CENSUS METHODS FOR GULF COAST WATERBIRDS

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ABSTRACT

Various census and sampling methods were used to enumerate the abundant colonially breeding waterbirds of coastal Louisiana, Mississippi, and Alabama in 1976 and 1978. Nesting habitats and substrates of the more common nesters are described, and criteria for selecting specific inventory techniques are explained.

In the past several years, the censusing of colonial waterbirds has been facilitated by a considerable federal commitment, both in the United States and Canada, to locate, measure, and monitor concentrations of coastal birds that could be adversely affected by petrochemical expansion within the estuarine and marine environment. Recent research efforts have been directed toward obtaining much more precise and comprehensive census data than were previously required and obtained by local resource managers. The goal has been accurate and repeatable regional censuses that allow detection of significant annual changes in breeding populations.

Federally backed increases in personnel and research funds have allowed more careful consideration of factors affecting apparent breeding abundance, such as habitat type, reproductive stage, and breeding bird conspicuousness. These complicating factors, which often act to confound accurate inventories, also control the development of inventory methodology and the final selection of census methods. It has become evident that most accurate censuses result from individually applying specific methods (and precise timing) to each colony during each season.

During the entire 1976 nesting season, and again for two short periods in April and June 1978, I had the opportunity to work on the census of colonial waterbirds of the northern Gulf of Mexico. Much of this region remains undeveloped, except for oil and gas operations, and contains very large and practically unstudied populations of colonial seabirds and waders (Ogden, 1978), nesting in a variety of habitats. I first arrived on the north Gulf coast in August 1975 with very little practical experience in the censusing of colonial birds, and with very little knowledge of their specific breeding habits in this region. Thus unencumbered by methodological prejudices, I reviewed the available literature, spoke with experienced field workers, and spent considerable time over, under, and among colonial birds to develop a set of census methods that seemed to apply to the specific nesting situations encountered on the north Gulf coast.

My purpose here is to describe these associated methods and nesting situations, discuss the reliability of census results, and present a classification system of census methods, ordered by species, habitat, and degree of expected reliability.

STUDY AREA AND NESTING SITUATIONS

In a previous paper (Portnoy, 1977), I described and quantified habitat types of the 2.4 million ha study area, and discussed the relative use of these types by 26 species of nesting waterbirds. Specific nest sites of the most common species are briefly reviewed here.

On the unvegetated barrier beaches, Black Skimmers (*Rynchops niger*), Sandwich Terns (*Sterna sandvicensis*), Royal Terns (*S. maxima*), and Least Terns (*S. albifrons*) nest in large colonies or closely adjacent subcolonies. Immediately behind the beaches, Laughing Gulls (*Larus atricilla*) commonly nested concealed in *Spartina patens* or exposed on salt-marsh islands. Forster's Terns (*Sterna forsteri*) also nest on marsh islands at the seaward edge of the Louisiana salt marsh.

Within saline coastal bays, on either side of the Mississippi Delta, are occasional Black-Mangrove (*Avicenna germinans*) islands popul-

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ated with nesting herons, egrets, and ibises. In the brackish water of the Delta itself, emergent "islands" of *Phragmites communis* serve as the predominant heron nesting sites. Louisiana Herons (*Hydranassa tricolor*), Snowy Egrets (*Egretta thula*), Great Egrets (*Casmerodius albus*), Black-crowned Night Herons (*Nycticorax nycticorax*), White-faced Ibis (*Plegadis chihi*), and White Ibis (*Eudocimus albus*) are the most abundant species in both saline and brackish areas.

Farther north in freshwater marshes, large wader colonies occur on emergent woody vegetation, usually Buttonbush (*Cephalanthus occidentalis*) in floating marshes. Where oil-drilling activities have created islands of dredged material, the invasion of Black Willow (*Salix nigra*) onto these spoil islands has often been followed with the colonization by ciconiiform birds. Common species in both floating marsh and in spoil island colonies are Snowy Egret, Little Blue Heron (*Florida caerulea*), Great Egret, Louisiana Heron, White-faced Ibis, Cattle Egret (*Bubulcus ibis*), and Black-crowned Night Heron. In the freshwater marshes of southwestern Louisiana, colonies often include Roseate Spoonbills (*Ajaia ajaja*) and Olivaceous Cormorants (*Phalacrocorax olivaceus*), in addition to the waders mentioned above.

Still farther north in the Baldcypress (*Taxodium distichum*)-Water Tupelo (*Nyssa aquatica*) swamps, Great Egrets and Great Blue Herons (*Ardea herodius*) usually nest atop tall trees in distinct groups separate from the smaller ardeids. The smaller wading birds—Snowy and Cattle Egrets, Louisiana and Little Blue Herons, and White Ibises—generally nest on shrubs (*Cephalanthus, Salix,* and small *Taxodium*) that emerge from ponds in the swamp forest.

Except for small colonies of Forster's Terns and Least Terns, nesting aggregations in all the above-mentioned habitats normally contain thousands of nesting pairs.

Finding Colonies

A small fixed-wing aircraft (*e.g.*, Cessna 172) operated at about 200 m altitude and 160 km/hr speed is completely satisfactory and the best choice for finding colonies of conspicuous species in extensive habitat. Helicopters are much more expensive to charter and their slower speed capability is not enough of an advantage to justify their use when simply searching for colonies of all species except highly cryptic and diffusely nesting Least Terns on barrier beaches.

Census Methods

Selection of an ideal environmental barometer. Much of the federal push for colonial waterbird inventories was directed toward monitoring coastal bird populations as indicators of environmental contamination or habitat destruction. Although no provision was included in recent inventories to concurrently monitor estuarine pollution flux or habitat loss along with coastal bird populations, the principal idea was to closely follow an easily censused (thus colonial), discrete population (thus comprehensive, coastwide inventories) as an indicator of ecosystem stability. Ideal "indicators" would be: 1) conspicuous and thus easy to find; 2) predictable in nesting location and timing, and thus easy to find; 3) reproductively synchronous within and among colonies; 4) quickly and inexpensively censused; 5) censused with minimal disturbance to breeding birds. (A sixth requirement, not addressed in the present study, would of course be that these indicator species truly reflect habitat degradation important to the whole system.) In many habitats, field workers would find it difficult to select a "best" species, whose nesting characteristics would at least approximate what is required to employ methods that produce comparable annual counts.

The following methods are rated according to ease of application in obtaining reliable breeding-pair counts on the northern Gulf of Mexico coast. Ease of application is based upon my subjective judgment from having employed all these methods in the field; reliability is based upon an objective appraisal from comparisons of various census results. Note that the reliability and applicability of each method is intimately associated with characteristics of specific species at specific nest sites.

Aerial photography. Prints from 35 mm or 6 × 7 cm black and white aerial photographs of Great Egret, Royal Tern, and Sandwich Tern colonies clearly show each nesting attempt (*i.e.* incubating bird or attendant pair) currently active on colonies. Aerial photo counts and the visual estimates of two observers were generally comparable during an April 1978 Great Egret survey (Table 1). Tern colonies were ground-checked during the 1976 census to verify that individuals recorded on aerial photographs were in fact incubating eggs or brooding young.

Aerial photography is also useful for censusing Black Skimmer colonies, even though the relationship of birds (or pairs) to active nests within a given nesting area is not one to one. A total count from aerial photographs taken at midday (1000 to 1400 h) of skimmers present within the nesting area during late incubation will yield a reliable active nest estimate when divided by a correction factor generated for this specific time of day and reproductive stage (Portnoy, 1978). This technique should be appropriate for other conspicuous species nesting in exposed areas where total counts of adults present within the nesting area are obtainable from aerial photographs.

TABLE 1
Comparison of Aerial Photographic Counts and Visual Estimates of Great Egret Breeding Pairs at Louisiana Colonies in April 1978

Colony	Visual Estimate[a]	Count from Photographs
Atchafalaya 1	300	432
Atchafalaya 7	75	84
Atchafalaya 8	1500	1015
N of I-10	500	598
NW of Maurepas	135	122
SE of Ponchatoula	400	360
S of Maurepas	300	359
S of I-10	130	136
S of I-10	700	799
Creole	60	66
Sidney I.	1300	2434
Grand Chenier	400	448
Lake Misere	160	161
Deadman I.	250	380
Avery I. tupelo	225	241
Lake Fausse Pointe	120	123
Amelia	1400	2163
E of Lake Verret	1200	1176
Queen Bess I.	800	1035

[a]The estimates of two observers were averaged.

Aerial estimation of breeding birds or "pairs." Visual estimates of abundance are quickly made by observers in aircraft, but are of limited reliability with very large colonies, cryptic species, or birds that nest under vegetation, unless related to contemporary ground counts (Kadlec and Drury, 1968). Table 2 indicates that the percentage error of visual estimates, compared with concurrent "ground counts" (either photographic counts or the results of transect sampling), is correlated with nesting bird conspicuousness. Nesting Louisiana Herons and Black-crowned Night Herons were grossly underestimated or often completely missed. In 1976, in mangrove colonies where I had estimated from the air a few hundred Louisiana Heron pairs, I counted about that number in only a *10% sample* of the nesting area.

Wide variation in percent error of visual estimates (Table 2) appears to preclude generation of correction factors, at least for these large colonies surveyed by fixed-wing aircraft. The use of helicopters would probably increase the accuracy of visual estimation, assuming that successive bird counts could be accurately tallied while hovering over a typical 30-ha and 15,000-pair heronry.

Aerial estimation is unfortunately the only method currently available for censusing most wading birds (except for Great Egrets) in large swamp and floating marsh colonies, where ground counts or samples are impossible because of the lack of a solid substrate to walk upon, and where aerial photographs do not completely record cryptic and/or concealed species.

Transect sampling of active nests. In large colonies with species that cannot be totally seen or photographed from aircraft, and with a substrate firm enough to support the observer's weight, the preferred method is some sort of random sample collected across the entire nesting area. The belt transect scheme used during the 1976 Gulf coast survey has been described

TABLE 2
Visual Estimates of Adult Birds *vs.* Contemporary Nest Counts at Gulf Coast Heronries During Incubation
(Estimates of adult birds were made by two observers in a fixed-wing aircraft; nest "counts" were from aerial photographs [for the Great Egret] or from transect sampling [smaller ardeids].)

Species	Colonies	Mean Colony Size (nests)	Average Error of Visual Estimate (%)[a]	SD
Great Egret	33	511	−4.2	12.2
Snowy Egret	6	1992	−8.7	92.0
Louisiana Heron	8	3192	−79.1	25.1
Black-crowned Night Heron	7	573	−84.4	14.7

[a]I assumed that each bird observed from the aircraft represented an active nest. Thus bird estimates and nest counts have the same units.

(Portnoy 1977; also see Eberhardt 1978 for theoretical considerations). Total nest estimates from belt transect sampling and confidence limits generated from nest densities per transect are presented for typical heronries (Table 3). An expected maximum error of 3000 nests may seem unacceptable in a 14,000-nest heronry, but when compared with other methods, transect sampling appears the only way to at least measure order of magnitude in such large colonies—and for all nesting species regardless of conspicuousness (as long as nests can be separated by species).

In addition to mangrove and spoil island heronries, randomly spaced belt transects were applied to Laughing Gull colonies in *Spartina patens* and Forster's Tern colonies on *Spartina alterniflora*. The 95% confidence limits of a 10-percent-sampled Laughing Gull colony was ±2326 nests with a total nest estimate of 17,326; total nest estimates from sampling on a few large Forster's Tern colonies were within 25% of concurrent total nest counts. Belt transects also produced estimates that closely approximated total nest counts on some Herring Gull (*Larus argentatus*) colonies and heronries on Massachusetts coastal islands in 1977 (Erwin, pers. comm.).

Total ground nest counts. Because of time limitations, this is practical only in small colonies, and even here the disturbance to nesting birds appears considerable (Ellison and Cleary, 1978). Although total active nest counts are desirable, if not requisite, for evaluating other census methods, field workers involved in extensive regional surveys rarely have the time to totally count nests in very large shrub or treetop heronries by carefully demarcating counted versus uncounted sections. In 1976, I found this method appropriate and quick for censusing barrier beach skimmer colonies and salt-marsh Forster's Tern colonies.

TABLE 3
Typial Results of 10% Belt Transect Sampling on Gulf Coast Heronries (1976) with 95% Confidence Limits Calculated from Nest Densities Per Transect

Nesting Substrate	Transects Required	Nest Estimate	Confidence Limits (nests)
Willow shrubs	12	3,240	810
Willow shrubs	35	5,012	1498
Spartina patens	91	7,775	2752
Mangrove shrubs	33	12,666	1337
Mangrove shrubs	8	2,522	560
Mangrove shrubs	14	9,683	2738
Mangrove shrubs	54	14,279	1809
Mangrove shrubs	31	14,938	3090
Mangrove shrubs	19	4,502	1422
Mangrove shrubs	136	16,880	2672

Ground estimation of adult birds. This too applies only to small colonies. To visually estimate the total adult population of a colony without duplication or omission, an observer must be able to see the whole nesting group at once. At large colonies in vegetation this is generally impossible.

I used this method in 1976 to census beach-nesting Least Terns, by counting and/or estimating the number of adults flushed from colonies as I walked along the beach berm. It was assumed that each singly flushed adult represented a nesting attempt, but this was never tested by concurrently counting nests.

Classification of Census Methods

I find it useful to summarize the above methods and their applications on the northern Gulf of Mexico coast in a simple diagram (Figs. 1 and 2). For each species and nesting situation there follows a list of census methods, in decreasing order of reliability, that could be physically applied. Similar priority listings of appropriate census methods might be useful to field workers in other habitats. Although observers in each region and habitat type must individually choose, adapt, and implement the most appropriate census methods for their area, it might facilitate information exchange, in addition to clarifying coastwide inventories and regional comparisons, if researchers agreed on a universal procedure for census method selection. A universal classification of colonial waterbird inventory methods, similar in organization to Figs. 1 and 2, would at least outline the state of the art of waterbird inventory, put each specific method in perspective of overall applicability, and encourage careful consideration of the range of utility of each method.

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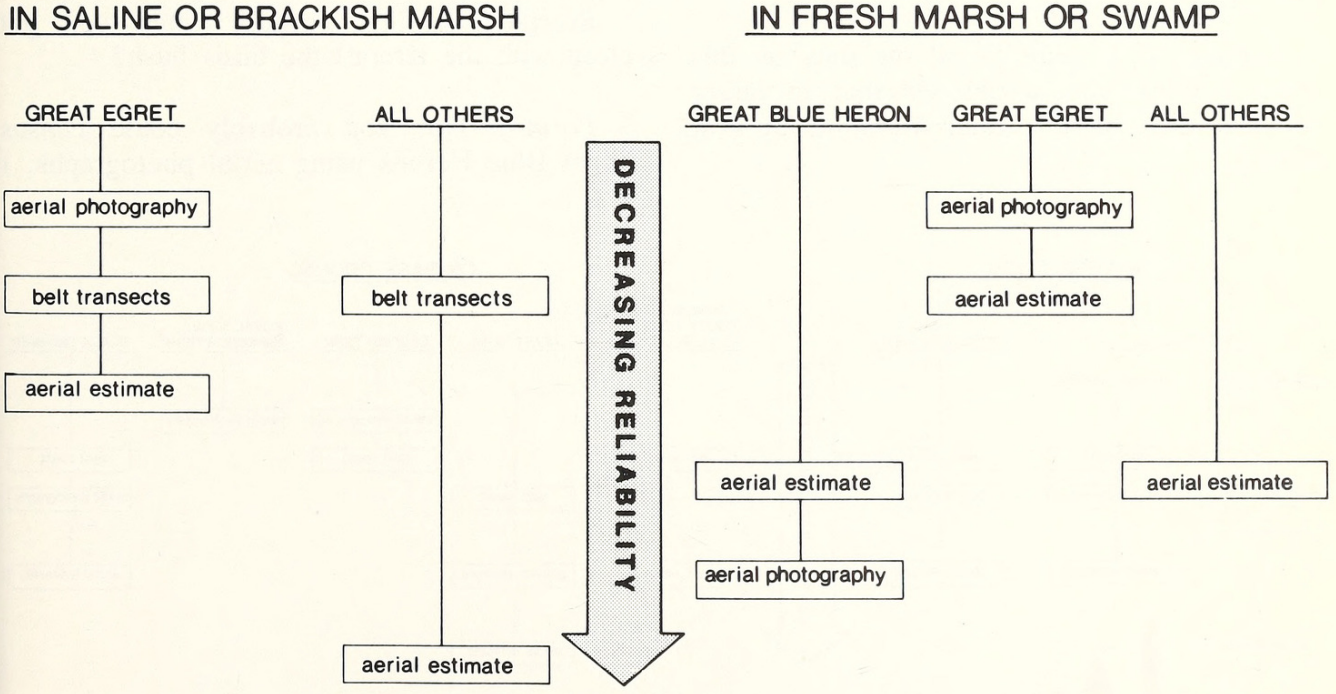

Figure 1. Relative reliability of inventory techniques for wading bird colonies in coastal Louisiana-Mississippi-Alabama.

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Comments

Gochfeld: I appreciated your emphasis on the fact that any census technique is a trade-off between how much you are willing to disturb the birds in question and how accurate an estimate you think you need for a particular problem. We in the Northeast rarely see colonies of such magnitude as you describe for the Gulf coast, and therefore our whole approach toward estimating tends to be quite different. I noticed when you showed the belt transect that the confidence limits around the mean estimates didn't seem to be correlated with the actual mean value. In other words, it didn't seem that the confidence limits varied directly. Is there any consistency to that?

Portnoy: If I could fit all the data on this slide, I think you would see that in larger colonies there is a greater variation in nest density.

Gochfeld: The second comment I have pertains to skimmers. I have done a lot of aerial estimating of skimmer numbers in the Northeast, and I wonder if you have had the opportunity to compare your 2.2 ratio, which is higher than we usually have, both diurnally and across seasons?

Portnoy: The seasonal change in the bird to nest ratio?

Gochfeld: Yes.

Portnoy: Yes, in 1976 the counts were made at the end of June, the peak of incubation, and the ratio was 2.2 at midday. I flew again at the end of July, and the ratio was much reduced in all the colonies I checked. I have forgotten what the ratio was. Also, the bird to nest ratio was higher at midday than during early morning or late afternoon.

Blokpoel: I noted that for the Great Blue Heron you consider aerial estimates to be more reliable than aerial photography. Is that correct?

Portnoy: Right.

Blokpoel: Is that because when you get close with the aircraft the birds flush?

Portnoy: No, you probably could census Great Blue Herons using aerial photographs. I

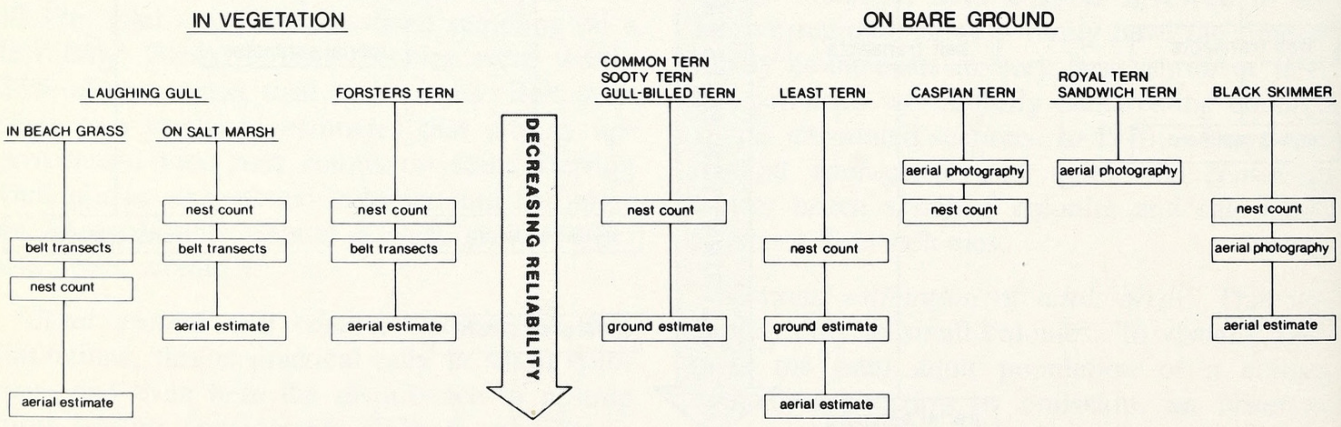

Figure 2. Relative reliability of inventory techniques for seabird colonies in coastal Louisiana-Mississippi-Alabama.

know Mike Erwin has. In small colonies you could get the whole colony on the relatively small negative size that I was using. With the large colonies that I had, I didn't have the time to stay up high and get all the colony in the frame for censusing Great Egrets, and then later go down low and take overlapping close-ups that would show Great Blue Herons. I was aiming mainly at Great Egrets, and they will show up on high-altitude photography. The photo census of Great Blue Herons on these large colonies would require very many overlapping photographs that would be difficult to juxtapose in such uniform habitats.

F. G. Buckley: Are you aware of any studies on human perceptual difficulties in estimating large numbers? I am very impressed by the large-sized colonies you have, and we don't really have that problem here in the Northeast.

Portnoy: I should think that the psychologists would have done something with this. There are really a lot of psychological factors involved in the estimation.

F. G. Buckley: If anyone in the audience is aware of such studies, I would like to learn of them.