

Interregional Breeding Dispersal of Adult Roseate Terns

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Abstract.—Long-distance breeding dispersal is infrequent among seabirds and has rarely been quantified. Six adult Roseate Terns (*Sterna dougallii*) that had bred at colony sites in Buzzards Bay, Massachusetts, USA from 2004–2006 switched regions and moved 200–400 km to two colony sites in Maine between 2005 and 2007. Two of the emigrants presumably had nested for at least eight years in Massachusetts before moving to Maine, demonstrating that even long-time philopatric residents of one region may switch to another region. Received 6 October 2009, accepted 25 February 2010.

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Roseate Terns (*Sterna dougallii*) returning from South America to nest along the western North Atlantic Ocean arrive first at Cape Cod, Massachusetts, USA (Gochfeld *et al.* 1998) where they choose among two regions by either moving west to nest in the relatively warm water areas of Massachusetts (Nantucket Sound, Buzzards Bay), New York, and Connecticut (Nisbet and Spendelow 1999), or further north to nest in the cold water-influenced regions of the Gulf of Maine in New Hampshire, Maine and Canada. Nesting birds from both regions may mix during the post-breeding period, during migration or in their wintering areas (Nisbet 1984; Shealer and Kress 1994; Hays *et al.* 1997; Trull *et al.* 1999), birds banded as chicks in both regions have become breeding birds in the other region (Spendelow *et al.*, unpublished data), and within each region breeding birds may switch colony sites (e.g. Spendelow *et al.* 1995; Lebreton *et al.* 2003). However, based on results from other seabirds (Bradley and Wooller 1991), the assumption was that once the initial choice of nesting region has been made, breeding adults remain philopatric to that region. However, here we

present six cases of breeding adults that changed regions and emigrated from Buzzards Bay, Massachusetts to Maine over a three-year period.

STUDY AREAS AND METHODS

From 2004–2007, approximately 1,625–1,775 pairs of Roseate Terns nested on three islands (Penikese [41°27'N, 70°56'W], Ram [41°37'N, 70°48'W] and Bird [41°40'N, 70°43'W]) in Buzzards Bay, about 30–60 pairs nested on the eastern side of Nantucket Sound on two adjacent islands at about 41°37'N, 69°59'W in the Monomoy National Wildlife Refuge (NWR) and about 280–320 pairs nested north of Massachusetts at several sites in the U.S. Gulf of Maine (USFWS, unpublished data). Sites in the latter region where 15 or more pairs nested in at least one year from 2005–2007 include Seavey Island, Isles of Shoals, New Hampshire (42°58'N, 70°38'W), and in Maine: Stratton Island (43°31'N, 70°19'W), Outer Green Island (43°39'N, 70°07'W), Jenny Island (43°46'N, 69°54'W), Eastern Egg Rock (43°52'N, 69°23'W), and Petit Manan Island (44°22'N, 67°52'W). Seavey Island and Stratton Island are, respectively, about 145 and 205 km from Bird Island; Eastern Egg Rock and Petit Manan Island are, respectively, about 85 and 220 km from Stratton Island. Locations of the primary sites of interest are shown in Shealer and Kress (1994), USFWS (1998), Nisbet and Spendelow (1999), and Tims *et al.* (2004).

Virtually all Roseate Tern chicks banded in the Northwestern Atlantic Ocean area of the USA and Canada since 1992 have been given two metal bands: a U.S.

Geological Survey Bird Banding Laboratory (BBL) stainless steel or incoloy band on one leg, and a 'field-readable' (FR) incoloy band with a 4-character complex (two upper and two lower characters stamped twice on the circumference for identification with a spotting scope at distances up to about 25 m) on the other leg. Adults at Buzzards Bay sites from 1992-2003 also were given just two metal bands, but starting in 2004 most adults in this area received a unique six-band combination of a lower metal band (one leg BBL, the other FR) and two plastic color bands on each leg. We color-banded 347, 651 and 524 adult Roseate Terns at nests in 2004, 2005 and 2006, respectively. Adults were not trapped at nests at colony sites in Maine, but colorband combinations and/or FR bands were read using spotting scopes. Prior re-sighting efforts in this region were less intensive and more variable annually than at the larger colonies in Massachusetts, Connecticut and New York (Spendelov *et al.* 1995, 2008; Lebreton *et al.* 2003), but have increased in recent years.

RESULTS AND DISCUSSION

The estimated total nesting pairs and the number of individual Roseate Terns identified at the five Maine colony sites that had 15 or more nesting pairs in at least one year from 2005-2007 are shown in Table 1. Prior to 2005, a few adult Roseate Terns from the warm water breeding population had been reported as moving and probably nesting at a site on the outer part of Cape Cod (Spendelov *et al.* 1995), but none had been positively identified as nesting in the colony sites further north in the Gulf of Maine.

On 8 June 2005, an adult Roseate Tern with a white color band above the FR band on the left leg and a yellow color band above the BBL band on the right leg was seen on Petit Manan Island. The same bird was confirmed nesting there in July 2006 when both upper and middle colorbands were seen and the FR band (6T49) was read. First banded as a chick in 1999 at Bird Island, it was color-banded at a nest on Ram Island in June 2004,

and nested about 400 km from Buzzards Bay in 2005 and 2006. The bird was not seen in 2007 when the Roseate Tern breeding population at Petit Manan Island declined (Table 1), but in 2008 it nested at Eastern Egg Rock in June and was seen back at Petit Manan Island on 6 July.

A second color-banded adult (63M5) was seen several times in June and July 2006 at a nest on Stratton Island. First banded as a chick at Ram Island in 2002, it was color-banded in 2005 at Bird Island at what was probably its first nesting attempt (Spendelov *et al.* 2002). In 2006, it nested about 205 km from its previous site in 2005.

A third color-banded adult (479C) was seen on 23 July 2006 at Stratton Island, but its breeding status could not be confirmed. First color-banded as an adult in 2004 at a nest at Bird Island and not observed in 2005 or 2006 in Buzzards Bay, it was re-sighted ten times (three times by a nest) at Stratton Island in June and July 2007.

A fourth color-banded Roseate Tern (0R05) observed seven times in June and July 2007 at Stratton Island was identified at a nest. First banded as an adult with only metal bands in 1999 at a nest at Ram Island, it was not seen in 2000, but was re-sighted at Ram from 2001-2004 before being color-banded at a nest there in 2005. The individual was re-trapped in 2006 at a nest at Bird Island, so presumably spent a minimum of eight years nesting in Buzzards Bay before immigrating to Stratton Island in 2007.

A fifth color-banded individual (457A) was seen four times in June 2007 at Stratton Island with two observers reporting it paired to a bird that had only FR band S524. Originally color-banded in 2005 at a nest at Peni-

Table 1. Estimated number of nesting pairs of Roseate Terns at colony sites in Maine with 15+ pairs in at least one year from 2005-2007. The number of breeding/nonbreeding adults from all US colony sites identified at each Maine site is given within parentheses.

Year	Site				
	Stratton Island	Outer Green Island	Jenny Island	Eastern Egg Rock	Petit Manan Island
2005	2 (9)	42 (17)	12 (2)	146 (84)	9 (9)
2006	90 (62)	6 (0)	15 (4)	113 (67)	23 (33)
2007	83 (93)	8 (2)	17 (12)	119 (57)	5 (6)

kese Island, 457A was seen on 2 July 2006 at Ram Island where it presumably nested.

The mate of 457A in 2007, S524, was originally banded as a chick in 1995 at Ram Island, trapped as a breeding adult in 1999 at its natal colony site and was next seen there in June 2004. The same bird was seen at Penikese Island on 28 June 2005 and back at Ram Island on 6 June 2006. Although it was not known to have been paired with 457A in 2005 or 2006, the fact that they both were seen at Penikese Island in 2005, at Ram Island in 2006, and reported as paired at Stratton Island in 2007 suggests that they may have been paired and moving together for several years. Similarly to 0R05, S524 presumably spent a minimum of eight years nesting in Buzzards Bay before moving to Stratton Island in 2007.

In general, 'breeding dispersal', i.e. movement between successive breeding attempts (Greenwood and Harvey 1982), is thought to occur at a lower rate than 'natal dispersal', the movement from the natal site to the site of first reproduction, in seabirds (Bradley and Wooller 1991), and this has been demonstrated for Roseate Terns (Lebreton *et al.* 2003). Most long-distance movements resulting in 'out of normal range' re-encounters of banded Roseate Terns, including some extreme examples of trans-Atlantic movements of birds banded in Europe or the Azores to the Western Hemisphere and vice versa (Nisbet and Cabot 1995; Hays *et al.* 2000, 2002a, 2002b), probably occurred prior to the first breeding attempt of those individuals and so can be considered to be part of the process of natal dispersal. We have yet to formally quantify the degree to which it occurs, but, based on results of natal dispersal within just the warm water sites (Lebreton *et al.* 2003: Table 8) and our unpublished data, we estimate that about 2-4% of the Roseate Terns banded as chicks in the warm water region that survive to recruit into the breeding population probably disperse to the cold water region.

In this first attempt at estimating the degree of breeding dispersal from the warm water to the cold water region, only five (0.33%) of the 1,522 adult Roseate Terns color banded

at the three colony sites in Buzzards Bay from 2004-2006 were detected as breeding birds after moving to Maine between 2005-2007. Adjusting for an annual survival rate of 0.85 (Lebreton *et al.* 2003) produces an *ad hoc* 'interregional' movement rate estimate of adult Roseate Terns from Buzzards Bay to Maine of 0.004. The rate is similar to the 0.004 average rate found using formal capture-recapture models by Spendelov *et al.* (1995) for movements from Bird Island to Falkner Island, Connecticut (170 km) from 1988-1992, but lower than the average rates of movements from Bird Island to Great Gull Island, New York (130 km) of 0.017 and 0.014 reported, respectively, for the same period by Spendelov *et al.* (1995) and a longer period (1988-1998) by Lebreton *et al.* (2003). Shealer and Kress (1994) reported that adults from several warm water breeding colonies visited Stratton Island in August (some in successive years) from 1989-1992, so presumably some of the emigrants reported here may have behaved similarly and gained familiarity with this colony site and nearby foraging areas during the year(s) prior to their breeding dispersal.

None of the emigrants initially joined the largest, and presumably relatively stable, Roseate Tern colony at Eastern Egg Rock. One bird (which eventually nested there a few years later) apparently bypassed this site and several others in going to Petit Manan Island, and therefore moved what we consider to be an unusually large distance of about 400 km between successive breeding sites. However, while switching regions, the others nonetheless still moved distances that are within the maximum range (250 km) previously reported for adults dispersing between sites within the warm water region (Spendelov *et al.* 1995). Hays *et al.* (2002a) reported a color banded adult Roseate Tern that apparently emigrated from the Western Hemisphere to the Azores, a much greater distance than those reported here, but because this bird had lost its BBL band, it and its prior breeding site could not be identified.

We suspect that the degree of interregional breeding dispersal of Roseate Terns reported here does not represent a recent phenomenon. Given some of the large annual increas-

es in size in the Gulf of Maine breeding population over the past 20 years (e.g. from 171 to 247 pairs from 1996 to 1997 [USFWS 1998: Appendix B]), it seems likely that a combination of both natal and breeding dispersal of birds from the warm water region to the cold water region played a role in such increases. We now suggest that interregional breeding dispersal occurred in the past, but went unrecognized because of the lack of intensive systematic resighting efforts in the 1990s at all colony sites in the Gulf of Maine. That most of the individuals reported here probably were observed the year they emigrated is related, no doubt, to their either having been color banded, or mated to a color-banded bird.

While the short three-year period for the detection of movements used here did not warrant a formal modeling approach (e.g. Lebreton *et al.* 2003), we note that three of the six emigrating adults reported here would have been categorized as transients (*sensu* Pradel *et al.* 1997) in the formal mark-recapture/resighting analysis of the survival of adults from the warm water region (Spendelov *et al.* 2008). Also, while we do not know what caused these six birds to switch regions, because two did so after having been resident for a minimum of eight years in the warm water region indicates the need for examining the metapopulation dynamics of this species on even larger geographic and temporal scales than has been done to date.

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