

**RECORDING DISTRIBUTION AND ABUNDANCE OF SEABIRDS AT SEA IN
THE SOUTHERN OCEAN: METHODS USED IN THE BIOMASS PROGRAMME**

BIOMASS WORKING PARTY ON BIRD ECOLOGY

*c/o Scientific Committee on Antarctic Research, Scott Polar Research Institute, Lensfield Road,
Cambridge, CB2 1ER, UK*

Received 18 August 1992, accepted 30 September 1992

SUMMARY

BIOMASS WORKING PARTY ON BIRD ECOLOGY 1992. Recording distribution and abundance of seabirds at sea in the Southern Ocean: Methods used in the BIOMASS Programme. *Marine Ornithology* 20: 51-59.

Methods used to record birds at sea during the Second International BIOMASS Experiment are described in detail.

PREFACE

An important part of the BIOMASS Programme - an international multidisciplinary framework for marine biological research in the Southern Ocean (BIOMASS 1977), whose accomplishments have been reviewed by El Sayed (in press) - was the organization of co-ordinated programmes of shipboard research.

These research cruises were principally designed to investigate the distribution and abundance of zooplankton, especially krill, in relation to physical and biological environmental characteristics. These cruises also offered a unique opportunity to collect data simultaneously on the distribution and abundance of marine top predators (seals, seabirds, whales). However, to do this effectively it was necessary to devise standardized recording methods for use at sea. Since 1976 the Bird Biology Subcommittee of the Scientific Committee on Antarctic Research had been developing standard instructions (including recording cards) for recording sightings of seabirds at sea. Details of these methods were published in 1982 as *BIOMASS Handbook* No. 18. These methods were widely used in the cruises

associated with the First International BIOMASS Experiment (FIBEX) in 1980-81.

During the review of seabird data collected during these cruises and as part of the planning for the Second International BIOMASS Experiment (SIBEX) implemented in 1983-84 and 1984-85, it was recognized that significant modifications to the standard instructions were needed. Of particular importance were more accurate methods for recording seabird density at sea. The BIOMASS Working Party on Bird Ecology accordingly prepared a completely revised edition of the original handbook. This was made available in February 1984 to all participants in SIBEX (and subsequently to various other interested parties) but was never published.

Most papers published on seabird data collected during BIOMASS have very abbreviated descriptions of the methodology employed. In reviewing these data Hunt *et al.* (in press) and Cooper *et al.* (in press) recognized that full details of the methods used in SIBEX and subsequently should be freely available in order to permit comparison with results obtained using different techniques. The remainder of this paper consists of

the text on methods exactly as circulated to all the participants in SIBEX.

INTRODUCTION

Knowledge of the pelagic distribution and abundance of seabirds is an important element in the assessment of their role as predators in marine ecosystems. This is nowhere more true than in the Southern Ocean where the sum of direct and indirect consumption of krill by seabirds probably exceeds 175 million tonnes, which is slightly larger than the consumption by whales, and two-thirds the consumption by seals, calculated by similar methods.

Acting in response to a request of the Technical Group on Programme Implementation and Co-ordination of BIOMASS, the Working Party on Bird Ecology investigated the most effective means of recording observations of birds at sea in the Southern Ocean. In drawing up a set of instructions for observing and recording birds, the Working Party was guided by a need for information which should contribute to a better understanding of the Southern Ocean ecosystem, and make an important contribution to BIOMASS. More particularly the following requirements were considered:

- (a) to obtain detailed information on the spatial and temporal distribution of avian species, their species diversity and their biomass;
- (b) to relate seabird behaviour and distribution to data on the physical and biological features of the environment, collected simultaneously;
- (c) to determine to what extent seabirds can be used as indicators of the distribution and abundance of selected prey populations, especially krill and cephalopods; and,
- (d) to assess the ability of seabirds to locate and exploit prey populations that are distributed in high-density patches, such as krill swarms.

This text presents the instructions and the card formats for recording seabirds at sea. The cards are designed to record the occurrence, distribution and behaviour of seabirds in coastal, offshore and oceanic sub-Antarctic and Antarctic waters. In

addition to general information on seasonal distribution, migrations and movements, the cards can be used to assess seabird density and to investigate relationships between bird distribution and oceanographic and topographic features.

Special attempts to keep detailed records of seabirds should be made for areas of potentially high concentrations of krill (e.g. at oceanic fronts, divergences and other areas of local water-mixing and shelf-slopes). Also, all associations of seabirds with other organisms, especially krill swarms, should be recorded. Such aggregations are likely to attract an abundance and diversity of predators and the nature of the interactions between these predators and between them and their prey is of considerable interest and importance. Indeed, the ability of predators to locate krill swarms or patches may be a key feature of their feeding ecology and hence of their impact on krill populations.

INSTRUCTIONS FOR USE OF RECORD CARDS

There are two types of card: the VOYAGE MASTER card and the SEABIRD RECORD card (Figs 1 & 2). Both of these should be completed for each voyage. The cards are designed to be used by relatively inexperienced observers as well as experts, and as much information as possible should be recorded. Please note that cards are NOT available from BIOMASS and SCAR; researchers must arrange for their own supply.

The VOYAGE MASTER Card (Fig. 1)

One of these cards should be completed for each voyage. The following information is called for:

1. Name of vessel, overall length and, if possible, displacement.
2. Port of departure, port of destination and dates of departure and arrival.
3. Name and initials of principal observer.
4. Position on ship, and height of eyes (in metres) above sea level. The flying bridge is often the best vantage point.

- *5. Field of view covered. FOR SIBEX AND OTHER OPERATIONS FROM NOW ON PLEASE USE ONLY 90° QUADRANT TO ONE SIDE OF BOW (selecting side of least glare).
- *6. Equipment type and magnification of optical instruments used (8 x 40 binoculars are ideal for at-sea observations). For SIBEX we recommend that the field of view be scanned by eye and binoculars normally used only to make or confirm observations.
- 7. Additional notes, relevant to any of the above, or to special points of interest of the voyage, particularly including cross reference to oceanographic and hydrographic data collected during the SAME VOYAGE.

THE SEABIRD RECORD CARD (Fig. 2a,b)

Observations should be recorded on the card during a standard observation period of 10 minutes. A new card should be started for each 10-minute period. As many cards as possible should be completed spread over the daylight hours, preferably in one-hour blocks. At least one normal count and one stern count of seabirds should be made for each 1° x 0.5° square (latitude and longitude - see F below) every hour, whichever gives the more extensive sampling. Continuous observations should be made, but must still be in 10-minute periods, e.g. continuous observation for 1 hour = 6 cards. Normal counts are of greater use for comparing data than stern counts and should always be given preference. Special care should be taken to avoid re-counting ship-following and, especially, ship-circling individuals. Observation periods where NIL birds are seen must be recorded as a NIL card (see D below). Where one card is insufficient to record all data for a 10-minute period, than additional cards should be stapled behind the first card. Cards may be used for special isolated observations (see C below). It is recommended that counts are NOT made when ship's speed is less than 6 knots.

FACE OF CARD (Fig. 2a)

A. General reference information

1. Observer: Name or initials (if principal observer) on all cards.
- *2. Speed: Mean speed of ship for each observation period in knots; where possible record individually on each 10-minute card, since errors in ship speed estimates introduce considerable biases in estimates of area covered by transect.
3. Date: Day, Month, Year (e.g. 10 May 1979 is 10/05/79).
4. Time: State time of each observation period. Preferably record as Greenwich Mean Time (GMT), and failing this, as standard ship time, both on 24-hour clock. Indicate on VOYAGE MASTER card (under notes) which convention is being used and employ it throughout.
- *5. Ship's position: Latitude and longitude in degrees and minutes (preferably to the nearest MINUTE). In case of difficulty or uncertainty, record ship's noon position (and mark as such).
6. Ship's activity: All activities occurring in the observation period should be marked by circling the number referring to each category.

B. Weather, wind, sea, etc.

1. Circle all categories of weather which occurred in the 10-minute observation period. These general categories should be used to give an impression of the weather conditions as they may affect observations.
- *2. The wind scale (Beaufort categories) refers to the mean wind speed for the observation period. It is PREFERABLE to record wind speed in KNOTS, especially for SIBEX operations. 3. Air temperature should be recorded in °C, wind direction as the compass point from which the wind is blowing.
4. Estimate limit of effective visibility.
5. Sea temperature should be recorded in °C, to nearest 0.1°C.

6. When recording pack ice, the categories refer to differing densities of sea-surface cover.

*7. Record water depth in metres (data should be available from ship's echosounder; if not estimate from ship's position on a suitable bathymetric chart).

8. Record salinity in parts per thousand (‰).

9. Record barometric pressure in mm of mercury.

*10. Distance to shore (calculate from charts using ship's position).

*11. Visibility in metres. If less than 300 m do NOT make counts.

C. Full or partial list

1. Part list should be marked (ticked) where:

- (a) observation period is less than 10 minutes;
- (b) a special spot record is made of an item of interest outside an observation period;
- (c) observations are made on a restricted number of species instead of all birds seen;
- (d) visibility was less than 300 m. The nature of the part list should be noted on the card (under notes). Partial lists should be AVOIDED.

2. Full list should be marked (ticked) in all other cases.

*D. Nil birds observed

If no birds are observed in the standard 10-minute period then tick the appropriate box. This is an ESSENTIAL part of the record.

E. Association with other phenomena

1. The presence of whales or seals should be recorded (tick item), and identity, number and distance from ship noted whenever possible.
2. The existence of a fish shoal or presence of oil should be recorded.
3. The presence of a krill swarm should be recorded.

4. All associations should be described in the Notes (see G below).

F. Normal or stern count

1. It is important to distinguish between birds which associate with vessels (including those which tend to circle ships) and those which do not do so.

2. While most observations should be made from a flying bridge, looking ahead and laterally (normal 90° quadrant count), it is recommended that at least one 10-minute count per hour of observation should be devoted to a watch astern (stern count), paying particular attention to the species, and number of individuals, in the wake, or circling the ship.

*3. Mark the box appropriate to each type of count. For SIBEX please use NORMAL counts ONLY.

G. Notes

1. This space is reserved for any information which is not recorded as standard, or expansion or explanation of standard observations.

2. Descriptions or diagrams of unusual or unidentified species should also be recorded under this space.

3. Descriptions of associations.

REVERSE of CARD (Fig. 2b)

H. Species

1. Record the common name (or unambiguous abbreviation) of the species.

2. Where birds are identified to group, only record as follows: e.g. Prion sp., Shearwater sp.

3. If unsure, record as A, B, etc., and describe in notes the plumage and flight pattern of the bird.

I. Sex and age

These can rarely be determined in the field although a distinction between adult and juvenile plumages is apparent in some species. The appropriate numbers in the tally score should be followed by J (J = Juvenile), or S (S = Subadult) where such a distinction can be made.

J. Tally score

Use this space as a score pad to tally the number of individuals seen and counted so that the total may be calculated, e.g. 1. 1. 5. 7. 15. 1. 1. (= 31).

K. Total

Use for recording total, produced by addition of tally scores for each species.

L. Activity

1. This is designed to indicate in general terms the activity of the birds observed.
2. All birds are assumed to be flying past, unless otherwise recorded. The other basic categories are feeding and sitting and these can be totalled in the appropriate subcolumn. Birds accompanying or following the ship will generally be recorded only on stern count cards.
3. Definitions

Flying past = moving past ship from ahead or sides without diverting towards ship (normal card).
Accompanying = moving around or at sides of ship.

Follow-wake = consistently following the ship within the line of the wake to limit of vision.
For practical purposes, the last two categories can usually be combined (stern card).

*M. Distance

It is suggested that, in conditions where it is practicable, an attempt should be made to estimate the distance of seabirds from the vessel. This should be done in broad categories, as follows: A (0-300

m), B (300-1000 m), C (1000 m +). Tally scores can be recorded for each distance category by dividing the space on the back of the 10-minute card into three columns. Each tally can be summed to give a separate score for each distance category. For SIBEX, and subsequently, it is vital to try to derive numerical estimates that are comparable between ships, observers etc.. A STANDARD TRANSECT WIDTH of 300 m should be used for ALL records. (If a second band width is used it should be 1000 m.) Sighting boards or sticks should be used to define and check transect width and the ways of calibrating these are described in detail in Appendix 1.

Bear in mind that at least some seabirds have a tendency to be attracted to ships. The normal extent of this effect can be assessed to some degree by ensuring that stern counts are conducted from time to time. The augmented effect caused by a ship's fishing activities can probably be assessed by comparing data in relation to ship's activities and it is important that the latter be recorded accurately.

Jettisoning of garbage, unwanted specimens (or parts thereof) or portions of catches will all greatly attract seabirds and should as far as possible be avoided, or at least confined to night-time when detailed seabird observations are impossible. Please bring this matter to the attention of both the senior scientist and the master of the ship.

SIGHTINGS OF COLOUR-RINGED OR COLOUR-MARKED SEABIRDS

Additional interest is attached to sightings of marked birds and such records should be identified clearly on the cards or in supplementary information.

SEABIRDS CAPTURED ON BOARD SHIPS

Useful information on the following can be obtained.

- (a) Weight

- (b) Basic morphometric measurements: wing length and bill dimensions (at least length). Tail and tarsus length are less important, except for prions for which bill depth (just anterior to nostril) and bill width (at base) are also important.
- (c) Food: stomach contents, whether of dead birds, or regurgitations by live ones, should be preserved for subsequent analysis.
- (d) Fresh corpses, particularly of prions, should be stored deep frozen or preserved in 70% alcohol. These specimens have a number of potential uses (e.g., pesticide residue analysis) in addition to their value as museum specimens. All specimens should be clearly labelled with date and position of capture. Bird banding is NOT recommended, unless it is done as part of a specific project with defined aims.

*CODING SEABIRD DISTRIBUTIONAL DATA

It is recommended that all data recorded on the 10-minute seabird cards be encoded, for computer-analysis, in the form set out by Cram (1981). Please note that we have requested the following modifications to the data base:

Wind speed: requires a two field code (i.e. up to 99 knots)

Bird numbers: requires a four field code (i.e. up to 9999 individuals)

Transect width: requires a four field code (i.e. up to 9999 m)

Depth to bottom: requires a four field code (i.e. up to 9999m)

Distance to shore: requires a four field code (i.e. up to 9999 m)

Visibility: requires a four field code (i.e. up to 9999 m)

It is envisaged that potential analyses will include geographical plots of seabird distribution and density, as minimum objectives, and more detailed statistical correlations between these and relevant

aspects of the oceanographic environment, net-haul data on plankton, and krill acoustic survey information.

ACKNOWLEDGEMENTS

The following persons formed the membership of the BIOMASS Working Party on Bird Ecology in 1984: D.G. Ainley, R. Bannasch, J.P. Croxall (Secretary), P.C. Harper, G.W. Johnstone, P. Jouventin, A. Myrcha, H. Remmert, R.P. Schllater, W.R. Siegfried (Chairperson) & W.Z. Trivelpiece.

REFERENCES

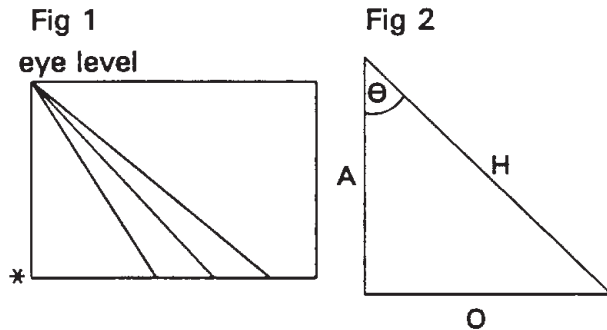
- BIOMASS 1977. Biological Investigation of Marine Antarctic Systems and Stocks (BIOMASS). Volume 1: research proposals. Cambridge: Scientific Committee on Antarctic Research and Scientific Committee on Oceanic Research.
- BIOMASS Working Party on Bird Ecology 1982. Recording observations of birds at sea. *BIOMASS Handbook* 18: 1-14.
- COOPER, J. & WOehler, E.J. in press. Consumption of Antarctic Krill *Euphausia superba* by seabirds during summer in the Prydz Bay region, Antarctica. In: EL-SAYED, S.Z. (Ed.). Southern Ocean ecology: the BIOMASS perspective. Cambridge: Cambridge University Press.
- CRAM, D.L. 1981. Methods for the transmission of data to the post-FIBEX data interpretation workshop. *BIOMASS Handbook* 16: 1-60.
- EL-SAYED, S.Z. (Ed.). in press. Southern Ocean ecology: the BIOMASS perspective. Cambridge: Cambridge University Press.
- HUNT JR, G.L., CROXALL, J.P. & TRATHAN, P. in press. Marine ornithology in the southern Drake Passage and Bransfield Strait during the BIOMASS Programme. In: EL-SAYED, S.Z. (Ed.). Southern Ocean ecology: the BIOMASS perspective. Cambridge: Cambridge University Press.

* APPENDIX 1 - RANGEFINDER

There are two basic techniques, using a board or a stick, for estimating the width of a seabird count strip. After constructing a rangefinder, try to calibrate it using the ship's radar (in port or harbour).

Board technique:

The purpose of the following discussion is to measure the distance from the * along the base of the board to a length that represents the 100, 200, 300 m mark (Fig. 1). You must know the height from the water surface to the observer's eye (in meters). Based on the following triangle (Fig. 2) we can calculate this distance.



Given: A = constant, height from surface of water to eye (m)

O(x) where $O_1 = 100, O_2 = 200, O_3 = 300$ m

$$A^2 + O^2 = H^2$$

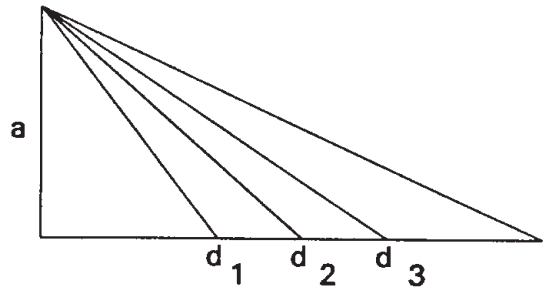
H = length of hypotenuse

Solve for H_1 using O_1
 H_2 using O_2

H_3 using O_3

Given: $\text{ARCSIN } O/H = \theta$

Fig 3



Solve for θ_1 using O_1/H_1
 θ_2 using O_2/H_2
 θ_3 using O_3/H_3

Using similar triangles (Fig. 3):

Given: a = length of side of board d(x) (x = 100, 200, 300) = distance, "*" to 100, 200, 300 m mark

$$\text{TAN } \theta = O/A$$

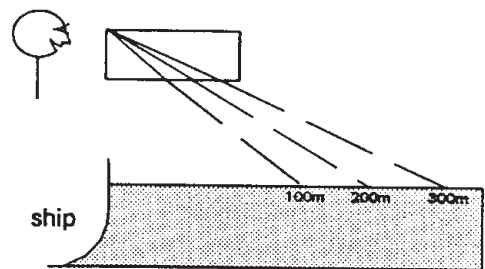
$$A \text{ TAN } \theta = O$$

$$A \text{ TAN } \theta_x = d(x)$$

Solve for d_1 using θ_1
 d_2 using θ_2
 d_3 using θ_3

Draw marks, lines, and use as depicted (Fig. 4).

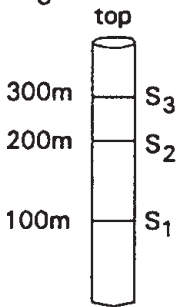
Fig 4



Stick technique:

To measure the distance from the top of the sighting stick down to the 300, 200, 100 m mark, (see Fig. 5), we must know the height from the water surface to the observer's eye, and the observer's arm length (use average lengths if there is more than one observer). Based on Fig. 6 we can calculate these distances.

Fig 5



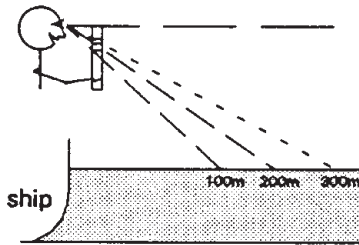
Given: $s = hl / d$

$d(x) =$ distance from ship; $d_1 = 100$ m

$d_2 = 200$ m

$d_3 = 300$ m

Fig 6



$h =$ height (surface of water to eye in metres)
 $l =$ arm length in meters $s =$ distance from top of
 dowel to the 300, 200, 100 m mark

Solve for s_1 using d_1

s_2 using d_2

s_3 using d_3

To use: Hold dowel at eye level extending straight out towards the bird (arm fully extended). Position the top of the dowel on the horizon. Use the example below for determining if the bird is in the transect area.

We are particularly grateful to G.L. Hunt Jr and B.M. Braun (University of California at Irvine) for assistance in preparing this Appendix.