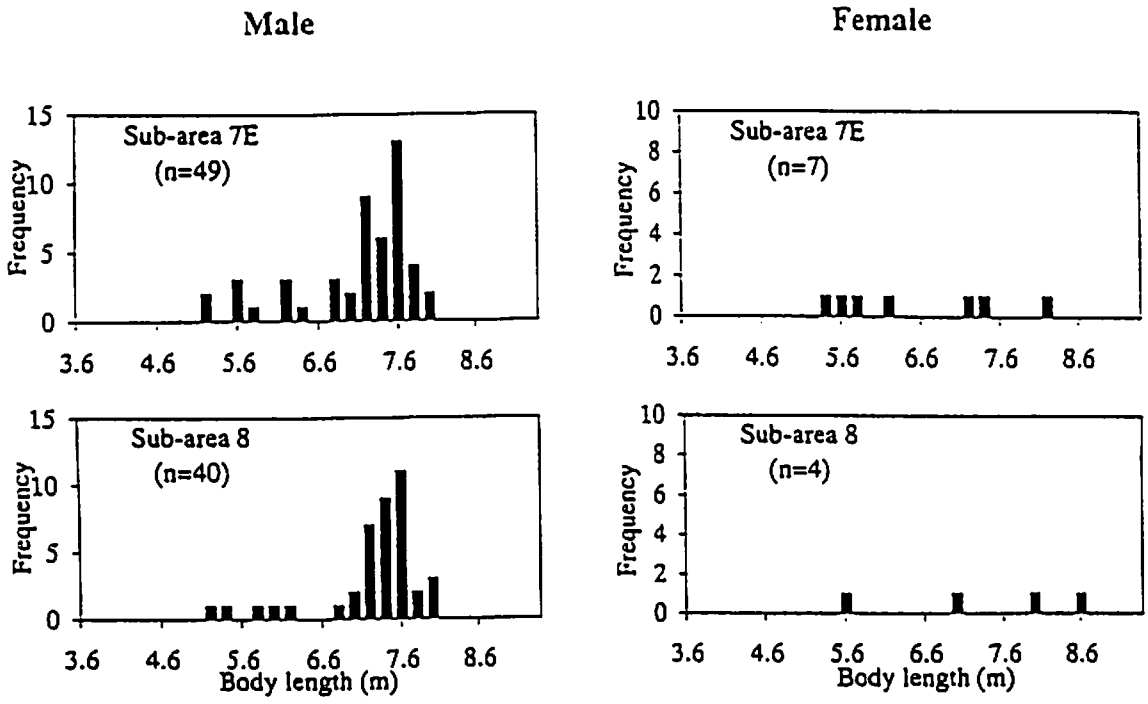

Fig. 9. Body length distribution of minke whales collected by 1998 JARPN survey, by sex and sub-area.

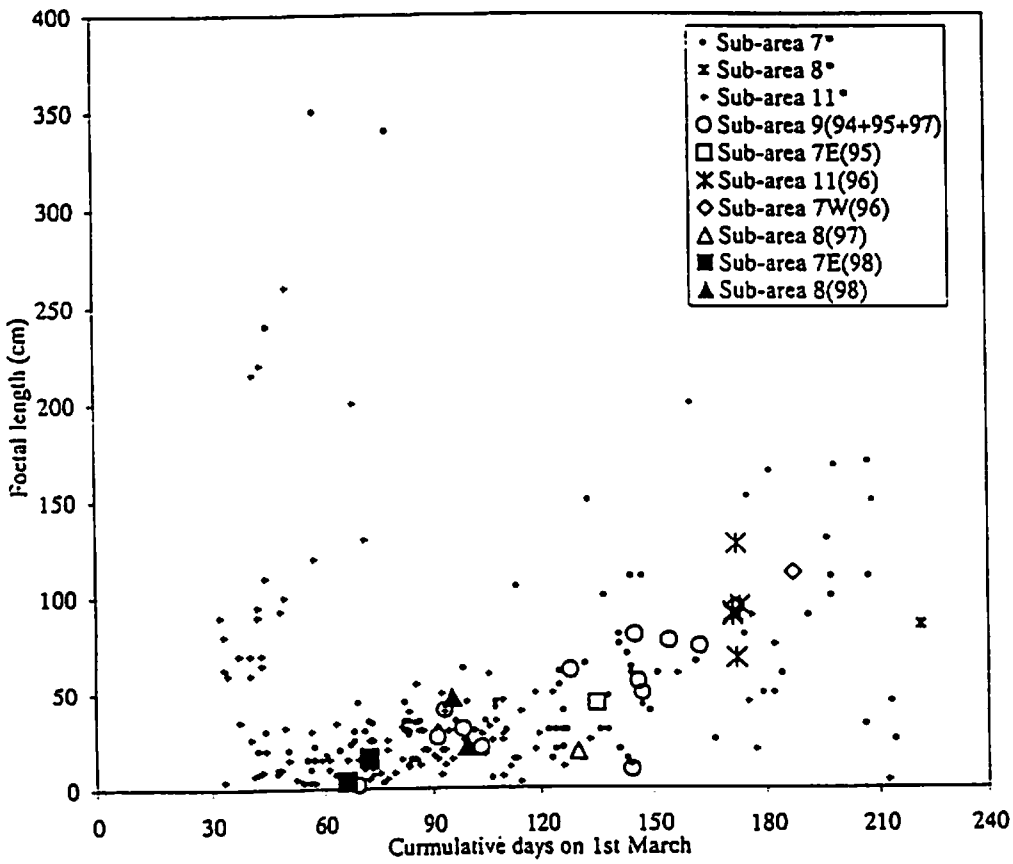

Fig.10. Plots of foetal body length against collection date by area.
* : Data for Japanese coastal whaling samples (Kato, 1992).