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The Research Plan for the Feasibility Study on  
"The Program for Research on the  
Southern Hemisphere Minke Whale and  
for Preliminary Research on the  
Marine Ecosystem in the Antarctic"

The Government of Japan

October 1987

## 1. INTRODUCTION

The Government of Japan presented to the International Whaling Commission (IWC) at its 39th annual meeting "The Program for Research on the Southern Hemisphere Minke Whale and for Preliminary Research on the Marine Ecosystem in the Antarctic" (SC/39/04) (to be referred to as "the original program" hereafter) as a research to be implemented according to Article VIII of the International Convention for the Regulation of Whaling (ICRW) for the following purposes:

- (a) Estimation of the Biological Parameters Required for the Stock Management of the Southern Hemisphere Minke Whale
- (b) Elucidation of the Role of Whales in the Antarctic Marine Ecosystem

The Scientific Committee of the IWC (IWC/SC) reviewed the original program along its procedures and asked for the comments of its members. Several issues were brought up regarding the original program, which can be summarized into the following three questions:

- (1) Whether determination of age-specific natural mortality coefficient is possible by using the method of analysis and sample size (825 samples/year) proposed in the original program
- (2) Whether collection of samples fully reflecting the population is possible by the original program
- (3) Whether the results obtained by the original program will contribute to the Comprehensive Assessment carried out by the Scientific Committee of the IWC

The Japanese scientists noted that, from a scientific viewpoint, answers to the above three questions have already been provided during the Scientific Committee meeting of the 39th annual meeting of the IWC. However, the following examinations were made to promote further understanding on the questions raised at the meeting of the Scientific Committee.

Regarding question (1), it was noted that a simulation study based on the rationale outlined in Annex R2 of the Report of the Scientific Committee (IWC/39/4) is under way, and that the analyzed results will be presented to the Scientific Committee meeting in 1988. As to question (3), it was re-confirmed that the data to be newly collected by the original program will make substantial contribution to the Comprehensive Assessment not only because they are useful for evaluation and correction of the vast amount of data and resultant biological parameters on the stock accumulated by past commercial whaling operations but also because information from sampling and sighting information on the whale density can be acquired simultaneously from the original program.

It was recognized that for a more intensive review on question (2), and also because decision was made to provide for the coming IWC/IDCR Southern Hemisphere Minke Whale Assessment Cruise the research vessels which had been allocated to the sighting survey in the original program, it would be necessary to carry out a supplementary research the purpose of which is outlined in Section II. Consequently, a program titled 'The Research Plan for the Feasibility Study on "The Program for Research on the Southern Hemisphere Minke Whale and for

Preliminary Research on the Marine Ecosystem in the Antarctic" (to be referred to as "the preliminary research" hereafter) is now newly developed. It was decided that the sample size to be taken for the preliminary research should not exceed 300 minke whales.

As outlined above, the preliminary research constitutes a part of the original program presented to, and reviewed at, the Scientific Committee meeting of the 39th annual meeting of the IWC and it does not change, in essence, the contents of the original program. The samples to be taken are used for the purpose of the preliminary research but maximum biological informations are also collected from them along the line of the original program. These studies will include preliminary research and feasibility study on biopsy as a practical new technique for future cetacean research.

The study on sperm whales included in the original program will not be conducted under the preliminary research.

## II. PURPOSE OF THE RESEARCH

The preliminary research will be conducted in order to determine whether collection of samples fully reflecting the southern hemisphere minke whale population is possible through implementation of the original program. Details are as follows.

1. The feasibility study of the newly refined sampling scheme (refer to SC/39/04 Appendix 3, addendum) designed

for stochastic sampling in the original program (e.g. whether the required number of samples can be collected by the designated method within the given period).

2. The feasibility study on the technical problems encountered in the survey by the sampling vessels which collect sighting data and whale samples concurrently.
3. Investigation on the extent of segregation by age, sex, reproductive condition, etc. in the distribution of the southern hemisphere minke whale, from samples collected from an area extending widely north and south.
4. Investigation on the uniformity or non-uniformity of the biological characteristics according to school size.
5. Sighting survey in low-latitudinal waters in order to examine the stock identity, estimation of reproductive parameters, timing of migration, whale density etc. of the southern hemisphere minke whale as shown in the original program.

### III. ITEMS FOR THE PRELIMINARY RESEARCH

#### A. Research Items

For purposes 1 and 2: Studies should be conducted on the following items;

- (1) Collection of the time budget for sampling and sighting survey (adopting a similar type of searching effort and recording for the time budget as those used for the IWC/IDCR Southern Hemisphere Minke Whale Assessment Cruise)

(2) Examination on the relationship between sampling and sighting survey, and weather and sea conditions

(3) Observation of whale behavior against the sampling vessels  
[behavior of the whales when approached by the sampling vessels] will be studied

For purpose 3: Biological characteristics according to latitudinal and seasonal changes, from the samples and analyzed data collected by the sampling scheme outlined in Section VII, are to be obtained.

(1) Comparison among latitudes and among seasons on school size and whale density

(2) Comparison among latitudes and among seasons on age composition from the samples collected

(3) Comparison among latitudes and among seasons on other biological characteristics (sex, length, reproductive condition, apparent pregnancy rate and age at sexual maturity) from the samples collected

For purpose 4: In the preliminary research, two samples are randomly collected from all sighted schools (one sample in case of a single-whale school), as described in Section VII. By this sampling procedure, unbiased samples regarding school size and latitude can be obtained. These samples will be used for investigating the relationship between school size and its structure (age, sex, length, reproductive condition, etc.), together with the change of these biological characteristics by season and by latitude.

For purpose 5: Sighting survey will be carried out in the low latitudinal waters for collecting the following information;

- (1) whale density
- (2) frequency and distribution of cow-calf pairs
- (3) whale behavior

#### B. Other Researches

##### 1. Preliminary Study on Biopsy

- (1) Development of Biopsy Dart and Feasibility Study on Biopsy Sampling to the Minke Whale
- (2) Basic Study for Establishing a Standard for Analyzing the Samples Collected by Biopsy

Basic study will be conducted for obtaining biological information from blubber tissues and blood samples that are expected to be collected by biopsy sampling in future.

##### 2. Other Biological Studies

Efforts will be made to obtain maximum biological information from samples taken under the preliminary research. Details on the specific items of biological studies have been presented to the Scientific Committee meeting of the 39th annual meeting of the IWC (SHMi/WP9).

#### IV. RESEARCH AREA

The area between  $105^{\circ}$  -  $115^{\circ}$  E, from the ice-edge to  $60^{\circ}$  S and  $55^{\circ}$  -  $60^{\circ}$  S, (refer to Fig. 1) has been designated as the sampling area for the preliminary research. This area was considered to be most suitable for studying the north-south

movement of the minke whale. The area was also selected in view of the limited efforts available. The sighting area in the low-latitudinal waters has been designated as shown in Fig. 1.

The past commercial whaling operations have covered the waters up to about 30 n.miles from the ice-edge. However, since emphasis is to be placed on collecting samples from wider north-south waters in the preliminary research, the waters up to 55° S (about 600 n.miles from the ice edge) will be covered. By carrying out the sighting survey also in the low-latitudinal (northern) waters, collection of data from a further latitudinally extended area can be expected.

#### V. RESEARCH PERIOD

In view of the importance of the changes in biological characteristics by latitude, the sampling period has been designated from early January to late February, which coincides with the peak of migration of the southern hemisphere minke whale to high latitudes. Sighting survey in the low-latitudinal waters will be carried out in early December and in February.

#### VI. VESSELS

The following vessels are assigned for the preliminary research.

- (1) one factory ship (research base)
- (2) two sampling and sighting vessels
- (3) two sighting vessels in the breeding ground



## VII SAMPLING SCHEME

In general, the southern hemisphere minke whale migrates to its feeding ground, the Antarctic, in summer, moving mainly in the north-south direction corresponding to the movement of the pack-ice. The density distribution of this species in summer is higher along the ice edge waters and becomes lower with the distance from the ice edge line. It is unlikely that individual animals maintain uniform or random spatial distribution, and it is more realistic to suppose that it has a tendency to patchy distribution. It is also noted that the southern hemisphere minke whale distribute as schools and not as individual animals. By further elucidation of these characteristics through the preliminary research, the feasibility of the basic concept of the line-transect sampling scheme adopted in the original program (SC/39/04 Appendix 3 Addendum) should be tested.

As the waters north of  $60^{\circ}$  S belong to the storm zone, the survey area is divided into two:  $55^{\circ}$  S -  $60^{\circ}$  S (northern stratum) and south of  $60^{\circ}$  S (southern stratum). Since the survey in the northern stratum is affected by weather conditions, different course lines should be adopted from those in the southern stratum.

As is shown in Fig. 2, course lines are set in north-south direction in the northern stratum and by the reflection method in the southern stratum. The survey starts from a point randomly selected on  $55^{\circ}$  S moving due south. When the vessel meets the  $60^{\circ}$  S line, the course is changed to the direction at some angle selected randomly from  $0^{\circ}$  -  $180^{\circ}$  against the line (e.g.  $140^{\circ}$ , see

Fig. 2) and continues by following the reflection method.

The reflection method is described as follows: when the vessels meet a boundary or pack ice edge, the vessels change the course with a pre-determined angle (e.g. angle between old course and new course is set at  $70^\circ$ , see Fig. 2).

When the weather turns favorable in the northern stratum during the operations in the southern stratum, the survey is suspended and the vessel moves north to cover the northern stratum. After the cruise is ended in the northern stratum, it returns to the point where it left for the north, to continue researches in the southern stratum on the trackline already designated.

By these survey cruise plans, searching efforts will be randomly distributed in terms of times and space so that it is assured that whales distributing in the survey area can be sampled with equal probability. In the area south of  $55^\circ$  S, searching efforts per unit area can be distributed evenly.

The two sampling vessels will navigate on the two sub-tracklines running in parallel lines on either side of the main trackline (6 n. miles away, respectively, from the main trackline). The searching and sampling are to be conducted independently by the two vessels. A constant searching effort is maintained throughout the survey. Only the minke whales sighted during the primary searching along the two sub-tracklines (to be defined as primary sighting) are subject to sampling. All the schools observed by the primary sighting within 3 n. miles perpendicular to the sub-tracklines are closed with and subject to sampling. Schools sighted while the vessels are not engaged

in primary searching (i.e. confirming, chasing, handling and towing whales or drifting) (to be defined as secondary sighting) are not subject to sampling. Upon completing the closing, confirming, handling and towing operations, the research vessels are instructed to return to the original position at which they left the trackline and resume their searching efforts.

When the vessel reaches the point where a school is positioned at an angle of  $60^\circ$  from the trackline, the school is closed with and the number of animals contained in the school is counted. If it is a single-whale or two-whale school, all the whales are taken. In case the school consists of more than two animals, two samples are randomly taken. The sampled whales are transferred to the factory ship when convenient.

The data to be collected in the preliminary research are the same as those described in SC/39/04 Appendix 3, Addendum. The data will be sent to the IWC after they have been validated.

*Ratio → Proportion*

#### VIII ACCURACY OF THE ESTIMATES FROM THE SAMPLE SIZE IN THE PRELIMINARY RESEARCH

The sample size for the preliminary research is 300 minke whales. Statistical analyses were made on the magnitude of accuracy of estimates on biological parameters obtained from this sample size. The details are given in Appendix 1. Judging from the results, it was noted that difference by latitude and by season in estimates that are expressed by ratio can be significantly detected from this sample size.

IX OPPORTUNITIES FOR PARTICIPATION BY FOREIGN SCIENTISTS

Foreign scientists can participate in the preliminary research under the same arrangements as those outlined in the original program.

X EXPECTED EFFECTS OF THE CATCHES ON THE STOCK

It has been explained in the original program that the annual take of 825 animals from Area IV in the original program (average take of 413 animals per year, in actual terms) will have no serious effect on the conservation of the stock.

Since the 300 animals to be taken for the preliminary research is less than the number of animals taken in the original program, the effect of the catches on the stock is expected to be even smaller.

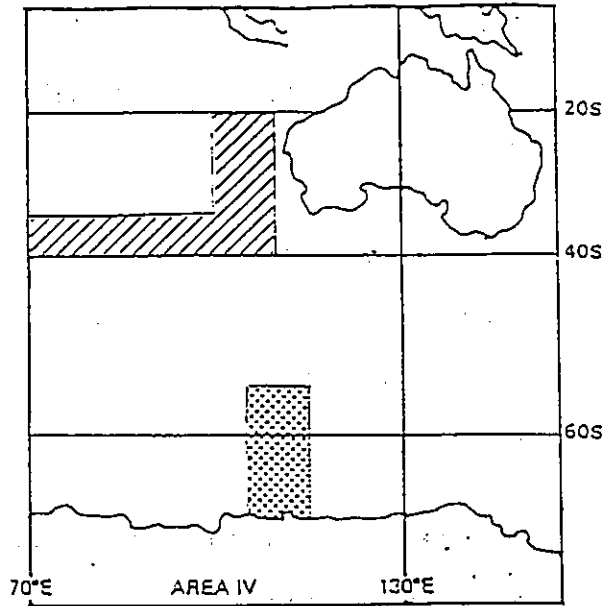




Fig. 1. Areas where the preliminary research will be conducted.

-  area where the sighting survey in breeding ground will be conducted.
-  area where the sampling and sighting survey will be conducted.

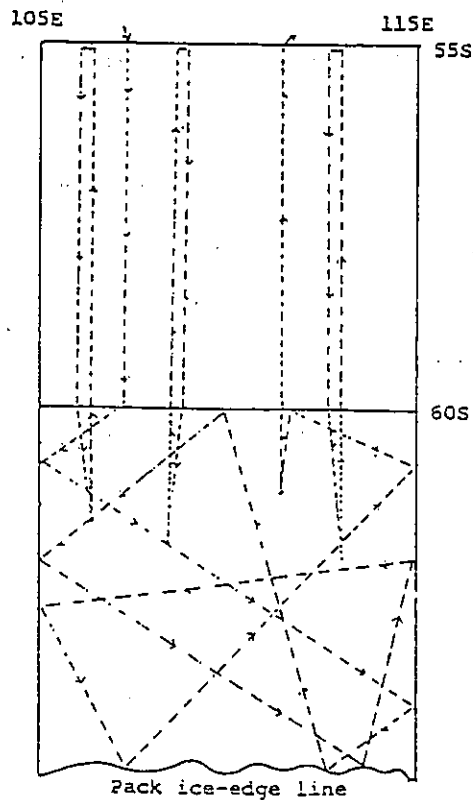


Fig. 2: Outline of cruise track for sampling and sighting survey.

APPENDIX 1: ACCURACY OF THE ESTIMATES FROM THE SAMPLE SIZE  
IN THE PRELIMINARY RESEARCH

The maximum sample size is 300 minke whales. If the searching effort (in terms of distance) is allocated randomly within the research area, it is expected that samples proportional to the whale density can be obtained.

A. From the past sighting data on the whale density by latitude and by school size composition, it is expected that 255 minke whales can be obtained from the southern stratum (south of  $60^{\circ}$  S) and 45 minke whales can be obtained from the northern stratum (north of  $60^{\circ}$  S). Table 1 indicates the expected accuracy (standard error) of estimates (% of one category against others in certain biological parameters) under the assumption that samples are randomly obtained from each stratum.

The difference between two estimates in the northern stratum and southern stratum can be detected with 5% significance level when the two values are positioned within the hatched area of Fig. 1. When there is a difference of about 15% between the estimates in the northern stratum and the southern stratum, the difference can be significantly detected from the data.

Furthermore, Table 2 indicates the expected standard error of the estimates by area stratum and by period when dividing the research period into the first half and the second half.

B. If the changes of estimates (%) with latitude and time are expressed by using the following model:

$$\text{Model (I)} \quad p(x, t) = A + B(x - 300) / 300$$

$$\text{Model (II)} \quad p(x, t) = A + C(t - 30) / 30$$

$$\text{Model (III)} \quad p(x, t) = A + B(x - 300) / 300 + C(t - 30) / 30$$

where,  $x$  = distance from the ice edge and  $t$  = number of days from the start of research, the expected standard error for the estimates of  $A$ ,  $B$  and  $C$  are obtained from the expected values of  $(x_i, t_i)_{i=1, 2, \dots, 300}$  (Table 3).

The expected standard error of each estimate ranges from 0.04 to 0.05, and therefore the changes of parameters with latitude and time can be detected with 5% significance level when the absolute values of  $B$ ,  $C$  are 0.1 or more.

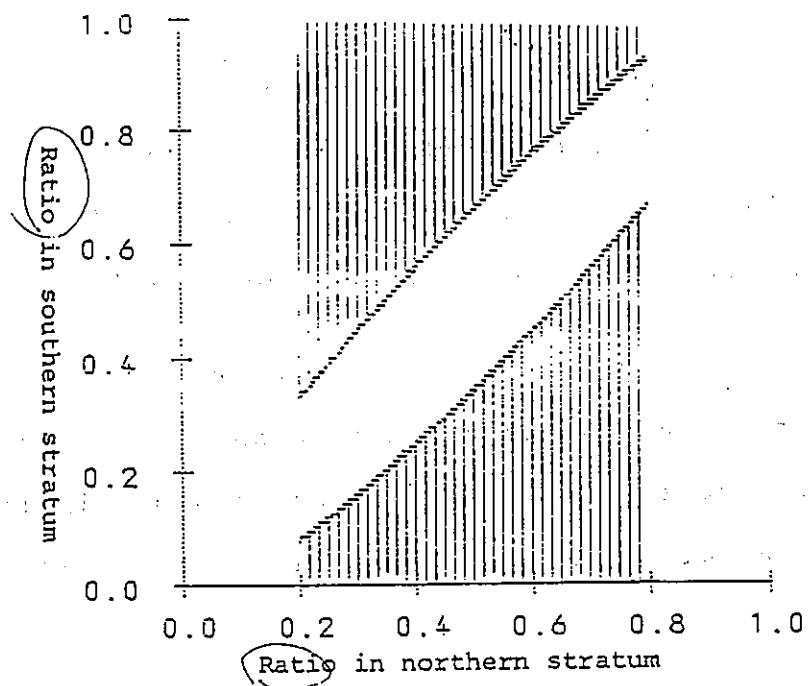


Fig. 1. Region where the detection of difference with 5% significance level is possible.



Table 1. Expected standard errors of estimate in southern and northern stratum.

	0.2	0.3	Ratio 0.4	0.5	0.6	0.7	0.8
Southern stratum	0.0250	0.0287	0.0307	0.0313	0.0307	0.0287	0.0250
Northern stratum	0.0596	0.0683	0.0730	0.0745	0.0730	0.0683	0.0596

Table 2. Expected standard errors of estimate in case where the research period is divided in first and second half.

	0.2	0.3	Ratio 0.4	0.5	0.6	0.7	0.8
Southern stratum	0.0354	0.0405	0.0433	0.0442	0.0433	0.0405	0.0354
Northern stratum	0.0834	0.0956	0.1022	0.1043	0.1022	0.0956	0.0834

Table 3. Expected standard errors of regression coefficients (symbols see text).

<u>Model (I)</u>		<u>A=0.5</u>			<u>A=0.4</u>		
		<u>Value of B</u>			<u>Value of B</u>		
		-0.15	0.00	0.15	-0.15	0.00	0.15
Standard error of A	A	0.0405	0.0412	0.0405	0.0389	0.0403	0.0404
	B	0.0567	0.0582	0.0567	0.0551	0.0571	0.0557
<u>Model (II)</u>		<u>A=0.5</u>			<u>A=0.4</u>		
		<u>Value of C</u>			<u>Value of C</u>		
		-0.15	0.00	0.15	-0.15	0.00	0.15
Standard error of A	A	0.0286	0.0291	0.0286	0.0279	0.0285	0.0281
	C	0.0483	0.0496	0.0483	0.0473	0.0486	0.0470
<u>Model (III)</u>		<u>A=0.5</u>			<u>A=0.4</u>		
		<u>Value of B</u>			<u>Value of B</u>		
		-0.15	0.00	0.15	-0.15	0.00	0.15
C=-0.15 Standard error of A	A	0.0399	0.0406	0.0399	0.0380	0.0397	0.0398
	B	0.0559	0.0574	0.0556	0.0541	0.0562	0.0544
	C	0.0469	0.0484	0.0470	0.0477	0.0474	0.0470
C=0.00 Standard error of A	A	0.0406	0.0412	0.0406	0.0389	0.0404	0.0405
	B	0.0568	0.0583	0.0568	0.0551	0.0571	0.0557
	C	0.0485	0.0497	0.0485	0.0490	0.0487	0.0455
C=0.15 Standard error of A	A	0.0399	0.0406	0.0399	0.0379	0.0397	0.0398
	B	0.0556	0.0574	0.0559	0.0533	0.0559	0.0545
	C	0.0470	0.0484	0.0469	0.0474	0.0471	0.0433

1. BACKGROUND

The southern hemisphere minke whale principally migrates to the low latitudinal waters (breeding ground) in winter and to the Antarctic for feeding in summer, but it has been recognized that there is some extent of segregation by sex and by reproductive condition. In order to make random sampling scheme, the patchy distribution and segregation of this species should be taken into account.

It was planned that the sighting vessels previously used for the IWC/IDCR Southern Hemisphere Minke Whale Assessment Cruise would be assigned for the sighting survey in the program because the activities of sighting and sampling are inseparable. However, continuation of the IWC/IDCR Southern Hemisphere Minke Whale Assessment Cruise was recommended at the meeting of the Scientific Committee of the 39th annual meeting of the IWC in June 1987. In the light of this recommendation, the Japanese scientists discussed with other IWC scientists the possibility of a sampling scheme which enables research vessels to conduct sighting and sampling survey at the same time. The Government of Japan decided to allocate the two sighting vessels to the forthcoming 10th IWC/IDCR Southern Hemisphere Minke Whale Assessment Cruise in 1987/88. As a result, an alternative sampling scheme was developed. The rationale and operations for the newly-developed sampling scheme are outlined below.

## 2. RATIONALE FOR SAMPLING

A systematic sampling scheme is adopted to ensure that schools distributed throughout the research area can be evenly subject to sampling. The design of this sampling scheme is based on the line transect sampling scheme, which means that sighting and sampling can be conducted concurrently. In this sampling scheme, the starting point of the trackline is randomly determined and the trackline is systematically located to cover the research area. Samples should be taken from schools sighted (primary sighting) by research vessels steaming along this trackline.

Segregation by age, sex and reproductive condition has been recognized in the distribution of the southern hemisphere minke whale within the research area. Time-space stratification should therefore be required in order to minimize the bias in sample collection generated from these trends.

## 3. GUIDELINE FOR SAMPLING PROCEDURE

### (1) Sampling Area and Period

The sampling area and period in each season are the same as those described in SC/39/04.

### (2) Sampling Procedure

#### (a) Trackline

A trackline is systematically allocated in sawtooth pattern within the research area constituting a  $30^{\circ}$  longitudinal strip of the sea. The starting point is randomly determined.

(b) Searching

The two sampling vessels survey on the two sub-tracklines running in parallel lines 6 n.miles away to the right and left, respectively, of the pre-determined main trackline (the distance between the 2 vessels will therefore be 12 n.miles). The searching and sampling are to be conducted independently by the two vessels. A constant searching effort (searching speed of 12 knots, number of observers) is maintained throughout the survey. Only the minke whales sighted during the primary searching along the two sub-tracklines (to be defined as primary sighting) are subject to sampling. Schools sighted while the vessels are not engaged in primary searching (i.e. closing with, confirming, handling and towing whales or drifting) (to be defined as secondary sighting) are not subject to sampling. Secondary sighting and schools other than southern hemisphere minke whale are not to be closed with. Upon completing the closing, confirming, handling and towing operations, the research vessels are instructed to return to the original position at which they left the trackline and resume their searching.

(c) Operational Procedure

When the vessel reaches the point where the primary sighted school is positioned at an angle of  $60^{\circ}$  from the trackline, the school is closed with and the number of animals within the school is counted. If it is a single-whale or two-whale school, all the animals are taken. In case the school consists of more than two

animals, two samples are randomly taken.

Only the the firstly targeted whale by random sampling scheme is to be chased and sampled. After the sampling of the firstly targeted whale, the remaining individuals in the school are identified over again so as to select randomly the secondly targeted whale. There may be cases (although not so frequently) in which the targeted whale cannot be sampled despite a long chasing time. Sampling efforts may be abandoned after a pre-determined give-up time for chasing. The sampled whales are transferred to the factory ship when convenient.

#### 4. DATA TO BE COLLECTED

##### a. Environmental Information

weather, wind direction, wind force, visibility, air temperature, sea surface temperature, ice condition, etc.

##### b. Information on Effort

sighting effort, sampling effort

searching time, confirming time, chasing time, handling time, towing time, resting time, etc.

##### c. Sighting Information

position sighted, species, number of animals, sighting angle, sighting distance, behavior, etc.

These data will be coded by computer and sent to the IWC after they have been validated.