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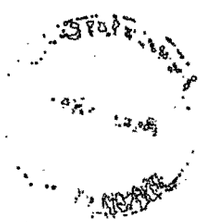

Census techniques for seabirds of arctic and eastern Canada*

by D. N. Nettleship

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Abstract

This paper reports on the various census techniques that have been used and tested during a lengthy study of the breeding and pelagic distributions of seabirds in the western North Atlantic and adjacent parts of the Arctic Ocean by the Canadian Wildlife Service's program "Studies on northern seabirds". Emphasis is on census techniques used to estimate population size and monitor changes in bird numbers at colonies of individual species within the families Procellariidae, Hydrobatidae, Sulidae, Phalacrocoracidae, Laridae, and Alcidae. The methods employed for gathering quantitative information on bird numbers at sea are also briefly reviewed.

The immediate purpose of this manual is to attempt to standardize census procedures used by investigators in the study region, in the hope that the techniques will be sufficiently precise to measure *real* changes in numbers within individual colonies and be sufficiently rigid to reduce observer error to a minimum, thus making the data more valuable in identifying substantial numerical changes and geographical shifts of species populations. The methods described are group-specific, not species-specific, in that the census procedures outlined can be extended to species breeding in similar situations or habitats in other geographic areas.

Résumé

La présente publication traite des diverses techniques de recensement essayées au cours d'une longue étude de la distribution des oiseaux de mer tant au large que dans leurs aires de reproduction menée par le Service canadien de la faune dans l'ouest de l'Atlantique Nord et les eaux arctiques adjacentes, au titre de son programme d'études des oiseaux de mer du nord. L'accent porte sur les techniques de mesure des variations d'effectif de colonies d'espèces choisies à même les familles *Procellariidae*, *Hydrobatidae*, *Sulidae*, *Phalocrocoracidae*, *Laridae* et *Alcidae*. On effectue aussi un examen sommaire des méthodes de collecte de données quantitatives sur les effectifs d'oiseaux en mer.

Cette étude est d'emblée une entreprise de normalisation des méthodes de recensement en usage dans l'aire à l'étude, dans l'espoir qu'elles soient, et assez fines pour mesurer les variations *réelles* d'effectif au sein de colonies données, et d'une rigidité qui réduise au minimum le risque d'erreur du fait de l'observateur, de façon que les données obtenues y gagnent en valeur vu qu'elles permettraient de déceler des variations numériques et biogéographiques d'importance chez une espèce donnée. La spécificité de ces méthodes est fonction du type d'habitat ou de situation plutôt que de l'espèce, ce qui en permet l'application à des espèces se reproduisant en d'autres lieux aux caractéristiques semblables.

Introduction

It is impossible to be interested in the sea without becoming aware of the presence of vast numbers of marine-associated bird populations — seabirds, shorebirds and waterfowl. What may be less obvious is how endangered these populations have become due to the acceleration of certain human activities (e.g., mining and drilling, oil spills, use of toxic chemicals, fishing, and domestic and industrial sewage disposal) in, or in areas draining into, marine water areas most critical to the reproduction and survival of marine birds.

Precisely how these forms of pollution are affecting marine water systems and marine life is by no means clear. However, what is clear is the likelihood of continued and increased exploitation of non-renewable natural resources, often in areas only recently believed to be inaccessible. The threat to seabird populations in arctic and eastern Canada is particularly evident as extensive areas of the continental shelf and arctic islands are being subjected to oil and gas drilling, pipeline construction, and mining operations.

We urgently need a carefully integrated research program to enlarge our understanding of the role of migratory birds in the marine ecosystem. We must also develop a monitoring system sufficiently sensitive to detect real population changes in bird numbers, both at sea and at breeding colonies, so as to establish a baseline for comparing population changes over long periods.

The present paper reports on the various census techniques that have been used and tested during a lengthy study of the breeding and pelagic distributions of seabirds in the western North Atlantic and adjacent parts of the Arctic Ocean by the Canadian Wildlife Service (Brown *et al*, 1975). The accuracy of these methods varies with the species involved, survey conditions (e.g., nature of nesting habitat, weather, etc.), and objectives. In general, techniques based on counts of nests (e.g., Gannet, kittiwake) are more reliable than those using other measures of population. Possible bias and error are highest when estimates of numbers require the use of a sampling procedure (e.g., representative study plots) or correction factors (e.g., for diurnal activity patterns, egg loss and replacement, etc.) or both. Much remains to be done to elucidate, measure, and correct major sources of census error in order to produce reliable estimates of population (for further discussions on the accuracy of seabird population estimates and surveys see Belopol'skii, 1957; Uspenski, 1958; Kartaschew, 1963; Swartz, 1966; Kadlec and Drury, 1968*a;* Brun, 1969*a,b*; Joensen and Preuss, 1972; Lock and Ross, 1973; Nettleship and Lock, 1973; Nisbet, 1973; Drury, 1973–74; Cramp *et al*, 1974; and Birkhead and Ashcroft, 1975).

The immediate purpose of this manual is to attempt to standardize census procedures used in the study region, in the hope that the techniques will be sufficiently precise to measure real changes in numbers within individual colonies and be sufficiently rigid to reduce observer error to a minimum, thus making the data more valuable in identifying substantial numerical changes and geographical shifts of species populations.

It is also evident that the methods described in this manual can be extended to situations and species elsewhere. In general, the methodologies outlined are group-specific (e.g., Laridae, Alcidae), not species-specific, in that the census procedures can be applied to species populations breeding in similar situations or habitats in other geographic areas. This is exemplified by the recent adoption of the described colony census procedures by several marine bird research groups and organizations including the Pacific Seabird Group, U.S. Fish and Wildlife Service's Seabird Survey Program (Alaska and Atlantic regions), and the Colonial Bird Survey Program (Laboratory of Ornithology, Cornell University).

Census of breeding birds at colonies

During each census of breeding birds at colonies certain data must be routinely recorded to ensure that the information gathered during any single survey can be used for comparative purposes in assessing changes in species population levels and distribution. The appendix to this publication gives details of the recording system which has been adopted by the Canadian Wildlife Service (CWS) seabird program to tabulate field data and permit coding for computer storage and retrieval with a form for recording census data in the field.

Most parts of the recording system and field form are self-explanatory. Some sections, however, require special attention and further instructions, as follows.

1. Selection of census technique

The intensity and precision of any seabird census technique will be determined mainly by the ultimate aims of the census program. For example, a survey of breeding birds over a large geographic region in a single season may require a less precise and time-consuming technique, whereas if the prime objective is to assess changes in local population levels, a detailed permanent census plot system is the most adequate procedure. In many cases, however, the species involved and the accessibility of the breeding colonies and nesting habitats, and to some extent time, weather conditions, topographic features of the area, and manpower, will also play an important role in the final selection of a census technique. Furthermore, colony size will influence the technique selected (especially where time is short). In small colonies (<2000 pairs) you should make direct counts of all birds and/or nests; if the colony is larger, you should census only a proportion of the total population according to the appropriate counting method listed for each species.

2. Description of the colony

It is extremely important to describe each colony in detail giving as much information as possible about its structure and associated habitat and physical features. This procedure will include preparing two sketch maps, photographing the colony and census areas, and providing precise details of each census area and census technique.

2.1. General sketch map

Show the location of each colony or area censused to ensure that comparative counts can be made in the future, as in Figures 1a, 2a, and 3a. If an area is large and the associated bird distribution small and/or aggregated, draw an inset map showing the nesting sites in relation to distinct natural features of the total region.

2.2. Detailed sketch map

Define the limits of the colony being censused and show with precision the census methods used to determine population size, as in Figures 1b, 2b, and 3b. In preparing any sketch map of the limits of a colony, show these boundaries in relation to main features of the region such as gullies, streams, fault lines, crevices, etc., as these permanent reference points or landmarks will be invaluable to other observers in recognizing the census area in future years.

2.3. Photography

The colony and census areas must be photographed to provide a permanent record of colony size, structure, and locations, which can be used to draw accurate boundaries of colonies and study plots (census transect lines, quadrats, etc.). The best method is to use a Polaroid camera so that areas counted or censused can be marked directly onto the print in the field (Polaroid camera using film type 105 permits the

Figure 1a
General sketch map showing the Black-legged Kittiwake colony on Outer Birch Island (50°14′N, 63°59′W), northshore of the Gulf of St. Lawrence.

Figure 1b
Detailed sketch map showing the distribution of nests on cliffs in the Black-legged Kittiwake colony on Outer Birch Island.

Figure 1a

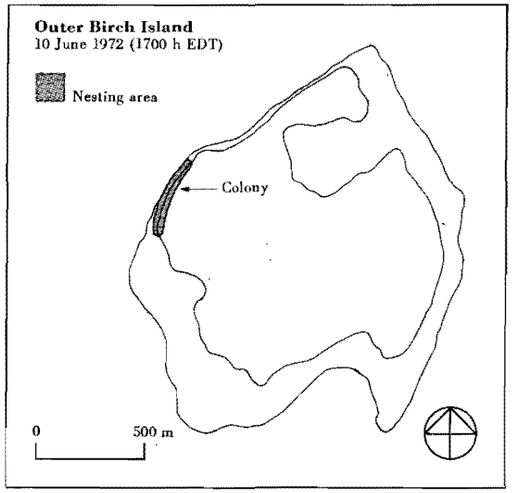


Figure 1b

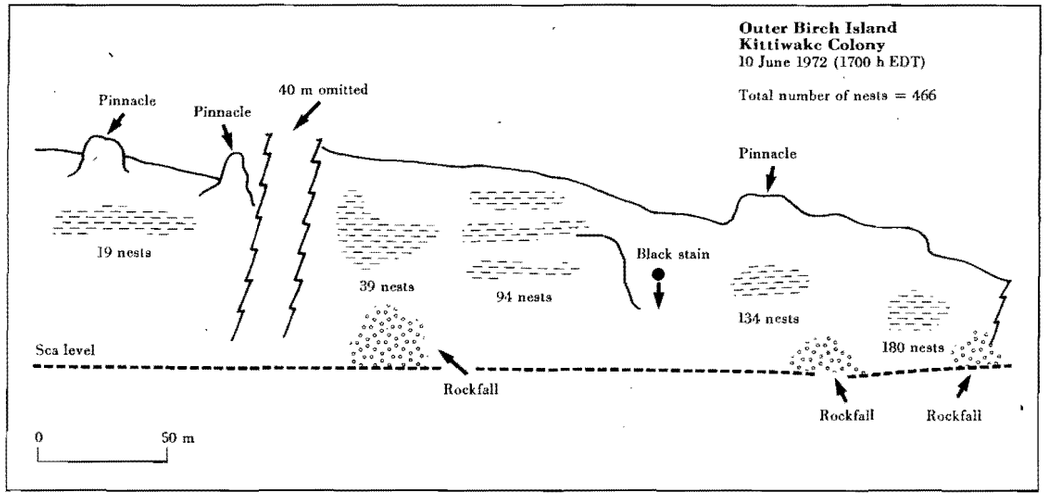


Figure 2a
General sketch map showing the Herring Gull colonies, A and B, on Inner Birch Island (50°14′N, 63°59′W), northshore of the Gulf of St. Lawrence.

Figure 2b
Detailed sketch map showing line-transect census method (distribution of quadrats and nests) on colony A, shown in Figure 2a.

Figure 2a

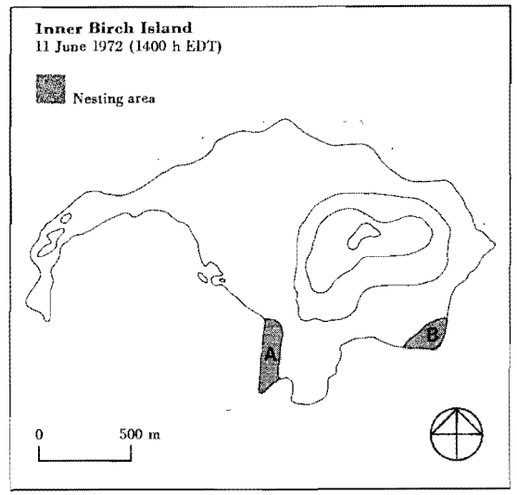


Figure 2b

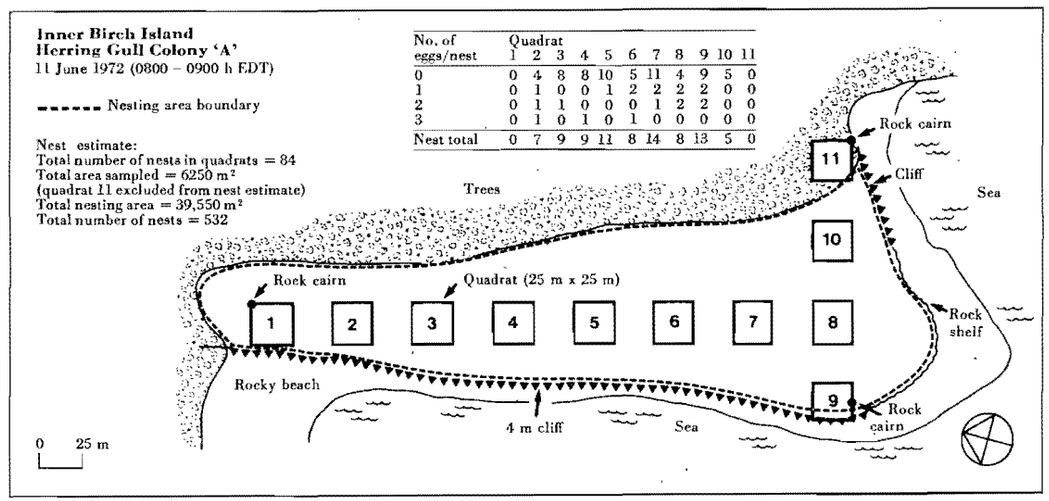


Figure 3a
General sketch map showing the approximate locations of Atlantic Puffin colonies, A–I, on Wolf Island (50°10′N, 60°17′W), north shore of the Gulf of St. Lawrence.

Figure 3b
Detailed sketch map showing line-transect census method (distribution of transect lines A–D, quadrats and active puffin burrows) on colony A, shown in Figure 3a.

Figure 3a

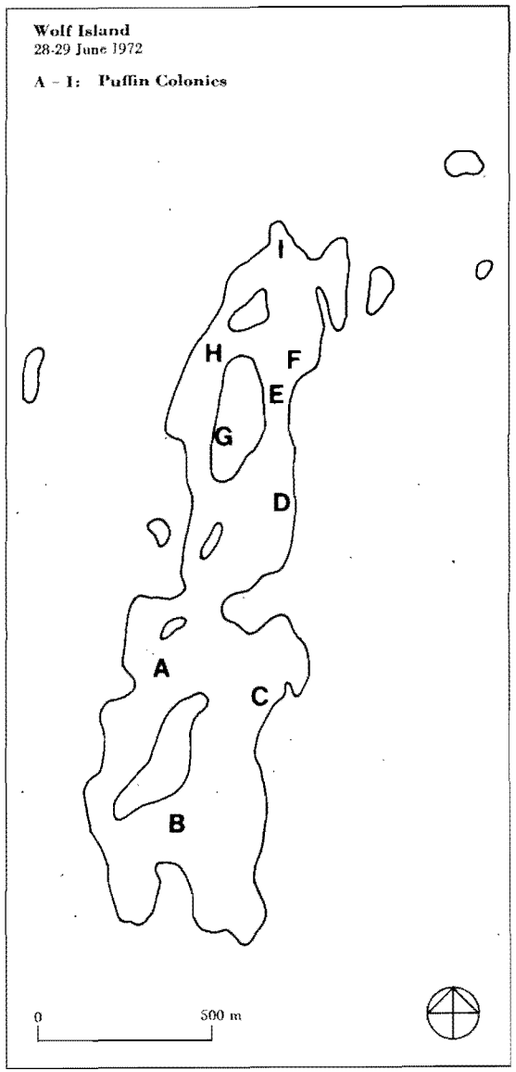
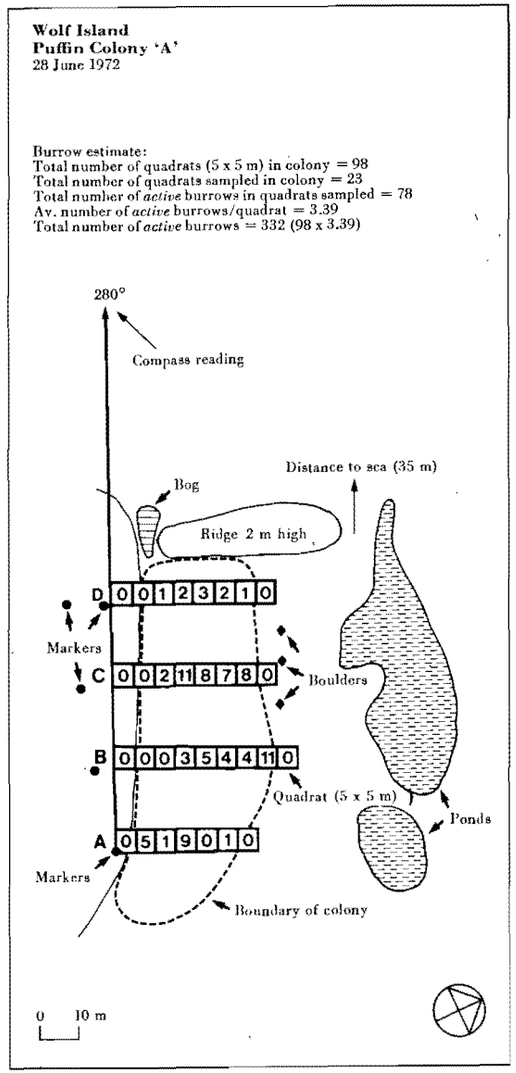


Figure 3b



production of both a print and negative). When photographing a colony, be sure to record the photographer's name, location (show position and direction to subject for each photograph taken on the general and/or detailed sketch maps), date and time, camera and lens types, film type, shooting detail (subject, distance, scale, etc.) and weather conditions.

2.4. Extent of each census

It is important to describe the completeness and exactness of the census. Some of this information will be given on the field form under *Reliability of total census* and *Reliability of count of number of breeding birds*, but additional details may be given in the *Special notes* section. For example, were any areas overlooked or inaccessible and if so, to what extent (i.e., proportion of total colony not censused, etc.)?

3. Phase of the breeding cycle

The census of breeding birds at colonies is normally conducted during the middle and last half of the incubation period of the species involved, although in some cases the best time for census activities is at an earlier (e.g., Black Guillemot) or later phase (e.g., Leach's Storm-Petrel) of the breeding cycle. However, even where the breeding time of a species is well known, it is important to estimate the phase of the breeding cycle for the population at the time the census is made — that is, by recording the nest contents (e.g., 4 eggs, or 2 eggs + 2 chicks, or 4 chicks, etc.) for an adequate sample of nests examined at random within the census area, as in Figure 2b. This information will assist in the interpretation of the census and increase its comparative value. Enter the results on the field form under *Phase of breeding cycle at time of census* and/or *Special notes*.

4. Miscellaneous observations and remarks

It is important to record and comment upon any outstanding or unusual features of the colony, particularly those concerning census procedures and the condition of nesting habitats and birds. Examples may include:
(a) the occurrence of high bird-mortality within the colony (accurate counts of broken and/or deserted eggs and dead and/or dying birds, with comments on the suspected or known causes);
(b) the presence of avian and/or mammalian predators at the colony;
(c) the existence of human disturbance with a description of the level of activity (i.e., none, light, medium, or heavy) based on immediate and observable activity (e.g., shooting–hunting of nesting birds, drowning of birds in fish-nets placed close to colony, etc.); also report any potential activities (e.g., proposed construction of power plant, refinery, etc.) which may result in environmental damage to the colony either directly or indirectly;
(d) the recording of any information which will facilitate a repeat census of the colony in the future—one which would be conducted in a way virtually identical to the baseline census and, therefore, would permit a precise measurement of change in bird numbers.

In most cases, information of this kind will be recorded on the field form under the appropriate section heading and/or given as a *Special note*, using a specific reference number (see Appendix).

Census techniques for individual species

1. Northern Fulmar (*Fulmarus glacialis*)

1.1. Distribution Maps

(1) Mark locations of all colonies on general sketch map.

(2) Describe each colony (topography, physical features, vegetation, etc.).

(3) Make detailed sketch map (to scale) of each colony showing: (a) limits of the colony (use main physical features as land-marks), and (b) outline and estimate of the total nesting area.

(4) Photograph each colony.

1.2. Census techniques

It is usually difficult to determine the number of breeding pairs at a fulmar colony because of the presence of prospecting birds (nonbreeders and immatures) which may occupy ledges for several years before producing an egg. Consequently, the most satisfactory census method is to make a detailed survey of each colony and count all apparently occupied nest sites in the colony or census plots. Although this gives the number of *nest-site holders* rather than the number of *true breeders* (i.e., pairs that occupied a site and laid one egg), it does provide a reliable index of population size. The procedure outlined below should be followed.

The number of birds occupying ledges fluctuates irregularly within fairly wide limits (3 to 6 days) throughout the breeding season. Consequently, counts should be made over a series of 3 to 7 days in order to determine the average number of birds, both pairs and singles, in attendance at the colony (or representative study plots). Make the counts between 1200 to 1300 hours (maximum extremes: 0900 to 1600 hours) as attendance is highest towards mid-day (see below for time of breeding cycle in which to census). Record the status of sites as: site + 2 adults, site + 1 adult, site with 0 adults, or site with egg or young.

A reliable index of population size cannot be obtained without a series of counts because daily attendance at the colony is variable (even when the count is taken at the same time of day on consecutive days). The 3 to 7 days series provides an accurate average occupancy figure and should also maximize the likelihood of identifying those sites where an egg is under the attending adult, in order to calculate the percentage of occupied sites with eggs.

1.3. Time of census

The best time to census is the middle two weeks of the 49-day incubation period, when breeding birds sit tight and many pairs are together on the ledges, and when the chance of missing birds which have lost eggs and departed from the colony is lowest. In the eastern Canadian Arctic this is the last week of June and first week of July.

2. Leach's Storm-Petrel (*Oceanodroma leucorhoa*)

2.1. Distribution maps

(1) Mark locations of all colonies on general sketch map.

(2) Describe each colony (topography, physical features, vegetation, and cover, etc.) and divide into sub-areas according to burrow density, if necessary.

(3) Make detailed sketch map (to scale) of each colony showing: (a) limits of the colony (use main physical features as land-marks) and sub-areas, and (b) outline and estimate of the total nesting area.

(4) Photograph each colony.

2.2. Census techniques

2.2.1. Counts of burrows in accessible habitat

Counts of burrows provide an accurate measure of the size of the breeding population in a colony, though it may be impossible to count or estimate numbers at small colonies with a low density and patchy distribution of burrows. In general, the best method is a systematic count and inspection of all burrows to determine the number of occupied burrows (i.e., burrows with an egg or chick). When colonies are large, the determination of their abundance will depend on sampling the total nesting area (or sub-areas) using one of the following methods, which are given in descending order of reliability.

Line transect method

Place fixed line transects (assign each line a letter—A, B, C, etc.) across the colony from edge to edge to ensure total coverage of the colony and to detect changes in numbers at the periphery in future years. The number of transects will depend on colony size and time available, but you will need a minimum of 3 transects comprising at least 30 quadrat samples.

Permanently mark each transect line by placing stakes or some suitable markers at both ends of the line and at regular intervals along the line if the transect is extremely long. Mark points along the line at 1-m intervals and use each point as a corner of a 1 x 1 m quadrat for a high density (5 x 5 m for medium or 10 x 10 m for low density). If transect is very long, select sample quadrats at regular intervals along the line beginning at the front of the colony. Measure the following characters within each quadrat:

(a) burrow number and status—count all burrows in quadrat and determine status of each, either active (with egg, chick, etc.) or inactive (unoccupied); record inaccessible burrows, but note any nest not checked; avoid disturbance of nesting birds as they may desert; also *use extreme caution when examining a nest as the single egg is very fragile;*

(b) habitat description—describe habitat of each quadrat, including vegetation and cover, angle of slope, position within colony (peripheral edge or central region);

(c) distance from front of colony—record distance from furthest side of quadrat to origin of transect line.

Sub-area sample method

Make direct counts of burrows in as many 1 x 1 m (or 5 x 5 m or 10 x 10 m) quadrats within the defined sub-area as time permits (a minimum of 10 quadrats per area or sub-area). Select quadrats at random, although samples should be as typical of the sub-area as possible, and record (as with the line-transect method): (a) burrow number and status; (b) habitat description; (c) distance from front of colony.

2.2.2. Counts of birds in inaccessible habitat

There is no method of reliably determining or estimating the population size at nest sites which are inaccessible or unclimbable. You can attempt to provide an index of the population with the capture – recapture method or flight-activity and/or flight-call rate, but both techniques have serious shortcomings: the first because of movement of non-breeding birds between colonies and the second from large changes in daily and seasonal activity patterns. Consequently, counts using any of these approaches are of very limited value.

2.2.3. Time of census

Census during the last half of the incubation period and keep disturbance to a minimum, as this species deserts readily during incubation.

3. Gannet (*Morus bassanus*)

3.1. Census techniques

Procedures used to census Gannets in the North Atlantic have ranged from simple visual impressions of bird numbers from both land and sea to detailed ground counts of nests (Nettleship, 1976). Ground counts cannot be made at most colonies because of the inaccessibility of the nesting habitat. Moreover, it is difficult to divide a large colony into small sections and make a systematic search. The most satisfactory method of population analysis is from aerial photography (Barrett and Harris, 1963; Nettleship 1975, 1976) by taking a series of overlapping photographs during the incubation period from a light fixed-wing aircraft using a 70-mm camera with standard lenses (100 or 150 mm) and black-and-white film (Plus-X professional) at a distance from the colony of about 550 to 600 m. Delimit the nesting areas on 18 x 25 cm glossy enlargements and count individual nests under a hand lens (8x) using a plastic grid overlay. Since only attended nests are counted, and the status of each nest is unknown, this assessment of breeding population represents the number of *nest-site holders* rather than the number of *true breeders* (i.e., pairs that built a nest and laid one egg).

3.2. Time of census

Census during the last half of the incubation period. In North American colonies that is late June to mid-July.

4. Great Cormorant (*Phalacrocorax carbo*) and Double-crested Cormorant (*Phalacrocorax auritus*)

4.1. Distribution maps

(1) Mark locations of all colonies on general sketch map.

(2) Describe each colony (topography, physical features, etc.).

(3) Make detailed sketch map (to scale) on each colony showing: (a) limits of the colony based on natural features, (b) outline and estimate of total nesting area, and (c) in mixed-species colonies, distribution of each species within the total nesting area.

(4) Photograph each colony.

4.2. Species identification

It is difficult to distinguish between these two species unless at close range, especially after early June. The less common Great Cormorant is often misidentified as Double-crested. The recognition features are:

(1) body size—Great is slightly larger (20-30%) than Double-crested;

(2) bill size—Great's bill is considerably longer and wider than the Double-crested's;

(3) throat-pouch colour—Great has yellowish gular pouch with white hind border, and Double-crested has orange-yellow gular pouch which lacks a white hind border.

4.3. Census techniques

4.3.1. Counts of nests in accessible habitat

You can make accurate nest counts in a single-species colony with direct counts of all nests located on either cliff ledges or in trees. (Where possible, record status of nests separately as: nest + eggs, nest + chicks, or nest with adults only). However, in mixed-species colonies you may have some difficulty in establishing species identity for nests where the owners are absent. When censusing, keep disturbance to a minimum and make the count from as far away as possible so as to prevent gulls and other avian predators from taking exposed eggs or small young.

4.3.2. Counts of nests in inaccessible habitat

Where it is not possible to census a colony from land (e.g., tree-top nesting colony with thick undergrowth and/or diffuse nature) or sea (e.g., top of unclimbable rock stack), you can make an accurate count by aerial photography using a 70-mm camera with standard lenses (100 and 150 mm) and black-and-white film. Individual nests are visible on 18 x 25 cm glossy enlargements.

4.3.3. Time of census

The ideal time to census single-species colonies is midway through the nestling period when young are too large to be taken by gulls and yet too underdeveloped to leave the nest prematurely. Visit mixed colonies early in the nesting season when distinctive plumages make each species more recognizable. In Atlantic Canada this is in late May.

5. Gulls (*Larus* spp.)

5.1. Distribution maps

(1) Mark locations of all colonies on general sketch map.

(2) Describe each colony (topography, physical features, vegetation, cover, etc.) and divide into sub-areas according to density if nests are scattered or clumped.

(3) Make detailed sketch map (to scale) of each colony showing: (a) limits of the colony and sub-areas (use main physical features as landmarks or reference points), (b) estimate of total nesting area, and (c) species composition — single-species colony or associated with other gulls and non-gull species (if colony is mixed, outline the distribution of each species within the colony if possible).

(4) Photograph each colony.

5.2. Census techniques

You can derive gull census figures by several methods, including: (1) full nest count (a nest is considered to be any structure more elaborate than a simple scrape — it must have some built-up edge to qualify); (2) nest estimate using line-transect techniques to sample the total nesting space; (3) breeding-pair estimate by a boat count of adults standing or flying over the colony multiplied by the ratio of nests to adults recorded on control areas selected prior to the boat count; (4) boat count of adults alone; or (5) aerial estimation and photography.

The selection of a technique will depend largely upon the accessibility of the colony, the time available, and the degree of precision required. The most satisfactory method is a direct count of all nests in the colony, but a sampling procedure may be required at very large colonies or where nests are located in dense vegetation. Restrict counts of birds alone to sites where nests are not visible and are inaccessible, or when time is short, as estimates derived from these techniques are subject to a high degree of error.

5.2.1. Counts of nests in accessible habitat

Open land areas

Make a detailed survey of the entire area of the colony and count all nests. Survey colony systematically and mark each nest counted with spray-paint to avoid an omission or double count.

Dense vegetation

You may estimate the number of nests in dense vegetation by performing the following work sequence:

(a) delineate the colony boundaries (occupied area),

(b) divide the colony into sub-areas based on density (density estimate determined by using

binoculars to observe birds flying away and/or roosting),
(c) sample colony or sub-areas using one of the following methods, which are given in descending order of reliability.

Method 1: Line transect (strip transect) — Place two fixed transect lines (10 m apart, but quadrat size can vary with nest density) across the colony from edge to edge to ensure total coverage of the colony or sub-area. The number of transects will depend on the colony size and time available, although several transects should be done. Permanently mark each transect by placing stakes or some suitable markers at both ends of the line or at regular intervals if the transect is extremely long. Mark points along the transect lines at 10 m intervals and count the number of nests in each 10 x 10 m quadrat (or whatever size is indicated by nest density). If transect is very long, select sample quadrats at regular intervals along the lines beginning at the front edge of the colony or sub-area. Record data for each quadrat separately and in order. Extrapolate an estimate of the total number of nests in the colony from the transect nest density figures.

Method 2: Control samples — Record the number of individuals present (N_i) in representative *control areas* where the number of breeding pairs (N_p) is known (based on the number of nests) and use this ratio ($k = N_p/N_i$) to calculate the total number of pairs in the colony.

Method 3: Quadrat samples — Count the number of nests within sample 10 x 10 m quadrats (quadrat size can vary with nest density). The number of quadrats sampled will depend on the colony size and time available. Select quadrats at random, although samples should be as typical of the colony or sub-areas as possible. Once you know the nest density of these areas, extrapolate the data for the entire colony.

Cliff-ledge sites

Make a detailed survey from land and/or sea and count all nests. Only *actual* nests are to be counted; do not confuse *whitewash* loafing sites with nests. Usually you can accurately determine the number of nests and consequently the number of breeding pairs.

5.2.2. Counts of birds in inaccessible habitat

Small colonies

In colonies with sparse vegetation, determine the numbers of birds and location of nests by observing the nesting area through binoculars from a distant vantage point. When vegetation is dense, it may only be possible to count birds roosting or flying in the area.

Large colonies

Where you can view a large colony from a distant vantage point, visually divide the nesting area by natural topographic features into small sections and count the birds in each area. In cases where the size of the colony and/or the terrain do not allow a visual count, take a series of overlapping photographs of the colony to attempt to determine the number of adult gulls present from black-and-white glossy print enlargements.

Aerial estimation and photography

You can measure gull populations nesting on cliffs and flattish ground by aerial estimation and photography. The procedure is simple: identify species and estimate gull numbers and location of colony as the aircraft passes close to each colony (e.g., Nettleship, 1974). Photographs can be taken at large colonies to count the number of gulls or to supplement the visual estimate.

While the accuracy of visual estimates and those based on the counts of gulls in photographs is low (Kadlec and Drury, 1968*b*; and Drury, 1973-74 give detailed reviews of errors inherent in aerial censuses), the information does provide some indication of the size of individual colonies and an estimate of the numbers of gulls in geographic regions.

Attempts to determine the numbers of breeding pairs from visual counts of individual gulls in attendance at the time of the aerial census are not profitable, as the number of birds present at the colony varies within any single day, as well as at different times of the nesting season. Thus, where the relationship of visually estimated and/or counted numbers of gulls to actual numbers of nests is not known, give the estimates as the numbers of individual birds seen or counted.

5.2.3. Time of census

The census should be made when most birds are in the late stage of incubation.

6. Black-legged Kittiwake (*Rissa tridactyla*)

6.1. Distribution maps

(1) Mark locations of all colonies on general sketch maps.

(2) Describe each colony (topography, physical features, etc.).

(3) Make detailed sketch map (to scale) of each colony showing: (a) limits of the colony (using main physical features as landmarks), and (b) outline and estimate of the total nesting area.

(4) Photograph each colony.

6.2. Census techniques (all habitats)

The kittiwake can be censused with relative ease by either making a count of nests from the land and/or sea or using aerial and boat photography. Count only actual nests (structures with sufficient nesting material to retain eggs); do not confuse *whitewash* loafing sites with nests.

6.2.1. Counts of nests at the colony

Make a detailed survey and count all nests. Nest counts can be made from vantage points along the cliff top and/or from the sea below the cliffs. You can census large colonies by dividing the total nesting area into small sections using natural topographic features as reference points and counting the nests in each section. The nest count for each region should be the mean value of at least three separate counts.

6.2.2. Counts of nests on photographs

You can make a reliable census by taking a series of overlapping photographs from either a boat below the cliffs or a light aircraft around the colony. The nests are readily distinguishable on black-and-white glossy print enlargements (usually 28 x 36 cm photos) and can be systematically counted to provide a reliable means of monitoring a breeding kittiwake population.

6.2.3. Time of census

Census during the middle and last half of the incubation period.

7. Terns (*Sterna* spp.)

7.1. Distribution maps

(1) Mark locations of all colonies on general sketch map.

(2) Describe each colony (topography, physical features, vegetation, cover, etc.) and divide into sub-areas according to density if nests are scattered or clumped.

(3) Make detailed sketch map (to scale) of each colony showing: (a) limits of the colony and sub-areas (use main physical features as land-

marks), (b) estimate of total nesting area, and (c) composition — single-species colony or associated with other terns and/or gulls; if a mixed-species colony, outline the distribution of each species as very seldom does complete integration occur.

(4) Photograph each colony.

7.2. Census techniques

Keep visits to colonies short (20 minutes) and take special care to avoid unnecessary disturbance. When the colony is large, it may be safe to extend this time period if disturbance is local and birds in adjacent areas remain on their nests. However, birds in small new colonies are very susceptible to desertion after some disturbance and extreme caution should be exercised.

7.2.1. Counts of nests in accessible habitat

Direct counts of all nests may be possible at small or scattered colonies, but a sampling procedure may be required at large colonies. When sampling the total nesting area, use one of the following methods, which are given in descending order of reliability.

Method 1: Line transect (strip transect)— Place two fixed transect lines, 5 m apart (but quadrat size can vary with nest density) across the colony from edge to edge to ensure total coverage of the colony or sub-area. The number of transects will depend on the colony size and time available, although several transects should be done. Permanently mark each transect by placing stakes or some suitable markers at both ends of the line or at regular intervals if the transect is extremely long. Mark points along the transect lines at 5 m intervals and count the number of nests in each 5 x 5 m, or other, quadrat (if transect is very long, select sample quadrats at regular intervals along the lines beginning at the front edge of the colony or sub-area). Record data for each quadrat separately and in order. Extrapolate an estimate of the total number of nests in the colony from the transect nest density figures.

Method 2: Control samples — Record the number of individuals present (N_i) in representative *control areas* where the number of breeding pairs (N_p) is known (based on the number of nests) and use this ratio ($k = N_p/N_i$) to calculate the total number of pairs in the colony.

Method 3: Quadrat sample — Make direct counts of nests in as many 5 x 5 m, or other, quadrats within each colony or sub-area as time permits. Select quadrats at random, although samples should be as typical of the colony or sub-area as possible. Once the nest density of these areas is known, the data are extrapolated for the entire colony.

7.2.2. Counts of birds in accessible and inaccessible habitats

Counts of birds are easier than counts of nests. Incubating birds may be counted from a distant vantage point using binoculars without causing disturbance. Where birds are nesting in habitats with uneven terrain or dense vegetation, the best method (at least for Common Tern, *Sterna hirundo* and Arctic Tern, *S. paradisaea*) for obtaining replicable estimates of breeding pairs is to count the number of birds loafing away from the colony and then estimate the number of birds that fly up over the nesting area when flushed, less 10%; the census should be made soon after the main peak of egg-laying; for complete details see Nisbet (1973). Since attendance varies with time of day, time of season, and weather conditions, make a careful note of these parameters at time of census.

If time is available and the nesting area accessible, establish control areas within the colony where the number of breeding pairs (N_p) is known (based on the number of nests) and then record the number of individuals present (N_i) in these areas. Use the ratio N_p/N_i to calculate the total number of pairs for all areas censused.

7.2.3. Time of census

Census during the last half of the incubation period when making actual counts of nests or soon after the main peak of egg-laying for counts of birds.

8. Alcids

The Alcids are a varied and difficult group to census with precision. In general, the number of birds present at a colony varies within very wide limits with time of day, between days (phase of the breeding cycle), and weather conditions. This variation in attendance at the colony severely limits the value of counts unless you determine associated correction factors, especially for Razorbills, murres, and puffins.

The method for calculating the necessary correction factors (k) is given in the individual species accounts. These correction factors vary with time, the nature of the nesting habitat, and weather conditions, and so several correction factors may have to be derived where significant differences in census conditions occur. For example, a new correction factor is required for each two-hour period during the day and where the phase of the breeding cycle has changed. Furthermore, it is useful to derive a k value for several control areas under identical conditions (time of day, etc.) to assess variation in k between areas, especially between areas with large (> 30 pairs) and small (10 pairs) groups.

In general, Razorbill and murre counts are based on egg and/or nest counts alone or, where total egg counts are not possible (e.g., certain murre ledges), by determining the ratio of birds present on control ledges and the total number of eggs and/or young on the same ledges, and using this ratio to calculate the number of pairs for inaccessible colonies. Black Guillemot number estimates are from counts of birds seen during a systematic survey of the coast early in the breeding season. Puffins in accessible habitats are censused using grid and line-transect procedures. Details of specific procedures are given in sections 9 to 12.

9. Razorbill (*Alca torda*)

9.1. Distribution maps

(1) Mark locations of all nests and/or nesting concentrations on general map.

(2) Make detailed sketch map (to scale) of each nesting area showing exact location of nest-sites and limits of the colony based on main physical features of the area.

(3) Photograph the nesting area.

9.2. Census techniques

Razorbills usually nest in scattered pairs, sometimes mixed with murres, on rock ledges, in crevices, under boulders, and in broken cliffs. Birds on ledges are easily observed and counted, but birds nesting in other habitats are often not visible from a distance. In these cases an egg and/or chick count may be the only feasible counting method.

9.2.1. Counts of birds and/or eggs and chicks in accessible habitat

Make a direct count of the numbers of birds on the nesting areas and then systematically search the areas for incubating birds, eggs or chicks to determine the number of breeding pairs.

When colonies are too large to search thoroughly or insufficient time is available, establish *control areas* within the nesting areas and: (1) record the numbers of birds on all nesting areas including those present (N_i) in the *control areas* where the number of breeding pairs (N_p) is known (based on the number of eggs and/or chicks); (2) use this ratio ($k = N_p/N_i$) to calculate the number of pairs for all areas censused. As this ratio (N_p/N_i) varies with time and weather conditions, several correction factors (k) may have to be derived where a significant change in census conditions occurs (e.g., time of day — new k value required for each two-hour period — or different phase of breeding cycle, etc.).

9.2.2. Counts of birds in inaccessible habitat

When breeding sites are inaccessible, make direct counts of birds on the nesting areas and nearby locations. Although such counts are inadequate to assess the number of breeding pairs, they may provide a rough index of numbers, especially if the counting procedure is standardized for time of day, phase of breeding cycle, and weather conditions.

9.2.3. Time of census

Counts should be made in the second half of the incubation period.

10. Common Murre (*Uria aalge*) and Thick-billed Murre (*Uria lomvia*)

10.1 Distribution maps

(1) Mark locations of all colonies on general sketch map.

(2) Describe each colony: topography, physical features, etc.

(3) Make detailed sketch map (to scale) of each colony showing: (a) limits of the colony based on the main physical features, (b) ledges occupied by birds, and (c) estimate of total nesting area.

(4) Photograph each colony.

(5) At mixed-species colonies be careful in making species determination and note precisely the limits for each species.

10.2. Census techniques

10.2.1. Counts of birds and/or eggs and chicks in accessible habitat

Although counts of individual birds on bare rock ledges or open nesting sites are relatively easy to make, estimates of the number of breeding pairs are more difficult. At small colonies where the nesting ledges are clearly visible, count the eggs and chicks to give a reliable estimate of the number of pairs. However, when colonies are extremely large and eggs and chicks are not easily seen, the best method is to establish *control ledges* within the total nesting area, and (1) make direct counts of the numbers of birds on all ledges in the colony (do not correct for birds alighting and departing during the count unless flushing occurred because of observer's presence) including those present (N_i) on the *control ledges* where the number of breeding pairs (N_p) is known (based on a count of the total number of eggs and/or chicks); (2) use this ratio ($k = N_p/N_i$) to calculate the number of pairs for all colonies censused. Derive a k value (N_p/N_i) for several control areas under identical conditions (time of day, etc.) to assess variation between areas, especially between control ledges with large (>30 pairs) and small (10 pairs) groups.

10.2.2. Counts of birds in inaccessible habitat

At colonies where egg and/or chick counts are not possible, the preferred method is an individual count of adults. You can make accurate counts of either all birds present at the colony (small colonies) or the number of individuals in clearly delineated study plots or subdivisions (large colonies) within the colony. Since the necessary correction factors cannot be derived (because of the inaccessibility of the nesting ledges) an estimate of the size of the true breeding population is not possible. However, even though the counts do not represent the entire population, they can be used as an index of colony size with which repeat censuses made under the same conditions (i.e., time of day, phase of breeding cycle, and weather) can be compared.

10.2.3. Population analysis from photography

Murre populations nesting on steep cliffs or flat-topped surfaces can often be measured and analyzed from aerial photography: take a series of overlapping photographs during the last half of the incubation period from a light aircraft using a 70-mm camera with standard lenses (100 or 150 mm) and black-and-white film (Plus-X professional) at a distance from the cliff of about 200 to 250 m. Individual birds can be systematically counted on 18 x 25 cm glossy enlargements using a hand lens (8x) or binocular microscope and plastic grid overlay. Where you know the relationship of numbers of murres to actual numbers of eggs and/or chicks (control areas established prior to aerial photography), you can estimate the number of breeding pairs. If correction factors are not available the count can still be used as an index of the population (see above). Moreover, this census method provides a permanent and precise record of the distribution and numbers of birds at individual colonies that could be extremely valuable in the future.

10.2.4. Time of census

Census during the last half of the incubation period.

11. Black Guillemot (*Cepphus grylle*)

11.1. Census techniques (all habitats)

Nest-sites of Black Guillemots are difficult to count as they are usually hidden in inaccessible rock crevices or sheer cliffs and boulder beaches. Some nests can be located during the incubation period by watching adult movements in the early morning and evening, and during the chick-rearing period by watching adults returning with food for their young. However, this method is time-consuming and cannot be easily used over large geographic areas.

The best census method for obtaining standardized counts of breeding populations is to census the coast systematically early on calm mornings (i.e., good weather conditions and not windy) before egg-laying, when pairs are displaying on the sea. Make counts from a boat on the water or from cliff-top vantage points and: (a) mark locations of birds seen on the sea along the coastline and record whether solitary or associated with another Black Guillemot; (2) when a nest-site is identified (e.g., bird seen departing from a rock crevice) make a detailed map to show the exact location of the site and describe the main physical features of the nesting area for future reference.

11.2. Time of census

Census early in the breeding season before egg-laying (see above).

12. Atlantic Puffin (*Fratercula arctica*)

12.1. Distribution maps

(1) Mark locations of all colonies on general sketch map.

(2) Describe each colony (topography, physical features, vegetation) and, if necessary, divide each colony into sub-areas according to burrow density.

(3) Make detailed sketch map (to scale) of each colony showing: (a) limits of the colony (based on main physical features) and sub-areas (if present), and (b) estimate of total nesting area.

(4) Photograph each colony.

12.2. Census techniques

12.2.1. Counts of burrows in accessible habitat

Census of puffins presents special problems because they usually nest in burrows in the ground. The best method to determine breeding population size is to count the occupied burrows (burrows with an egg, chick, nest material, defecation stains, etc. [Nettleship, 1972]). You may be able to inspect all burrows at small colonies, but these cases are the exception, and to determine the abundance of burrows you usually have to sample the total nesting area (or sub-areas) using one of the following methods, which are given in descending order of reliability.

Line transect method

Place fixed line transects (assign each line a letter—A, B, C, etc.) across the colony from edge to edge to ensure total coverage and to detect changes in numbers at the periphery in future years (e.g., from maritime cliff-edge inland to where burrow density is zero). The number of transects will depend on colony size and the time available, though you will need a minimum of three transects comprising at least 30 quadrats.

Permanently mark each transect line by placing stakes or some suitable markers at both ends of the line and at regular intervals along it if the transect is extremely long. Mark points along the line at 5 m intervals and use each point as a corner of a 5 x 5 m quadrat (quadrat size can vary with burrow density). If transect is very long, select sample quadrats at regular intervals along the line beginning at the front of the colony. Measure the following characters within each quadrat:

(a) burrow number and status — count all burrows in quadrat (record a hole as a burrow only when it is at least half a metre in length) and determine status of each — active (with egg, chick, nest material, defecation stains, etc.) or inactive (unoccupied); record inaccessible burrows, but note nest status not determined;

(b) briefly describe habitat of each quadrat: vegetation, angle of slope, position within colony and/or sub-area;

(c) distance from front of colony — i.e., record distance from furthest side of quadrat to origin of transect line.

Extrapolate an estimate of the total number of breeding pairs in the colony from the line-transect and occupied burrow density figures.

Sub-area sample method

Make direct counts of burrows in as many 5 x 5 m (or other) quadrats within the defined sub-areas as time permits. Select quadrats at random, though samples should be as typical of the sub-area as possible, and record, as with the line-transect method: (a) burrow number and status, (b) habitat description, (c) distance from front of colony.

12.2.2. Counts of burrows in rock scree or boulders

It is often difficult to distinguish a burrow from a natural cavity in this habitat (Grant and Nettleship, 1971), but careful examination of holes for signs of excavation and other nesting activities does make it possible to record accurately the number of burrows (use methods described in section 12.2.1.: Counts of burrows in accessible habitat). In rocky habitat quadrat size may have to be adjusted to the local conditions, where boulders are very large or nest density exceptionally low.

12.2.3. Counts of birds in all habitats

There is no method sufficiently accurate to determine or estimate population size from counts of birds standing on the colony during one day. Puffins not only display large daily and seasonal fluctuations in colony attendance, but also vary in a quasi-cyclical fashion throughout most of the breeding cycle, the length of which appears to differ between colonies (4 to 5 days at Great Island, Witless Bay, Newfoundland [Nettleship, 1972]). This means that counts made when peak numbers are present might be more than 100 times the counts made at the same time two days later (Nettleship, 1972).

Therefore, if counts of birds must be used to census the colony (e.g., where the terrain is difficult or inaccessible), make systematic counts of the number of birds standing on the colony through the day (i.e., morning: early, mid, and late; afternoon: early, mid, and late; and evening) from a hidden viewpoint for several consecutive days (total days required will depend on features of the cycle: length and phase when census initiated). Count them early in the breeding cycle; the ideal time is during the prelaying period. Use the count when peak numbers were present as an index of population size.

When accessible colonies cannot be censused by burrow count methods (e.g., lack of time or difficult terrain) you can make a reliable estimate of population with the following technique:

(1) establish *control areas* (areas within the colony where the number of breeding pairs (N_p) is known, based on number of burrows with eggs or young);

(2) make a direct count of the number of birds standing on the colony (or representative sections) when peak numbers are present (determine peak using method described above) which includes individuals (N_i) on the *control areas;*

(3) use this ratio ($k = N_p/N_i$) to calculate the number of pairs for all colonies censused.

Note: It is essential to establish control areas in all habitats occurring within the total nesting area (e.g., maritime slope, flattish ground, etc.) as the relationship between the distribution of adults and the distribution of nest sites differs between habitats.

12.2.4. Time of census

Counts of birds should be done early during the pre-laying period. Estimates of burrows can be made from late in incubation onward, though the census time at each colony should be standardized. Special care must be taken during the incubation period as extended disturbance will cause nest desertion.

Census of birds at sea

Quantitative observations of seabirds at sea provide a reliable estimate of bird numbers, diversity, and numerical ratio of species which can be used as a measure of populations over either a small or extensive water area of coast or sea. The method is the same whether the intent is to perform a regular route census between two close geographic points for an index of species occurrence (Nettleship and Tull, 1970) or the observations are part of a series of systematic surveys of the distributions of seabirds at sea used to clarify aspects of individual species' pelagic ecology (Brown *et al.*, 1975).

The procedure requires the observer to record birds observed with the unaided eye (binoculars used only to identify species) along the coast (inshore and offshore) or at sea (pelagic) in a standardized manner based on a 10-minute observation period. Observations should be made from a *moving* ship, but 10-minute watches from a stationary vessel are acceptable provided that it is made clear in the records that the ship was not moving.

The four basic factors to note for each 10-minute watch are *time*, *position*, *species and numbers*, and *weather conditions*, as follows:
(1) record the time at start of the 10-minute watch (note whether DST, ADT, AST, etc.);
(2) record the position at start of the 10-minute watch (a map showing the exact route would be most useful);
(3) count and identify all birds sighted during the 10-minute watch; give an estimate of the accuracy of identification and count (e.g., murre sp. — could have been a Razorbill; 100 eiders ± 10%); add anything significant about their behaviour (e.g., following the ship, feeding, sitting on the water, direction of flight); also note plumage differences (e.g., ages in gulls, colour phases in fulmars and jaegers);
(4) record weather conditions during the watch and make a point of noting anything such as fog, rain, high seas, sun-glare, etc., which may have hampered observations.

For complete details of procedures and the recording scheme used to census birds at sea, see Brown *et al.* (1975).

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Canadian Wildlife Service
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COLONY CENSUS
FIELD TABULATION FORM

COLONY

1. Name:
3. Position:
(latitude) (longitude)
4. Situation:
5. Size (hectares):
7. Species:
8. Other species:

2. Census date:
(month) (day) (year)
6. Observer:
(name)
(address)

9. Type of census (census technique):

10. Reliability of total census:

11. Weather during census:
12. Wind during census: 13. State of sea:
14. State of tide during census:
15. Time of census: to (time zone:)
(start) (end)
16. Numbers of observers: (names:)

17. Number of breeding birds: individuals or pairs (circle one)
18. Reliability of count of breeding birds:

19. Total population estimate: (leave blank)
20. Status of population: 21. Phase of cycle:
22. Breeding details collected:
23. Type of nesting habitat:

24. Condition of nesting habitats and birds:

25. Disturbance factors:

26. Photography:

27. Special study:
28. Special notes:

Appendix

The CWS colony census field tabulation format and coding scheme.

The following is an explanation of the CWS Colony Census Field Tabulation Form. Each data item listed below is to be completed when conducting a colony census (leaving item 19 blank) and recorded on the form, and then coded numerically, so that the observations can be key-punched into the columns of a standard 80-column computer card for storage and retrieval.

Data item	Instructions
1. Colony name:	official name (from Gazetteer of Canada) and local name(s) if different; also province or state.
2. Census date:	month, day and year.
3. Colony position:	latitude and longitude in degrees and minutes.
4. Colony situation:	located on: (1) island, (2) mainland, (3) other.
5. Colony size:	total area of colony (nesting space) in hectares (1 ha = 10,000 sq. m or 2.47 acres).
6. Observer:	name (first names and surname) and address.
7. Species name:	common and/or scientific name (use AOU Check-list of North American Birds. 1957).
8. Association with other species:	(1) no (i.e., not associated with other spp.) (2) yes (i.e., mixed colony — list other breeding species present).
9. Type of census (census technique):	record type of census using categories listed below and give complete details — (00) no data, (01) visual estimate — ground, (02) visual estimate — air (specify aircraft type, etc.), (03) visual estimate — sea (specify boat type, etc.), (04) total ground count of individuals, (05) total ground count of nests, (06) line transect and quadrat census, (07) photographic count — ground (specify camera type, etc.) (08) photographic count — air (specify aircraft and camera types), (09) photographic count — sea (specify boat and camera types, etc.), (10) other.
10. Reliability of total census:	(1) observer feels data are quantitatively comparable with those collected in good conditions (e.g. comparable with earlier censuses, sufficient time, good weather, etc.); (2) observer feels data are not representative — give details.

11. Weather during census: select one of the following categories and provide details where necessary —
(0) good (none of the following),
(1) drizzle, (5) fog,
(2) light rain, (6) hail,
(3) heavy rain, (7) snow,
(4) intermittent showers, (8) other conditions (give details).

12. Wind during census: assess wind speed with an anemometer (if available) or using sea-surface conditions according to the Beaufort Scale:

Beaufort number	Description	Effect caused by wind at sea
0	Calm	Surface mirror-like
1	Light air	Only ripples form
2	Light breeze	Small, short wavelets, distinct but not breaking
3	Gentle breeze	Larger wavelets beginning to break, glassy foam, perhaps scattered white horses
4	Moderate breeze	Small waves still but longer, fairly frequent white horses
5	Fresh breeze	Moderate waves, distinctly elongated, many white horses, perhaps isolated spray
6	Strong wind	Large waves begin with extensive white foam crests breaking; spray probable
7	Stiff wind or moderate gale	Sea heaps up, lines of white foam begin to be blown downwind
8	Stormy wind or fresh gale	Moderately high waves with crests of considerable length; foam blown in well-marked streaks; spray blown from crests
9	Storm or strong gale	High waves, rolling sea, dense streaks of foam; spray may already reduce visibility
10	Heavy storm or whole gale	Heavy rolling sea, white with great foam patches and dense streaks, very high waves with overhanging crests; much spray reduces visibility

13. State of sea during census: select category below and where necessary elaborate using the Beaufort Scale (see item 12) —
(0) no data,
(1) flat calm,
(2) light sea (4 ft or less),
(3) medium sea (4–10 ft),
(4) heavy sea (10–20 ft),
(5) rough sea (over 20 ft),
(6) no waves but considerable swell,
(7) little sea but considerable swell.

14. State of tide during census: select one category below and elaborate where necessary —
(0) no data,
(1) high,
(2) low,
(3) half ebb,
(4) half flood,
(5) storm.

15. Time of census: local time and time zone (e.g., EST—Eastern Standard Time, ADT—Atlantic Daylight Time, etc.) at both *start* and *end* of census, and use military time (e.g., 1.00 PM = 1300) —
(1) start time (census initiated),
(2) end time (census completed).

16. Number of observers: total number of workers and names of each.

17. Number of breeding birds: total number of birds expressed as individuals or pairs (the census technique employed will determine whether the count will be expressed as individuals or pairs; for example, a count of active nests will be given as pairs whereas a count of standing adults would be recorded as individuals).

18. Reliability of count of breeding birds: select one category below and elaborate giving complete details —
(0) actual count,
(1) 5%,
(2) 10%,
(3) 15%,
(4) 20%,
(5) 25%,
(6) 30%,
(7) 40%,
(8) greater than 40%.

19. Total population estimate:	estimate of total population size given as number of individuals (field observers do *not* determine this population parameter; it will be calculated, where possible, by CWS record office staff after reviewing all available information for the colony).
20. Status of population:	select one category and elaborate if necessary — (0) no data, (1) stable, (2) increasing, (3) decreasing.
21. Phase of breeding cycle at time of census:	select one category below and state where details of breeding information are located (e.g., see item 22 and item 28, Special note No.) — (0) no data, (1) prelaying, (2) egg-laying, (3) incubation, (4) hatching, (5) downy young, (6) feathered young, (7) young flying or ready for flight, (8) other (e.g., see Special notes).
22. Breeding details collected:	select one category below and state where information (when available) is filed (e.g., see Special notes) — (1) yes, (2) no.
23. Type of nesting habitat:	brief description of typical nest-site situation of breeding birds in the colony (e.g., grassy-turfed maritime slope, bare rock cliff ledges, etc.).
24. Condition of nesting habitats and birds:	select one category below and give complete details where necessary — (0) no data, (1) good, no obvious disturbance, etc., (2) poor (give level of disturbance and source, e.g., human activity — shooting — several wounded and dead birds examined, etc.).
25. Disturbance factors:	if source of disturbance noted in item 24 is known, record available information in as complete detail as possible.
26. Photography:	brief description of extent of photography used during the census and where material is filed.

27. Special study:	if colony is being used for a special study (e.g., reproductive ecology of Herring Gulls, *Larus argentatus*, etc.) select one category below and elaborate on nature and time span of study — (0) no data, (1) breeding study, (2) experimental study (e.g., control, etc.), (3) other (give details).
28. Special notes:	used when amount of information recorded for any of the items listed above is too lengthy to be given on the field form. (Special notes should be numbered successively for each colony census of a particular species population, starting with Special note no. 01).
29. General sketch map:	see instructions given in section *Description of the colony* and when preparing map include scale, north heading, compass coordinates, and colony locations (for examples see Figures 1a, 2a, and 3a).
30. Detailed sketch map:	see instructions given in section *Description of the colony* and when preparing map include precise details of census technique and procedure; locations of transect lines, quadrats, sample plots, etc.; scale; north heading; and compass coordinates (for examples see Figures 1b, 2b, and 3b).

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