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 Empressa De Protecas Ambiental Do Polo Petrocemico De Camacari
Interligacao 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
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 BAHIA, 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. Non-breeding 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. supercilias), 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.


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 (Spendingo 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.

<table>
<thead>
<tr>
<th></th>
<th>December 1996</th>
<th>February 1997</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>(%)</td>
</tr>
<tr>
<td>Common Tern</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unbanded</td>
<td>201</td>
<td>(94.2)</td>
</tr>
<tr>
<td>Banded</td>
<td>44</td>
<td></td>
</tr>
<tr>
<td>Subtotal</td>
<td>245</td>
<td>(94.2)</td>
</tr>
<tr>
<td>Roseate Tern</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unbanded</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Banded</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Subtotal</td>
<td>12</td>
<td>(4.6)</td>
</tr>
<tr>
<td>Unidentified</td>
<td>3</td>
<td>(1.2)</td>
</tr>
<tr>
<td>Total</td>
<td>260</td>
<td>(100.0)</td>
</tr>
</tbody>
</table>

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>
<thead>
<tr>
<th>Banding location</th>
<th>Estimated no. surviving</th>
<th>Recovered</th>
<th>Birds banded as chicks&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Estimated no. surviving</th>
<th>Recovered</th>
<th>Birds banded as adults&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maine</td>
<td>81</td>
<td>1</td>
<td>125</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Massachusetts</td>
<td>1515</td>
<td>1</td>
<td>1829</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Connecticut</td>
<td>251</td>
<td>1</td>
<td>282</td>
<td>4</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>New York</td>
<td>1369</td>
<td>1</td>
<td>1504</td>
<td>5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Subtotal</td>
<td>3216</td>
<td>1</td>
<td>3582</td>
<td>10</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Puerto Rico/U.S. Virgin Is.</td>
<td>95</td>
<td>0</td>
<td>117</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Totals</td>
<td>3311</td>
<td>1</td>
<td>3658</td>
<td>10</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

<sup>a</sup> Birds banded as chicks (banding age classes I and HI).

<sup>b</sup> Birds banded as adult (banding age classes A1H and A3Y).
cantly different from each other (Northeast population: \( \chi^2 = 0.125, \text{df} = 1, P = 0.72 \); Puerto Rico/U.S. Virgin Is: \( G = 0.993, \text{df} = 1, P = 0.32 \); \( G \) 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 (\( \chi^2 = 0.158, \text{df} = 1, P = 0.691 \); 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 (\( \chi^2 = 5.439, \text{df} = 1, P = 0.02 \)). 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 (\( \chi^2 = 5.274, \text{df} = 1, P = 0.02 \)), 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: \( \chi^2 = 0.417, \text{df} = 1, P = 0.52 \); adults: \( G = 0.034, \text{df} = 1, P = 0.85 \); \( G \) 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 (\( G < 0.001, \text{df} = 1, P = 0.98 \); \( G \) 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 (\( \chi^2 = 10.75, \text{df} = 1, P = 0.001 \)). 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>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Maine</td>
<td>920</td>
<td>1208</td>
<td>1044</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Massachusetts</td>
<td>2863</td>
<td>5401</td>
<td>4116</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Connecticut</td>
<td>6971</td>
<td>6735</td>
<td>6120</td>
<td>12</td>
<td>2</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>New York</td>
<td>16,705</td>
<td>18,588</td>
<td>18,941</td>
<td>15</td>
<td>12</td>
<td>12</td>
<td>1</td>
</tr>
<tr>
<td>New Jersey</td>
<td>0</td>
<td>922</td>
<td>292</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Maryland</td>
<td>74</td>
<td>90</td>
<td>69</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>U.S. Totals</td>
<td>27,855</td>
<td>30,314</td>
<td>30,600</td>
<td>29</td>
<td>17</td>
<td>17</td>
<td>3</td>
</tr>
<tr>
<td>Azores</td>
<td>206</td>
<td>201</td>
<td>180</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>0</td>
</tr>
</tbody>
</table>

* Birds banded in New Brunswick, New Jersey, Rhode Island, and New York.

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

---

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

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 move-
ment may explain the change between December and February in pro-
portions of Roseate and Common Terns netted at Mangue Seco. The
concentration at Mangue Seco in December might include many Com-
mon 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 repres-
ent an increase in the numbers of Roseate Terns in February relative to De-
cember. 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 high-
er 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 combina-
tions 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, ob-
served 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 Sa-
fin 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.

ACKNOWLEDGMENTS

We thank the following banders for permission to use recoveries included in this paper: J. E. Gates, R. Harlow, S. Kress, A. R. Lock, L. R. Pharo, S. Ruppert, C. Safina, F. Sibley, and D. B. Wingate. We also thank Hans Blokpoel, Charles Collins, Paul Meyer, Robert F. Rockwell, and an anonymous reviewer for constructive comments on the manuscript.

The Great Gull Island Project thanks the Norcross Fund for supporting their 1997 work in Bahia; the Gordon Fund for support in computerizing data; the Linnaean Society of New York, the Chester W. Kitchens Fund, the Charles W. Kitchens Fund of the Québec-Labrador Foundation, the American Museum of Natural History, and its Department of Ornithology for their continued support. The project also thanks the Bird Banding Laboratory of the U.S. Geological Survey (USGS) Patuxent Wildlife Research Center for banding data summaries. Hays, DiCostanzo, and Cormons are most grateful to Pedro Lima and his family for their hospitality at Mangue Seco. They also thank Mauricio Calvo for his invaluable assistance in driving and translating, Thomas Cormons for help during the trip and Gonçalo Ferraz de Oliveira and Ana Luz Porzecanski for translating correspondence.

Participants in the Roseate Tern metapopulation study acknowledge support from the USFWS Regional Office and the USGS Patuxent Wildlife Research Center for work done at the breeding colony sites since 1987.

Lima thanks Rolf Grantseau for his help in identifying Common and Roseate terns in non-breeding plumage. Monteiro thanks the Life Program of the European Commission and the Royal Society for the Protection of Birds for financial support. Nisbet thanks the Massachusetts Audubon Society and the late W. H. Drury for permission to band under their banding permits in 1971–1980. Spendelow thanks the staff of the USFWS's Stewart, B. McKinney National Wildlife Refuge for their support and permission to work on Falkner I.; and the Connecticut Department of Environmental Protection, Connecticut Audubon Society, Connecticut Chapter of The Nature Conservancy, Fulton Foundation, Little Harbor Laboratory, Menunkatuck Audubon Society, USFWS Region 5 Division of Refuges and Office of Endangered Species, Massachusetts Cooperative Fish and Wildlife Research Unit (University of Massachusetts-Amherst),
and the USGS Patuxent Wildlife Research Center for logistic and/or financial support. Pierce thanks the USFWS and Pittman-Robertson Wildlife Restoration Program for support.

LITERATURE CITED


Received 14 Jan. 1999; accepted 5 May 1999.