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COMPARISON OF TECHNIQUES FOR CENSUSING GREAT BLUE HERON NESTS

JAMES P. GIBBS[1]
Wildlife Department
College of Forest Resources
University of Maine
Orono, Maine 04469 USA

SUSAN WOODWARD
Maine Department of Inland Fisheries and Wildlife
Bangor, Maine 04401 USA

MALCOLM L. HUNTER
Wildlife Department
College of Forest Resources
University of Maine
Orono, Maine 04469 USA

ALAN E. HUTCHINSON
Maine Department of Inland Fisheries and Wildlife
Bangor, Maine 04401 USA

Abstract.—A comparison of the accuracy of different techniques for counting Great Blue Heron (*Ardea herodias*) nests suggests that aerial-visual estimates and aerial photographic counts provide reliable measures of colony size while minimizing disturbance to nesting herons. Additionally, post-nesting season ground counts of nests provide a suitable, less disruptive alternative to mid-nesting season ground counts at colony sites.

COMPARACIÓN DE TÉCNICAS PARA HACER CENSOS DE NIDOS DE *ARDEA HERODIAS*

Resumen.—Un examen de la eficacia de diferentes técnicas para contar nidos del garzón cenizo (*Ardea herodias*) sugiere que estimados visuales hechos desde el aire y fotos aéreas proveen medidas confiables sobre el tamaño de la colonia mientras que minimiza la perturbación a los garzones que se encuentran anidando.

To evaluate the numerical status of wading bird populations biologists must employ census techniques at colony sites that yield relatively precise results but do not adversely disturb nesting activities. Ground counts of nests during the nesting season generally yield the most reliable estimates of heron colony size (King 1976), but frequently result in a major disruption to nesting herons (Erwin 1981, Tremblay and Ellison 1979), whereas less disruptive techniques (i.e., aerial-visual estimates and counts from aerial photographs) may be too unreliable to be of use (Erwin 1979, Hutchinson 1979, Kadlec and Drury 1968). In this paper we examine the precision and accuracy of determining the size of colonies of Great Blue Herons (*Ardea herodias*), a species particularly vulnerable to human disturbance at nesting colonies (Bjorklund 1975, Werschkul et al. 1976),

[1] *Current address: Division of Biological Sciences, 105 Tucker Hall, University of Missouri–Columbia, Columbia, Missouri 65211 USA.*

through the use of aerial-visual estimates, aerial photographic counts, and post-season ground counts. Mid-season ground counts of nests were used as the standard for comparison (cf., Buckley et al. 1977, Kushlan 1979, McCrimmon 1982). These three techniques could be used as non-disturbing alternatives to mid-season ground counts if estimates were comparable to direct counts of Great Blue Heron nests.

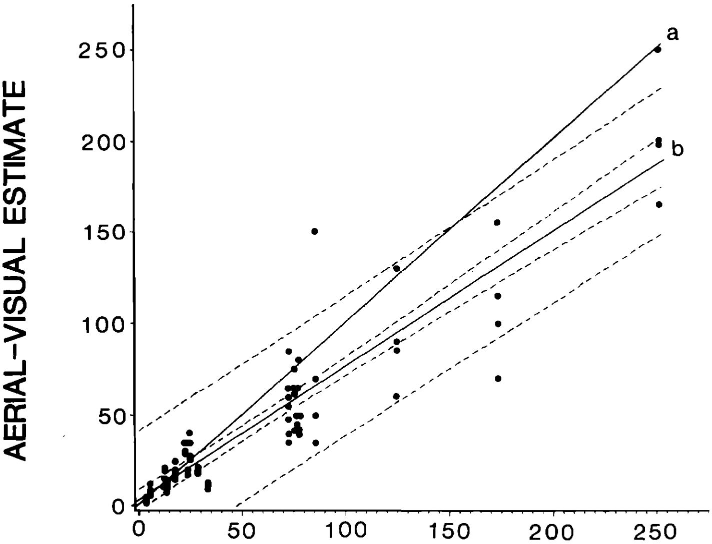
STUDY AREA AND METHODS

Approximately 25% of the entire Atlantic coast population of Great Blue Herons nests along the Maine coast between Casco Bay and Machias Bay (Custer and Osborn 1977), a straight-line distance of about 250 km, where this study was conducted. These single-species colonies are small to medium-sized (<250 nests) throughout the region (Tyler 1977). Colonies are formed on remote, densely forested marine islands where Great Blue Herons typically build large twig nests singly in the tops of softwood trees (mainly *Picea* spp.) at heights of 4–20 m and at densities of about 150 nests/ha (Gibbs et al. 1987, Tyler 1977). At each colony site located during an aerial survey conducted from a fixed-wing aircraft in mid-Apr. 1983 (see Gibbs et al. 1987) ground counts were made to determine numbers of active nests present (i.e., nests that contained adults or young, or had excrement, egg shells, or the remains of recent meals visible on the ground directly below). Direct ground counts of nests were made during the breeding season (mid-season ground counts) from 2–21 Jun. 1983 in 15 colonies. After the breeding season, 1 Aug.–21 Oct. 1983, 10 colonies were recensused and the remaining colonies were censused for the first time (post-season ground counts). Differences between replicate nest counts were tested with the Wilcoxon paired-sample test, and no seasonal difference was found ($P > 0.05$, see results). Because post- and mid-season counts were so similar, post-season counts were used as baseline size data for five colonies where mid-season ground counts were not made.

Aerial-visual estimates of the number of nests at colony sites were made on 20 Jun. 1983 from a fixed-wing aircraft independently by four observers. The presence of adult herons incubating eggs and small chicks at colonies on this date enhanced the ability of aerial observers to locate active nests at colony sites. Aerial photographs of colony sites were taken at this time through the side window of the aircraft with a hand-held 35 mm camera using color transparency film. Counts of active nests were later obtained independently from four observers viewing slides that offered complete colony site coverage (available for 15 colonies). Least squares regression analysis and analysis of covariance (SAS 1982) were used to examine the precision of aerial estimates in relation to ground counts made at the same sites and to examine observer bias.

RESULTS AND DISCUSSION

Replicate ground counts were not seasonally different ($z = -0.36$, $n = 11$, $P > 0.05$, Wilcoxon paired-sample test). For both aerial tech-



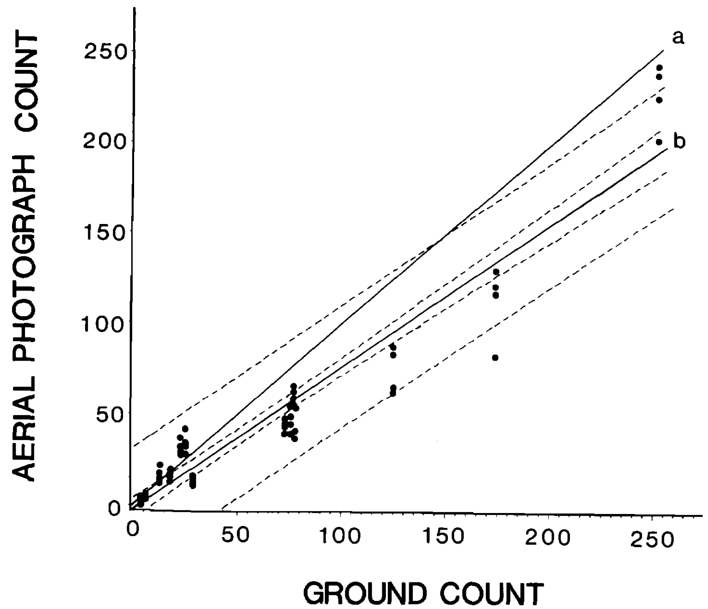


FIGURE 1. Relationship between the actual number of nests at a Great Blue Heron colony site and the number estimated aerial-visually ($r = 0.93$, $P < 0.001$) and counted from aerial photographs ($r = 0.96$, $P < 0.001$). On each graph, line (a) represents a hypothetical perfect coincidence ($r = 1.0$) of aerial and ground counts and line (b) represents the actual relationship observed, surrounded by 95% confidence limits for mean (inner set of dotted lines) and individual (outer set of dotted lines) predicted values of X.

niques, the slope of each observer regression was found to be different from 0 (minimum $P < 0.05$, where Y = aerial-visual estimate or aerial photograph count, X = ground count). Analysis of covariance revealed no differences between the slopes of individual observer regressions (aerial-visual estimates: $F = 2.41$, df = 3, $P > 0.05$; aerial photograph counts: $F = 0.08$, df = 3, $P > 0.05$) or the intercepts of individual observer regressions (aerial-visual estimates: $F = 2.68$, df = 3, $P > 0.05$; aerial photograph counts: $F = 0.08$, df = 3, $P > 0.05$). Because observer bias was therefore not apparent estimates from all observers were pooled to obtain a single regression for each technique, which indicated a close correspondence between actual numbers of nests at colony sites and both aerial-visual estimates ($F = 462.26$, df = 79, $P < 0.001$, $r^2 = 0.86$; $Y = 2.87 + 0.73X$, Fig. 1) and aerial photographic counts ($F = 641.09$, df = 59, $P < 0.001$, $r^2 = 0.92$; $Y = -1.95 + 0.78X$, Fig. 1).

While the precision of observers using both aerial methods was high, aerial observers consistently underestimated the number of nests at colony sites (aerial-visual estimates averaged 87% of ground count; aerial photographs averaged 83% of ground counts). The mean difference between ground counts and aerial-visual estimates was 13.2 nests (±25.07 SD); for photographic counts it was 16.7 nests (±22.27 SD). These values differed significantly from 0 (aerial-visual estimates: $t = 4.71$, $n = 80$, $P < 0.001$, two-tailed t-test; aerial photographic counts: $t = 7.72$, $n = 60$, $P < 0.001$, two-tailed t-test).

Although aerial-visual estimates and aerial photographic counts were consistently low, the high precision of counts allows their use in combination with conversion factors (i.e., regression slopes [Erwin 1979]) to predict colony size. Erwin (1979), Korschgen (1979), and McCrimmon (1982) also reported that aerial-visual estimates of Great Blue Heron colony size were quite comparable to ground counts. Our study corroborates these reports and suggests that aerial photographic counts or post-nesting season ground counts also can be used to obtain reasonably reliable estimates of the number of Great Blue Heron nests at colony sites while minimizing disturbance to nesting herons. The results of this study may be useful in monitoring Great Blue Herons nesting in similar habitats and tentatively applied to other species of tree-nesting, conspicuous wading birds.

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