SC/46/NP1.

STRICTLY CONFIDENTIAL UNTILL AFTER THE DISCUSSION OF THE SCIENTIFIC COMMITTEE OF THE 46TH IWC

RESEARCH PROGRAM FOR CLARIFICATION OF MINKE WHALE STOCK STRUCTURE IN THE NORTHWESTERN PART OF THE NORTH PACIFIC

The Government of Japan

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CONTENTS

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I. Introduction

A three-day Working Group meeting to consider application of the RMP to the Northwestern Pacific minke whale was held prior to the 45th annual meeting of the IWC Scientific Committee in 1993. The meeting formulated a series of working hypothesized models based on available information (Annex G to 45/IWC/SC Report). However, a doubt was raised whether it is meaningful to advance the work in circumstances where the possibility of zero catch limit is not precluded because of shortage of information. Information is conspicuously lacking for the stock structures, differentiation and mixing pattern of the Sea of Japan -Yellow Sea-East China Sea Stock (hereinafter referred to as J Stock), the Okhotsk Sea Stock (hereinafter referred to as O Stock), and Western Pacific Stock (hereinafter referred to as W Stock). In this regard, the Scientific Committee also noted the desirability of obtaining improved data on stock identity and migration pattern, and further noted that such information would reduce the range of plausible hypotheses that need to be considered (45/IWC/SC Report, 7.2.3 North Pacific Minke Whales, para 9).

The Working Group established 13 sub-areas in the northwestern North Pacific (Fig. 1), 3 sub-stocks in J Stock and 4 sub-stocks in O Stock as well as W stock in the Northwestern Pacific. The Working Group also established 22 cases as options for trials of the RMP (Annex G to 45/IWC/SC Report, Appendix 3, Specifications of the North pacific minke Whale trials).

As regards minke whales in areas around Japan, the 2-stock theory has been propounded (Omura & Sakiura, 1956 : Ohsumi, 1983 : Wada, 1991 : Kato & Kasuya, 1992 : IWC, 1992), but the Working Group has established a complicated scenario hypothesized with O Sub-stocks, and W Stock existence, etc. The issues about stock structure can be summarized as under the following two headings.

(1) validity of sub-stock structure:

This issue is discussed in the attached paper (Hatanaka, Kato and Ohsumi, MS Appendix II). The gist of the paper is that existing data and information show that there is no reason to change the conventional assumption that the two stocks (J Stock and O Stock) migrate to the waters surrounding Japan and more mature individuals make northward feeding migration. The paper also argues that there is no ground to support the existence of sub-stocks.

The sub-stock scenario puts unrealistic conditions on the trials, which are likely to lead to large and unnecessary reductions in catch limits calculated, especially in Japanese traditional whaling grounds.

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(2) validity of W Stock:

This hypothesis involves the presence of a stock which winters in the middle and low latitudinal areas in the central North Pacific and the stock makes direct feeding migration to the Okhotsk Sea without coming close to the east coast of Japan. (The case that it does not enter the area of west of 157 degrees E is also assumed.) It is unknown whether such a stock actually exists independently of O Stock.

The present research is designed to collect information concerning these issues, thereby to build up more credible hypotheses concerning stock structure, to facilitate RMP trials and bring about meaningful results.

II. Objectives of research

Clarify the stock structure differentiation and mixing of minke whales distributed in the waters around Japan. Specifically, emphasis will be given to the following three points.

1. Clarify whether W Stock exists

Clarify whether there exists a hypothesized W stock which migrates from the central North Pacific (Sub-area 9 and 13) into the Okhotsk Sea (Sub-area 12) and the offshore area on the side of Pacific east coast of Japan (Sub-area 8) without approaching the Japanese coast regardless of whether there is O Stock in the other Sub-areas adjacent, or where the eastern boundary for O Stock lies.

2. Clarify the mixing rate of W stock

Clarify the extent to which W stock (if it exists) mixes with O stock in Sub-areas 8, 9, and 12 (Fig1)

3. Clarify the validity of O sub-stock scenario

With respect to the O stock, clarify whether there is evidence for site-specific sub-stocks in Sub-areas 7, 11 and 12, or rather there is a homogeneous O stock which has segregation by sex and growth stage and repeats latitudinal and onshore-offshore migration making northward shift in search of feeding grounds.

The present research will not cover the three sub-stocks hypothesised in J Stock because they range in the waters of Russia, North Korea, the Republic of Korea and China. Implementation of the research in those areas seems to be politically complicated in view of the recent international situation.

III. Research method and items

1. Research method

In the first year, a feasibility study will be conducted in Sub-area 9 in order to obtain preliminary information on stock structure (from DNA information, isozyme information, conception date information, length and sex structure data, morphometric information, and pollutant, parasite and heavy metal data) and the variability of such data. Based on such information, the catch level of animals needed to get sufficiently precise answers from future research will be determined.

For the following years, the research programme will be conducted according to the result of the first year's feasibility study. For example, if the existence of W stock is detected in Sub-area 9 in the first year's feasibility study, the research programme in the following years' will be conducted for investigating existence or proportion of W stock in Subareas 8, 9, and 12. In this case, the boundary between O Stock and W Stock or mixing rate between them will be identified in those sub-areas. However, if predominance of O stock is detected in Sub-area 9 in the first year's feasibility study, the following research programme will rather focus on the detection of the existence or otherwise of O Sub-stocks in Sub-area 7, 8, and 11 in the following years.

2. Research items

Random sampling (catch) will be carried out. The following research items and sampling will be addressed.

(1) Morphometric information (body color, body size, size of part of the body, sex)

This information is valuable as one of information to assist to determine stock-identification among hypothesized O and W stocks and hypothesized Sub-stocks among O Stock.

This information can be particularly valuable when the genetic data fail to provide information able to determine the differentiation of stocks and sub-stocks as in the case of North Atlantic pilot whales.

(2) Conception date data

These data are inferred from foetus length. These data were extremely valuable for determining O and J Stock differentiation and mixing.

These data also would naturally be expected to be useful to determine the stock differentiation and mixing between O and W Stocks.

(3) Collection of biochemical samples (samples of skin, liver, muscle, brain, etc., for genomic DNA, mtDNA and isozyme analyses)

Genomic DNA and mtDNA analyses are powerful in detecting genetic variations, and are useful for individual identification. However, it may not be effective in detecting mixing of stocks without pure samples from each stock.

Isozyme analysis is useful for analysing samples from mixed stocks, because isozyme data, as they are, can tell us whether they are homogeneous or not, through Hardy Winberg's principle.

(4) Collection of samples for quantification and qualification of contaminant substances (heavy metals and organochloride, etc.) These data may suggest the different past locations of the whales and thereby stock segregation.

(5) Length and sex composition data

This information may suggest the difference of character of stock differentiation.

(6) Collection of data and samples on parasites

Parasites could be considered as natural tagging and may suggest the location of inhabitation of stocks and thereby stock segregation.

These data ((4)-(6)) provide supplementary or indirect evidence for stock structure, and may be valuable for determining stock identification and structure particularly when biochemical information may not be strong enough to indicate the differentiation.

(7) Research on stomach contents

Stomach content data will be collected routinely for feeding studies, and may perhaps also provide information on stock separation.

(8) Sighting survey data

Sighting survey data will be obtained from sampling activity.

IV. Research area and period

1. Research area

First year (1994): Feasibility study in Sub-area 9 (157 E to 170 E, South of the 200 mile EEZ of Russian Federation and the US, North of 35 N) will be conducted to preliminarily detect the stock structure and for designing the research in the following years.

Following years: The research area will be determined by taking the due consideration of the result of the feasibility study.

2. Research period

First year (1994): Up to 90 days in June to September

Following years: The research period will be determined by taking the due consideration of the result of the feasibility study. Nevertheless, the entire period for the research, including the feasibility study, will not exceed 3 to 5 years.

V. Number of whales to be taken and the effect on the stock(s)

1. Number of whales to be taken

The sample size necessary for feasibility study has been set at 100 animals based upon information below.

(1) At the 1989 IWC Workshop on the Genetic Analysis of Cetacean Populations (IWC, 1991), it was recommended that at least 20 to 50 animals per stock is the appropriate number of specimens when the genetic method is used. Assuming the existence of the W stock as well as the O stock in Sub-area 9, the number of samples must certainly be set well above 50 to ensure sufficient representation of each stock. The J stock and O stock have been easy to distinguish by electrophoresis because the difference between their allele frequencies is very large. A smaller difference between the O stock and the W stock will require a larger sample size for detection.

These considerations suggest 100 animals as an appropriate sample size.

(2) Conception date data has already been used for determining stock structure for the North Pacific (NP) Minke Stocks with results from this source providing most of the information used to determine J and O stock proportions in the Sub-areas when these two stocks are mixing for the purpose of conditioning the current NP minke trials (IWC 45/SC Annex G). Attempts must therefore also be made to examine similar data concerning O and W stock differentiation. Foetus length data from about 30 specimens will be preferable for this exercise. Profile for sex and maturity within any catch taken suggest that foetus will be present in perhaps 30% of the animals. Therefore, 100 specimens would be necessary. If two stocks are mixed in Sub-area 9, and the conception date is different between them, there is a danger that a smaller number of specimens and therefore less foetus data may prove too few to detect a stock present in only a small proportion.

(3) With respect to other indicator of stock identification such as morphometric information and pollutant, parasite and heavy

metal data, a very large sample is likely to be needed to establish stock differentiation with statistical certainty. However, a sample size of 100 would provide a start for this collection process.

2. The effect on stock(s)

Japanese scientists requested Dr. D. Butterworth and Dr. A. Punt to examine the effect of takes of hypothesized number of whales from Sub-area 9 on the populations. The results are shown in Appendix 1. From these, it is judged that the take in the range of 100 to 200 whales has no harmful effect on the populations even in the worst case scenario.

VI. Research vessels and organization of the research

1. Research vessels

In order to minimize costs required for conducting research and obtaining necessary data, two catcher boats for effectively taking animals and one factory ship for possessing and preserving whale samples caught will be deployed. Factory ship is also appropriate to command, supervise and implement the research programme.

2. Organizations of the research

The following institutions and scientists will be involved in the programme.

a. National Research Institute of Far Seas Fisheries and other national research institutes of Fisheries Agency.

b. Institute of Cetacean Research

c. Scientists of appropriate universities in Japan

3. Participation by 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 programme in the Antarctic.

VII. Matters related to "Resolution on Special Permits for Scientific Research"

3/Appx4

In the Resolution on Special Permits for Scientific Research (IWC/37), it was recommended that Contracting Government when considering proposed research permits should take into account some aspects of the programme. Those are as follows.

1. Whether the objectives of the research are not practically and scientifically feasible through non-lethal techniques

The lethal catch is essential to satisfy the objectives of the programme. The reasons are written in the Section VIII-1.

2. Whether the research contributes information essential for rational management

The purpose of this programme is to clarify the stock identification, structure and differentiation of Northwest Pacific minke whales as the IWC Scientific Committee has already stated to be desirable, and to facilitate RMP trials for setting appropriate level of catch quota. Therefore, it will greatly contribute to the rational management.

3. Whether the number, age and sex of whales to be taken are necessary to complete the research and facilitate the conduct of the CA

100 whales, randomly taken independent of age and sex, will be sampled for the feasibility study in the first year. Then the number of specimens needed to obtain sufficiently precise results from the research programme will be determined from data provided by the feasibility study. Those takes will greatly contribute to the facilitation of the recommendations in the CA of the North Pacific minke whales conducted in 1991 by the Scientific Committee of IWC (IWC, 1992) and the completion of RMP and thereby the objective of research. CA will be appropriately modified if necessary for its stock structure and identification once the information will be obtained from this research programme.

4. Whether whales will be killed in humane manner

This is written in the section VIII-2.

VIII. Other matters to be considered

1. The reasons why lethal catch is needed

(1) Obtaining samples in a small amount by a biopsy sampling may not be sufficient for clarification of stock identification and structure for the following reasons.

(a) Only small amount (5g) of outer skin material can be collected through non-lethal sampling of biopsy. This small amount of sample will make possible DNA and organochlorine concentration

analysis, DNA analysis is valuable only for determining DNA patterns of samples of individual animals. However, it may not be sufficient for stock identification and structure and it may not be capable of detecting mixing of more than one stock.

(b) Amount of meat from biopsy is insufficient for analysis of accumulated elements such as heavy metals.

(c) Because the physical constraints of reach of the biopsy gun shooting to the animals is shorter so that it cannot conduct the effective sampling.

(2) There are cases suggestive of presence of the different stocks from morphometric information even though genetic information such as mtDNA analysis shows no affirmative evidence for the stock differentiation. The RMP trials have shown the danger of assuming only one stock if two are actually present.

(3) Conception date data inferred from foetus length have already been used as one of the best sources of evidence for stock identification and differentiation and mixing (IWC 45/SC Annex G). These data can be obtained only from lethal methods.

(4) Isozyme analysis is one of the best indicator for stock identification of J and O Stocks and for detecting stock mixture (Wada, 1991). In order to ensure the analysis of isozyme, the Japanese experts firmly believe that amount of sample necessary is at least 20-30g and the suitable samples should be obtained from the liver.

(5) Information on morphometric, length and sex, pollution, parasite, and heavy metal data may strongly supplement the other information to judge stock identification, structure and differentiation.

Therefore, it is considered as requisite to acquire information and data from as many sources as possible to detect a stock identification and differentiation based upon analyses by as many methods as possible.

2. Humane killing

All whales in the research programme will be killed by explosive harpoon.

3. Need for joint research with the Russian Federation

As regards research in Sub-area 8,9, and 12 in the following

years after the feasibility study, it is desirable to cover the Russian waters along the Kamtchatka Peninsula and Kurile Island and in the Okhostk Sea by means of joint research with the Russian Federation.

4. Preserved samples

A total of 1004 samples collected from the past commercial whaling during 1980-87 fishing season (Wada, IWC/SC/43/Mi32) in coastal area in northern Japan, the traditional whaling ground in the country, are being currently preserved in -20 c. The samples are in small amount (a few grams), and will not be used suitably for biochemical analysis such as mtDNA and isozyme analysis because of the deterioration of the samples after long years of refrigeration. The Japanese scientists finished isozyme analyses before 1989 using these specimens, and no such analyses have been launched thereafter. All these samples are considered to be significantly deteriorated and could not be used for a complete analysis. In any case, all these samples have been taken close to the coast of Japan from Sub-areas 7 and 11. They therefore provide no information on stock structure further to the north and east of Japan, which is the important question that this feasibility study will address.

5. Treatment of whales taken

Any whale taken under this special permit shall be processed in accordance with Article VIII-2 of the Convention. The meat will be consumed exclusively in Japan.

6. Report

The preliminary results of this special permit shall be made available for the next meeting of the Scientific Committee as a special report.

References

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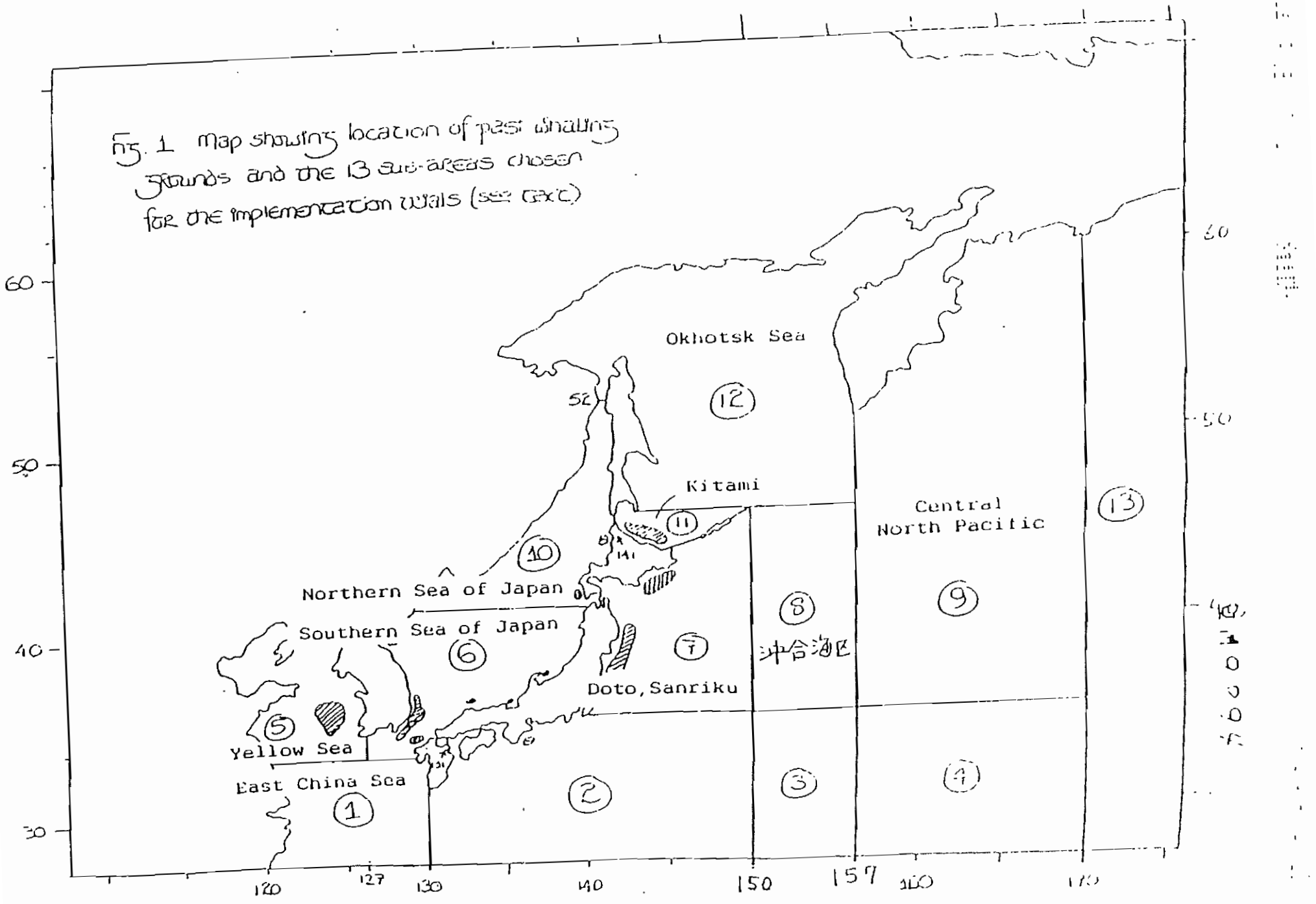
Fig. 1 Map showing location of past whaling grounds and the 13 sub-areas chosen for the implementation trials (see text)



APPENDIX I

THE POSSIBLE IMPACT OF A RESEARCH TAKE OF MINKES FROM SUBAREA 9 (AS DEFINED FOR NORTH PACIFIC MINKE MANAGEMENT TRIALS) ON THE NORTH PACIFIC MINKE WHALE STOCKS

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INTRODUCTION

We have been requested by Japanese scientists to provide an analysis of the possible impact of different levels of a research take of minke whales from subarea 9, as defined for the present trials for RMP management of the north Pacific minke whale resource (Fig. 1 of Annex G of the Report of the 1993 Annual Meeting of the IWC Scientific Committee).

Past assessments of the consequences of such takes have been based primarily upon estimates of replacement yield for what are assumed to be discrete stocks with well-defined boundaries. However, the IWC Scientific Committee at its 1993 Meeting developed a rather more intricate basis (including stock-mixing effects, for example) for trials of the RMP for this resource. It therefore seems to us to be more appropriate to focus upon the scenarios envisaged in those trials to provide a framework to address the question posed.

TRIALS DEVELOPED

Our approach in selecting trials for this evaluation has been to attempt to select "worst case" scenarios, i.e. ones for which the catch proposed might have the greatest impact on the stock / "sub-stock" involved in terms of depletion. For this reason, we have restricted attention to situations where the MSY rate is 1% (in terms of the mature component of the population) for all stocks / "sub-stocks" considered. Furthermore, although we understand that random sampling is proposed for the research take, with the intent to provide a representative sample from the population concerned, it is possible that (as in the Antarctic) younger animals may be underrepresented at higher latitudes. Accordingly, we have retained the same assumption as in the North Pacific (NP) minke trials of an age-at-50%-recruitment of 4 years for our calculations. This will result in a (slightly) greater impact of any catch on the population than were we to assume uniform selectivity across all ages.

The two extreme scenarios which, it seems to us, would maximize concern about the impact of any research take on the population, are as follows.

1) Despite selecting a region for the research take which is far to the east of Japan (and hence far from the regions of past catches from the so-called "O" stock), the take will nevertheless be made from the same stock as all those past catches, so that the depletion resulting from such catches needs to be taken into account. In the trials context, this amounts to the assumption of a single O stock to the north and east of Japan, where this stock is homogeneous (i.e. without sub-stock structure)

2) Subarea 9 contains a discrete isolated "stock" (this could be either an "O-IV-like" sub-stock, or a W (sub-)stock), so that the research take will impact that "stock" alone. This raises the question of how the level of take relates to the available sighting survey abundance estimate of 8264 (c.v.=0.396) reported for minke whales in subarea 9 in Table 4(a) of Appendix 3 of Annex G of the 1993 Report of the Scientific Committee.

The second of these scenarios is the more extreme, in the sense that it is clearly more pessimistic than any plausible reality, both because it is hardly conceivable that any single stock in subarea 9 would be bounded in its distribution by the boundaries of that subarea, and also because the survey on which the abundance estimate for this subarea is based covered considerably less than the full extent of this subarea (see Fig. 2 of RIWC 42. 387-92).

Trial NPM14 of the current set of NP minke trials comes closest to the scenario envisaged in 1) above. It requires some adjustment, however, to what we term trial "NPM14b" as the original trial incorporated sub-stock structure, whereas no such structure is desired in this instance, so as to reflect a situation of the take being made from a stock reduced by past harvesting. The catch mixing matrices (A', B', I', J') for trial NPM14b (Table 1) were developed by conditioning a slightly modified version of trial NPM14, and then calculating the fractions of the O and J stocks that are found (on average) in each subarea, for each of the original A, B, I and J matrices which form part of the specifications for the original NPM14 trial. This calculation involved, for each of the 100 simulations, pooling across the substocks which make up these two stocks (three for the J stock, and four for the O stock) to estimate the fraction of the J and O stocks in each subarea for each simulation, and then averaging these fractions over the 100 simulations. A further modification made to the specifications of the original NPM14 trial is that the O stock does not mix into subarea 13, so that the O stock size is not inflated via extrapolation to unsurveyed regions. The abundance estimates used to condition this trial have been extended to include the results from the 1992 surveys in the Sea of Japan and north Pacific (Table 2).

To address the second scenario above, the distribution of the number of mature females at the start of 1994 in a discrete isolated stock in subarea 9 was obtained by generating 100 values from a log-normal distribution for the sighting survey estimate of the total (1+) number of animals in that subarea (8264, CV 0.396 - see Table 2) viz. :

$$P = 8264\, e^{\varepsilon - 0.396^2/2} \qquad \varepsilon \sim N(0; 0.396^2) \qquad (1)$$

For each of these 100 abundance estimates generated for subarea 9, the corresponding number of mature females was then calculated by assuming that the estimate corresponds to an unexploited state (this is a reasonable assumption because although some catch has been taken from subarea 9, the total number of animals harvested (27) is very small relative to the estimate of abundance from the sighting survey)

RESULTS

The results for trial NPM14b (a homogeneous O stock to the east of Japan, extending to 170°E) are shown in Table 3, and those for the case of an isolated discrete stock in subarea 9 are given in Table 4. The format used for presentation is similar to that developed for the NP minke trials.

Results are presented for four different levels of an annual research take: 50, 100, 150, and 200, as well as zero for comparative purposes. Although the take involved is, we understand, proposed for a single year only at this stage, the continuation of similar levels of research take for the next few years remains a possibility. Accordingly, it seemed best to us to present the results of projections for a five year, rather than a single year period. The results shown therefore reflect the assessed "worst case scenario" consequences of the levels of annual take investigated, when continued for the five year period 1994-1998.

Table 1 : The catch (and sightings) mixing matrices for trial NPM14b Periods 1, 2, and 3 refer to April - May, June - July, and August - September respectively.

	J - stock						O-stock					
Area	A'			B'			I'			J'		
Period	1	2	3	1	2	3	1	2	3	1	2	3
1	0.42	0	0	0.42	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0.26	0	0	0.26	0	0
3	0	0	0	0	0	0	0.16	0	0	0.16	0	0
4	0	0	0	0	0	0	0.11	0	0	0.11	0	0
5	0.28	0.56	0.56	0.28	0.56	0.56	0	0	0	0	0	0
6	0.14	0.18	0.21	0.14	0.18	0.21	0	0	0	0	0	0
7	0	0	0	0	0	0	0.07	0.13	0.15	0.07	0.13	0.15
8	0	0	0	0	0	0	0.04	0.08	0.04	0.04	0.08	0.04
9	0	0	0	0	0	0	0.11	0.19	0.16	0.11	0.19	0.16
10	0.14	0.27	0.23	0.14	0.22	0.18	0	0	0.06	0	0.06	0.06
11	0.02	0	0	0.02	0	0.03	0.18	0.23	0.09	0.18	0.17	0.09
12	0	0	0	0	0.04	0.02	0.08	0.36	0.5	0.08	0.36	0.5
13	0	0	0	0	0	0	0	0	0	0	0	0

Table 2 Absolute estimates of abundance used to condition the trial NPM145. These include both the estimates adopted by the 1993 IWC Scientific Committee for the purposes of conditioning of trials (Table 4 of Appendix 3 of Annex G of the 1993 Scientific Committee report), and more recent results from surveys conducted in 1992 (T. Miyashita, pers. comm.). As those latter surveys included coverage of only about 50% of the Sea of Japan (subareas 6 and 10), the actual estimates from the surveys in these two subareas have been doubled to provide the values shown below - an approximation which should be adequate for the purposes of the trial.

Subarea	Year	Estimate (c.v.)
6	1992	938 (0.475)
7	1990	1741 (0.655)
7	1992	1265 (0.623)
8	1990	1057 (0.706)
9	1990	8264 (0.396)
10	1992	2058 (0.497)
11	1990	2120 (0.449)
12	1990	15641 (0.363)
11+12	1992	11506 (0.453)

Table 3 Performance statistics for trial NPM14b. Results are shown for a no-catch scenario and for five different levels of constant annual catch in subarea 9. The management period is taken to be five years, commencing in 1994, in all cases. Results which differ from the no-catch case are given in bold typeface. The trial assumes that both the J and the O stocks have an MSY rate of 3% (in terms of the mature component of the population)

Stock	Initial Stock Size Absolute			Initial Stock Size Relative			Final Stock Size			Lowest Size		
	Median	5%	95%	Median	5%	95%	Median	5%	95%	5%	10%	25%
Catch	0											
J	1233	667	2493	0.219	0.130	0.366	0.225	0.134	0.377	0.130	0.146	0.184
O	6648	4553	8684	0.738	0.651	0.790	0.750	0.664	0.801	0.651	0.667	0.719
Catch	50											
J	1233	667	2493	0.219	0.130	0.366	0.225	0.134	0.377	0.130	0.146	0.184
O	6648	4553	8684	0.738	0.651	0.790	**0.741**	**0.652**	**0.794**	0.651	0.667	0.719
Catch	100											
J	1233	667	2493	0.219	0.130	0.366	0.225	0.134	0.377	0.130	0.146	0.184
O	6648	4553	8684	0.738	0.651	0.790	**0.732**	**0.641**	**0.786**	0.641	0.657	0.712
Catch	150											
J	1233	667	2493	0.219	0.130	0.366	0.225	0.134	0.377	0.130	0.146	0.184
O	6648	4553	8684	0.738	0.651	0.790	**0.723**	**0.629**	**0.779**	0.629	0.646	0.703
Catch	200											
J	1233	667	2493	0.219	0.130	0.366	0.225	0.134	0.377	0.130	0.146	0.184
O	6648	4553	8684	0.738	0.651	0.790	**0.715**	**0.618**	**0.772**	0.618	0.635	0.693

Note : Absolute values for stock size are given in terms of the mature female component of the population. The median values for the initial sizes of the J / O stocks in terms of this component are 1233 / 6648, whereas median values for the total (1+) population are 4839 / 25131 respectively

Table 4 : Performance statistics for catches in subarea 9 for the case in which this subarea contains a discrete stock with an MSY rate of 1% (in terms of the mature component of the population). The management period is taken to be five years in all of the trials. Results which differ from the no-catch case are given in bold typeface.

Initial Stock Size Absolute			Initial Stock Size Relative			Final Stock Size			Lowest Size		
Median	5%	95%	Median	5%	95%	Median	5%	95%	5%	10%	25%
Catch 0											
2120	905	5024	0.998	0.995	0.999	0.998	0.995	0.999	0.995	0.996	0.997
Catch 50											
2120	905	5024	0.998	0.995	0.999	**0.960**	**0.907**	**0.983**	**0.907**	**0.923**	**0.946**
Catch 100											
2120	905	5024	0.998	0.995	0.999	**0.922**	**0.818**	**0.967**	**0.818**	**0.851**	**0.895**
Catch 150											
2120	905	5024	0.998	0.995	0.999	**0.884**	**0.731**	**0.951**	**0.731**	**0.778**	**0.844**
Catch 200											
2120	905	5024	0.998	0.995	0.999	**0.846**	**0.644**	**0.935**	**0.644**	**0.707**	**0.793**

Note : Absolute values for stock size are given in terms of the mature female component of the population. The median value for the initial size of this component of the hypothesised stock is 2120, which is to be compared with the survey estimate of 8264 for the total (1+) population in subarea 9.

APPENDIX II

IS THE SUB-STOCK SCENARIO FOR MINKE WHALE STOCK STRUCTURE IN THE WATERS SURROUNDING JAPAN PLAUSIBLE ?

-- Counter argument to the Working Group on North Pacific Minke Whale Management Trials --

by

H. Hatanaka, H. Kato and S. Ohsumi

The Working Group on North Pacific Minke Whale Management Trials (hereunder referred to as the Working Group) did not adopt the assumption that there exist two separate stocks of minke whales in the western side of the North Pacific. Those are Japan Sea-Yellow Sea-East China Sea Stock (J Stock) and Okhotsk Sea-West Pacific Stock (O Stock), and this assumption was examined and recognized in the Comprehensive Assessment of the Scientific Committee in 1991 (IWC, 1992). This theory has been propounded based on biological information. Instead, the Working Group adopted the assumption of dividing the J Stock into three sub-stocks (J-I to J-III) and the O Stock into four sub-stocks (O-I to O-IV), and adding Western Pacific stock (W Stock). In this paper, the assumption by the Working Group is called "sub-stock scenario". This scenario assumes the presence of eight stocks/sub-stocks, which all move and mix in spatio-temporal terms. This paper is aimed at clarifying the basis for such sub-stock scenario and at assessing the scientific validity in the light of materials and knowledge made available to date.

1. Basis for sub-stock scenario

The basis for sub-stock scenario as it is described in the Working Group report (Annex G to IWC/45/SC Report) is as follows:

a. If the whale showed site-specificity to different feeding grounds, the available data did not preclude the possibility that there were sub-stocks in this area. (6.1.1 on Page 2 of the report).

b. The assumptions regarding site-specificity which are implicit in this structure were developed on the basis of the locations of past whaling grounds (IWC, 1992a, p.157;Fig.1), together with information on the times of the catches on each of these grounds (Appendix 2). The O-IV component contains whales which do not move close to the coast during their migration. Neither historic catch information nor geography suggests an obvious need for substructure for W Stock, so that none was assumed.(6.1.1 on P.3).

c. Extrapolated conception dates (Best and Kato ,1992) suggest possible mixing of J Stock whales east of Hokkaido and Honshu,

and O Stock whales into the Southern Sea of Japan. (6.2.3. on p.5).

d. The available data on allele frequencies provide no information on whether or not mixing occurs in these areas. (6.1.3 on p.5).

2. Plausibility of description in Working Group report

The following is an examination of validity of each item of the above description.

a. Site specificity to feeding grounds:

There is no evidence available showing that such a phenomenon exists. For example, the Working Group report classifies the stock feeding and migrating to the Okhotsk Sea (Sub-area 12), off Kitami (Sub-area 11) and off Sanriku and eastern Hokkaido (Sub-area 7) as sub-stock O-I, sub-stock O-II and sub-stock O-III, respectively. In other words, the borderline for such migration is fixed throughout the life history of whales. For example, then, the individuals which migrated to Sub-area 7 this year never enter the Okhotsk Sea next year. Species for which breeding area is fixed are often observed (humpback=Kato), but feeding area normally changes according to sea conditions, distribution of prey species, abundance of the species and growth stage of the individuals. Furthermore, The assumption that some individuals remained in the area off Kitami (Sub-area 11) and never enter northern area (Sub-area 12) throughout their life does not seem plausible in view of their migrating ability. In other words, fidelity to narrow feeding area for all life span conditioned under the sub-stock scenario is doubtful. Establishing sub-stocks purely because of the lack of definitive evidence to negate this possibility is hardly convincing. To then further treat these sub-stocks as stocks is extreme and unrealistic.

b. Whaling ground and whaling season:

It is a fact that there exist several independent whaling grounds and whaling seasons. This is caused from that Minke whale catcher boats were so small and their whaling grounds were formed within short distance from land stations which were used by them. Therefore, this fact in no way supports the sub-stock scenario. As will be shown later, it signifies catching from one stock in the course of its migratory route. The establishment of O-IV and W Stock will stress only longitudinal migration, thereby negating the northwestern direction element (southeastern direction element in the case of southward movement) from the offshore area toward the Japanese coast (Ohsumi, 1983).

c. Date of conception:

The Working Group noted that Best and Kato (1992) suggested that part of J Stock migrate in the Pacific and part of O Stock mi-

grate in the southern part of the Sea of Japan. However, this is a quotation from Omura and Sakiura (1956). MG/WP13 (1993) by Kato et al., which can be considered a revised version of the Best and Kato (1992), states that two individuals conceived in autumn--which is the benchmark individual of J Stock in Area 7--were observed. Viewed from the figure in MP/WP13, it is not appropriate to conclude that the individuals were ones which were conceived in autumn. The points for these two individuals (shown by arrows in Fig. 2) are not clearly separated from other points, and the conception date as counted backward from the large-size embryo is inaccurate. Therefore, this should be regarded as the middle-type individual which cannot be clearly classified in either group (Fig. 2). It was inappropriate to determine this whale to have been conceived in autumn. It is plausible to interpret that a tendency towards differences are observed among different stocks, not that the difference in gestation period determines the stock. In view of the relatively longer breeding period of minke whales as compared with other whale species, it is not appropriate to seek high precision in gestation period in making stock identification.

d. The Working Group actually decided to use information on allele frequencies from SC/43/Mi32 (Wada, 1991) as a primary base to determine the mixing of J Stock and O Stock in Sub-area 11. The statement in Section 6.1.3 that such data provide no information whether or not mixing occurs is a misunderstanding. It is important to take into consideration that the statistical test on Hardy Weinberg Expectations was highly significant in whales from Sub-area 11 but not in those from Sub-area 7 (Wada, 1991). This means that whales in Sub-area 11 is composed of more than two genetic groups but whales in Sub-area 7 of single genetic group. The Working Group also assumed entering of O Stock to Sub-area 6 (southern Sea of Japan). This is derived from Omura and Sakiura (1956) which reported the occurrence of winter conception foetus in Sub-area 6. But they never said that these animal migrated from the Pacific, and as it is discussed later the credibility of foetus data used is doubtful.

Summing up the above consideration, no evidence is found to support the sub-stock scenario and the basis for assuming their mixing (i.e. that J Stock moves to the Pacific and O Stock moves to the southern part of the Sea of Japan) is inadequate.

3. Other information to examine the plausibility of the O sub-stock scenario

In building up its hypotheses on stock structure, the Working Group report does not take into consideration such factors as segregation according to growth, sexual and maturity stages and changes in the whaling seasons and grounds, which is inconsistent with their hypotheses.

a. Omura & Sakiura (1956) stated that more large mature individuals were found in the northern area, while young small individu-

als were found in the southern areas (Fig. 3). They said that segregation according to growth stage was observed, with schools composed of mature individuals making northward feeding migration. Further, Ohsumi(1983), Wada (1989) and Kato (1992), which used data from commercial whaling in recent years, reported that the percentage of small individuals is higher in Sub-area 7 (the area off Sanriku) while large individuals formed the bulk of the whales in the northern area.

b. As regards sex ratio of caught whales, Ohsumi (1983) and Kato (1992) have compiled data made available to date. According to their studies, an obvious trend was observed on the Pacific side, with higher female ratio in the northern areas (See Table 1).

c. Wada (1989) showed that sex ratio and percentage of mature individuals changed according to area and season. Further, Kato (1992) showed that the percentage of immature individuals is higher for both sexes in the southern area (off Sanriku), and the appearance rate of pregnant individuals was higher in the northern areas, with 2% of all females in Sanriku (Sub-area 7), 17 % in eastern Hokkaido (Sub-area 7), and 23 % in areas off Kitami (Sub-area 11).

d. With respect to whaling seasons, Ohsumi (1983) compiled the past data and showed that, as an overall trend, the whale move northward from spring to summer. It seems that young individuals, mature females and males have different migration patterns, particularly on the Pacific side, and move along the coast after approaching the Sanriku and eastern Hokkaido (Sub-area 7) from the offshore area.

e. The Appendix 2 to the Working Group report shows the past catch by Japan and the Republic of Korea. Figure 4 shows these data disaggregated by area and two-month interval. It shows clearly that the whaling season moved from south to north both in the Sea of Japan and the Pacific/Okhotsk Sea. Further, Korean data show two obvious peaks in the southern part of the Sea of Japan, suggesting that the whales migrating northward and later those migrating southward had been caught in spring and autumn, respectively.

f. According to a study on external morphology submitted for the comprehensive assessment of the North Pacific minke whale (Kato et al., 1992), the color patterns of flippers are peculiar to J Stock, but individuals having such patterns are not found in the Pacific side.

g. No minke whales were found in the Tsugaru Strait as a result of 14-month sighting surveys from ferryboats traveling in the strait (Kawamura et al. 1983), suggesting that there was no mixing through the strait, or even if there was some, it was extremely small. (In the sub-stock scenario, it is assumed in option C that 30% of J-I sub-stock migrate to Sub-area 7 (the area off eastern Hokkaido and Sanriku)).

Summing up the above points, all the existing data deny the presence of fixed sub-stock in each area, but support the assumption that two separate stocks move northward and southward in the waters adjacent to Japan. Notably, the trend that many large individuals are found in high latitudinal areas and many young individuals in lower latitudinal areas--the trend consistently pointed out in many papers--is in common with the Antarctic minke whale. (IWC, 1979: Ohsumi et al., 1970: Kato et al., 1990: 1991: Fujise et al., 1993). It is concluded from this that the sub-stock scenario lacks plausibility.

Further, the Working Group report establishes O-IV which enters the Okhotsk Sea through offshore area (without moving close to the coast of Japan). But, as far as seen in existing data, many large individuals of O Stock may enter the Okhotsk Sea directly, without coming near to the Sanriku coast (Ohsumi, 1983).

4. Discussion

Three problems can be raised as regards the sub-stock scenario which the Working Group established for applying the RMP to the North Pacific minke whale: (1) whether there exist sub-stocks; (2) whether J Stock migrates to Sub-area 7 (the area off eastern Hokkaido and Sanriku) and O Stock migrates to Sub-area 6 (the area south of the Sea of Japan); and (3) whether W Stock, which is separate from O Stock migrating to the coastal waters of Japan and the Okhotsk Sea, exists (or, where is the eastern limit of the O Stock?). Each question will be discussed separately in the following.

1) Do O sub-stock exist?

If sub-stock existed with fixed feeding ground for each small Sub-area, as established by the Working Group, each sub-area should show similar size compositions (including small size to large size), maturity ratios and sex ratio (about 50%). Gaps may have arisen if the history of catch differs from one sub-stock to another, but those gaps may have been reduced over a span of several decades. For example, the percentage of small individuals was high in Sub-area 7 (the area off Sanriku) from 1948 to 1954 (Omura & Sakiura, 1956). After about 30 years, the percentage of small individuals remain high (Ohsumi, 1983) in spite of that small whales were exclusively caught in this sub-area. The sex ratio of females and ratio of large individuals were high in Sub-area 11 in 1950s (Omura and Sakiura, 1956), and the same phenomena continued in the same sub-area after about 30 years (Ohsumi, 1983). These facts cannot be properly explained by the sub-stock scenario.

Existing data and results of their analyses suggest that J Stock and O Stock whales migrate northward and southward in waters surrounding Japan and change their migration range according to growth stage, maturity and sex. At the same time, they deny the presence of semi-independent sub-stocks having fixed feeding

ground for each small area (as established by the Working Group). The Working Group itself said it has established sub-stocks because there is no evidence to deny the possibility that sub-stock exists, thus implicitly recognizing the lack of evidence to support the presence of sub-stocks. Moreover, the possibility that sub-stock exists was not mentioned in the Comprehensive Assessment of North Pacific Minke Whales in 1991, and instead two stocks of J Stock and O Stock or a stock structure resembling it was established (Rep. Int. Whal. Commn 42, 1992).

From the foregoing, it is clear that the sub-stock scenario is merely a mathematical idea that suddenly emerged from the discussion at the Working Group. The effect is to render the trials more difficult to pass, but for not reason based upon data, and therefore to have an unrealistic and inappropriate impact on catch limits. A doubt is raised in the Working Group report that "whether it is worth advancing the work under the condition where the possibility of zero catch limit to be calculated cannot be precluded."

Furthermore, to treat sub-stocks as stocks is an extreme and implausible approach. The two-stock structure, which had been propounded by many scientists and which was nearly agreed at the 1991 meeting, should be applied for the RMP trials.

2) mixing of J Stock and O Stock

The results of enzyme analysis (Wada, 1991) and data on the date of conception (Kato, 1992 : Kato and Kasuya, 1992: MG/WP13) both support mixing of the two stocks in the northern part of the Sea of Japan (Sub-area 10) and the area off Kitami (Sub-area 11). On the other hand, only Omura & Sakiura (1956) argue that both of autumn and winter conception groups appeared in Sub-areas 7 and 6. (They never said that J Stock enters to the Pacific (Sub-area 7) and O Stock enters the southern part of the Sea of Japan (Sub-area 6)). Data collected subsequently do not support their view. Further, the credibility of data used by Omura and Sakiura (1956) is doubtful, as far as foetus data are concerned. This paper was the first comprehensive paper dealing with minke whales in waters surrounding Japan, and has been quoted and referred to both by Japanese and foreign researchers for many years. The paper is considered to be evaluated highly as it introduced new knowledge such as whaling ground distribution and segregation. However, caution should be taken regarding the results of analysis for some specific types of data. The data which served as the basis of these studies include in part those collected by Sakiura but were mostly taken from whaling statistics based on the reports from small-type whalers. Small-type whaling was placed under the government's license system in 1947 (Ohsumi, 1974), but it is inconceivable that data concerning the minke whale which had not been subjected to the International Convention for the Regulation of Whaling, especially data on foetal size (which is definitely more difficult to obtain than size and sex data), were efficiently collected on small whaling vessels in the years immediately after World War II. Data from large-type fleet opera-

tion were barely collected in a satisfactory manners.

This issue has not been thoroughly resolved even for small-type coastal whaling until recently. Kato (1992) considered overall credibility of the data and conducted analyses using data from commercial whaling from 1977 to 1987 when the Far Seas Research Institute started collecting catch data of small-type coastal whaling. MP/WP13 added data from a highly credible test operation (1973-75) to the above data. Therefore, data in Fig. 2 do not include data source of Omura and Sakiura (1956).

From the foregoing, the possibility of mixing in Sub-areas 7 and 6 is questionable, and there seems to be need to reinvestigate this matter through new surveys.

3) concerning W Stock

The Working Group adopted a scenario that there exists W Stock which moves northward in the offshore area and enters the Okhotsk Sea, in addition to O Stock which moves longitudinally along the Pacific coast of Japan. However, no direct evidence exists for W Stock.

On the other hand, Ohsumi(1983) argued that whale migrate from the offshore to the northern part of Japanese coast and then they move northward. Some animals enter Okhotsk Sea directly through straits between Kurile Islands.

Minke whale commonly migrate into coastal waters and stay there. Small-type catcher boats can easily take them, if they were in coastal water. Until 1950s many small-type catcher boats widely operated around Japan throughout the year (Ohsumi, 1974). However, as far as the area in the south coast of Japan from Chiba to Kyushu (Sub-area 2) is concerned, only one minke whale was caught off Taiji during these decades (Omura and Sakiura, 1956). This denies that minke whale migrate northward along the Japan coast from Sub-area 2 to 7, and supports that minke come from offshore area in Sub-areas 3 and 4 to Sanriku and East-Hokkaido coast (Sub-area 7). In this case there is no need to assume W Stock.

Whatever the case that O Stock and W are an single stock or two separate ones, we have no materials and evidence for Sub-area 9. It will be necessary to gather new information through research concerning these issues.

5. Conclusion

This paper concludes that the sub-stock scenario for stock structure of minke whale in the waters surrounding Japan is not plausible. We must collect more biological data and materials to establish biological base for the RMP implementation applied to these whale stocks.

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0.9897 - 6%0004

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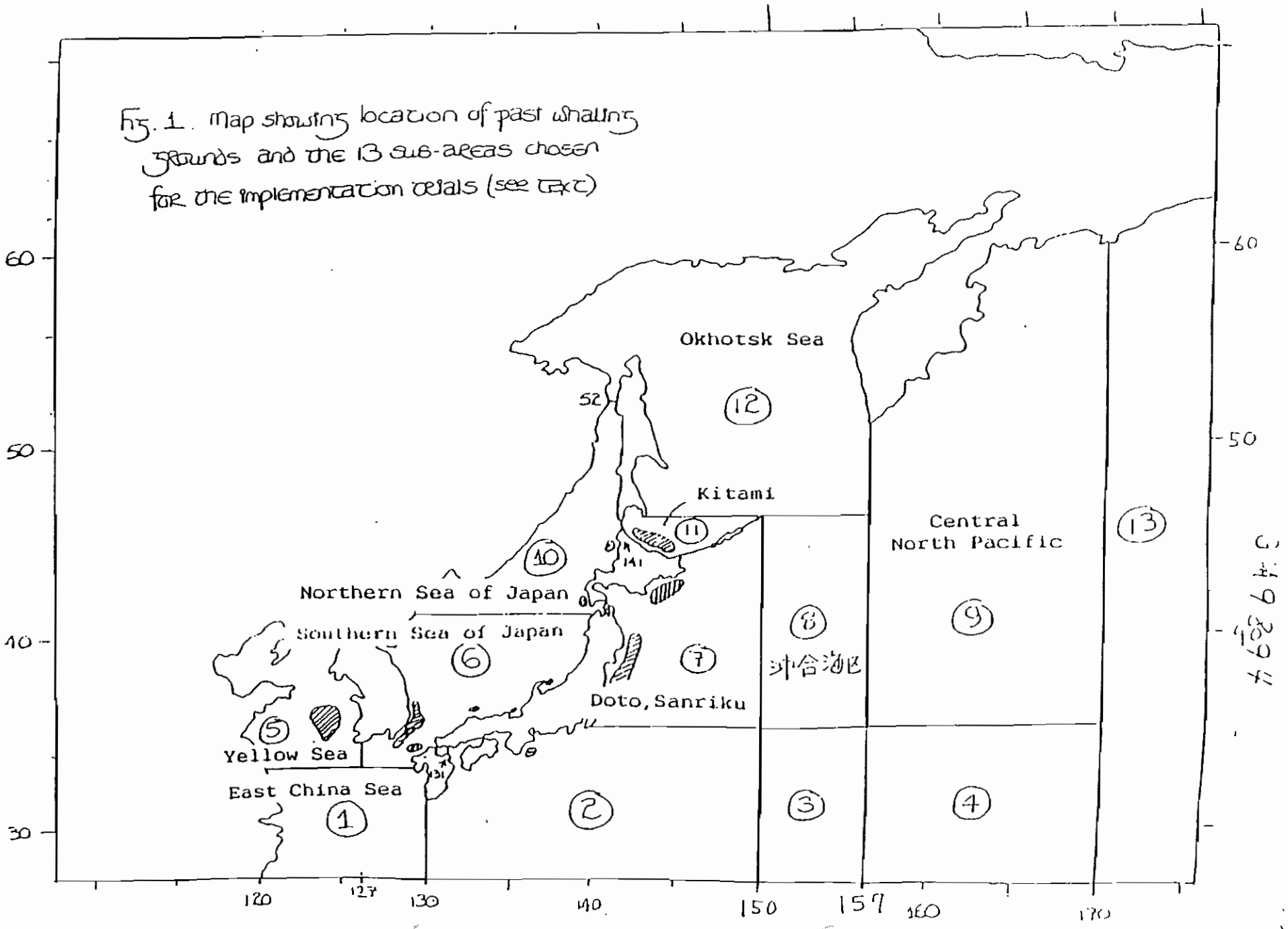
Table 1. Sex ratio (percentage of females) of minke whale in Northwest Pacific, modified from Ohsumi (1983) and Kato (1992). Figures in parentheses are number of specimens.

Sub-area	Matsuura (1936)	Omura & Sakiura (1956)	Ohsumi (1983)	Kato (1992)
Sub-area 7 East Hokkaido, Sanriku	-	38.0 (865)	41.4 (3128)	32.3 (2689)
Sub-area 11 Off Kitami	57.1 (7)	73.1 (622)	60.6 (2490)	69.9 (921)

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



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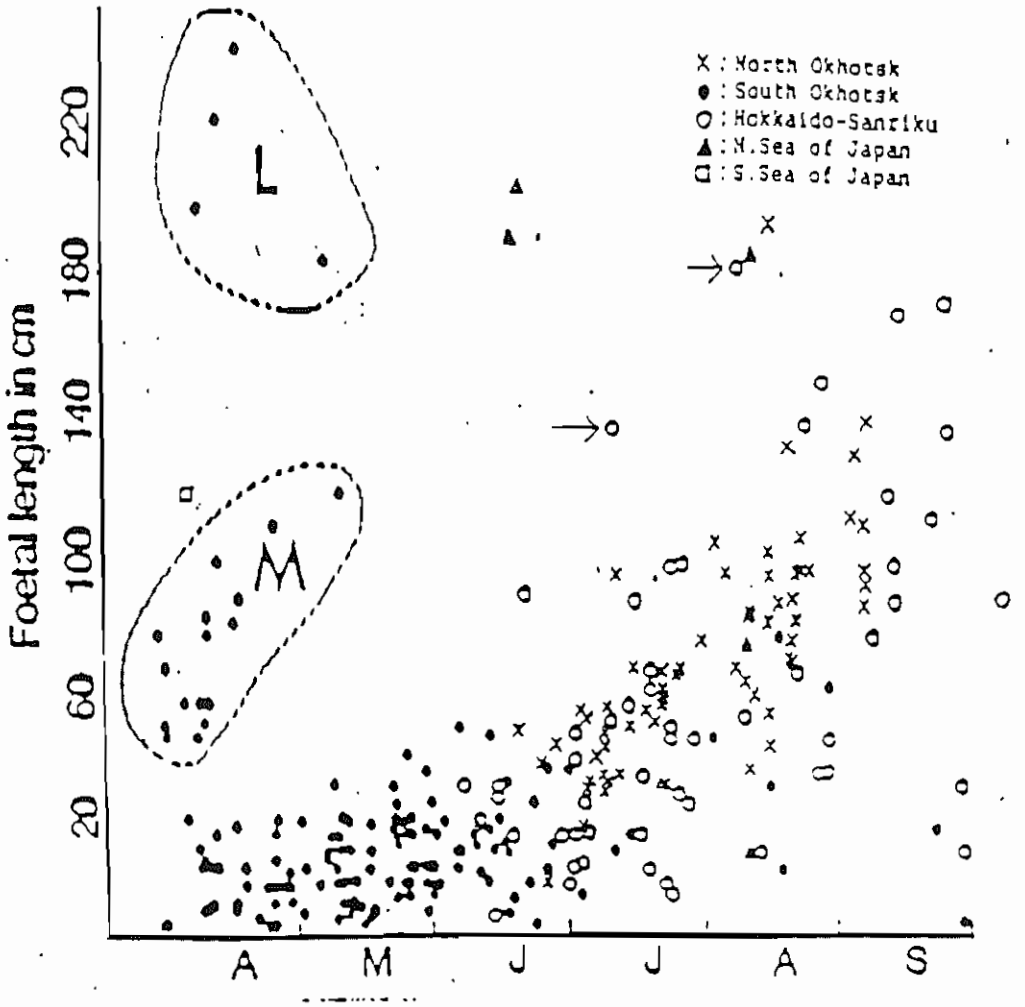

Fig. 2. Plots of foetal body length against collection date by whaling ground (from Kato et al., 1993). Arrow indicates individual which judged as autmn conception group.

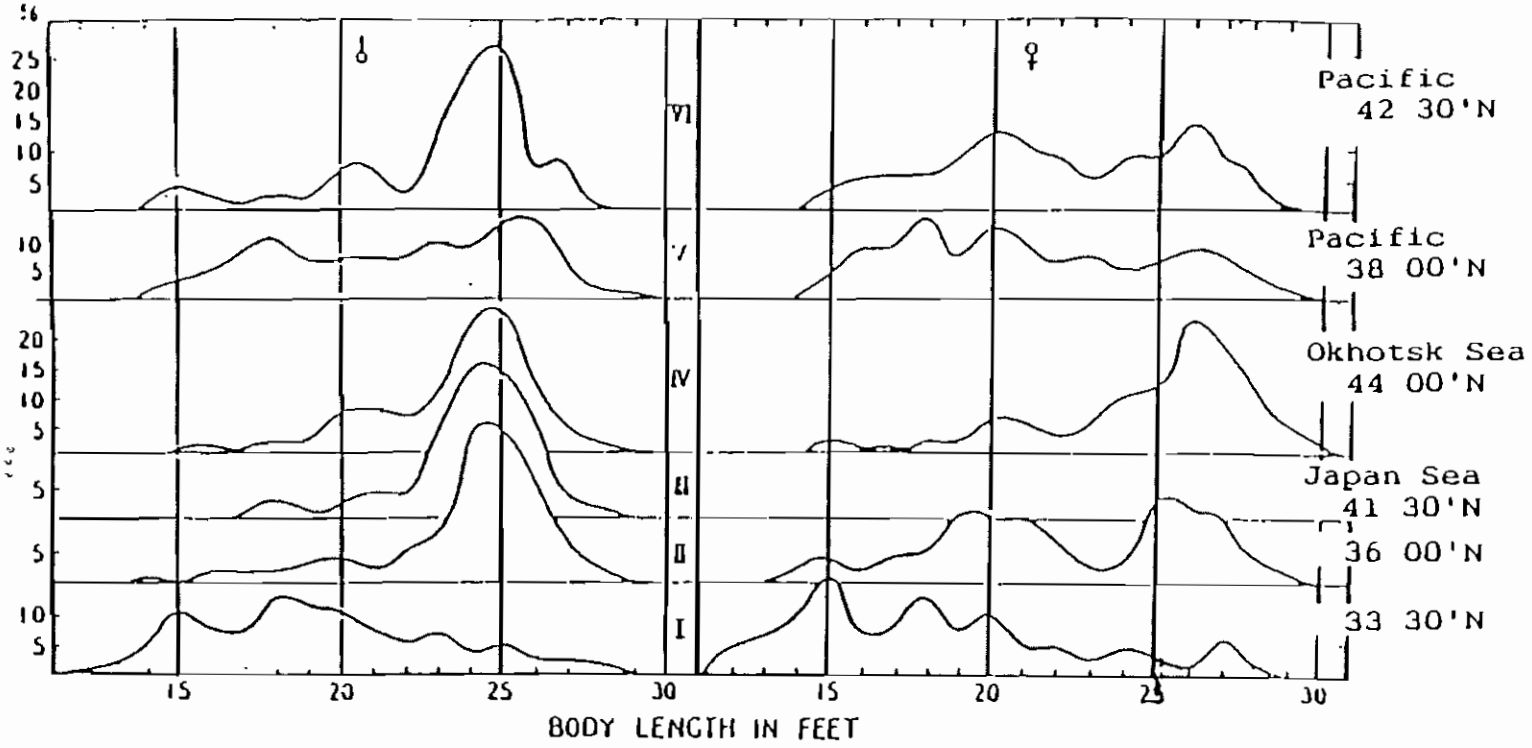

Fig. 3. Body length frequencies by area (1948-54) (from Omura and Sakiura, 1956). Latitudes are the center of positions caught.

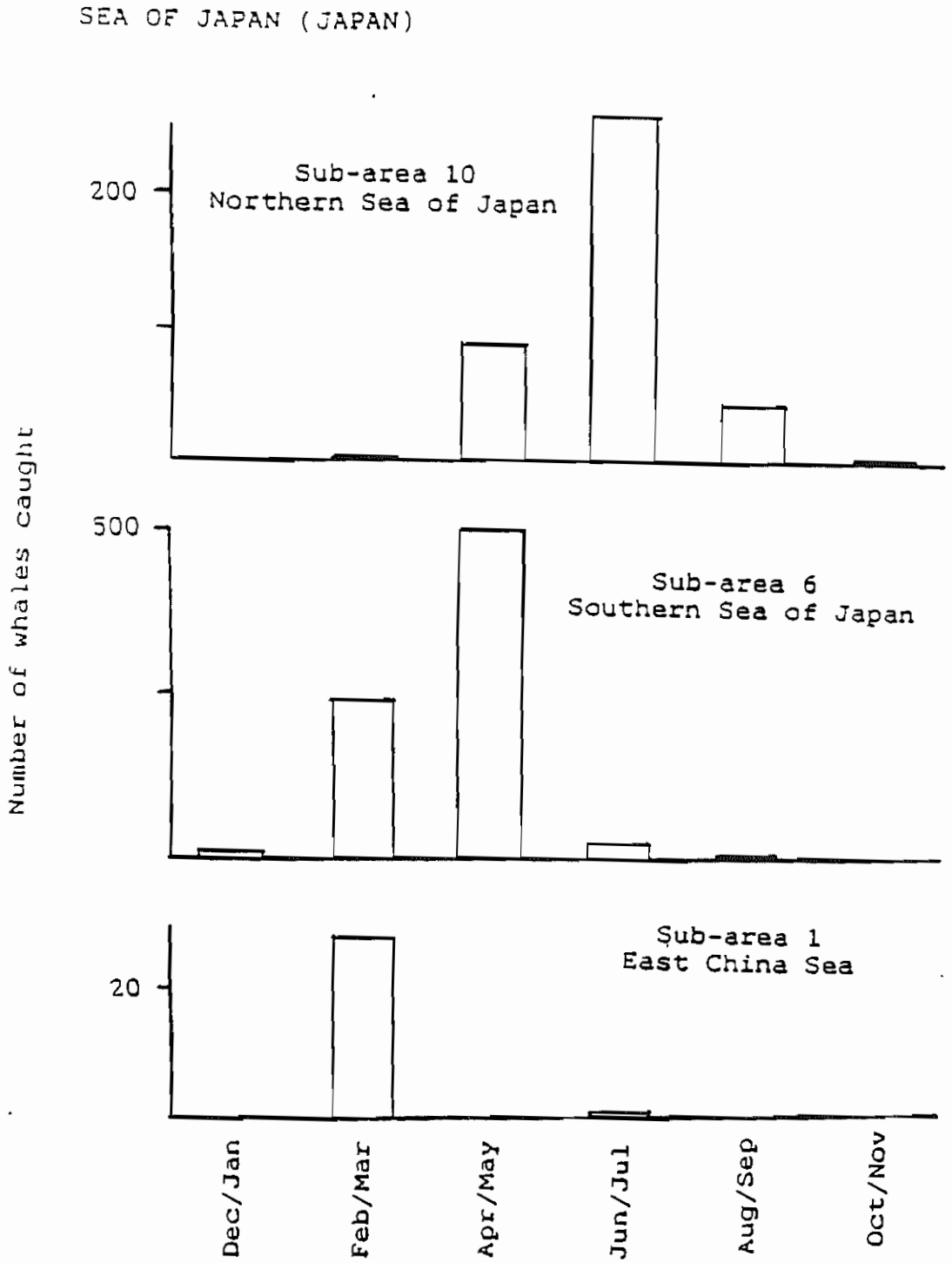

Fig. 4. Historical accumulated catch by two-months in each sub-area around Japan and Korea.

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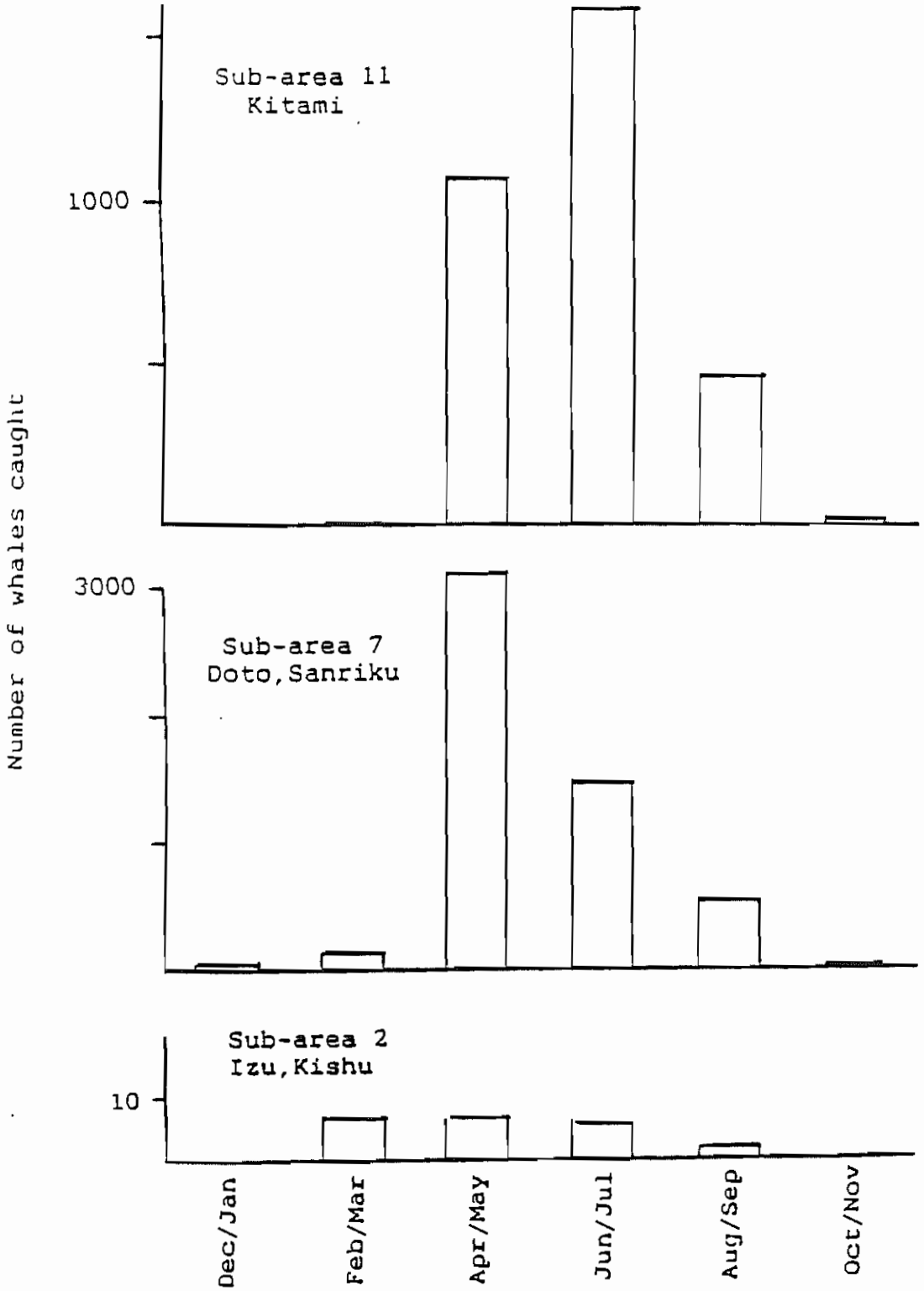

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SEA OF JAPAN - YELLOW SEA (KOREA)