

SC/41/SHM113

THE RESEARCH PLAN IN 1989/90 SEASON
IN CONJUNCTION WITH NOTE FOR "THE PROGRAM
FOR THE RESEARCH ON THE SOUTHERN HEMISPHERE
MINKE WHALE AND FOR THE PRELIMINARY
RESEARCH ON THE MARINE ECOSYSTEM IN THE
ANTARCTIC (SC/39/04)"

GOVERNMENT OF JAPAN

May, 1989

1. Background for the Japanese Research and Improvements Made Over the Original Program (SC/39/04)

1.1 Comments Received by the IWC on the Original Program

The Government of Japan presented to the 39th IWC Scientific Committee "The Program for Research on the Southern Hemisphere Minke Whale and for Preliminary Research on the Antarctic Ecosystem (SC/39/04)".

The main objective of this Original Program was to estimate the biological parameters for elucidating the population dynamics of the Southern Hemisphere minke whale. In particular, age composition of minke whales and estimation of the age specific natural mortality rates based on age composition data were recognized as principal items of the study.

The discussions carried out at the IWC Scientific Committee on the Original Program have been summarized in the Report of the Scientific Committee (Rep. Int. Whal. Comm. 38:55-58.). In regard to the research methodology, the discussions were focused on the following three questions:

- a) Possibility of estimating the age specific natural mortality rates using the information obtained from the age composition
- b) Collection of samples fully representing the migrating population to the Antarctic.
- c) Reliability of the estimates on the natural mortality rates.

1.2 Japan's Responce to the Comments

At the 39th IWC Scientific Committee, the Japanese scientists explained the scientific grounds for the validity and appropriateness of the Japanese research program. At the 40th IWC Scientific Committee in 1988, possibility of estimating natural mortality rate was shown on the basis of cohort analysis (Nakamura: SC/40/025) and the predicted accuracy of the estimated mortality rate was figured out (Tanaka and Sakuramoto: SC/40/023), so that the natural mortality rates effective for elucidating the population dynamics can be obtained.

Although a theoretically sound design was adopted in the Original Program for collecting samples that fully represent the population, it was impossible to know for certain whether the plan could be put into actual practice under the severe natural environment of the Antarctic. Consequently, it was decided that a feasibility study be conducted in advance of the implementation of the Original Program.

The Research Plan for the Feasibility Study (SC/D87/1) was discussed at the special meeting of the IWC Scientific Committee held in December 1987. Japan, taking into consideration effective suggestions derived from the discussion, carried out the feasibility study in a part of Area IV during the period December 1987 to April 1988.

Feasibility study for 1988/89 were carried out in a part of

Area V from December 1988 to April 1989, in accordance with the research plan distributed to members of the IWC Scientific Committee from the Secretariat on September 26, 1988.

1.3 Results from the Feasibility Studies.

Results from the 1987/88 survey were reported in two documents submitted at the 40th IWC Scientific Committee: preliminary analysis of biological aspects by Kato, Hiroyama, Fujise, and Ono (SC/40/Mi18), and analysis of sighting for various species of whales in lower latitudinal waters by Kasamatsu (SC/40/O22). In response to the requests for detail analysis, four documents were submitted to facilitate discussions at the 41th IWC Scientific Committee; estimation of abundance of minke whales by Kasamatsu, and Kishino (SC/41/SHMi1), age composition and segregation of minke whales by Kato, Kishino and Fujise (SC/41/SHMi2), biological parameters by Kishino, Kato, Kasamatsu and Fujise (SC/41/SHMi3), and oceanographical analysis on the southern minke whale distribution by Naganobu, Shimamoto and Kato (SC/41/SHMi18).

Out of the various information obtained from the feasibility study in 1987/88, the following four points have been recognized as significant results contributive to the design and implementation of the future researches.

- (i) It is possible to collect samples that represent the population : Minke whales sighted along the systematically designed trackline were sampled almost completely in accordance with the designed plan, so that it would be possible to estimate abundance of whales and biological parameters of the population without bias. However, the relatively low sampling efficiency from small schools has presented another problem to be resolved in the future surveys.
- (ii) The characteristics of the geographical distribution and the biological features by school size have been ascertained: Younger females tend to be seen off pack ice edge and in small schools, while older females near pack ice and in larger schools. Males do not show such segregation.
- (iii) A larger difference of the age composition exists between the samples collected by commercial whaling and that collected by the feasibility study: Because the commercial whaling selectively took larger size animals, the samples collected by commercial whaling consisted more of the animals of ages 15 to 20 and less of the animals of the younger ages. The most numerous of the animals sampled by the research, in comparison, are the individuals of ages 1 to 5, and the less number of animals as the age grows higher, as the result of the randomness of the sampling free from the size selectivity. The age composition estimated from the research sampling showed greater improvement than had been expected by many scientists. This improvement has significantly helped to

enhance the validity of the age composition used for the estimation of parameter values such as the natural mortality rates.

- (iv) For a higher accuracy of the estimation of the biological parameters such as the age specific natural mortality rate, an increased number of the samples will be required: The estimation with higher accuracy of biological parameter values such as the age specific natural mortality rates is difficult to achieve with age data based on the sample size of approximately 300 whales taken according to the rule in the current feasibility study.

Kato et al. (SC/41/SHMi14), and Kasamatsu and Shigemune (SC/41/SHMi15) submitted preliminary reports in relation to the feasibility study 1988/89 to the 41st IWC Scientific Committee for discussion. As in the case of the previous feasibility study in 1987/88, the samples collected by the current research in 1988/89 show the length composition, which show higher proportion of smaller animals than those in commercial catches, suggesting such samples are representative of the whales migrating to the Antarctic.

1.4 Improvements Made Over the Original Program

As outlined in the foregoing paragraphs 1.2, theoretically valid explanation has already been given by the Japanese scientists to the question raised against the objectives of the Original Program asserting that "it is theoretically impossible to estimate natural mortality rate by separating natural mortality rate from recruitment rate on the basis of age composition (Rep. Int. Whal. Comm. 38:56.)". A recent paper by Tanaka (SC/41/O15) provides further evidence that it is possible to separate natural mortality rate from recruitment rate, and to estimate natural mortality rate.

In the light of these progresses, and taking into account the actual circumstances encountered during the two feasibility studies carried out in the past, we have decided to improve the Original Program in the following three aspects:

- (i) To include monitoring recruitments among the principal subjects of the study: The flow chart of data and information originated from the survey and analysis on the Antarctic minke whale stock is given in Annex to the Research Plan for the Feasibility Study in 1988/89. The chart has been repeated as Annex 1 to this document. Estimation and continued monitoring of the number of recruitments by year (N_{1y}) is an essential factor for examining the present status and forecasting the future trends in the population dynamics. The feasibility study in Area IV brought about even more valuable results than had been anticipated, for it revealed that the age composition yield simple decreasing pattern starting with the largest group from age 1.

As the number of recruitment of 1-year-old minke whales are possibly estimated with less biases, the monitoring of recruitments is now enlisted to as one of the principal subjects of the study.

- (ii) Shorter interval between the sampling years: According to the original plan, age composition data are to be collected over two consecutive years in a given area. Thereafter, researches are continued for the ensuing two years (third and fourth year) in another area. Repeating the samplings in this manner, age composition data thus obtained in separate years are compared to estimate natural mortality rates. Recent development in age composition analysis since the original plan reveals that estimated mortality rates from age composition data in single research year are much improved in accuracy because of no noise generated by integration of two years data.

According to the feasibility study in Area IV, it is indicated that coefficients of variation in estimated number of animals (\sum Nat) are 0.26-0.65 (different by research vessels) and standard error in pooled age composition by five years of age are 0.053, where P is 0.33, in 1-5 years old group and 0.023, where P=0.10, in 21-25 years old group.

Tanaka's method for estimating natural mortality rates (SC/41/015) indicates that more effective estimates can be expected from improved accuracy of sighting results (\sum Nat) rather than increase of samples for age composition data.

For the reasons mentioned above, the interval between research years are to be shortened from two years to one year and Areas IV and V are covered alternately.

- (iii) Survey by line transect method: In the original plan, sampling was designed to collect whales in nearest distance from a designated station selected at random, while sighting for abundance estimates were to be made by other research vessel exclusively assigned for sighting. However, it was learned that sampling by nearest distance method may not theoretically yield unbiased age composition of the population, and that cost for its implementation is high. Since Japan had to provide research vessels for IDCR, remaining facilities available for the national scientific research were limited. To overcome these problems, the two feasibility studies carried out in the past were designed in such a way that sighting and sampling of whales by the line transect method are conducted concurrently by the same vessel. The plan was put into practice with little difficulty and the various required studies such as the estimation of biological parameters were carried out with relative ease, as summarized in the "Results of the Feasibility Study". Hence, for the future researches, the nearest

distance method as planned in the Original Program was replaced by a scheme in which sighting and sampling are carried out concurrently by a single vessel steaming along a systematically designed trackline.

2. Research Plan in 1989/90

2.1 Objectives

The item 1.4 (i) explained above is to be added to the objectives given in the Original Program (SC/39/04).

2.2 Number, Sex and Stock of the Whales to be Sampled

Sample size amounting to more than 300 whales would be desirable to ensure the statistical accuracy of estimated natural mortality rate. On the other hand, there are no facility such as research vessels for 1989/90 season to implement sampling of 825 whales in a year. Therefore, number of samples would be decided later after careful consideration of the balance between expected accuracy and research capacity.

Samples are to be collected without predetermination of sexes.

Samplings are to be made in Area IV.

2.3 Opportunities for Participation by Foreign Scientists

Refer to item 6-1 of the Original Program (Annex 2).

2.4 Expected Effects of the Catches on the Stock

The 40th IWC Scientific Committee was agreed that the total population of 72,357 (cv: 0.156) in Area IV south of 60° S and the takable population of 47,611 (CV: 0.1610) are to be adopted as the best estimates. The Scientific Committee also estimated the total population and takable population for the western half of Area IV (70°- 100°E) as 19,980 (cv: 0.181) and 13,147 (cv: 0.185), respectively.

The Sub-Committee on the Southern Hemisphere Minke Whale in the same year made a trial calculation on the RY adopting Pella-Tomlinson model under the MSY rate of 1-4%. The replacement yield (RY) for 1988, obtained from the recruited population of the animals aged 6 or more, was 314-872. The RY was 161-377 when the assumption was adopted that the recruited population in the western half of Area IV constitute a single stock.

With these calculations in mind, the Sub-Committee

noted, as a most pessimistic assumption, that the take of 300 whales may exceed the RY if the sampling of all of 300 samples were concentrated in the area of 70° - 100°E.

Such concerns as expressed by some members of the Subcommittee will be totally unwarranted, since the plan for the sampling scheme is designed so as to avoid concentration of sampling within any specific waters of Area IV and to make collection of samples in proportion to the density distribution throughout all the waters of Area IV. In addition, the result of the feasibility study has revealed that the age at recruitment of research take is age 1, instead of age 6 which was believed by the data of commercial whaling in the past. For this reason, it is obvious that RY should not be calculated at age 6.

2.5 Research Method

(i) The Waters to be surveyed and the composition of the research fleet

Sampling and sighting surveys will be conducted in the waters south of 60°S in principle. In addition, sampling and sighting surveys will be carried out also in the waters 55° - 60°S in Area IV at least during the leg to and from the waters described above. Further, independent sighting surveys will be conducted in the mid-to-low latitudinal waters.

The research fleet will be of six vessels in total, consisted of 1 mothership, 3 sampling vessels to be used for sampling and sighting and 2 sighting vessels to be used for sighting in the mid-to-low latitudinal waters.

(ii) Stratification of the designated waters of the survey

Research efforts are to be distributed throughout Area IV south of 60°S stratified latitudinally into two strata.

(iii) Consideration for analysing the seasonal and areal factors for biological parameters

The survey will follow the cruise trackline in the predetermined order shown in Fig. 1 in order to collect samples that are effective for elucidating the segregation of the whales in relation to their migration pattern and biological parameters. As a result, sampling will be carried out twice in the same waters at different times, making it possible to analyse the changes by season and area.

It will be necessary to steam to the next starting point of the survey without research operations during the night to ensure that the cruise trackline is distributed as widely as possible within the designated waters for the survey. The schematic diagram for the trackline is, in

survey. The schematic diagram for the trackline is, in principle, given in Fig. 2.

(iv) Trackline for the survey

Refer to Fig. 1. Fig. 1 shows the basic trackline. Three sampling vessels will operate independently on the basic trackline with given intership distance away from each other to conduct sighting and sampling.

(v) Collection of samples within the schools

As in the case of the previous two feasibility studies, trials are to be made to sample all of animals of single-animal-schools and two from two-and-more-animal-schools.

(vi) Collection of samples of cetaceans other than minke whales

This is not planned for 1989/90.

(vii) Accuracy of estimation of natural mortality rates

One of the most outstanding features of the Japanese research program is in its design of making it possible to evaluate the accuracy of estimation and to improve the accuracy by repeating surveys. While the detailed analyses are conducted by Tanaka (SC/41/015), at least the following expression is possible. For reference, coefficients of variation of the estimated stock size (N) and age composition (p) achieved by the feasibility study in 1987/88 are shown in 1.4 (ii). In addition, Tanaka (SC/41/015) demonstrates that the estimate of natural mortality rates (M) in its accuracy is largely dependent on the accuracy of estimated N.

The expected coefficient of variation of the estimated age composition based on the sample size, say, amounting to 400 is approximately 0.5 when p is 1%. If this value is assumed, the error at around 0.15 of the deviation of age specific natural mortality coefficient (Ma) from the average (\bar{M}) would be obtained when surveys are repeated every two years for 6 - 8 times. With this magnitude of error, changing rate of Ma larger than 0.006/year could be detected.

(viii) Other Matters

The relationship between the Japanese Research Program

and the Comprehensive Assessment is given in Annex 3. The general applicability of non-lethal methods for the subjects of study of the Japanese research plan is itemized in Annex 4. The lethal method heretofore adopted pursuant to Schedule III will continue to be employed in 1989/90.

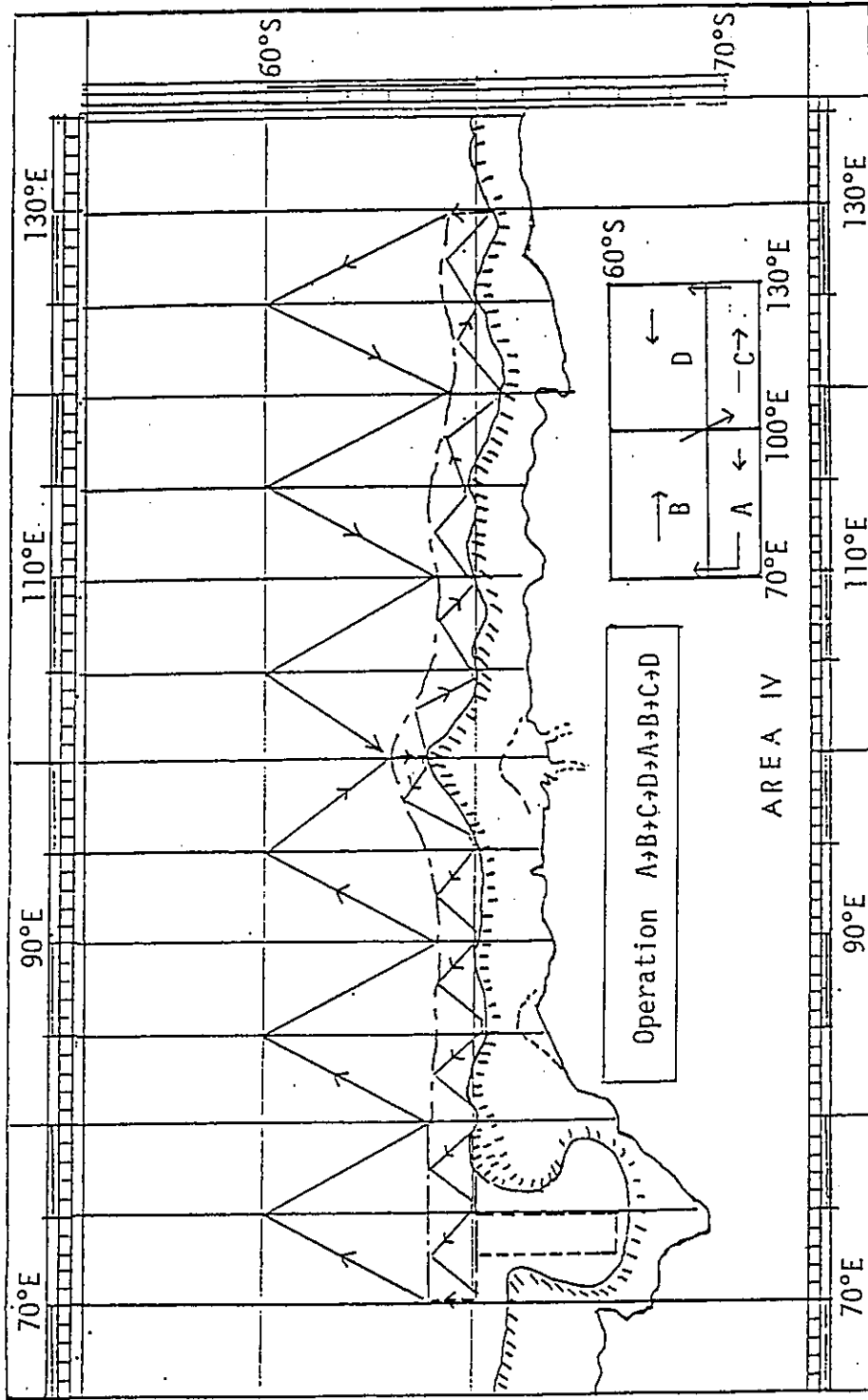
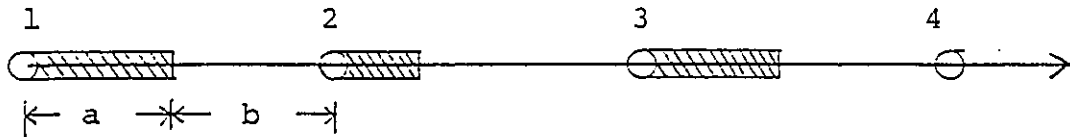


Fig. 1. Sampling and sighting area of the 1989/90 research plan with breakdown of strata and an example of tracklines in each stratum.



- 1; Start point on i th day
- 2; Start point on $(i+1)$ day
- .
- .

- a; Trackline with effort
- b; Trackline without effort
(Top-down steaming or night steaming)

Although a and b are variable according to weather.
and whale density (a+b) is constant.

Fig. 2. Illustration of trackline with effort and without effort.

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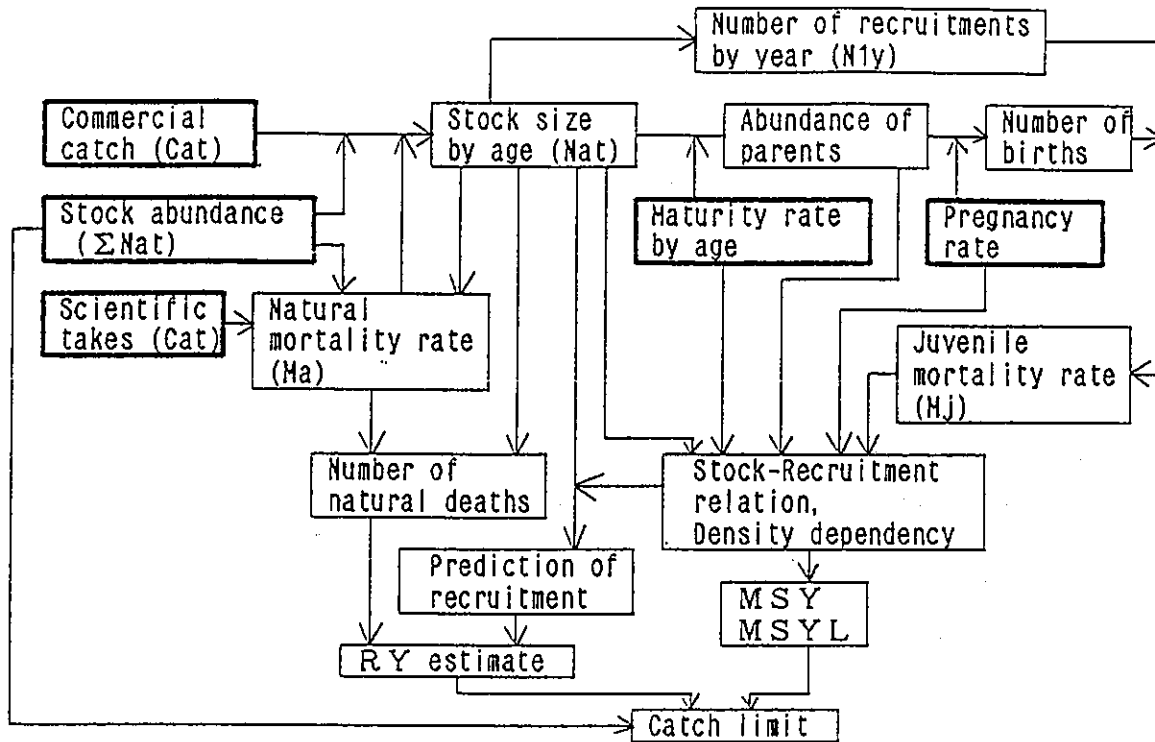
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ANNEX 1. Flow chart of data and information originated from the survey and analysis on the Antarctic Minke Stock.



NOTE: The items boxed with bold-type lines are materials and estimates directly obtainable from the sampling and sighting survey. The items boxed with fine lines are the information obtained by the analyses of the foregoing estimates and materials.

Notation for the suffix

a;age

j;age at juvenile

t;year

y;year class

ANNEX 2.

Extract from SC/39/04, the programme for research on the southern hemisphere minke whale and preliminary research on the marine ecosystem in the Antarctic.

(5) Opportunities for Participation by Foreign Scientists

Opportunities for participation in the research cruises under this program will be given to any scientist to the extent allowed by accommodation and other logistic consideration, provided that such participation does not cause inconveniences in the implementation of the program. The selection of the participants, however, will be finalized by the Whale Research Coordinating Committee who will consider the various conditions such as accommodation and others for determination.

(6) Conditions for Participation

i) Costs:

Costs for participation, travel expenses to and from the port of boarding the research vessel, meals on board the research vessel, and any special instruments required by the participant will be borne by the participant.

ii) Indemnification and insurance for casualty or personal injury on board the research vessels:

The Whale Research Institute and the crew of the research vessel or research team will not be held responsible for any casualty or personal injury to the participants resulting from the participant's negligence or force majeure.

iii) Cancellation of participation:

Any participants who are found to have intentionally sabotaged in the course of implementation of the researches and thereby impaired the execution of such researches shall be cancelled of his/her participation in this program.

ANNEX 3. The relationship between
Japanese research programme and Comprehensive Assessment

Summary of discussion at the 40th IWC/SC on C. A.	Japanese Research Programme
<p>1. Biochemical Genetics:</p> <ul style="list-style-type: none"> i) Allocation of fund proposed for contract studies on DNA for stock identity and school structure. ii) Recommendation of coding of existing tissue samples by the Secretariat. iii) Facilitation of the exchange of cetacean tissues between scientific institutions. iv) Recommendation of IWC Workshop on the genetic and biochemical analysis of tissue samples collected by biopsy sampling and other means. <p>2. Analysis of Southern Hemisphere minke whale marking data:</p> <ul style="list-style-type: none"> i) Analysis of the effects on heterogeneity in the probabilities between the marking and re-capture on mark-recapture estimates. ii) Recommendation of implementation of the study on the mark shedding mortality of short term based on firing experiments and natural mark recoveries on board the Japanese factory ship in the past. iii) Completion of the data registration by the Secretariat. 	<p>1. Samples from 273 individuals (154 males, 119 females) have been collected from 1987/88 research. It is expected that the sampling of the similar level will be conducted in 1988/89. Simultaneously, the analyses of the collected samples will commence.</p> <p>2. Filling of data on the newly recaptured whales.</p>

ANNEX 3 (continued)

Summary of discussion at the 40th IWC/SC on C.A.

3. Analyses of the Southern Hemisphere non-minke sighting data:

4. Photo-identification;

i) Endorsement of the conclusion by the Working Group.

ii) Proposal for funding of the computerization of the natural marking records of the whale species.

iii) Proposal for funding of the analyses of the whale photographs taken during the IDCR Sighting Cruise in the Southern Hemisphere.

5. Feeding Ecology:

In relation to the proposed joint-workshop with CCAMLR, and the review and preparation of the paper for the workshop, the following items have been raised:

a) Estimates of abundance for minke whale and other species from IDCR cruises by the most detailed geographical breakdown possible.

b) Review of available information on the southern baleen whales including prey species and size composition by month and year and locality, stomach fullness and nutritive value of prey where possible.

Japanese Research Programme

3. 138 individuals, 71 schools of humpback, fin, right, sei and sperm whales were sighted by 1987/88 research.
The similar research is scheduled in 1988/89.

4.

iii) Material collected in 1987/88 research will be offered.

5. The relevant information regarding the waters between 105°E and 115°E will be provided.

b) Providing the information on minke whales. Basic information will be made available.

ANNEX 3 (continued)

Summary of discussion at the 40th IWC/SC on C.A.

Japanese Research Programme

- c) Analysis of new information on diet and the feeding rate of minke whales.
- d) Review of morphological feeding adaptations in baleen whales.
- e) Review of feeding strategies in baleen whales particularly energetic implications of food-gathering.
- f) Review of available knowledge on summer krill distribution in the Antarctic, including diurnal movements and swarming behavior.
- g) Review of distribution of commercial krill fishing activities and catches within the Antarctic.
- h) Analysis of body condition (blubber thickness, girth, carcass lipid content) of baleen whales in relation to food availability.
- i) Review of annual trends in growth and reproductive rates of Antarctic baleen whales.
- j) Analysis of variations in oil yields from commercial whaling operations in the Antarctic.
- k) Analysis of IDCR data on school size, diving/feeding behavior of minke whales in relation to abiotic factors (e.g. proximity of ice edge, sea surface temperature, whale abundance, etc.).

c) Same as above.

h) Information on minke whales will be provided.

i) The recent information on minke whales will be made available.

k) It is possible to obtain more detailed information than the one obtained by IDCR. This can be made available.

Summary of discussion at the 40th IWC/SC on C.A.

6. Catch Curves:

A small group was formed to make estimates of the net recruitment rate and natural mortality. The group has met to agree on the protocol for these studies and the analyses of the result will be conducted in the next annual Scientific Committee meeting.

7. Management Procedures:

- i) Recommendation for consideration how to proceed with the further evaluation of management procedures.
- ii) Recommendation for funding of the participating scientists to the workshop meeting.

8. Biological Parameters:

The Scientific Committee has noted its importance and recognized the need of further consideration at next year's Annual Meeting.

9. Sighting Survey:

- i) Repeating of recommendation up to the previous year regarding the continuation of monitoring studies including Antarctic IDCR cruise and NASS, etc.
- ii) Recommendation for the continuation of the aerial survey of the right whale off South African coasts.

Japanese Research Programme

6. This subject is one of the most important objectives of the Japanese original research programme.

8. This subject is one of the most important objectives of the Japanese original research programme. The Japanese preliminary research generates useful information also.

9. Providing the information of the quality about the same level as that provided by the IDCR.

Summary of discussion at the 40th IWC/SC on C.A.

10. Telemetry and remote sensing working group:
- i) Recommendation of mounting of a dual beam interferometer on the satellite in future.
 - ii) Recommendation for more adequate funding to allow the development and use of telemetry to progress rapidly by the member nations.
 - iii) Recommendation for continuous funding for several years for the special requirement of this work.

11. Follow up to CPUE Workshop:

12. Estimating MSY rate:

- i) The Scientific Committee agreed on the importance of this work and recommended that papers dealing with this should be prepared for the next Annual Meeting.
- ii) Examination and re-analysis of the existing data, consideration for design for collecting adequate data and procedures for analyzing them, and justification for inter-stock comparisons were agreed.

13. Data Inventories:

14. Priority Groups/Stocks:

Priority was given to the Southern Hemisphere minke whale as substantial work on this stock is underway.

Japanese Research Programme

12. This subject is one of the most important potential of the Japanese original research programme.

13. Japan is prepared to provide the list of the data for data inventory.

14. Judging from the foregoing items, it is obvious that the Japanese research programme has a great deal of contribution to the Comprehensive Assessment.

ANNEX 4. The generation of data in the Japanese research Programme

Subject for study	Materials	Methods in the plan	General applicability of non-lethal method
Stock Size	Sighting	non-lethal	yes
Population size at age (*)	Sighting + Age	non-lethal + lethal	no
Basic studies for the sighting survey	Sighting	non-lethal	yes
Probability of sighting and effective search width by school size	Sighting	non-lethal	yes
Age and growth (*)	Body length	lethal (exact) / non-lethal (approximately)	yes (inaccurate)
	Body weight		
	Foetal length and weight		
	Corpus luteum	lethal	no
	Earplug		
	Tympanic Bulla		
	Baleen plate		
Reproductive Status (*)	Sex, Lactation	lethal/non-lethal	yes
	Age, Mammary gland		
	Milk		
	Ovarian corpora		
	Uterine horn		
	Endometrium	lethal	no
	Uterine fluid		
	Testis, Epididymis		
	Gonadal hormone		
	Foetus		
	(sex, number, length)		

ANNEX 4 (continued)

Subject for study	Materials	Methods in the plan	General applicability of non-lethal method
Stock Identity			
Possibility of Individual recognition	Photographs	lethal	almost impossible
Morphological analysis	Allometry (including Foetus)	lethal	no
Bio-chemical analysis	Skin Muscle, Liver, Heart, etc.	lethal/non-lethal lethal	yes no
Nutrition	Blubber thickness Stomach contents Lipids	lethal	no
Migration	Diatom film	lethal	yes
Environment			
Oceanography			yes
Pollution	Tissue, Blood Foetus	lethal lethal	no no
Random sampling			
Biological Characteristics by School Size		lethal	no
Enhancement of sampling efficiency from small schools		lethal	no
Analysis of Segregation		lethal	no
Others			
Skeleton		lethal	no

(*) : Including the study of catching selectivity by commercial whaling.