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NESTING STATUS AND COLONY SITE VARIABILITY OF LAUGHING GULLS IN SOUTHERN FLORIDA

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Abstract.—Laughing Gulls (*Larus atricilla*) used twenty-six nesting sites in Florida Bay, southern Florida, from 1976 through 1982, breeding from mid-April to August. Colony site use and nesting numbers were highly variable, and nesting success appeared to be poor. Fewer than half of the known nesting sites were used in any year. Limiting factors included flooding and food availability. We hypothesize that the southern Florida nesting population may be of relatively recent origin resulting from repeated colonization by birds from further north. It appears to be supported primarily by the availability of sanitary landfills and agricultural fields, and so may be affected as these types of land uses are scaled back in southern Florida.

The Laughing Gull (*Larus atricilla*) is a familiar bird along the southern Florida coast, but little attention has been paid to its status, probably because it is so common. The first and only enumeration of its nesting population was a series of censuses by Kushlan and White (1977) in the mid 1970s. According to these data the breeding population appears to be much smaller than populations further north (e.g., Patton and Hanners 1984). It is also at the southeastern limit of its continental North American range and thus may be in a marginal environment.

In this paper we report on the status of the Laughing Gull in Florida Bay, based upon censuses conducted from 1976 through 1982. We also have examined historic information on the species in southern Florida and draw inferences with respect to its history in the area. The results of our study indicate that this group has a highly unstable nesting pattern.

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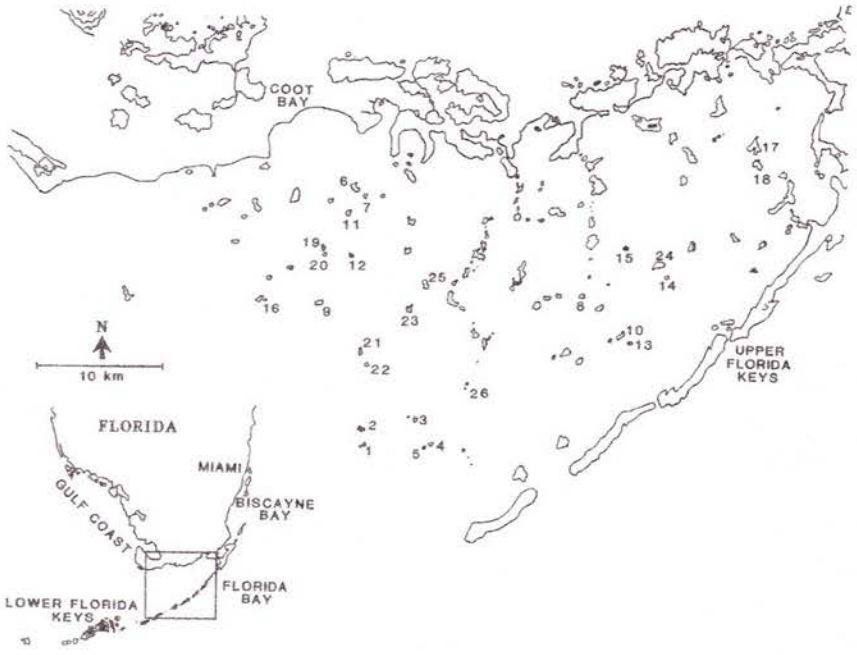

Figure 1. Map of Florida Bay showing Laughing Gull colony sites. See Table 2 for numerical key to colony sites.

METHODS

The study was conducted in southern Florida, especially in Florida Bay (Fig. 1). We located all nesting sites in Florida Bay each year from 1976 through 1982 using helicopter and fixed-wing aircraft. In 1976, 1981 and 1982, we conducted ground censuses at each colony site having more than five nests. All potential sites were observed monthly or every other month year-round in 1977-80. In 1981-1982 they were observed from April through August. In 1982 detailed observations were made to evaluate the effects of heavy rainfall on nesting. To analyze the status of Laughing Gulls in winter, we examined the results of Christmas counts held in or near the study area (published in Audubon Field Notes and American Birds). We also examined all available historic information including published literature and unpublished notes available in the files of the Everglades National Park, National Audubon Society, and U.S. Fish and Wildlife Service Refuges.

Analyses were performed using SPSS, SAS statistical packages at Florida International University and East Texas State University. Equitability was calculated as $E' = H'/\ln S$, where $H' = p_i \log p_i$, p_i = proportion of the gull population in each colony, and s = total number of colonies. Turnover rate was calculated as $T = (1/2)\ ((S_1/n_1) + (S_2/n_2))$, where S_1 = number of sites occupied only on first survey, S_2 = number of sites occupied only on second survey, n_1 = total number of sites occupied on the first survey, and n_2 = total number of sites occupied on the second survey (Erwin et al. 1981).

RESULTS

Historical Information.—The nesting status of the Laughing Gull in southern Florida prior to the last decade is problematical at best. Only a few records even suggest that Laughing Gulls nested historically in extreme southern Florida. Audubon (1967) observed this species "on the shores and keys of the Floridas, where [he] found it breeding." Howell (1932) cited Nicholson as reporting a small colony in 1927 on a mangrove island near Tavernier and also stated that "Bent and Job discovered a breeding colony on a key near Cape Sable." However, nesting was not actually documented in the original report, which stated: "On a large, partly sandy key we found a colony of Laughing Gulls preparing to breed" (Dutcher 1904). Bent (1921) himself did not include the southern part of the state in the breeding range of the species in Florida.

The remaining historical records come from unpublished notes by federal and conservation society personnel taken during sundry aerial wildlife surveys flown over Florida Bay. The earliest such record was at East Key in 1949. Three hundred gulls were reported flying over Stake Key in July, 1964 "possibly nesting." On June 30, 1965, over 60 birds were observed in the air and on the ground at Curlew Key "probably nesting." In mid-July, 1967, "apparent nesting" was reported on an island southeast of Buoy Key, and on Curlew, East and Rabbit keys. No ground censuses of nests or birds were reported throughout the historical record. Because we found a multitude of references to large numbers of Laughing Gulls without mention of nesting, we suspect that any actual nesting observed in southern Florida would have been reported. The first explicit census of Laughing Gull nesting in southern Florida came from the survey conducted in 1976 (Kushlan and White 1977).

Census techniques.—We found considerable differences in the censuses of Laughing Gull colonies conducted by different methods (Table 1). We attempted to discriminate between the methods with respect to the situation in Florida Bay.

Colonially nesting wading birds are frequently censused using aircraft, most commonly fixed-wing airplanes. However we found in attempting to census Laughing Gull colonies that it was not usually possible to discriminate between nesting and nonnesting birds present at a potential colony site. Thus it is not appropriate to infer directly the number of nests present from a count of birds made from a fixed-wing airplane.

Table 1. Comparisons of censuses of Laughing Gulls conducted from the ground and from helicopters in 1981 and 1982, and the proportion of nests containing eggs.

	1981			1982		
Colony Site	Helicopter Aerial Count of Birds	Ground Count of Birds	Ground Count of Nests (% egg nests)	Helicopter Aerial Count of Birds	Ground Count of Birds	Ground Count of nests (% egg nests)
3 Barnes Key	20	40	63 (36)			
8 Captains Key	11	35	22 (100)			
9 Cluett Key	85	120	105 (43)	60	40	7 (43)[1]
12 Dead Terrapin Key	41	81	76 (18)			
20 S.E.-of-Pelican Key				35	75	46 (48)
14 Low Key	59	120	139 (24)	100	85	61 (36)
15 Manatee Key	45	70	72 (4)	150	280	143 (91)
16 Man-of-War Key	46	50	8 (0)			
17 North Nest Key	65	90	92 (12)	315	375	216[1,2]
19 Pelican Key	22	22	25 (4)			
23 Sid Key	35	35	44 (20)			
24 Stake Key	35	65	119 (16)	250	250	208 (89)
25 Topsy Key	35	35	36 (22)			
26 Twin Key	110	90	134 (16)	17	32	23 (26)

[1]Nest number estimate from nest counts in one portion of colony.
[2]Not included in regression analysis because ground counts were not complete.

Counts of birds at potential colony sites made from helicopters were generally higher than those made from fixed-wing airplanes. We evaluated the relationship between counts of birds made from helicopters and the number of nests present on the same day. The best relationship ($Y = -10.653 + 1.068\ X$, $S_b = 0.172$, $P < 0.001$, $R^2 = 0.694$, where Y is the aerial bird count and X is the ground nest count) seriously underestimated nest counts of the larger colonies. The difference between the predicted bird count and actual bird count for 210 nests was over 50%, and eliminating high nest counts failed to improve the overall realtionship for the smaller colonies. Thus it seems that the variability between counts of birds from helicopters and ground counts of nests is too great to be useful in such a small population.

We also evaluated the relationship between counts of birds at colony sites made from the ground to the actual number of nests present on the same day. Ground counts of birds were best predicted from the independent variable of nest counts using a semilog transformation ($\text{Log } Y = 3.408 + 0.011\ X$, $S_b = 0.001$, $R^2 = 0.80$, $F = 66.98$, $P < 0.0001$, where Y is the ground count of birds and X is the actual nest count). Clearly ground counts of birds were more closely related to nest counts than were either of the aerial techniques. It would be possible to generate a correction factor by running the regression analyses backward, as was proposed by Kadlec and Drury (1968), in order to be able to use bird counts to predict nest counts.

However in the population of Laughing Gulls we studied, it is not clear what the actual nest count means. In that a large proportion of nests did not contain eggs (Table 1), the actual reproductive effort was lower than the count of nests. The instability of nesting further increases the uncertainty of any point count. Considering that the colonies are small and adversely affected by disturbance (see below), it would seem that none of these techniques used were adequate for monitoring the population actually nesting.

Nesting population.—Because of the uncertainty in relating bird counts to nest counts and nest counts to nesting status, we express our population figures directly as the number of birds actually counted at colony sites. Based on the highest month's count from each active colony, we estimate that the nesting season population ranged from 280 in 1980 to 1618 birds in 1982 (Table 2). The number of gulls counted at any potential colony site was relatively small, averaging about 60 birds (range 3 to 250, mean=59.3, s=56.58, n=96). The number of nests actually counted per site was also small, averaging about 70 nests (range 1 to 216, mean=70.4, s=60.53, n=32, 1976, 1981, 1982) (Table 3).

Table 2. Peak number of Laughing Gulls occurring on islands in Florida Bay from April through August in 1976 through 1982.

Colony Site	Year 1976	1977	1978	1979	1980	1981	1982
1 Lower Arsnicker Key	30	0	25	0	0	11	0
2 Upper Arsnicker Key	3	20	85	0	0	4	0
3 Barnes Key	50	25	50	50	35	20	50
4 East Buchanan Key	1	20	100	0	0	16	0
5 West Buchanan Key	0	70	110	80	125	0	80
6 Buoy Key	0	0	0	0	0	0	3
7 S.E.-of-Buoy Key	30	100	30	35	0	18	55
8 Captains Key	0	0	0	0	0	11	15
9 Cluett Key	30	30	75	125	0	85	100
10 Crane Key	0	0	0	20	0	0	0
11 Curlew Key	25	100	25	0	0	16	20
12 Dead Terrapin Key	0	0	0	0	0	45	0
13 East Key	100	0	5	0	0	0	4
14 Low Key	0	0	0	15	40	59	180
15 Manatee Key	0	0	0	0	0	45	150
16 Man-of-War Key	60	12	0	10	0	46	55
17 North Nest Key	125	0	85	80	40	65	315
18 South Nest Key	0	230	90	80	0	0	0
19 Pelican Key	75	120	205	75	0	22	20
20 S.E.-of-Pelican Key	20	3	100	0	0	0	130
21 Big Rabbit Key	30	0	0	0	0	0	12
22 Little Rabbit Key	0	70	65	20	0	5	0
23 Sid Key	0	0	0	0	0	35	9
24 Stake Key	0	15	35	85	40	35	250
25 Topsy Key	0	0	0	0	0	35	50
26 Twin Key	0	0	0	0	0	110	120
Total number of birds	579	815	1085	675	280	683	1618
Total number of locations occupied	13	13	15	12	5	19	19

Nesting chronology.—Laughing Gulls nest in Florida Bay in spring and summer, beginning mid-April to May. In only two instances were gulls observed at potential colony sites as early as mid-April. Our monthly data from 1976 to 1981 showed that peak numbers occurred 38% of the time in May, 25% of the time in June, and 23% of the time in July. The mean number of gulls per colony did not differ significantly among months ($F_{(3,40)}=0.195$, $p<0.75$). (Because of the variability in site occupancy noted below, this mean was not over the same colony sites throughout the season.) Gulls were seldom present at colony sites after August. We observed young in colonies beginning in July but expect that some hatching occurred earlier.

Table 3. Number of Laughing Gull nests counted from the ground.

Colony	Year		
	1976	1981	1982
1 Lower Arsnicker	30	0	0
2 Upper Arsnicker	3	0	0
3 Barnes	60	63	6
4 East Buchanan	1	0	0
5 West Buchanan	0	0	0
6 Buoy Key	0	0	0
7 S.E. of Buoy Key	30	0	0
8 Captains	0	22	0
9 Cluett		105	
10 Crane	0	0	0
11 Curlew	35	0	0
12 Dead Terrapin	0	76	
13 East	183	0	0
14 Low	0	139	61
15 Manatee	0	72	143
16 Man-of-War	60	8	0
17 North Nest	125	92	216
18 South Nest	0	0	0
19 Pelican	75	25	0
20 S.E. Pelican		0	46
22 Little Rabbit	0	5	0
23 Sid	0	44	0
24 Stake	0	119	208
25 Topsy	0	36	23
26 Twin	0	134	0
Total number of nests	602	940	710

We found considerable variability in timing of nesting at a colony site in different years and among colony sites in a single year. In fact, new colony sites were occupied as late as August indicating substantial nesting asynchrony among southern Florida Laughing Gulls. Birds were present at some sites on only one or two monthly censuses, suggesting that some of the variation may have resulted from nesting failure followed by shifts to other colony sites. It could also be the result of differences in the timing of food availability at different sites.

Colony site distribution and stability.—Laughing Gulls occupied 26 islands (called keys) in Florida Bay during the nesting seasons from 1976 through 1982 (Figure 1, Table 2). We found an unexpected lack of colony site tenacity between years. The mean occupancy of any colony was only

Table 4. Turnover in the use of Laughing Gull colony sites in Florida Bay, 1976 through 1982.

Years Compared	Turnover Rate[1]
1976, 1977	0.31
1977, 1978	0.14
1978, 1979	0.32
1979, 1980	0.29
1980, 1981	0.43
1981, 1982	0.26

[1]See Methods section for calculation.

3.7 years (s=1.83, n=7), and the mean number of colony sites used per year, 13.7 (s=4.78, n=7), was only about half the total number of sites used over the entire study period.

Turnover rates, a measure of colony site stability, were calculated for sequential years (Table 4). These were relatively high averaging 0.29 (s=0.094). The highest turnover rate was between 1981 and 1980, a year when very few sites were occupied.

Equitability of population distribution among colony sites was calculated over the number of colonies active in each year (Table 5). Generally equitability was lower than expected if birds had evenly distributed themselves among colonies (maximum equitability in Table 5). The mean equitability over the 7 year period, 0.383 (s=0.028), was significantly lower than the mean maximum equitability, 0.435 (s=0.002) ($T=4.333$, $df=12$, $p<0.001$).

We examined whether the frequency of colony use was related to the number of birds using the site (Table 2). We found that the larger colonies were more frequently used (Spearman rank correlation $r_s = 0.38$ corrected for ties, $p<0.05$).

Nest sites.—In southern Florida Laughing Gulls nested only on natural islands. Nests were clumped around the base of red mangroves (*Rhyzophora mangle*) and were dispersed in low herbaceous vegetation, including *Batis maritima* and *Sesuvium portulacastrum*. At two locations Laughing Gulls selected sites in tall grasses including *Cenchrus myosuroides* and *Spartina bakerii*. Each of these sites were typically in or adjacent to open salt pans formed by the evaporation in the dry season of rainfall or overwash salt water.

Table 5. Equitability in distribution of birds among colonies in the years surveyed, 1976-1982.

Year	Number of Locations	Total Number of Birds Present	Equitability[1]	Maximum[2] Equitability
1976	13	579	0.350	0.435
1977	13	815	0.350	0.435
1978	15	1085	0.401	0.432
1979	12	675	0.398	0.433
1980	5	280	0.393	0.434
1981	19	683	0.422	0.437
1982	19	1618	0.365	0.437

[1]See Methods section for calculation.
[2]Calculated based upon an even distribution.

The nests under mangroves were generally larger than those in the herbaceous vegetation. Mangrove sites also appeared to have a higher frequency of completed clutches and a higher nest density, but the concentrated nesting described by Dinsmore and Schreiber (1974) was not found in southern Florida.

Nesting effort and success.—On ground visits made in late May through early June in 1976, 1981 and 1982, we found limited nesting success, and on post-nesting aerial surveys we observed very few juveniles over the entire study area.

Signs of human disturbance such as footprints and litter were found on several of the nesting islands, and this may have contributed to nest losses.

Additionally we found flooding of nests to be common. Most nest sites selected by Laughing Gulls were in or adjacent to salt flats that were frequently flooded by wind-driven tides and rainfall. Kushlan and White (1977) reported large numbers of drowned chicks and eggs after flooding in 1976, and in 1981 we observed abandonment of colonies by gulls after the sites had flooded.

Food availability is also a potential limiting factor for gulls in Florida Bay. We know little about the food or habitats used by gulls in Florida Bay in that they were seldom observed feeding any where other than near marinas. However we consistently observed gulls feeding in agricultural fields and landfills. Three landfills readily accessible to gulls nesting in Florida Bay were on Key Largo, Long Key, and Cudjoe Key (Fig. 1). Incineration of waste began in 1981 and 1982 at all three sites. To test the possible effect of this potential change in food availability, we conducted an aerial survey in late August, 1982 and found no birds foraging at the Key Largo and Long Key sites.

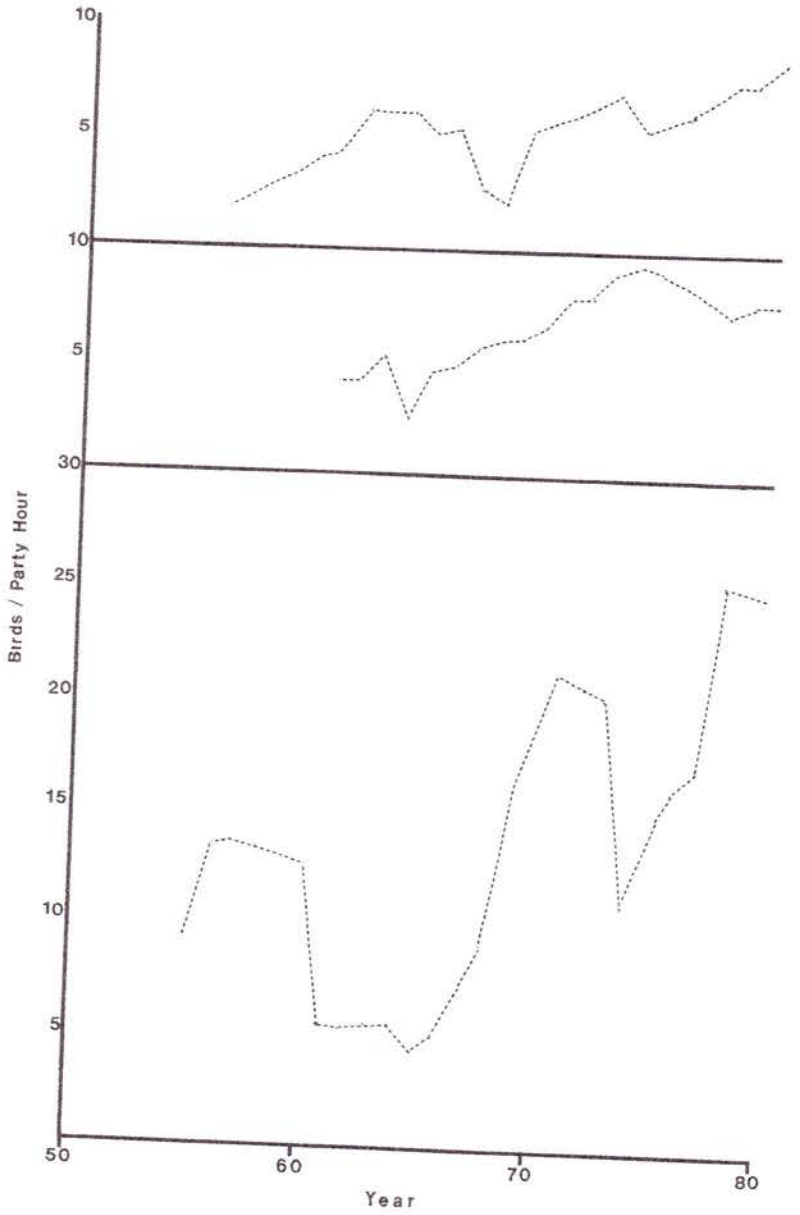

Figure 2. Five year moving averages in Laughing Gulls counted in three southern Florida Christmas counts. Top: Lower Florida Keys. Center: Upper Florida Keys. Bottom: Northwest Florida Bay.

Table 6. Numbers of Laughing Gulls recorded in southern Florida Christmas counts.[1]

Year	Total number (number/party hour) Northern Biscayne Bay	Northwest Florida Bay	Upper Florida Keys	Lower Florida Keys	Total
1975	12,725 (126.0)	6,160 (29.6)	543 (8.2)	311 (4.5)	19,739
1976	10,000 (80.6)	6,058 (34.2)	319 (6.0)	345 (7.1)	16,722
1977	18,862 (115.7)	1,927 (10.6)	444 (7.7)	588 (9.9)	21,821
1978	no data	8,012 (47.5)	461 (6.11)	360 (7.3)	—
1979	15,464 (88.9)	3,324 (25.8)	532 (10.5)	444 (8.8)	19,764
1980	23,137 (661.1)	800 (6.3)	358 (7.4)	501 (10.3)	24,796
1981	10,017 (233.0)	3,233 (24.1)	268 (5.36)	418 (8.1)	13,936
1982	15,683 (155.3)	2,177 (17.7)	348 (6.8)	239 (4.0)	18,447

[1]Northern Biscayne Bay = Dade County Count, Northwest Florida Bay = Coot Bay Count, Upper Florida Keys = Upper Florida Keys Count, Lower Florida Keys = Lower Florida Keys Count. Data from American Birds.

Winter population.—Laughing Gulls occur in southern Florida throughout the year. No historical information on total wintering numbers exists, although numerous unpublished notes recorded their presence in small concentrations prior to 1950. Christmas counts from three areas immediately surrounding Florida Bay show a gradual increase in wintering numbers (Figure 2) from the early 1950s to 1982. Although the areas covered by Christmas counts are small portions of the wintering grounds for gulls in southern Florida, the data indicate that the wintering population far outnumbers the nesting population (Table 6).

Banding recoveries suggest that Laughing Gulls recovered in southern Florida originated from nesting grounds further north, including 75 from New Jersey, 35 from Virginia, 19 from Maryland, 11 from South Carolina, 5 from Wisconsin, 1 from Minnesota, 1 from North Carolina, and 2 from Mississippi. Banding data also suggest that gulls nesting in Florida either remain in Florida or move southward as far as the Caribbean. They seem not to disperse northward. This presumably is also the case for birds nesting in southern Florida.

DISCUSSION

Census techniques.—Aerial counts out of fixed-wing aircraft are the least accurate technique available for censusing colonial waterbirds, including Laughing Gulls. The advantages are logistical, in that it is efficient with respect to cost and time. It also to known to be minimally disruptive to a nesting population (Hutchinson 1979). Fixed-wing censuses for Laughing Gulls were adequate only to determine the number

of birds present at a colony site. Underestimates will result from incubating birds not being visible from the air, and overestimates from non-nesting Laughing Gulls congregating at a colony site.

Helicopters usually produced higher counts because birds on nests under the mangroves could be seen. Thus helicopters provided a more accurate count than did fixed-wing aircraft. Disturbance was similar to that of fixed-wing aircraft in some cases but differed among colony sites. In one instance not a single bird flew up and several remained on nests within 50 meters of our landing site. In other cases birds took to the air and remained in the air until we left the colony. Counts of birds taken from helicopters underestimated the nests present in the largest, and therefore most important, colony sites.

Ground counts of birds at colony sites were higher than counts taken from a helicopter. Regression analysis showed nest counts were related to ground counts of birds. Thus this technique might be applicable to censusing nests without counting them (Kadlec and Drury 1968). In that such counts can be done from outside the nesting area they are less disruptive than walking through the colony for a nest by nest count.

It is usual to use corrections factors to estimate nesting numbers from counts. Nisbet (1971) divided the number of adults counted from the ground by 1.2 and 1.8 depending upon the evaluation of the number present but not nesting. Erwin (1979) proposed a factor of 1.0 to convert aerial estimates of adult Laughing Gulls to number of nesting pairs (nests). In Florida Bay use of regression models to convert between bird counts and nest counts is not appropriate because of the strong effect of errors in estimating such a small population and the unknown, and perhaps nonexistent, relationship between nest counts and nesting effort.

In conducting ground nest counts we found many empty, poorly constructed nests which we suspect were unused (Ryder 1976). Dinsmore and Schreiber (1974) found unused nests in Laughing Gull colonies, noting more unused nests occurring among later nesting birds and a higher frequency among late nesting young birds. If this occurred in Florida Bay, the actual nesting population may be considerably smaller than the number of nests we counted.

An appropriate monitoring scheme in southern Florida would involve monthly aerial surveys from April through August to identify potential nesting locations. In order to assess the changing status of this small and variable nesting population, the actual productivity needs to be monitored.

Wintering and nesting numbers.—We found sporadic counts of wintering concentrations in unpublished notes, but no total censuses for the entire study area. From the 1950s onward, Christmas counts show an increase in numbers of Laughing Gulls throughout the area peripheral to Florida Bay.

Historical records of Laughing Gulls nesting in Florida Bay are depauperate. We have only the ground censuses conducted in 1976 as concrete evidence of nesting prior to our study. Lack of verifiable nesting records suggests that nesting at the level we found it may not be a longstanding phenomenon in Florida Bay.

Using flight data alone, we estimate that a maximum of 1618 Laughing Gulls occurred at potential colony sites during the period of study. We must conclude this is a small population relative to other populations, such as the 50,000 reported from Tampa Bay (Patton and Hanners 1984). The low number of gulls occurring in 1980 demonstrates the high variation in nesting effort in different years.

Nesting chronology.—The Laughing Gull nesting season is extended over a longer, less synchronous period in Florida Bay than in the nearest nesting sites studied, Tampa Bay. In this more northern area, Dinsmore and Schreiber (1974) determined that gulls complete their nesting cycle from egg-laying to fledging from early May to late June. In southern Florida we found no significant differences in mean number of gulls per colony among the months of April through August; abandonment and establishment of colonies occurred throughout these months each year. This extended nesting period cannot be specifically attributed to the more tropical latitude of Florida Bay, as Morris (1984) found a sharp peak in clutch initiation in late April and early May among Laughing Gulls nesting on Little Tobago, West Indies.

The synchronous nesting in the West Indies occurred during the spring dry season. In Florida Bay the prolongation of nest initiation throughout the summer wet season would seem less conducive to success than would nesting during the dry season of early spring, more comparable in timing to Trinidad. We know of no ecological reason why gulls in southern Florida should nest in the rainy season, during which their colony sites are subjected to frequent flooding. Such summer nesting characterizes populations nesting further north, suggesting that the Florida Bay population may be the result of repeated colonization by these more northern birds.

Colony site use.—Variation in colony site use was high, and equitability was low in that frequently used sites held most of the birds. Over the several year study period Laughing Gulls occupied 26 islands in northern Florida Bay, but the mean number of colonies active per year was only 13.7. Each colony was occupied in about half of the 7 years of the study. Thus colony site stability (McNicholl 1975, Southern 1977) was relatively low.

Laughing Gulls elsewhere show rather strong colony site stability (Stone 1937, Nobel and Wurm 1943, Bongiorno 1970, Dinsmore and Schreiber 1974, Nisbet 1971, Burger and Schisler 1978, 1980, Erwin et al. 1981). Turnover rates have been reported as 0.10 in North Carolina, 0.19 on the Delmarva Penninsula, and 0.20 in New Jersey (McCrimmon and Parnell 1983, Erwin 1978, Erwin et al. 1981). However inappropriate averaging and wide confidence limits impairs quantitive comparisons with our data (Frohring and Kushlan in prep.).

Colony shifts have been attributed to external factors such as predation (Montevecchi 1975, 1977, Nisbet 1971, Southern 1977), human disturbance (Gillett et al. 1978, Conover and Miller 1978, Burger 1981), tidal washouts (Burger and Schisler 1980), competition for suitable habitat and vegetational changes (Nesbit 1971, Burger and Schisler 1978, 1980, Patton and Hanners 1984). Previous nesting failure also has been proposed as a factor causing shifts in colony location (Southern 1977).

Competition for space limits colony site use by Laughing Gulls elsewhere. Dinsmore and Schreiber (1974) found that with increased density of nesting at a colony in Tampa Bay, Laughing Gull clutch size decreased suggesting that the colony might be reaching limits of maximum productivity. Because only about half of the islands known to be used as colony sites were occupied in any year we do not expect colony use to be related to density limits. Abandonment and colony shifts also have been attributed to competition for nesting space with larger species of gulls (Nisbet 1971, Burger and Schisler 1978, Erwin et al. 1981). The only other species nesting near Laughing Gulls in Florida Bay is the Least Tern (*Sterna albifrons*), so this population does not experience such interspecific competition for nesting space.

Limiting factors.—We saw some evidence of predation in the colonies we visited, especially in 1981. Laughing Gulls are known to have a less developed anti-predator response to ground predators than other gull species (Montevecchi 1977). Avoidance, noted as an anti-predator mechanism among other larids (Cullen 1960, Kruuk 1964), may be one reason why Laughing Gulls did not nest in the middle of Florida Bay where islands are easily accessible to raccoons.

Human disturbance will cause Laughing Gulls to puncture their own eggs (Bongiorno 1968, Schreiber et al. 1979). Therefore the source of cracked eggs that we observed in 1981 may have ultimately been gulls themselves in response to human visitation rather than heterospecific depredation. We know that some of the islands were visited by humans because of debris, footprints, and other such evidence. Some colony sites such as Nest Key are regularly visited by people yet reform yearly, so disturbance does not seem to affect colony formation. In that this factor is known to affect nesting success in larids elsewhere (Burger 1981), it probably contributes to the apparent low productivity in Florida Bay.

Tidal washouts flood Laughing Gull nesting colonies all along the Atlantic Coast. Burger and Schisler (1980) noted that nesting colonies in New Jersey shifted, and the birds nested in more concentrated groups on higher elevations a year following flooding. These authors and Borngiorno (1970) also recorded gulls renesting within a season either at the same or different locations after tidal flooding destroyed most of the nests. Flooding due to rainfall and wind-driven tides may account for some of the monthly and annual shifts of colony sites observed in Florida Bay, but some colony sites are reused despite repeated flooding. Horseshoe Key in the lower Florida Keys, for example, flooded in 1976 causing mortality among later nesting birds (Kushlan and White 1977), yet has been reused. North Nest Key periodically floods yet is one of the most consistently used sites. Variation in response may occur when only some nests are destroyed by flooding within a colony, perhaps because the eggs experienced different emersion times (Burger 1979).

We suggest that food availability may be a limiting factor for Florida Bay gulls, and that the opening of artificial food sources in southern Florida may have led to the development of the current nesting population of Laughing Gulls in southern Florida. Patton and Hanners (1984) suggested that the opening of landfills may have caused the increase in nesting sites observed in birds in Tampa Bay. Both they and Dinsmore and Schreiber (1974) reported that a large portion of food regurgitated from the Tampa Bay Laughing Gull chicks came from landfills. The human population in the Florida Keys doubled from 12,768 in 1970 to 25,108 in 1980 (R. Goldstein pers. comm.), providing an increasing food base at landfills in the Florida Keys. However technical changes may have recently reduced food availability at these sites, as they have at the 58th Street landfill in Miami, which is heavily used by wintering gulls. There the amount of exposed waste available to foraging birds has been reduced from ten acres to one-half an acre (T. Sobrino pers. comm.).

Agricultural techniques have been implemented over the past twenty years that permits the same land to produce two crops every year rather than one crop on alternate years. Because preparation of individual fields is staggered over a period from spring to fall, food resources are continuously made available, and these fields are occupied by aggregations of gulls before, during, and after nesting season. However this reliable, concentrated food resource is diminishing at the rate of 10,000 acres per year (R. Champagne pers. comm.) in southern Florida as land is developed.

Population characterisitics and status.—The Florida Bay Laughing Gulls represent a small nesting population at the edge of its North American range. It exhibits a nesting schedule that renders its nesting susceptible to flooding, which appears to limit production. It seems possible that nesting on an extended late spring to summer schedule is a reflection of the genetic composition of a population derived from repeated colonization by more northern birds. It is also possible that the present nesting population is a rather recent phenomenon resulting from the provisioning of artificial food sources. If so we can expect it to be afffected by future reductions in the availability of these sources.

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