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Outline of the research activities of the Japanese Whale Research Program under Special Permit in the North Pacific (JARPN) from 1994 to 1999

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ABSTRACT

The JARPN survey began to elucidate the stock structure of western North Pacific minke whale in 1994. In 1996 a new objective related to elucidate the feeding ecology of minke whales, was added. A total of six surveys was conducted until 1999. This paper outline the research activities conducted under JARPN. A total of 498 minke whales was collected in these surveys. These samples covers sub-areas 7, 8, 9 and 11, which were planned for the surveys. The sampling also covered most of the migrating season (between middle May and early September). After compare the locations of sighting and sampling of minke whales, it seems that JARPN sampling reflects the distribution of minke whales in the area.

INTRODUCTION

The JARPN (the Japanese Whale Research Program under special Permit in the North Pacific) was planned in 1994 by the Government of Japan and the research started in the same year as a feasibility study (Government of Japan, 1994). The feasibility study continued in 1995 and the full research started in the 1996 season. Including the feasibility surveys a total of six JARPN surveys was conducted. Numerous data and samples are collected in the field with the objective to study the stock structure, feeding ecology and other questions related to environmental concerns.

At the 50th annual meeting of the Scientific Committee (SC) of the International Whaling Commission, the SC felt that it was necessary to carry out a comprehensive review of JARPN, especially on the sample size and survey methods, and the SC agreed

that such review should be planned for 2000 (IWC, 1999). At the 51 annual meeting, the review was confirmed to be carried out in 2000 (IWC, 1999).

In this paper, an outline of the research activities of the JARPN from 1994 to 1999, including sampling methodology and results, is described.

BACKGROUND

The western North Pacific minke whale (*Balaenoptera acutorostrata*) was one of whales that had been caught by the past small type coastal whaling in Japan. The commercial catch for this stock was suspended in 1987 by the moratorium adopted in the IWC.

In 1991, during the 43rd meeting, the Scientific Committee of the IWC (IWC/SC) conducted a comprehensive assessment of the North Pacific minke whale, and concluded that the abundance of the Okhotsk Sea stock (O stock) was 25,000 or more (IWC, 1992). In 1993, a working group was established and considered the application of the RMP for this stock. This Working Group concluded that there was a lack of information on stock structure. To compensate this lack of information, the Working Group established 13 sub-areas in the northwestern North Pacific (Fig. 1), three sub-stocks in the J stock and four sub-stocks in the O stock as well hypothesized the occurrence of a third stock (W) in the western North Pacific. The two-stock theory has been proposed previously for minke whales in areas around Japan (Omura & Sakiura, 1956; Ohsumi, 1983; Wada, 1991; Kato & Kasuya, 1992; IWC, 1992). On this controversy, the SC noted that it is desirable to obtain improved data on stock identity and migration pattern. The SC further noted that such information would reduce the range of plausible hypotheses which need to be considered for RMP implementation simulation trials (IWC, 1994).

RESEARCH OUTLINES

Details of the research activities in each cruise were already presented to the IWC/SC in several documents (Fujise *et al.*, 1995, 1996, 1997; Ishikawa *et al.*, 1997; Zenitani *et al.*, 1999). For the 1999 season a cruise report is presented at this meeting (Fujise *et al.*, 2000). A summary of the cruises and research activities of each JARPN surveys is shown in Table 1. Table 2 shows a summary of the sighting activities by the two or three sighting/sampling vessels (SSVs) while Table 3 is a summary of the sighting activities by the dedicated sighting vessel (SV). Table 4 is a summary of the sampling activities and

Table 5 summarizes the results of some experiments such as natural makings, biopsy sampling and oceanographical observations by XBT or XCTD.

1994 JARPN

Type of survey

This survey was conducted as a feasibility study

Survey area

The survey area was a part of sub-area 9 (north of 35°N, between 157°E and 170°E)

Aim of research

To obtain preliminary information on stock structure (using a variety of approaches such as DNA and isozyme, conception date, length and sex structure, morphometric, and pollutant and parasite) in an offshore sub-area from where no information nor biological samples were available.

Survey period

Mid summer, from 5 July to 7 September 1994.

Fleet

One research mother ship and two sighting/sampling vessels (SSVs).

Survey trackline (Fig. 2)

The survey course adopted the billiard method by means of fixed angle of reflection using the line transect method, which was similar to those in the feasibility studies of JARPA in 1987/88 season (Kato *et al.*, 1998, 1999). Furthermore, the special monitoring survey (SMS) was conducted in the area where the numbers of minke whales were expected to be large. Trackline in the SMS was designed to be independent from that of the original trackline. The SMS was conducted for four days.

Searching method

Searching was conducted under closing mode. Furthermore the survey under closing mode was further divided into two types of surveys (*BC and BS modes*) by taking into consideration weather and sea conditions mainly. The BC mode surveys was 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), and conducted at a speed of 11.5 knots from 30 minutes after sunrise to 30 minutes before sunset (or from 06:00 to 19:00), with two topmen assigned at the barrel. The BS mode survey was conducted under more critical weather conditions (i.e. poor visibility of less than 2 n.miles and wind speed of more than 4) although the sampling of whale was considered to be possible. These two survey modes were recorded separately for future analysis.

Sampling activity and result

The initial aim was to collect 100 animals. However, only 21 individuals were sampled in 65 days of survey. The reason was attributed first to abnormal weather condition in summer in that year (Fujise *et al.*, 1995). It was an exceptionally hot summer, causing serious water shortage throughout Japan. The rise of water temperature was observed in the seas surrounding Japan because the high atmospheric pressures in the Pacific developed larger than in ordinary years. The research area in the North Pacific was also affected by this anomalous climate.

1995 JARPN

Type of survey

Continuation of the 1994 feasibility study.

Survey area

Same as the 1994 survey, the sub-area 9.

Aim of research

To compensate small number of samples of minke whales collected in the sub-area 9 in the previous survey. The purpose of selecting the same sub-area was to increase the sample size and discuss annual fluctuations of population distribution in that area.

Survey period

Early summer, from 13 June to 22 August.

Fleet

Modified. An additional sighting/sampling vessel (SSVs) was incorporated into the research fleet. Then the research fleet was composed of one research mother ship and

three sighting/sampling vessels (SSVs).

Survey trackline (Fig. 3)

The survey was carried out in three periods. In each period a different method to establish survey courses, was employed. In the first period (13-30 June), the trackline was established as in the 1994 survey. In the second and third periods (1 July-6 August and 7-22 August, respectively), sub-areas were established within the research area, in which zigzag research course was established on an arbitrary basis, reflecting the sighting of minke whales and sea weather condition in the first period. Furthermore, during the survey in the second and third periods, the SMS was conducted in separate courses to emphasize on the east-west direction.

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

Searching method

Modified. The searching speed was changed from 11.5 to 10.5 knots. The number of topmen at the barrel was also changed from two to three men (Government of Japan, 1996; Fujise *et al.*, 1996).

Sampling activity and result

Modified partly. The sampling was made by three sighting/sampling vessels in this survey. Furthermore, sampling effort was applied outside the established research hours (06:00-19:00), if collection of whale samples was considered to be possible.

All of minke whales sighted on the trackline were approached for sampling. Unlike the case of 1994 survey season, the 1995 survey was blessed with favorable weather conditions, resulting in the catch of the planned 100 minke whales.

1996 JARPN

Type of survey

Full scale study.

Survey area

The survey targeted sub-areas 7 (7E and 7W), 8 and 11

Aim of research

Samples obtained in sub-area 9 in the 1994 and 1995 surveys were examined for mtDNA and isozyme, morphometry and pollutant accumulations. The results showed no evidence to support the occurrence of a hypothetical 'W' stock in sub-area 9. These results were consistent with the hypothesis that whales from sub-area 7 and 9 belong to the same stock (O stock). Thus the purpose of the 1996 survey was to address the question of sub-stock structure within the O stock instead of the 'W' stock hypothesis (Government of Japan, 1996).

Addition of objectives

The research plan for the 1996 JARPN incorporated a new objective related to the feeding ecology of the minke whales (Government of Japan, 1996). In the western North Pacific, dramatic changes of availability for pelagic fish stocks (from sardine to Pacific saury) occurred during 1980s and 1990s. These fish species are major food sources for minke whales. It was considered that interaction between minke whale and these fish species should be investigated. The information on feeding ecology is also important for the interpretation of results on pollutants, internal parasites and stable isotope analyses, because all of them are primarily originated in the whale's food. To meet such objective, a Norwegian scientist with experience in feeding ecology studies in the North Atlantic minke whale also participated in the 1996 surveys (Fujise *et al.*, 1997).

Survey period

Mid summer, from 7 July to 17 September 1996.

Fleet

Same as in the previous research. One research mother ship and three sighting/sampling vessels (SSVs) were used.

Survey trackline (Fig. 4)

The zigzag-shaped trackline was established on an arbitrary basis in each sub-area and research period, reflecting previous sighting information of minke whales and sea conditions. Furthermore, 'special monitoring survey (SMS)' was conducted in areas where the number of minke whales was expected to be large. Trackline in the SMS was

designed independently from the original trackline.

Searching method

Same as the previous JARPN survey.

Sampling activity and result

The sampling method was the same as in the previous research. All the minke whales sighted on the trackline were approached for the 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 composed of at least two animals, numbering was given to all individuals in the school, to set sampling order randomly in accordance with the table of random numbers. As in the previous JARPN survey, the sampling was made by the three sighting/sampling vessels.

A total of 171 minke whale schools (177 individuals) was sighted. 135 schools (137 individuals) were approached for sampling which resulted in the catch of 77 animals (63 males and 14 females) of the 100 planned. Number of sample were: 1 in sub-area7E, 30 in sub-area 7W, 16 in sub-area 8 and 30 in sub-area 11. Mature males were dominant in sub-areas 8 and 9. In the coastal sub-areas 7 and 11, mature females and immature animals of both sexes were present in a relatively high proportion.

1997 JARPN

Type of survey

Full scale study.

Survey area

The target sub-areas were sub-areas 7E, 8 and 9

Aim of research

In 1996 the Working Group meeting on implementation simulation trials for North Pacific minke whales was held and the meeting reviewed the results from studies using data and samples from the 1994 and 1995 JARPN surveys. The group agreed that these results were not conclusive because they were obtained from surveys conducted in the mid summer season and there was no information on the early migration season during April and May (IWC, 1997).

In response to these discussions, the 1997 JARPN survey was planned for the early

migration season (from May to early July) in sub-areas 7E, 8 and 9 (Government of Japan, 1997).

Survey period

Early migration season (from May to early July).

Fleet

A dedicated sighting vessel (SV) was added to the research fleet. Thus the fleet in 1997 was composed of one research mother ship, three sighting/sampling vessels (SSVs) and one dedicated sighting vessel (SV).

Survey trackline (Fig. 5)

At the beginning of this survey, the setting method of the trackline was similar to those in the previous surveys. However, most of these survey areas were found to be covered with the colder water below to 12 or 13 degree C, in where minke whales were known to be not abundant, from the results of previous JARPN surveys. As a result, setting methods was changed from those of the previous surveys. Trackline of the SSVs was designed to target the areas where density of minke whale should be high from the basis of data on surface water temperatures obtained from the latest chart reported by the Japan Fisheries Information Service Center. Furthermore, the SMS was designed as in the previous survey. As the survey by the SSVs did not cover the entire survey area, the dedicated sighting vessel (SV) surveyed the entire area in order to cover the areas not covered by the SSV.

Searching method

Similar to those in the previous JARPN surveys, with some changes especially in the SMS. In the SMS the survey was conducted as soon as possible in case minke whales were concentrated within a limited area.

Sampling activity and result

A total of 12,155.5 n.miles was searched by the SSVs and 149 individual minke whales were sighted. From these 144 minke whales were targeted and 100 individuals were sampled. Number of samples was: 2 in sub-area7E, 31 in sub-area 8 and 67 in sub-area 9.

In this survey large number of mature males were collected. However, it was also noted that considerable number of immature and females were collected in the sub-area 9 in the early summer.

The main food for minke whales was also different. Previous JARPN surveys suggested that Pacific saury was the main food species. However, in the1997 JARPN the main prey species was the Japanese anchovy.

1998 JARPN

Type of survey

Full scale study.

Survey area

The survey targeted sub-areas 7E, 8 and 11

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 the sub-area 11, which was originally planned for the latter half of the research period, was postponed and emphasis was put on securing samples in the sub-area 7E and western part of the sub-area 8.

Aim of research

In response to the comments of the Working Group meeting in 1996 (Government of Japan, 1997; IWC, 1997), the 1998 survey targeted the early migration season (from May to June) in sub-areas 7E and 8. Another reason was that the number of samples obtained through the previous surveys was only 3 in the sub-area 7E and 7 in western part of the sub-area 8. The survey was also designed to cover sub-area 11 in July, when number of previous samples was not sufficient to examine the mixing of J and O stocks animals.

Survey period

The early migration season (May to June) was targeted. Actually, the survey was conducted from 26 April to 21 June 1998.

Fleet

Same as in the previous survey. One research mother ship, three sighting/sampling vessels (SSVs) and one dedicated sighting vessel (SV) were used.

Survey trackline (Fig. 6)

Three types of sighting and sampling surveys were conducted in the 1998 JARPN: pre-survey, main survey and the SMS. **Pre-survey**: since most of the minke whales were sighted in the area with a surface temperature ranging from 12°C to 13°C in the previous

surveys, the pre-survey was conducted to obtain the information on water temperature and minke whales distribution in May at 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. Such trackline was designed by taking into consideration the information derived from the sighting of minke whales and surface temperature obtained by the SV, which worked in an earlier period. **Main survey**: the zigzag-shaped trackline was established from north to south which included sub-area 7E and the western part of the sub-area 8 (to 153°30'E). **The SMS:** the SMS was conducted in the area where the sightings of minke whales were expected to be high on the basis of accumulated information from the pre-survey and the main survey. The trackline in the SMS was designed to be different from the trackline in the pre-survey and the main survey.

Searching method

Same as in the previous JARPN research.

Sampling activity and result

In total, 4,944.5 n.miles was searched by the three SSVs and 155 schools/165 minke whales were sighted during the survey. Of these whales, 126 animals (from 119 schools) were targeted for sampling. As a result the planned 100 minke whales were sampled. Number of samples were: 56 in the sub-area 7E and 44 in the sub-areas 8 (west).

Analysis of samples showed that mature males were dominant and few immature animals and mature females were distributed in sub-areas 7E and 8. The peak of body length frequency for male was 7.6m in both sub-areas and the body length distributions in the 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.

1999 JARPN

Type of survey

Full scale study

Survey area

The 1999 JARPN survey was conducted in sub-areas 7 and 11 during June and July (Government of Japan, 1998, 1999; Fujise *et al.*, 2000) .

Aim of research

These sub-areas had not been covered by previous JARPN surveys or commercial operations in those months. Originally, the survey in the sub-area 11 was planned in the 1998, but it was postponed.

Survey period

The survey was conducted during June and July (Government of Japan, 1998). The 1999 JARPN survey started on 19 June in sub-area 7W and ended the survey in this area on 3 July 1999. Then, the research fleet moved to sub-area 11 resuming the sampling activities on 6 July 1999. The survey finished on 15 July 1999.

Fleet

Same as in the previous research. One research mother ship, three sighting/sampling vessels (SSVs) and one dedicated sighting vessel (SV) were used.

Survey trackline (Fig. 7)

Same as in the previous 1996 JARPN survey. In sub-area 7W it was expected that most of minke whales was moved to the northern part of this sub-area. Thus, the research effort was concentrated in this part (40°N or north) of the research area.

Searching method

In this survey the name of the searching modes changed from BC mode to NSC mode, and from BS mode to NSS mode. Furthermore BC mode survey after sampling within a day was called as ASP mode survey. However the content of the research activities was not changed.

Sampling activity and result

A total of 2,571.2 n.miles for the searching was covered and a total of 176 minke whales (165 schools) was sighted. As planned, 50 individuals were collected in each sub-area (sub-area 7W and sub-area 11). Thus a total of 100 minke whales was collected.

Composition of sex and maturity of the collected samples in these sub-areas was similar to those of the previous 1996 JARPN survey, which was conducted one month earlier than the present survey. In the western half of the sub-area 11, remarkable segregation by sex and maturity of minke whales was observed. Females, especially pregnant females, were dominant in sub-area 11 (west of the Kitami Yamato Bank). In contrast, in the eastern half of the sub-area 11 (east of Kitami Yamato Bank), mature

males were dominantly distributed. Furthermore, based on foetal growth curves, it was suggested that females distributing in the western half of sub-area 11, belong to a different breeding stocks.

OUTLINES OF SAMPLING METHOD AND SAMPING RESULTS

Methods of sampling adopted in the JARPN survey were established during the first two feasibility surveys as follows:

1994 JARPN

At the beginning of the research, sampling method of whale was also similar to those of the JARPA survey in the Antarctic, in which only the primary sighting are targeted. For schools of at least two animals, numbering was given to all the minke whales in the school and sampling was conducted for order randomly in accordance with the table of random numbers (Kato *et al.*, 1989).

However, the target of school was expanded from primary sighting to all sightings (primary and secondary sightings) after 22 July 1994, because distribution pattern of minke whales was different from those in the Antarctic. In this area, whales tend to be spread extensively, and consisted by singleton. Furthermore no concentration area for minke whales, was observed.

1995JARPN

It was necessary to implement the research in a more flexible way, giving due consideration to the actual situation. For example, the area of water temperature where minke whales cannot be expected to be distributed was excluded. This area would be set at 15 degree C or more based upon the previous survey. Alternatively, after a whole area sighting survey, specified research area would be chosen based on the density of animals and other information such as water temperature. Thus research effort would be concentrated to take animals within the specified areas. This is necessary to increase the rate at which animals can be taken so as to meet the goals of the feasibility study (Government of Japan, 1995).

Sampling results

Table 6 shows the sampling results and their efficiencies in each of the JARPN surveys. A total of 875 animals was sighted. Out of them, sampling effort was focussed for 742

animals and 498 individuals were collected (Figs. 8 and 9). The total technical efficiency (samples per targeted) was 0.67 and the true efficiency was 0.57. It seems that these efficiencies were almost equal among sub-areas although relative lower efficiencies were observed for the true efficiency in sub-area 11. Comparing the locations of sightings and samples (Figs. 10-21) we can say that the sampling was almost conducted evenly and samples seems to be reflect to, at least in some extent, the true distribution of the animals.

DISCUSSION

The JARPN survey was aimed to elucidate the stock structure of western North Pacific minke whale in 1994. In addition, a new objective was adopted in the 1996 plan. This was to elucidate the feeding ecology of minke whales in response to a need for ecosystem survey in Japan, especially in light of the competition between whales and human activities. After then, the research continued to 1999 season.

A total of 498 minke whales was collected. These samples cover sub-areas 7, 8, 9 and 11, which were planned. The sampling also covered most of the migration season (between middle May and early September). Furthermore, these samples seem to reflect to the distribution of minke whales as derived from a comparison between the locations of sightings and sampling.

However it is still remained the problem on the lack of samples from sub-area 12, which has been suggested as one of the major feeding grounds for the minke whale. Sexual composition of the samples was biased to male. This male-biased sample might make difficult the interpretation of stock structure.

If samples from sub-area 12 are obtained, their analyses will contribute to further interpret the hypothesis of the W-stock from the view point of the migration pattern and segregation of O-stock minke whales. Furthermore it will be possible to estimate the mixing rate of O and J stocks in this sub-area. This information would contribute greatly to the management to these stocks.

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REFERENCES

Fujise, Y., Kishiro, T., Zenitani, R., Matsuoka, K., Kawasaki, M. and Shimamoto, K. 1995. Cruise report of the Japanese Whale Research Program under a Special Permit for North Pacific Minke Whales in 1994. Paper SC/47/NP3 presented to the IWC Scientific Committee, May 1995 (unpublished). 29pp.

Fujise, Y., Iwasaki, T., Zenitani, R., Araki, J., Matsuoka, K., Tamura, T., Aono, S., Yoshida, T., Hidaka, H., Nibe, T. and Tohyama, D. 1996. Cruise report of the Japanese Whale Research Program under a Special Permit for North Pacific minke whales in 1995 with the results of a preliminary analysis of data collected. Paper SC/48/NP13 presented to the IWC Scientific Committee, June 1996 (unpublished). 39pp.

Fujise, Y., Shimada, H., Zenitani, R., Goto, M., Tamura, T., Lindstrøm, U., Uchida, A., Yoshida, H., Shimamoto, K., Yuzu, S., Kasai, H., Kinoshita, T., Iwata, T. and Toyama, D. 1997. Cruise report of the Japanese Whale Research Program under a Special Permit in the North Pacific (JARPN) in 1996 with some preliminary analysis of data collected during the 1994-1996 JARPN surveys. Paper SC/49/NP8 presented to the IWC Scientific Committee, September 1997 (unpublished). 38pp.

Fujise, Y., Zenitani, R., Tamura, T., Bando, T., Ohtani, S., Takeda, S., Kitajima, A., Kimura, T., Masaki, T. Tohyama, D. 2000. Cruise Report of the Japanese Whale Research Program under Special Permit in the North Pacific (JARPN) in 1999. Paper will be presented to this meeting.

Government of Japan. 1994. Reconsideration of the 1994 Japanese research program for clarification of minke whale stock-structure in the northwestern part of the North Pacific. Circular Communication to Members of the Scientific Committee (Ref. RG/VJH/25352) (unpublished). 6pp.

Government of Japan. 1995. The 1995 research plan for the Japanese Whale Research Program under Special Permit in the Northwestern part of the North Pacific - continuation of the feasibility study -. Paper SC/47/NP1 presented to the IWC Scientific Committee, May 1995 (unpublished). 8pp. + Appendix 13pp.

Government of Japan. 1996. The 1996 and 1997 research plan for the Japanese Whale Research Program to elucidate the stock structure of the minke whale in the northwestern part of the North Pacific. Paper SC/48/NP1 presented to the IWC Scientific Committee, June 1996 (unpublished). 14pp.

Government of Japan. 1997. Implementation of the 1996 research and minor modifications for the 1997 plan of the Japanese Whale Research Program under Special Permit in the North Pacific (JARPN). Circular Communication to Members of the Scientific Committee (Ref. RG/JAC/26700) (unpublished). 4pp.

Government of Japan. 1997. The 1998 research plan for the Japanese Whale Research Program under Special Permit in the Northwestern part of the North Pacific (JARPN). Paper SC/49/NP1 presented to the IWC Scientific Committee, September 1997 (unpublished). 5pp.

Government of Japan. 1998. The 1999 research plan for the Japanese Whale Research Program under Special Permit in the Northwestern part of the North Pacific (JARPN). Paper SC/50/O2 presented to the IWC Scientific Committee, April 1998 (unpublished). 3pp.

International Whaling Commission. 1992. Report of the Scientific Committee, Annex F. Report of the sub-committee on North Pacific Minke whales *Rep. Int. Whal. Commn.* 42:156-177.

International Whaling Commission, 1994. Report of the working group on North Pacific minke whale management trials. *Rep. int. Whal. Commn* 44:120-44.

International Whaling Commission, 1997. Report of the North Pacific minke whale trials. Rep. int. Whal. Commn 47:203-26.

Ishikawa, H., Yuzu, S., Shimamoto, K., Bando, T., Ohshima, K., Kasai, H., Kinoshita, T., Mizushima, Y., Iwakami, H., Nibe, T., Hosoyama, T., Kuramochi, T., Numano, K. and Miyamoto, M. 1997. Cruise report of the Japanese Whale Research Program under a Special Permit in the North Pacific (JARPN) in 1997. Paper SC/49/NP9 presented to the IWC Scientific Committee, September 1997 (unpublished). 28pp.

Kato, H., Hiroyama, H., Fujise, Y. and Ono, K. 1989. Preliminary report of the 1987/88 Japanese feasibility study of the special permit proposal for Southern Hemisphere minke whales. *Rep. int. Whal. Commn* 39:235-48.

Kato, H. and Kasuya, T. 1992. Report of the Sub-committee on North Pacific minke whales. Appendix 6. Boundaries of minke whale stocks in the western North Pacific: an interpretation of avail-able data. *Rep. int. Whal Commn* 42:167.

Ohsumi, S. 1983. Minke whales in the coastal waters of Japan in 1981, with special reference to their stock boundary. *Rep. int. Whal. Commn* 33:365-71.

Omura, H. and Sakiura, H. 1956. Studies on the little piked whale from the coast of Japan. *Sci. Rep. Whales Res. Inst., Tokyo* 11:1-37.

Wada, S. 1991. Genetic heterogeneity in the Okhotsk Sea-west Pacific stock of minke whales. Paper SC/43/Mi32 presented to the IWC Scientific Committee, May 1991

(unpublished) 17pp.

Zenitani, R., Fujise, Y., Matsuoka, K., Tamura, T., Bando, T., Ichihashi, H., Shimokawa, T., Krasnenko, A.S., Taguchi F., Kinoshita, T., Mori, M., Watanabe, M., Ichinomiya, D., Nakamura, M., Sakai, K., Matsuzaka, K., Kamei, H. and Tohyama, D. 1999. Cruise report of the Japanese Whale Research Program under a Special Permit in the North Pacific in 1998. Paper SC/51/RMP7 presented to the IWC Scientific Committee, May 1999 (unpublished). 20pp.

Table 1. Summary of the JARPN researches from 1994 to 1999.

Year	Research type	Research sub-area	Research base ship / Sighting/Sampling vessels	Cruise period	Survey period	Number of crew
1994	Feasibility	9	NM	1994/6/30−9/12	1994/7/5−9/7	117
			T18/T25	1994/6/29−9/14	1994/7/5−9/7	
1995	Feasibility	9	NM	1995/6/9−8/22	1995/6/13−8/16	151
			K01/T18/T25	1995/6/9−8/29	1995/6/13−8/22	
1996	Full-scale	7E·7W·8·11	NM	1996/7/5−9/17	1996/7/7−9/13	168
			K01/T18/T25	1996/7/5−9/18	1996/7/7−9/13	
1997	Full-scale	7E·8·9	NM	1997/5/1−7/18	1997/5/6−7/14	169+21
			K01/T18/T25	1997/5/1−7/19	1997/5/6−7/14	
			KS2 *	1997/5/9−7/11	1997/5/15−7/8	
1998	Full-scale	7E·8	NM	1998/5/1−6/17	1998/5/2−6/13	169+21
			K01/T18/T25	1998/5/1−6/19	1998/5/2−6/15	
			KS2 *	1998/4/24−(6/30)	1998/4/26−6/21	
1999	Full-scale	7W·11·(7E)	NM	1999/6/15−7/20	1999/6/18−7/15	161+21
			YS1/K01/T25	1999/6/15−7/19	1999/6/18−7/15	
			KS2 *	1999/6/8−7/26	1999/6/9−7/23	

*: dedicated sighitng vessel

Table 2. Summary of sighting survey by the three sighting/sampling vessels (SSVs) in JARPN surveys.

Year	Number of Topmen	Survey sub-area	Survey period in each sub-area *	Searching distances (n.miles)		Sighting survey during transit from/to home port
1994	2	9	1994/7/5−8/6(F), 8/7−9/7(S)	7,926.6	7,926.6	1994/7/1−4 1994/9/8−11
1995	3	9	1995/6/13−30(F), 7/1−8/6(S), 8/7−16(T)	13,274.3	13,274.3	1995/6/9−12 1995/8/23−28
1996	3	7E	1996/7/7−12(F), 7/13−15(S), 9/6−7(T)	2,101.5	11,168.0	1996/9/14
		7W	1996/8/24−9/4(F) 9/4−5(S)	2,091.1		
		8	1996/7/16−8/7(F) 8/7−13(S), 9/8−13(T)	5,742.3		
		11	1996/8/15−22(F)	1,233.1		
1997	3	7E	1997/6/22−27	930.5	12,098.8	1997/5/2−5
		8	1997/6/28−7/14	2,886.6		
		9	1997/5/6−6/19	8,281.7		1997/7/15−16
1998	3	7E	1998/5/2−16, 5/19−24	2891.5	4875.9	1998/6/15−18
		8	1998/5/17−18, 5/25−14	1984.4		
1999	3	7W	1999/6/19−7/3	1,433.6	2,361.6	1999/6/16−17
		11	1999/7/6−15	928.0		

*: (F): First period, (S): Second period, (T): Third period

Table 3. Summary of sighting survey by the dedicated sighting vessel (SV) in JARPN surveys.

Year	Ship	Survey area	Sighting survey	Searching distances (n.miles)		
1994	—	—	—	—	—	Not conducted
1995	—	—	—	—	—	Not conducted
1996	—	—	—	—	—	Not conducted
1997	KS2	7E	—	—	3,310.1	
		8	1997/7/1−7/8	326.3		
		9	1997/5/15−7/1	2,983.8		
1998	KS2	7E	1998/4/26−5/16	1,136.6	2,640.2	
		8	1998/5/17−6/21	1,503.6		
1999	KS2	7W	1999/6/9−6/29	1,031.7	1,887.8	
		11	1999/7/3−7/16	595.2		
		7E	1999/7/21−7/23	260.9		

Table 4. Summary of sampling activities by the three sighting/sampling vessels (SSVs) and research base ship in JARPN surveys.

Year	Sightings of minke whales (Sch./Ind.)	Samples of minke whales	Survey area	Sex		Items for biological survey
				male	female	
1994	45/46	21	9	18	3	47
1995	144/151	100	9	91	9	49
1996	171/177	77	7E	-	1	45
			7W	28	2	
			8	16	-	
			11	19	11	
1997	143/149	100	7E	2	-	47
			8	30	1	
			9	55	12	
1998	155/165	100	7E	49	7	48
			8	40	4	
1999	176/187	100	7W	43	7	54
			11	28	22	

Table 5. Summary of some experiments and observations in the JARPN surveys

Year	Photographic records for natural marks (Sch/Ind)			Biopsy skin samples		Biopsy samples by trial for minke whale	Oceanographcal observations	
	B	H	R	H	F		XBT	XCTD
1994	3/3	1/1	1/2	—	—	—	58	-
1995	6/14	3/5	1/1	—	—	3	58	-
1996	1/1	2/3		—	—	2	64	-
1997	5/5	5/6	1/1	1	1	—	63	-
1998	1/2	3/3	3/5	—	—	—	-	51
1999		1/1		1	—	2	-	42

B: blue whale, H: humpback whale, R: right whale, F: fin whale

Table 6. Numbers of minke whales sighted, targeted, sampled, and their sampling efficiencies.

Sub-area	Year	Sighted	Targeted	Sampled	Sampling efficiency	
		Sch. / Ind. (A) (B)	Sch. / Ind. (C) (D)	Ind. (E)	Technical (E/D)	True (E/B)
7	1996	1 / 1	1 / 1	1	1.00	1.00
	1997	2 / 2	2 / 2	2	1.00	1.00
	1998	94 / 100	64 / 67	56	0.84	0.56
	1996	67 / 68	59 / 59	30	0.51	0.44
	1999	77 / 82	66 / 71	50	0.70	0.61
	Total	241 / 253	192 / 200	139	0.70	0.55
8	1996	33 / 33	31 / 31	16	0.52	0.48
	1997	49 / 51	? / 46	31	0.67	0.61
	1998	61 / 65	55 / 59	44	0.75	0.68
	Total	143 / 149	86+ / 136	91	0.67	0.61
9	1994	45 / 46	42 / 43	21	0.49	0.46
	1995	144 / 151	131 / 138	100	0.72	0.66
	1997	92 / 96	92 / 96	67	0.70	0.70
	Total	281 / 293	265 / 277	188	0.68	0.64
11	1996	70 / 75	44 / 46	30	0.65	0.40
	1999	99 / 105	77 / 83	50	0.60	0.48
	Total	169 / 180	121 / 129	80	0.62	0.44

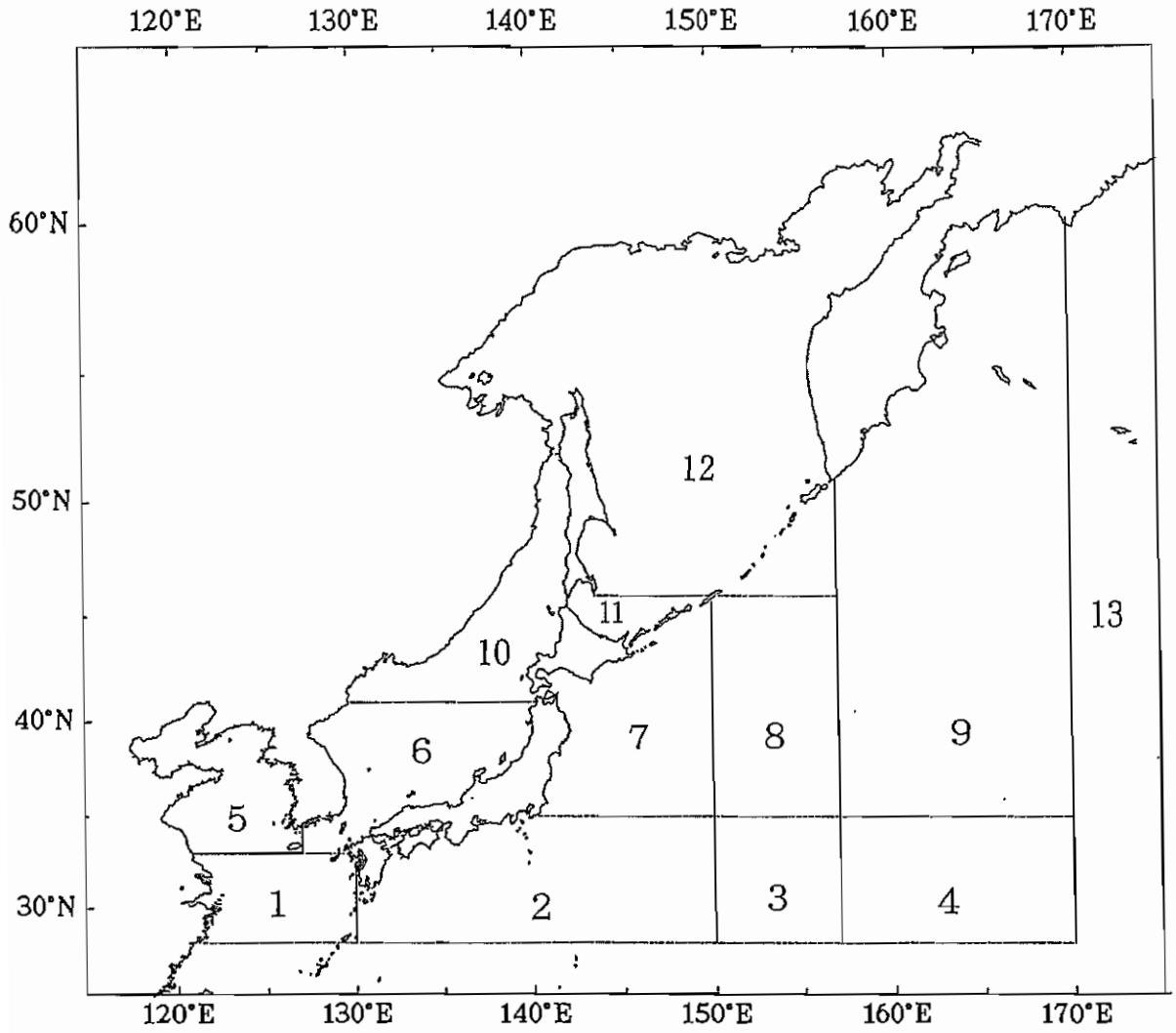


Fig.1. 13 sub-areas

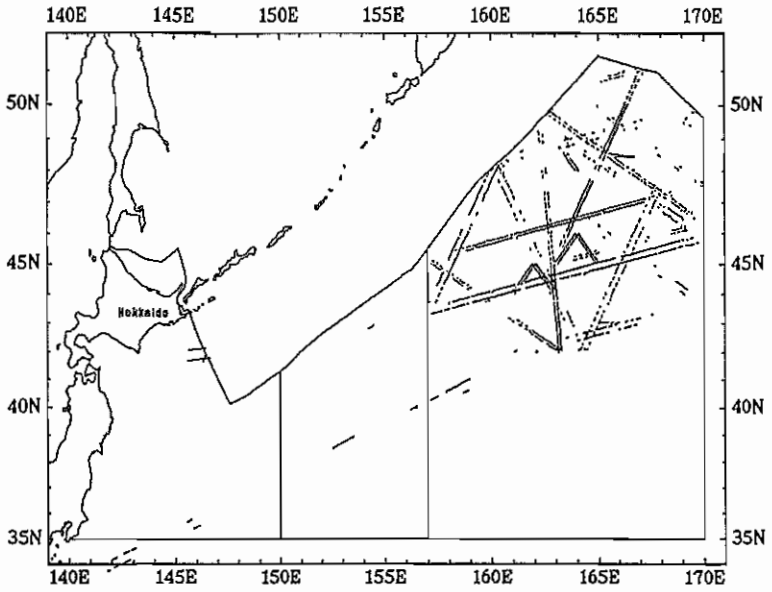


Fig.2. Cruise tracks of the two sighting/sampling vessels (T25 and T18) during the 1994 JARPN survey.

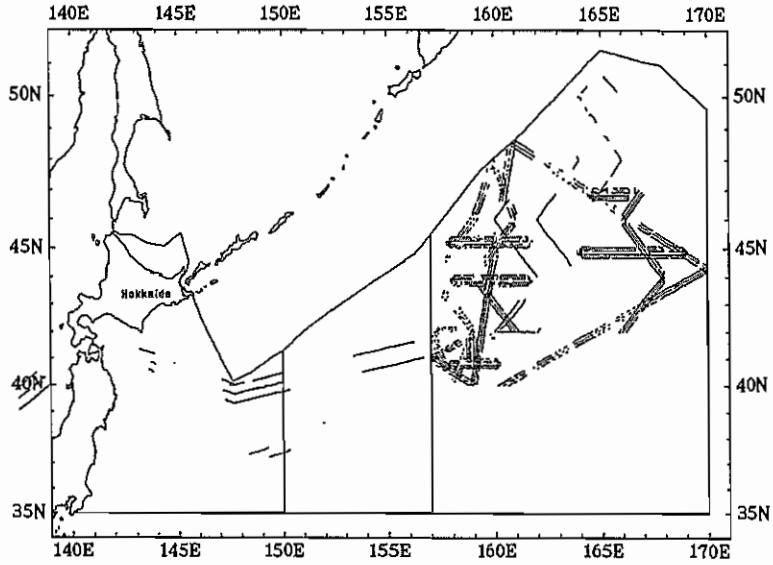


Fig.3. Cruise tracks of the three sighting/sampling vessels (K01, T25 and T18) during the 1995 JARPN survey.

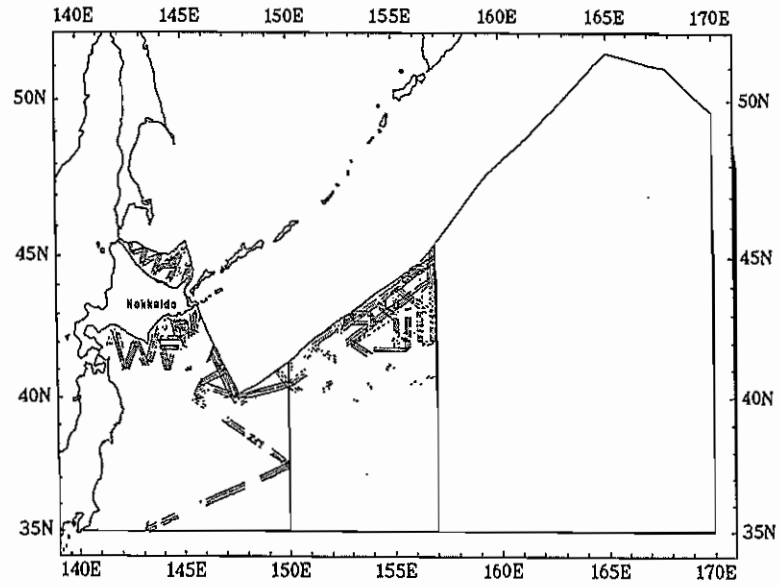


Fig.4. Cruise tracks of the three sighting/sampling vessels during the 1996 JARPN survey.

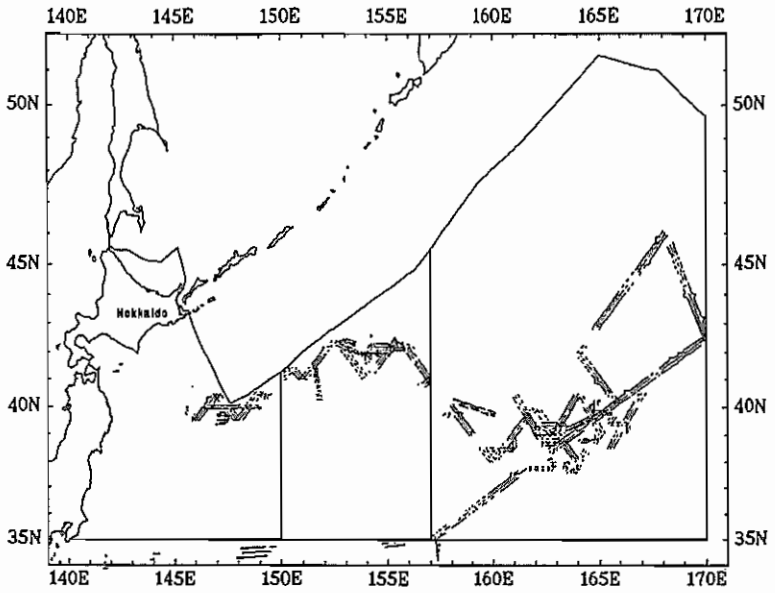


Fig.5. Cruise tracks of the three sighting/sampling vessels during the 1997 JARPN survey.

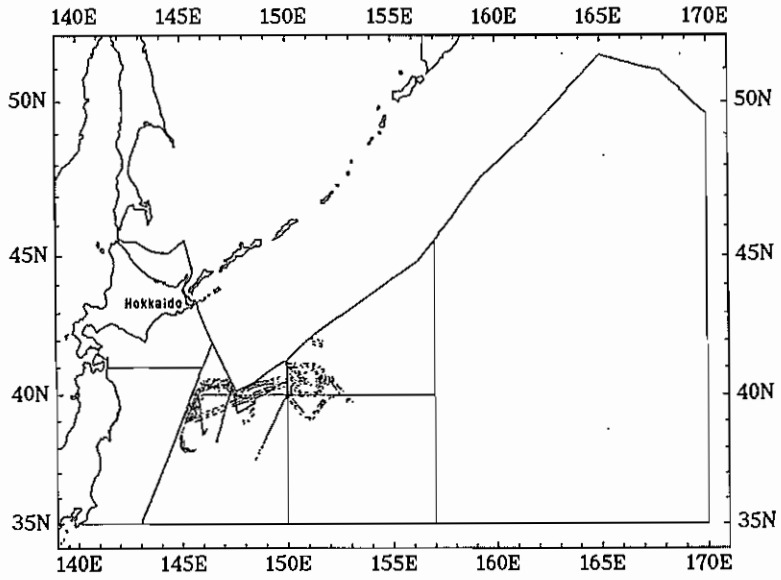


Fig.6. Cruise tracks of the three sighting/sampling vessels during the 1998 JARPN survey.

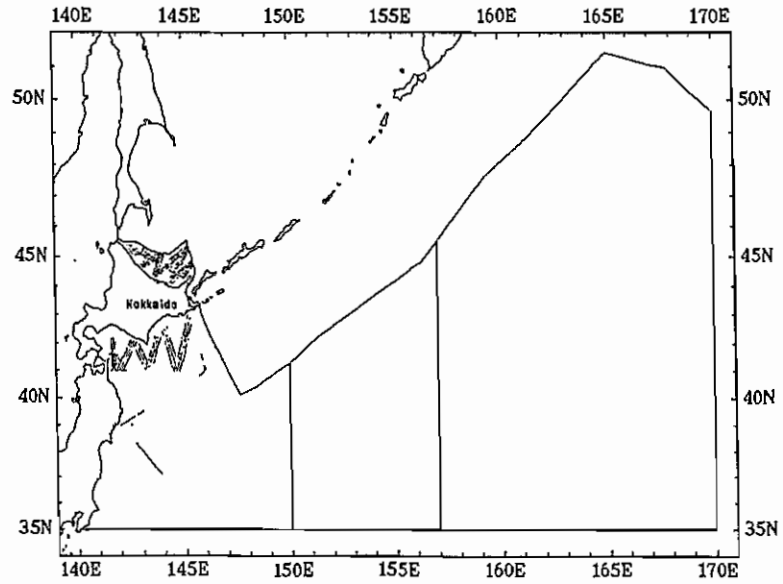


Fig.7. Cruise tracks of the three sighting/sampling vessels during the 1999 JARPN survey.

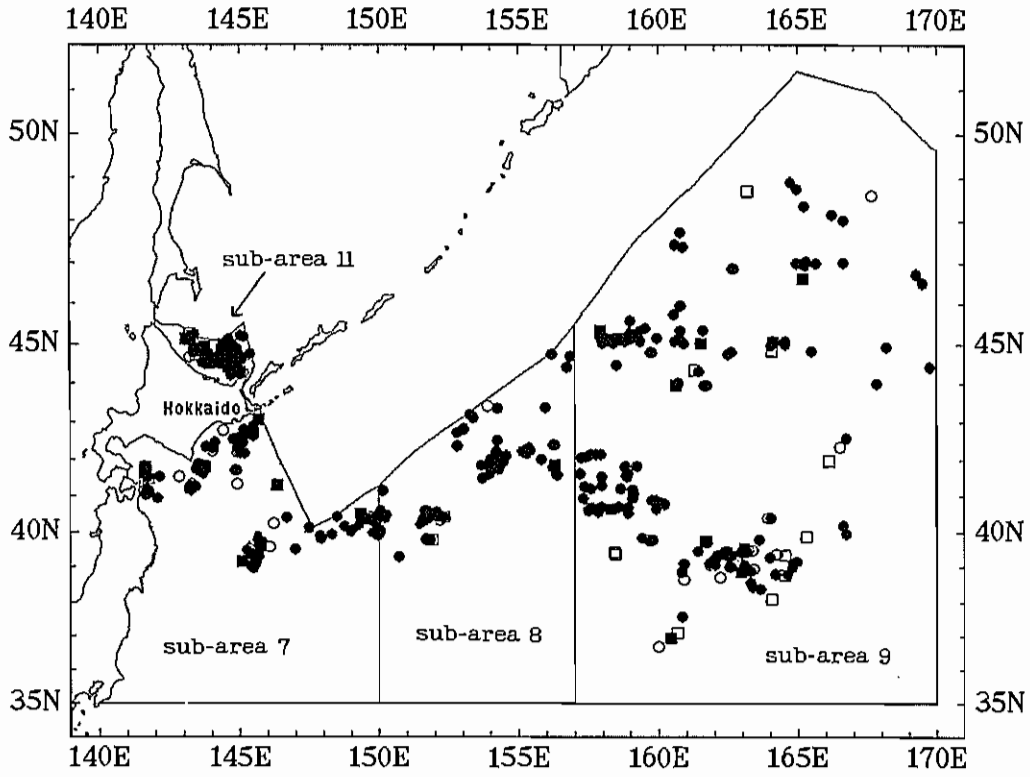


Fig.8. Distribution of minke whales sampled collected during the 1994-1999 JARPN surveys.

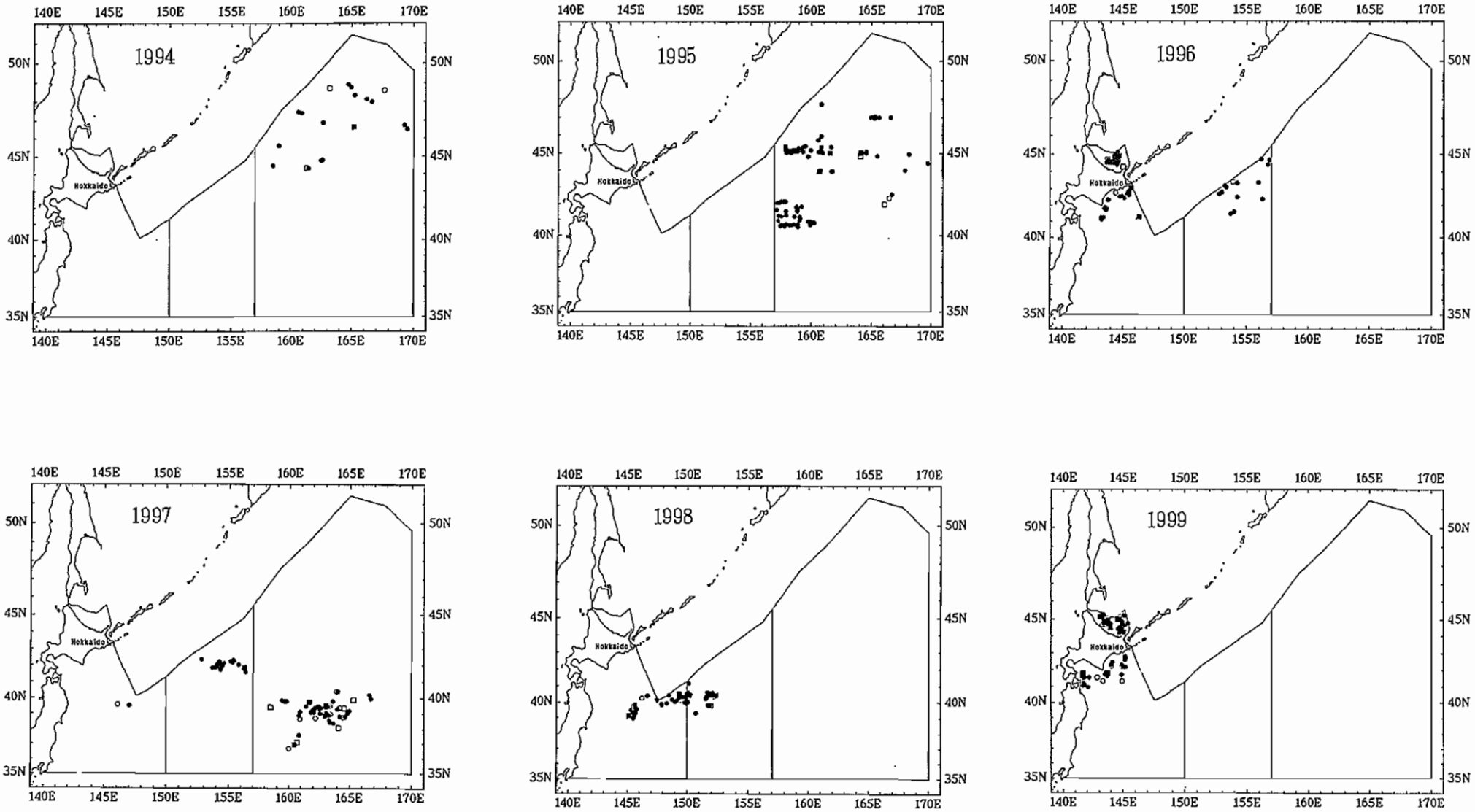


Fig.9. Geographical distribution of whale samples in each survey year

1994 JARPN
(sub-area 9)

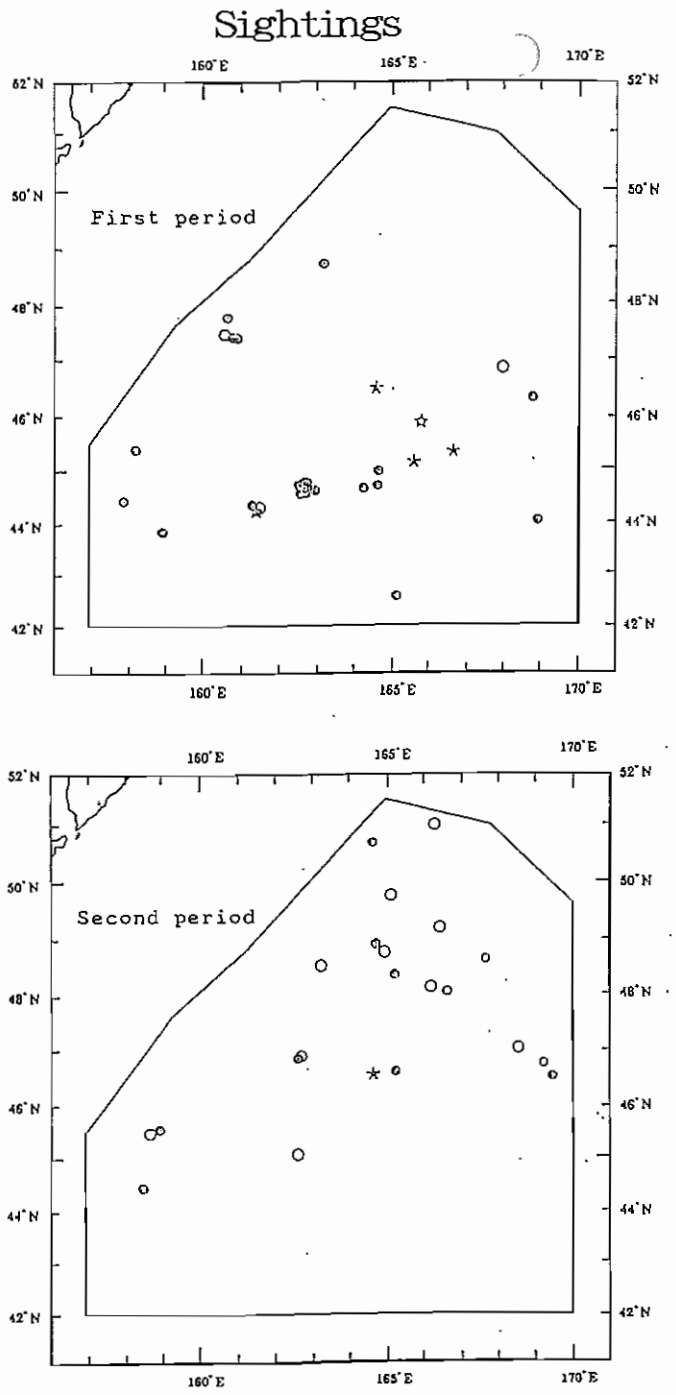


Fig.10. Distribution of minke whale by two sampling and sighting vessels.
Minke whale: ⊙primary, ○secondary; Like minke whale: ☆primary, ☆secondary.

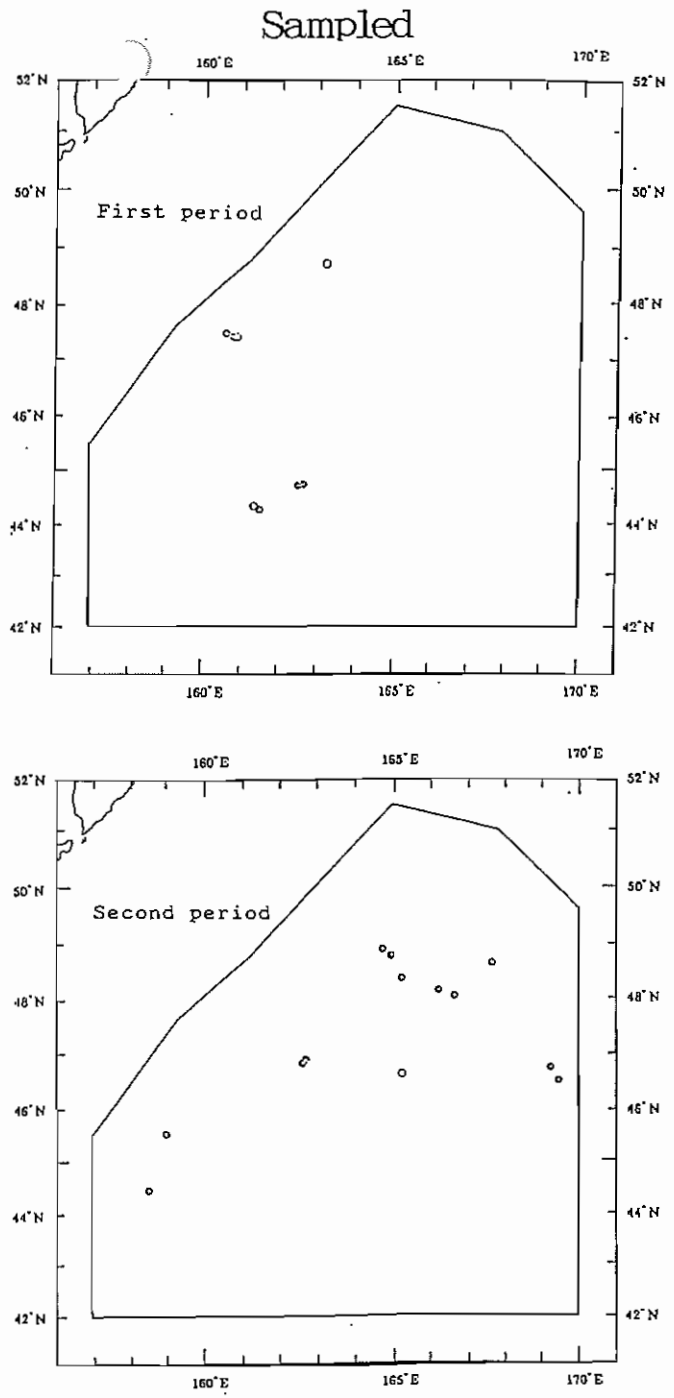
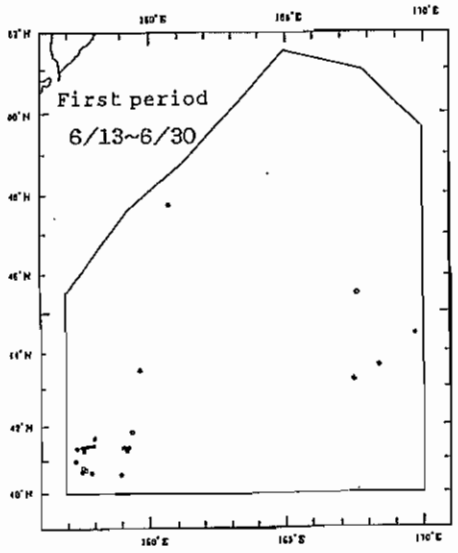


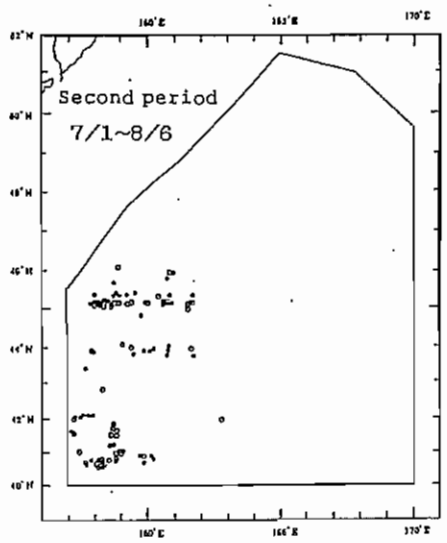
Fig.11. Distribution of sampled minke whales based on their sighting position. ⊙: Male; ○: Female.

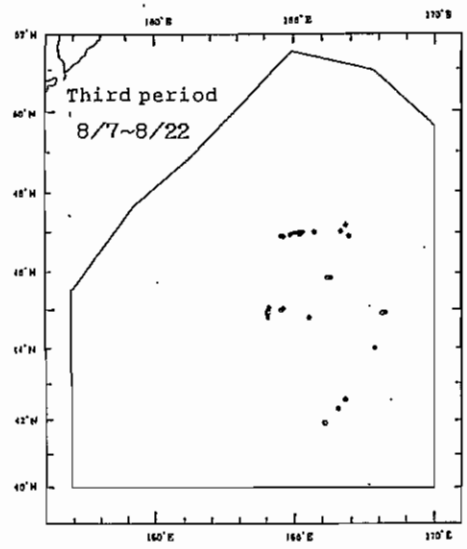
After Fujise *et al.*, 1995

1995 JARPN
(sub-area 9)

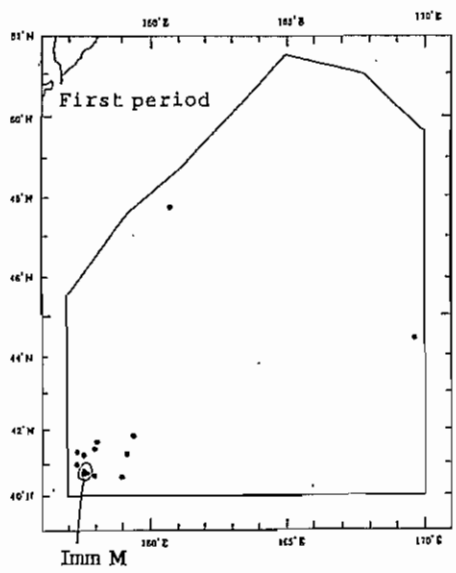
Sightings

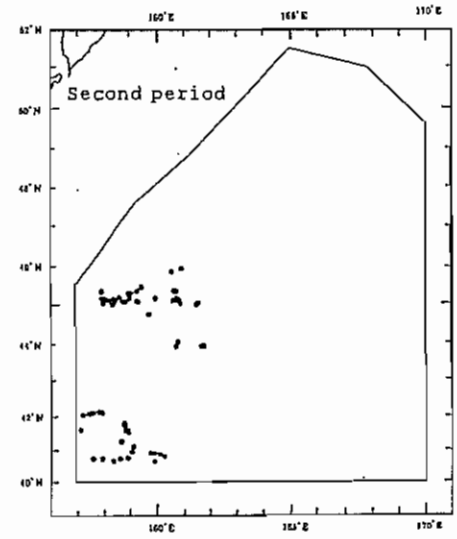


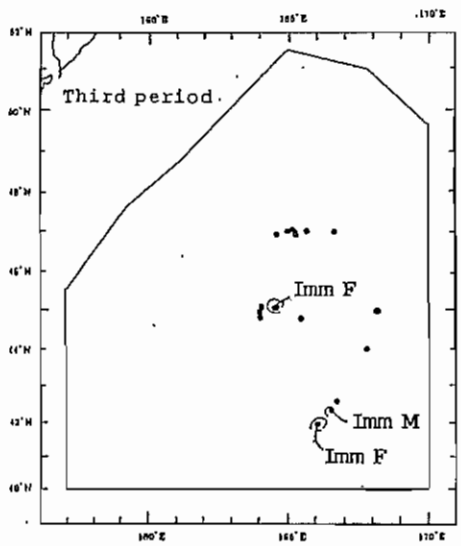




Sampled







Left column

Fig.12. Distribution of minke whales sighted by three sampling/sighting vessels during the 1995 JARPN. Confirmed minke whale: ● primary, ○ secondary; like minke whale: ✻ primary, ☆ secondary.

Right column

Fig.13. Distribution of minke whales sampled during the 1995 JARPN, based on their sighting position.

After Fujise *et al.*, 1996

1996 JARPN
(sub-areas 7W,7E,8 and 11)

Sightings

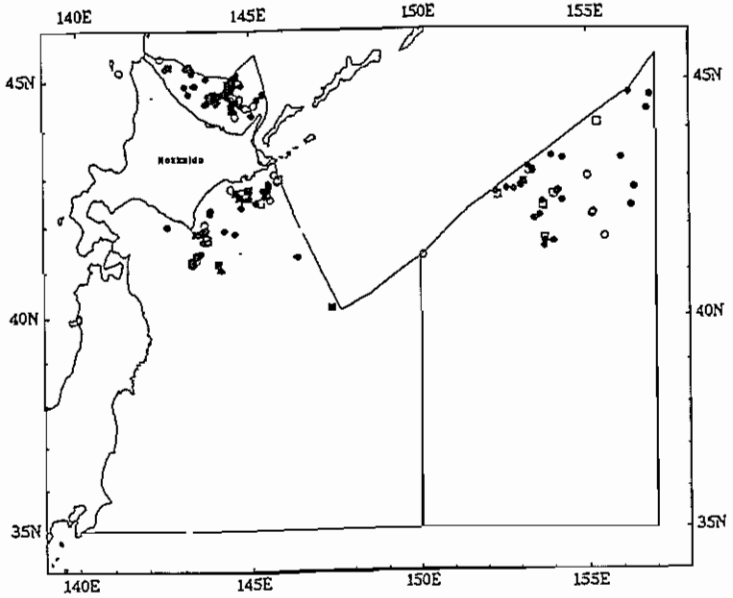


Fig.14. Distribution of minke whales sighted by three sighting/sampling vessels during the 1996 JARPN survey. Minke whale : ● primary, ○ secondary; 'like minke whale': ■ primary, □ secondary.

Sampled

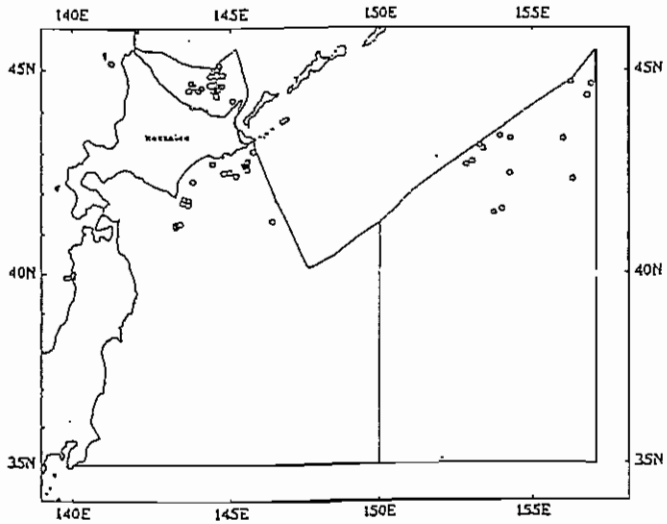


Fig.15. Distribution of minke whales sampled in the 1996 JARPN survey, based on their sighting position.

After Fujise *et al.*, 1997

Sightings

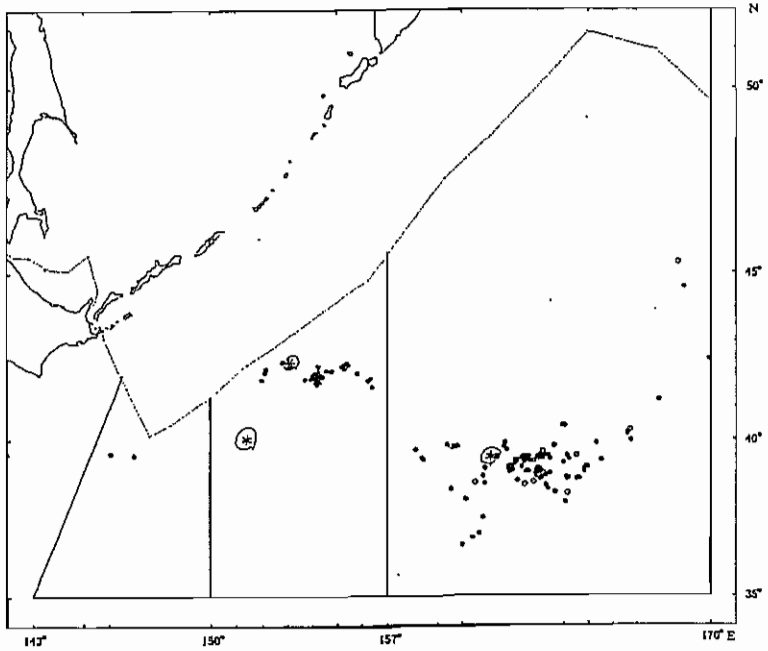


Fig.16. Distribution of the sighting of minke whale (closed circle) and like minke whale (open circle). Asterisks represent sightings of a dedicated sighting vessel.

Sampled

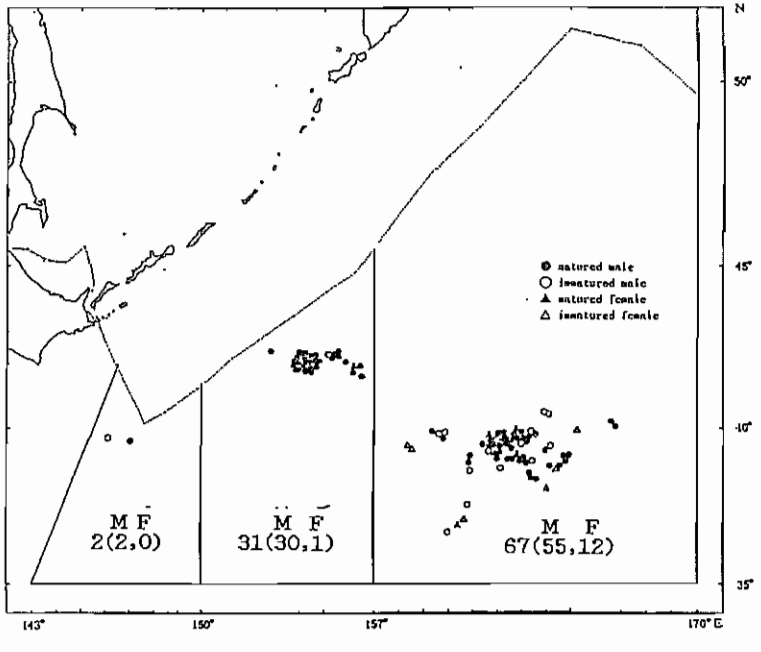


Fig.17. Distribution of sampled minke whales by sex and reproductive status. Maturity of male was tentatively classified by the weight of testis.

After Ishikawa *et al.*, 1997

1998 JARPN
(sub-areas 7E and 8(west))

Sightings

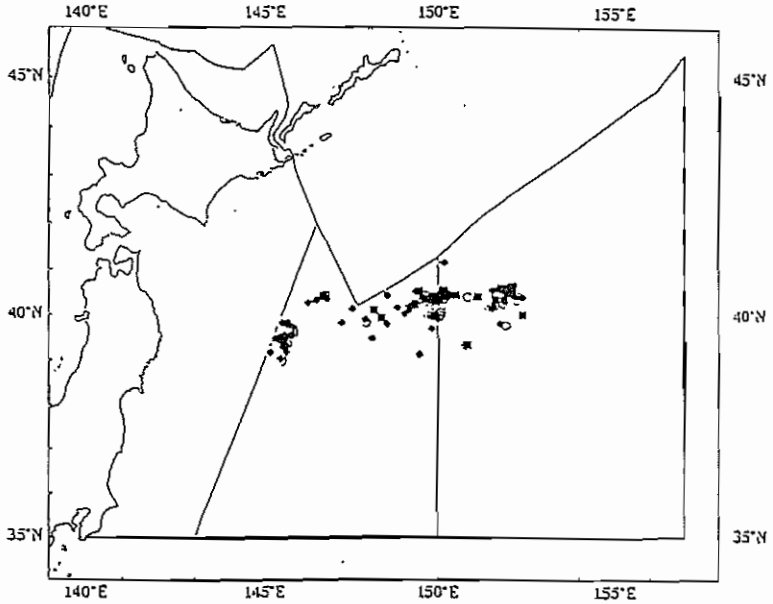


Fig.18. Distribution of minke whales sighted by the three SSVs during the 1998 JARPN survey. Minke whale: ●primary, ○secondary; 'like minke whale': ■primary, □secondary.

Sampled

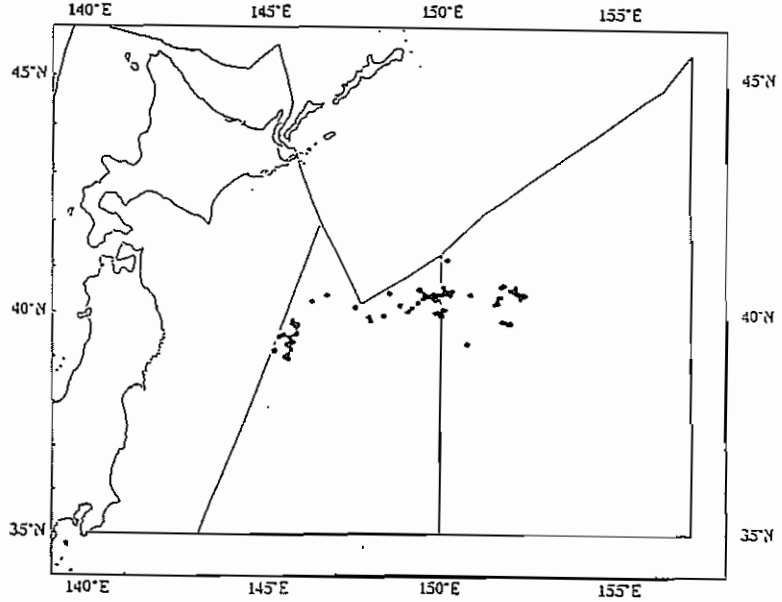
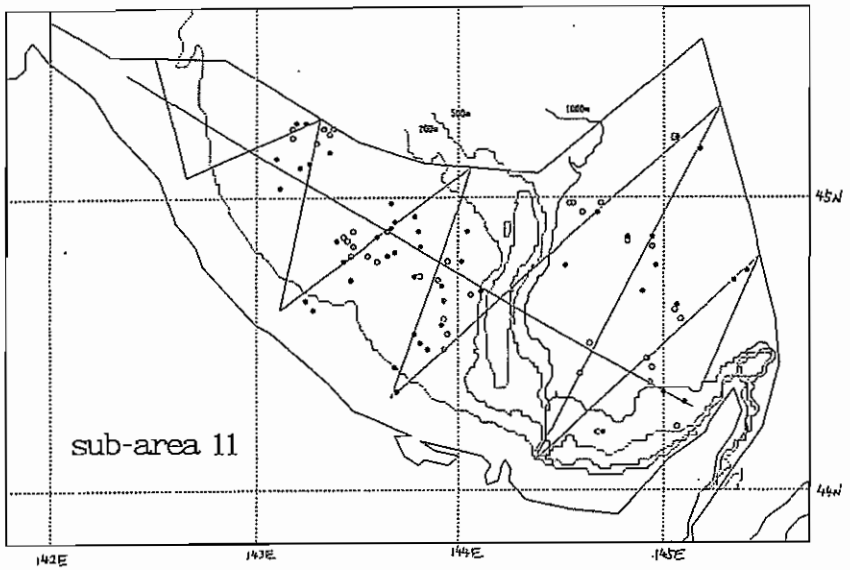


Fig.19. Distribution of minke whales sampled in the 1998 JARPN survey, based on their sighting position.

After Zenitani *et al.*, 1999

1999 JARPN
(sub-areas 7W and 11)

Sightings



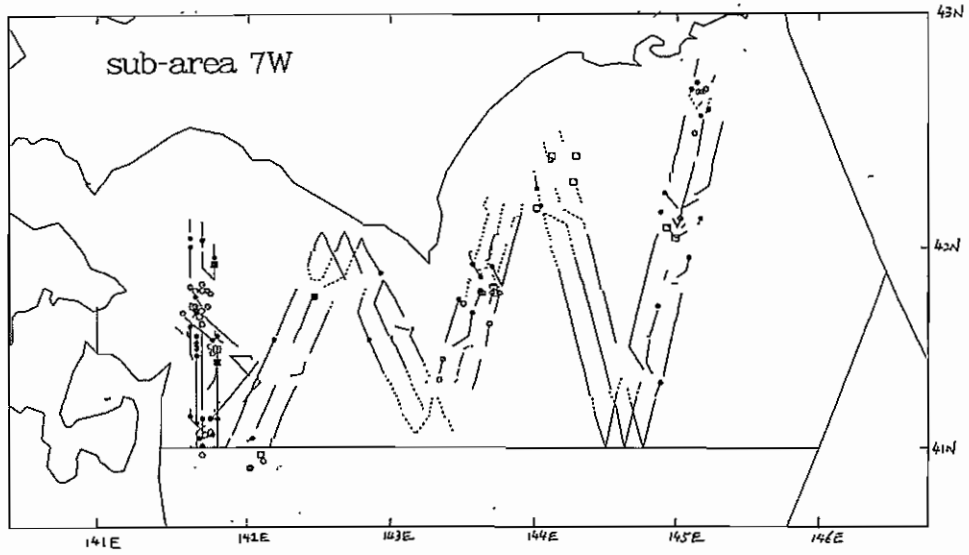
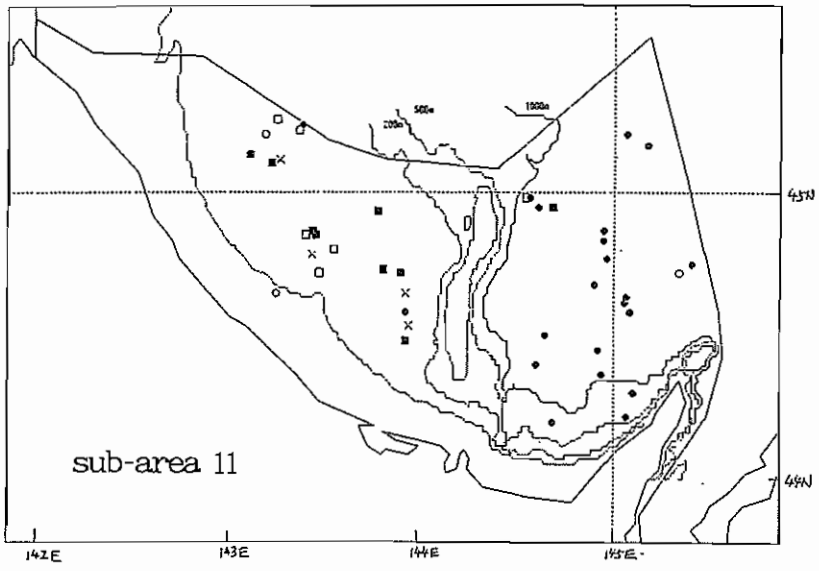


Fig.20. Cruise tracks and locations of minke whale sightings in the sub-areas 11(upper) and 7W(lower) during the 1999 JARPN survey.

Sampled



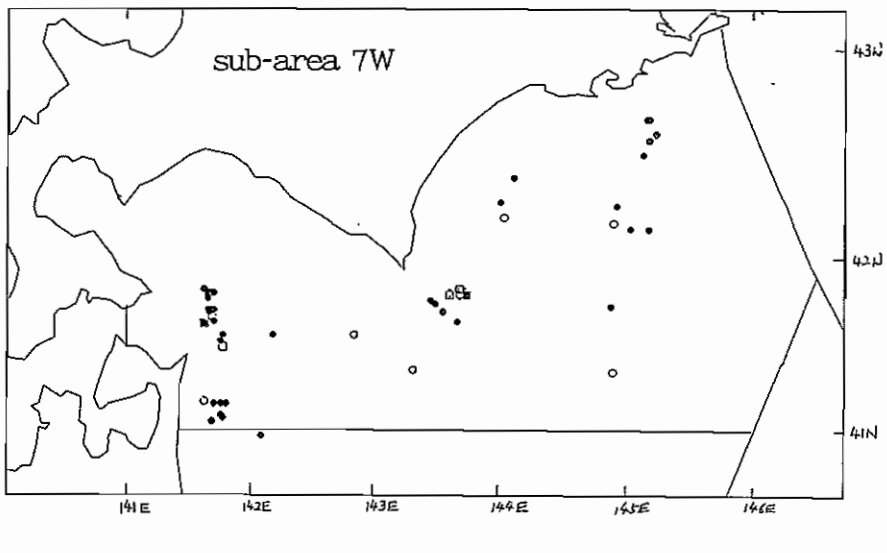


Fig.21. Geographical locations of minke whale samples collected in the sub-areas 11(upper) and 7W(lower) during the 1999 JARPN survey.

After Fujise *et al.*, 2000