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THE MIGRATION OF THE COMMON TERN (*Sterna hirundo*) IN THE WESTERN HEMISPHERE¹

BY OLIVER L. AUSTIN, SR., M.D.

Every summer many thousand Common Terns return from the south to breed in North America. Their essentially colonial nesting is carried on either alone, or in company with other species of terns, Arctics (*Sterna paradisæa*), Forster's (*Sterna forsteri*), and Roseates (*Sterna dougalli*). The numbers of other species in the colonies vary from a few to predominance. When nesting has been completed, the Common Terns, more or less in company with terns of other species, return with the young they have been able to mature to their customary wintering grounds. The purpose of this contribution is to present what has been learned about their migrations, in particular the routes followed, and to locate the wintering grounds. By wintering grounds is meant the territory in which the birds can be found during the interval between the completion of the migration southward and the beginning of the one northward; by migration route, the course travelled and ground covered in either direction.

Three sets of data are available, the information on the labels of collected specimens, sight records in the literature, and the recoveries of banded birds. (A recovery in this sense is a bird found elsewhere than within the breeding territory of the group of which it was a member when banded.) It has not been practical to secure the records of specimens scattered widely in museums and other collections throughout the world. Also, each such specimen shows only one individual's presence at one time and place.

In spite of the current tendency to accept sight records as factual, they are not used here because their correctness varies with the experience and competence of those making them, and it is impossible to evaluate the reliability of all the observers. All the species of terns concerned tend to travel or to flock together at certain points along their routes, and the Arctic and Forster's Terns differ so little morphologically from the Common Tern that a differential identification is credible only when made by an expert and under ideal conditions. Confusion with the Arctic is negligible except in the northern part of the Common's range, for the two species do not occur together elsewhere in the western hemisphere (Austin, Jr., 1928). Possible confusion of the Common Tern with Forster's Tern, however, renders sight records questionable in the Central, Southern, and Gulf States.

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Accordingly this study is limited to the data available from the recoveries of banded birds. Thanks to the courtesy of the Fish and Wildlife Service, this Station has compiled a practically complete record of all Common Terns banded in North America, and of all the returns (birds found more than one season in the same territory) and recoveries which have been reported.

It is expedient to recall attention to two major behavior traits exhibited by the Common Tern, group adherence, and its corollary, site tenacity. The former is the result of an attachment of birds to each other, and aligns them, at least during the nesting season, into bands of a few individuals, these into colonies, the colonies into groups, and the groups into units. Site tenacity is the attachment of the birds to specific terrain, and influences individuals and the various aggregations of individuals to return seasonally to the same locations they had occupied before. Both traits have been described and substantiated in preceding contributions (Austin Sr., 1949; 1951).

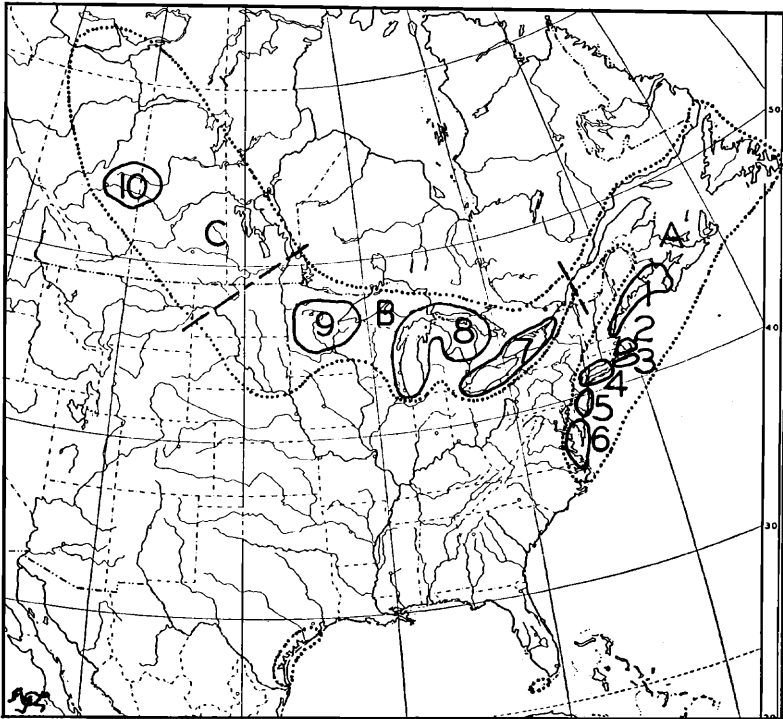


Figure 1: Breeding range of the Common Tern, *Sterna hirundo*, in North America. Dotted lines enclose known breeding range; solid lines indicate major concentrations where banding has been done and the group domains suggested by the banding returns; broken lines separate the three hypothetical units.

Extensive field work during the last few decades has located most of the nesting sites of our Common Terns, and it is believed that no large or important colony has been overlooked. (See Figure 1.) Far more than one-half the total population breeds along the Atlantic Coast from Nova Scotia to southern Virginia; roughly one-fourth in the region of the Great Lakes between the St. Lawrence area in the east and Minnesota on the west. Relatively smaller colonies are located in the lakes and muskegs of the northwestern Great Plains, in Newfoundland and southern Labrador, in coastal North Carolina, also in the Florida Keys and along the Gulf Coast of southern Texas. As yet no banding has been done in any of these outlying colonies, except at one in Alberta.

Since the comparatively recent discovery of some of these outlying small colonies is possibly the result of more extensive exploration, their existence does not necessarily indicate any recent extension of breeding range by this old age, inaggressive species. More likely those in the Gulf area are remnants of a former wide, more continuous distribution of the species, possibly in large colonies. In the Cape Cod group where a large population occupies a small territory, the trend is toward concentration, not toward expansion.

In 1940 the writer postulated that "the Cape Cod colonies of breeding Common Terns form a distinct, self-perpetuating group, free from association with other colonies during the nesting season." The results of continued investigations have warranted the concept that most breeding colonies are segregated into discrete groups, each group continuing to occupy the same specific territory year after year with only a negligible interchange of individual memberships. Seasonally some individual members of a group nest in a different colony, and some colonies may amalgamate or occupy new sites, but these variations occur wholly within the boundaries of the group's domain. The data now at hand suggest the existence of at least six such groups along the Atlantic coast, three in the Great Lakes area, and one in the far northwest, with domains that are irregular in shape and extent. Undoubtedly there are others, but it will require much more banding throughout the species' range, and particularly more trapping of adults, to delineate each population's territory and relationships accurately. The units and groups indicated by the evidence now available are located as follows (see Figure 1):

A. ATLANTIC COAST UNIT

1. Coastal New Hampshire, Maine, and southern Nova Scotia.
2. Cape Cod, Massachusetts, area.
3. Martha's Vineyard, Nantucket, and Elizabeth Islands.
4. Long Island and Long Island Sound area.
5. Coastal New Jersey.
6. Chesapeake Bay area.

B. CENTRAL UNIT

7. Lakes Erie and Huron and the upper St. Lawrence River.
8. Lakes Michigan and Huron.
9. Western Lake Superior and central Minnesota.

C. NORTHWEST UNIT

10. Alberta and Saskatchewan.

TABLE 1

COMMON TERNS BANDED IN NORTH AMERICA (to 1 January 1951)				
GROUP	ADULTS	CHICKS	TOTAL	PERCENT
1. New Hampshire, Maine, Nova Scotia	66	6,197	6,263	1.6
2. Cape Cod, Massachusetts	52,942	202,989	255,931	66.3
3. Martha's Vineyard area	2,776	29,206	31,982	8.2
4. Long Island area	253	9,664	9,917	2.5
5. Coastal New Jersey	5	8,850	8,855	2.3
6. Chesapeake Bay area	30	3,462	3,492	0.9
TOTAL ATLANTIC COAST UNIT	56,072	260,368	316,440	81.8
7. Eastern Great Lakes	195	15,567	15,762	4.2
8. Central Great Lakes		43,521	43,521	11.2
9. Western Great Lakes	1	10,019	10,020	2.5
TOTAL CENTRAL UNIT	196	69,107	69,303	17.9
10. Alberta		1,009	1,009	0.3
GRAND TOTAL	56,268	330,484	386,752	100.

Table 1 shows that 386,752 Common Terns had been banded in North America prior to 1 January 1951, 14.5 percent of them as adults, 85.6 as juveniles (young of the year before leaving the sites where they were hatched), and that three-fourths of this total (including 99 percent or all but 550 of the 56,268 adults) were banded in the contiguous Cape Cod and Martha's Vineyard groups alone. This age disparity has but a negligible effect on the findings, for major behavior trends are essentially consistent for the species at all ages.

Returns totalling 38,145 have been taken in the Cape group; comparatively few elsewhere. Of these, from a low of 30 percent to a high of 69 percent came back from two to nine different years. Apparently these were older birds for, as shown previously (Austin, 1945), the influence of site tenacity increases with the age of the individual. In no direct way do returns indicate either migration routes or wintering grounds, but they warrant, by analogy, the inference of a yearly return to the same localities in the wintering range and by the same routes. Each of the reported recoveries has been evaluated. Some have been discarded because they are simply returns, and a few others for incompleteness.

Incident to every nesting are two phenomena which must be discussed. One is post-nuptial wandering; the other is the trapping of adults banded in other groups. Every season since this Station began work with terns, 24 years ago, as soon as the chicks are able to fly away from their natal sites, reports come in of their having been found dead or "exhausted" or "sick." Some are within the Cape group's boundaries, others in all directions beyond it. Unfortunately it is only in recent years, since the import of these early nearby recoveries was realized, that careful records of their occurrence have been kept. A duplicating dispersal has occurred in other groups, and the scattering in all directions immediately after leaving the breeding grounds is apparently an essential part of tern behavior.

The records show that 37 banded Cape group birds were taken north of the Cape in the following locations: Northern Massachusetts 28, Maine 6, Nova Scotia 2, Lake Ontario 1. Nine, or 25 percent of these were taken within 30 days after being banded; 26 or 70 percent by 45 days. One had travelled 75 miles in 18 days, another 175 miles to Maine

in 21 days. South of the Cape 42 birds were reported during the same period. Since there is recovery evidence that migration has begun by mid-July, surely at least a few of these 42 were definitely migrating. Inasmuch as quite as many terns go north as south at first, this early explosive dispersal probably is not a part of migration, but rather a preliminary preparation of juveniles for their long and strenuous journey to the wintering grounds. These early recoveries are not used in this study of migration otherwise.

Adult trapping in the Cape group has resulted in the capture of many mated pairs. A few of these have consisted of a Cape bird united to one banded some former year in another group, in particular one of the Great Lakes groups. It has been contended that pairing takes place on the wintering grounds, where birds from diverse groups come more or less in contact; that new pairs return to breed with the group to which one of the pair had the greater attachment (Austin 1947). The recoveries of these foreign birds in the Cape area are not usable, for they had arrived by a route new to them, one they would not have taken had they mated with one of their own group.

After all such necessary eliminations have been made, 709 recoveries remain, arranged according to the groups of which they were members when banded as follows:

TABLE 2

GROUP	TOTAL USABLE RECOVERIES BY GROUPS		
	BANDED	RECOVERED	PERCENT
1. N. H., Maine, N. S.	6,263	15	0.24
2. Cape Cod	255,931	383	0.15
3. Martha's Vineyard	31,982	106	0.32
4. Long Island	9,917	37	0.37
5. New Jersey	8,855	31	0.35
6. Chesapeake Bay	3,492	6	0.17
TOTAL ATLANTIC UNIT	316,440	578	0.182
7. Eastern Great Lakes	15,762	32	0.204
8. Central Great Lakes	43,521	69	0.16
9. Western Great Lakes	10,020	27	0.27
TOTAL CENTRAL UNIT	69,303	128	0.185
10. Alberta	1,009	3	0.30
GRAND TOTAL	386,752	709	0.184

The 709 recoveries are 0.184 percent of all the bandings, an average of 28 in each of 25 years. Of the 709, 82 percent were from the Atlantic coast groups as a whole (54 percent from the Cape group alone) and 18 percent from all the other groups. This disparity does not make the smaller ones inadequate samples, for the recovery percentages are practically identical when based on the number of banded birds available for recovery: 0.182 percent for the Atlantic unit, 0.185 for the Central unit, 0.184 for the entire country.

A further breakdown (Table 3) of the 578 recoveries for the Atlantic unit reveals that 532 or 92 percent of them were banded as juveniles, 46 or 8 percent as adults. As all the adults were banded in the Cape and Vineyard groups alone, of the 489 recoveries from these two groups alone, 94 percent were juvenile, only 6 percent adult bandings. So it

TABLE 3

GROUP	BANDING AGES OF ATLANTIC UNIT RECOVERIES					
	BANDED AS ADULTS			BANDED AS JUVENILES		
	BANDED	RECOVERED	PERCENT	BANDED	RECOVERED	PERCENT
1. Cape Cod	52,942	43	0.08	202,989	340	0.17
2. Martha's Vin.	2,776	3	0.11	29,206	103	0.31
3. All others	354	0	0	28,173	89	0.31
UNIT TOTAL	56,072	46	0.082	260,368	532	0.20

appears that even when extensive adult banding is done the recoveries still consist of a very high percentage of juvenile bandings. However, this does not lessen the great value of adult banding. Until it has been shown that birds of the year inherit knowledge of migration routes and wintering grounds, the guidance of adults remains essential. More significant are the relative percentages of adult- and juvenile-banded recoveries based on the numbers of each available for recovery. For all the Atlantic unit they are: juvenile-banded 0.20 percent, adult-banded 0.082 percent; for the Cape and Vineyard groups alone juvenile 0.19 percent, adult 0.081 percent. Also, of the 532 juvenile-banded recoveries, 442 or 83 percent were made during the first year of their lives. These findings do not indicate that there is a corresponding predominance of juveniles during migration and on the wintering grounds, for they are solely the result of the high vulnerability of young birds.

The term "wintering ground" implies both time and place and is defined as the territories in which the birds can be found during the interval between the completion of the southward migration and the start of the return northward in the spring. It is impossible to determine these dates, so they are assumed arbitrarily to be December first and March first. With some explainable exceptions, recoveries made between these dates indicate the location and extent of the wintering grounds. Corroboration is given by the recovery of non-breeding birds in these same places during the nesting season. By these criteria, the wintering grounds are found to be the entire coast line of the Gulf of Mexico, the West Indies, all of Central America, and both the east and west coasts of South America. (See Figures 2 and 3.)

The behavior of the Common Tern has become so fixed that its major trends function at all seasons. It has been shown that group adherence persists to some degree after the breeding season (Austin 1951; 13). So it may be assumed that its cofunctioning trend, site tenacity, influences a Common Tern to reoccupy from year to year the same wintering location, provided ecological conditions are propitious. Certainly the size of a location and the consistency of birds staying within it must vary. There are no eggs or fledglings to tie old birds to an area the size of a nesting site, no juveniles to curtail exploration as they do during postnuptial wandering, for the immatures have now reached the age of independent action. Even when the bulk of the recoveries from any group has been made in one restricted area, some of the others are frequently scattered in faraway places.

The only data indicating the migration routes used for the return northward are the four following recoveries made in the United States in April and May:

	BANDED	RECOVERED
Juvenile	Minnesota, July 10, 1931	West coast of Florida, May 25, 1932
Juvenile	Lake Michigan, July 13, 1932	Key West, Florida, April 27, 1933
Juvenile	Long Island, N. Y., July 16, 1936	Northfield, N. J., May 21, 1941
Adult	Plymouth, Mass., June 19, 1946	Ocean City, N. J., May 20, 1950

Of course, the first two may have been still occupying their wintering grounds. Each had been banded in one of four widely separated groups. Each was made on the route it will be shown its group uses when migrating southward. This at least suggests the possible use of the same migration route regardless of the direction in which it is travelled.

That so few recoveries are made in the spring in comparison with the large numbers secured in the autumn is not surprising. With the exception of a rare anomaly, such as the Common Tern "observed" in Chicago 2 December 1934 (Black, 1936), no Terns remain in the nesting area during the winter months. Some of the adults, tired and worn after the breeding season, and many of the weak young, physically unable to complete the journey, perish along the routes to the wintering grounds. The northward flight in spring is made only by birds in good physical condition, and the mortality is consequently far lower at this time.

It is believed that only birds with fully developed, active gonads leave their wintering ground in the spring because no evidence has been found indicating the presence of non-breeding birds in the Cape Cod colonies. Sexually quiescent birds are not impelled to leave their wintering grounds by any environmental changes, and many remain there instead of returning northward during the nesting months of May, June, and July. This is shown by the following recoveries made in the wintering area during this interval:

TABLE 4

BREEDING SEASON RECOVERIES ON THE		WINTERING GROUNDS	
BANDED AS ADULT		BANDED AS JUVENILE	
Trinidad	1	Mexico	1
Brazil	1	British Guiana	1
		Hispaniola	1
		Puerto Rico	1
		Trinidad	6
		Brazil	1
		Peru	1
Total	<u>2</u>		<u>12</u>

It is possible that most of the 12 banded while chicks had not yet reached breeding age, for fewer than 25 percent do so during their first two years (Austin, 1942: 168). However, all these 14 were in at least their third year of life when recovered.

There is a decided difference in behavior, at least by the Atlantic coast groups, during the two migrations, especially in the matter of tempo. As breeding nears completion the birds first flock along the adjacent shore lines and then begin a gradual, slow departure from the terneries. Several weeks may elapse before all have left. After the period of postnuptial wandering, they travel leisurely southward along

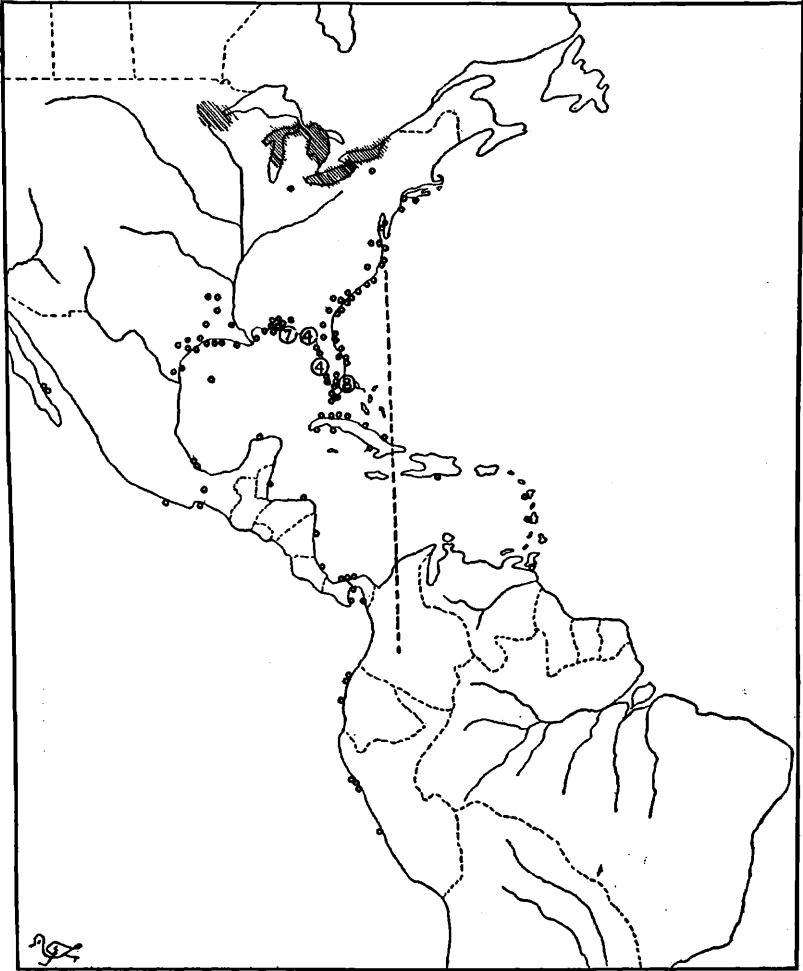


Figure 2: Atlantic unit recoveries. The shaded area is the breeding grounds where the banding was done. Individual recoveries are shown by single small circles; where recoveries are too concentrated to be shown individually, the totals are shown in the larger numbered circles.

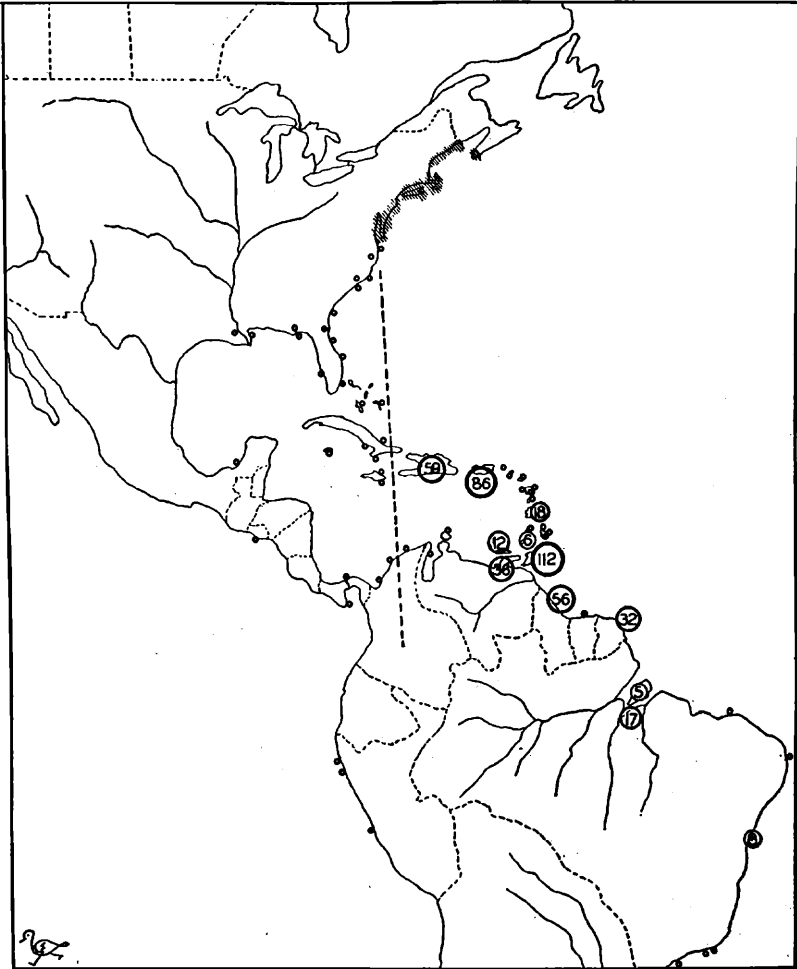


Figure 3: Central unit recoveries. The shaded area is the breeding grounds where the banding was done. Individual recoveries are shown by single small circles; where recoveries are too concentrated to be shown individually, the totals are shown in the larger numbered circles.

the shore line, strung out in long lines, and fishing as they go. Promontories become resting places, but even there large flocks are unusual. This is during daylight; what occurs at night is not known. On the return northward, in contrast, action is concerted; large aggregations are the rule; there is no loitering along shore lines. In fact the few credible observations available suggest that there may be even some direct over-water flight from wintering ground to nesting site. In the Cape group, the trend is for the larger part of a colony to make the initial descent on its nesting site in a body; Palmer (1941: 39) records similar descents elsewhere.

The recoveries show that there are three major routes, and possibly a fourth of minor importance, used by the birds going to their wintering grounds; also that group adherence further unites the ten specified groups into three discrete units, each unit using a different one of the routes and occupying in a general way some particular part of the entire wintering grounds. The first unit consists of the six Atlantic groups; the second comprises the three Great Lakes groups; the third is the far Northwest group. This concept is not invalidated by the fact that, for a short distance in the middle of each, the first and second routes are over the same territory.

For the Atlantic coast unit, consisting of the six groups which breed somewhat continuously from Nova Scotia to the Carolinas, there are 578 recoveries. Even though 489 or 85 percent of them were of birds from the adjoining Cape Cod and Martha's Vineyard groups, the recoveries from the other Atlantic groups are sufficient to show they use the same migration route and wintering ground. While nesting the groups maintain strict isolation until post-nuptial wandering and early migration begin to mingle their memberships. As migration advances, coalescence increases until distributionally all six become a single population.

Table 5 shows where the 578 recoveries were made. They alone indicate the migration route, but Figure 2 on which the numbers of birds taken in each place are shown demonstrates it far more convincingly. Not shown on the map are the concentrations of early recoveries along the coast from Rhode Island to Maryland, which show the migrants follow the coast line as far south as Cape May or Cape Hatteras. South of this point it is of particular significance to note that only 33, or 5 percent, of the recoveries lie to the westward of the line drawn from Cape Hatteras through eastern Cuba to Colombia. These are simply the inevitable non-conformists, for 95 percent of the Atlantic unit migrants apparently fly over the ocean, by-passing all but the eastern tip of Cuba, and cross the West Indies to the north coast of South America. This is indicated by the pronounced concentrations of recoveries in Hispaniola, Puerto Rico, Trinidad and adjacent Venezuela, two of the Guianas, and at the mouth of the Amazon River.

With the exception of short flights of 20 to 75 miles across Long Island and some of the larger West Indies, it is entirely a water route, for which the species has shown a preference in other ways. There is no evidence for or against some birds making a direct transoceanic flight from a nesting site to the West Indies and even so far as to southern Brazil.

TABLE 5

DISTRIBUTION OF THE ATLANTIC UNIT RECOVERIES			
UNITED STATES		WEST INDIES	
Rhode Island and Connecticut	29	Bahamas	2
Long Island and New York	27	Cuba	3
New Jersey	18	Cayman I.	1
Maryland	3	Jamaica	2
Delaware	2	Hispaniola	59
Virginia	2	Puerto Rico	86
North Carolina	3	Virgin Is.	3
South Carolina	1	St. Kitts	1
Florida	6	Guadeloupe	3
Alabama	1	Martinique	18
Louisiana	2	St. Lucia	1
	94	Barbados	3
		Grenada	6
		Trinidad	112
		Aruba	1
			301
SOUTH AMERICA		CENTRAL AMERICA	
Margarita I.	12	Mexico	1
Venezuela	36	San Salvador	1
British Guiana	56	Panama	2
Dutch Guiana	1		
French Guiana	32		
Brazil	35		
Colombia	4		
Peru	3		
	179		4

The exact time of the start of migration is not known, for post-nuptial wandering invalidates all early recoveries within a reasonable distance of the colonies. In the Cape group the time of the break-up of the colonies varies according to the success of the nesting. In years of extensive or late re-nesting, as in 1944 and 1949, the larger part of some colonies were still on their nests the end of July. In 1951 the early first laying was so successful and chick mortality so unprecedentedly trivial that by the end of the first week in July most of the birds were out of the nesting territory. Adults which have matured no chicks may possibly leave even earlier. Also, the dates of a bird's arrival and recovery in a locality are not necessarily identical. Other findings could be added to justify further the arbitrary but necessary assumption that any bird found after July first 100 miles or more from its colony in the direction of the wintering grounds is migrating. The earliest recoveries of Cape bandings are shown in table 6:

TABLE 6

EARLY RECOVERIES OF CAPE GROUP TERNS			
WHERE RECOVERED	AGE AT BANDING	DATE BANDED	DATE RECOVERED
Rhode Island	Juv	2 Jul 33	12 Jul 33
" "	Juv	4 Jul 36	22 Jul 36
New York	Ad	15 Jun 50	30 Jun 50
" "	Juv	2 Jul 33	5 Jul 33
New Jersey	Juv	7 Jul 30	23 Aug 30
Delaware	Juv	8 Jul 39	10 Sep 39
Maryland	Juv	15 Jul 39	23 Aug 39
Virginia	Juv	6 Jul 34	23 Sep 34
North Carolina	Juv	28 Jun 35	8 Sep 35

TABLE 6 (CONTINUED)

EARLY RECOVERIES OF CAPE GROUP TERNS			
WHERE RECOVERED	AGE AT BANDING	DATE BANDED	DATE RECOVERED
Florida	Juv	27 Jun 32	11 Sep 32
Cuba	Juv	2 Jul 33	8 Sep 33
Puerto Rico	Juv	8 Jul 42	30 Aug 42
Hispaniola	Juv	23 Jun 33	17 Aug 33
"	Ad	20 Jun 47	29 Aug 47
Martinique	Ad	12 Jun 42	5 Aug 42
Grenada	Juv	1 Jul 44	6 Sep 44
Panama	Juv	1 Jul 46	13 Sep 46
Aruba	Juv	2 Jul 33	8 Sep 33
Trinidad	Juv	6 Jul 36	15 Sep 36

The progress of the migration southward can be determined best by dividing the entire territory in which the recoveries were made into latitudinal zones, in each of which the recoveries are concentrated at some given time yearly. Table 7 shows the number of recoveries each month in the several zones:

TABLE 7

ZONE	MONTH AND ZONE DISTRIBUTION OF ATLANTIC UNIT RECOVERIES												TOTAL	
	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN		
Atlantic Coast north of Cape May	19	24	13	5	2						2	5	4	74
Atlantic Coast south of Cape May	2	2	9		3							1		17
Northern West Indies	1	6	60	67	10	7	3						4	158
Southern West Indies, Trinidad, Col., Venez.		9	16	20	26	9	10	23	11	25	18	13		180
Guianas to mouth of the Amazon			2	5	14	13	24	16	10	8	1	1		94
Brazil, mouth of the Amazon and southward	1		1		6	8	7	7	5	1	3	2		41
Mexico and Central America				1	2							1		4
Not included:														
Alabama 1; Louisiana 2; Colombia 4; Peru 3														10
														Total: 578

It appears that, after discarding probably precocious or belated birds, the migrants are usually found in each zone at the following times:

- North Atlantic Coast—early July through the first week in September
- South Atlantic Coast—July through the second week in September
- Northern West Indies—first week of August through first week of December
- Southern West Indies—mid-September through May
- Northern S. America—November to April
- Southern S. America—late November to March

Further, Table 8 shows that high percentages of recoveries were made during short periods in some zones:

TABLE 8

ZONE	TOTAL REC.	INTERVAL OF TIME	NO. OF	
			REC.	PERCENT
North Atlantic Coast	74	July to September	56	75
South Atlantic Coast	17	August and September	11	64
North West Indies	158	September and October	127	80

Thus the mid-peak of these concentrations is seen to be on the north Atlantic coast in August, on the south Atlantic coast in September, in the northern West Indies in October, and from the southern West Indies southward from November to April. This suggests that in a period of about three months the population of the Atlantic Coast unit has moved from its breeding to its wintering range. Of course this does not necessarily apply to individual birds, and there are no data to suggest the average time an individual spends in transit. However, it appears that the Atlantic unit population tends overwhelmingly to winter in the southern West Indies and coastal northeastern South America; that most of the 127 recoveries in the northern West Indies were still migrating; and that recoveries elsewhere would be designated "uncommon" or "casual" were a regional status list being made.

An instructive picture of the behavior of the Atlantic population can be presented best by stating what these birds do, and where, throughout the year, by discarding the indefinite terms wintering and its compounds, and by considering migration an act of varying beginning and ending. From early May until early September they are breeding on the United States coast between Canada and the Carolinas. Early in July, when each has completed its nesting, the birds start on a leisurely journey southward along a narrow route which runs almost in a straight line down the coast to the Virginia Capes, across the West Indies to the northeast coast of South America. Some birds continue on southward as far as lower Brazil. At Cape May, New Jersey, about midway between Maine and Cape Hatteras, the peak number of birds passes through about the end of August; all have gone on by mid-November. At Cape Hatteras the peak occurs in mid-September; none remains after the end of November. In the northern West Indies the large majority pass through during September and October; by mid-December all have gone on except the few that will remain until spring. Birds begin to arrive in northern South America in early September and reach a peak on the first of November which remains almost constant until the end of February. From March first until the end of June there is a gradual decrease in the number of birds as the return journey to the nesting grounds progresses. This is made in reverse along the same route, but far more rapidly and concertedly, with a minimum of stopovers and delays.

The Central unit, consisting of the three groups which breed in the north center of the continent in the Great Lakes area, has its own migration route and preferred part of the wintering ground. They overlap somewhat those of the Atlantic Coast unit, and are less closely

Lakes at the start of the ice recession was not through the St. Lawrence as at present, but across the Appalachians in the vicinity of the Hudson and Delaware rivers. The Great Lakes breeding area was probably populated by birds reaching it via this waterway from the same wintering grounds they occupy today. Despite the slow geological and geographical changes of subsequent time, the offspring of the early Great Lakes terns have followed the same itinerary generation after generation ever since.

The three groups constituting this large Central unit differ somewhat as populations in their use of the migration route and winter grounds (see Table 9). Of the 33 recoveries from the eastern Great Lakes group which travels the route already delineated, 23 were concentrated in a region 800 miles square, its center being the center of the Gulf of Mexico; one-third of the others were in the West Indies east of mid-Cuba where there was only one other recovery from all the three groups. These findings indicated that this eastern group tends to winter west of the central group birds. However, this does not indicate infidelity to group adherence any more than does a group's colonies nesting on different sites.

The central Great Lakes group travels the same route and tends to occupy the center, longitudinally, of the wintering range. Eighty percent of the recoveries of its numbers were made between parallel lines, one extending from the west border of Lake Michigan through the west end of Florida, the other running past the Carolina Capes through the middle of Cuba and just inside the west coast of South America. None were made east of this area in either the West Indies or South America, yet two birds of the year strayed far west to the Gulf of California. This group winters definitely east of the eastern Great Lakes group.

The group immediately west of the Great Lakes is very much smaller than the other two, and its colonies are farther apart. This results in less well coordinated behavior. The recoveries of its members have been widely scattered on the outskirts of the usual migration route and the wintering grounds — Long Island, N. Y., Martinique in the southeast West Indies, Ecuador, the southwest coast of Mexico, and even in the Gulf of California. If a line is drawn southward from Lake Michigan through the middle of the Gulf of Mexico it is seen that while 18 birds from this group were recovered east of it, 12 were taken to the west. The 18 indicate that two-thirds of this group migrate via the Atlantic coast. But the other, of which one-half were taken in northeastern Texas and adjacent Oklahoma, suggest that there may be a secondary migration route across the great plains west of the Mississippi River used by some of these western birds.

There is a small group of colonies in the far northwest, from Montana and the Dakotas northwestward into adjacent Canada. Very little is known of their numbers, locations, and sizes, and only a few of their terns have been banded. Nevertheless, three banded in Alberta have been recovered on the Pacific coast, two in California, and one in Peru. The only credible inference is the existence of a migration route crossing the Rockies and following southward along the Pacific coast.

Although the several concepts expressed appear to be those most warranted by the data, most of them are tentative. Certainly it is venturesome to infer from a mere three recoveries the existence of a Pacific coast migration route. The most likely source of error is the predominance of juvenile-banded recoveries. This does not apply to the Cape group where probably one-third of the living adults carry bands and an average of two-thirds of the young are banded yearly; but elsewhere the coverage, rather sporadic and superficial, has by-passed the adults. Assuredly the efforts of this Station to make knowledge of the Common Tern more extensive and always correct can succeed only when it has been supplemented by the duplicating work of other banders elsewhere, by banding chicks particularly in the many colonies that have yet to be banded, and more than all else by trapping the adults. Repeatedly in this study group adherence and site tenacity have provided the most acceptable explanations for what the data have indicated. This gives additional support to the opinion that the two trends are of maximum importance in the Common Tern's behavior pattern, and even to the welfare of the species.

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**THE RECORDING OF DIURNAL ACTIVITY PATTERNS
IN CAGED BIRDS***

By DONALD S. FARNER and L. R. MEWALDT

INTRODUCTION

The recording of activity of caged birds may be a useful tool in a variety of problems in avian physiology and psychology. Thus far, however, primary attention has been directed toward the investigation of *Zugunruhe*, the nocturnal activity of caged nocturnal migrants during the migratory season. This phenomenon has been known for more than a century, the early published records having been summarized by von Homeyer (1881) and Wachs (1926). Apparently *Zugunruhe* was first investigated quantitatively by Wagner (1930) with five passerine species

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