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Abstract.—The 3662 recovery records for Laughing Gulls (*Larus atricilla*) banded in North America from 1924 to 1991 were analyzed to determine migration and dispersal patterns for Northeast (Maine to Virginia) and Gulf Coast (west coast of Florida to Texas) populations. Autumn migration for Northeast Laughing Gulls was initiated in October. Northeast Laughing Gulls migrated greater distances and were recovered farther south during winter than Gulf Coast gulls. Significantly more Gulf Coast Laughing Gulls wintered along the Gulf Coast than did Northeast Laughing Gulls. In contrast, significantly more Northeast Laughing Gulls wintered in Central and South America. Adult Laughing Gulls returned to breeding areas between March and May. Sixty-four percent of adult recoveries during subsequent breeding seasons were within 50 km of their natal banding locations. Significantly more Laughing Gulls were recovered north of their natal banding location than south during subsequent breeding seasons. Autumn dispersal of hatching-year Laughing Gulls was characterized by northward movements before migration. There was little interchange between Northeast and Gulf Coast populations.

MIGRACIÓN Y PATRONES DE DISPERSIÓN DE INDIVIDUOS DE *LARUS ATRICILLA* EN LOS ESTADOS UNIDOS

Sinopsis.—El recobro de 3662 de individuos de *Larus atricilla* anillados en Norte América entre 1924 y 1991 fue analizado para determinar la migracion y patrones de dispersión de las poblaciones del noreste (Maine a Virginia) y la costa del golfo (costa oeste de Florida hasta Texas). La migración otoñal de la población del noreste se inició en octubre. Los individuos de esta población migraron distancias más largas y se recobraron más al sur durante el invierno que las aves de la costa del golfo. El número de gaviotas del golfo que pasaron el invierno en las costas del mismo fue significativamente mayor que el número de aves del noreste. En contraste, un número significativamente mayor de gaviotas del noreste pasaron el invierno en Centro y Sur América. Las gaviotas adultas regresaron a las áreas de reproducción entre marzo y mayo. El 64% de los adultos recobrados durante épocas reproductivas subsiguientes fueron encontrados dentro de un radio de unos 50 km de su lugar natal. El número de gaviotas recuperadas en épocas reproductivas subsiguientes, al norte de su lugar de nacimiento fue significativamente mayor que gaviotas que fueron recuperadas al sur. La dispersión otoñal de individuos de primer año, se caracterizó por movimientos hacia el norte previo a la migración. Se encontró poco intercambio entre las poblaciones del noreste y el golfo.

Numerous studies of band recoveries in North America have been conducted to document migration and dispersal of Herring Gulls (*Larus argentatus*; e.g., Dexter 1978, Ludwig 1963, Threlfall 1978, Weseloh 1984) and Ring-billed Gulls (*L. delawarensis*; e.g., Forsythe 1972a; Ludwig 1943; Southern 1967, 1974). There is less detailed information available, however, regarding migration and dispersal patterns of Laughing

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Gulls (*L. atricilla*). Telfer and Shisler (1981) reported a record movement (about 8000 km) of a hatching-year Laughing Gull from New Jersey to Hawaii. Forsythe (1972b) provided a description of Laughing Gull movements; however, his analysis was limited to gulls banded or recovered in South Carolina through 1970. Southern (1980) provided more detailed analyses of the continental Laughing Gull population recovered through the late 1970s (1521 records), but excluded recoveries south of 19°N and did not consider age classes. Although general breeding and wintering distributions of Laughing Gulls are known (e.g., Bent 1921, Grant 1986, Southern 1980), specific wintering areas and migration and dispersal patterns of various populations are unknown.

Laughing Gull populations in the northeastern United States have been increasing since the late 1970s (Belant and Dolbeer 1993), possibly a consequence of increased use of landfills as a source of food (Patton 1988, Patton and Hanners 1984). These increasing populations have caused a concurrent increase in gull/people conflicts, including a hazard to aircraft (Dolbeer et al. 1993, Seubert 1990). An improved understanding of the population dynamics of migratory species at a regional or national level is essential for the development of management programs. Our objective was to determine migration and dispersal patterns of populations of Laughing Gulls in the United States.

METHODS

Band recovery records for Laughing Gulls through 1992 were obtained from the U.S. Fish and Wildlife Service, Office of Migratory Bird Management, Laurel, Maryland. Methods primarily followed those of Dolbeer (1991) and Moore and Dolbeer (1989). Recoveries with "How Obtained" codes 50, 56, 96, or 98 (Canadian Wildlife Service 1984), which imply the month or location of recovery may not have been accurately known, were excluded. Also, Laughing Gulls collected as scientific specimens (How Obtained code 16) were excluded as they represented non-random recoveries. Finally, we used only birds that were banded as hatching-year birds (age codes 2 and 4, Canadian Wildlife Service 1984) in June or July to ensure that the natal location was known for each bird.

From a preliminary analysis of recovery data, we divided the population into two regions, birds banded in the Northeast (coastal states from Maine to Virginia) and birds banded in the Gulf Coast (coastal states from the west coast of Florida to Texas). These two geographic regions contained 96% of the banded birds that were subsequently recovered.

The timing and distance of Laughing Gull migration for each of these regions was determined by calculating the mean and median distance from banding to recovery locations for gulls banded as chicks during June or July (breeding season) and recovered at subsequent monthly intervals. The distribution of recoveries during January and February (winter) and during the breeding season from the two banding regions was compared. We also determined the amount of interchange between the regional adult ($\geq$2 yr old) populations.

We used the General Linear Models procedure (SAS Inst., Inc. 1988)

to compare mean distances among age classes and regions after transformation of the data (log[x + 1], where x = distance from banding to recovery site) to normalize the distribution of recovery distances (Steel and Torrie 1960). If significant differences ($P < 0.05$) occurred, Tukey multiple comparison tests were used to determine which values differed. Chi-squared tests of independence were used to compare direction of Laughing Gull dispersal and chi-squared statistics for proportional data (Fleiss 1973) were used to analyze locations of winter recoveries by age class and banding region. For all analyses, we assumed that the probability of an individual recovery was constant among locations and years.

RESULTS

Sample sizes and characteristics of data.—Of the 3662 recovery records available through 1992, 90% (3294) represented Laughing Gulls banded during June or July as chicks or recently fledged birds (age codes 2 and 4, Canadian Wildlife Service 1984). An additional 2% (81) of the recovery records represented Laughing Gulls banded during other months as chicks or recently fledged birds, 1% (53) were banded as adults (age codes 1, 5–8), and age was not determined for 6% (234, age codes 0 and 3) of the birds recovered.

Approximately 34% (1236) of the Laughing Gulls recovered were found dead, 11% (415) were captured in fishing equipment or nets, and 10% (360) were captured by hand. About 16% (598) of the records were excluded from analyses because the "How Obtained" codes indicated inadequate information regarding the date or location of recovery or because Laughing Gulls were collected as scientific specimens. An additional 8% (300) of the Laughing Gulls recovered were because of injury, 6% (236) were shot, and 5% (167) were sight records. About 1% (27) of Laughing Gulls were recovered after colliding with aircraft.

Migration

Recovery distance from hatching site by monthly interval.—For Northeast Laughing Gulls, autumn migration was initiated in October (Fig. 1). By November, both first-year (<1 yr old) and adult (≥2 yr old) Northeast Laughing gulls had migrated a median distance of about 1200 km, approximately to the Gulf Coast. During December and January, first-year Northeast Laughing Gulls, joined by first-year Gulf Coast gulls, migrated another 1800 km S, across the Gulf of Mexico and Caribbean Sea. In contrast, many adult Northeast Laughing Gulls remained along the Gulf Coast through winter as did the majority of adult Gulf Coast Laughing Gulls. Adult Laughing Gulls returned to breeding areas between March (Gulf Coast) and April–May (Northeast). In contrast, first-year Northeast Laughing Gulls remained on wintering areas through at least April.

Distribution of recoveries in winter.—Northeast Laughing Gulls migrated greater ($F = 110.49$; 1, 404 df; $P < 0.01$) distances than Gulf Coast Laughing Gulls (Table 1). There were also differences among age classes ($F = 28.16$; 3, 404 df; $P < 0.01$) and the interaction of age class

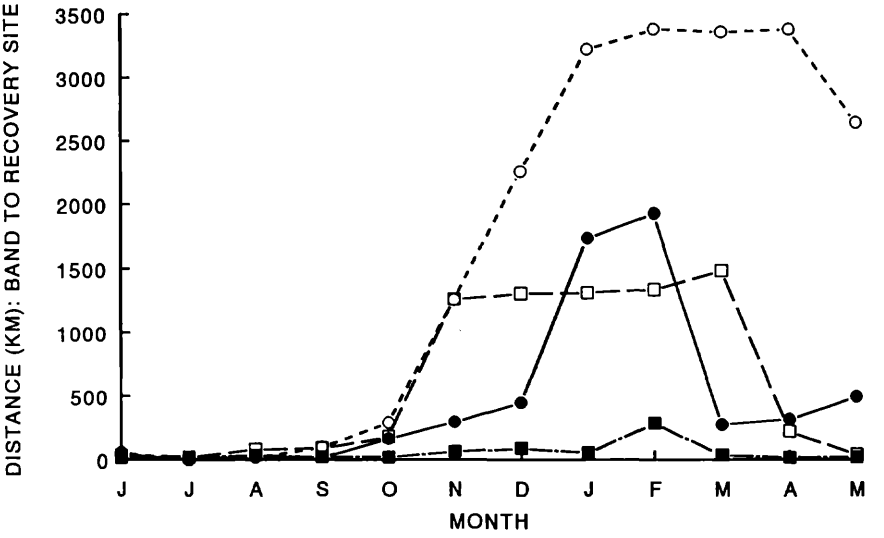

FIGURE 1. Median distance from banding site to recovery site by month for Laughing Gulls banded as chicks (June–July) in the Northeast (Maine to Virginia, unshaded data points) and Gulf Coast (Florida to Texas, shaded data points) and recovered during winter (January–February). Circles = 0–11-mo-old gulls, squares = ≥24-mo-old gulls. Sample sizes for individual data points ranged from 4 to 248 ($\bar{x}$ = 46 ± 51 [SD]).

and banding region was significant (F = 3.50; 3, 404 df; $P < 0.01$). Laughing Gulls 0.5 yr old migrated farther ($P < 0.05$) than ≥3.5-yr-old Laughing Gulls. Fifty percent of Gulf Coast Laughing Gulls ≥3.5 yr old wintered ≤57 km from their natal banding site.

The mean latitude (N) of recovery during January and February for Northeast Laughing Gulls was lower (F = 6.50; 1, 404 df; P = 0.01) than was the mean latitude of recovery for Gulf Coast Laughing Gulls. There was also an age effect (F = 22.82; 3, 404 df; $P < 0.01$), with 0.5-yr old Laughing Gulls recovered farther ($P < 0.05$) south than ≥3.5-yr old Laughing Gulls for both regions (Table 2). For Northeast Laughing Gulls, the mean latitude of recovery was similar ($P > 0.05$) for 0.5- to 2.5-yr old gulls. In contrast, the mean latitude of recovery for 0.5-yr old Gulf Coast Laughing Gulls was less ($P < 0.05$) than that of 1.5-yr-old Gulf Coast gulls. The overall difference in mean latitude of winter recoveries between the two regions was a consequence of the 1.5- and 2.5-yr age classes.

Proportionally more (χ^2 = 33.87, 1 df, $P < 0.01$) Gulf Coast Laughing Gulls (42%) wintered along the Gulf Coast than did Northeast Laughing Gulls (16%, Table 3). In contrast, proportionally more (χ^2 = 34.50, 1 df, $P < 0.01$) Northeast Laughing Gulls (72%) wintered in Central and South America than did Gulf Coast gulls (42%). Most (73%, χ^2 = 223.57, 1 df, $P < 0.01$) winter recoveries were of Laughing Gulls <1 yr old.

TABLE 1. Mean and median distance (km) from banding site to recovery site for Laughing Gulls banded as chicks (June–July) in the Northeast (Maine to Virginia) and Gulf Coast (Florida to Texas) and recovered during winter (January–February). Means within a column with different letters are different ($P < 0.05$, Tukey tests).

Age (yr) at recovery	Distance from banding to recovery site for Laughing Gulls banded in:							
	Northeast				Gulf Coast			
	n	$\bar{x}$	SD	Median	*n*	$\bar{x}$	SD	Median
0.5	223	3146 A	1299	3307	78	1936 A	1428	1740
1.5	28	3084 AB	1323	3318	24	1054 A	1639	308
2.5	13	2917 AB	1029	3350	9	1046 A	1187	417
≥3.5	15	1384 B	989	1254	22	614 B	1126	57

Dispersal

Dispersal during the breeding season.—Mean distance from banding to recovery location during subsequent breeding seasons was affected by the age of gulls ($F = 47.11$; 3, 264 df; $P < 0.01$) and the region where banded ($F = 6.07$; 1, 264 df; $P = 0.01$); the interaction of age and banding region was significant ($F = 8.42$; 3, 264 df; $P < 0.01$). Most Northeast Laughing Gulls did not return to their natal area during their first year (Table 4). The median distance from the natal banding site for 1-yr old gulls from the Northeast recovered in June or July was 1518 km. Twenty-four percent of these birds were recovered in the Northeast, 31% were recovered along the Gulf Coast, and 36% were recovered in Central and South America. In contrast, 50% of 1-yr old Gulf Coast gulls were recovered <158 km from their natal banding site. Fidelity to the area of natal origin was high for Laughing Gulls ≥2 yr old, with ≥50% recovered within 55 km of their banding locations.

More ($\chi^2 = 44.8$, 1 df, $P < 0.01$) Laughing Gulls banded as chicks were recovered as adults north (74%) of their banding site than south (26%) during subsequent breeding seasons (Table 5). Also, most (64%) adult Laughing Gulls recovered were within 50 km of their natal colony

TABLE 2. Mean and median degree of latitude of winter (January–February) recoveries for Laughing Gulls banded as chicks (June–July) in the Northeast (Maine to Virginia) and Gulf Coast (Florida to Texas). Means within a column with different letters are different ($P < 0.05$, Tukey tests).

Age (yr) at recovery	Latitude (°N) of recovery for Laughing Gulls banded in:							
	Northeast				Gulf Coast			
	n	$\bar{x}$	SD	Median	*n*	$\bar{x}$	SD	Median
0.5	223	12.3 A	8.9	9.2	78	13.8 A	9.3	13.6
1.5	28	12.9 A	9.5	8.8	24	21.0 B	10.1	26.2
2.5	13	12.9 A	9.4	8.8	9	20.3 AB	10.2	26.5
≥3.5	15	26.7 B	8.4	27.8	22	24.4 B	7.4	27.8

TABLE 3. Proportion (%) and location of recoveries for Laughing Gulls banded as chicks (June–July) in the Northeast (Maine to Virginia) and Gulf Coast (Florida to Texas) and recovered during winter (January–February).

Location of recoveries	% recovered by banding location and age class					
	Northeast			Gulf Coast		
	<1 yr	>1 yr	Total	<1 yr	>1 yr	Total
Northeast, U.S.A.	3	4	3	0	0	0
Southeast, U.S.A.[a]	1	2	1	0	0	0
Gulf Coast, U.S.A.	13	30	16	24	67	42
Cuba	4	4	4	1	2	2
Mexico	3	2	3	12	16	14
Central America[b]	57	39	53	54	13	37
South America[c]	20	16	19	6	2	5
Other	1	2	1	3	0	2
Number recovered	223	56	279	78	55	133

[a] Georgia, North Carolina and South Carolina.
[b] N = 198 recoveries: Panama (43%), Guatemala (19%), Nicaragua (11%), four other countries (27%).
[c] N = 60 recoveries: Colombia (83%), Ecuador (13%) and Peru (3%).

(χ^2 = 81.81, 2 df, $P < 0.01$). Only 15% of adult Laughing Gulls were recovered at distances >100 km from their natal colony during the breeding season.

There was little interchange between Northeast and Gulf Coast breeding populations of Laughing Gulls. Of 120 Laughing Gulls banded as chicks in the Northeast and recovered as adults (≥2 yr old) during subsequent breeding seasons, 96% were recovered from the Northeast and 2% were from the Gulf Coast. Of 73 Laughing Gulls banded as chicks in the Gulf Coast and recovered as adults during subsequent breeding

TABLE 4. Mean and median distance (km) from banding site to recovery site for Laughing Gulls banded as chicks (June–July) in the Northeast (Maine to Virginia) and Gulf Coast (Florida to Texas) and recovered during subsequent breeding seasons (June–July). Means within a column with different letters are different ($P < 0.05$, Tukey tests).

Age (yr) at recovery	Distance from banding to recovery site for Laughing Gulls banded in:							
	Northeast				Gulf Coast			
	n	$\bar{x}$	SD	Median	n	$\bar{x}$	SD	Median
1	49	2131 A	2010	1518[a]	28	583 A	1134	158
2	22	426 B	1073	55	26	369 A	1226	21
3	30	153 B	591	30	13	73 B	119	21
≥4	68	114 B	530	24	34	43 B	59	20

[a] Twenty-four percent were recovered in the Northeast and 31% were recovered in Gulf Coast states.

TABLE 5. Direction and distance of dispersal for adult (≥2 yrs old) Laughing Gulls banded as chicks (June–July) in the Northeast (Maine to Virginia) and Gulf Coast (Florida to Texas) and recovered during subsequent breeding seasons (June–July).

Banding location	*n*	% of recoveries				
		Direction		Dispersal distance (km)		
		North	South	0–50	51–100	>100
Northeast	120	74	26	60	29	11
Gulf Coast	73	74	26	70	10	21
All locations	193	74	26	64	22	15

seasons, 95% were from the Gulf Coast, 3% were from Georgia, and none were from the Northeast.

Autumn juvenile dispersal.—Overall, more ($\chi^2 = 95.13$, 1 df, $P < 0.01$) hatching-year gulls dispersed north (72%) of their banding site than south (28%) during August and September of the same year (Table 6). This relationship was similar for Northeast and Gulf Coast populations.

DISCUSSION

Our results generally agree with those of Southern (1980), although migration and dispersal by age class was not considered in this earlier report. The greater distances first-year (<1-yr old) Laughing Gulls migrate to wintering areas compared to >2-yr-old gulls appears characteristic of several North American gull species (Southern 1980), as well as certain passerine species (Dolbeer 1982). Also, first-year (non-breeding) Laughing Gulls remained in their wintering areas longer and were recovered significantly farther from their natal sites during the breeding season than were Laughing Gulls ≥2 or 3 yr old. This phenomenon also occurs among non-breeding cohorts in other species (e.g., Double-crested Cormorants [*Phalacrocorax auritus*], Dolbeer 1991). Laughing Gulls typically do not obtain adult breeding plumage until their third summer (3 yr old, Grant 1986), and have been considered not to breed until this time. The high fidelity (low median distance) of 2-yr-old Laughing Gulls

TABLE 6. Mean and median distance (km) from banding site to recovery site by direction for Laughing Gulls banded as chicks (June–July) in the Northeast (Maine to Virginia) and Gulf Coast (Florida to Texas) and recovered during August or September of the same year.

Location	*n*	Direction dispersing (%)		Distance from banding to recovery site		
		North	South	$\bar{x}$	SD	Median
Northeast	429	72	28	114	272	45
Gulf Coast	66	73	27	134	210	19
All locations	495	72	28	117	262	43

to their area of natal origin during the breeding season, however, particularly in the Gulf Cost population, suggests that a portion of this age class does breed. This suggestion is supported by Dolbeer and Belant (unpubl. data), who have observed fully developed brood patches in Laughing Gulls considered 2-yr old based on plumage characteristics.

The broad winter distribution of regional populations of Laughing Gulls is advantageous, as localized food shortages or natural catastrophes would probably not drastically affect these breeding populations. Patton (1988) and Patton and Hanners (1984), however, suggested that increased use of landfills in Florida by Laughing Gulls may be responsible for increasing populations and that closure of these landfills could result in changes in distribution and lower overwinter survival. Our data indicate that reduced availability of food at landfills in the southern United States may particularly affect the overall population size and winter distribution of adult Laughing Gulls. Central and South America also are important wintering areas for Laughing Gulls, particularly first-year birds. Sixty percent of first-year Gulf Coast Laughing Gulls and 77% of first-year Northeast gulls winter in Central and South America.

The total population of $\geq$2-yr-old Laughing Gulls along the Gulf Cost is probably only slightly lower during winter than during summer. About 200,000 and 260,000 adult Laughing Gulls currently breed in the Northeast and Gulf Coast, respectively (Belant and Dolbeer 1993). On the basis of these population estimates and band recovery data (Table 3), a minimum of 230,000 adult Laughing Gulls winter in Gulf Coast states.

The northward dispersal of hatching-year Laughing Gulls during late summer and early fall based on band recoveries is corroborated by Burger and Galli (1986), whose observations of Laughing Gulls in New Jersey suggested a similar post-breeding dispersal. Also, Southern (1974) noted that some Ring-billed Gull movements were in northerly directions during August–October and Parsons and Duncan (1978) determined that about 13% of hatching-year Herring Gulls in England dispersed north during July–December.

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