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A NONBREEDING CONCENTRATION OF ROSEATE AND COMMON TERNs IN BAHIA, BRAZIL

HELEN HAYS

*Great Gull Island Project
American Museum of Natural History
Central Park West at 79th Street
New York, New York 10024 USA*

PEDRO LIMA

*Cetrel S/A Empresa De Protecas Ambiental Do Polo Petrocemico De Camacari
Interligaco Estrada Do Coco Km 9
CEP 42810, 000
Camacari, Bahia, Brazil*

LUIS MONTEIRO

*Department of Oceanography and Fisheries
University of the Azores
9900 Horta, Portugal*

JOSEPH DICOSTANZO

*Great Gull Island Project
American Museum of Natural History
Central Park West at 79th Street
New York, New York 10024 USA*

GRACE CORMONS

*26201 Dennis Road
Parksley, Virginia 23421 USA*

IAN C. T. NISBET

*I. C. T. Nisbet & Company
150 Alder Lane
North Falmouth, Massachusetts 02556 USA*

JORGE E. SALIVA

*Caribbean Field Office
U.S. Fish and Wildlife Service
P.O. Box 491
Boqueron, Puerto Rico 00622 USA*

JEFFREY A. SPENDELOW

USGS Patuxent Wildlife Research Center
11510 American Holly Drive
Laurel, Maryland 20708-4017 USA

JOANNA BURGER

Rutgers University
P.O. Box 1059
Department of Biological Sciences
Piscataway, New Jersey 08855 USA

JUDY PIERCE

Division of Fish and Wildlife
6291 Estate Nazareth 101
St. Thomas, U.S. Virgin Islands 00802 USA

MICHAEL GOCHFELD

Department of Environmental Medicine
Robert Wood Johnson Medical School
Piscataway, New Jersey 08854 USA

Abstract.—We report recoveries of banded Roseate (*Sterna dougallii*) and Common (*S. hirundo*) Terns netted at Mangue Seco, Bahia, Brazil (11°27'S, 37°21'W). Mangue Seco is the first reported South American location where large numbers of Roseate Terns concentrate December–March, and where members of both the North American and Caribbean populations occur together during these months. A Roseate Tern recovered at Mangue Seco sets an age record of 25.6 years for the species. Recoveries at Mangue Seco of Common Terns banded in the Azores (37°–38°N, 25°–29°W) suggest there is a regular transatlantic movement by Common Terns between the two locations.

CONCENTRACIÓN DE INDIVIDUOS DE *STERNA DOUGALLII* Y DE *S. HIRUNDO* EN BAHÍA, BRAZIL

Sinopsis.—Informamos el recobro de individuos anillados de *Sterna dougallii* y de *S. hirundo* en Mangue Seco, Bahia, Brazil. Mangue Seco es la primera localidad suramericana en donde se concentran, en grandes cantidades (de diciembre a marzo), y en donde se pueden encontrar juntos, individuos de *Sterna dougallii* de las poblaciones de Norte América y el Caribe. Un individuo de *S. dougallii*, recobrado en Mangue Seco, establece un registro de longevidad para la especie de 25.6 años. El recobro de individuos de *S. hirundo*, anillados en las Azores, sugiere que hay un movimiento transatlántico regular entre esa localidad y la de Brazil.

In 1986 the Roseate Tern (*Sterna dougallii*) was listed as threatened in Canada (Kirkham and Nettleship 1987), and in 1987 it was listed as endangered in the U.S. and threatened in the Caribbean (U.S. Fish and Wildlife Service 1987). The listing prompted an increase in studies at breeding colonies in the U.S., Puerto Rico and the Virgin Is. However, an important question for management of the species remained unaddressed: where do most Roseate Terns spend the months of January, February, and March? Recoveries of banded birds gave an idea of the timing and routes the species takes as it moves south to its nonbreeding areas (Hamilton 1981, Nisbet 1984) however, there were only two reports of small groups of Roseate Terns seen during the nonbreeding season (U.S. Fish and Wildlife Service 1993, Hays et al. 1997). For the conservation of

Roseate Terns it is critical to know where most spend the nonbreeding season and to determine the factors affecting their survival there. Nonbreeding groups of Common Terns (*S. hirundo*) have been reported from a few localities along the South American coast (Blokpoel et al. 1982, 1984, 1989; Lara Resende and Leal 1982; Erwin et al. 1986; Lara Resende 1988; Cordeiro et al. 1996; Hays et al. 1997). In 1995 Lima discovered a large concentration of Roseate and Common Terns at Mangue Seco on the coast of Bahia, Brazil. This paper reports recoveries from there.

STUDY AREA AND METHODS

Mangue Seco, Bahia, Brazil (11°27'S, 37°21'W) is a sandy point on the south side of the mouth of the Rio Real. At low tide extensive sandbars and mudflats lie west of the point; here Cayenne (*S. [sandvicensis] eurygnatha*), Yellow-billed (*S. superciliaris*), and Least (*S. antillarum*) Terns gather during the day. Roseate and Common Terns come in after dark and leave before first light. Lima's assistant, Sidnei Dos Santos, estimated 10,000 terns roosting in the area in February 1997.

In 1995, 1996, and 1997, Lima and assistants set up mist nets across the point where high tide concentrates the roosting birds. They operated nets on 41 nights during three field seasons: 26–30 Jan. 1995, 23 Feb.–5 Mar. 1995 (15 6-m nets); 12–25 Feb. 1996 (20 12-m nets); and 28 Dec. 1996–1 Jan. 1997 (15 12-m nets), 4–11 Feb. 1997 (12 12-m nets). The 2.7-m high nets were checked every hour from 2000–0500 h. Netted birds were banded, weighed, and measured. Prior to December 1996, Lima did not distinguish Roseate from Common Terns. Cormons, T. Cormons, DiCostanzo, and Hays assisted with the netting 6–11 Feb. 1997.

At the two largest Roseate Tern colonies in the U.S., Great Gull Is., New York and Bird Is., Massachusetts, birds have been banded each year since the late 1960s (Hays 1970, Nisbet and Drury 1972). Since 1987, participants in a metapopulation study of Roseate Terns in the northeastern U.S. have banded at several colonies (Spendelov et al. 1995). Other workers have banded Roseate Terns at colonies in Canada, the U.S., and the Caribbean (Pierce 1996).

Recoveries of Common Terns at Mangue Seco were possible because of the banding efforts of researchers working in breeding colonies in Canada, the U.S. and Bermuda. Limited banding of Common Terns in the Azores (37°–38°N, 25°–29°W) began in 1984 when a few individuals were banded. No terns were banded in 1985–1988; banding resumed in 1989.

In analyzing the recoveries from Mangue Seco in 1995, 1996, and 1997, we have restricted the analysis to birds banded from 1987–1996, the period of increased banding activity of Roseate Terns after they were listed as endangered. We used the same period for Common Terns for consistency. Numbers of surviving banded Roseate and Common Terns were estimated using a method outlined by Blokpoel and Haymes (1979). We applied annual survival rates to the totals of birds banded provided by the U.S. Bird Banding Laboratory. For adult birds we used an annual

TABLE 1. Roseate and Common Terns netted at Mangue Seco in December 1996 and February 1997.

	December 1996		February 1997	
	<i>n</i>	(%)	<i>n</i>	(%)
Common Tern				
Unbanded	201		142	
Banded	44		17	
Subtotal	245	(94.2)	159	(66.0)
Roseate Tern				
Unbanded	10		68	
Banded	2		10	
Subtotal	12	(4.6)	78	(32.3)
Unidentified	3	(1.2)	4	(1.7)
Total	260	(100.0)	241	(100.0)

survival rate of 0.81 for Roseate Terns (Spendelow et al. 1995) and 0.92 for Common Terns (DiCostanzo 1980). Estimating the survival rate of young birds is complicated by the delayed maturity exhibited by both species. Published survival rates are estimates from hatching year to first breeding: 0.156 to 3 yr of age for Roseates (Nichols et al. 1990) and 0.143 to 4 yr of age for Commons (DiCostanzo 1980). In calculating the numbers of surviving birds banded as young we assumed their survival rate to be the same as adults after age one; this resulted in a calculated first year survival rate of 0.238 for Roseate Terns and 0.184 for Common Terns. For all birds we assumed a survival rate of half the annual rate for the 6-mo interval between the Northern Hemisphere breeding season and the netting season in Mangue Seco. The numbers of recovered birds in each netting season were low, therefore we pooled the data from the three seasons to make the statistical tests more powerful. Additional pooling of data was done as noted below.

RESULTS

Roseate and Common Terns made up 90% of the terns netted at Mangue Seco in December 1996 and February 1997 (Table 1). The remaining 10% were Cayenne, Yellow-billed, and Least Terns. Over 80% of both the Roseate and Common Terns netted in each month were unbanded. The difference in the proportion of banded to unbanded Roseate Terns in the two periods was not significant ($\chi^2 = 0.83$, $df = 1$, $P = 0.36$), but for Common Terns the difference was significant ($\chi^2 = 5.70$, $df = 1$, $P = 0.02$). The proportion of Roseate Terns netted in February, was seven times higher than in December. This difference is significant ($\chi^2 = 424.7$, $df = 1$, $P < 0.001$).

Table 2 shows the estimated numbers of surviving Roseate Terns from those banded 1987–1996 and the recoveries at Mangue Seco 1995–1997. Recovery rates of birds banded as young and as adults were not signifi-

TABLE 2. Estimated numbers (see text) of surviving Roseate Terns banded in 1987–1996 and birds recovered at Mangue Seco, Brazil, 1995–1997.

Banding location	Birds banded as chicks ^a						Birds banded as adults ^b					
	Estimated no. surviving			Recovered			Estimated no. surviving			Recovered		
	1995	1996	1997	1995	1996	1997	1995	1996	1997	1995	1996	1997
Maine	81	121	126	1	0	0	1	1	1	0	0	0
Massachusetts	1515	1680	1829	3	3	4	633	627	563	1	0	3
Connecticut	251	227	221	1	1	0	111	97	92	0	0	0
New York	1369	1504	1406	5	3	0	680	635	577	1	1	1
Subtotal	3216	3532	3582	10	7	4	1425	1360	1233	2	1	4
Puerto Rico/U.S. Virgin Is.	95	117	76	0	0	0	376	349	375	3	3	1
Totals	3311	3649	3658	10	7	4	1801	1709	1608	5	4	5

^a Birds banded as chicks (banding age classes L and HY).

^b Birds banded as adult (banding age classes AHY and ASY).

cantly different from each other (Northeast population: $\chi^2 = 0.125$, $df = 1$, $P = 0.72$; Puerto Rico/U.S. Virgin Is: $G = 0.993$, $df = 1$, $P = 0.32$; G test with Yates continuity correction for small sample size), therefore we pooled these recoveries. Birds from the U.S. were recovered in the proportions expected given the numbers banded in the different states and estimated to have survived ($\chi^2 = 0.158$, $df = 1$, $P = 0.691$; ME, MA, and CT pooled due to low numbers). Compared to birds from the U.S., birds from the Caribbean were recovered 2.3 times more frequently than expected given the numbers of birds estimated to have survived; this difference was significant ($\chi^2 = 5.439$, $df = 1$, $P = 0.02$). An additional four Roseate Terns banded prior to 1987 were recovered at Mangue Seco: one each from MA, CT, NY, and the U.S. Virgin Is.

Table 3 shows the estimated numbers of surviving Common Terns from those banded 1987–1996 and the recoveries at Mangue Seco 1995–1997. The recovery rates of birds from the U.S. banded as young and as adults were significantly different from each other ($\chi^2 = 5.274$, $df = 1$, $P = 0.02$), therefore we did not pool these recoveries. Regardless of age at banding, birds from the U.S. were recovered in the proportions expected given the numbers banded in the states and estimated to have survived (young: $\chi^2 = 0.417$, $df = 1$, $P = 0.52$; adults: $G = 0.034$, $df = 1$, $P = 0.85$; G test with Yates continuity correction; ME, MA, CT pooled and NY, NJ, MD pooled in both tests due to low numbers). An additional 25 Common Terns banded prior to 1987 were recovered at Mangue Seco: MA (2), CT (7), NY (14), Nova Scotia (1), and Bermuda (1).

Three Common Terns banded as chicks in the Azores were netted at Mangue Seco: G-003913 banded Faial Is., 18 Jul. 1992, netted 15 Feb. 1996; G-002318 banded Flores, 5 Jul. 1990, netted 29 Dec. 1996; G-002722 banded Vila Islet, Santa Maria, 13 Jul. 1993, netted 30 Dec. 1996. Though only birds banded as young in the Azores were recovered, this was not significant given the small numbers of adults banded there ($G < 0.001$, $df = 1$, $P = 0.98$; G test with Yates continuity correction). Compared to birds banded as young in the U.S., birds banded as young in the Azores were recovered 5.5 times more frequently than expected given the estimated numbers of surviving birds. This difference was significant ($\chi^2 = 10.75$, $df = 1$, $P = 0.001$). In addition, G-005079, a chick banded Vila Islet, 3 Jul. 1994, was picked up oiled at Mangue Seco on 13 Feb. 1996 and subsequently died. The Azores recoveries to date are from the entire length of the archipelago. On 8 Jun. 1997, a Common Tern, H-35381, banded at Mangue Seco on 28 Dec. 1996 was trapped on a nest on Vila Islet.

The recoveries at Mangue Seco included 25 Roseate Terns and 105 Common Terns of known-age (birds originally banded in their hatching year). The Roseate Terns had a mean age of 6.1 yr (range 0.6–25.6; SE = 1.28). The mean age of the Common Terns was 5.7 yr (range 0.5–24.4; SE = 0.48). The oldest Roseate Tern (25.6 yr) sets an age record for the species, more than doubling the previously published age record of 12.1 yr (Clapp et al. 1982). The bird was originally banded (762-03835) as a

TABLE 3. Estimated numbers (see text) of surviving Common Terns banded in 1987–1996 and birds recovered at Mangue Seco, Brazil, 1995–1997.^a

Banding location	Birds banded as chicks ^b						Birds banded as adults ^c					
	Estimated nos. surviving			Recovered			Estimated nos. surviving			Recovered		
	1995	1996	1997	1995	1996	1997	1995	1996	1997	1995	1996	1997
Maine	920	1208	1044	1	0	0	385	437	452	0	0	1
Massachusetts	2863	3401	4116	0	2	3	623	818	978	0	0	0
Connecticut	6971	6735	6120	12	3	7	800	777	736	0	1	0
New York ^d	16,705	18,588	18,941	15	12	25	6335	6410	6377	2	2	5
New Jersey	322	292	310	0	0	1	331	305	280	0	0	1
Maryland	74	90	69	1	0	0	2	1	1	0	0	0
U.S. Totals	27,855	30,314	30,600	29	17	36	8476	8748	8824	2	3	7
Azores	206	180	201	0	1	2	38	35	40	0	0	0

^a Birds banded in Newfoundland, New Brunswick, Virginia, North Carolina and Bermuda are not included in this table (<1.0% of total). None were recovered in Mangue Seco.

^b Birds banded as chicks (banding age classes L and HY).

^c Birds banded as adult (banding age classes AHY and ASY).

^d Number banded includes only coastal New York.

chick by Nisbet on 20 Jul. 1971 at Bird Is. MA and was again trapped on Bird Is., and rebanded (1103-65574) by Nisbet on 12 Jun. 1980. It was netted at Mangue Seco on 8 Feb. 1997.

DISCUSSION

During November and December older Common Terns migrate to southern Brazil and Argentina, while younger birds are found primarily along the north coast of South America (Hays et al. 1997). This movement may explain the change between December and February in proportions of Roseate and Common Terns netted at Mangue Seco. The concentration at Mangue Seco in December might include many Common Terns that are still moving south. By February this movement is probably completed, resulting in a greater proportion of Roseate Terns at Mangue Seco. Alternatively, the change in proportion might represent an increase in the numbers of Roseate Terns in February relative to December. However, since the proportion of banded to unbanded Common Terns changes significantly, and the Roseates do not, this suggests it is the Common Tern population that changes.

The proportions of Roseate and Common Terns recovered at Mangue Seco from states in the U.S. are what one would expect given the numbers of banded birds estimated to have survived. In contrast, a significantly higher than expected number of Caribbean Roseate Terns were recovered at Mangue Seco. Nisbet and Spendelow (unpubl. data) estimate 65% of the U.S. population of Roseate Terns are banded, but only 13% of the Roseate Terns netted at Mangue Seco, December 1996–February 1997 were banded (Table 1). Mangue Seco appears to be a more important area for birds from the Caribbean than for those from the U.S., and therefore there are probably additional sites where Roseate Terns from the U.S. and possibly the Caribbean occur along the South American coast.

The finding that Roseate Terns from the Caribbean and U.S. populations are found together during the nonbreeding season raises the possibility birds from one population might accompany birds from the other to their breeding grounds. Interestingly, four birds wearing color band combinations put on in the Caribbean have been reported in the U.S. Three were adults banded at La Parguera, Puerto Rico: one banded 8 Jun. 1991, observed by Jim Zingo on Falkner Is., CT on 31 Jul. 1993; two others banded 22 May 1992 and 11 Jun. 1992 observed by Hays on Great Gull Is., NY on 22 May 1997 and 18 May 1994, respectively. A fourth bird banded as a hatching year bird at Leduck, St. Johns, U.S. Virgin Is. 26 Jun. 1991 was observed by Hays on Great Gull Is., NY 18 May 1994. However, because of the possibility of misbanding or misreading it is essential to read the band numbers or trap the birds wearing foreign color combinations to provide firm evidence of Caribbean birds in northern nesting colonies.

A previously undocumented migration of Common Terns between the Azores and the coast of Brazil is indicated by the recoveries reported here. There are few transatlantic recoveries of Common Terns (Nisbet and Safina 1996), and all are isolated records, possibly of storm-driven or lost

birds. Monteiro et al. (1996) reported a Common Tern, banded as a chick at Plymouth, MA and recovered eight years later in the Azores. However, Nisbet and Safina (1996) questioned the identity of this bird and suggested it may have been an Arctic Tern (*S. paradisaea*). In March and April, Common Terns arrive in the western islands of the Azores 30–40 d before their arrival in the eastern islands (Monteiro et al. 1996). Given this arrival pattern, Monteiro et al. (1996) suggested the species returns from the western Atlantic. They reported observers on ships coming from the West Indies have seen flocks of terns flying east towards the Azores in March and April; one observer, O. Kneiss, reported a flock about 1000 km southwest of Flores in March 1993. The relatively high recovery rate of Azores Common Terns at Mangue Seco suggests it is a major gathering point for them in the nonbreeding season.

The concentration of terns at Mangue Seco includes the largest known gathering of Roseate Terns along the South American coast and is the first reported area where numbers of birds from the U.S. and Caribbean populations occur together. It is also the first place in the Western Hemisphere where Common Terns from the Azores have been found during their nonbreeding season. Thus Mangue Seco's importance to Roseate Terns from the New World, as well as Common Terns from the Azores, is clear. The area warrants protection and every effort should be made to prevent development that would adversely impact the terns.

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