

## DISTRIBUTION DURING POST-BREEDING DISPERSAL, MIGRATION, AND OVERWINTERING OF COMMON TERNS COLOR-MARKED ON THE LOWER GREAT LAKES

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**Abstract.**—Common Terns (*Sterna hirundo*) were marked with colored wing tags at two colonies in the lower Great Lakes. Sightings of these birds were used to examine their post-breeding dispersal in the Great Lakes, migratory routes, and winter distribution. Adults and juveniles disperse along the shores of lakes Erie and Ontario from July through October: 97.1% of adults and 80.8% of juveniles that were sighted on the Great Lakes were seen on Lake Erie. Only five color-marked adults were observed south of the Great Lakes and north of Florida. These sightings were consistent with an Atlantic coast fall migration route.

Between December and March, Great Lakes adult and juvenile Common Terns winter on the U. S. Gulf coast, the Caribbean, Central America, and north coast of South America. Adults also winter on the Atlantic coast of Florida and the west coast of South America.

### PATRONES DE DISPERSIÓN, RUTAS DE MIGRACIÓN Y DISTRIBUCIÓN EN EL INVIERNO DE GAVIOTAS COMUNES (*STERNA HIRUNDO*) MARCADAS EN LOS GRANDES LAGOS INFERIORES

**Sinopsis.**—En un estudio que se llevo a cabo en los Grandes Lagos inferiores, se marcaron en el ala con marbetes de colores especímenes de dos colonias de gaviota común (*Sterna hirundo*). Observaciones subsiguientes de las aves marcadas, permitió estudiar los patrones de dispersión, rutas de migración y su distribución en el invierno. De julio a octubre, los juveniles se dispersan a lo largo de la costa de los lagos Erie y Ontario. El 97.1% de los adultos y el 80.8% de los juveniles observados en los Grandes Lagos inferiores fueron más tarde vistos en el Lago Erie. Solo 5 de los adultos marcados fueron observados al sur de los Grandes Lagos o al norte de Florida, lo que coincide con la migración de aves que utiliza la ruta del Atlántico. Tanto adultos como juveniles de las aves marcadas, pasan el invierno (diciembre a marzo) en las costas continentales del Golfo, el Caribe, América Central y la costa norte de Sur América. Algunos adultos también pasaron inviernos en la costa del Atlántico (en Florida) y la costa oeste de Sur América.

The number of Common Terns (*Sterna hirundo*) at colonies in the lower Great Lakes has declined since the mid-1960s (reviewed by Courtney and Blokpoel 1983). The breeding ecology of Great Lakes Common Terns has been studied in considerable detail (ibid.), but little is known about the terns' ecology on their wintering grounds. We wanted to study the terns' winter ecology and we, therefore, needed to know specific locations where a significant number of this species could be found in most years. Although banding returns have indicated that the winter range includes southern Florida and the Gulf coast of the U.S.A., the Caribbean, Central America, and the north and northwest coasts of South America (Austin 1953, Haymes and Blokpoel 1978), we needed more detailed information about the distribution of the terns during the non-breeding season in order to identify suitable study areas. Thus, we de-

veloped a color-marking program for Common Terns at two colonies in the Great Lakes basin. This report describes the results of that color-marking project.

#### METHODS AND MATERIALS

During the 1981–1984 breeding seasons, we color-marked 1772 Common Terns at the Eastern Headland in Toronto, Ontario and Tower Island in the Niagara River, New York. We used wing tags (Fig. 1) that were slightly modified from a design developed by I. C. T. Nisbet (pers. comm.). We cut the tags from a vinyl coated polyester material (Sopers Ltd., Hamilton, Ontario, Canada) with the exception of the pink tags used on juveniles in 1981 which we made from Saflag material (Safety Flag Company of America, Pawtucket, Rhode Island). We painted an alpha-numerical code on each pair of wing tags using Selectone Fabric Coating (Selectone Paints Ltd., Toronto, Ontario). The vinyl coated polyester and Saflag tags weighed approx. 0.6 g and 0.3 g, respectively. Thus the vinyl coated polyester tags averaged about 0.45% of an adult's body weight and 0.50% of a juvenile's; the Saflag tags were approx. 0.25% of the average juvenile body weight.

We trapped adult Common Terns on their nests and caught pre-fledged juveniles by hand. We weighed each bird in 1981–1983 and approx. one third of the adults in 1984 with a 300-g Pesola scale and put a standard USFWS band on one leg and a plastic butt-end legband (yellow with a black horizontal stripe) on the other leg of all birds. We then attached the wing tag by wrapping the shaft of the tag around the humerus (between the fourth and fifth secondaries) and inserting the handle through the slit in the blade with tweezers. The number of birds tagged and the colors of tags used are summarized in Table 1.

In the fall of 1981 we sent approximately 950 letters requesting reports of sightings of color-marked terns. We added addresses each year so that by 1984 we contacted 73 Ontarian, 708 U.S., 29 Caribbean, 49 Central American and 121 South American organizations and individuals. These included federal, state, and provincial wildlife officials; national, state, and provincial parks, editors of ornithological and nature journals/newsletters, universities, museums, nature clubs, and bird watchers (Anon. 1981, Pratt 1981, Rickert 1978). The letters, in five languages included a brief description of the project, color drawings of the wing tags and bands used each year as they would appear on a standing tern, and a request to report sightings. We sent each respondent a letter of acknowledgement and a request for further sightings.

In addition, two of us (HB and GDT) visited South America during three successive winters in order to search for color-marked Common Terns. In 1983 we surveyed the coastline of NW Venezuela between 17 January and 11 February (Blokpoel et al. 1984) and made brief visits to the mid-Caribbean and southern Pacific coasts of Colombia during 11–20 February. During 20 February–28 March 1984, we searched

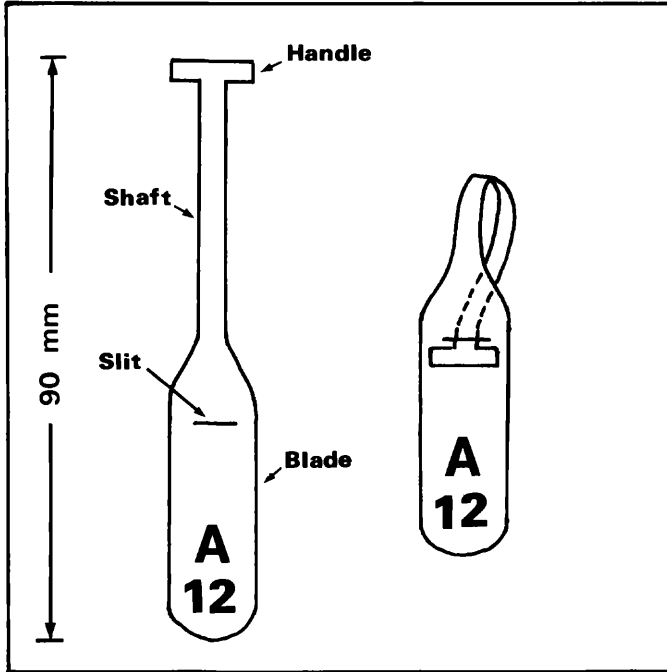


FIGURE 1. Design for Common Tern wing tag.

sections of the Peruvian coast from Paraiso (north of Lima) south to Mollendo. The Paracas to Mollendo area of Peru was again checked during 8 February–3 March 1985.

To analyze the sightings we divided them into two categories: (1) individual sightings where both the color of the tag and the alpha-numeric code had been recorded, and (2) category sightings where only the tag color was seen or a non-existent code was reported for a given color tag. Three sightings were not detailed enough to be categorized, but nevertheless provided interesting information. These are discussed separately below. Seven responses were discarded due to lack of sufficient data. We also received six non-sighting reports, i.e., reports from individuals who spent extended periods of time observing birds in particular locales but did not see any color-marked Common Terns.

For the purposes of this report, the number of individuals reported for an area is the total number of different Common Terns seen in that area. If the same individual was seen more than once in an area, we did not add it again to the totals. All category sightings were included in tabulations because it was not possible to determine which reports were repeated sightings of the same tern. We combined the results for Tower Island and Eastern Headland adults because of the similarity of their

TABLE 1. Number of Common Terns wing tagged at the Eastern Headland, Toronto, Ontario and Tower Island, Niagara River, New York in 1981-1984.

Year	Age	Wing tag (color of tag/ color of code)	Number of Common Terns tagged			Weight in g ( $\bar{x} \pm SD$ )
			East- ern Head- land	Tower Island	Total	
1981	adult	orange/black	167	70	237	132.6 $\pm$ 9.34
	juvenile	pink/black	308	0	308	125.1 $\pm$ 9.88
1982	adult	blue/black	214	13	227	135.9 $\pm$ 8.27
	juvenile	black/yellow	312	0	312	126.6 $\pm$ 10.21
1983	adult	red/yellow	237	34	271	129.5 $\pm$ 8.85
	juvenile	green/yellow	227	0	227	122.2 $\pm$ 11.23
1984	adult	red/white	154	0	154	135.5 $\pm$ 6.35 <sup>a</sup>
	juvenile	yellow/black	36	0	36	— <sup>b</sup> —
Total	adult		772	117	889	
Total	juvenile		883	0	883	

<sup>a</sup> Only 46 birds were weighed.

<sup>b</sup> Juveniles were not weighed in 1984.

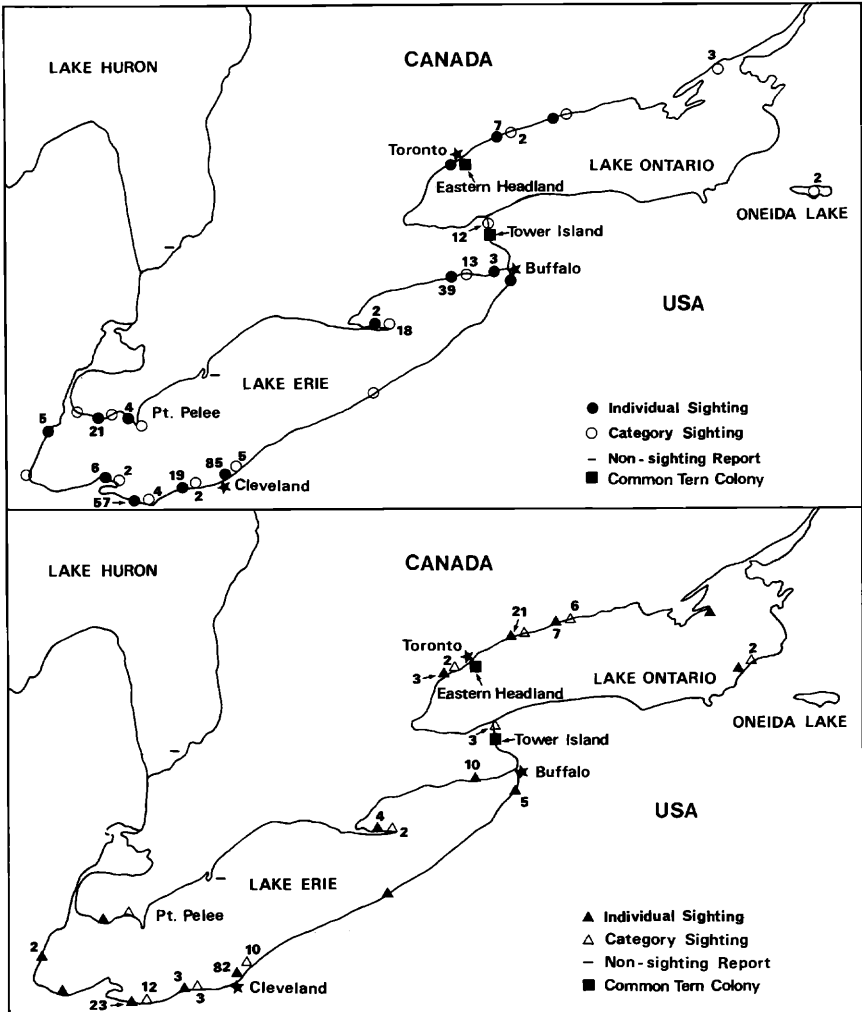
distribution patterns. After an initial examination, we also combined the sightings of adults banded in each of the four breeding seasons because we could not detect annual differences in distribution.

Sightings of adults 1 and 2 yrs after the year of tagging are combined with sightings during the year of tagging. We believe that terns not seen at the Eastern Headland or Tower Island colonies during the intervening breeding seasons were present on the Great Lakes but not observed, rather than breeding elsewhere (Haymes and Blokpoel 1978). We have presumed, therefore, that their post-breeding distribution reflects that of Great Lakes Common Terns.

The results for juveniles refer to the 12-month period post-tagging because with one exception discussed separately, all sightings were from this interval.

#### RESULTS AND DISCUSSION

*Post-breeding distribution.*—Most adult color-marked Common Terns dispersed to Lake Erie; a small number moved to Lake Ontario and Oneida Lake (Fig. 2a). Of the 205 individuals sighted in the Great Lakes basin, 97.1% were seen on Lake Erie and 3.9% on Lake Ontario (two adults, 1.0%, were observed on both lakes). The distributions of Tower Island and Eastern Headland adults on Lake Erie were similar, although none of the terns seen on Lake Ontario was from the Tower Island colony. These sightings began on 10 July and ended, with one exception, by the end of October. The number of reports peaked in August and



FIGURES 2a (top) and 2b (bottom). Locations of sightings in the Great Lakes basin during post-breeding dispersal of adult (a) and juvenile (b) Common Terns wing-tagged at the Eastern Headland, Toronto and Tower Island, Niagara River, 1981-1984. A number above or next to an individual sighting denotes the number of individual terns observed at least once at that site. A number above or next to a category sighting indicates the number of category sightings at that site.

September. The early sightings may pertain to birds which deserted their nests immediately after being tagged. Desertion was not common; most tagged adults remained at the breeding colony through chick-rearing.

Of the 199 individual adults sighted on Lake Erie, 71 were seen two

or more times over an average of  $19.3 \pm 19.7$  d ( $\bar{x} \pm$  SD). The longest that a bird is known to have spent on Lake Erie was 76 d. Only one tern was sighted more than once on Lake Ontario and the observations occurred over a 20 d period. Terns did not remain at the same sites for the duration of their stay in the Great Lakes; several individuals were sighted at more than one location along the Erie shore. For example, in 1983 adult red X-11 was seen at Lorain, Ohio (approx. 30 km west of Cleveland) on 2, 6 and 7 August; Cleveland on 18 August; Huron, Ohio (approx. 60 km west of Cleveland) on 31 August, 2 and 4 September; Cleveland on 3, 8, 11 and 28 September; Huron on 7 October; Cleveland on 8 and 15 October; Huron on 17 October. Other adults moved greater distances. In 1981, sightings for orange B-12 were as follows: Rock Pt. Provincial Park, Ontario (approx. 25 km west of Buffalo) on 27 June; Kingsville, Ontario (approx. 20 km west of Pt. Pelee) on 22 July; Cleveland on 17 August, 7 September. One Eastern Headland adult that dispersed to Cleveland, where it was sighted seven times between 30 July and 14 August, moved back to Lake Ontario and was resighted in Oshawa, Ontario (approx. 40 km east of Toronto) on 7 October.

Many juvenile color-marked Common Terns also dispersed to Lake Erie during the period July through October, though a greater percentage stayed on Lake Ontario than did adults (Fig. 2b). Of the 156 individual juveniles observed on the Great Lakes, 80.8% were seen on Lake Erie and 21.2% on Lake Ontario (three juveniles, 2%, were seen on both lakes). The number of sightings on Lake Ontario peaked in July and August and sightings on Lake Erie peaked in August and September. Only three juveniles were seen west of Toronto before August.

Thirty-nine juveniles were sighted more than once on Lake Erie over an average of  $12.6 \pm 14.6$  d; six were observed twice or more on Lake Ontario, averaging  $13.7 \pm 7.6$  d. The maximum durations that juveniles are known to have spent on the lakes are 66 and 24 d for Erie and Ontario, respectively. As was observed for adults, juveniles move between sites on the shores of Lake Erie and between Lakes Erie and Ontario. In 1981, for example, pink SW was seen in Port Hope, Ontario (approx. 85 km east of Toronto) on 26 July; Huron on 8 and 30 August; and Cleveland on 5–7 September. One Common Tern, color-marked as a juvenile, was observed in Buffalo in October as a one-year-old.

We believe that the movements of adult and juvenile wing-tagged Common Terns and the duration of their stay in the Great Lakes are normal and not caused by the tags. Most observers noted that the color-marked birds were in single species flocks of up to 800, or in mixed flocks with Caspian (*Sterna caspia*), Forster's (*S. forsteri*) and/or Black (*Chlidonias nigra*) Terns. None remarked on any apparent abnormal behavior. Nisbet (1981) found that the behavior of Roseate Terns (*S. dougallii*) returned to normal 2 d after the birds were trapped and wing tagged.

Previous banding studies (Austin 1953, Haymes and Blokpoel 1978) indicated that Common Terns remain in the Great Lakes basin up to 4

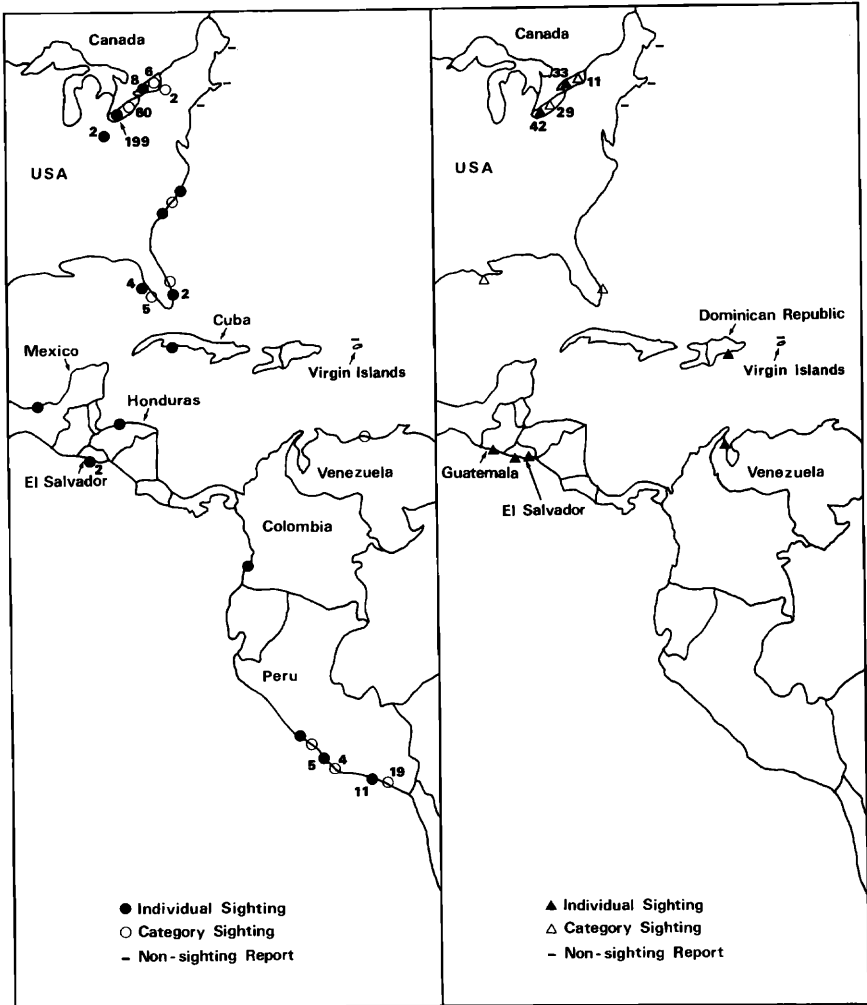
mo after the breeding season, but these studies did not examine the distribution within the lakes. The terns may move as far as 550 km from their breeding colony. This distance was covered by two adults seen in inland Ohio in October. We considered this post-breeding dispersal (Landsborough Thomson 1964) and not the beginning of migration because both birds were seen on the Great Lakes later the same fall. Roseate Terns also exhibit post-breeding dispersal and have been found as far as 300 km from the breeding colony (Nisbet 1984). While the Atlantic coast populations of Common and Roseate Terns disperse throughout the surrounding states and provinces (Austin 1953, Nisbet 1984), Great Lakes Common Terns from the two colonies studied here moved mainly to the southwest. We received no sightings from Lake Huron or from the St. Lawrence River.

The results reported here are biased because they were dependent on the non-random presence of observers and their efforts in the Great Lakes area. The large number of sightings from Cleveland, for example, were primarily from two people who made almost daily observations from mid-July to early October for three successive years. There are a sufficient number of observers on Lake Ontario to confirm that the dispersal to Lake Erie is general, but it is unclear why most adult and juvenile Common Terns move there. Ring-billed Gulls (*Larus delawarensis*) also stage in Lake Erie in November and December before migrating southward (Southern 1974). One possible reason is a greater availability of food. That is difficult to assess, because the diet of terns after the breeding season and the availability of small fish in the two lakes are both unknown.

*Distribution during fall and spring migration.*—We received only five sightings of color-marked Common Terns between the Great Lakes and Florida/Gulf coast (Fig. 3a, b), so are unable to add significantly to the available information concerning migration routes. The three sightings from North Carolina are in agreement with previous studies that suggest that the birds migrate along the Atlantic coast (Austin 1953, Haymes and Blokpoel 1978). Our limited data suggest that the terns migrate south from Lake Erie to the Atlantic coast.

Twelve of 14 Florida sightings and two of three Gulf coast observations (Fig. 3a, b) occurred prior to December, the date indicated by previous studies for the arrival of the birds on their wintering grounds (Austin 1953, Haymes and Blokpoel 1978) and most were probably of birds in migration. One adult, red X-5, was sighted on the Gulf coast of Florida in November and again in Peru in March of the same winter.

The low number of reports from the fall migration route may indicate that the terns migrate quickly and spend little time loafing once they leave the area of post-breeding dispersal. One adult had moved from the west end of Lake Erie in July of 1983 to the coast of North Carolina (a distance of some 905 km) 6 d later. Migration may become more leisurely at the more southern latitudes: two adults, red X-51 and T-48, were



FIGURES 3a (left) and 3b (right). Locations of sightings of adult (a) and juvenile (b) Common Terns wing-tagged at the Eastern Headland, Toronto and Tower Island, Niagara River, 1981–1984. A number above or next to an individual sighting denotes the number of individual terns observed at least once at that site. A number above or next to a category sighting indicates the number of category sightings in that area.

seen twice each, over 21- and 6-d intervals, respectively, on Florida’s west coast in October–November. Although he had no data concerning the transit time of individual Common Terns, Austin (1953) suggested that observations of terns feeding and resting along the coast during fall migration indicated a leisurely southward flight.



We received no sightings from the Atlantic coast during spring. This lack may be explained by a more hasty northward migration, when Common Terns are not seen loitering along the shorelines (Austin 1953). European Common Terns also migrate more quickly during spring than during fall migration (Kasperek 1982).

The sighting of a wing-tagged adult in El Salvador in April may have involved a tern on its return migration from more southern wintering grounds or a bird late in leaving its wintering area. A sighting from Colombia in April of a Common Tern with a yellow leg band may have been an adult or a juvenile staying in South America.

*Distribution on the wintering grounds.*—We define wintering grounds as those areas used by the Common Terns between the completion of the fall migration and the beginning of the spring return. The wintering time must be set arbitrarily because it is impossible to determine the dates from the banding returns (Austin 1953). Austin (1953) defined the period as December through February and Haymes and Blokpoel (1978) extended it through March. As wing-tagged terns were still in South America during March, we will use the latter definition here.

During the period December through March, wing-tagged adult Common Terns were sighted along the coast of Florida, the Caribbean and Central America, and the north and west coasts of South America (Fig. 3a, b). This range is similar to that described for adults from the Great Lakes by Haymes and Blokpoel (1978), though they did not include the Caribbean in the winter range. One wing-tagged adult was found in Cuba in February, indicating that at least one, and probably some, adults winter in the Caribbean (Fig. 3a).

The winter range of juvenile Common Terns from the Great Lakes includes the U.S. Gulf coast, the Caribbean, Central America, and the north coast of South America (Fig. 3b). Haymes and Blokpoel (1978) reported banding recoveries of juveniles from the west coast of South America as well.

The sightings of wing-tagged adults and juveniles, describe a winter range similar to that found by Austin (1953), though the sightings from southern Peru extend the known winter range of the Great Lakes Common Terns. This may represent an actual shift or be due to poor reporting of band recoveries in the past.

Field work in the winters of 1984 and 1985 showed that sandy beaches of the Peruvian coast are important staging areas for adult Common Terns from the Great Lakes. No Common Terns were seen on rocky sections of shoreline. We concentrated our work on the Mollendo area of southern Peru, where 11 color-marked individuals were identified during three winters (1982/83–1984/85). Our field observations, together with those of a local birdwatcher (R. A. Hughes, pers. comm.), indicate that some of the terns spend much of the winter near Mollendo. Four individuals were sighted more than once: red T-27 11 times during 13 Feb.–30 March 1984, blue X-109 10 times during 3 Feb.–15 March

1984, red X-45 8 times during 9 Feb.–8 March 1984, and blue X-76 5 times during 3–21 March 1984. These individuals were part of flocks of up to an estimated 800 Common Terns observed on a given day on three km of beach near Mollendo. The sandy beaches near Paracas are also important staging areas: we observed 5 wing-tagged individuals there and one adult, first observed on 26 Feb., was again seen on 14 March 1984.

The terns for which there was only a single observation near Mollendo may have remained in the area and been missed in the regular surveys, or they may have continued southward, perhaps into Chile. Although no wing-tagged terns were sighted in Chile, a fisherman reported a tern with a yellow leg band at Hueicolla, Chile at between 40° and 41° southern latitude. This may have been one of our birds which lost its tags. Common Terns have been observed very close to the Peru-Chile border flying south (R. A. Hughes, pers. comm.) and R. P. Schlatter, Universidad Austral, Valdivia, Chile, believes that Common Terns are more common in Chile than indicated in the literature (pers. comm.).

During our field surveys in Venezuela and Colombia we found no Common Terns which suggests that previous sightings from these two countries were of birds still in migration. In addition to the individual sighting in northwestern Venezuela, the observer noted "some" other Common Terns in that area wearing our plastic legbands but without wing tags. All the Venezuelan observations occurred in December. However, no Common Terns were seen in September or October (C. Casler, pers. comm.) or in January or February by our field team and they are believed to be only casual visitors to the area (Casler and Lira 1979).

*Effectiveness of wing tags.*—Compared to leg banding, the use of colored wing tags on Common Terns greatly increases the amount of information and the rate at which it is received. Of the 1772 individuals wing-tagged between 1981 and 1984, 318 (7.9%) had been sighted by November 1985 and 115 had been observed more than once. In contrast, only 11 (2.5%) of the 447 Common Terns banded but not wing tagged on the Great Lakes during 1981–1984 were recovered by November 1985 (C.W.S. Banding Office, pers. comm.). During a longer recovery period, the percentage of band recoveries would continue to increase while the percentage of tagged birds sighted would remain relatively constant because of the limited durability of wing tags. Therefore, wing tags are most useful for projects where information is needed quickly. Moreover, supplementary information provided by category sightings is not available if only a USFWS standard band is used.

In contrast to these benefits, there may be problems associated with the use of wing tags: a decreased return rate to the colony and interference in the ability to acquire a mate in Ring-billed Gulls (Southern and Southern 1985), possible decreased survival in Band-tailed Pigeons (*Columba fasciata*) (Curtis et al. 1983) and changes in behavior in Mourning Doves (*Zenaida macroura*) (Frankel and Baskett 1963). When consid-

ering the use of wing tags, the likely advantages and disadvantages need to be taken into account.

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