COUNTING SEABIRDS AT SEA FROM SHIPS: A REVIEW OF METHODS EMPLOYED AND A SUGGESTION FOR A STANDARDIZED APPROACH

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ABSTRACT.—We review the methods used to study seabirds at sea from ships, discuss the problems posed in making reliable observations in relation to the design of research programs, and describe a method currently in use around the seas of Great Britain. We suggest a framework for future studies, incorporating features likely to stabilize bias. The key items in this recommendation are (1) the use of a band transect in order to provide density estimates, and (2) a method to correct for movement of flying birds in the band transect in order to minimize bias caused by such movement. *Received 13 October 1982, accepted 5 December 1983.*

THE recent upsurge in studies of seabirds at sea has often been in response to the need to assess the potential impact of hydrocarbon developments offshore. Marine biologists are also realizing that seabirds play an important part in marine ecosystems, and seabird ornithologists are becoming aware of the fact that studies of seabird biology must extend beyond the colonies. Attempts to produce systematic counts of seabirds at sea have resulted in almost as many methods as there have been studies. In this paper, we review these methods and discuss associated problems. If studies are to become more comparable, the methods used will have to become more standardized; therefore, we suggest an approach that may help achieve this aim.

DEVELOPMENT OF QUANTITATIVE SURVEYS OF SEABIRDS AT SEA

The first systematic study of pelagic seabird distribution was undertaken as part of a marine biological survey of the North Atlantic by Jespersen (1924). He recorded the number of birds seen per day, and most of his surveys were done in areas of low bird numbers; his system was unable to cope with the high numbers of birds found close to northwest Europe. Wynne-Edwards' study (1935) was based on a series of transatlantic crossings but incorporated many other previous, mainly anecdotal, accounts from the same area. Birds were recorded as numbers seen per hour of continuous viewing in a 180° bow-to-stern arc. Similar methods have been used by other workers elsewhere (e.g. Tickell and Woods 1972). In the early 1960's a major oceanographic research program incorporating bird observations was conducted in the Pacific; Gould (1974) recorded birds seen per hour and reported them as birds per linear mile traveled, as did Bailey (1966) off the coast of southeast Arabia.

The hour-long unit was insensitive in areas of varying bird numbers; thus, when work started off eastern Canada in the late 1960's, birds were counted by units of 10 min. These shorter recording periods were essential in order to relate the observations to the varied oceanographic environment of the area. Ten-minute watches were also used for work in the northeastern Atlantic (Bourne 1976). These two studies differed in that the Canadian work made use of all birds seen from the ship (Brown et al. 1975), while only those seen within a 90° bow-beam sector were counted in European waters (T. J. Dixon pers. obs.). At this time the Australasian Seabird Group began recording seabirds at sea using 10-min periods. This system was later adopted for recording all southern ocean observations by the Scientific Committee for Antarctic Research (Croxall MS).

In the early 1970's work was started off California (Briggs et al. 1978) and off Alaska (Gould et al. 1978). Both studies made extensive use of aircraft as well as ships. The results of the Alaskan studies suffered in that they were conducted by several groups using different techniques. Most of the Alaskan researchers used 10-min periods; a 300-m band transect was in-

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corporated so that the results could be expressed as birds per square kilometer. Various refinements were also made to allow for flying birds in the band transect. Wiens et al. (1978) used a computer to simulate the results from line-transect methods for seabird recording off Alaska, but they concluded that these methods were too cumbersome for use at sea. They also looked critically at the 300-m band transect of Gould et al. (1978) and showed it to be inadequate for detecting smaller species of seabirds on the water. Hunt et al. (1981) had recognized this problem and subdivided the 300-m band at 100 m and 200 m. Limited field tests off southern California indicated that inconspicuous seabirds were not adequately counted, even in good conditions, at distances exceeding 150 m (Briggs and Hunt 1981).

In 1978, workers at the Manomet Bird Observatory began work at sea off the northeast United States. The methods used included a 300-m band transect, although without the refinements of Gould et al. (1978) for reducing the exaggeration of flying bird densities (Powers et al. 1980, Powers 1982). More recently studies have been started off southern Africa (Griffiths 1981), off France (Hemery 1982), off Svalbard (Mehlum pers. comm.), and in the North Sea (Blake et al. 1984). Workers off southern Africa, France, and Svalbard used methods based on bird numbers per 10-min period. The methods used in the North Sea are described in Appendix 1. The major features of all the above studies are summarized in Table 1.

DETECTION OF BIRDS AT SEA

The problems.—There are a number of problems that ensure that not all seabirds will be detected in a given area of sea and that counts will be biased. They may be broadly divided into five interrelated categories: size, color, behavior, weather, and observer ability. The interaction of these factors can also cause considerable variation in these biases. Variation may also be introduced by using many different observers (e.g. NERC 1977, Powers et al. 1980) or a number of observation platforms.

A large bird is easier to see than a small bird at the same distance; surface area is probably a key detection factor. A storm-petrel with a wingspan one-fifth that of a sulid is considerably more difficult to detect. The color of a bird may enhance or reduce its chances of detection depending on the nature of the background. A murre is less likely to be seen against a dark sea surface than a light sea surface; similarly, a kittiwake seen against a light sky is less likely to be detected than against a dark sky.

The behavior of an individual bird also affects its detectability, either through the bird's normal behavior or through alterations in that pattern due to the presence of the observation platform. Species belonging to the surface-diving category of Ashmole and Ashmole (1967), such as penguins and auks, are usually found on the surface of the water, whereas the Procellariformes are typically more aerial; a moving bird is often more easily detected than a stationary bird. These behavioral differences may be reinforced by size and color differences: a light-colored Northern Fulmar (*Fulmarus glacialis*) is more visible than a murre on the water, and the difference between these species may be accentuated as the fulmar spends more time flying. In addition, many surface divers spend a proportion of their time underwater hunting for food where they are undetectable. These behavior patterns are not uniform in all sea areas. Surface-divers, many of which are more easily detected when flying than when on the water, will be more conspicuous in areas through which they are only flying than in those in which they are mainly feeding. A bird that is visible for a longer period is more likely to be detected than a bird only briefly visible. Hence, if a ship is moving in the same direction as flying birds, more birds are likely to be seen than if the ship is moving in the opposite direction. This effect may cause particular problems around colonies or point sources of food, such as fishing vessels.

The effect of ships on the behavior of birds has long been recognized as a problem in counting seabirds at sea (Bailey and Bourne 1972). They can either attract (e.g. Northern Fulmar or Tufted Puffin, *Fratercula cirrhata*) or repel (e.g. some small alcids and storm-petrels) birds (Wiens et al. 1978). Penguins and some alcids spend much time underwater and may also dive in response to a ship's approach (e.g. Jehl 1974, Griffiths pers. comm.) although the extent of this problem is variable (Ainley and Jacobs 1981). The length of time that a bird remains attracted to a ship varies: Tufted Puffins often circle the ship once or twice and then leave, whereas other species, such as large *Larus* gulls and some albatrosses, can be persistent ship-followers.

It is easier to detect a flock of birds than a single bird of the same species. Because some birds occur in flocks more frequently than others, these species will be more conspicuous. Common Murres (*Uria aalge*), for example, frequently occur in small groups, whereas the Atlantic Puffin (*Fratercula arctica*) is often solitary.

Meteorological factors can bias counts directly; waves may obscure a bird and considerably shorten the time available for detection. Sun glare and fog may limit visibility (NERC 1977); Dixon (1977) found that cloud cover and wave angle to viewing direction were important in detecting birds on the water. The interaction of weather with other features can cause much variation in the biases. Weather affects birds' behavior; in calm conditions birds may rest on the water rather than fly, thus rendering them less conspicuous. Wind direction may affect the flight direction of birds, thus potentially affecting the period available for bird detection. Dixon (1977) found that weather conditions interacted with size and color of certain birds to affect conspicuousness. As wave heights and winds increase, an observer's ability to count declines, which may make observations impossible.

Variations may be caused by observer ability; visual acuity and ability to resist fatigue or sickness varies among people.

The problem caused by movement of the animals being surveyed by line-transect methods has been described by Burnham et al. (1980). If a target animal is slow moving in relation to the observer's movement (for example, a bird on the water), the difficulty is limited, but if the target is moving faster than the observer there is a significant problem. This occurs with flying seabirds recorded from a ship. During any one counting period more birds will fly through the total area surveyed than are present at any one instant in this area. A count of all flying birds seen to pass through this zone during the 10-min period would be a measure of bird flux and would be an overestimate of actual bird density (see Wiens et al. 1978 for data on this effect). This overestimation of flying-bird density would cause particular problems if a period when a species was confined to the water (e.g. by molt) was compared with a period when the species could also fly. An instantaneous count of flying birds in the observation zone would give the best density estimate for flying birds, and this could then be compared validly with the density of stationary birds.

Implications for methods.—The objectives set in a project will determine the methods used. When quantitative results are required, unwanted systematic bias and variations in that bias must be controlled whenever possible. The earliest studies were qualitative; indices of abundance were then developed using birds per unit time. While these may be adequate for producing comparisons between areas for one species, they cannot be used for interspecific comparison without considerable qualification. Attempts have been made to produce correction factors for variations in bird detectability between species. This has usually been done by making an assumption about the maximum range at which birds were seen. These assumptions have usually been made without the support of data (Crossin 1974, Bourne 1982). Wiens et al. (1978) determined some co-efficients of detection for some Alaskan species of seabirds, although these did not allow for varying meteorological and observational conditions.

A major fault of the assessment of birds per unit time lies in the overestimation of the relative abundance of flying birds due to the movement of birds. None of the researchers using such indices has made allowance for this bias, and there is often no mention of this critical factor in comparisons of inter- or even intraspecific densities. Without allowance for this bias, even data on apparent relative abundance must be treated with caution. Such studies cannot provide data for the calculation of absolute abundances, which are particularly important where population size and biomass in a defined area are required.

Transect methods were developed to minimize many of the biases and variables discussed above. They do so mainly by reducing the area of sea examined at any one time so that a substantial proportion of birds within it are detectable. The proportion of nonflying birds detected against total number of nonflying birds present may be assessed by examining the uniformity of detection within perpendicular range from the observer (see Burnham

TABLE 1. Summary of major seabirds-at-sea projects and their methods.

Project	Method		Viewing arc	Time block	Ship speed	Accompanying birds	Flying bird transect	Band transect width
	Birds per unit time	Birds per unit area						
POBSP 1963–1966 Gould (1974)	X		270°	1 h (exact minute)	10 kts	All recorded	—	—
Bourne (U.K.) 1969–1973 T. J. Dixon (pers. obs.)	X		90° Bow/beam	10 min	6 kts	Noted separately	—	—
E. Canada 1969–1973 Brown et al. (1975)	X		360°	10 min	4 kts	All recorded (annotated)	—	—
Australia/SCAR 1974–present Croxall (MS)	X		360°	10 min	All	All recorded (annotated)	—	—
California 1975–present Briggs and Hunt (1981)	X		180° for (+binoculars)	10 km length	15–21 kph	Recorded once, then ignored	All counted	400 m both sides
Alaska 1975–present								
RU 83 Hunt et al. (1981)	(X)	X	90° Bow/beam	10 min	?	Noted separately	10-min block	300 m + 100 m + 200 m
RU108 Wiens et al. (1978)	X		90° Bow/beam	15–30 min	?	Noted separately	N.A.	Line transect

TABLE 1. Continued.

Project	Method		Viewing arc	Time block	Ship speed	Accompanying birds	Flying bird transect	Band transect width
	Birds per unit time	Birds per unit area						
RU337 Gould et al. (1978)	(X)	X	90° Bow/beam	10 min	6–15 kts	Noted separately	Split 10 min block	300 m
N.E. USA 1978–present Powers et al. (1980)	X	X	90° Bow/beam	10 min	4 kts	Recorded once, then separately	10-min block	300 m
S. Africa 1979–present Griffiths (1981)	X		130° side (+ binoculars)	10 min	?	Once per hour	—	—
U.K. 1979–present Appendix 1	X	X	180° for	10 min	4 kts	Recorded separately every 100 min	Split 10-min block	300 m
Svalbard 1980–present Mehlum (pers. comm.)	X		180° for	10 min	5–10 kts	Once per hour	—	—
France 1980–present Hemery (1982)	X		360°	Exact min	16–22 kts	?	—	—
Suggested standard	(X)	X	90° Bow/beam	10 min	Between 6 and 40 kph	Noted separately	Split 10-min block	300 m + 100 m

et al. 1980 for methods). Coefficients of detection can be established, which may be different for each species; data may be further partitioned to allow for weather conditions and perhaps observer ability. Correction factors derived from these coefficients of detection may then be applied to the original data. In practice, this has yet to be achieved, as it is difficult to distinguish whether differences in data are caused by such biases or by short-term changes in seabird distribution. An examination of coefficients of detection may allow practical transect widths to be established.

Most band-transect methods do not allow for the problems of bird movement (e.g. Hunt et al. 1981). Ideally, an instantaneous count of all birds within the transect band should be made; in practice, this is impossible, particularly at higher ship speeds. At 10 knots, a ship covers 3.2 km in 10 min, and it would be necessary to detect all birds within this distance for an instantaneous count. The obvious modification of this is to divide the 10-min block into smaller discrete units and count these separately as they are reached. Gould et al. (1978), with a ship speed of 10 knots, split the transect band into 3 × 1 km lengths, but even this is probably too far under most circumstances.

In practice, it is difficult to determine the average range of detection of a flying bird. It is impossible to determine coefficients of detection by means of perpendicular distance to ship's track because of bird movement, and the use of sighting angles and ranges are, in general, impractical in all but the calmest conditions at sea. Coefficients of detection, therefore, have to be based on the ranges at which birds are seen (ignoring the effects of sighting angle). A suitable frequency histogram for detection distances may then be derived. This frequency has then to be converted to intervals of time calculated by means of the ship's speed and the maximum distance at which all flying birds can be detected. An upper limit to the frequency of these successive counts occurs when the time taken to scan the area becomes a substantial proportion of the time spent traveling through the area. This condition imposes limits on maximum ship speed and minimum visibility conditions during which the system is valid.

The problem of how to record ship-associated birds has been tackled in a variety of ways depending on the species involved; birds associated with the ship must be recorded discretely.

SUGGESTION FOR A STANDARDIZED APPROACH

If different studies of seabirds at sea are to be compared, data must be collected and analyzed by means of similar techniques. The approach we suggest aims to maximize comparability with past observations and to improve future data collection. These recommendations are based on 3 yr experience of counting seabirds in the North Sea and on discussions with seabird biologists in other parts of the world. The use of the "snap-shot" sampling technique for flying birds removes many of the biases associated with previous methods. Standardized methods for counting birds per unit time are also recommended to enable comparison with data gathered by means of these earlier methods (Bailey and Bourne 1972). These recommended methods do not deal with the problems of systematic bias caused by variation in detectability of a species under different conditions when there is relative movement between the observer and the bird. Due to the effects of bird movement, it seems unlikely that the conversion of raw counts of all birds seen (birds/unit time) to densities of birds (birds/unit area) will ever be possible.

The methods are divided into three sections. Method I would allow the collection of data as density estimates (numbers/km^2); it incorporates features that compensate particularly for the overestimation of bird density caused by flux. The conversion to density estimates should be undertaken using correction factors for bias; these would need to be particular to a study. Method II would provide indices of birds seen per unit time or distance in areas of higher bird density, while Method III would provide a similar record in areas of low bird density. The relationship between the latter two methods has been examined by Powers (1982).

METHOD I

(*a*) *A count of all birds on the sea within a defined band transect.*—The recommended band width is 300 m with inner divisions; 10 min ship steaming time is likely to be a suitable duration, and a series of 10-min counts should be continuous for as long as possible without excessive observer fatigue. Band widths and lengths are not critical; these could be varied to suit the particular study but should be consistent within it. Results should be expressed in terms of birds on the sea per unit area. Results from densities of birds on the sea might then be corrected for bias using correction factors derived by analysis of coefficients of detection for each species.

(*b*) *A count of flying birds made instantaneously within a defined band width.*—The same considerations apply to band width and length as mentioned in (a) above. Results should be expressed as flying birds per unit area. This is one of the most important aspects of the standardized approach.

(*c*) *Birds moving across the bows of the ship.*—A modification of (b) may be necessary for areas where large numbers of birds (such as shearwaters) are moving across the bows of the ship. The number of birds per minute crossing the forward path of the ship to a specified distance ahead are counted. This distance varies with the detectability of the species. A sample of 3-5 of these counts is taken per 10-min period. The mean time taken for one bird to cross the 300-m band transect is also measured. These two pieces of information are then used to calculate the mean numbers of birds per unit area (Gould et al. 1978). This streaming of birds may be caused by the presence of the ship and thus may not be random. The method has not been tested by the authors and may perhaps be most useful in measuring the size of a flock.

(*d*) *Birds associated with the ship.*—These birds should be recorded separately and not included in any calculation for density of birds per unit area.

METHOD II

A count of all birds seen to the limits of unaided visibility is made in a 90° bow-beam arc ahead of the ship per 10 min (or converted to birds per linear distance). This details the presence of rarer species more effectively than the 300-m transect; it would also provide some comparisons with past indices of birds per unit time. The 180° scan carried out by the North Sea study (Appendix 1) was found to be too large an arc when high densities of birds were observed. The narrowed arc of viewing would also probably improve physical viewing conditions for the observer. This method is relatively simple to use and could be used by casual observers. It would be conducted concurrently with Method I and could be compared validly with many past observations.

METHOD III

All birds seen in a 360° scan around the ship are recorded every 10 min (or linear distance). This would conform to the Pacific Ocean Biological Survey Program method (Gould 1974).

CONCLUDING COMMENTS

The statistical framework within which sampling of seabirds at sea operates depends to a large extent on the available resources. Most projects have been conducted from ships on an opportunistic basis where observers do not have the chance to direct the ship's course. Any form of random sampling is therefore impossible. Stratified sampling may be possible, but this requires a previous knowledge of the area so that suitable strata may be chosen; in addition, there must be sufficient data collected within each strata to avoid the problems of pooling data sets (Burnham et al. 1980). Such problems have occurred in one seabirds-at-sea study off the eastern United States (Powers et al. 1980).

At low bird density, all these methods can sometimes be used simultaneously. As densities increase, the 360° scan (Method III) is discontinued, followed by Method II. Method I gives the least biased information. The use of the other methods ensures that birds present at low densities are not entirely ignored.

Method I provides the best method of estimating the density or relative abundance of seabirds at sea from ships. An unbiased relative abundance of birds provides good information on the location of seabirds. Density estimates are required for further study of the energetics of seabirds and their role in marine ecosystems in order to quantify the potential effects of oil spills and to examine the relationship between seabirds and commercial fishing activities.

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APPENDIX 1.

The methods used by the Seabirds at Sea Team, 1979–1982. Past studies of seabirds at sea have often failed to describe precisely the methods used (e.g. work in N.E. Atlantic, 1969–1973). This has three consequences: first, it is impossible to attempt to standardize methods; second, it makes meaningful comparisons between studies difficult; third, workers repeatedly come against and fail to solve (or allow for) the same problems as encountered elsewhere. To avoid these consequences, the methods used in the North Sea from 1979–1982 are described as precisely as possible.

OBSERVATION POSITION

Auks are one of the most important components of the North Sea fauna and often dive before a ship reaches them; hence, a high forward-looking observation point was chosen to maximize the chances of detection. The chosen viewing position was in the open, both to improve visibility and to reduce distraction from the crew.

OBSERVATION CONDITIONS AND ENVIRONMENTAL RECORDS

Standard forms were used to record information about the ship and the environment. These records fell into three categories. (1) The ship's position, course, and speed and the starting time of observation were noted. Observations were not undertaken if the ship was engaged in fishing activity or moving at under 6 kph (4 knots). Slow steaming and fishing attracted large numbers of offal-feeding birds to the ship. (2) Other ship-related features such as height of eye above water (important for band-width determination) and viewing arc (180° forward was not always possible) were noted. (3) Environmental factors were recorded; normally these were wind speed and direction, cloud cover, barometric pressure and tendency, precipitation type and intensity, visibility, sea state, swell height and direction, air (and sometimes water) temperature, and an assessment of the sun's effect on the observation area, based on the strength of the sun and its direction relative to the direction of viewing. These notes on observation conditions were repeated at sea at least every 100 min, with any major changes being noted as they occurred. Each 10-min period was later coded with an interpolated position and a set of environmental parameters. Ship-associated birds were generally counted once every 100 min.

RECORDS OF BIRDS

180° scan ahead.—This method was used to obtain an index of abundance in terms of birds seen per 10-min cruising time. This was later converted, using ship's speed, to birds recorded per unit distance traveled. Scanning was carried out by eye in the 180° sector ahead of the ship; confirmation of species, details of molt, and age were determined with binoculars *after* initial detection. Birds not visible to the unaided eye but seen through binoculars were ignored. Continuous scanning with binoculars was found to be too exhausting when used for long periods.

For each observation of a bird the following were recorded: (1) species (or the lowest grouping or taxon possible); (2) number of individuals present; (3) activity (whether flying or on water); (4) plumage and age of bird where possible [plumage types generally described molt condition, but for Gannet (*Morus bassonus*) and Northern Fulmar a series of standard plumage types was used (Blake et al. 1984)]; (5) an approximate assessment of a bird's flight direction, if it was flying; and (6) notes on whether or not a bird was feeding or oiled and on associations between species and within species. These last two categories were disregarded in areas of high bird density.

Counts were conducted during as many daylight hours as possible, and all counting periods were divided into a series of 10-min units.

300 m band transect.—This method was employed concurrently with the 180° scan ahead. One side of the ship's track was chosen for the transect, being the better side for detecting birds. One side very often had the sun path within it or was directly upwind, making observations difficult. A 300-m-wide band extending forward of the ship was counted; the band width was determined with either a rangefinder (*Ranging 1200*, rangematic Mark V, 46–1,000 m) or the rangefinder described by Heinemann (1981). With practice, estimates could be made by eye on most occasions, any doubtful observations being checked by rangefinder.

All birds on the water within the 300-m band were recorded. For flying birds the transect was split into discrete blocks of time. The length of these was determined by the observer's subjective ability to see flying birds ahead under the prevailing weather conditions and the ship's speed. Faster ship speeds and shorter detection distances for birds increased the frequency of these time blocks. Appendix 2 gives a table of the divisions of the 10-min period and how they relate to these factors. Thus, at a ship speed of 9 knots, and when the observer felt that all flying birds were being detected within 500-m, 6 evenly spaced counts were made within the 10-min period. At the start of each time block, an instantaneous count was made of all birds flying within the transect. A first approximation to bird density could then be made, knowing band width, distance traveled by the ship in 10 min, and numbers of birds within the transect in that period. This 300-m band transect is illustrated in Fig. 1.

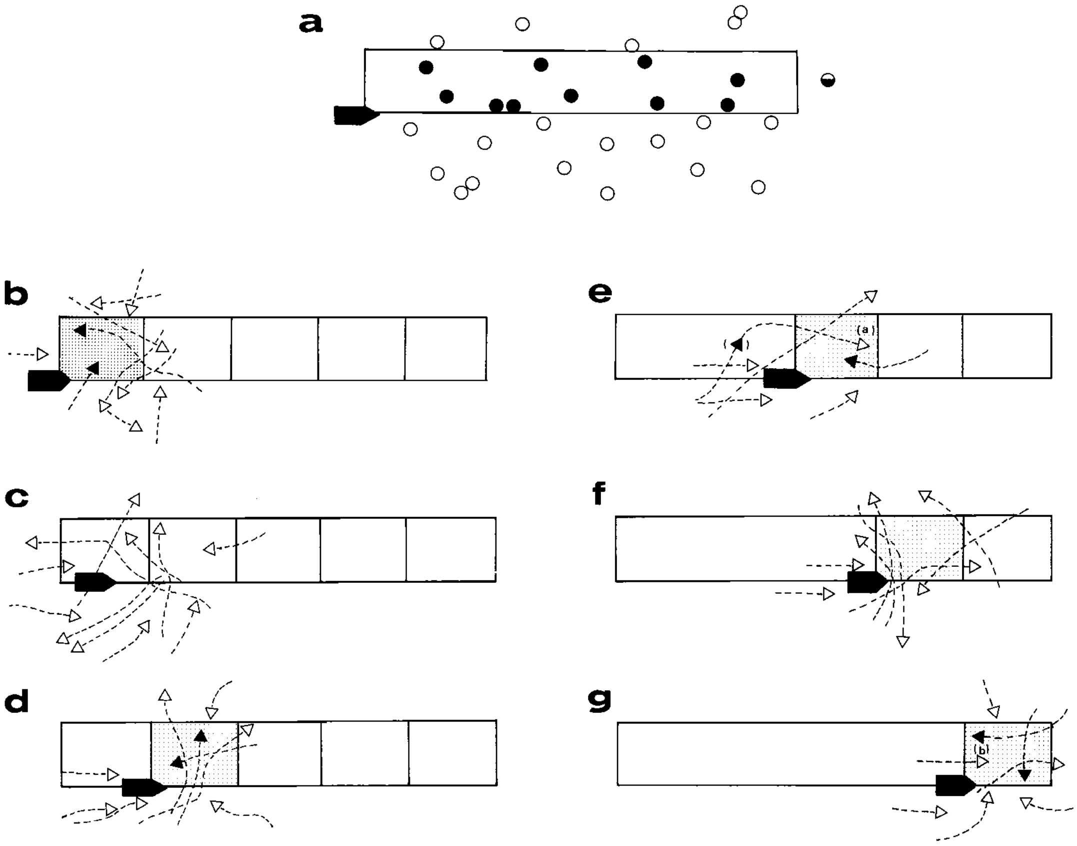

Fig. 1. An example of one 10-min period of band-transect methodology. Figure 1a illustrates the principles and some conventions of the 300-m-band transect system as applied to sitting birds, and Fig. 1b–1g illustrate the progress of an observer through a 10-min period, using the flying transect (birds on the water omitted). The ship's speed and visibility conditions in this hypothetical case necessitated splitting the 10-min period into 5 × 2-min blocks. (**a**) Birds seen on the water (stationary) during one 10-min period. The shaded dots represent those within the transect and unshaded dots those birds detected but outside the transect. The half shaded dot represents a bird detected inside the band-width but outside the 10-min period. It would be counted in the following 10-min period. (**b**) At the start of the 10-min period (minute 0), 2 birds are observed within the block boundaries (shaded), 9 birds are within the 180° forward view, and 1 bird is a ship follower. (**c**) At minute 1, the ship is halfway along the block counted at the start of the 10-min period; birds are present within this block (some new), but these are *not* counted. (**d**) At minute 2, the ship has reached the end of the first block counted. The observer now counts the second block; two birds are within the area counted. (**e**) At minute 4, the observer counts the next block of the 10-min period. Although 2 birds are inside the area, only 1 is counted, as 1(a) is identified as having been counted in the previous time block and is therefore ignored. It is important to avoid double counting. (**f**) At minute 6, no flying birds are present within the block counted. (**g**) At minute 8, 3 birds are within the area, but 1(b) is not counted, being a persistent ship follower. In summary, in this hypothetical 10-min period, 10 birds have been seen on the water in the transect (out of 30 birds detected in total), and 7 birds have been seen flying in the transect (out of a considerably larger number seen within the transect boundaries).

APPENDIX 2. Numbers of instantaneous counts of flying birds in transect needed per 10 min. Derived from ship's speed and detectability of birds. At 8 knots, the ship will cover 2.5 km per 10 min; thus, if all flying birds within 500 m are detected, five counts will be necessary per 10 min.

Ship's speed (knots)	Maximum distance at which all flying birds can be detected		
	300 m	500 m	800 m
4	4	2	2
5	5	3	2
6	6	4	2
7	7	4	3
8	8	5	3
9	9	6	3
10	10	6	4
11	11	7	4
12	12	7	5
13	13	8	5
14	14	9	5
15	15	9	6
16	16	10	6
17	17	10	6
18	19	11	7
19	20	12	7
20		12	7
21		13	8
22		14	8
23		14	9
24		15	9
25		15	9