CENSUSING HOLE-NESTING AUKS BY VISUAL COUNTS

By David Cairns

INTRODUCTION

Recent attempts to census breeding seabirds over large geographical areas, such as eastern Canada (Brown et al., 1975) and Britain and Ireland (Cramp et al., 1974), have focused attention on the problem of obtaining maximum census accuracy from survey teams whose time and manpower are often limited. Ideally, direct nest counts should be made to indicate best the number of breeding pairs (Nettleship, 1976), but counts of birds at or near colonies continue to be used because of restrictions of time or because the nests are hidden or inaccessible (e.g., Harris, 1976).

The number of birds at a colony depends on daily and seasonal cycles, as well as on random and weather-induced fluctuations. Several European workers, including Dyck and Meltofte (1975) and Birkhead (1978), have derived correction factors to convert counts of ledge-nesting Common Murres (*Uria aalge*) made at specific times of the day and the season into estimates of the breeding population. Lloyd (1975) and Harris (1976) used series of repeated counts of Common Murre and Razorbill (*Alca torda*) colonies to calculate the expected count error, but were unable to determine the number of nesters because of the inaccessibility of the colonies.

Hole-nesting seabirds such as Black Guillemots (*Cepphus grylle*), Atlantic Puffins (*Fratercula arctica*), and most Razorbills cannot be counted on the nest, and little information is available on the relation between the number of birds found near the colony and the true breeding population. In this paper I present data on the daily and seasonal colony attendance patterns of guillemots, puffins, and Razorbills, and from these data determine optimum count times, correction factors, and expected errors for the estimation of breeding populations from visual counts.

METHODS

This study was conducted on St. Mary's Island (50°18'N, 59°39'W) on the north shore of the Gulf of St. Lawrence, and at Cap d'Espoir (48°25'N, 64°19'W) on Québec's Gaspé Peninsula. On St. Mary's, puffins and Razorbills were counted on land, and guillemots were counted on land and water, from a low hill overlooking a 0.6-km-wide cove. I did not attempt sea counts for puffins and Razorbills because their distributions on the water tended to be continuous from near shore to the limit of vision, and any counts would probably have depended more on visibility and wave height than on the actual number of birds present.

Guillemots were censused at Cap d'Espoir from three cliff-top vantage points. At one of these (Cap d'Espoir South) the curvature of the cliff

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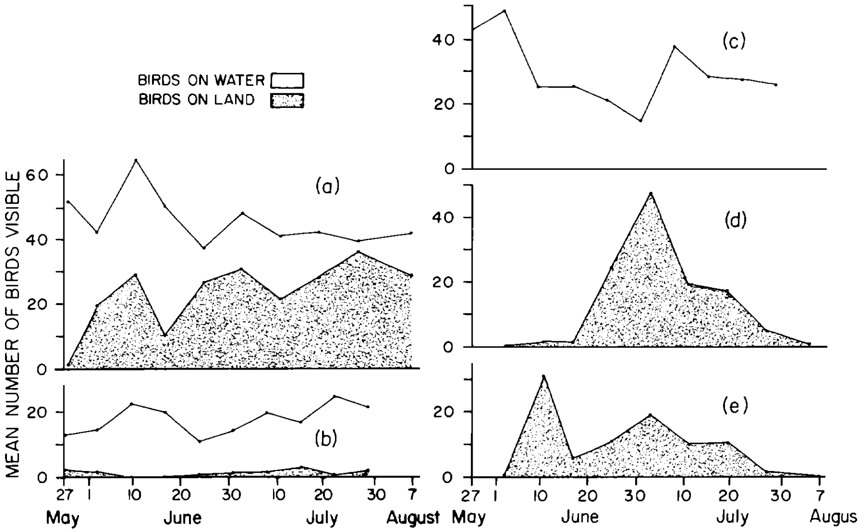

FIGURE 1. Seasonal changes in Black Guillemot, Atlantic Puffin, and Razorbill attendance at the colony. (a) guillemot numbers at St. Mary's, from counts between 0500 and 0700. (b) guillemot numbers at Cap d'Espoir South, from counts between 0500 and 0700. (c) guillemot numbers at Cap d'Espoir North, from counts between 0500 and 0700. (d) puffin numbers at St. Mary's, from counts between 0500 and 1300. (e) Razorbill numbers at St. Mary's, from counts between 0500 and 1900.

permitted counts of birds on both land and water, but at the other two only birds on the water could be seen; these latter counts have been summed as Cap d'Espoir North.

The number of nests on St. Mary's was determined by thorough ground searches repeated every one or two weeks throughout the breeding season. At Cap d'Espoir South I located nests by observing arrivals and departures of adults, thus gradually assembling a complete map of nest sites.

In all study areas the birds were counted hourly from 0400 to 2000 on 10 census days. The censuses ran from 28 May to 7 August 1977, on St. Mary's, and from 27 May to 29 July 1978, at Cap d'Espoir. All times are Atlantic Standard Time.

RESULTS

Thirty-one pairs of Black Guillemots, 18 pairs of Atlantic Puffins, and 22 pairs of Razorbills nested in the St. Mary's study area. The guillemot colony at Cap d'Espoir South numbered 17 pairs.

Numerous guillemots were visible in the three count areas on all census days, but substantial attendance on St. Mary's was limited to the

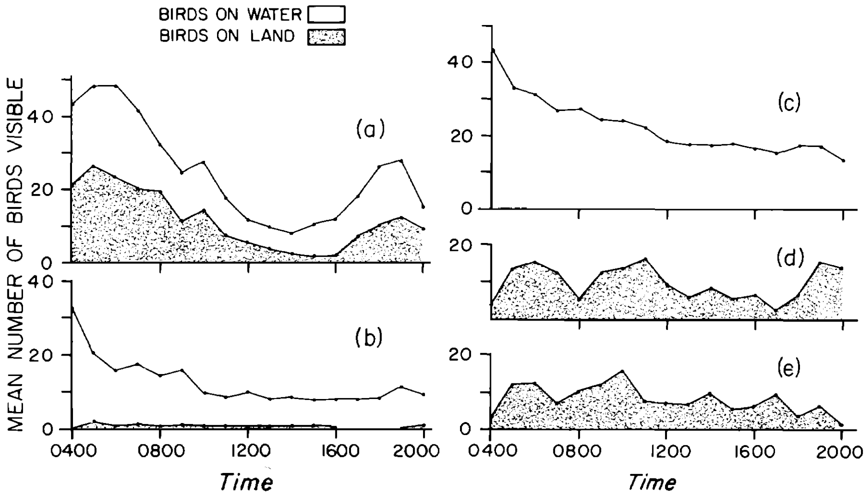

FIGURE 2. Daily attendance patterns of Black Guillemots, Atlantic Puffins, and Razorbills. Data from 10 census days 28 May to 7 August for St. Mary's, and from 10 census days 27 May to 29 July for Cap d'Espoir. (a) guillemots, St. Mary's. (b) guillemots, Cap d'Espoir South. (c) guillemots, Cap d'Espoir North. (d) puffins, St. Mary's. (e) Razorbills, St. Mary's.

periods of 25 June–19 July for puffins, and 11 June–19 July for Razorbills (Fig. 1). Attendance for all species and count areas tended to be highest in the morning, although guillemots and puffins at St. Mary's also showed distinct evening peaks (Fig. 2). Guillemot attendance at Cap d'Espoir North and South decreased throughout the day. Razorbill numbers on St. Mary's also decreased, but in a much less regular fashion.

In order to determine the time periods during which counts were the least subject to variation, I grouped hourly counts into three-hour blocks and computed their means and coefficients of variation (Table 1). Black Guillemot counts in all three study areas were least variable between 0500 and 0700. Puffin counts were most stable between 0500 and 1300, but the variability of Razorbill counts fluctuated irregularly throughout the day.

The correction factors (k) needed to estimate the number of breeding pairs from visual counts conducted at the optimum times listed above are presented in Table 2. In the case of St. Mary's guillemots, the application of a correction factor to the mean of several early morning counts would yield a relatively accurate estimate of the breeding population. The expected errors of the Cap d'Espoir counts are higher than the errors from the St. Mary's counts (71% and 82% vs. 42% for single counts), but reasonable accuracy could still be achieved if the counts were repeated a number of times.

TABLE 1.

Variation in hourly counts of Black Guillemots, Atlantic Puffins, and Razorbills grouped in three-hour blocks.[1]

	Black Guillemots									Atlantic Puffins			Razorbills		
	St. Mary's			Cap d'Espoir S.			Cap d'Espoir N.								
Time	$\bar{x}$	SD	CV	$\bar{x}$	SD	CV	$\bar{x}$	SD	CV	$\bar{x}$	SD	CV	$\bar{x}$	SD	CV
0500–0700	46.1	9.5	.21	18.0	6.2	.34	30.3	12.2	.40	30.3	18.2	.60	17.5	14.7	.84
0800–1000	28.2	14.9	.53	13.4	6.6	.49	25.2	13.1	.52	25.6	17.7	.69	21.0	18.8	.90
1100–1300	13.1	11.4	.87	8.7	5.1	.59	19.4	14.8	.76	26.1	20.3	.78	12.1	7.7	.64
1400–1600	10.1	8.9	.88	8.2	6.3	.76	17.5	11.2	.64	17.0	23.6	1.39	12.1	11.0	.90
1700–1900	24.1	16.9	.70	9.2	7.5	.82	16.6	10.2	.61	17.0	24.1	1.42	9.4	10.4	1.10

[1] Data from 10 censuses 28 May to 7 August for St. Mary's guillemots, 10 censuses 27 May to 29 July for Cap d'Espoir guillemots, four censuses 25 June to 19 July for puffins, and six censuses 11 June to 19 July for Razorbills.

TABLE 2.

Correction factors and estimated percent errors for the prediction of number of breeding pairs from visual counts.

Species	Time	Correction factor (k)[1]	Estimated error of the mean (95% confidence limits)		
			1 count	5 counts	10 counts
Black Guillemot					
St. Mary's	0500–0700	0.67	42%	19%	13%
Cap d'Espoir S.	0500–0700	0.95	71%	32%	22%
Cap d'Espoir N.	0500–0700	—	82%	37%	26%
Atlantic Puffin	0500–1300	0.66	136%	61%	43%
Razorbill	0500–1900	1.53	186%	83%	59%

[1] $k = \frac{\text{number of breeding pairs}}{\text{mean visual count}}$

The expected errors of population estimates of puffins and Razorbills are much higher than those of guillemots: even after 10 counts the error levels remain at 43% for puffins and 59% for Razorbills (Table 2).

DISCUSSION

A strong morning attendance peak is a common feature of Black Guillemot colonies, having been reported from the Gulf of Finland (Koskimies, 1949; Bergman, 1971) and Shetland (Slater and Slater, 1972), as well as from British Columbia for the Pigeon Guillemot (*C. columba*) (Drent, 1965). Guillemot numbers were highest in the early morning at both St. Mary's and Cap d'Espoir, but the St. Mary's birds also showed a lesser evening attendance peak (Fig. 2). Maximum numbers were recorded at Cap d'Espoir at 0400 and these counts probably included some nonbreeding individuals, because the total count at Cap d'Espoir South exceeded the population of the colony on several occasions.

The difference between the correction factors for the St. Mary's and Cap d'Espoir South colonies (0.67 vs. 0.95) suggests that there is no universally valid ratio of the number of guillemots visible near the colony to the breeding population. Visual counts may therefore be more useful as indices of year-to-year population changes than as indicators of true colony size. Count variation in British Razorbill and murre colonies seems to be greater among colonies than among years within the same colony (Harris, 1976), but information on year-to-year changes in Black Guillemot attendance patterns is lacking.

The numbers of seabirds at a colony can be altered by several unpredictable phenomena, including visits of birds from other colonies, visits of nonbreeding birds, and weather and tide factors. My data are insufficient to compute compensating factors for the effects of weather and tide on guillemot attendance, but probably rough seas substantially reduce water counts because the birds are harder to see among waves. Tidal amplitude is weak (less than 1.5 m) at both St. Mary's and Cap d'Espoir, but in areas with a large tidal range guillemot attendance varies closely with tide level, and the daily cycle is masked by a tidal one (Preston, 1968; Cairns, 1978). In some colonies human or other disturbance may discourage birds from appearing near the colony. This may have been the case at Cap d'Espoir South, where a large colony of Herring Gulls (*Larus argentatus*) occupied the talus heap in which the guillemots nested, and the guillemots were seldom seen on land.

Puffins and Razorbills are much more variable in their attendance than are guillemots, and their counts are of little use as indicators of true population levels. The much greater stability of British Razorbill counts as reported by Lloyd (1975; estimated error as low as 17% for single counts) was apparently due to the fact that many ledge-nesting birds were visible on their nest sites, a situation that occurs infrequently in Gulf of St. Lawrence colonies.

Fortunately, both puffins and Razorbills can usually be censused by direct nest counts. In those colonies where nest counts are precluded by inaccessible terrain or because the birds nest in deep or hidden crevices, censusing of these species will continue to pose problems. Black Guillemot nests are nearly always too well concealed to be located during seabird censuses, but, as the data in this paper suggest, properly conducted visual counts can provide a useful population index.

SUMMARY

Data from daily and seasonal occurrences of hole-nesting Black Guillemots, Atlantic Puffins, and Razorbills are used to determine optimum count times, correction factors, and expected errors for the estimation of breeding populations from visual counts. The relative stability of early morning guillemot counts in three study areas suggests that such counts can provide reasonably precise indices of colony size if they are repeated several times. However, differences in attendance patterns among colonies will preclude the direct estimation of true breeding population from visual counts. The attendance of puffins and Razorbills at the colony fluctuated widely, and visual counts of these species are of limited use as population indicators.

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Département de biologie, Université Laval, Québec, Québec, Canada G1K 7P4. (Present address: Seabird Research Unit, Canadian Wildlife Service, Bedford Institute of Oceanography, P.O. Box 1006, Dartmouth, Nova Scotia, Canada B2Y 4A2.). Received 14 October 1978, accepted 29 May 1979.

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