# Cruise Report of the Japanese Whale Research Program under Special Permit in the North Pacific (JARPN) in 1999

Yoshihiro Fujise[1)], Ryoko Zenitani[1)], Tsutomu Tamura[1)],
Takeharu Bando[1)], Seiji Ohtani[1)],
Shintaro Takeda[1)], Akihiro Kitajima[1)], Takayuki Kimura[1)], Tomoyuki Masaki[1)]
and Daisuke Tohyama [2)]

[1)] *The Institute of Cetacean Research, 4-18, Toyomi-cho, Chuo-ku, Tokyo 104-0055, Japan.*
[2)] *Kyodo Senpaku Co. Ltd., Higashi-nihonbashi, Chuo-ku, Tokyo 103-0004, Japan.*

## ABSTRACT

The 1999 survey of the Japanese Whale Research Program under Special Permit in the North Pacific (JARPN) was conducted in sub-areas 7 and 11 in June and July, using one research mother ship, three sighting/sampling vessels and one dedicated sighting vessel. A total of 4,459 n.miles searching was covered and a total of 293 minke whales (271 schools) was sighted. As planned, 100 individuals were collected in these sub-areas. Composition of sex and maturity of the samples in these sub-areas was similar to those for the previous 1996 JARPN survey, which was conducted one month later than the present survey. In the sub-area 11, remarkable segregation by sex and maturity of minke whales was observed. In the western half of sub-area 11 (west of Kitami Yamato Tai Bank), females especially pregnant females, were dominant. In contrast, in the eastern half of this sub-area (east of Kitami Yamato Tai Bank), mature males were distributed dominantly. Furthermore, based on foetal growth curves, it was suggested that females distributing in the western half of sub-area 11, belong to different breeding stocks.

## INTRODUCTION

The Japanese Whale Research Program under Special Permit in the North Pacific (JARPN) was started in 1994 with the aim to elucidate the stock structure of the western North Pacific minke whale (Government of Japan, 1994). The original objectives of the JARPN were: (1) to investigate whether the W-stock exist and (2) whether sub-stocks exist within the O stock. An additional objective was added later, which was the elucidation of the feeding ecology of the western North Pacific minke whale (Government of Japan, 1996). After two feasibility researches in 1994 and 1995, the full scale JARPN survey started in 1996.

The 1999 JARPN survey was conducted in sub-areas 7 and 11 in June and July, respectively. These sub-areas had not been covered by previous JARPN surveys or commercial operations in those months. In this paper we present an outline of the 1999 JARPN survey, which was conducted from 8 June to 26 July 1999.

## MATERIALS AND METHOD

### Research area and survey period

Sub-areas 7 and 11 in June and July, respectively (excluding the EEZ zones of foreign countries), were chosen for the JARPN survey in 1999 (Fig. 1).

### Research vessels

A total of five research vessels was used. The research mother ship *Nisshin Maru* (7,575GT) commanded the research and was engaged in the biological examination of whale samples and of by-products. *Yushin Maru* (720GT), *Kyo Maru No.1* (812.08GT) and *Toshi Maru No. 25* (739.92GT) were used as the sighting/sampling vessels (SSVs), which conducted sighting activities, sampling of minke whales and various experiments and observations. One of the SSVs (*Yushin Maru*) was also engaged in oceanographic observations using CTD and EPCS. *Kyoshin Maru No. 2* (368GT) was used as a dedicated sighting vessel (SV), which was engaged in oceanographic observations using XCTD and in the collection of information on sea and weather conditions.

### Cruise trackline

The setting manner of the cruise trackline and allocation of vessels were similar to that used in previous JARPN surveys (Fujise *et al.*, 1995, 1996, 1997; Zenitani *et al.*, 1999). The zigzag-shaped trackline 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 number of minke whales was expected to be large. Trackline in the SMS was designed separately from the original trackline. In the present survey, a total of five and half days was used for the SMS (3.5 days in sub-area 7 and 2 days in sub-area 11). The planed trackline (main course) is shown in Fig. 1. List of way points (main course) used in this survey is also shown in Table 1.

The research course consisted of one main track and two parallel tracks established six n.miles apart on both sides. In the SMS the distance between the main and parallel tracks was set at four n.miles, considering efficiency of sampling. Three SSVs were allocated to these tracks with the allocation being changed every day. The trackline of the SV was also similar to those of the SSVs. The actual waypoints of the SSVs and SV are shown in Table 1.

### Sighting surveys

Sighting procedure was similar as in the previous surveys of JARPN (Fujise *et al.*, 1995, 1996, 1997; Ishikawa *et al.*, 1997; Zenitani *et al.*, 1999). In the research area sighting was conducted 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 which, 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 the NSP mode was adopted (passing mode without sampling activities under normal sighting conditions).

Closing was made mainly on sightings of minke whales or on schools that looked like minke whales. Furthermore it was planned that closing was made on large whales species sightings, such as blue, humpback, right, fin and sperm 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 whales**

Sampling activities were conducted with the aim to take 100 minke whales (50 whales in sub-area 7, and 50 whales in sub-area 11). All the minke whales 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 minke 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).

**Experiments**

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

1. Sighting distance and angle experiments to examine the precision of sighting data.
2. Oceanographic survey by means of CTD.
3. Preliminary oceanographic survey experiment using the EPCS (electric particle counting and sizing system).

On board the SV, 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. Satellite tagging on minke whales.
4. Biopsy sampling on blue, fin, humpback and right whales.
5. Photographic records of natural marks in blue, humpback and right whales.
6. Behaviour patterns of blue, fin and sperm whales.
7. Oceanographic survey by means of XCTD.
8. Feasibility study to estimate abundance of prey species of minke and other large whale species using an echo sounder system.
9. Feasibility study for sampling prey species of minke and other large whale species.

On board the research mother ship (*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 whales sampled.

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

## RESULTS

**Narrative of the cruise**

Sighting and sampling vessels (SSVs)

The three SSVs (YS1, K01 and T25) and the research mother ship departed from their homeports toward the research area on 15 June (Shimonoseki for K01 and T25, Taguma for YS1 and Habu for NM).

*Sighting and sampling vessels (SSVs), sub-area 7W*
Sub-area 7W was surveyed in 15 days, between 19 June and 3 July. All the vessels arrived at the start WP (WP1: 41°N, 142°E) on 19 June. The survey started on that day. After two days of surveys, the research fleet suspended the normal survey and started the special monitoring survey (SMS) in the western part of sub-area 7W. The SMS-A started at the WP A1: 41°-40'N, 141°-35'E on 21 June and continued till 23 June. A total of 25 minke whales was sampled in the western half of the northern part of sub-area 7W. From the evening of 23 June, the fleet moved to resume the normal survey. However the fleet had to drift during the following two days due to a gale. On 26 June the normal sighting and sampling survey was re-initiated. The SMS-B was conducted off Erimo Point on 27 June. Once that the SMS-B was completed, the normal survey was re-initiated again until 30 June. By 30 June, the 50 minke whales planned for sub-area 7 had been sampled. For this reason the rest of the trackline in this sub-area was covered by sighting survey only. This trackline was completed on 3 July.

*Sighting and sampling vessels (SSVs), sub-area 11*
This sub-area was surveyed in 10 days, between 6 and 15 July. The fleet reached the start point (WP201) on 6 July beginning the survey on this day. The fleet reached the eastern end of this sub-area (WP210) on 13 July. The survey continued on a new trackline, from WP501 (44°-17'N, 145°-08'E) to WP502 (45°-25'N, 142°-22'E). By 15 July 50 individuals had been sampled, and then the sampling activities were terminated.

All three SSVs and NM returned to their homeports, Tokyo for NM on 20 July, Taguma for YS1 on 20 July, Shiogama for K01 on 19 July and Shimonoseki for T25 on 19 July.

*Dedicated sighting vessel (SV, Kyoshin Maru No.2), sub-area 7W*
On 8 June the SV departed from Shiogama. It surveyed the western part of sub-area 7 (7W) in 21 days, from 9 to 23 June. Sighting was conducted only under *NSC mode.* Sighting survey in the northern part of sub-area 7W started at noon of 9 June from WP0 (42°N, 141°-10'E). Due to a low pressure affecting the research area, this vessel had to drift during 13 - 14 June. The SV reached the end point of the survey in the northern part of sub-area 7W (WP8: 41°-52'N, 146°-28'E) on 22 June, and moved then to the start point of the survey in the southern part of sub-area 7W (WP9: 41°N, 147°E), where the survey started on 23 June. The survey in the southern part of sub-area 7W (south of 41°N) ended on 30 June at point 37°-39'N, 142°-35'E. The vessel returned then to Shiogama for refuelling.

*Dedicated sighting vessel (SV, Kyoshin Maru No.2), sub-area 11*
Survey in sub-area 11 by SV was conducted in 14 days, from 3 to 16 July. The sighting survey in this sub-area started on 3 July at WP 201: 45°-28'N, 142°-30'E. However, the visibility was limited between that day and 5 July, for which the SV had to drift at the start point. Due to bad weather condition, SV had to move from WP 201 to WP206 (44°-19'N, 143°-40'E) without sighting effort. On 6 July the SV could start the sighting survey in this sub-area. The survey was continued under suitable sea condition reaching WP210 (44°-20'N, 145°-10'E), the easternmost point of this sub-area, on 9 July. In order to survey the uncovered trackline (from WP201 to WP206), the SV moved to WP201 again and began the survey from that WP on 10 July. On 16 July the SV ended the dedicated sighting survey in this sub-area and moved then to sub-area 7W. *Kyoshin Maru No2 conducted the feasibility survey for prey species in sub-area 7W* between 18 and 20 July.

*Dedicated sighting vessel (SV, Kyoshin Maru No2), sub-area 7 East survey (21 July - 23 July, 1999) --- 3 days*
Sighting survey in sub-area 7E started on 21 July from WP401 (41°N, 146°E). The survey in this sub-area was terminated at the end of 23 July. The SV returned to Yokosuka port on 26 July.

**Searching distance**
*Sighting and sampling vessels (SSVs)*
Table 2 shows the searching distances by survey mode and sub-area made by the three SSVs. The total searching distance was 2,571.2 n.miles with 54.2% of the distance made under *NSC and ASP mode* surveys. Searching distances in sub-areas 7W and 11 were 1,512.5 n.miles and 1,058.7 n.miles, respectively.

The distribution of searching effort under *NSC and NSS modes* are shown in Table 3 and 4, respectively. In sub-area 7W, most of the survey under *NSS mode* was concentrated between 142°E and 144°E.

*Dedicated sighting vessel (SV)*
Table 5 shows the searching distances made by the dedicated sighting vessel (SV). A total of 1,887.8 n.miles was covered under the *ASP mode*.

**Sightings of minke whales**
*Sighting and sampling vessels (SSVs)*
Table 6 shows the cetacean species sighted during the survey by the three SSVs in each sub-area, by survey mode and sighting type. The minke whale was the dominant species in both sub-areas 7W and 11. A total of 165 schools/176 animals (primary: 89/95; secondary: 76/81) was sighted.

A total of 47 schools/50 animals (58% of total) were made as primary sightings in sub-area 11 with 805.5 n.miles of searching effort made under NSC and ASP modes. In sub-area 7W, 33 schools/36 animals were primary sightings in 1,056.4 n.miles of searching effort under *NSC and ASP modes*.

Figs. 2 and 3 shows the distribution of sightings of minke whales and 'like minke whales' in sub-area 7W for the SSVs and SV, respectively. Distribution of minke whales was not uniform and two concentration areas are observed: western part of sub-area 7W along longitude 142°E, and east half of sub-area 7W (between 143°-30'E and 145°-30'E).

Figs. 4 and 5 shows the distribution of sightings of minke whale and 'like minke whales' in sub-area 11 for the SSVs and the SV, respectively. In contrast to sub-area 7W, minke whales were distributed uniformly in this sub-area. Relative large number of minke whale schools was found to the west of Kitami Yamato Tai Bank.

Tables 7 and 8 show the number of primary sightings by one-degree latitude, made under *NSC and ASP modes* and under *NSS mode*, respectively. Table 9 shows the density index (DI: the number of schools found per 100 n.miles searched under normal sighting conditions) by one degree. Grid of 44°N-143°E (corresponding to sub-area 11) shows the highest DI (24 schools /27 individuals). The second highest DI is found in grid 41°N-141°E in sub-area 7W. These

grids were also high in the DI (7.74-6.21). The DI for sub-areas 7W and 11 is 2.73 and 5.83, respectively.

*Dedicated sighting vessel (SV)*
Table 10 shows cetacean species sighted during the sighting survey by the SV in each sub-area, by survey mode and sighting type. The minke whale was the dominant species in the northern part of sub-area 7W and the sub-areas 11. A total of 117 minke whales (106 schools) was sighted with consisting of 64 primary sightings (72 animals) and 42 secondary sightings (45 individuals).

**Sightings of other cetacean species**
*Sighting and sampling vessels (SSVs)*
Table 6 also shows the other cetacean species sighted by the three SSVs in each sub-area. Regarding large baleen whales, one sei and three humpback whales were found in the northern part of sub-area 7W; one Bryde's whale was found in the southern part of sub-area 7W and three fin and seven sei whales were sighted in sub-area 11.

Eleven individuals of Baird's beaked whale were found in sub-area 11. Some species of Ziphiidae were also found in all sub-areas.

*Dedicated sighting vessel (SV)*
Table 10 also shows the other cetacean species sighted by the SV. One fin whale, one humpback whale and 16 Bryde's whales (13 schools) were recorded as the other baleen whale. It should be noted that 15 Bryde's whales were sighted in the sub-area 7 (east) during 3 searching days.

**Sampling of minke whales**
Table 11 shows the number of minke whales sighted, targeted and sampled, by survey mode and sub-area. Technical efficiency range 0.64-0.80 and 0.50-0.90 were calculated in sub-areas 7W and 11, respectively. Overall the technical and true efficiency is 0.65 and 0.53, respectively.

The most common reason for missing whales during chasing was due to whale behaviours such as long diving and/or quick mobile behaviours. Another reason of failures was missing the whales while waiting to finish biological survey onboard the research mother ship.

Geographical distribution of whales sampled is shown in Figs. 6 and 7 for sub-areas 7W and 11, respectively. The distribution of whale sampled follows the pattern of distribution of sightings.

**Experiments and oceanographical surveys**
*Photographic records of natural marks*
Photographs of natural marks were obtained on one humpback whale in sub-area 7W by the SV.

*Biopsy sampling trial for minke whale*
A total of 24 schools/30 individuals of minke whale was targeted for biopsy sampling trial by the SV. There were ten shoots, of which two hit the whale body. Two biopsy skin samples were collected from two whales.

*Biopsy sampling experiment*
One humpback whale and one fin whale were targeted for biopsy sampling experiments. Of two shoots, only one tissue sample was collected from the humpback whale.

*Distance and angle experiment*
This experiment was conducted on 14 and 15 July by the SSVs and SV, respectively. A total of 424 trials (336 for the SSVs and 88 for the SV) were made.

*Satellite tagging*
The experiment was conducted on two individuals minke whales in sub-area 7W but the objective of attach the tag could not be reached.

*XCTD and CTD surveys*
XCTD and other oceanographic observations were conducted by *Kyoshin Maru No.2* from 17 June and 23 July. A total of 42 stations were conducted. One of the SSVs (*Yushin Maru*) conducted similar observations using CTD (22 stations made).

*Observation of marine debris*
Observation of marine debris was conducted from the bridge of the research mother ship (NM) during the transit from sub-area 7W to sub-area 11 (4-6 July) and during the return (16-18 July). Observation totalled 55 hours and 55 minutes. On the other hand, numerous artifacts were found in the stomach of minke whales sampled. Details on this will be reported in future.

*Survey on the whale killing method*
Observations were made and several data were collected on the performance of rifle and harpoons as secondary measure for killing the animal. A summary of those observation and data will be presented in future.

**Biological research for minke whales sampled**
Table 12 summarises the biological data and samples obtained from the minke whales sampled. A total of 54 research items was covered. These items are related to the studies conducted under the two main objectives of the JARPN: elucidation of stock structure and feeding ecology.

**By-products**
After biological research and tissue sampling was completed, all the whales were processed according to the provisions of Convention Article VIII. Total by-product from all of the sampled whales was 293t (Table 13).

**Preliminary analyses of biological data**
In this section, some preliminary analyses of biological data such as body length, maturity, foetal length and stomach contents based on data obtained from the 1999 JARPN survey, are presented.

*Sex ratio and maturity status*
Table 14 shows the sex ratio, maturity rate and maturity composition in sub-areas 7W and 11 for the 1996 and 1999 JARPN surveys. In 1999 the survey was conducted one month earlier than that in 1996. However, composition of sex and maturity was similar in these two surveys. Also maturity rates for males and females and the apparent pregnancy rate were similar between surveys.

*Body length and length distribution*
Body length distributions for males and females in sub-areas 7W and 11 are shown in Figs. 8 and 9, respectively. In both sub-areas, males have a remarkable peak at 7.4m and their range tends to be wide. The distribution for females tended to be wider and no peak is observed. These distributions seemed to be similar between the 1996 and 1999 surveys.

*Foetus size (conception date)*
In this survey a total of 14 foetuses was collected from two females in sub-area 7W and 12 females in sub-area 11. The size of the two foetuses from sub-area 7W and seven from sub-area 11 were similar to those found in JARPN surveys 1994 and 1998. However, remarkable large foetuses were found in 5 of the 12 females in sub-area 11 (Table 15).

Fig. 10 shows the relationship between the sampling date and the body length of foetuses collected during JARPN surveys. Apart the large five foetuses of the 1999 survey, all the other foetuses are considered to have conceived at roughly the same time as the Okhotsk-Western North Pacific stock (O stock) (e.g. winter breeding stock). The five females having large foetuses have a conception season similar to that of the East China Sea – Yellow Sea – Sea of Japan stock (J stock) (e.g. autumn breeding stock) (IWC, 1994).

*Anomaly in gonadal tissues of sampled whales*
As in previous JARPN surveys, anomaly was observed in testes of matured males (Table 16). A total of 74 males (20.3%) presented abnormal testis. The frequency was 20.1%, 29.5%, 15.0%, 14.0% and 17.5% for sub-areas 9, 8, 7E, 7W and 11, respectively.

*Feeding habit*
Table 17 shows the major prey species in the forestomach of minke whales and their frequencies. In the present survey, it became clear that Japanese anchovy (*Engraulis japonicus*) is the dominant species in the early migrating season in sub-area 7W as well as those for offshore area (sub-areas 8 and 9). In sub-area 11, minke whales mainly feed on krill (*Euphausia pacifica*) in July (97.5%) and August (100%).

## DISCUSSION

The 1999 JARPN survey was conducted in sub-areas 7W (June) and 11 (July). A total of 50 individuals was collected in each sub-area. The JARPN 1999 allowed a larger temporal covering in these sub-areas.

In the present survey, remarkable segregation by sex and maturity of minke whales was observed in sub-area 11. Table 18 shows a comparison between compositions of whales sampled in the western and eastern parts of sub-area 11. In the western half (west of Kitami Yamato Tai Bank) where shallow water of 200m depths or less occur (Fig. 7), females especially pregnant females, were dominant. In contrast, in the eastern half of this sub-area (east of Kitami Yamato Tai Bank) where deeper water as 1000m depths or more occur (Fig. 7), mature males were distributed dominantly. Furthermore, based on foetal growth curves, it was suggested that different breeding stocks (J and O stocks) distribute in the western half of sub-area 11.

In sub-area 11, it was known that animals from the J and O stocks mix in April. It was also suggested that the mixing also occurred in August at least for male individuals. From the results of the present survey, a similar situation could occur in July. As remarkable differences of mtDNA haplotype frequencies was observed between J and O stocks (Goto and Pastene, 1997), it is expected that the DNA analysis of the 1999 samples in this sub-area could clarify further the pattern of mixing in this month.

On the other hand, no absolute genetic marker has been obtained (Goto *et al.*, 2000). This means the DNA analysis alone is not sufficient to discriminate stocks on an individual base. In the JARPN survey, several types of data have been collected: biological parameters, pollution contents and parasite burden. Several analyses are being conducted (Fujise, 1996; Fujise and Kato, 1996; Araki *et al.*, 1996; Pastene *et al.*, 1997; Wada, 1996). Then a comprehensive analysis using all these approaches should be carried out.

## ACKNOWLEDGMENTS

The authors are greatly indebted to Dr. Hiroshi Hatanaka, the National Research Institute of Fisheries Science, Mr. Nobuyuki Yagi, the Embassy of Japan, Dr. Seiji Ohsumi, the Institute of Cetacean Research (ICR), for their guidance in the design and implementation of this research. We are also indebted to all the crew and the staff of the ICR, the National Research Institute of Far Seas Fisheries, and Kyodo-Senpaku Co. Ltd. We also thank to Dr. Luis A. Pastene of the ICR for valuable suggestion for preparing of 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. Summary of cruise track of the 1999 JARPN survey

Sighting and sampling survey by the SSVs and NM

| Stratum/survey | Way point | | | Course direction | Distance (n. miles) | Date |
|---|---|---|---|---|---|---|
| Sub-area 7W | WP1 | 41°-00'N | 142°-00'E | 25 | 72.0 | 19 June |
| | WP2 | 42°-06'N | 142°-40'E | 156 | 72.0 | 20 June |
| | WP3 | 41°-00'N | 143°-20'E | 16 | 111.0 | 24 June |
| | WP4 | 42°-47'N | 144°-00'E | 164 | 111.0 | 27 June |
| | WP5 | 41°-00'N | 144°-40'E | 14 | 123.0 | 29 June |
| | WP6 | 43°-00'N | 145°-20'E | 166 | 123.0 | 2 July |
| | WP7 | 41°-00'N | 146°-00'E | 237 | 220.0 | 3 July |
| | WP8 | 39°-00'N | 142°-00'E | 142 | 153.0 | 3 July |
| | WP9 | 37°-00'N | 144°-00'E | 235 | 208.0 | 2 July |
| | WP10 | 35°-00'N | 140°-30'E | | | - |
| Sub-area 11 | WP201 | 45°-28'N | 142°-30'E | 166 | 26.0 | 6 July |
| | WP202 | 45°-04'N | 142°-39'E | 67 | 31.0 | 6 July |
| | WP203 | 45°-16'N | 143°-19'E | 192 | 40.0 | 6 July |
| | WP204 | 44°-37'N | 143°-07'E | 54 | 50.0 | 7 July |
| | WP205 | 45°-06'N | 144°-04'E | 200 | 50.0 | 8 July |
| | WP206 | 44°-19'N | 143°-40'E | 49 | 91.0 | 9 July |
| | WP207 | 45°-19'N | 145°-16'E | 207 | 82.0 | 10 July |
| | WP208 | 44°-06'N | 144°-23'E | 48 | 62.0 | 12 July |
| | WP209 | 44°-48'N | 145°-27'E | 203 | 31.0 | 13 July |
| | WP210 | 44°-20'N | 145°-10'E | | | 13 July |
| | WP501 | 44°-17'N | 145°-08'E | 300 | | 14 July |
| | WP502 | 45°-10'N | 143°-00'E | | | 15 July |
| SMS-A | WPA1 | 41°-40'N | 141°-35'E | 132 | 30.0 | 21 June |
| | WPA2 | 41°-20'N | 142°-05'E | 221 | 26.0 | 21 June |
| | WPA3 | 41°-00'N | 141°-42'E | 360 | 70.0 | 22 June |
| | WPA4 | 42°-10'N | 141°-42'E | | | 23 June |
| SMS-B | WPB1 | 41°-45'N | 143°-37'E | 15 | 29.0 | 27 June |
| | WPB2 | 42°-13'N | 143°-47'E | | | 27 June |

SMS: Special monitoring survey

Dedicated sighting survey by the SV

| Stratum | Way point | | | Course direction | Distance (n. miles) | Date |
|---|---|---|---|---|---|---|
| Sub-area 7W | WP100 | 42°-00'N | 141°-10'E | 148 | 71.0 | 9 June |
| | WP101 | 41°-00'N | 142°-00'E | 25 | 72.0 | 10 June |
| | WP102 | 42°-06'N | 142°-40'E | 156 | 72.0 | 11 June |
| | WP103 | 41°-00'N | 143°-20'E | 16 | 111.0 | 11 June |
| | WP104 | 42°-47'N | 144°-00'E | 164 | 111.0 | 16 June |
| | WP105 | 41°-00'N | 144°-40'E | 14 | 123.0 | 19 June |
| | WP106 | 43°-00'N | 145°-20'E | 166 | 123.0 | 21 June |
| | WP107 | 41°-00'N | 146°-00'E | 22 | 56.0 | 22 June |
| | WP108 | 41°-52'N | 146°-28'E | | | 22 June |
| | WP109 | 41°-00'N | 146°-00'E | 237 | 220.0 | 23 June |
| | WP110 | 39°-00'N | 142°-00'E | 142 | 153.0 | 26 June |
| | WP111 | 37°-00'N | 144°-00'E | 235 | 208.0 | - |
| | WP112 | 35°-00'N | 140°-30'E | | | - |
| Sub-area 11 | WP201 | 45°-28'N | 142°-30'E | 166 | 26.0 | 3 July |
| | WP206 | 44°-19'N | 143°-40'E | 49 | 91.0 | 6 July |
| | WP207 | 45°-19'N | 145°-16'E | 207 | 82.0 | 6 July |
| | WP208 | 44°-06'N | 144°-23'E | 48 | 62.0 | 8 July |
| | WP209 | 44°-48'N | 145°-27'E | 203 | 31.0 | 9 July |
| | WP210 | 44°-20'N | 145°-10'E | | | 9 July |
| | WP201 | 45°-28'N | 142°-30'E | 166 | 26.0 | 10 July |
| | WP202 | 45°-04'N | 142°-39'E | 67 | 31.0 | 10 July |
| | WP203 | 45°-16'N | 143°-19'E | 192 | 40.0 | 10 July |
| | WP204 | 44°-37'N | 143°-07'E | 54 | 50.0 | 10 July |
| | WP205 | 45°-06'N | 144°-04'E | 200 | 50.0 | 12 July |
| | WP206 | 44°-19'N | 143°-40'E | | | 14 July |
| | WP304 | 44°-27'N | 143°-25'E | 39 | 50.0 | 14 July |
| | WP305 | 45°-06'N | 144°-10'E | 180 | 54.0 | 14 July |
| | WP306 | 44°-12'N | 144°-10'E | 26 | 81.0 | 16 July |
| | WP307 | 45°-25'N | 145°-00'E | | | 16 July |
| PS | WP501 | 42°-00'N | 141°-20'E | 132 | 30.0 | 18 July |
| | WP502 | 41°-20'N | 142°-00'E | | | 19 July |
| | WP503 | 41°-20'N | 143°-20'E | | | 20 July |
| | WP504 | 42°-00'N | 144°-00'E | | | 20 July |
| Sub-area 7E | WP401 | 41°-00'N | 146°-00'E | | | 21 July |
| | WP402 | 38°-30'N | 150°-00'E | | | - |
| | WP403 | 35°-00'N | 143°-00'E | | | - |

PS: preliminary survey for sampling the pray species for whales

Table 2. Searching distances made by the three sighting/sampling vessels (YS1, K01 and T25) in the 1999 JARPN survey

| Sub-area | Vessel | Period | Day | Searching distance (n.miles) | | | | | Memo |
|---|---|---|---|---|---|---|---|---|---|
| | | | | NSC | ASP | NSS | NSP | Total | |
| 10 | K01, T25 | 16-17 June | 2 | | | | 171.9 | 171.9 | transit |
| 7 (WS) | YS1 | 18 June | 1 | | | | 95.3 | 95.3 | transit |
| 7 (WN) | K01, T25 | 18 June | 1 | | 67.0 | | | 67.0 | Pre-survey |
| 7(WN) | YS1, K01, T25 | 19 June - 3 July | 15 | 918.6 | 137.8 | 305.4 | | 1,361.8 | |
| 7(WS) | YS1, K01, T25 | 1 - 3 July | 3 | | 150.7 | | | 150.7 | |
| Combined | YS1, K01, T25 | 19 June - 3 July | 15 | 918.6 | 288.5 | 305.4 | | 1,512.5 | |
| 11 | YS1, K01, T25 | 6 - 15 July | 10 | 474.7 | 330.8 | 253.2 | | 1,058.7 | |
| Total | | | | 1,393.3 | 619.3 | 558.6 | | 2,571.2 | |

NSC: Closing mode survey with sampling activities under condition of normal sighting survey

ASP: Closing mode survey without sampling activities under condition of normal sighting survey

NSS: Closing mode survey with sampling activities under out of condition for normal sighting survey

NSP: Passing mode survey without sampling activities under condition of normal sighting survey

Table 3. Searching distances (n.miles) under NSC+ASP modes*) by one degree

| | 140° E | 141° E | 142° E | 143° E | 144° E | 145° E | Total |
|---|---|---|---|---|---|---|---|
| 45° N | | | 16.4 | 94.7 | 63.8 | 88.1 | 263.0 |
| 44° N | | | - | 309.9 | 177.9 | 54.7 | 542.5 |
| 43° N | | | | | - | - | 0.0 |
| 42° N | - | 15.6 | 33.2 | 15.6 | 27.3 | 100.8 | 192.5 |
| 41° N | - | 177.2 | 199.9 | 140.4 | 280.5 | 44.6 | 842.6 |
| 40° N | | 2.8 | - | - | - | 18.5 | 21.3 |
| 39° N | | - | 49.9 | 2.7 | - | - | 52.6 |
| 38° N | | - | 21.5 | 1.0 | - | - | 22.5 |
| 37° N | - | - | - | 75.6 | - | - | 75.6 |
| 36° N | - | - | - | - | - | - | 0.0 |
| 35° N | - | - | - | - | - | - | 0.0 |
| Total | 0.0 | 195.6 | 320.9 | 639.9 | 549.5 | 306.7 | 2,012.6 |

*) searching activities under normal sighting survey condition.

Table 4. Searching distances (n.miles) under NSS mode*) survey by one degree

| | 140° E | 141° E | 142° E | 143° E | 144° E | 145° E | Total |
|---|---|---|---|---|---|---|---|
| 45° N | | | 93.0 | 13.3 | - | - | 106.3 |
| 44° N | | | - | 17.7 | 124.6 | 4.6 | 146.9 |
| 43° N | | | | | - | - | 0.0 |
| 42° N | - | - | 1.6 | 47.1 | 64.1 | 13.3 | 126.1 |
| 41° N | - | 6.7 | 47.6 | 92.0 | 33.0 | - | 179.3 |
| 40° N | | - | - | - | - | - | 0.0 |
| Total | 0.0 | 6.7 | 142.2 | 170.1 | 221.7 | 17.9 | 558.6 |

*) searching activity without normal sighting survey condition.

Table 5. Searching distances made by the dedicated sighting vessel (KS2) in the 1999 JARPN survey.

| Sub-area | | Period | Day | ASP (n.miles) |
|---|---|---|---|---|
| 7W | Northern part | 9-22 June | 14 | 672.6 |
| | Southern part | 23-29 June | 7 | 359.1 |
| | Combined | 9-29 June | 21 | 1,031.7 |
| 7E | | 21 - 23 July | 3 | 260.9 |
| 11 | | 3-16 July | 14 | 595.2 |
| Total | | 6/9-7/16 | 35 | 1,887.8 |

Table 6. List of cetacean species and number of sightings (no. schools/no. individuals) were made by three sighting/sampling vessels in the 1999 JARPN survey.

| Cetacean species | NSC + ASP modes[1] | | NSS mode[2] | | OE |
|---|---|---|---|---|---|
| | Primary | Secondary | Primary | Secondary | Secondary |
| | Sch. / Ind. | Sch. / Ind. | Sch. / Ind. | Sch. / Ind. | Sch. / Ind. |
| ***Sub-area 7W (North)*** | | | | | |
| Minke whale | 33 / 36 | 17 / 17 | 5 / 5 | 14 / 16 | 5 / 5 |
| Like minke whale | 2 / 2 | 4 / 4 | 1 / 1 | 2 / 2 | 2 / 2 |
| Sei whale | 1 / 1 | | | | |
| Humpback whale | | | 2 / 3 | | |
| Sperm whale | 8 / 10 | 4 / 5 | 1 / 1 | | |
| Killer whale | 2 / 7 | | | | |
| Baird's beaked whale | 1 / 6 | | | | |
| Unidentified Mesoplodon | 3 / 9 | | | | |
| Unidentified Ziphiidae | 8 / 16 | 2 / 5 | 2 / 2 | 1 / 1 | |
| Dall's porpoise | | | | | |
| *dalli* type | 1 / 3 | | | | |
| Unidentified type | | | 1 / 4 | | |
| Unidentified dolphin | 6 / 31 | | 2 / 4 | | |
| Unidentified cetacean | 16 / 17 | 7 / 8 | 4 / 4 | 3 / 3 | 4 / 4 |
| ***Sub-area 7W (South)*** | | | | | |
| Bryde's whale | 1 / 1 | | | | |
| Unidentified Mesoplodon | 1 / 5 | | | | |
| Unidentified large whales | 2 / 2 | | | | |
| Unidentified dolphin | 1 / 1 | | | | |
| Unidentified cetacean | 1 / 1 | | | | |
| ***Sub-area 11*** | | | | | |
| Minke whale | 47 / 50 | 26 / 27 | 4 / 4 | 8 / 9 | 6 / 7 |
| Like minke whale | 1 / 1 | 2 / 2 | | | 1 / 1 |
| Fin whale | 2 / 2 | 1 / 1 | | | |
| Sei whale | 2 / 2 | 5 / 5 | | | |
| Killer whale | 3 / 11 | | | | |
| Baird's beaked whale | 1 / 5 | | | | |
| Unidentified dolphin | 3 / 9 | 1 / 2 | 1 / 3 | 1 / 3 | |
| Unidentified cetacean | 5 / 14 | 3 / 3 | 5 / 5 | 1 / 1 | 1 / 1 |

[1]: searching activities under normal sighting survey condition

[2]: searching activity without normal sighting survey condition.

Table 7. Distribution of primary sighting (schools/individuals) of minke whale under NSC+ASP mode searching in the 1999 JARPN by one degree

| | 140° E | 141° E | 142° E | 143° E | 144° E | 145° E | Total |
|---|---|---|---|---|---|---|---|
| 45° N | | | 0/0 | 8/8 | 1/1 | 2/2 | 11/11 |
| 44° N | | | - | 24/27 | 10/10 | 2/2 | 36/39 |
| 43° N | | | | | - | - | 0/0 |
| 42° N | - | 3/3 | 0/0 | 0/0 | 3/3 | 2/3 | 8/9 |
| 41° N | - | 11/12 | 4/4 | 6/7 | 2/2 | 2/2 | 25/27 |
| 40° N | | 0/0 | - | - | - | 0/0 | 0/0 |
| 39° N | | - | 0/0 | 0/0 | - | - | 0/0 |
| 38° N | | - | 0/0 | 0/0 | - | - | 0/0 |
| 37° N | - | - | - | 0/0 | - | - | 0/0 |
| 36° N | - | - | - | - | - | - | 0/0 |
| 35° N | - | - | - | - | - | - | 0/0 |
| Total | 0/0 | 14/15 | 4/4 | 38/42 | 16/16 | 8/9 | 80/86 |

Table 8. Distribution of primary sighting (schools/individuals) of minke whale under NSS mode searching in the 1999 JARPN by one degree

| | 140° E | 141° E | 142° E | 143° E | 144° E | 145° E | Total |
|---|---|---|---|---|---|---|---|
| 45° N | | | 0/0 | 3/3 | - | - | 3/3 |
| 44° N | | | - | 1/1 | 0/0 | 0/0 | 1/1 |
| 43° N | | | | | - | - | 0/0 |
| 42° N | - | - | 0/0 | 0/0 | 1/1 | 2/2 | 3/3 |
| 41° N | - | 2/2 | 0/0 | 0/0 | 0/0 | - | 2/2 |
| 40° N | | - | - | - | - | - | 0/0 |
| Total | 0/0 | 2/2 | 0/0 | 4/4 | 1/1 | 2/2 | 9/9 |

Table 9. Density indices (no. of schools/100 n.miles) of minke whales sighted under NSC+ASP mode searchings by one degree.

| | 140° E | 141° E | 142° E | 143° E | 144° E | 145° E | Total |
|---|---|---|---|---|---|---|---|
| 45° N | | | 0.00 | 8.45 | 1.57 | 2.27 | 4.18 |
| 44° N | | | - | 7.74 | 5.62 | 3.66 | 6.64 |
| 43° N | | | | | - | - | - |
| 42° N | - | 19.23 | 0.00 | 0.00 | 10.99 | 1.98 | 4.16 |
| 41° N | - | 6.21 | 2.00 | 4.27 | 0.71 | 4.48 | 2.97 |
| 40° N | | 0.00 | - | - | - | 0.00 | 0.00 |
| 39° N | | - | 0.00 | 0.00 | - | - | 0.00 |
| 38° N | | - | 0.00 | 0.00 | - | - | 0.00 |
| 37° N | - | - | - | 0.00 | - | - | 0.00 |
| 36° N | - | - | - | - | - | - | - |
| 35° N | - | - | - | - | - | - | - |
| Total | - | 7.16 | 1.25 | 5.94 | 2.91 | 2.61 | 3.97 |

Table 10. List of cetacean species and number of sightings (no. schools/no. individuals) were made by a dedicated sighting vessel (SV) in the 1999 JARPN survey.

| Cetacean species | ASP modes* | | OE |
|---|---|---|---|
| | Primary | Secondary | Secondary |
| | Sch. / Ind. | Sch. / Ind. | Sch. / Ind. |
| ***Sub-area 7W (North of 41N)*** | | | |
| Minke whale | 36 / 43 | 16 / 16 | 5 / 5 |
| Like minke whale | 4 / 4 | 5 / 5 | 3 / 3 |
| Fin whale | 1 / 1 | | |
| Humpback whale | 1 / 1 | | |
| Sperm whale | 1 / 1 | | |
| Killer whale | 3 / 24 | 1 / 7 | |
| Baird's beaked whale | 3 / 13 | | |
| Unidentified Ziphiidae | 11 / 37 | | |
| Dall's porpoise | | | |
| *dalli* type | 15 / 137 | | |
| *truei* type | 3 / 26 | | |
| Unidentified type | 26 / 145 | | |
| Pacific white-sided dolphin | 1 / 5 | | |
| Unidentified dolphin | 6 / 53 | | |
| Unidentified cetacean | 4 / 4 | | |
| ***Sub-area 7W (South of 41 N)*** | | | |
| Minke whale | 2 / 2 | | 1 / 1 |
| Like minke whale | 1 / 1 | | |
| Bryde's whale | 1 / 1 | | |
| Sperm whale | 7 / 12 | | |
| Baird's beaked whale | 1 / 3 | | |
| Cuvier's beaked whale | 1 / 1 | | |
| Unidentified Ziphiidae | 1 / 2 | | |
| Dall's porpoise | | | |
| *truei* type | 3 / 14 | | |
| Unidentified type | 3 / 24 | | |
| Risso's dolphin | | | 1 / 5 |
| Unidentified pilot whales | 1 / 2 | | |
| Unidentified large cetacean | 1 / 1 | 1 / 1 | |
| Unidentified dolphin | 2 / 4 | | |
| Unidentified cetacean | 1 / 1 | | |
| ***Sub-area 11*** | | | |
| Minke whale | 26 / 27 | 8 / 9 | 12 / 14 |
| Like minke whale | 1 / 1 | 1 / 1 | 2 / 2 |
| Sperm whale | 1 / 1 | | |
| Killer whale | 1 / 3 | | |
| Baird's beaked whale | 5 / 16 | 1 / 4 | |
| Unidentified Ziphiidae | 2 / 5 | | |
| Dall's porpoise | | | |
| *dalli* type | 3 / 11 | | |
| Unidentified type | 36 / 114 | | |
| Pacific white-sided dolphin | 7 / 28 | | |
| Unidentified dolphin | 4 / 20 | | |
| Unidentified cetacean | 3 / 3 | | |
| ***Sub-area 7E*** | | | |
| Bryde's whale | 9 / 11 | 3 / 4 | |
| Unidentified Mesoplodon | 1 / 3 | | |
| Unidentified Ziphiidae | 3 / 4 | | |
| Common dolphin | 4 / 205 | | |
| Striped dolphin | 1 / 30 | | |
| Unidentified pilot whales | 1 / 25 | | |
| Unidentified large cetacean | 1 / 1 | 2 / 2 | |
| Unidentified dolphin | 22 / 533 | | |
| Unidentified cetacean | 1 / 1 | | |

*: searching activities under normal sighting survey condition

Table 11. Numbers of minke whales sighted, targeted and sampled, and their sampling efficiencies

| Sub-area | | | Sighted | Targeted | Sampled | Sampling efficiencies | |
|---|---|---|---|---|---|---|---|
| | | | Sch. / Ind. (A) (B) | Sch. / Ind. (C) (D) | Ind. (E) | Technical (E/D) | True (E/B) |
| 7W | NSC | primary | 25 / 28 | 25 / 28 | 21 | 0.75 | 0.75 |
| | | secondary | 18 / 18 | 18 / 18 | 12 | 0.67 | 0.67 |
| | NSS | primary | 5 / 5 | 5 / 5 | 4 | 0.80 | 0.80 |
| | | secondary | 15 / 17 | 12 / 14 | 9 | 0.64 | 0.53 |
| | ASP | primary | 8 / 8 | 0 / 0 | 0 | | |
| | | secondary | 0 / 0 | 0 / 0 | 0 | | |
| | OE | | 6 / 6 | 6 / 6 | 4 | 0.67 | 0.67 |
| | Total | | 77 / 82 | 66 / 71 | 50 | 0.70 | 0.61 |
| 11 | NSC | primary | 34 / 37 | 31 / 34 | 20 | 0.59 | 0.54 |
| | | secondary | 25 / 26 | 25 / 26 | 13 | 0.50 | 0.50 |
| | NSS | primary | 6 / 6 | 6 / 6 | 3 | 0.50 | 0.50 |
| | | secondary | 9 / 10 | 9 / 10 | 9 | 0.90 | 0.90 |
| | ASP | primary | 17 / 17 | 0 / 0 | 0 | | |
| | | secondary | 2 / 2 | 0 / 0 | 0 | | |
| | OE | | 6 / 7 | 6 / 7 | 5 | 0.71 | 0.71 |
| | Total | | 99 / 105 | 77 / 83 | 50 | 0.60 | 0.48 |
| Total | | | 176 / 187 | 143 / 154 | 100 | 0.65 | 0.53 |

Table 12. Summary of biological data and samples collected during the 1999 JARPN survey

| Samples and data | Number of whales | | |
|---|---|---|---|
| | Male | Female | Total |
| Body length and sex | 71 | 29 | 100 |
| External body proportion | 71 | 29 | 100 |
| Photographic record and external character | 71 | 29 | 100 |
| Diatom film record and sampling | 71 | 29 | 100 |
| Standard measurements of blubber thickness (eleven points) | 71 | 29 | 100 |
| Detailed measurements of blubber thickness (fourteen points) | 14 | 6 | 20 |
| Body weight | 71 | 29 | 100 |
| Body weight by parts | 14 | 6 | 20 |
| Blubber, muscle, liver and heart tissues for DNA study | 71 | 29 | 100 |
| Muscle, liver and heart tissues for isozyme analysis | 71 | 29 | 100 |
| Muscle, liver and kidney tissues for heavy metal analysis | 71 | 29 | 100 |
| Blubber, muscle, liver and kidney tissues for organochlorine analysis | 71 | 29 | 100 |
| Tissues for lipid analysis | 14 | 6 | 20 |
| Tissues for endocrine disrupters analysis | 71 | 29 | 100 |
| Muscle, liver tissues and baleen plate for stable isotopes | 28 | 22 | 50 |
| Mammary grand; lactation status, measurement and histological sample | - | 29 | 29 |
| Uterine horn; measurement and endometrium sample | - | 29 | 29 |
| Uterine mucus for sperm detection | - | 28 | 28 |
| Collection of ovary | - | 29 | 29 |
| Photographic record of foetus | 8 | 6 | 14 |
| Foetal sex (identified by visual observation) | 8 | 6 | 14 |
| Foetal length and weight | 8 | 6 | 14 |
| External measurements of foetus | 7 | 2 | 9 |
| Collection of foetus | 8 | 6 | 14 |
| Testis and epididymis; weight and histological sample | 71 | - | 71 |
| Smear samples from testis and epididymis tissues | 71 | - | 71 |
| Urine sample for sperm detection | 46 | - | 46 |
| Collection of serum sample | 71 | 29 | 100 |
| Blood samples from umbilical cord | - | 5 | 5 |
| Serum samples from umbilical cord | - | 11 | 11 |
| Stomach content, conventional record | 71 | 29 | 100 |
| Volume and weight of stomach content in each compartment | 71 | 29 | 100 |
| Stomach contents for feeding study | 71 | 29 | 100 |
| Record of external parasites | 71 | 29 | 100 |
| Collection of external parasites | 7 | 6 | 13 |
| Record of parasites in 1st stomach | 71 | 29 | 100 |
| Record of parasites in 2nd stomach | 71 | 29 | 100 |
| Record of parasites in 3rd stomach | 71 | 29 | 100 |
| Record of parasites in 4th stomach | 71 | 29 | 100 |
| Record of parasites in intestine | 71 | 29 | 100 |
| Record of parasites in liver | 71 | 29 | 100 |
| Earplug for age determination | 71 | 29 | 100 |
| Collection of 2nd stomach contents for parasitological study | 6 | 10 | 16 |
| Tympanic bulla for age determination | 71 | 29 | 100 |
| Largest baleen plate for morphologic study and age determination | 70 | 29 | 99 |
| Vertebral epiphyses sample | 71 | 28 | 99 |
| Baleen plate measurements (length and breadth) | 71 | 29 | 100 |
| Length of each baleen plate series | 71 | 29 | 100 |
| Number of vertebrae | 71 | 29 | 100 |
| Number of ribs | 71 | 29 | 100 |
| Skull measurement (length and breadth) | 71 | 28 | 99 |
| Detailed measurements of skull | 0 | 1 | 1 |
| Collection of skull | 0 | 3 | 3 |
| Collection of whole skeleton | 0 | 1 | 1 |

Table 13. List of by-products in the 1999 JARPN survey.

| Name of by-product | Amount (kg) | Name of by-product | Amount (kg) |
|---|---|---|---|
| O-niku* | 128 | Throat mottled meat | 1,744 |
| O-niku* (regular) | 176 | Bacon (grade 1) | 10,458 |
| Ventral blubber (neck) | 144 | Bacon (grade 2) | 208 |
| Jaw skin (mottled) | 272 | Bacon (small pieces) | 4,064 |
| Jaw skin (regular) | 208 | Ventral blubber | 1,120 |
| Red meat (premium) | 1,024 | Blubber (grade 1) | 19,698 |
| Red meat | 96,416 | Kidney | 736 |
| Red meat (regular) | 2,096 | Heart | 864 |
| Small pieces | 4,144 | Pancreas | 144 |
| Small pieces (grade 2) | 5,655 | Esophagus | 128 |
| Small pieces (for process | 6,896 | Mandibular ligaments (hard | 368 |
| Breast meat | 21,792 | Mandibular ligaments (soft) | 128 |
| Breast meat (grade 2) | 13,712 | Tongue | 2,678 |
| Breast meat (grade 3) | 48,960 | Intestine | 3,408 |
| Cartilage | 50 | Underside of blubber | 3,984 |
| Diaphragm | 1,328 | Lining of meat | 3,280 |
| Blubber (regular) | 12,650 | process meat | 3,824 |
| Posterior ventral blubber | 13,975 | Caudal tendon | 800 |
| Nasal plug | 550 | Tendon | 5,696 |
| Tail flukes (premium) | 4,100 | Maxillary cartilage | 250 |
| Tail flukes (regular) | 725 | | |

*: Muscles associated with caudal vertebra.

Table 14. Compositon of sex and sexual maturity of minke whales sampled in the sub-areas 7W and 11, collected by the JARPN surveys during 1996 and 1999.

| Sub-area | Survey year | Month | no. samples | Male | | Female | | | Sex ratio (% males) | Maturity | | Pregnancy rate*) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Imm. | Mat. | Imm. | Mat. | [Preg.] | | Male | Female | |
| 7W | 1999 | June | 50 | 9 (18.0) | 34 (64.0) | 5 (10.0) | 2 (4.0) | [2] | 86.0 | 79.1 | 28.6 | 100 |
| | 1996 | Aug. - Sept. | 30 | 5 (16.7) | 23 (76.7) | 0 (0) | 2 (6.7) | [1] | 93.3 | 82.1 | 100.0 | 50.0 |
| 11 | 1999 | July | 50 | 4 (8.0) | 24 (48.0) | 8 (16.0) | 14 (28.0) | [12] | 56.0 | 85.7 | 63.6 | 92.3 |
| | 1996 | Aug. | 30 | 2 (6.7) | 17 (56.7) | 4 (13.3) | 7 (23.3) | [5] | 63.3 | 89.5 | 63.6 | 71.4 |

Figure in parenthes indicate percentage to the total
*) Apparant pregnancy rate

Table 15. Summary of pregnant females and their foetuses collected in the 1999 JARPN survey.

| Sampling Date | Sub-area | Sample No. | Body length (m) | Blubber thickness (cm) | Fetus | | |
|---|---|---|---|---|---|---|---|
| | | | | | Length (cm) | Weight (kg) | Sex |
| 23 Jun. 1999 | 7W | 23 | 7.77 | 5.2 | 62.7 | 3.3 | M |
| 26 Jun. 1999 | 7W | 33 | 8.21 | 4.2 | 52 | 1.8 | M |
| 6 Jul. 1999 | 11 | 51 | 7.64 | 3.3 | 56.8 | 2.3 | M |
| 7 Jul. 1999 | 11 | 58 | 7.09 | 3.3 | 40 | 0.9 | M |
| 7 Jul. 1999 | 11 | 59 | 7.33 | 4.2 | 207.5 | 106.8 | F |
| 8 Jul. 1999 | 11 | 63 | 7.31 | 4.4 | 184.8 | 62.2 | M |
| 8 Jul. 1999 | 11 | 64 | 8.05 | 4.9 | 79.3 | 6.8 | F |
| 8 Jul. 1999 | 11 | 65 | 8.18 | 4.6 | 58.3 | 3.0 | F |
| 8 Jul. 1999 | 11 | 68 | 7.66 | 2 | 22.9 | 0.2 | F |
| 9 Jul. 1999 | 11 | 69 | 8.06 | 3.9 | 46.8 | 1.2 | F |
| 9 Jul. 1999 | 11 | 71 | 7.54 | 4.3 | 208.4 | 98.7 | M |
| 9 Jul. 1999 | 11 | 73 | 7.3 | 5.4 | 144.7 | 44.0 | M |
| 10 Jul. 1999 | 11 | 75 | 7.33 | 4 | 47.1 | 1.5 | M |
| 15 Jul. 1999 | 11 | 98 | 7.11 | 4.9 | 186.3 | 78.2 | F |

Table 16. Number of male whales with abnormal gonadal tissues, by sub-area.

| Sub-area | Year | Maturity | n | Normal | Abnormal | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Both side | One side | Total | |
| | | | | | | | n | (%) |
| 9 | 1994-1999 | Imm. | 15 | 15 | 0.0 | 0 | 0.0 | ( 0.0 ) |
| | | Mat. | 149 | 119 | 8.0 | 22 | 30.0 | ( 20.1 ) |
| 8 | 1996-1998 | Imm. | 8 | 7 | 1 | 0 | 1 | ( 12.5 ) |
| | | Mat. | 78 | 55 | 4 | 19 | 23 | ( 29.5 ) |
| 7E | 1996-1998 | Imm. | 11 | 11 | 0 | 0 | 0 | ( 0.0 ) |
| | | Mat. | 40 | 34 | 0 | 6 | 6 | ( 15.0 ) |
| 7W | 1996 | Imm. | 5 | 5 | 0 | 0 | 0 | ( 0.0 ) |
| | | Mat. | 23 | 19 | 0 | 4 | 4 | ( 17.4 ) |
| | 1999 | Imm. | 9 | 9 | 0 | 0 | 0 | ( 0.0 ) |
| | | Mat. | 34 | 30 | 0 | 4 | 4 | ( 11.8 ) |
| | Combined | Imm. | 14 | 14 | 0 | 0 | 0 | ( 0.0 ) |
| | | Mat. | 57 | 49 | 0 | 8 | 8 | ( 14.0 ) |
| 11 | 1996 | Imm. | 2 | 2 | 0 | 0 | 0 | ( 0.0 ) |
| | | Mat. | 17 | 16 | 0 | 1 | 1 | ( 5.9 ) |
| | 1999 | Imm. | 4 | 4 | 0 | 0 | 0 | ( 0.0 ) |
| | | Mat. | 23 | 17 | 1 | 5 | 6 | ( 26.1 ) |
| | Combined | Imm. | 6 | 6 | 0 | 0 | 0 | ( 0.0 ) |
| | | Mat. | 40 | 33 | 1 | 6 | 7 | ( 17.5 ) |
| Total | | Imm. | 54 | 53 | 1 | 0 | 1 | ( 1.9 ) |
| | | Mat. | 364 | 290 | 13 | 61 | 74 | ( 20.3 ) |

Table 17. Food species of North Pacific minke whales and their frequency of occurrence by sub-area.

| Food species | | Sub-area and season | | | | | | | | | | | | | | | | Combined | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 11 (6) (July) | | 11 (1) (Aug.) | | 7W (6) (June) | | 7W (1) (Aug.-Sep.) | | 7E (5) (May) | | 7E (2) (July) | | 8 (5) (May-June) | | 8 (2) (July-Aug.) | | 9 (3) (May-June) | | 9 (4) (June-Sep.) | | | |
| | | n | (%) | n | (%) | n | (%) | n | (%) | n | (%) | n | (%) | n | (%) | n | (%) | n | (%) | n | (%) | n | (%) |
| Euphausiacea | Euphausiids (*Euphausia pacifica*) | 39 | ( 97.5 ) | 22 | ( 100 ) | | | 10 | ( 38.5 ) | | | | | 1 | 2.9 | 1 | ( 2.4 ) | | | 2 | ( 1.8 ) | 35 | (13.3 ) |
| | Euphausiids (*Thysanoessa* spp.) | | | | | | | | | | | | | | | | | | | 4 | ( 3.5 ) | 4 | ( 1.5 ) |
| | Unidentified Euphausiids | | | | | | | | | | | 2 | ( 66.7 ) | | | | | 1 | ( 1.8 ) | 1 | ( 0.9 ) | 4 | ( 1.5 |
| Copepods | Copepods (*Neocalanus* sp.) | | | | | | | | | | | | | | | | | | | 1 | ( 0.9 ) | 1 | ( 0.4 ) |
| Sauries | Pacific saury (*Cololabis saira*) | | | | | | | 13 | ( 50.0 ) | | | 1 | ( 33.3 ) | 1 | 2.9 | 36 | (85.7 ) | 1 | ( 1.8 ) | 86 | (75.4 ) | 137 | (52.1 ) |
| Anchovies | Japanese anchovy (*Engraulis japonicus*) | 1 | | | | 38 | ( 76.0 ) | | | 43 | 97.7 | | | 33 | 94.3 | 4 | ( 9.5 ) | 54 | (96.4 ) | 15 | (13.2 ) | 73 | (27.8 ) |
| | Unidentified sardines | | | | | 7 | ( 14.0 ) | | | | | | | | | | | | | | | | |
| Mackerels | Chub mackerel (*Scomber japonicus*) | | | | | | | | | | | | | | | 1 | ( 2.4 ) | | | | | 1 | ( 0.4 ) |
| Pomfrets | Japanese pomfret (*Brama japonica*) | | | | | | | | | | | | | | | | | | | 1 | ( 0.9 ) | 1 | ( 0.4 ) |
| Salmonids | Pink salmon (*Oncorhynchus gorbuscha*) | | | | | | | | | | | | | | | | | | | 1 | ( 0.9 ) | 1 | ( 0.4 ) |
| | Unidentified salmon | | | | | | | | | 1 | 2.3 | | | | | | | | | 1 | ( 0.9 ) | 1 | ( 0.4 ) |
| Barracudas | Unidentified barracuda | | | | | | | | | | | | | | | | | | | 2 | ( 1.8 ) | 2 | ( 0.8 ) |
| Cods | Walleye pollock (*Theragra chalcogramma*) | | | | | 5 | ( 10.0 ) | 3 | ( 11.5 ) | | | | | | | | | | | | | 3 | ( 1.1 ) |
| Empty or broken | | 10 | | | | | | | | | | | | | | | | | | | | | |
| No. whales observed | | 50 | ( 100 ) | 22 | ( 100 ) | 50 | ( 100 ) | 26 | ( 100 ) | 44 | ( 100 ) | 3 | ( 100 ) | 35 | ( 100 ) | 42 | ( 100 ) | 56 | ( 100 ) | 114 | ( 100 ) | 263 | ( 100 ) |

(1): Date from the 1996 JARPN survey.
(2): Date from the JARPN surveys in 1996 and 1997.
(3): Data from the 1997 JARPN survey.
(4): Date from the JARPN surveys in 1994 and 1995.
(5): Date from the 1998 JARPN survey.
(6): Date from the 1999 JARPN survey.

Table 18. Comparison between composition of minke whales collected in the western and eastern halves of sub-area 11 in the 1999 JARPN survey.

| Sub-area | no. samples | Male | | Female | | | Sex ratio (% males) | Maturity | | Pregnancy rate*) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Imm. | Mat. | Imm. | Mat. | [Preg.] | | Male | Female | |
| 11 (West) | 27 | 3 (11.1) | 4 (14.8) | 7 (25.0) | 13**) (48.1) | [ 11] | 25.9 | 57.1 | 65.0 | 91.7 |
| 11 (East) | 23 | 1 (4.3) | 20 (87.0) | 1 (4.3) | 1 (4.3) | [ 1] | 91.3 | 95.2 | 50.0 | 100.0 |

Figure in parentheses indicate percentage to the total

*) Apparent pregnancy rate

**) Including one individual of mature female which was unknown for pregnancy

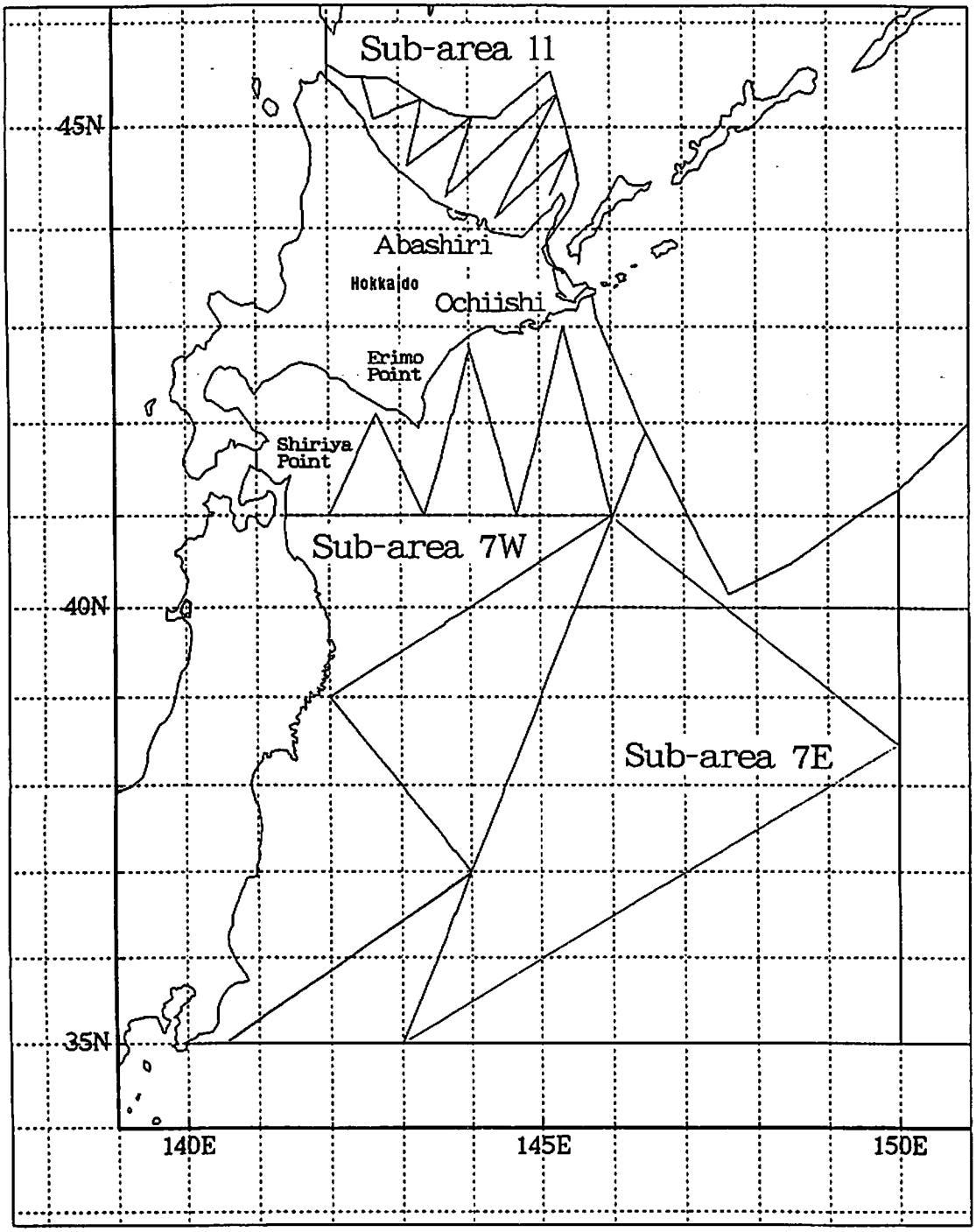


Fig. 1. Research sub-areas and planned cruise tracks in the 1999 JARPN survey.

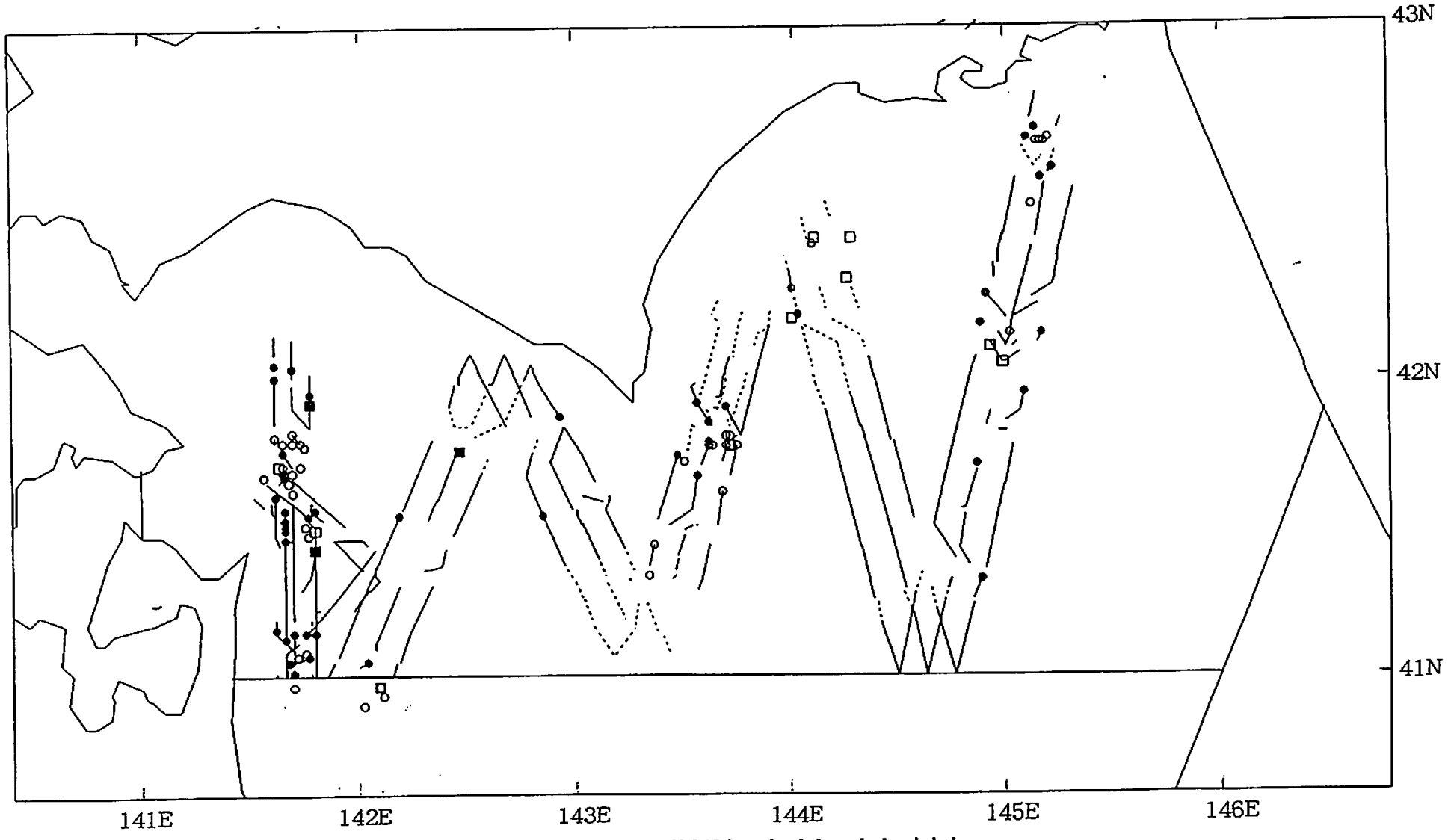


Fig. 2. Cruise tracks of the three sighting/sampling vessels (SSVs) and minke whale sightings in sub-area 7W. Solid line indicates the NSC and ASP mode surveys, and broken line the NSS mode survey. Sightings of minke whales are shown for ● primary and ○ secondary; and those for 'like minke whale' were also shown for ■ primary, and □

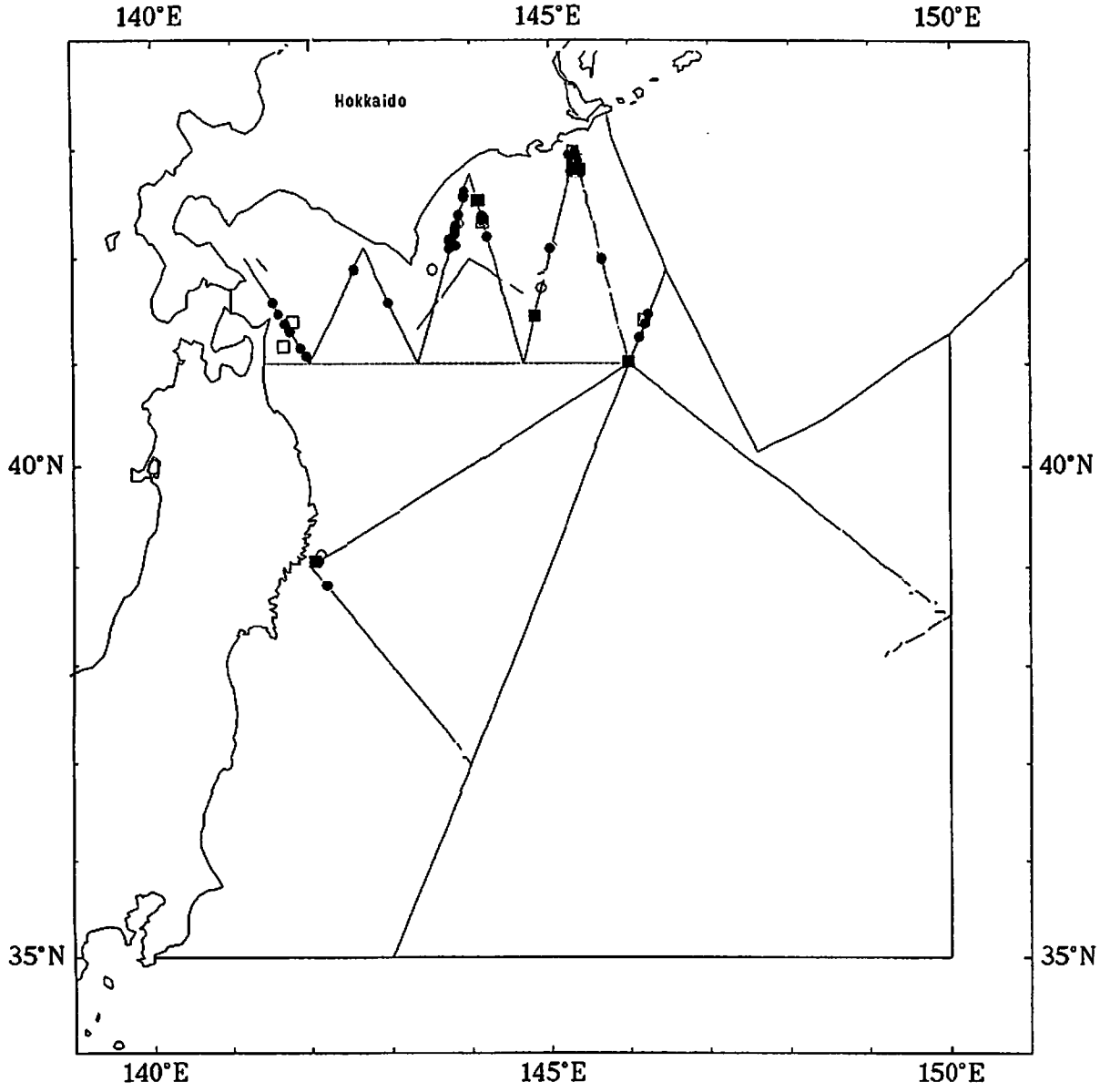


Fig. 3. Cruise track of the dedicated sighting vessel (SV) Kyoshin Maru No.2 (KS2) and minke whale sightings in the sub-area 7 (West and East). Minke whale: ● primary, ○ secondary; 'like minke whale': ■ primary, □ secondary.

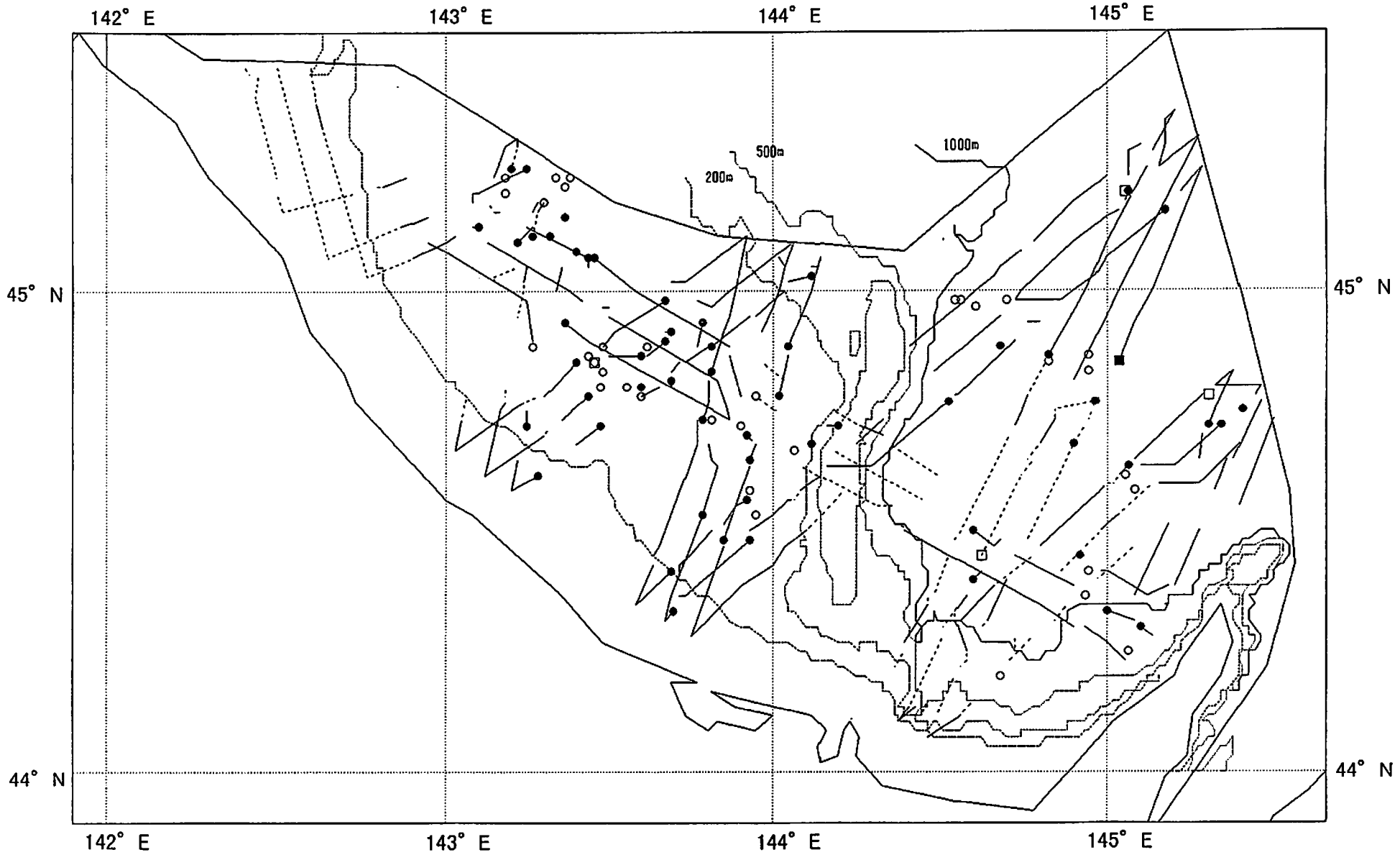


Fig. 4. Cruise tracks and minke whales sighted by the three SSVs in the sub-area 11. Sightings of minke whales are shown for ● primary and ○ secondary; and those for 'like minke whale' were also shown for ■ primary, and □ secondary. This figure also shows four contour lines as 50m, 200m, 500m and 1,000m depth

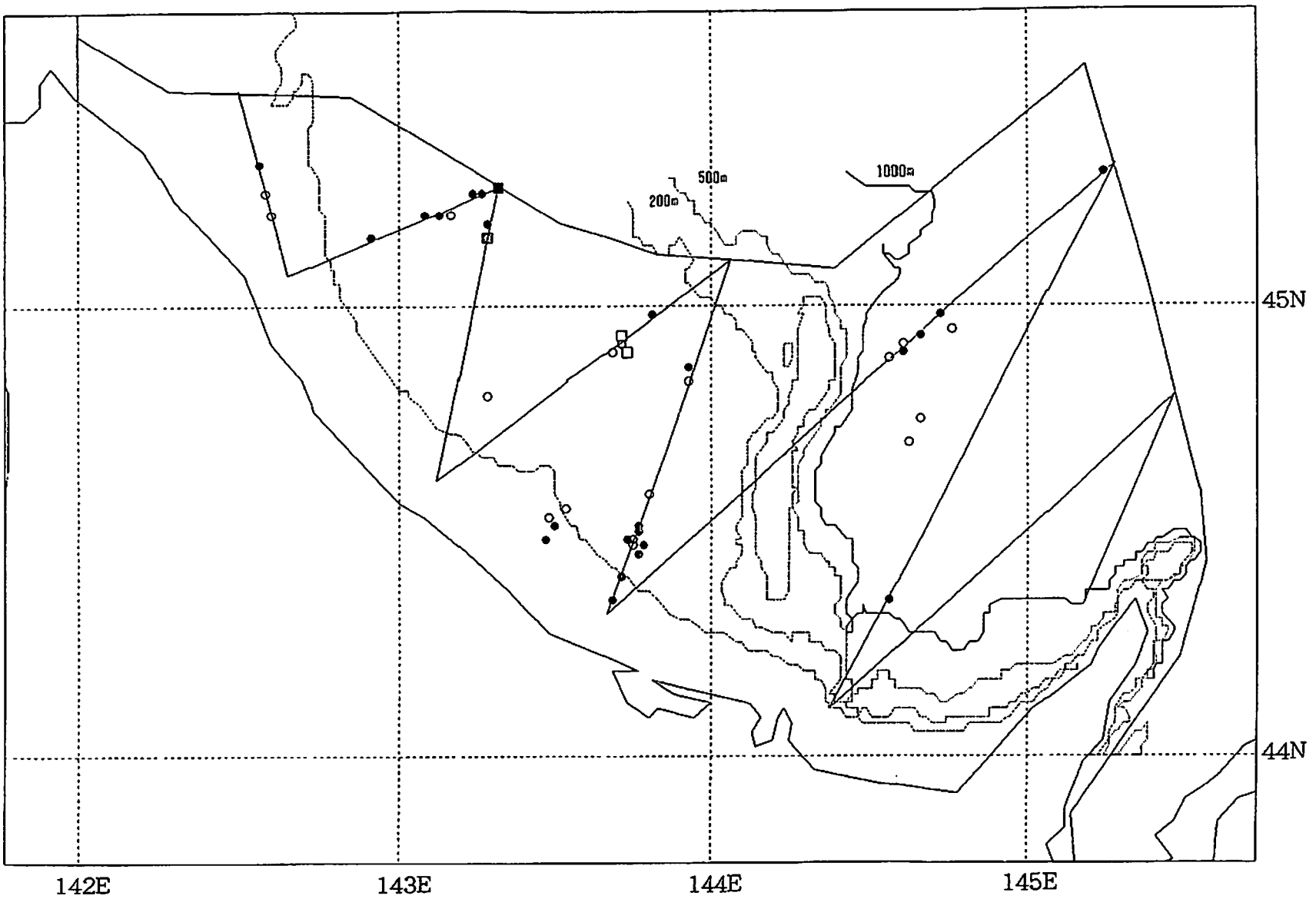


Fig. 5. Cruise track of the dedicated sighting vessel (SV) Kyoshin Maru No.2 (KS2) and minke whale sightings in sub-area 11. Minke whale: ● primary, ○ secondary; 'like

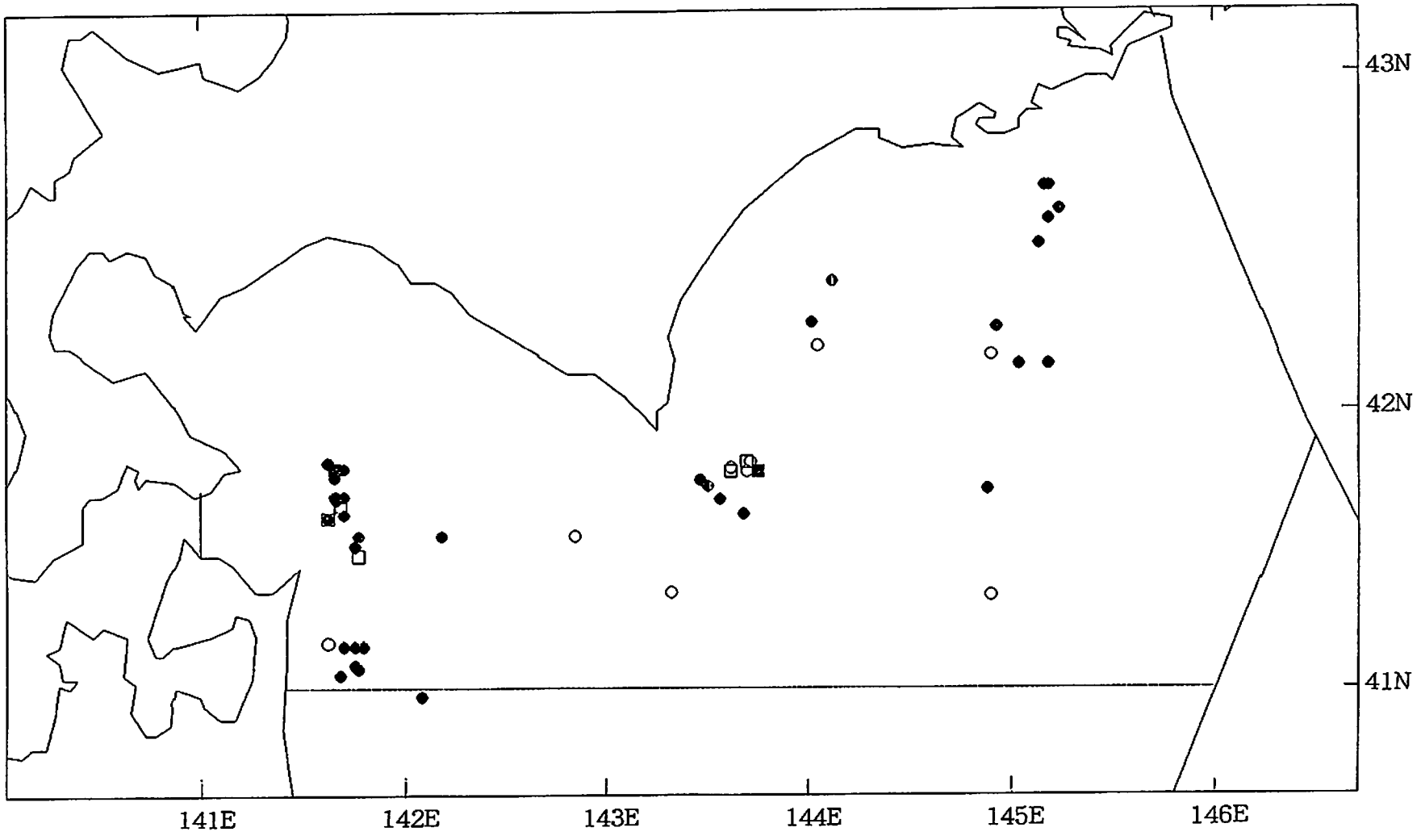


Fig. 6. Geographical distribution of minke whales sampled in sub-area 7W during the 1999 JARPN survey, based on their sighting position. ○: immature male, ●: mature male, □: immature female and ■: mature female.

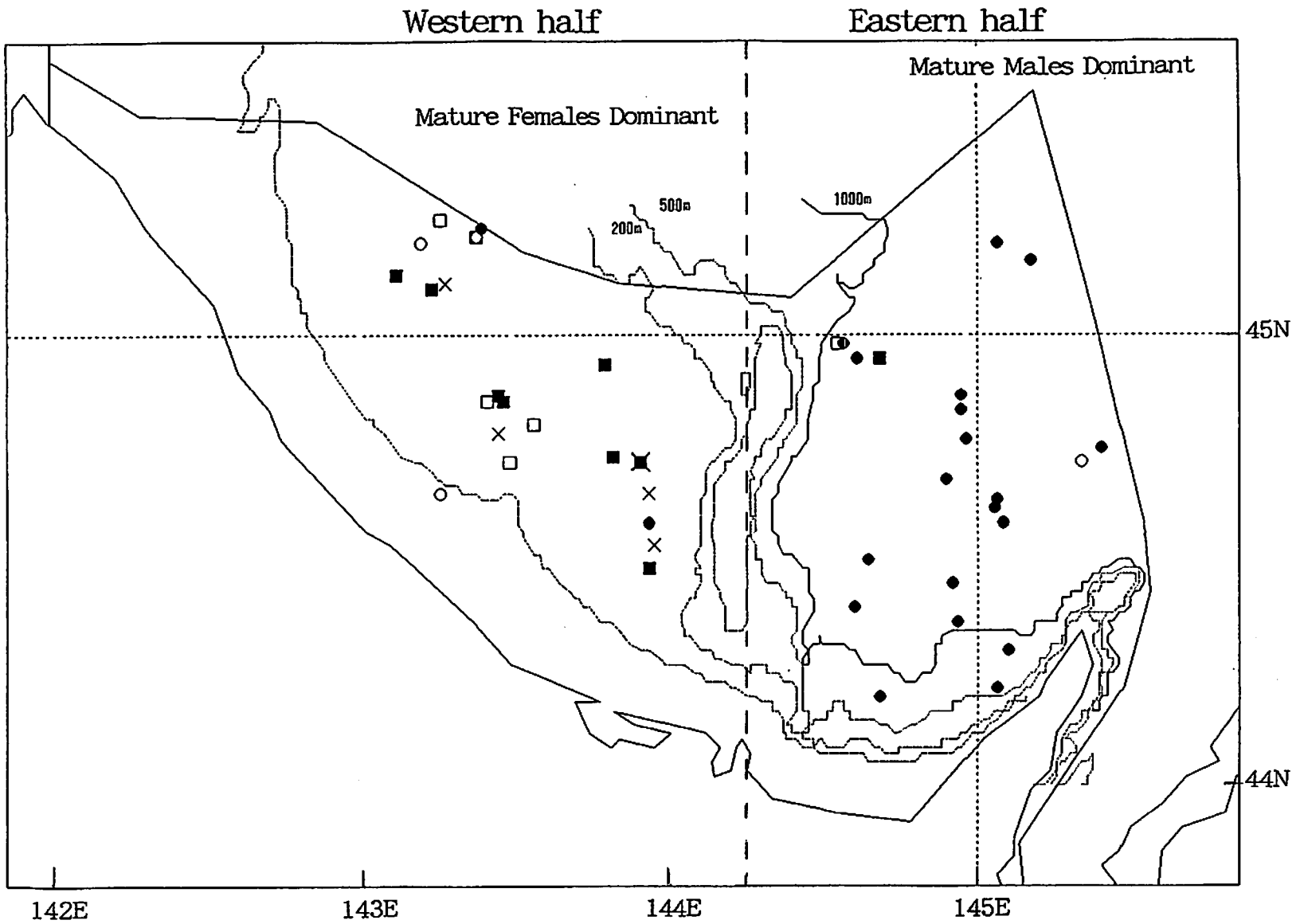


Fig. 7. Geographical distribution of 50 minke whales and their relation ship to depth, sampled in the sub-area 11 during the 1999 JARPN survey, based on their sighting position. Thin lines are shown in the bathymetric line. ○: immature male, ●: mature male, □: immature female and ■: mature female (pregnant), ×: mature pregnant female having larger foetus. This figure also shows four contour lines as 50m, 200m,

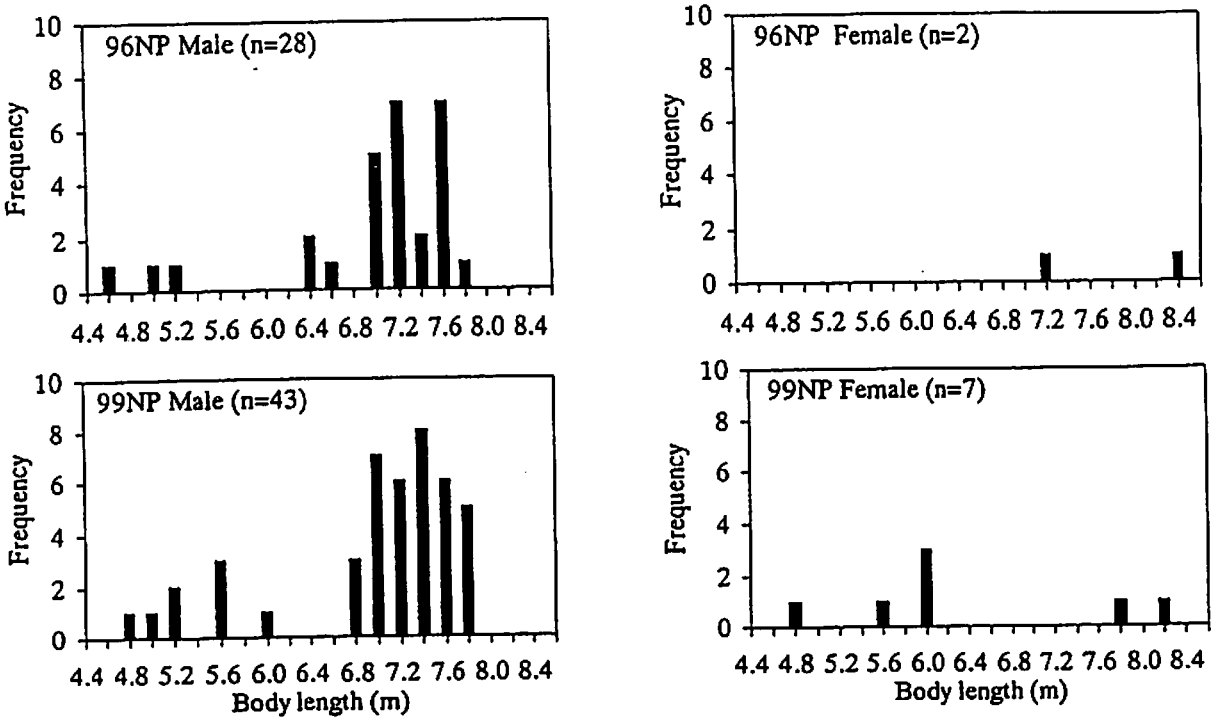


Fig. 8. Comparison of body length frequencies of whale samples in the sub-area 7(West) taken in the 1996 survey (upper) and 1999 survey (lower). Left: males, right: females

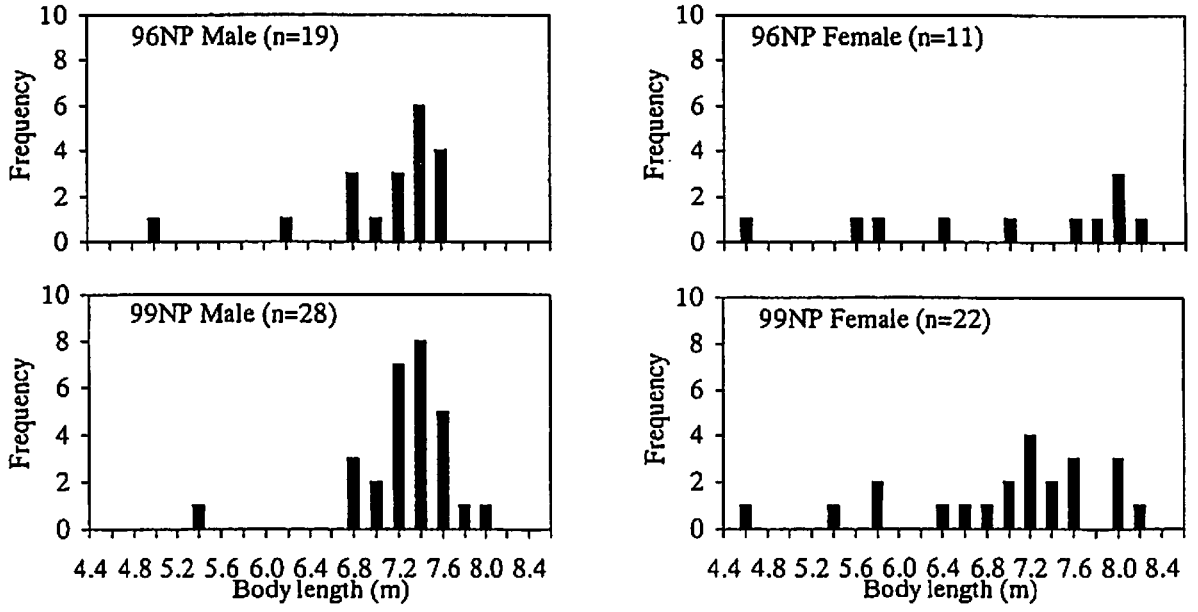


Fig. 9. Comparison of body length frequencies of whale samples in the sub-area 11 taken in the 1996 survey (upper) and 1999 survey (lower). Left: males, right: females

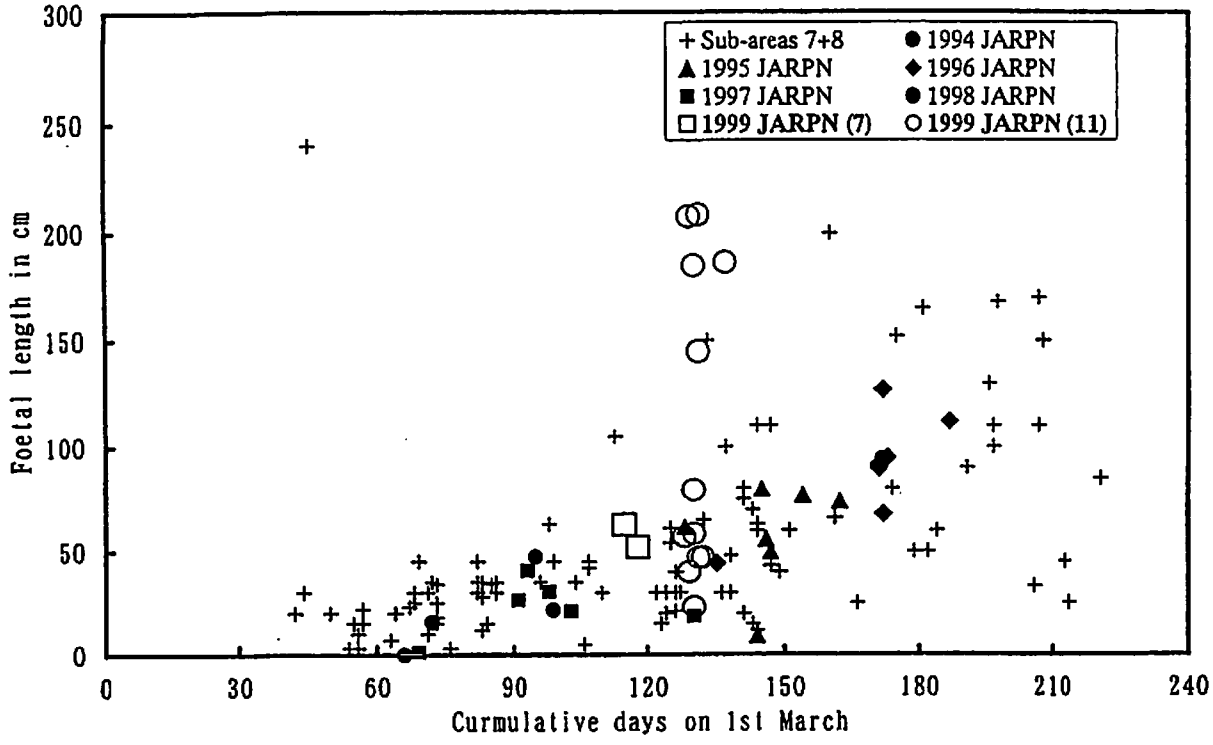


Fig. 10. Relationship between length of foetuses and sampling date in minke whales taken from sub-areas 7, 8, 9 and 11 where conducted the 1994-1996 JARPN surveys, and those from Pacific coast of northern Japan (Kato, 1992).