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# 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

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## CONTENTS



## I. PREFACE

The IWC had for a long period of time recognized the presence of two stocks of minke whales in the north western Pacific region: the Sea of Japan – Yellow Sea – East China Sea stock (J Stock) and the Okhotsk Sea – Western Pacific stock (O Stock).

In 1993, however, new hypotheses on the stock structure were proposed at the Working Group on RMP Trial for the North Pacific Minke Whales at the 45th Annual Meeting of the Scientific Committee, where it was argued that no adequate ground exists for asserting the presence of two stocks only. Eventually the Working Group set up a working model for testing the application of the RMP assuming the hypothetical presence of three sub-stocks within the J Stock, four sub-stocks within the O Stock and an additional new stock (W Stock) in the central part of the North Pacific (44th Report of IWC, Annex G (IWC, 1994a)).

At that time, however, no direct evidence was available to support the presence of these hypothetical new stock/sub-stocks. The Scientific Committee, therefore, expressed the desirability of improving information on the stock structure (44th Report of IWC, Report of SC (IWC, 1994b)).

The key information needed to respond the questions of the Scientific Committee can be summarized in the following:

(i) Whether or not sub-stocks exist within the O Stock.

(ii) Whether or not W Stock exists. If it does exist, what is the rate of mixing with the O Stock.

To address these points, the Government of Japan started a new research program in 1994 for the in depth study of the stock structure of the minke whales in question. The J Stock (Sea of Japan – Yellow Sea – East China Stock) was excluded from the research target, because it is classified as a protected stock and will not be subject to utilization in the near future.

The research in 1994 was a feasibility study to examine the second part stated above. Specifically, it was aimed at sampling 100 animals in Sub-area 9 (Fig. 1) from which no materials and data were available. However, the survey in the initial year ended up with only 21 whales due to a combined effect of unexpected adverse weather conditions and lack of operational experience in the area (Fujise et al., 1995).

To complete the feasibility study, the 1994 research program was repeated in 1995 and 100 whales were sampled (Fujise et al., 1996).

## II. OUTLINE OF THE RESULTS OF 1994 AND 1995 RESEARCHES

The results of the study on isozyme, mtDNA, morphometric characteristics, and others are summarized below. The analyses incorporated all 121 whales taken in 1994 and 1995, as no statistical differences in research results were observed between the two years.

(i) The result of isozyme analysis suggested that the 121 whales belong to the same breeding group (i.e. not the mixing of two or more stocks) (Wada, 1996).

(ii) The sampled whales showed no differences from the past samples of O stock (Sub-areas 7 and 11), which had been stored in the National Research Institute of Far Seas Fisheries, in terms of allele frequencies determined from isozyme analysis (Wada, 1996). The proportion of animals which might belong to a separate stock was estimated to be very low, based on analysis of these allele frequencies (Butterworth and Punt, 1996).

(iii) A comparison between the sampled whales and the past samples of O Stock (Sub-areas 7 and 11) was made using mtDNA PCR/D-loop method as well as the whole RFLP method. In both cases, no significant differences between the two sample sets were observed (Goto and Pastene, 1996).

(iv) Nine out of a total of 12 females sampled had a fetus, and their estimated conception dates were consistent with those for the O Stock (Sub-area 7 and 11) (Fujise et al., 1996).

(v) No differences between the sampled whales and the past samples from the O Stock (Sub-area 7 and 11) were detected in a linear discriminant function analysis using body proportion data (Fujise et al., 1996).

(vi) Mercury and organochlorines (PCB and DDE) were measured. No differences between the sampled whales and past samples from the O Stock (Sub-area 7 and 11) were

found, after animal length was taken into account (Fujise et al., 1996).

(vii) Because of the markedly skew sex ratio (109 males and 12 females) and length composition (mostly large male individuals), sampled whales in Sub-area 9 can be interpreted as a component of a widely distributed stock. It is unreasonable to assume that the group of sampled whales represent an isolated separate stock or sub-stock.

In sum, it was concluded that the samples obtained from Sub-area 9 had mostly the same characteristics of past samples in Sub-area 7 and 11, and that the possibility of the existence of the hypothetical W Stock was extremely unlikely (Hatanaka, 1996). However, some additional laboratory analyses will still be carried out to avoid the risk of incorrectly rejecting the W Stock hypothesis.

In the meantime, the field survey in 1996 and 1997 will focus on another objective (i.e. clarifying whether or not sub-stocks exist within the O Stock), in order to obtain more comprehensive picture of the stock structure of the O stock. This is because (a) this study is equally important to respond the query raised at the Scientific Committee (IWC 1994), and (b) the results from new survey areas might also be helpful to further understand the research data of Sub-area 9 by providing a larger picture of stock structure and migration patterns of the O Stock.

## III. OBJECTIVES OF THE RESEARCH IN 1996 AND 1997

(i) Sub-stock identification

The research attempts to elucidate whether sub-stocks exist within the O Stock. In 1996 and 1997, samples will be collected from Sub-areas 7, 8, 11 and possibly 12. Data analyses, which are elaborated in Section IV below, will be carried out in order to test the Sub-stock hypothesis of the O Stock in the Okhotsk Sea and the northwestern part of the Pacific west of 170 degrees E (Sub-areas 7, 8, 9, 11, 12).

In 1993 at the Scientific Committee, it was argued that the possibility of the presence of sub-stocks could not be excluded because the past whaling grounds were separated and the minke whales might show site specificity to different feeding grounds (44th Report of IWC, Annex G (IWC, 1994a)).

It was agreed at the Scientific Committee meeting in 1995 that biological and behavioral characteristics were useful in establishing the stock structure hypotheses (SC/47/Mg2). It was also recognized that the presence of sub-stocks should be tested from the estimation of mixing rate among various parts of the population's range, and that there are a number of ways to estimate the mixing rate, such as from marking data including photo-identification, telemetry data and data on biological markers. Moreover, some members drew attention to the possibility of drawing conclusions from sex and age structure data (IWC, 1995).

No marking experiment (i.e. conventional type of marking) has been conducted with respect to the North Pacific minke whales, and no photo-identification tests were made because of the large number of the individuals and because of scarcity of marks and the difficulty of photographing from short distance. Efforts have been made to develop telemetry but they have

yet to achieve success even after the several years of trials. Therefore, as described below, the possible presence of sub-stocks will be examined through biological markers and sex and age (body length) structure.

(ii) Feeding ecology

An additional objective is to start a feasibility study on feeding ecology of minke whales. In the Northwestern Pacific, dramatic changes have been observed in pelagic fish stocks which are thought to be a major source of food for minke whales. For example, two million tons of sardine were caught annually in Sub-area 7 in 1980s, but the sardine abundance has since decreased drastically and the fishery yield has become almost zero at present. On the other hand, pacific saury was frequently observed in the stomach of minke whales sampled in Sub-area 9, and salmon were also found in the stomach of minke whales (Fujise et al., 1996).

A "Top Down Control" concept, which assume higher components (species) of trophic level control the biomass of lower contents through feeding, has been suggested by salmon scientists specializing in the North Pacific (Nagasawa et al., 1995). Also, the North Pacific Marine Science Organization (PICES) established the "Working Group on Consumption of Marine Resources by Marine Birds and Mammals" at its 1995 annual meeting. It has been revealed by the Norwegian scientific permit research that minke whales contributed to reduce the abundance of food species such as capelin and herring in the North Atlantic (Haug, 1996).

The information on feeding ecology is essential for interpretation of results on pollutants, parasites, and stable isotopes, because they are primarily originated from the whales' food.

In sum, the study of feeding ecology of minke whales in the North Pacific is necessary to elucidate the role of minke whales in stabilizing or shifting the ecosystem of Northwest Pacific through predation.

## IV. RESEARCH METHOD AND RESEARCH ITEMS

1. Sampling Method

In principle, cruise tracks are determined randomly to cover the entire research area, and sighting is conducted on the predetermined cruise lines. Minke whales will be sampled when sighted.

2. Research Items

The following measurements and collection of samples will be made to detect quantitative and qualitative differences between samples obtained in each Sub-areas.

(i) Morphometric Measurement:

Sex, body color, body size, weight/size of parts of the body, and others will be examined to detect morphometric differences by Sub-area. Relative weight of various parts of the body will be useful to examine the nutritional condition of whales, which may help identify sub-stocks, if any, in different feeding grounds.

(ii) Conception Date:

Conception date will be analyzed because it may have some difference between the hypothesized sub-stocks.

(iii) Genetic Analyses:

Tissue samples will be collected from skin, liver, muscle, and other body parts for isozyme and DNA analysis. Wada (1991) conducted isozyme analysis and found no differences between Sub-areas 11 and 7 (excluding the early months of the season when J-Stock animals are present in Sub-area 11.) No statistically significant differences were observed in the isozyme analysis using samples from Sub-area 9 (Wada, 1996). Also, using mtDNA analyses, no significant differences were observed between these three Sub-areas (Goto and Pastene, 1996). So far, no statistically significant information has been obtained regarding differences on the sub-stock level as long as the conventional analysis methods are employed. However, further genetic study will be incorporated into study to avoid the risk of incorrectly rejecting hypotheses.

(iv) Heavy Metals and Pollutants:

If some difference exist among groups linked to specific feeding sites, differences may arise in the accumulation of heavy metals and pollutants. In other species, differences in such accumulation are observed in the groups living in different grounds (Subramanian et al., 1986). The accumulation can differ by sex (maturity condition) or by age. It is also necessary to compare the samples taken in the same or nearby years, because the ocean pollution level changes year by year.

(v) Parasite Samples:

Several papers have been presented on stock identification using parasites (e.g. Dailey and Vogelbein, 1991). Differences among sub-stocks may arise in the parasite species composition and the infection rate, as in the case of the accumulated pollutants. It is also theoretically possible to detect regional stock of the parasites themselves by genetic analyses, which might be useful to identify sub-stocks of whales. Parasite data have been obtained from Sub-area 9 in the past two years, but to date no samples have been collected systematically in other Sub-areas (Araki et al., 1996; Kuramochi et al., 1995).

(vi) Anomalous Tissue:

Observations of anomalous tissues were made in 1994 and 1995 for samples from Sub-area 9, and a high rate of occurrence (about 20%) of anomalous testis was observed (Fujise et al., 1996). The cause will be further examined pathologically. In the mean time, the rate of the anomaly might be a useful indicator for detecting the different feeding groups ( sub-stocks) of minke whales, if any.

(vii) Stable Isotope:

Techniques have been developed to measure the water temperature using the proportion of isotopes in oxygen of carbonic calcium in hard tissues of animals (Urey et al., 1951). These methods will be applied to analyze the water temperature of whale's feeding area using baleen. About a 10 degree centigrade difference in surface water temperature is usually observed between the area off Sanriku (Sub-area 7) and

the Okhotsk Sea (Sub-area 12), providing the potential to examine whether or not minke whales chose a fixed feeding ground year by year.

In addition, measures to analyze feeding habit and trophic level using carbon and nitrogen isotopes will be considered for their possible application to the whale stock study, as this technique is usually applied in determining nationality and other characteristics in the case of human beings (Minagawa, 1987).

(viii) Length Composition, Sex Ratio, etc.:

If sub-stocks form independent groups like the matrilineal group during the feeding period (even if they mix with each other during the breeding period), the following would be reasonably observed within each group: (i) a group's body length composition which is reasonably distributed from juvenile to aged whales, and (ii) a group's sex ratio which is approximately on a par (50:50).

Past catch records of Sub-area 7 and 11 show a highly skewed length composition and sex ratio. After the moratorium, the catch has been suspended for around 10 years. The sex and length structures of sub-stocks specific to these Sub-areas must have changed during this period of time. A comparison analysis between past samples and newly obtained samples may useful to detect whether or not such change actually occurred. Similar analyses were already carried out during the period of commercial whaling (Okamura and Hatanaka, 1996).

(ix) Satellite Tagging Experiment:

Experiments to develop telemetry techniques using an ALGOS tag were planned for 1994 and 1995 seasons. The progress has not been satisfactory so far because of bad weather and the swift movement of animals. The experiment will be continued in 1996 and 1997.

(x) Research on Feeding Habits:

The research on stomach contents of sampled minke whales will be strengthened from this year. Yearly monitoring is valuable, especially when there are dramatic drastic changes in pelagic fish abundance, to detect any changes of species consumed by minke whales. Comparison of food species between the past samples and current samples will be made. Also, detailed materials will be collected to estimate the volume of total food intake by analyzing the stomach contents.

(xi) Sighting Survey:

Data to estimate stock size will be collected through a sighting survey, and possible discontinuities in whale distribution will be sought to help identify sub-stocks, if any. In addition, sighting will be undertaken on other species as in the Sub-area 9, where more blue whales and, sperm whales were sighted than anticipated. Photographs of natural marking of those species will be taken.

## V. THE NEEDS TO COLLECT NEW MATERIALS AND DATA

(i) Materials needed

New samples will be collected in Areas 7, 8, 11, and 12 during the two research periods.

In Sub-areas 7 and 11, substantial numbers of samples for DNA analyses and data on body length composition do exist. However, because of the selective nature of the commercial catching, the materials have unknown degree of sampling bias. There are virtually no materials and samples in Sub-areas 8 and 12, because there was almost no commercial whaling in these regions.

Samples are available to compare genetic evidence (DNA) from the various Sub-areas, but as indicated above the genetic methods have not indicated any differences. They, therefore, appear not to have the power to detect the differences between sub-stocks (or, of course, there are no such sub-stocks), so that other analyses based on biological markers – heavy metals, pollutants, parasites, stable isotopes, and anomalous tissue – must be conducted to attempt to detect evidence for sub-stocks. At present, such information is available for Sub-area 9 only, so that samples are required from Sub-areas 7, 8, 11 and 12. Also, it is necessary to synchronize the years of comparisons on heavy metals, pollutants, and anomalous tissues.

There are virtually no materials and samples in Sub-areas 8 and 12, where almost no commercial whaling have been operated.

The amount (in terms of the number of animals) of preserved materials and data is as follows:

| Materials & Data | Sub-area 7 | 8 | 9 | 11 | 12 |
|---|---|---|---|---|---|
| Morphometric data | exist(1) | 0 | 121 | exist(1) | 0 |
| Conception date data | 80(1) | 0 | 9 | 241(1) | 28 |
| Isozyme/DNA samples | 686(1)(2) | 0 | 121 | 310(1)(2) | 0 |
| Heavy metal/pollutant data | 38 | 0 | 121 | 0 | 0 |
| Anomalous tissue | 0 | 0 | 121 | 0 | 0 |
| Parasites samples | nil(3) | 0 | 121 | nil(3) | 0 |
| Baleens | 0 | 0 | 121 | 0 | 0 |
| Length, sex ratio data | sufficient(1) | 0 | 121 | sufficient | 165 |
| Stomach contents | exist | 0 | 121 | exist | 0 |

Note(1) Obtained from commercial whaling in 1987 and before. But most may not be in the ideal condition because of low-quality of the data. A need exists for collecting new data.

Note(2) A considerable number have degraded and are not suitable for isozyme analyses.

Note(3) Only old records exist for several species of parasites. Records are opportunistic and not usable for estimating the infection rate.

Note(4) Materials from Sub-area 12 are from Miwamaru.

(ii) Necessity of Lethal Research

Although around five grams of outer skin collected through biopsy can make DNA and organochlorine analyses possible, this limited amount of information is not sufficient for study on stock/sub-stock structure because the study requires a comparison and analysis of the following data, most of which requires lethal take of the animals:

a) The shooting range is smaller in case of biopsy gun because of the limited power of the gun. This usually results in ineffective opportunistic sampling. In the 1995 survey only, 7 animals could be targeted for biopsy sampling and only 3 attempts were succeeded. On the other hand, 138 animals were targeted for lethal sampling and 100 animals were taken. (ii) There are cases that a group of the effectively the same genetic characteristics shows different morphometric characteristics. The RMP trials have shown the danger of assuming only one stock if two are actually present.

b) Information on morphometric, length and sex, pollution, parasite, and heavy metal data may strongly supplement the other information to comprehend stock/sub-stock structure.

c) Conception date data inferred from fetus length have already been used as one of the best sources of evidence for stock identification, differentiation and mixing (IWC 45/SC Annex G). Collection of these data requires lethal method.

d) In the conventional analyses of heavy metal accumulation, internal organs are required because it is uncertain that the skin and blubber part represent the overall accumulation level of animals, because data obtained from skin and blubber are not comparable with the past data which used internal organs, and because the amount of blubber and skin from biopsy is insufficient for this sort of analysis.

e) Isozyme analysis is one of the best indicators for stock identification of the J and O Stocks and for detecting stock mixture (Wada, 1991). In order to ensure the possibility of isozyme analysis, the amount of sample necessary is at least 20-30 grams and the suitable samples should be obtained from the liver.

f) Analysis on stable isotope requires hard tissues, such as whale baleen.

## VI. RESEARCH AREAS AND PERIOD

The plan for 1996 is to cover Sub-areas 7 and 8. In 1997 Sub-areas 11 and 12 will be investigated. No whales will be taken in Sub-area 11 before June to avoid the risk of catching J Stock whales.

If any difficulties arise in arranging for operations in Sub-area 12, these will be transferred to Sub-area 8 and the offshore region of Sub-area 7; in such circumstances, Sub-area 11 operations may also be transferred to the coastal region of Sub-area 7 in the early part of the year depending upon analysis of results from 1996 research.

The basic reason for these choices are:

(i) to attempt to discover evidence for sub-stocks in the region east of Japan by comparing data from Sub-areas 7 and 8 with those already obtained in Sub-area 9;

(ii) investigation whether or not there is a evidence for any difference between the large number of minke whales to be found in mid summer in the north Okhotsk Sea (Sub-area 12) and those located close to the coast of Japan in Sub-areas 7 and 11.

In 1996, the research will start in July in response to the discussion at the Scientific Committee meeting in June. In 1997, the research will start in late April or early May.

## VII. NUMBER OF WHALES TO BE SAMPLED AND POSSIBLE EFFECT ON THE STOCK

### (i) Number of Whales to Be Sampled

The sub-stock hypotheses for the O Stock have been put forward without any concrete evidence (e.g. specific examples of statistically significant differences): this vagueness complicates the futation of such hypotheses. Nevertheless, sample size must be kept sufficiently low that there is no chance of an adverse effect on the stock (or possible sub-stock). For this reason the total sample size is limited to 100 per year to avoid an adverse effect on the O stock as a whole, and to 30 per year in Sub-areas 7 and 11 to prevent reduction of a possible coastal sub-stock in these regions.

In 1996, it is planned to sample 30 whales from the western sector of Sub-area 7. This sector is defined by the part of this sub-area covered in the 1991 and 1992 sighting surveys (see Fig.3 of Miyashita and Shimada, 1994) and includes essentially the complete portion of this sub-area from which minke whales were taken in past commercial operations. The other 70 whales will be sampled from the eastern sector of Sub-area 7 and Sub-area 8.

In the absence of existing data on the biological markers in Sub-area 7, it is not yet possible to carry out calculations of the power of statistical methods to detect differences between hypothesized different sub-stocks in this region and Sub-areas further to the east of Japan. The proposed sample size of 30 is seen as a "feasibility study" whose results will allow such calculations to be undertaken. It will also be sufficient for an initial study of feeding habits.

Almost no samples are available from past commercial samples in Sub-area 8 and the eastern sector of Sub-area 7, and the latter has had effectively no coverage in past sighting surveys. Because of the indications that migration pattern for the O Stock involve animals of different sizes and sexes in different sub-areas (Hatanaka and Miyashita, 1996), a sample from this region is important. Further, the sample size of 121 whales from Sub-area 9 has provided useful genetic information. It is therefore concluded that a sample size of 70 from Sub-area 8 and 7 (east) in 1996 will be sufficient to provide important information on these matters. If analysis shows that greater numbers are needed for increased statistical power, further sampling size is possible later in the research program.

The proposed sample sizes for 1997 are 30 in Sub-area 11 and 70 in Sub-area 12. However, if difficulty arise for operation in Sub-area 12, where most of the area is falls in the Russian

waters, 70 animals will be taken in Sub-areas 7 (east) and 8. The reasons for these choices are essentially the same as given above for 7 (west) and 8 + 7 (east) respectively.

(ii) Effect on the stock

The effect of the catches have been evaluated in two ways, based upon the standard Hitter-Fitter methods used by the IWC Scientific Committee for resource assessment (detailed results of calculations are shown in Butterworth, 1996). In the Hitter approach, the consequences for the O Stock as a whole are examined under the continuation of a catch of 100 whales per year until 1998. Under the very conservative assumptions of abundance equal to the lower 5 % confidence limit from sighting surveys (20,603) and an MSY rate of 1 % of the mature component of the population, the mature female component of the population is projected to increase from 67.5 to 67.8 % of its level before any exploitation between the start of the program in 1994 and 1999.

The isozyme analysis from Sub-area 9, though consistent with the absence of any W Stock from this region, nevertheless does not exclude the possibility of a small fraction of the whales in the offshore Pacific region (Sub-areas 8, 9 and 12) belonging to a W Stock (Butterworth and Punt, 1996). If the calculations above are repeated taking this into account, but assuming the extreme case that all the whales captured from these regions belong to the O and none to such a W Stock, the mature female component of the O Stock is still protected to increase from 61.3 % in 1994 to 61.5 % in 1999.

The other method of examination assumes that the O Stock whales in the coastal Sub-areas 7 and 11 are independent, and that essentially all the past catches made from these Sub-areas belong to a separate O Sub-stock which behaves as an independent stock. Furthermore it is assumed that none of the whales surveyed in Sub-areas 8, 9 and 12 belong to this sub-stock. If calculation of the same type as above are repeated for this scenario and an MSY rate of 1% of the mature component of the population, catches of 30 animals in both 1996 and 1997 from such a sub-stock result in a 1994 estimate of the mature female population of 26.2% of its initial level increasing to 26.6% in 1999 for a best estimate of 3,687 (from sighting surveys) for the 1990 population level. If the lower 5% confidence limit of 2,151 for this abundance is used, these proportions change to 17.6% increasing to 17.7%.

Such result must, however, be seen in the context of the extreme nature of this scenario, which can scarcely be considered as realistic:

(i) the sex and size composition of past catches from Sub-areas 7 and 11 are hardly consistent with an isolated stock, particularly when considered together with such information for other Sub-areas (Hatanaka and Miyashita, 1996), so that the abundance estimates used in the calculations cannot reflect the whole stock/sub-stock;

(ii) the abundance estimates apply to the August-September period, when it seems nearly certain that most of the whales that pass through these Sub-areas have already moved further north into the Okhotsk Sea (Hatanaka and Miyashita, 1996);

(iii) the abundance estimates themselves are based on the assumption g(0)=1, while detailed analysis of the North Atlantic minke whale surveys, which are very similar

to these in the North Pacific, suggest g(0) values considerably less than 1 (Schweder et al., 1995; Cooke, 995).

(iv) the use of an MSY rate of 1% is extremely conservative, given the rates of population increase which have been observed in other baleen whale species.

In sum:

a) the actual abundance is likely to be much higher than, these conservative calculations assumed;
b) even were this not the case, the mature female numbers increase under the extreme hypothesis examined;
c) the sub-stock scenario for the O Stock in any case seems virtually ruled out by existing data, rendering it of very low plausibility.

Taking all these factors into account, the only conclusion possible is that the catches proposed will not have an adverse effect on the stock (or very possibly sub-stocks) from which they are taken.

## VIII. RESEARCH VESSELS AND RESEARCH ORGANIZATION

(i) Research Vessels

As in the 1995 research, three sampling vessels and one research mother ship will be used.

(ii) Research Organizations

Experts and staff from the following organizations will take part in the research:

a) National Research Institute of Far Seas Fisheries
b) Institute of Cetacean Research
c) Scientists from other universities and research institution

(iii) Participation of Foreign Scientists

The participation by scientists from foreign nations, particularly from neighboring nations, will be welcomed subject to the conditions put forward by the Government of Japan. These conditions will be similar to those which have applied to the research program in the Antarctic.

(iv) Need for Joint Research with the Russian Federation

It is desirable to cover the Russian water in the Okhotsk Sea and waters along the Kurile Islands by means of joint research with the Russian Federation.

(v) Report

The preliminary reports of this special permit research shall made available for the next meeting of the Scientific Committee.

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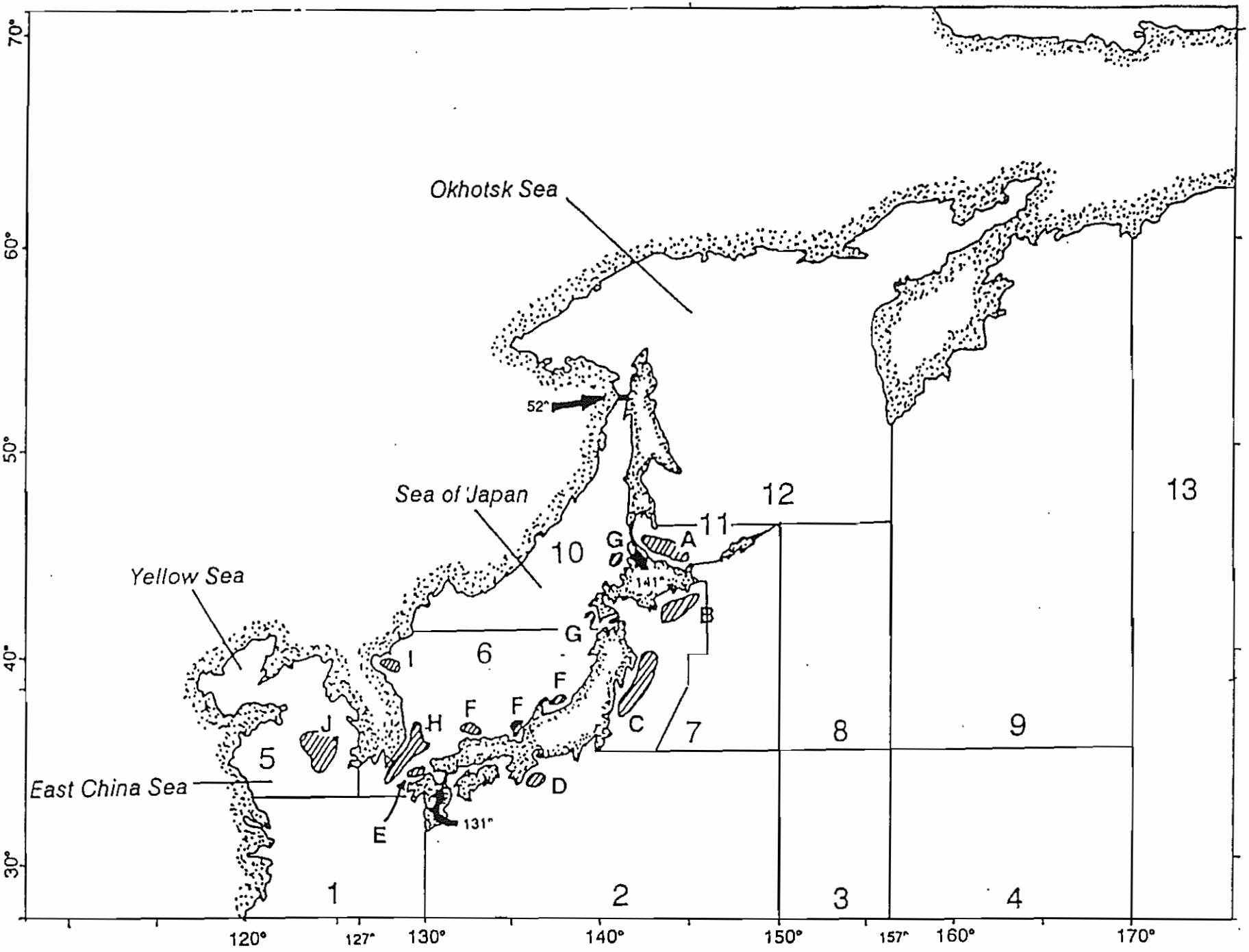


Fig. 1. Map showing location of past Japanese whaling grounds and the 13 sub-areas chosen for the implementation trials (see text).