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Population Estimates, Conservation Concerns, and Management of Tropicbirds in the Western Atlantic

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ABSTRACT.—Two species of tropicbirds (Phaethontidae) live in the Western North Atlantic. The White-tailed Tropicbird of the region is an endemic race, *Phaethon lepturus catesbyi*, with approximately 5000 pairs. This is half the estimate made less than two decades ago. The Red-billed Tropicbird, *P. aethereus*, has approximately 2000 pairs regionally and fewer than 8000 pairs globally. Neither species has been considered to be of conservation concern. We suggest that the Atlantic populations of *Phaethon lepturus* and the global population of *Phaethon aethereus* be considered for appropriate conservation status listings reflecting their rare and declining populations.

INTRODUCTION

Two of the three extant species of tropicbirds (Phaethontidae), the White-tailed Tropicbird (*Phaethon lepturus*) and the Red-billed Tropicbird (*Phaethon aethereus*), occur in the Atlantic (AOU, 1998). A large percentage of the Atlantic breeding populations of both species nests in the West Indies region.

The Western Atlantic population of White-tailed Tropicbirds is represented by an endemic subspecies (*P. l. catesbyi*) whose breeding distribution extends from Bermuda and the Bahamas, through the Greater and the northern Lesser Antilles, and reportedly, to Trinidad and Tobago (AOU, 1998). In the early 1980s, the total population was estimated at more than 10,000 pairs breeding at over 30 sites (van Halewyn and Norton, 1984) but since then no additional information has appeared. We have reassessed the population status of this species in the western North Atlantic and find the aggregate population to be significantly lower than previously reported.

Red-billed Tropicbirds in the Atlantic are represented by the subspecies *P. a. mesonauta*. This race breeds in the Lesser Antilles and southern Caribbean, the Gulf of California (350 pairs at 2 colonies), the Galapagos Islands (a few thousand pairs at 30 colonies), and was formerly reported as breeding off Ecuador and Peru. The same race also breeds in the Cape Verde Islands (less than 1000 pairs and perhaps as few as 100 pairs), islands off Senegal (status unknown) and the Madeleine Archipelago of Senegamba (30 pairs). Furness and Monteiro (1995) record a single breeding pair of Red-billed Tropicbirds in the Azores, the first European breeding record and the only example of a range expansion in this species. Van Halewyn and Norton (1984) estimated the West Indian population at 1600 pairs at 22 sites.

We review the distribution, abundance, breeding, and conservation status of these two pelagic seabirds in the Western North Atlantic and discuss possible management strategies.

MATERIALS AND METHODS

For historical records we relied on existing literature and on data from museum egg collections. Information compiled is derived from the previous two decades, the greater portion from the 1990s. On islands with scant recent information, historical reports always indicate small colony sizes. Whenever possible, population estimates are based on personal observations, re-

cently published reports and information given to us by resident authorities. We believe that we have up-to-date information on the species conservation status and local population sizes for all countries except several Lesser Antillean islands, where the populations of both species are believed to be small (Montserrat, St. Lucia, and St. Vincent & the Grenadines).

The aggregate population figures we have determined for both species in the region probably err on the high side. The only portion of the West Indies where sizeable populations of White-tailed Tropicbirds may remain undetected is the keys along the northern coast of Cuba. While it would be surprising if these birds did not breed there, recent surveys (H. Gonzalez, pers. comm.) give no indication that they do. Population numbers and the identification of colony sites for Red-billed Tropicbirds are less well documented than those for White-tailed Tropicbirds because many island groups in the Lesser Antilles are seldom visited by biologists, and because of the unknown sizes of the small, scattered breeding colonies on the northern South American and eastern Central American coasts.

Estimating the sizes of breeding tropicbird populations is difficult. Major problems include an inability to access colonies or vantage points from which to observe and count birds, and the optimal timing of visits, both seasonally and hourly. Bird numbers are variable, and behavior causes problems because birds are not always present on the nests and the intervals between the changing of incubation partners or feeding of chicks may last several days. Wingate (pers. comm.) believes that the number of nesting pairs of White-tailed Tropicbirds at any given location in Bermuda is six times the maximum number of birds seen in the air. This factor would not necessarily work for other populations, where feeding grounds may be closer or foraging grounds may be richer. While birds seen entering nesting holes clearly indicate local nesting activity, a tally of the number of holes visited does not necessarily equate to the total number of active nests. In the Bahamas, marked White-tailed Tropicbirds from known nest locations visited many occupied and unoccupied holes in the course of a morning. This behavior has been observed occasionally in Red-billed Tropicbirds on Saba (pers. obser.).

The problems in obtaining comparable population estimates are compounded by the lack of a central seabird information base, contact persons for a number of islands, and the multinational makeup of the region. Censusing and estimation methods vary. Many nesting sites are remote and seldom visited, and those visited by seabird students are often visited at times when terns and other species are in peak breeding numbers (usually a poor time to estimate tropicbird population sizes). A number of early surveys failed to differentiate the two species or have misidentified them.

Numbers of nesting pairs (Table 1) were obtained from literature, personal observations, and the observation of others. In all cases, we have attempted to cite the most recent source. Field observations are listed in ascending order of reliability; estimates, surveys, censuses, and counts.

RESULTS

The following is a compilation of the status and conservation concerns for White-tailed and Red-billed Tropicbirds in Bermuda, the United States, the Bahamas, the Greater and Lesser Antilles, Trinidad & Tobago and the Caribbean coast. Population estimates of both species are presented in Table 1.

Populations: status and trends

Bermuda: *White-tailed Tropicbird.*—The largest Atlantic population of this species breeds on Bermuda. After reviewing the historical records, D. B. Wingate (pers. comm.) has documented a drastic decline. Partially due to millinery use, the tropicbirds were afforded full legal protection by the Wild Birds Protection act of 1881. Nevertheless, since the 1920s the species has continued to decline steadily. It is estimated that in 1950 there were 3000 pairs nesting in Bermuda, but this number was reduced to 2500 by 1995 (D. B. Wingate,

TABLE 1. Population estimates for two species of tropicbirds (*Phaethon*) in the western North Atlantic. Symbols: — = absent: b = breeding (population size unknown): b? = breeding suspected: f = fossil record only: e = extirpated in historic period: e? = believed extirpated. Numbers indicate breeding pairs. Percentage numbers are for total Western North Atlantic populations.

Breeding location	White-tailed	Red-billed	Source	Census methods
Bermuda	2500 (45%)	—	Lee and Walsh-McGehee, 1998	Surveys
Bahamas	1000 (19%)	—	Walsh-McGehee et al., 1999	Literature reviews and surveys
United States				
Dry Tortugas	0-2 (0.1%)	—	Stevenson and Anderson, 1998	Count
Greater Antilles				
Cuba	>100 (2%)	—	Viña et al., 1998	Surveys
Jamaica	50-100 (2%)	—	A. Haynes-Sutton	Surveys
Cayman Islands	60 (1%)	—	P. Bradley, pers. comm.	Count
Hispaniola	1000 (19%)	—	J. Ottenwalder, pers. comm.	Estimate
Mona & Monito	100-200 (3%)	—	J. Saliva, pers. comm.	Census
Puerto Rico	200-300 (5%)	<10 (1.4%)	J. Saliva, pers. comm.	Census
U.S. Virgin Islands	<40 (0.1%)	300 (14%)	J. Pierce, pers. comm.	Count
British Virgin Islands	<50 (0.1%)	<100 (5%)	J. Pierce, pers. comm.	Count
Lesser Antilles				
Sombrero	—	b?	van Halewyn and Norton, 1984	Literature review
Redondo	b?	*c.* 100 (5%)	van Halewyn and Norton, 1984	Literature review
Antigua	f	*c.* 50 (2%)	K. Lindsay, pers. comm.	Observation
Barbuda	*c.* 10 (0.2%)	50-100 (5%)	K. Lindsay, pers. comm.	Observation
St. Maarten	15 (0.3%)	15 (7%)	van Halewyn and Norton, 1984	Literature review
Saba	50-100 (2%)	750-1000 (35%)	M. Walsh-McGehee, pers. comm.	Survey-island Count-10%
St. Bartholomew	—	e	Van Halewyn and Norton, 1984	Literature review
St. Eustatius	>10 (0.2%)	30	Voous, 1983	Survey
Montserrat	—?	*c.* 100 (5%)	J. Daley, pers. comm.	?
Guadeloupe	68 (1.2%)	69 (3%)	Guadeloupe WIldlife Dept., pers. comm.	Census
Dominica	10+ (0.2%)	e	R. Winston, pers. comm.	Observation
Martinique	*c.* 10 (0.2%)	*c.* 50 (2%)	van Halewyn and Norton, 1984	Literature review
St. Lucia	?	?	Evans, 1990	?
St. Vincent	b?	e?	Evans, 1990	?
Barbados	—	e	P. A. Buckley, pers. comm.	Recent observation
Grenadines	e	b	Evans, 1990	?
Trinidad & Tobago	—	*c.* 400 (20%)	Van Halewyn and Norton, 1984	Literature review
Caribbean Basin	—	*c.* <100 (5%)	van Halewyn and Norton, 1984	Literature review
Total	*c.* 5500	*c.* 2200		

pers. comm.). Development in outlying areas and increased predation from pet cats and dogs has accelerated the species decline (Wingate, 1988).

Bahamas and the Turks & Caicos: *White-tailed Tropicbird.*—Walsh-McGehee et al. (1999) identified 36 historic and extant breeding colonies of White-tailed Tropicbirds in the Bahamas archipelago. There are no documented island extirpations. Several sites identified by Bryant (1859) have not been revisited and the bird's status on those islands is unknown (Sprunt, 1984). To compensate for the fact that some nesting sites may remain undetected, Walsh-McGehee et al. (1999) provided high population estimates (pr./site) for all known extant sites, estimating a total of fewer than 1000 breeding pairs of White-tailed Tropicbirds for all islands in the archipelago. This figure agrees closely with earlier and current estimates made by Sprunt (1984 and pers. comm.). Following Bermuda, the Bahama archipelago is the second most important island group for breeding White-tailed Tropicbirds in the western North Atlantic.

United States: *White-tailed Tropicbird.*—This species is not known to breed in the United States, although between 1974 and 1984 one or two pairs were seen in courtship flight and in incubation positions at Ft. Jefferson, Dry Tortugas (Florida Keys) (Stevenson and Anderson, 1994). This is the only instance of attempted colonization of a new site documented for this species.

Greater Antilles

Cuba and Isle of Pines: *White-tailed Tropicbird.*—Viña et al. (1998) provide the only up-to-date summary of tropicbird nesting in Cuba. They found that nesting was restricted to two or three small areas, and conclude that the total population is fewer than 100 pairs. Documented nesting is limited to a small area along the southeastern coast, at sites where the species was first noted by Gundlach in the 1800s and last reported by Barbour (1943). The actual nesting area is about one third smaller than indicated by van Halewyn and Norton (1984). Viña et al. (1998) present evidence of a slightly larger area of distribution along the southeastern coast in the early 1900s. There is some indication that the species may breed on the cays of the north coast (Morales Leal and Garrido, 1996) but this remains to be validated. Despite seemingly appropriate cliff habitat on the Isle of Pines, residents interviewed by Lee in January 2000 indicated that the birds are not breeding there.

Jamaica: *White-tailed Tropicbird.*—Van Halewyn and Norton (1984) reported 200-1000 pairs nesting in Jamaica. Haynes-Sutton (pers. comm.) reports 10 active colonies with a total population of 50-100 pairs.

Cayman Islands: *White-tailed Tropicbird.*—Nesting is confined to the Bluff on Cayman Brac and the south coast of Grand Cayman (Bradley, in litt.). The colony on Grand Cayman has 18-20 pairs. The bird was an abundant breeder on Cayman Brac, where a sizeable colony was documented by Maynard in 1889. About 400 pairs bred on this island in the early 1980s, but by 1995 numbers fell to 40 pairs (P. Bradley, in litt.). By 1998 numbers had not recovered. Fossils were found on Cayman Brac by Morgan (1994).

Hispaniola: *White-tailed Tropicbird.*—José Ottenwalder (pers. comm.) has estimated the total population at 1000 pairs. Specific nesting localities are largely undocumented. **Haiti**: The U.S. National Museum of Natural History (USNM) has two specimens collected in 1931 by A. Wetmore at Ile-à-Vache. No other breeding localities are mentioned in the literature. Biologists working in the country agree that there has been a general loss of breeding sites and a reduction in the overall population (F. Sergile, pers. comm.) but this has not been documented. **Dominican Republic**: de Dod (1981) indicates that the species breeds only on the easternmost third of the coast and on a section along southwestern coast. Beata, Alto Velo, and Saona are extant breeding sites (J. Ottenwalder, pers. comm.), but colony sizes are unknown. A colony of 20-25 pairs nests at Cabo Cabrón, at Las Galeras, east of the Samaná peninsula. A colony of 60 pairs nests southwest of Cabo Rojo and the Bahía de Las Águilas.

Mona and Monito: *White-tailed Tropicbird*.—The USNM has birds collected in 1935 by J. Smyth and S. T. Danforth at Playa de Pájaros (Mona). Van Halewyn and Norton (1984) estimated the population of these islands at 1000 pairs but current estimates by the US Fish and Wildlife Service stand at 100-200 pairs. The large difference in estimates is believed to reflect errors in earlier calculations and is not interpreted as a major population decline.

Puerto Rico: *White-tailed Tropicbird*.—These birds were apparently common early in the 1900s along cliffs on the north and south coasts of western Puerto Rico, but are now limited to a few nesting pairs on the northwest coast (van Halewyn and Norton, 1984). Schaffner (1988) reported a minimum of 63 nests on the Culebra archipelago in 1984 and implied that current populations may be similar to those observed by Wetmore during April 1912 (Wetmore, 1917). Gochfield et al. (1994) reported that this population declined to fewer than 3 pairs by 1987. Nesting takes place on Vieques (less than 10 pairs), on Culebra at Cayo Lobos, Cayo del Agua, Cayo Luís Peña, Cayo Molinos, Cayo Norte, and Punta Soldado (40 pairs), and on mainland Puerto Rico at Quebradillas. Contrary to van Halewyn and Norton (1984) the species currently breeds on the south coast at Caja de Muerto, just off Ponce. *Red-billed Tropicbird*. Van Halewyn and Norton (1984) report at least one pair of birds and one former colony on the south coast of Puerto Rico. The species breeds at seven sites on Vieques and Culebra (Cayo Lobito, Cayo Alcarraza, Cayo Ratón, Cayo Luis Peña, Cayo Norte, Cayo Molinos, and Cayo Geniquí). Total population size is unknown.

US Virgin Islands: *White-tailed Tropicbird*.—J. Pierce (pers. comm.) estimates more than 40 pairs distributed in small colonies of 3-10 pairs on five islands. Nichols and Bond (1943) found 20 nesting pairs at Cas Cay, much higher than numbers seen there today (J. Pierce pers. comm.). The species formerly bred on Whistling Cay and it now breeds on Cas, Congo, Hans-Lollick, Outer Bass Cays, and Water Island. It may also breed on Carval Rock, Cockroach, Cricket, Dog, Dutchcap, Flanagan, and Frenchcap Cays. *Red-billed Tropicbird*. Based on a nest count of 225, J. Pierce (pers. comm.) estimated a maximum of 300 pairs. Most nests were found on Cockroach Cay, followed by Hans-Lollick, Mingo, Congo, Kalkun, Buck, and Capella Cays. Fewer nests were found on Carval Rock, Cas, Cricket, Dog, Dutchcap, Flanagan, Flat, French Cap, Grass, Inner Bass, Little St. James, Outer Bass, Ram's Head (St. James), Saba, Sail, Savannah, Shark, Sula, Two Brothers, Water Island, West, and Whistling Cays. One adult was seen searching for a nest on Hassel Island. Red-billed Tropicbirds may nest in very small numbers on the main islands of St. Thomas, St. John, and St. Croix. They formerly nested on Little Flat Cay. The Western Foundation of Vertebrate Zoology (WFVZ) collection has an egg from Cas Cay (31 March 1936).

British Virgin Islands: *White-tailed Tropicbird*.—J. Pierce and E. Schreiber (in litt.) estimated 20-50 pairs at Fallen Jerusalem, Great Tobago, Guana Island, and Norman Island. The USNM has a specimen from Tobago Island collected by G. Seaman in 1951. *Red-billed Tropicbird*. J. Pierce and E. Schreiber (in litt.) estimated 80-100 pairs at Cockroach Cay, Dog Islands, Fallen Jerusalem, Great Tobago, Little Tobago, Green Cay, Guana Island, and Norman Island.

Lesser Antilles

White-tailed Tropicbird.—Nesting is confined mostly to the northern islands, with Martinique being the southernmost known breeding site. Islands which do not support nesting birds include Anguilla, Antigua, Aves Islands, Barbados, Bequia, Carriacou, Desirade, Dod Island, Grenada, the Grenadines, Hat Island, Les Saintes, Marie Galante, Scrub Island, Sombrero, St. Barthlomew, St. Kitts-Nevis, St. Lucia, and St. Vincent. Wilson (pers. comm.) indicates that local fishermen have observed some nesting tropicbirds on St. Kitts but it is unclear which species is involved or whether the colony is still extant.

Red-billed Tropicbird.—This species breeds or has bred on all major islands in the Lesser

Antilles. There is currently no nesting on Barbados (P. A. Buckley, pers. comm.).

Sombrero: *Red-billed Tropicbird*.—Van Halewyn and Norton (1984) reported nesting on this island but recent surveys (J. Pierce, pers. comm.) suggest that the colony is not extant.

Redondo: *White-tailed Tropicbird*.—Van Halewyn and Norton (1984) reported nesting on this island but the species was not reported by K. Lindsay (pers. comm.). Either earlier information was in error or the species no longer breeds there. *Red-billed Tropicbird*. There may be more than 100 pairs (K. Lindsay, pers. comm.).

Antigua: *White-tailed Tropicbird*.—This species is known from a late Holocene vertebrate fossil deposit at Burma Quarry (Pregill et al., 1988) and is assumed to have bred on the main island. Bird Island, off Antigua, has 8-12 pairs (1973-83; P. Bradley, pers. comm.). *Red-billed Tropicbird*. There are 6 pairs on Bird Island off Antigua (1973-83; P. Bradley, pers. comm.). K. Lindsay (pers. comm.) estimated 50 breeding pairs on Antigua, with the largest population on Great Bird Island off the northeast coast.

Anguilla: *Red-billed Tropicbird*.—Van Halewyn and Norton (1984) reported this species as breeding on Anguilla but we have no recent information and assume that the colonies are not extant.

Barbuda: *White-tailed Tropicbird*.—Van Halewyn and Norton (1984) reported this species as breeding on Barbuda but we have no recent information and assume that the colonies are not extant. *Red-billed Tropicbird*. The USNM has two specimens collected in 1889 at Gun Shop Cliff, near Two Foot Bay. K. Lindsay (pers. comm.) estimates between 50-100 pairs nesting on the sea cliffs on the eastern coast.

St. Maarten: *White-tailed Tropicbird*.—There are approximately 15 breeding pairs. Birds have been observed in a sea cave at Maho Bay and probably occur at Mary's Point (Voous, 1983). *Red-billed Tropicbird*. Voous (op. cit.) estimated the breeding population at 15 pairs (Pelican Key, Maho Bay, and Mary's Point).

Saba: *White-tailed Tropicbird*.—Voous (op. cit.) estimated the breeding population at only a few pairs. Walsh-McGehee (pers. obser.) estimates the current population at 50-100 breeding pairs. Numbers have declined apparently a result of expanding Red-billed Tropicbird populations. Breeding has been recorded at Flat Point, Cove Bay, Fort Bay, and Ladder Bay. *Red-billed Tropicbird*. The USNM has a series of skins, including downy young, collected in 1937 by S. T. Danforth at Booby Hill and Little Booby Hill cliffs (both current nesting sites). Walsh-McGehee (pers. obser.) indicates that breeding activity occurs throughout the year, and that there is multiple use of some nest sites. An estimate of 750-1000 nesting pairs was made by detailed nesting density studies in one sub-colony, extrapolating colony size based on comparative numbers of flying adults at inaccessible colonies, and considering the multiple-use of nests resulting from year-round breeding. Breeding has been recorded at Flat Point, Cove Bay, Little Booby Hill, Booby Hill, Black Rocks, Tent Bay, Well's Bay, Great Point, Sulphur Mine, and Green Island.

St. Bartholomew: *Red-billed Tropicbird*.—Van Halewyn and Norton (1984) recorded this species as a breeder but we have no recent information and assume that the species no longer nests there.

St. Eustatius: *White-tailed Tropicbird*.—A few pairs were found breeding at Cupe Coy Bay (Voous, 1983). We assume a population of fewer than 10 pairs. *Red-billed Tropicbird*. The USNM has three skins collected by F. A. Ober in the 1800s. An estimated 30 pairs breed at Tumble Down Dick Bay, Yenkin's Bay, Gallows Bay, Cay Bay, White Wall, Venus Bay, and Concordia Bay (Voous, op. cit.).

Montserrat: *Red-billed Tropicbird*.—The USNM has a series of skins collected in 1938 by R. A. Tonge at Garabaldi Hill and at Rendezvous. Van Halewyn and Norton (1984) questioned the occurrence of this tropicbird on Montserrat but Blankenship (1990) considered both species of tropicbirds as common residents. James Daley (pers. comm.) estimated the total population of Red-billed Tropicbirds at *c*. 100 pairs. He reported breeding at Garabaldi Hill with additional small colonies from Viewpoint north to the airport. According to Daley, populations are dwindling.

Guadeloupe: *White-tailed Tropicbird*.—Reported as a breeder by Van Halewyn and Norton (1984). Unpublished studies conducted in 1998 by Guadeloupe biologists estimated the total population at 68 pairs in six colonies: Terre de Bas (26 pr), Terre de Haut (12), Cabrit (2), Grand Ile (6), Marie-Galante (20), and Desirade (2). *Red-billed Tropicbird*. The USNM has skins collected by F. A. Ober in the 1800s. Unpublished studies conducted in 1998 by Guadeloupe biologists estimated the total population at 69 pairs: Terre de Bas (2 pr.), Pointe des chateaux (20), l'Eperon (12), Marie-Galante (30).

Dominica: *White-tailed Tropicbird*.—The USNM has a specimen collected by D. Wingate in 1965 and the WFVZ has eggs collected in 1938 from near Petite Savanne. Van Halewyn and Norton (1984) considered the breeding status as unknown and assumed the species to be present in small numbers. Evans (1990) reported the species as breeding on the island. Randolph Winston (pers. comm.) reported the species as breeding on Dominica in the mid-1990s. The population is apparently small (less than 10 pairs). *Red-billed Tropicbird*. Evans (op. cit.) reported that the species occurs occasionally, but did not discuss breeding. Randolph Winston (pers. comm.) reported it as formerly breeding on Dominica.

Martinique: *White-tailed Tropicbird*.—Van Halewyn and Norton (1984) considered the breeding status as unknown. Evans (1990) reported nesting. The population is apparently small, probably less than 50 pairs. *Red-billed Tropicbird*. Van Halewyn and Norton (1984) reported this species but the population's current status is unknown.

St. Lucia: Van Halewyn and Norton (1984) and Evans (1990) doubted if either species nested on the island.

St. Vincent: *White-tailed Tropicbird*.—Van Halewyn and Norton (op. cit.) were uncertain if this species nested on this island, but Evans (op. cit.) reported it as nesting. The American Museum of Natural History (AMNH) has two eggs collected at Rock Fort on the south coast of St. Vincent (April 1924). *Red-billed Tropicbird*. Van Halewyn and Norton (op. cit.) recorded this species as nesting on St. Vincent but did not report colony size. Evans (op. cit.) questioned its nesting status. The USNM has a skin collected by F. A. Ober in the 1800s. We do not know if colonies are extant.

Barbados: Evans (1990) considered White-tailed Tropicbirds as accidental and Red-billed Tropicbirds as formerly nesting. Neither species nests on Barbados despite the presence of cliff faces that could provide good nesting sites (P. A. Buckley, pers. comm.).

Grenadines: *White-tailed Tropicbird*.—Van Halewyn and Norton (1984) reported this species nesting in the Grenadines, but Evans (op. cit.) indicated it was absent. The USNM has a specimen collected in 1937 by S. T. Danforth on Ramier Island. *Red-billed Tropicbird*. Evans (op. cit.) recorded the species as nesting. The USNM has two collected in the Grenadines in 1937 by S. T. Danforth. One is from Ramier Island and the other from the western cay of Bequia.

Trinidad and Tobago: *White-tailed Tropicbird*.—Despite earlier reports (de Dalmas, 1900; AOU, 1998) this species does not breed on islands off Tobago. Its inclusion as a breeding bird in the region is apparently based on a misidentified specimen of *P. aethereus* (ffrench, 1961). *Red-billed Tropicbird*. Van Halewyn and Norton (1984) estimated 400+ nesting pairs based on ffrench's (op. cit.) statement of 300 individuals nesting at three sites off Tobago (Little Tobago, St. Giles, and Smith Island).

Caribbean Basin: White-tailed Tropicbirds are absent from the remainder of the Caribbean Basin. Red-billed Tropicbirds were reported from mainland Venezuela, Los Testigos lslands, Los Hermanos Islands, Los Roques Archipelago, and Panama (islands off Chiriqui Lagoon) by van Halewyn and Norton (1984) and de Shauensee and Phelps (1978). Birds may breed at La Orchila and Margarita (van Halewyn and Norton, 1984). The aggregate population size is believed to be less than 100 pairs.

DISCUSSION

Population sizes

Based on the information compiled here, the maximum western Atlantic aggregate

breeding population for the White-tailed Tropicbird is 5000-6000 pairs. The number of Red-billed Tropicbirds nesting in the West Indies and Caribbean Basin exceeds 2000 pairs and the total population for the subspecies indigenous to the region (*P. a. mesonauta* of the Caribbean and eastern Pacific) is estimated at 4000-5000 pairs. Previous surveys are few, incomplete, and often unreliable. For most islands we have little or no information concerning former abundance. We have documented declines in numbers of birds or breeding sites for Bermuda, Cuba, the Cayman Islands, Puerto Rico, and Jamaica. Scott (1891) regarded White-tailed Tropicbirds as common along the entire north shore of Jamaica and referred to a population on the Pedro Keys. The species was obviously abundant at that time (he collected 25 adults on 25 and 26 February 1891) but Scott did not estimate the island's total population size. However, it is clear that the species has declined dramatically over the last 100 years. The recent declines in the Cayman Islands, one of the few breeding sites with a well-documented history, are particularly alarming.

Even before European contact, people colonizing islands had a major impact on seabird populations (Steadman, 1995a,b). Steadman postulated that pre-European people may have been caused a 95 % reduction in the number of seabirds on tropical islands. Tropicbirds, while not necessarily eliminated from local faunas, became restricted to inaccessible sites. Post-European clearing of forests and the introduction of feral animals further reduced their numbers. It is important to note that tropicbirds do not require cavities in rocks to nest. They have been documented as nesting under grasses and cedars in Bermuda (Wingate, pers. comm.), and the smaller, more agile White-tailed Tropicbird nests inland on forested islands in the Pacific, as well as in caves up to several kilometers from the coast (Lee, pers. obser; Lee and Walsh-McGehee, 1998).

The fossil record sheds little information on the former distribution and abundance of tropicbirds (see review by Lee and Walsh-McGehee, 1998). Excluding the subfossil records from Bermuda, the only material from the region was found by Morgan (1994) in the Caymans, where the species is extant, and by Pregill et al. (1988) in Anguilla, where White-tailed Tropicbirds no longer nest. There is no fossil record of Red-billed Tropicbirds from the region.

Using historical museum records, Walsh-McGehee et al. (1999) have shown that White-tailed Tropicbird colonies have persisted at their current sites for at least a century and surely much longer. There is no indication that sites are re-colonized once they are abandoned. Except for the one report from the Florida Keys, there is no historic evidence of these birds colonizing new sites within their current range, or that this species has exhibited range expansion since the late Pleistocene. However, the general absence of fossil tropicbirds from caves in Bermuda, in contrast to an abundance of fossil and sub-fossil Cahow (*Pterodroma cahow*) material, suggests that the White-tailed Tropicbird colonization of that island has been relatively recent.

Development

Road construction and housing development have impacted tropicbird populations (Lee and Walsh-McGehee, 1998). The construction of sea walls, filling in coastal property, and the carving out of cliffs for development have taken their toll on tropicbird populations. Tropicbirds have mostly been reduced to nesting on inaccessible sea cliffs and remote islands and cays. Tourists are increasingly visiting small remote cays, some of which are important seabird nesting islands.

Contamination

Wingate (1978) estimated that the Bermuda tropicbird population has decreased by up to 40 % over the previous 25 years, due in part to pesticides. Thirty-one 19th century-tropicbird eggs from Bermuda were compared with 10 broken eggshells collected in 1970. Measurements indicated a significant 5.3 % pollutant-induced eggshell thinning (James Wilson, unpub.).

Wingate (1990) cited oil pollution as a

contributing factor in tropicbird population decline. Tar balls from oil spills concentrated in the Sargasso Sea and became entangled in the flank feathers of tropicbirds resting on the surface. The number of White-tailed Tropicbirds exhibiting oil fouling on arrival in Bermuda rose from 1 in 100 in 1968 to about 1 in 15-20 in 1971 (Wingate, in Butler et al., 1973). In the early 1970's the ratio of oiled birds rose to 1 in 4. These birds failed to breed and disappeared from their nesting sites (Wingate, pers. comm.). Oil pollution peaked in the Sargasso Sea around 1972 and began to decline as a result of new regulations concerning dumping oil at sea.

Disease

Observations of White-tailed Tropicbird fledglings in Bermuda between 1958 and 1978 indicated that pox virus infections, although generally of low prevalence, were an important component of fledgling mortality, accounting for 7 % of the non-viable birds intercepted after departure from the nest. Only nestlings and fledglings were infected, and the condition seemed invariably fatal (Wingate et al., 1980).

Weather-related mortality

Mortality caused by hurricanes and other major weather systems is largely undocumented. White-tailed Tropicbirds are blown inland by storms in the SE United States with a frequency that exceeds their proportionate abundance in relation to other storm driven seabirds. However, since the major tropical storm season occurs after the primary nesting season of both tropicbirds, it seems that cyclones and other events impact only small populations. When hurricanes strike nesting areas during the late breeding season, there is some chick mortality from sea wash. Wingate (1995) reported that Hurricane Dean (August 6/7, 1989) and Hurricane Felix (August 14/15, 1995) caused high loss of chicks and even brooding adults because at least one third of the population was nesting when the storms hit Bermuda. More importantly, storms may deteriorate nesting sites. Wingate speculates that Hurricane Felix eliminated 30-50 % of the nesting sites along the south shore of Bermuda. At other nests, storm surge removed all sand substrate from nest chambers, making them temporarily unusable. A substantial increase in nest site competition occurred the following year. Indirect loss of populations as a result of nest site destruction is probably the most important long-lasting effect of hurricanes.

Predation from introduced animals

Schaffner (1988) reported that black rats were the most common cause of tropicbird nesting failure at one of his study sites in Culebra Island, Puerto Rico. Black rat nest predation was reported in Bermuda by Murphy (1936). Lee and Clark (1994) noted a strong correlation between islands not occupied by nesting tropicbirds and the presence of black rats in the Exumas (Bahamas). Black rats have recently expanded their populations and distribution on San Salvador, Bahamas (Dougherty et al., 1997). The rats were formerly confined to the interior of the island in low densities, but are now common in commercial areas and coastal habitats. This change is thought to be a result of a newly developed resort on the island. It will be interesting, although perhaps predictable, to see how the coastal nesting population of White-tailed Tropicbirds responds to this change. Preliminary comparisons between 1997 and 1999 showed desertion of the more accessible nesting sites, but the total number of nesting pairs was stable. In Bermuda, the brown rat occasionally takes tropicbird eggs and kills young chicks, but does not normally occur in coastal areas, where nesting takes place. Black rat predation of tropicbirds has also been reported in Bermuda (Murphy, 1936), as has predation by cats, dogs (the primary predator) and introduced American Crows. Bartram reported crows stealing chicks from nests as early as 1861 (Wingate, pers. comm.).

Predation from man

Man has clearly reduced the regional and global populations of tropicbirds. As stated

previously, pre-Columbian people had a major impact on seabird populations (Steadman, 1995a,b). Before 1880, tropicbirds were hunted in Bermuda to supply milliners with tail feathers. Egging, a common practice in some tropical seabird colonies, probably has little impact today on tropicbirds due to the difficulty in accessing nest sites. Haynes (1987) reported exploitation of White-tailed Tropicbird eggs in Jamaica, but indicated that the local conservation status of the species was of no immediate concern. Wingate (pers. comm.) believes that the relative unpalatability of its meat and eggs favors survival in Bermuda. Walsh-McGehee et al. (1998) document human consumption of White-tailed Tropicbirds in the Caicos Islands through the 1960s. On Saba, both species of tropicbirds were taken for food until the early 1950s.

Invasive exotics

Feral goats cause erosion through damage to vegetation and displacement of rocks and soil while climbing on steep hillsides. Early accounts of nesting White-tailed Tropicbirds indicated that they nested under grasses and other coastal vegetation (Gross, 1912). One of us (MWM) found a crushed tropicbird egg, only days away from hatching, with the print of a baby goat hoof clearly visible.

In Bermuda, and probably elsewhere the West Indies, naturalized Australian pines (*Casuarina equisetfolia*) cause problems at cliff nesting sites. These trees become established on limestone cliffs and their roots may fill nest cavities. The trees are easily uprooted by storms, resulting in the destruction of cliff nest sites.

Loss of nest cavities

Natural erosion of cliff faces has caused rock falls that have crushed nesting tropicbirds in Bermuda (Beebe, 1932; D. B. Wingate, pers. comm.). Saliva (1989) and Wiley and Wunderle (1993) report negative effects on nesting habitat of White-tailed Tropicbirds on Culebra after Hurricane Hugo. Hurricanes and other storms deposit rubble in nest cavities making them unusable. In Jamaica, traffic on adjacent roads has caused the collapse of nest burrows (C. Levy, pers. comm.). The construction of sea walls and other forms of coastal development often result in the loss of nest sites. Occupation of nesting cavities by honeybees or by nesting Barn Owls has been documented as sources of nest cavity loss to tropicbirds on Bermuda.

Availability of nest sites

This is probably the primary factor limiting population expansion. On Bermuda, and probably elsewhere, the adult population exceeds the number of available protected nesting cavities. The most common causes of nest failure at one Puerto Rican colony was nest-site abandonment resulting from agonistic encounters between conspecifics during the early part of the breeding cycle (Schaffner, 1990). These encounters often involved overt and severe fighting. Numerous failures have resulted from White-tails contesting nest site ownership in Bermuda. On Wardwick Wells (Exumas, Bahamas) White-tailed Tropicbirds nest not only on cliffs, but also commonly under rocks on the top of a plateau (Lee and Clark, 1994). We interpret this as a response to a complete lack of introduced predators on the island, and it is certain that the population could be increased with the provision of additional nesting shelters.

Interspecific competition for nest sites is also a problem from Culebra southward through the Lesser Antilles. Red-billed Tropicbirds begin nesting months earlier than White-tails and have occupied most of the nesting cavities before the arrival of the smaller species. One of us (MWM) has seen on Saba individual pairs of Red-billed Tropicbirds in the early phases of nesting drive White-tailed Tropicbird pairs out of nest cavities. Interactions with Red-billed Tropicbirds probably account for the relative rarity of White-tailed Tropicbirds as a nesting species east and south of Puerto Rico.

Management

Management is hampered by a general lack of studies on both species of tropic-

birds. Schaffner's (1988) study of White-tailed Tropicbirds in Puerto Rico provides the only quantitative data available for the West Indies. We are conducting similar studies of the Red-billed Tropicbirds on Saba. Because of the remote nature of many nesting colonies, many important sites are seldom visited, and information on historical or current populations is lacking. However, unlike many other tropical seabirds, tropicbirds are not confined to remote islands and many major islands still support viable colonies. Long-term banding studies would provide valuable information on the age structure of populations, loyalty to colonies and specific nest sites, age at first breeding, survival, longevity, and other important information needed to construct population viability models. Genetic studies would provide information about the degree of isolation between nesting colonies.

The scattered distribution of nesting colonies buffers problems that could otherwise affect the entire populations of these two species. However, it is hard to get resource managers to recognize the importance of colonies containing only a few dozen pairs or even fewer birds. From this viewpoint it is impossible to protect specific sites from the piecemeal development which is occurring in the West Indies, and because of the tourist industry, many coastal sites and remote cays are targeted for development.

The use of traps and rat bait in the immediate vicinity of nesting areas on Culebra (Puerto Rico) yielded very encouraging results. Schaffner (1988) showed a dramatic decrease in egg and chick predation (30-50%) and a corresponding major increase in hatching success (30-50%) by controlling rats around nest sites.

In Bermuda, the use of artificial nest burrows has been attempted in the sides of quarry walls and retaining walls. Several such sites were occupied within a year. On islands in the Pacific Ocean, the simple stacking of rocks in ways that provided shaded nesting shelters created dens that were occupied by tropicbirds within hours (Lee and Walsh-McGehee, 1998).

Summary and Conclusions

None of the Western North Atlantic tropicbird breeding populations is safe. Few colonies are in parks or other protected areas. Protective legislation is scant and enforcement of existing legislation is often lacking. Areas where these birds are currently nesting are under increasing threats.

Our ability to adequately determine conservation needs and management strategies is hampered by the general lack of studies on these species. Because breeding sites are often in remote and inaccessible areas, many are seldom visited. In many areas data on former abundance are unavailable and there is little standardization in colony estimates. This is further complicated by the large number of countries involved and the lack of a central seabird database.

Current population numbers for *P. l. catesbyi,* the race of the White-tailed Tropicbird in the western North Atlantic, range from 4546 to 5276 breeding pairs, a significant decrease from the 1984 estimate of more than 10,000 pairs. Adding to this the population estimates for *P. l. ascensionis*, the Atlantic population of White-tailed Tropicbirds, the global population is estimated at approximately 20,000 pairs.

The global population of Red-billed Tropicbirds is estimated at fewer than 8000 pairs; the *P a. mesonauta* race of the Red-billed Tropicbird is estimated at between 4000 and 5000 breeding pairs. The current estimate for the population of these birds in the West Indies is around 2200 pairs. In view of the material presented and reviewed in this paper, we suggest that the global population of the Red-billed Tropicbird and the Atlantic populations of the White-tailed Tropicbird should be regarded as rare and declining species of high conservation priority.

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