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MIGRATION AND WINTER QUARTERS OF NORTH AMERICAN ROSEATE TERNS AS SHOWN BY BANDING RECOVERIES

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This paper presents an analysis of recoveries and returns of Roseate Terns (*Sterna dougallii*) banded in northeastern North America and the Caribbean, and uses them to describe migration patterns and winter quarters of these populations. Data are also presented on seasonal occurrence, age at first breeding, and longevity. Hamilton (1981) summarized recoveries of Roseate Terns banded since 1966 at Great Gull Island, New York, and reported a concentration of recoveries in eastern Guyana. This paper places these findings in a wider perspective by pooling Hamilton's records with those from other sites in northeastern North America, including data on Roseate Terns banded prior to 1966. The data are also compared with results of Roseate Tern banding in Europe (Langham 1971, Mead 1978, Dunn and Mead 1982).

Roseate Terns breed in 2 discrete areas in the Western Hemisphere: along the Atlantic coast from Long Island to Nova Scotia, and around the Caribbean chain from the Florida Keys and the Bahamas to the Netherlands Lesser Antilles (Bent 1921, Bond 1956, Nisbet 1980). Roseate Terns from both areas winter in northern South America, but live birds have rarely been encountered there by ornithologists (Murphy 1936, Snyder 1966, Spaans 1978). Although banding recoveries are subject to bias, they provide the only useful information about the winter quarters of this species. Field observations are used in this paper primarily to help define the migration patterns and seasonal status of the populations.

This paper is based on 1185 recoveries and returns of Roseate Terns reported to the Bird Banding Laboratory through August 1979. For all recoveries and returns that were unusual in location or time, I checked the original recovery reports in the Bird Banding Laboratory. By this means I identified and corrected several erroneous recoveries that have appeared in earlier tabulations (Davis 1979, Nisbet 1980, 1981). The remaining recoveries are consistent with the information reported by the banders and finders and are included in this paper, but errors in this information are possible. Except for birds retrapped at breeding colonies, very few recoveries have been verified by ornithologists. Unusual records that have not been verified are pointed out in the text.

MIGRATION AND WINTER QUARTERS OF THE NORTHEASTERN POPULATION

Breeding distribution and phenology.—Roseate Terns have a limited breeding distribution in northeastern North America, extending along the Atlantic coast from New Jersey to Nova Scotia; most nest between central Long Island, New York, and Cape Cod, Massachusetts (Bent 1921, Nisbet 1980). They arrive in the breeding area in early May (exceptionally as early as 26 April) and lay eggs between 25 May and 15 July (extremes 12 May and 25 July). After breeding, they disperse throughout the breeding area and depart southwards in late August and early September; only stragglers remain into October and early November (Bailey 1955, 1968, Griscom and Snyder 1955, Hill 1965, Palmer 1949, Bull 1974, Nisbet 1980, 1981).

Compilation of banding recoveries.—Through December 1978, about 104,000 Roseate Terns had been banded in northeastern North America, and 1182 had been recovered through August 1979 (Table 1). Of these recoveries, 139 were of birds banded as chicks and reported in the year of banding (for dates see Table 2), either at the place of banding or within the same 10′ × 10′ block. Most probably died before or soon after fledging and these recoveries are not discussed further here. The remaining 1043 recoveries are divided into 4 groups for analysis: (1) 123 birds banded as chicks or as breeding adults were recovered between New Jersey and New Brunswick during post-breeding dispersal between 13 July and 15 October in the year of banding (Table 2). (2) Another 357 birds have been reported in the Caribbean or in the winter quarters in northern South America (Tables 3, 4; Fig. 1). (3) Twenty birds banded as chicks were recovered either at sea (Table 5) or at localities outside the normal breeding, migration or wintering areas (Table 6). These appear to include birds recovered on migration, birds summering outside the normal breeding area, and perhaps vagrants. They may also include some errors in reporting or processing, since none of these records has been verified individually. (4) 543 birds banded as chicks or as breeding adults were recovered in the breeding area in years subsequent to the year of banding (Table 7). Most of these records reflect return of birds to breed and/or dispersion between breeding colonies.

Post-breeding dispersal.—Recoveries between mid-July and mid-September (123) indicate a general dispersal of juveniles and adults throughout the breeding area and into neighboring states and provinces (New Jersey, western Long Island, Rhode Island, New Hampshire, New Brunswick). The earliest recovery outside the state of banding is 29 July, but I have seen color-banded juveniles from Great Gull Island, N.Y., in the company of their parents in eastern Massachusetts as early as 19 July. At this period concentrations of up to 5000 Roseate Terns have been reported near good feeding areas, such as Moriches Inlet, Shinnecock Inlet, and Montauk Point on Long Island, and Nantucket, Monomoy, Nauset, and Provincetown, Massachusetts (Bailey 1955, 1968, Griscom and Snyder 1955, Hill 1965, P. Buckley and B. Nikula, pers. comm.).

TABLE 1. Numbers of Roseate Terns banded in northeastern North America and recovered through August, 1979.

State or province of banding	No. banded			No. recovered				
	1922–1957	1958–1978	Total	In state of banding	Elsewhere in northeast[a]	In wintering area[b]	In other areas[c]	Total
Nova Scotia	—	96	96	—	—	—	—	—
Maine	—	395	395	2	1	1	—	4
Massachusetts	86,469[d]	3,885	90,354	561	34	199	11	805
Connecticut	1,060[d]	405	1,465	—	3	4	1	8
New York	50[d]	11,376	11,426	180	24	153	8	365
Total	87,579[d]	16,157	103,736	743	62	357	20	1182

[a] Between New Jersey and New Brunswick.
[b] In West Indies or northern South America.
[c] See Tables 5 and 6.
[d] These totals have been compiled from the MS notebooks of O. L. Austin, Sr., and records of other banders in the files of the Bird Banding Laboratory. Austin and C. B. Floyd banded 3202 adult Roseate Terns and 74,954 chicks in Massachusetts between 1922 and 1957; I have traced records of 30 adults and 9443 chicks banded by other banders. Although I may have missed records of a few banded birds, this compilation includes the data of all banders whose birds were recovered.

Although most recoveries have been in the state of banding throughout the autumn (Table 2), some indicate dispersal up to 300 km along the coast, e.g., from eastern Connecticut and eastern Long Island to eastern Massachusetts and vice versa. The longest recorded movements at this season are from Maine to Rhode Island (390 km SSW), and from Massachusetts to southern Long Island (410 km WSW), New Jersey (570 km WSW), New Brunswick (750 km NE), and Newfoundland (1430 km ENE; Table 6). None of these longer distance recoveries has been verified individually.

Autumn migration.—The frequency of recoveries in the breeding area drops off sharply after 15 September and only 5 or 6 recoveries have been reported in October, the latest being on 15 October. (It is possible that some of these were of birds which had died earlier.) Sight records also indicate that most Roseate Terns leave New York and New England waters by mid-September, and that only stragglers are left after 1 October (Bailey 1955, 1968, Griscom and Snyder 1955, Hill 1965, Bull 1974, R. Forster and B. Nikula, pers. comm.).

Few Roseate Terns have been recovered during autumn migration. Ten birds have been reported at sea, including 4 in September in the North Atlantic Ocean south and southwest of Bermuda (Table 5). Roseate Terns have not been reported on autumn migration at Bermuda (Wingate 1973), and are rare migrants on the U.S. coast south of New Jersey (Stone 1937, Stewart and Robbins 1958, Murray 1952, Pearson et al. 1942, Mack 1969, Soots and Parnell 1975, Sprunt and Chamberlain

TABLE 2. Temporal distribution of recoveries of northeastern juvenile Roseate Terns within the breeding area in the year of hatching.

	13–22 July	23 July–1 Aug.	2–11 Aug.	12–21 Aug.	22–31 Aug.	1–10 Sept.	11–20 Sept.	21–30 Sept.	1–10 Oct.	11–20 Oct.	No date	Total
At locality of banding	12	11	86	3	4	17	—	—	—	—	6	139
Within same state	6	13	19	17	12	14	7	1	2	1	6	98
In another state or province	—	4	3	6	2	4	2	1	2	1	—	25

TABLE 3. Distribution of 357 recoveries of northeastern Roseate Terns in the West Indies and South America.

Area and country of recovery	Number recovered						
	1927–1936	1937–1946	1947–1956	1957–1966	1967–1976	1977–1979	Total
Greater Antilles (51 recoveries)							
Cuba	—	3	1	1	—	—	5
Jamaica	—	—	—	—	1	—	1
Haiti	—	—	2	—	—	—	2
Dominican Republic	2	3	5	1	3	—	14
Puerto Rico	12	7	7	2	1	—	29
Lesser Antilles (12 recoveries)							
St. Kitts	—	—	1	—	—	—	1
Dominica	1	—	—	—	1	—	2
Martinique	—	—	3	1	—	—	4
Barbados	—	—	1	—	—	1	2
Unspecified[a]	—	1	1	—	1	—	3
South America (294 recoveries)							
Colombia	1	1	—	1	4	1	8
Venezuela	1	3	—	—	1	—	5
Trinidad	4	5	5	1	3	—	18
Guyana[b]	1	6	20	4	193	23	247
French Guiana	—	—	—	—	—	1	1
Brazil	—	3	4	1	5	2	15

[a] May include birds from Trinidad.

[b] Several of these records were from the Corentyne River on the boundary between Guyana and Suriname, but the recoveries from Suriname included in previous tabulations (Davis 1979, Nisbet 1980) proved to be erroneous.

1949, Burleigh 1958, Sprunt 1954). However, R. van Halewijn (pers. comm.) made 16 sightings of up to 30 birds at sea in the eastern and southeastern Caribbean between 7 September and 24 October 1970–1972. These data suggest that most Roseate Terns migrate south across the western part of the North Atlantic Ocean and the eastern Caribbean Sea. During September and October single Roseate Terns have been recovered in Florida, western Cuba, and Nicaragua (Table 6); these records are at the western fringe of the migration route (see Fig. 1) and may represent stragglers or vagrants.

Table 4 summarizes the temporal distribution of recoveries in the West Indies and South America. Juvenile Roseate Terns begin to arrive in the West Indies in late August (18 and 30 August, Dominican Republic; 27 August, Puerto Rico). Most records of juveniles and adults in the West Indies have been in September and October, with stragglers thereafter (adult, 9 November, Barbados; juvenile, 17 November, Dominica; 3-year-old, 29 November, Puerto Rico). In northern South America and in Trinidad, most records of adults and juveniles have been after 1 October, but there are 2 August records (adults, 27 and 30 August,

TABLE 4. Distribution of 357 recoveries of northeastern Roseate Terns in the West Indies and South America according to age at recovery.

Area of recovery	First autumn			First winter Nov.–Apr.	First summer May–Sept.	Second winter Oct.–Apr.	Second summer May–Sept.	Third winter Oct.–Apr.	Third summer May–Sept.	Subsequent winters[a] Oct.–Apr.	Subsequent summers[a] May–Sept.	Total
	Aug.	Sept.	Oct.									
Cuba & Jamaica		2	3							1		6
Haiti & Dominican Rep.	3	8	3	1			1					16
Puerto Rico	1	18	7				1	1	1			29
Lesser Antilles		2	4	1	1					1		9
Unspecified[b]				1	1					1		3
W. Indies total	4	30	17	3	2		2	1	1	3		63
Colombia			4	2		1				1		8
Venezuela		2	1			1				1		5
Trinidad			1	8	5	1	2			1		18
Guyana	1[c]	7	41	89	5	13	5	17	2	55	12[c]	247
French Guiana										1		1
Brazil				5	4	1			2	3		15
S. America total	1[c]	9	47	104	14	17	7	17	4	62	12[c]	294

[a] Including all birds banded as adults.
[b] May include birds from Trinidad.
[c] Dates of recovery questionable: see text.

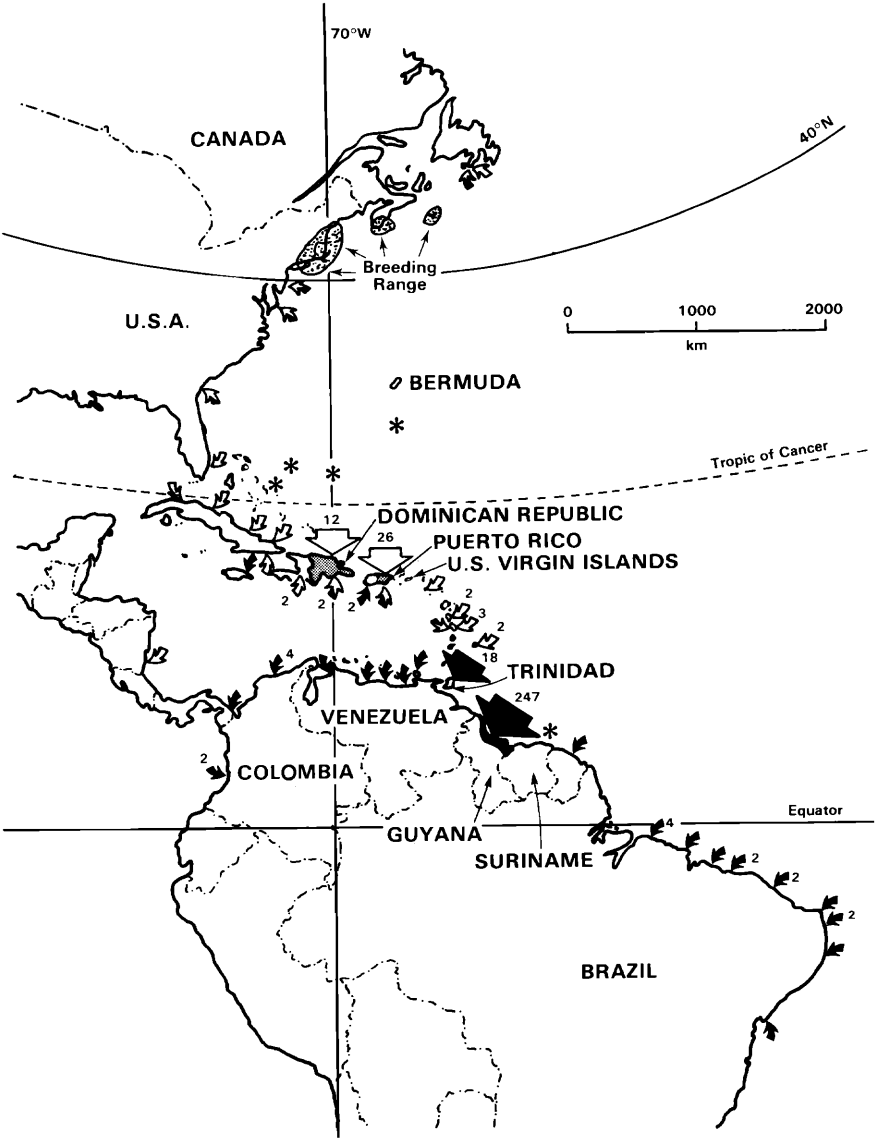

FIGURE 1. Locations of recoveries of Roseate Terns banded in northeastern North America. The stippled area denotes the breeding range. Stars: recoveries at sea (Table 5). Open arrows: recoveries in autumn (18 August–17 November) outside breeding or wintering areas. Solid arrows: recoveries in the wintering range (South America and Trinidad), including recoveries in the first autumn and subsequent summers, and winter recoveries in the West Indies. Black-and-white arrows: recoveries in the first or second summer outside the breeding and wintering ranges. A few recoveries without precise co-ordinates are omitted.

TABLE 5. Recoveries of banded Roseate Terns at sea in the North Atlantic Ocean.[a]

Band no.	Date and locality of banding		Date and locality of recovery	
363-46019	30 June 1937	Ram Is., Mass. 41°37′N, 70°48′W	26 June 1938	ca. 130 km N of Paramaribo ca. 06°50′N, 54°50′W
483-18579	24 June 1949	Bird Is., Mass. 41°40′N, 70°43′W	— Sep. 1949	ca. 250 km S of Bermuda 29°54′N, 64°40′W
523-01286	1 July 1952	Ram Is., Mass. 41°37′N, 70°48′W	29 Sep. 1952	ca. 500 km NE of Mayaguana Is. 26°04′N, 70°07′W
543-42180	16 July 1953	Bird Is., Mass. 41°40′N, 70°43′W	14 Sep. 1953	ca. 250 km NE of Eleuthera Is. 26°30′N, 74°20′W
553-90599	9 July 1954	Bird Is., Mass. 41°40′N, 70°43′W	7 Sep. 1954	60 km N of San Salvador Is. 24°50′N, 74°27′W

[a] Seven other banded Roseate Terns have been reported as recovered at sea at unspecified locations: of these recoveries 1 was in May, 1 in September, and 5 in "fall." Three other recoveries at sea but close to shore have been included with the recoveries for the corresponding coastal region.

TABLE 6. Recoveries of banded Roseate Terns outside normal breeding or wintering areas.

Band no.	Date and locality of banding		Date and locality of recovery	
23-43200	4 July 1929	Ram Is., Mass. 41°37′N, 70°48′W	28 July 1931	Lamaline, Nfld. 46°50′N, 55°40′W
353-14924	6 July 1935	Tern Is., Mass. 41°41′N, 69°57′W	ca. 5 Oct. 1935	Nr. Lawn, Nfld. 46°50′N, 55°30′W
523-03275	3 July 1952	Bird Is., Mass. 41°40′N, 70°43′W	14 Sep. 1952	Pompano Beach, Fla. 26°10′N, 80°00′W
543-37745	6 July 1953	Ram Is., Mass. 41°37′N, 70°48′W	(Sep. 1954)[a]	Everett City, Ga. 31°20′N, 81°40′W
553-90431	9 July 1954	Bird Is., Mass. 41°40′N, 70°43′W	1 Aug. 1957	Nr. Aurora, Ind. 39°00′N, 84°50′W
563-64095	29 July 1955	Tern Is., Mass. 41°41′N, 69°57′W	10 Oct. 1955	Great Corn Is., Nicaragua 12°00′N, 83°40′W
963-40720	9 July 1966	Great Gull Is., N.Y. 41°12′N, 72°07′W	2 July 1968	Assateague Is., Maryland 38°10′N, 75°00′W
752-90510	26 July 1971	Great Gull Is., N.Y. 41°12′N, 72°07′W	30 Apr. 1978	Gatesville, N. Carolina 36°20′N, 76°40′W

[a] Only bones found.

both in Guyana) and 15 September records (7 juveniles and 8 adults, mostly in Guyana). By the first week in October recoveries indicate that Roseate Terns are distributed along the north coast of South America west to Colombia, although there are no records in Brazil prior to November.

Summer records.—There is little evidence of northward migration in the first summer (second calendar year of life). A bird banded as a chick in New York was reported in the Dominican Republic the following April, and a bird banded as a chick in Massachusetts was reported in Martinique in August of the following year. Another bird banded as a chick in Massachusetts was reported dead in Georgia in September of the next year, but this bird may have died in the year of banding (see footnote to Table 6). None of these records has been verified specifically. Another bird banded in Massachusetts as a chick was found dead at the same place a year later, but this bird may have died in the year of banding. I have found no published records of Roseate Terns in first-year plumage ("*portlandica*" phase) in the breeding area, and I am aware of only 2 or 3 unpublished (but uncertain) sight records. At least 14 Roseate Terns have been recovered in South America or Trinidad in their first summers (Table 4) and another was recovered at sea off Suriname (Table 5). It appears that most spend their first summers in the winter quarters. Hamilton (1981) reported few recoveries of birds from Great Gull Island in Guyana in their second year of life, but the full data set shows no shortfall at this period (Table 4).

In their second summers (third calendar year of life), only 7 banded Roseate Terns have been reported in South America (Table 4). Two have been reported in the West Indies (19 June, Puerto Rico; 17 August, Dominican Republic) and 3 in non-breeding areas (2 July, Maryland; 15 July, New Jersey; 28 July, Newfoundland; see Table 6). In addition, 13 2-year-old Roseate Terns have been recovered in the breeding area, but only 6 of these were at breeding colonies and only 5 of these are known to have been breeding (Donaldson 1971; H. Hays pers. comm.). Thus it appears that some Roseate Terns migrate north in their second summers, but that not all of them reach the breeding colonies and few attempt to breed.

In their third summers, at least 66 banded Roseate Terns have been reported in the breeding areas, including many that were breeding when retrapped (Austin, MS notebooks; Harlow 1971). At this season, 4 birds have been reported in the winter quarters (18 May and 2 June, Brazil; 2 birds on 6 June, Guyana), but the records from Guyana are questionable (see below) and the records from Brazil have not been verified. It appears that many, if not most, Roseate Terns migrate north to the breeding area in their third year of life and that many breed.

In subsequent summers (after the third year of life) almost all the recoveries of Roseate Terns have been in the breeding area. Most of these records have been of birds retrapped on nests in New York or Massachusetts. Two older birds were reported in Guyana in June and

July 1977, but these and other recoveries in June–September 1977 are questionable because the recoveries were not reported until October and the dates were supplied later. Some older birds have been reported in Guyana in late August and September in other years, but these probably represented normal autumn migration (see above).

Spring migration.—Few recoveries indicate the timing or routes of spring migration. In addition to the May and June records in South America mentioned above, several birds have been recovered there in April, including individuals in their third and fourth springs (24 and 26 April, Guyana). No spring recoveries have been reported from the West Indies, but a 7-year-old bird was recovered in North Carolina on 30 April (Table 6). Seven sight records have been reported in South and North Carolina between 29 March and 23 May, mostly between 16 April and 14 May (Mack 1969, Soots and Parnell 1975). Since Roseate Terns usually start to arrive in their breeding areas in the first week of May, these data suggest that spring migration takes place rapidly in late April and early May.

Winter quarters.—The main winter quarters of Roseate Terns are along the northern coasts of South America, extending in the west from the Pacific coast of Colombia at 2°40′N (2 records from Isla Gorgona, one verified by color-banding: Hays 1971) to eastern Brazil. Fifteen birds have been recovered south of the Equator in Brazil, extending to 12°50′S at Salvador. Most South American recoveries have been from Guyana (Table 3), but this reflects local trapping and reporting behavior (see below). Except in Trinidad, which is part of the main wintering area (with 10–12 winter records), there is little evidence to indicate that northeastern Roseate Terns winter in the West Indies. The only records later than mid-November have been of single birds in Puerto Rico (29 November), Jamaica (letter dated 20 December), and Puerto Rico (20 February). It is not clear that any of these records was of a freshly-dead bird.

Recovery data provide limited information about the micro-distribution of Roseate Terns within the wintering area. In Guyana, most recoveries have been from a limited area along the northeast coast. P. Trull (pers. comm.), who visited this area in October 1980 and February 1982, reports that Roseate Terns are caught at night while roosting on offshore mudbanks. Trull did not observe Roseate Terns by day, despite an extensive search along the coasts of eastern Guyana and western Suriname. This suggests that they feed offshore and come to land primarily at night. Limited support for this is provided by one recovery on a ship 130 km off Suriname (Table 5), another recovery on a ship an unspecified distance off the coast of Colombia, and a record of a flock at sea off the coast of Brazil (Murphy 1936). However, several records in Guyana, Colombia, and Brazil have been of birds found dead or dying along the shore.

Change in recovery pattern.—The most striking feature of Table 3 is the marked change in the distribution of recoveries since 1966. Prior

to 1967, 60% (70/116) of the recoveries were in the West Indies (including Trinidad). Since 1966, 95% (230/241) of the recoveries have been in South America, of which 90% (216/241) were in Guyana. At the same time the recovery rate in the winter quarters has increased markedly. Only 109 of the 87,579 birds (.12%) banded in the period 1922–1957 were recovered in the West Indies or South America, whereas 248 of the 16,157 birds (1.53%) banded since 1958 have been recovered there. The difference was primarily due to an upsurge in recoveries from Guyana (217/16,157 versus 30/87,579; $P < .0001$, χ^2-test), but there were also significant increases in the frequency of recoveries from Colombia (6/16,157 versus 2/87,579; $P < .001$) and Brazil (8/16,157 versus 7/87,579; $P < .01$). There was a non-significant decrease in the frequency of recoveries from Puerto Rico (2/16,157 versus 27/87,579; $P = .10$, Fisher exact test), and a marginally significant increase in areas other than Guyana, Colombia, Brazil and Puerto Rico (15/16,157 versus 43/87,579; $P = .05$). The increase in the frequency of recoveries from Guyana appears to have started abruptly in the autumn of 1968: only 1 of 3336 birds banded between 1960 and 1967 was recovered in Guyana prior to October 1968.

A simultaneous change has taken place in the proportion of adults among the birds recovered in this area. Prior to 1957, most (25/27) of the Roseate Terns recovered in Guyana were in their first year of life, and none was older than 3 years old. Since 1957, however, almost half (101/220) of the birds recovered there have been over one year old, and 31% (68/220) have been over 3 years old.

It is not known whether these changes in recovery pattern reflect changes in numbers recovered, changes in reporting, or both. In Puerto Rico, most birds were reported as shot, and it is possible that the decrease in recoveries reflects a decline in seabird hunting. Most recoveries in Guyana since 1968 have been from a small area on the northeast coast and were reported by a single individual, Balram Pertab, who has trapped these and other terns intensively for sale in the local market since 1968 (Hamilton 1981). According to P. Trull, Pertab stopped reporting bands systematically after about 1977, and claims to have stopped intensive trapping in 1981. According to files in the Bird Banding Laboratory, another trapper in the same village reported 6 banded Roseate Terns in 1953–1955. It is not known whether other individuals trap terns in this area and do not report the bands, but Trull found no evidence of intensive trapping in other coastal villages in 1980 or 1982.

Ages of birds recovered breeding.—Table 7 summarizes the intervals between banding of Roseate Terns in northeastern North America and their return or recovery at breeding colonies in subsequent years. Few birds are known to have survived beyond the age of 11 yr, but the data on longevity are biased because of the lack of systematic trapping at any colony for longer than 10–15 yr (Austin MS), and the likelihood of band loss starting after about 6 yr (Nisbet and Hatch 1983).

Data on birds banded as chicks also provide some useful information

TABLE 7. Intervals between banding of Roseate Terns in northeastern North America and their return or recovery at breeding colonies.

Interval (yr) between banding and return[a]	1	2	3	4	5	6	7	8	9	10	11	12
Banded as adults	89	67	51	35	21	12	7	5	1	1	—	—
Banded as chicks	—	6	53	56	42	20	11	8	4	1	2	1[b]

[a] Most of these records were of birds retrapped on nests, but a few birds found dead at breeding colonies in the breeding season are included. Dates of banding and retrapping range from late May to early August; intervals are given to the nearest year.

[b] A bird previously listed as retrapped at ages 13 and 14 (Nisbet 1981) is omitted from this table because of uncertainty about its specific identity. Another bird was recovered in Jamaica at age 14 years and 5 months, but this recovery could not be verified.

about ages at first breeding (Table 7). A few birds have been retrapped breeding at age 2, and most appear to breed at age 3. However, the fact that more birds banded as chicks have been recovered at age 4 than at age 3, despite intervening mortality, suggests that some do not breed until age 4.

PHENOLOGY AND WINTER QUARTERS OF THE CARIBBEAN POPULATION

The Caribbean population of Roseate Terns nests in scattered colonies from the Dry Tortugas, Florida, and the central Bahamas, through the Greater and Lesser Antilles to Tobago, Los Roques, and the Netherlands Lesser Antilles (Bond 1956, Nisbet 1980). They are present at the breeding colonies from about 18 April until early October, laying between 13 May (once 30 April) and mid-July (Bent 1921, U.S. Virgin Islands Bureau of Fish & Wildlife 1976–1979, Robertson 1964, Nisbet 1981). Roseate Terns are reportedly absent in winter even from the southernmost breeding locations, such as Tobago (Bond 1970) and the Netherlands Lesser Antilles (Voous 1955), although they winter along the coast of Venezuela (Fig. 1) and in Trinidad (Belcher and Smooker 1934, Herklots 1961, Fig. 1).

Through 1978, 610 Roseate Terns had been banded at colonies in the Caribbean, mostly in the U.S. Virgin Islands. Three birds banded as chicks in the U.S. Virgin Islands in 1977 have been recovered: 2 in Guyana in September or October 1977, and the third in Puerto Rico in February 1978. The last date appears questionable in view of data on seasonal distribution summarized above.

DISCUSSION

North American Roseate Terns winter largely or exclusively along the north coast of South America (Fig. 1), from western Colombia at about 3°N to eastern Brazil at about 13°S. The wintering range is more extensive than the breeding range, but is restricted to a narrow latitudinal zone between 11°N and 13°S. There have been few, if any, reliable

winter records from Caribbean islands (other than Trinidad); even birds breeding on islands less than 100 km from the South American mainland appear to migrate south for the winter. This narrow latitudinal range contrasts with that of other terns for which recovery data are available, such as Common Terns (*Sterna hirundo*), which winter between 30°N and 25°S (Austin 1953, Haymes and Blokpoel 1978), or Royal Terns (*Sterna maxima*), which winter between 29°N and 14°S (Van Velzen 1968, Van Velzen and Benedict 1973).

In contrast to other terns (cf. Spaans 1978), Roseate Terns are rarely encountered along the shore in the winter quarters. Fragmentary records, summarized in the text, suggest that they may feed some distance offshore and come to land to roost. This would accord with observations in wintering areas in other parts of the world. In West Africa, Dunn (1981) saw only one Roseate Tern along the shore by day, but reported nocturnal roosts on a breakwater and on salt pans. In East Africa, wintering birds have been reported feeding in association with predatory fish 6–10 km out to sea (Britton and Brown 1974). In northwestern Australia, large numbers of Roseate Terns have been reported at sea and on offshore islands and reefs in winter and spring (Serventy 1952, Abbott 1979).

In September and early October, Roseate Terns from northeastern North America appear to migrate directly across the North Atlantic Ocean from their breeding grounds to the West Indies. At least 4 birds have been recovered on ships at this time (Table 5), but only stragglers have been found along the coast south of New Jersey.

A significant finding in this study is the change in the pattern of winter recoveries, associated with intensive trapping of Roseate Terns for food in a limited area in eastern Guyana. Between 1968 and 1977, about 1.2% (118/10,037) of the Roseate Terns banded as chicks or juveniles in the northeast were recovered in their first year of life in this area. The number of banded adults at risk during this period was about 3800 (2317 banded as adults between 1965 and 1977, plus about 15% of the 9872 chicks banded between 1965 and 1975). Of these, 68 (1.8%) were recovered as adults in Guyana between 1968 and 1977. Thus, Pertab and other trappers in eastern Guyana appear to have trapped about 1% of the juveniles and 2% of the adults banded at this period. Taken alone, this is insufficient to account for the decline of 30–40% in the breeding population during this period (Nisbet 1980). However, these figures demonstrate the impact that one individual trapper can have on a limited population, and hence indicate its vulnerability to systematic trapping in more than a few locations.

Data on European Roseate Terns show remarkably close parallels to those described in this paper. Roseate Terns banded in Great Britain have been recovered in winter in a narrow zone between 0° and 10°N in West Africa (Langham 1971). Birds banded as chicks disperse through the breeding area in July–September, migrate rapidly south in September, spend the first summer in the winter quarters, partially migrate

north at the age of 2, and migrate north to breed at the age of 3 or 4 (Langham 1971). In West Africa, Roseate Terns are rarely seen from shore by day, but come to land to roost (Dunn 1981). Most recent recoveries have been from Ghana, where up to 2.5% of banded birds have been recovered in their first winters (Mead 1978). Intensive trapping on the coast of Ghana has been associated with a rapid population decline in north-western Europe (Dunn 1981, Dunn and Mead 1982). These results and those reported in this paper show that the Roseate Tern, with small regional populations and concentrated winter quarters, is very vulnerable to intensive trapping.

SUMMARY

This paper analyses 1182 returns and recoveries from 104,000 Roseate Terns banded in northeastern North America, 1922–1978. From mid-July to mid-September, adults and juveniles disperse throughout the nesting area and into neighboring states and provinces (New Jersey to New Brunswick). They migrate rapidly south from late August to early October, when a number have been recovered at sea and in the West Indies (Dominican Republic to Trinidad). The winter quarters extend along the north coast of South America from western Colombia to eastern Brazil and are more restricted in latitude (11°N–13°S) than those of other North American terns. Roseate Terns are rarely seen from shore in winter and may feed offshore, roosting on offshore mudbanks. Most or all birds spend their first summer in the winter quarters. Many 2-year-olds migrate north and some breed. Most 3-year-olds migrate north and breed, but some do not breed until 4 years old. Roseate Terns have been recovered at ages of 12 and 14 years, but data on survival and longevity have not been collected systematically.

Roseate Terns also breed around the Caribbean from the Florida Keys and Bahamas to the Netherlands Lesser Antilles. Most or all are migratory, and even birds breeding within 100 km of the mainland of South America migrate south for the winter. Two birds banded in the Virgin Islands have been recovered in their first autumn in Guyana.

Since 1968 the pattern of recoveries has changed markedly. About 1% of banded juveniles and 2% of banded adults have been recovered in a small area in eastern Guyana, mostly by one market trapper. Similar data have been reported for Roseate Terns banded in Europe and trapped in winter in Ghana. This localized species appears especially vulnerable to intensive local trapping in winter quarters.

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LITERATURE CITED

ABBOTT, I. 1979. The distribution and abundance of seabirds at sea and on islands near the mid- and north-western coasts of Australia. Corella 3:93–102.

AUSTIN, O. L. 1927–1957. MS. Unpublished notebooks. Massachusetts Audubon Society, Lincoln, Mass.

———. 1953. The migration of the Common Tern (*Sterna hirundo*) in the Western Hemisphere. Bird-Banding 24:39–55.

BAILEY, W. 1955. Birds in Massachusetts. College Press, South Lancaster, Mass.

———. 1968. Birds of the Cape Cod National Seashore and adjacent areas, Massachusetts. Cape Cod National Seashore, National Park Service, U.S. Dept. of Interior, Wellfleet, Mass.

BELCHER, C., AND G. D. SMOOKER. 1934. Birds of the colony of Trinidad and Tobago. Ibis 4:572–595.

BENT, A. C. 1921. Life histories of North American gulls and terns. U.S. Natl. Mus. Bull. 113:256–264.

BOND, J. 1956. Check-List of the birds of the West Indies. Second ed. Acad. Nat. Sci., Philadephia.

———. 1970. Native and winter resident birds of Tobago. Acad. Nat. Sci., Philadephia.

BRITTON, P. L., AND L. H. BROWN. 1974. The status and breeding behavior of East African Lari. Ostrich 45:63–82.

BULL, J. 1974. Birds of New York State. Doubleday, Garden City, N.Y.

BURLEIGH, T. D. 1958. Georgia birds. Univ. of Oklahoma Press, Norman.

DAVIS, T. H. 1979. Additions to "The Birds of Suriname." Cont. Birdlife 1:136–145.

DONALDSON, G. 1971. Roseate Tern breeds during its second year. Bird-Banding 42: 300.

DUNN, E. 1981. Roseates on a lifeline. Birds 8:42–45.

DUNN, E. K., AND C. J. MEAD. 1982. Relationship between sardine fisheries and recovery rates of ringed terns in West Africa. Seabird Rep. (1977–1981) 6:98–104.

GRISCOM, L., AND D. E. SNYDER. 1955. The birds of Massachusetts. Peabody Museum, Salem, Mass.

HAMILTON, J. 1981. Recoveries of wintering Roseate Terns. J. Field Ornithol. 52: 36–43.

HARLOW, R. A. 1971. Roseate Tern breeds during its third year. Bird-Banding 42:50.

HAYMES, G. T., AND H. BLOKPOEL. 1978. Seasonal distribution and site tenacity of the Great Lakes Common Tern. Bird-Banding 49:142–151.

HAYS, H. 1971. Roseate Tern, *Sterna dougallii,* banded on Atlantic coast recovered on Pacific. Bird-Banding 42:295.

HERKLOTS, G. A. C. 1961. The birds of Trinidad and Tobago. Collins, London.

HILL, N. P. 1965. The birds of Cape Cod, Massachusetts. William Morrow, New York.

LANGHAM, N. P. E. 1971. Seasonal movements of British terns in the Atlantic Ocean. Bird Study 18:155–175.

MACK, B. 1969. The Roseate Tern in the Carolinas. Chat 33:85–87.

MEAD, C. J. 1978. Tern mortality in West Africa as shown by British and Dutch ringing results. Ibis 120:110.

MURPHY, R. C. 1936. Oceanic birds of South America. Vol. II. Am. Mus. Nat. Hist., New York.

MURRAY, J. J. 1952. A check-list of the birds of Virginia. Virginia Soc. Ornithol., Richmond, Va.

NISBET, I. C. T. 1980. Status and trends of the Roseate Tern *Sterna dougallii* in North America and the Caribbean. Unpublished report to U.S. Fish & Wildlife Service. Massachusetts Audubon Society, Lincoln, Mass.

———. 1981. Biological characteristics of the Roseate Tern *Sterna dougallii.* Unpublished report to the U.S. Fish & Wildlife Service. Massachusetts Audubon Society, Lincoln, Mass.

———, AND J. J. HATCH. 1983. Band wear and band loss in Roseate Terns. J. Field Ornithol. 54:90.

PALMER, R. S. 1949. Maine birds. Bull. Mus. Comp. Zool. Harvard Coll. 102.
PEARSON, T. G., C. S. BRIMLEY, AND H. H. BRIMLEY. 1942. Birds of North Carolina. N.C. Dept. Agric., Raleigh.
ROBERTSON, W. B., JR. 1964. The terns of the Dry Tortugas. Bull. Florida State Mus. 8: 1–94.
SERVENTY, D. L. 1952. The bird islands of the Sahul Shelf. Emu 52:33–59.
SNYDER, D. E. 1966. The birds of Guyana. Peabody Mus., Salem, Mass.
SOOTS, R. F., AND J. F. PARNELL. 1975. First record of the Roseate Tern nesting in North Carolina. Chat 39:20–21.
SPAANS, A. L. 1978. Status of terns along the Surinam coast. Bird-Banding 49:66–76.
SPRUNT, A. 1954. Florida Bird Life. Coward McCann, New York.
———, AND E. B. CHAMBERLAIN. 1949. South Carolina bird life. Contributions from the Charleston Museum: XI. Univ. S.C., Columbia, S.C.
STEWART, R. E., AND C. S. ROBBINS. 1958. Birds of Maryland and the District of Columbia. North Am. Fauna 62. U.S. Fish & Wildlife Serv., Washington, D.C.
STONE, W. 1937. Bird studies at old Cape May. Vol. I. Delaware Valley Ornithol. Club, Philadelphia.
U.S. VIRGIN ISLANDS BUREAU OF FISH & WILDLIFE. 1976–1979. Annual performance reports, Virgin Islands Fish and Wildlife Program, 1975–1979. Govt. U.S. Virgin Islands, St. Thomas.
VAN VELZEN, W. T. 1968. The status and dispersal of Virginia Royal Terns. Raven 39: 55–60.
———, AND R. D. BENEDICT. 1973. Recoveries of Royal Terns banded in Virginia. Part II: Central and South America. Ring 75:38–40.
VOOUS, K. H. 1955. De vogels van de Nederlandse Antillen. Curaçao.
WINGATE, D. B. 1973. A checklist and guide to the birds of Bermuda. D. B. Wingate, Hamilton, Bermuda.

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