Recovery Plan for the Common Tern, *Sterna hirundo*, on Bermuda

Government of Bermuda
Ministry of Home Affairs
Department of Environment and Natural Resources

Recovery Plan for the Common Tern, *Sterna hirundo*, on Bermuda

Prepared in Accordance with the Bermuda Protected Species Act 2003.

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Photos throughout this document were taken by Miguel Mejías unless otherwise stated.

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"To conserve and restore Bermuda's natural heritage"

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DISCLAIMER

Recovery plans delineate reasonable actions that are believed to be required to recover and/or protect listed species. We, the Department of Environment and Natural Resources, publish recovery plans, sometimes preparing them with the assistance of field scientists, other government departments, and other affected and interested parties, acting as independent advisors to us. Plans are submitted to additional peer review before they are adopted by us. Objectives of the recovery plan will be attained and necessary funds made available subject to budgetary and other constraints affecting the parties involved. Recovery plans may not represent the views nor the official positions or approval of any individuals or agencies involved in the recovery plan formulation, other than our own. They represent our official position only after they have been signed by the Director of Environment and Natural Resources as approved. Approved recovery plans are subject to modifications as dictated by new findings, changes in species status, and the completion of recovery actions.

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An electronic version of this recovery plan will also be made available at www.environment.bm

20th OCT. 2017

Director
Department of Environment and Natural Resources
Bermuda Government

Date

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EXECUTIVE SUMMARY

Current Species Status

This recovery plan highlights specific threats and feasible solutions deemed important to the survival of Common Terns (*Sterna hirundo*) on Bermuda. Globally, the International Union for Conservation of Nature (IUCN) currently lists the status of Common Terns as Least Concern (BirdLife International 2016). Ironically, the Common Tern is currently Bermuda's rarest breeding seabird; the White-tailed Tropicbird (*Phaethon lepturus catesbyi*) and Bermuda Petrel (*Pterodroma cahow*) are the first and second-most abundant respectively (Dobson and Madeiros 2008). In Bermuda, Common Terns are currently listed as Vulnerable under the Bermuda Protected Species Amendment Order 2016. As of 2017, the entire Bermuda tern population was comprised of five pairs (i.e. 10 adults); three of which were male-female pairs that produced viable clutches and two comprising female-female pairs which did not produce offspring. Genetic evidence also suggests that Common Terns in Bermuda are unique to the island; possible grounds for subspecies status (Szczys et al. 2012). Given these facts, it is highly recommended that the status of Bermuda's Common Terns be elevated to Critically Endangered.

Habitat Requirements and Threats

In Bermuda, Common Terns nest on small islets within the sounds and harbors. Unlike their continental counterparts, which nest in large, dense colonies (i.e. thousands of nesting pairs) on single islands, Bermudian Common Terns nest somewhat solitarily, with one or two pairs preferring to inhabit their own islet (del Hoyo et al. 1996, Nisbet et al. 2010). Isolated, artificial structures positioned in bays and harbors, providing flat, horizontal nesting surfaces (i.e. barges and buoys) are also accepted (M.M. pers. obs). Common Terns prefer open nest sites with sparse, stunted vegetation, which provide shade for offspring, although the artificial nest-sites presently used are devoid of vegetation (Burger and Gochfeld 1988, Ramos and del Nevo, 1995). As of 2017, three out of five nesting pairs (60%) are using islets and two (40%) on artificial constructs (i.e. metal navy buoys). Active islet sites on Bermuda occur in Harrington Sound, Hamilton Harbour and the Little Sound; presumably they prefer small rocky islets without beaches and surrounded by water due to their relative inaccessibility to mammalian predators (Nordström and Korpimäki 2004) and relative unattractiveness for human visitors.

Given this species incredibly precarious status in Bermuda it is not surprising it is faced with multiple threats (see Dobson and Madeiros 2008). The primary threat is powerful hurricanes, which overlap with the Common Tern breeding season (Nisbet et al. 2010). In addition to direct tern mortality, habitat degradation of nesting islets is also likely to occur during hurricanes, with low-laying nest sites (i.e. ca. 0.5 – 2 meters above sea level) being prone to over washing, submersion and erosion. Unlike cavity-nesting seabirds, which have some degree of shelter from adverse weather conditions, surface-nesting terns are completely exposed. Their only defense is to take flight, in an attempt to ride out the storm, whilst remaining close to their breeding sites (Wingate, pers. comm.). Adult Bermuda terns appear to withstand Category One hurricane force winds (74-95 mph; Saffir-Simpson scale) but Category Two (96-110 mph) and greater prove fatal to adults and chicks (Wingate, pers. comm.). Hurricane-induced tern mortality on Bermuda has had disastrous consequences on fledgling survival, as well as the sex-ratio among breeding adults (see Current Threats in section F for more details). This is likely to get worse with global

warming and sea level rise and could tip the scale to local extinction. The other main threat is predation from rats, typically *Rattus rattus*, which can easily swim to the islets. Lesser threats are disturbance and possible trampling or predation of birds by humans, especially if they land on the islets with dogs; and predation of chicks by land crabs *Gecarcinus lateralis* (Wingate, pers. comm.). Common Tern breeding sites are also threatened by fast growing, invasive plants, especially the salt-tolerant Australia pine (*Casuarina equstifolia*; hereafter 'Casuarina'). Casuarinas, once established on islets, quickly form a tall (ca. 30 feet), dense, impenetrable monoculture thicket that deter nesting Common Terns (M.M. pers. obs.). A potential threat is overfishing of baitfish, the primary food source of Bermuda's Common Terns, in bays, harbors and inlets, but the usually high fledging success on Bermuda suggests that this has not been a problem so far.

Recovery Objective

The primary objectives of this recovery plan are to stimulate population growth and nesting distribution of Common Terns on Bermuda.

Recovery Criteria

Down listing of Common Terns will be considered when:

- More than half of the historically occupied islets each support one or more male-female nesting tern pairs.
- The annual number of male-female pairs exceeds 25.
- Artificial structures in bays and harbors that could potentially attract prospecting terns are modified in order to increase breeding success.
- Casuarinas are removed from historically occupied and/or otherwise suitable nesting islets for terns.
- Suitable artificial nesting environments (i.e. large nesting rafts) have been installed in appropriate locations.

Actions Needed

1. Continued population monitoring.
2. Sign posting of all nesting islets.
3. Modification of artificial tern nesting structures.
4. Removal of invasive vegetation from nesting islets.
5. Control rats on nesting islets.
6. Amend fisheries regulations to better manage Bermuda's baitfish stocks.
7. Identify the non-breeding range of Bermuda's Common Terns.
8. Promote island wide awareness of Common Terns on Bermuda.

Recovery Costs

The total cost of recovery action cannot be defined at this time. However, the bulk of the costs will likely involve fueling research vessels to reach tern nesting sites. Funding for tern banding supplies and tracking devices can be obtained from local donors (e.g. conservation organizations, schools). Funding for nesting islets might be available from international conservation organizations if the tern is declared a distinct race or species.

Date of recovery

Meeting the recovery objectives of Bermuda Common Terns will depend on the degree of increase in tern numbers and distribution. Down listing will be considered following the practice of recovery actions for at least ten years and demonstrable recovery success. Given that seabirds are long-lived species, with slow rates of maturation, the recovery of the Bermuda terns is anticipated to be slow.

PART I: INTRODUCTION

A. Brief overview

Globally, Common Terns exhibit a circumpolar distribution, with birds breeding across the northern hemisphere and spending their non-breeding period in the southern hemisphere (Natural England 2012). In North America, Common Terns breed throughout southern Canada and the east coast of North America, reaching as far south as North Carolina (Floyd 2008, Nisbet et al. 2017). Although recognized as the one of the most abundant species of tern on the planet, their present numbers do not reflect their historical abundance. During the late 19th century heavy harvesting of Common Tern adults and chicks occurred for the fashion industry. In that period whole birds were often stuffed and mounted onto women's hats (Nisbet et al. 2017). It wasn't until 1918 where the near extirpation of Common Terns from many North American breeding sites prompted the enforcement of the Migratory Bird Treaty Act, between the USA and Canada, which granted full protection of the Common Tern (Nisbet et al. 2017). Although the release of hunting pressure saw an increase in Common Terns, their numbers began to decline again in the 20th century due to the range expansion and nest site competition of predatory gulls (Burger and Shisler 1978, O'Connell and Beck 2003, Nisbet et al. 2017).

In Bermuda, Common Tern nesting was historically widespread with no less than 40 small islets used by breeding pairs. During the 17th century, Bermuda Common Terns nested colonially with other tern species, including Least Tern (*Sterna antillarum*) and Roseate Tern (*Sterna dougallii*) on islets and rock outcrops, with Gurnet Rock identified as a nesting hotspot in the mid-1800s (Jones 1859). Like their North American counterparts, Common Terns in Bermuda were hunted for sport and specimen collections in the late-1800s (Jones 1859). This, coupled with the accidental introduction of rats to Bermuda soon after British settlement in 1612, contributed to their decline (Lefroy 1877). Conservation efforts began in the 1970s, marking the start of long-term nest monitoring. During that period the population grew to 31 breeding pairs in a period of little hurricane activity (Wingate, unpubl. data), however by 2017, the Bermuda population had reduced to only five pairs, three of which produced chicks. The life history data which has been obtained from over 40 years of nest monitoring, coupled with foraging observations, is crucial for informing management decisions.

B. Current protection status

Bermuda Common Terns have been classified as a level 1 protected species and considered to be Vulnerable under the Bermuda Protected Species Amendment Order (2016).

Legal Protection

The Protected Species Amendment Order (2016) considers it an offense for an unauthorized person to willfully damage, destroy, injure, disturb, remove, uproot, fell, kill, import, export, sell or purchase a level 1 protected species or any part of a level 1 protected species. Offenders are liable, on summary of conviction, to a fine of $25,000 or two years of imprisonment. Common Terns are also protected under the Bermuda Protection of Birds Act (1975).

Habitat Protection
Under the Protection of Birds Act 1975, all government owned tern nesting sites, and those belonging to private owners who have given consent, are protected under the Nature Reserves (Tern Nesting Areas) Order 1976. Ordnance maps showing the protected islets can be found by contacting the Department of Works and Engineering, the Department of Marine and Ports Services or the Botanical Gardens.

C. Taxonomy and description of species

Class: Aves (Birds)
Order: Charadriiformes (Wading birds)
Family: Laridae (Gulls and Terns)
Genus: *Sterna*
Species: *hirundo*

Common Terns belong to the family which includes gulls (better known to most people as 'seagulls') and terns. Gulls are generally larger than terns with longer, broader wings, longer, thicker legs and bills, and can walk, fly and swim equally well (Sibley 2003, Floyd 2008). Terns are smaller, with relatively shorter, narrower, and angular wings, shorter legs and pointed bills (Sibley 2003, Floyd 2008). Terns prefer catching their own prey and are generally fish and/or insect eaters whereas most gulls will readily scavenge human food. In Bermuda Common Terns can be readily distinguished from breeding White-tailed Tropicbirds (hereafter 'Longtails'), the most common seabird most likely to be mistaken for a tern on Bermuda (Figure 1). Breeding Common Terns have a jet-black cap that extends to the nape, contrasting with a whitish grey face. Their bills are blood-red with a black tip. Their upperparts are darkish grey, while their underparts are white with a light grey wash. Their primary feathers (i.e. outermost wing tips) are black, while the undersides of primaries have a narrower, black bar. Their greyish tails are forked and their short, stubby feet are as red as their bill. In contrast, Longtails are larger, with a white head, narrow black mask, and reddish-orange to yellow bill (Gross 1912). Although Longtails have short feet like terns, they are jet black and usually concealed under the plumage. Longtails are heavier and mainly white except for a black patch around the eye and black patches on the upper side of the wing. The tail has two extremely long feathers which extend approx. 12 inches beyond the body.

Terns can also be separated from Longtails by their flight style. Common Terns have slower, deeper wingbeats, giving them a dainty, more buoyant flight. Common Terns can also rapidly alternate between said flight, to quick, evasive turns, loops, and hovering; with birds needing to fan their tails to accomplish such feats. Whilst inshore, Common Terns fly relatively close to the water surface (i.e. ≤ 20 feet) and can be readily seen surface plunging for small fish. Longtails, however, have shallow, rapid, pigeon-like wingbeats and generally maintain the same flight speed and vary greatly in altitude over the ocean, with individuals often seen well over 100 feet. Unlike Bermuda Common Terns, which usually fly solitarily, Longtails often fly in loose, vocal flocks of three to six individuals. Lastly, Bermuda Longtails typically feed far offshore, and penetrate the water column with impressive dives from ca. 30-40 feet (M.M. pers. obs).

Figure 1. A female-female breeding pair of Common Terns at rest on an abandoned buoy located in the Little Sound of Bermuda. Note that the bird on the right is ringed on its right leg. Photo by Dr. Andre Raine.

D. Current Status

Global distribution

Common Terns have a broad geographic distribution (Figure 2). They occupy most continents, during a portion of the calendar year. Breeding occurs largely across the temperate, northern hemisphere in the spring and summer months and non-breeders spend fall and winter periods further south, some in the southern hemisphere (Burger and Gochfeld 1991). Common Terns in the western hemisphere breed throughout southern Canada and along the eastern seaboard of the United States, as far south as North Carolina, and winter further south in the Caribbean, the coasts of southern Mexico and South America (Haymes and Blokpoel 1978, Burger and Gochfeld 1991, Nisbet et al. 2011). Common Terns in the eastern hemisphere breed across Europe and spend winter periods as far south as western and South Africa and Australia (Rowan 1962, Chan and Dening 2007). Common Terns in both North America and Europe form large, loud, conspicuous breeding aggregates, with some areas supporting thousands of breeding pairs (Burger and Gochfeld 1991). For this reason, Common Terns are regarded as the most familiar tern species in both the eastern and western hemisphere.

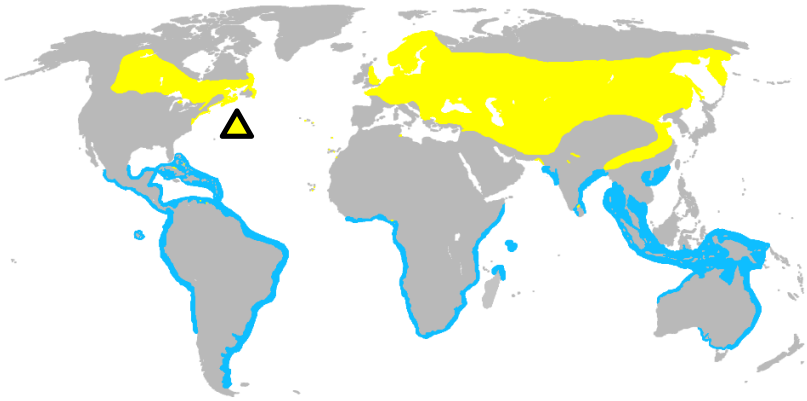

Figure 2. Map illustrating the global distribution of Common Terns. Northern breeding sites and southern wintering sites are depicted in yellow and blue respectively. Bermuda's location is marked with a triangle.
Photo taken from https://en.wikipedia.org/wiki/Common_tern#/media/File:CommonTernmap.png.

Local distribution

In the 1840s, Gurnet Rock, located in the east end of Bermuda, was known to support large, tern breeding colonies, comprised of Common and Roseate Terns (Jones 1859). Between 1973 and 2017, Dr. David Wingate identified 40 tern nesting sites across Bermuda's bays and harbors, each site varying greatly in annual breeding activity (Wingate, unpubl. data). During this time period, Common Terns reached their peak abundance (i.e. 31 pairs) in 1985. However, numbers plummeted to seven pairs by 2004, after Category 3 Hurricane Fabian passed directly over the island (Wingate, unpubl. data). Between 2004 and 2009, only nine small, sparsely vegetated islets in sheltered locations were used for nesting; Burch Rocks (in Mangrove Bay), Pearl Island, Rickett's Island, Agassiz Island (Great Sound), Collin's Island, the East and West Dumpling islands (Harrington Sound), North and South Cock Rocks (Castle Harbour) (Nisbet et al. 2010). By 2017, the entire Bermuda tern population consisted of 10 adults, comprising three male-female breeding pairs and two female-female non-breeding pairs, on five sites scattered across the island (Figure 3). Three of those sites are small, isolated islets, while the remaining two are old, abandoned navy buoys placed in the 1940s. All known nesting sites where terns were historically present are checked annually for signs of recolonization.

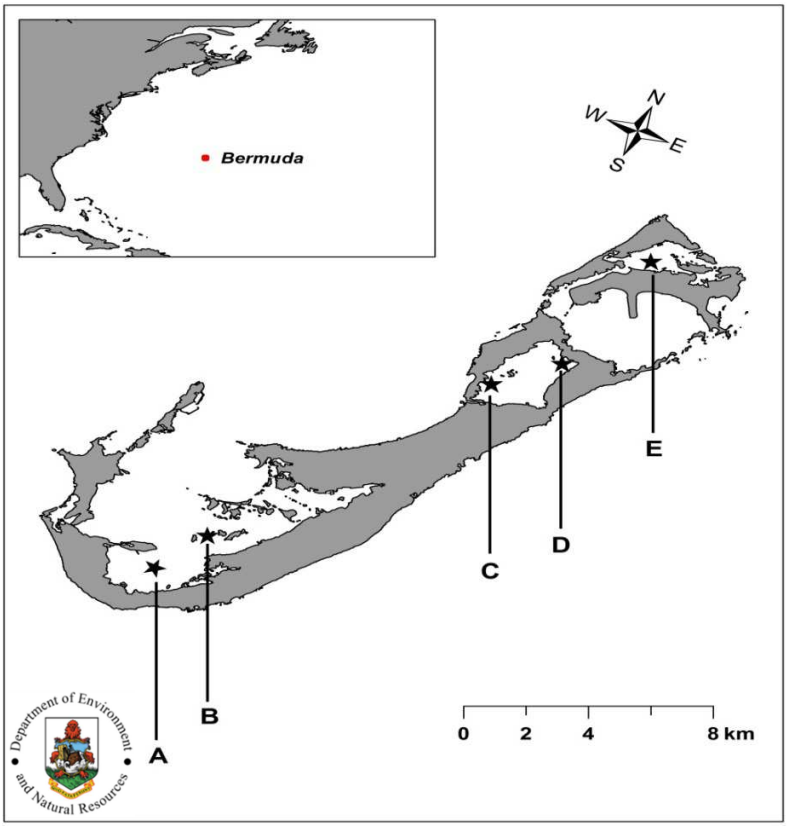

Figure 3. Locations of all known Common Tern breeding sites across Bermuda, during the 2017 breeding season. (A) Little Sound navy buoy, (B) Rickett's Island, (C) Collin's Island, (D) East Dumpling Islands and (E) St. George's navy buoy.

E. Ecology

Habitat Requirements

Globally, Common Terns nest on a wide variety of habitats. Coastal breeders typically favor inshore islands (Snow and Perrins 1998, Burger and Gochfeld 1991), coastal lagoons (Snow and Perrins 1998), sandy beaches, dunes, spits and grassy plateaus on top of coastal cliffs (del Hayo et al. 1996). Mainland breeders select islands in lakes, rivers, marshes and lake shores comprised of sand and shingle (Palmer 1941, Richards 1990, Burger and Gochfeld 1991, del Hayo et al. 1996, Snow and Perkins 1998). Continental Common Terns are largely gregarious, with sites supporting thousands of nesting pairs (del Hayo et al. 1996). Interestingly, the Bermudian terns prefer to nest solitarily on their own respective islets, even when their numbers were greater (Wingate, unpubl. data). Both continental and Bermudian birds share some similarities. For example, Common Terns in both localities select nest-sites with stunted and sparse vegetation.

In Bermuda, Common Terns nest on smaller islands and islets throughout sounds, harbors and inlets (Figure 4). Dominant native vegetation typically found on these sites includes Sea Ox-eye

(*Borrichia arborescens*), Buttonwood (*Conocarpus eretus*), Seaside Heliotrope (*Heliotropium curassavicum*), Coast Spurge (*Euphorbia mesembrianthemifolia*), Sheathed Paspalum (*Paspalum vaginatum*), Salt Grass (*Spartina patens*), Seashore Rush Grass (*Sporobolus virginicus*) and thick, mats of Seaside Purslane (*Sesuvium portulacastrum*). Common Terns appear to prefer sparse, stunted vegetation on nest sites because it doesn't obstruct their view, while at the same time providing some shade for chicks. The nesting sites in Bermuda usually have loose, sandy deposits and dead plant materials, which terns use to build nests.

Common Terns also nest on abandoned, floating, human-made structures (i.e. barges and buoys, see Figure 5). Although Bermuda terns have successfully reared chicks on such structures, it requires conservation intervention to ensure successful hatching (see section F), and fledging success can be poor (Wingate and Mejías, unpubl. data). Despite the drastic differences in appearance between islets and abandoned barges and buoys, they are all isolated nesting environments, making them equally attractive to prospecting terns. Common Terns may select these sites in an attempt to avoid mammalian predators, such as cats and rats.

Figure 4. Collin's Island, an islet used by nesting Common Terns in Harrington Sound. Note the tern "No Landing" sign, usually found on active breeding sites.

Figure 5. A defunct, navy buoy used by nesting terns in St. George's Harbour.

Population Biology

Long-term nesting surveys have shown that the Bermuda Common Tern population has significantly declined. During their peak productivity in the 1980s, the 31 nesting pairs produced an average of 2.5 chicks per pair per year (Wingate, unpubl. data). On September 5th 2013, Category 3 Hurricane Fabian made landfall over Bermuda, decimating many Common Tern adults and chicks (Nisbet et al. 2010). This mass mortality was made apparent the following breeding season, when no chicks were produced (Nisbet et al. 2010) despite the seven breeding pairs (a 77% decline from the previous year) which returned to Bermuda and laid eggs. Another anomalous event occurred in 2004, when the terns produced "super clutches," which comprised 5-7 egg clutches, as opposed to the typical 3-4 egg clutches (Wingate, unpubl. data; Figure 6). Subsequent DNA analyses from blood samples confirmed that Hurricane Fabian killed all of the breeding males the previous year, resulting in a nesting population comprised entirely of females in 2004. Without males in the population, the females paired up and shared a single nest, both contributing infertile eggs to the nest. This has also been observed in North America's Common Terns (Nisbet et al. 2011).

Females depart from Bermuda in August soon after their young fledge (usually July or early August); departing significantly earlier than male terns. This pattern is typically observed in other Common Tern colonies (Nisbet et al. 2010, Nisbet et al. 2011). The males remain longer in order to continue rearing the fledglings, before departing south with fledglings in September and October (Nisbet et al. 2011; Wingate, unpubl. data). This extended stay makes adult males and chicks vulnerable to tropical storms and hurricanes which occur most frequently on Bermuda in September and October. Despite the high mortality of the breeding males on Bermuda in 2003, the first year birds, which remain on the South American wintering grounds during their first summer were spared and returned to Bermuda in subsequent years to breed, thus saving the population from local extinction. The ill-effects of Hurricane Fabian are still observed within the Bermuda tern population nearly a decade and a half later. The current (2017) population

comprises five pairs, of which two of the three male-female breeding pairs have selected small, exposed, unstable navy buoys as nesting sites in the Little Sound and in St. George's Harbour (Wingate and Mejías unpubl. data). The latter pair has nested on the buoy for the past five years, with poor nesting success to show for it (i.e. one fledgling per year; Wingate and Mejías, unpubl.data). Conservation efforts were undertaken in 2017 to modify the St. George's buoy in order to promote nesting success which resulted in the pair successfully rearing three fledglings (see section F for more details).

Figure 6. (Left) A female-female clutch of Common Tern eggs from Dumpling Island-East, in Harrington Sound. Note the abnormaly large clutch size (i.e. ≥ 5 eggs) and the two distinct colors (i.e. buffy brown [n = 3 eggs] and olive green [n = 3]) between the six eggs, indicating the different contributions by the two females. (Right) A female-male clutch of Common Tern eggs from Rickett's Island, in the Great Sound, Bermuda. Note normal clutch size and uniform egg color, indicating a single female.

Given that Bermuda terns are currently close to local extirpation, the survival of breeding adults, as well as recruitment of new breeders, is considered vitally important. The lifespan of a Common Tern is ca. 25 years, with younger breeders having lower survival (Nisbet and Cam 2002). Common Terns reach maturity as young two years old, at which point they return to natal breeding sites (Nisbet and Cam 2002, Braasch et al. 2009). In the case of the Bermuda tern population, the number of viable breeding pairs has remained at 2-3 since 2011, suggesting recruitment of new adults is very low (Wingate and Mejías, unpubl. data). This is thought to be due to the small number of fledglings produced annually (mean 7) since 2011 (Wingate and Mejías, unpubl. data).

As with Common Terns throughout North America and Europe, Bermudian Common Terns are highly migratory; with non-breeders departing south from their breeding sites. Although there is more research required to understand the year-round distribution of Bermuda Common Terns, four ring recoveries (out of 945 banded chicks) indicated that individuals spend parts of their non-breeding period in South America, slightly south of the equator and mainly in coastal areas of Brazil (Wingate 2007, Szczys et al. 2012).

Reproduction

In Bermuda, the Common Tern breeding season occurs between April and October. Adults typically appear during the first few weeks in April, with some occasionally arriving as early as late-March (M.M. pers. obs). Individuals arrive at breeding areas singly, waiting ca. 2 weeks for their mate to appear. Common Terns, like many other seabirds, are monogamous and exhibit high mate and nest site fidelity (González-Solís et al. 1999). The courtship rituals of Common Terns are quite conspicuous. The male flies noisily overhead, in circles, close to a grounded female, who calls out loudly, whilst the male carries a fish in his bill (D.W. pers. obs). The male will present his offering to the female, and, if she accepts, she will take the fish from the male. Even after the pair bond is formed the male may conduct several of these offerings.

After courtship, terns proceed to make a small depression somewhere on the nesting islet. Common Terns use various materials to construct a rudimentary nest. In Bermuda the nest consists of a subtle depression in the center, ca. 4 inches in diameter around which dead stems, rootlets and leaves of coastal plants are placed. Fish bones lying about the nest sites are also incorporated into nests (M.M. pers. obs).

Copulation soon follows nest construction, with the female later laying 3-4 eggs that are either buffy brown, dark brown or olive-colored, each coated with black and grey speckles, spots and splotches (Figure 6). Clutch sizes ≥ 5 are indicative of a female-female nest pair, with both birds contributing. Eggs are typically laid within the first few weeks of May, and both sexes partake in a ca. 23 day incubation period. If the first nest attempt fails, the female can lay a replacement clutch ca. 11 days later. Peak hatching occurs late-May to early-June (Wingate and Mejías, unpubl. data). Hatchlings are initially covered in buffy brown down, covered in black spots (Figure 7); a color pattern highly reminiscent of their eggshells. Nestlings are precocious (i.e. can open their eyes and move around nest site immediately after hatching), although they still require frequent brooding by their parents. Even though their downy plumage sharply contrasts with the grey limestone terrain and bright green foliage of coastal plants on their nesting islets, the chicks are adept at hiding thereby making them surprisingly difficult to detect. When an intruder approaches and/or lands on a nest site, the adults immediately take flight and start to deliver a series of ear-piercing alarm calls, whilst aggressively dive-bombing and defecating on the intruders (Figure 8). The alarm calls, in turn, compel chicks to take cover in vegetation, nooks and crannies throughout the nest sites and remain still.

Chicks fledge 27-29 days after hatching and begin practicing flying within the immediate vicinity of their nest site. Approximately 2-3 weeks later the birds begin flying further and further afield with their parents, who continue to feed their young, whilst perched on buoys, reef markers and rock outcrops. It is at this point the tern family will abandon their nest site. By the

end of August, the females depart Bermuda, leaving the males to protect and defend the young in September and October.

Figure 7. Common Tern hatchling photographed on Rickett's Island, the Great Sound. Photo by Lynn Thorne.

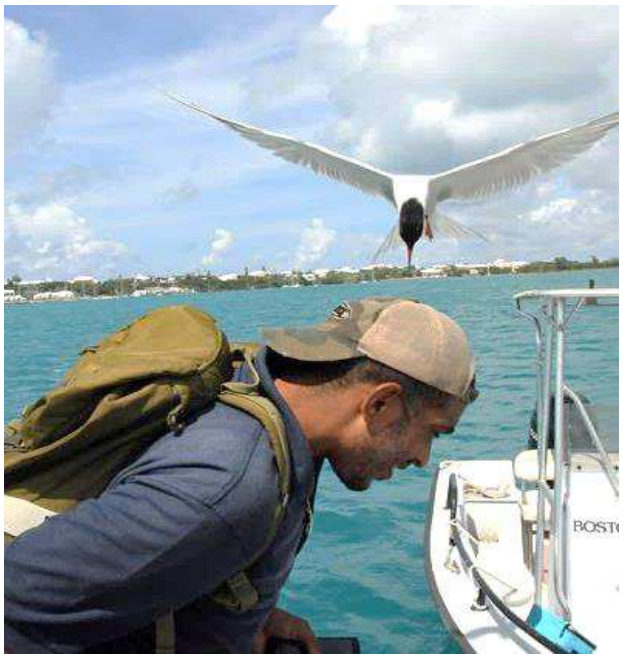

Figure 8. The author being dive-bombed by nesting Common Terns during a nest check survey at the St. George's Harbour tern buoy. Photo by Lynn Thorne.

Diet and Feeding
Common Terns feed on a wide variety of fish, favoring ones closest to the surface (Taylor 1979, Safina and Burger 1985, Safina et al. 1990). In Bermuda, Common Terns hunt a variety of small, schooling fishes known locally as 'bait fish'; anchovies (*Engraulidae*), herring and pilchards (*Clupeidae*), as well as needlefish (*Belonidae*) (Smith-Vaniz et al. 1999, M.M pers obs). Specific fish species known to be consumed by terns include Hogmouth Fry (*Anchoa choerostoma*) and Spanish Sardine (*Sardinella aurita*) (M.M. per obs). In Bermuda, Common Terns generally hunt for bait fishes in shallow waters and often patrol bays, inlets and harbors, looking for schooling fish. Common Terns locate fish on the wing, and capture them by plunging into ocean surface. Common Terns appear to carry only one fish at a time and feeding trips to chicks are frequent. Adults have been observed feeding chicks every 7-12 minutes during two separate one hour observation periods (M.M. pers. obs).

F. Current Threats

Although seabirds in Bermuda, including Common Terns, are no longer harvested for food or specimen collection, nesting terns continue to be disrupted and threatened by people, particularly when attempting to land on or operating a boat too close to tern nesting sites, prompting adults to attack intruders, leaving their vulnerable eggs and chicks unattended. Member of the public who are attacked by nesting terns sometimes resort to swatting them in midair with oars and/or boat lines, which can injure and/or kill birds. With this in mind, the following section aims to highlight and discuss the current threats faced by breeding Common Terns on Bermuda.

Hurricanes
The greatest threat facing Bermuda Common Terns is considered to be hurricanes, which negatively impact the breeding population by physically reducing their numbers and skewing the sex ratio of breeding pairs. Given that most nesting sites are $\leq$ 4 meters above sea level, the storm surge associated with hurricanes can readily over wash, submerge and erode tern nesting islets. Such disturbance forces terns to take flight, where they are met with hurricane force winds. Bermuda Common Terns appear to cope with Category 1 hurricanes, but hurricanes of Category 2 and above prove fatal (Wingate pers. comm). With the North Atlantic experiencing increasing hurricane severity, a trend dating back to 1995, the Bermuda Common Tern population might be at higher risk of long-term nesting failure (Goldenberg et al. 2001, Emanuel 2005). An additional climatic factor that threatens nesting terns in Bermuda is sea level rise. Sea level on Bermuda has risen at least six inches since the beginning of the twentieth century. It is estimated that a sea level rise of ca. 0.59 meters would greatly reduce the acreage of seabird nesting sites throughout Bermuda (Glasspool 2008). This, coupled with increasing hurricane strength and frequency, would greatly reduce the quality of the low-lying tern nesting sites.

Artificial structures
The breeding success of Common Terns can also be compromised by nesting on abandoned, human made structures, which are likely attractive to terns because of their isolation and flat, horizontal surfaces. However, terns on such structures exhibit poor breeding success, due to inadequate features of these constructs. For example, a clutch of eggs on a barge was once found on a mound of rusty, metal fragments, in full exposure to the summer sun (Figure 9). Some tern pairs also select unstable, partially sinking, navy buoys whose bare, metal and fiber glass surface also compromise breeding success (Figure 10). Without any sand or vegetation materials on the

buoys, tern eggs often break or roll off the buoy into the sea. Similarly, chicks ≤ 3 weeks old, which are incapable of strong flight, have been known to fall off human made structures, before fledging with no possibility of climbing back on because of their vertical sides (Wingate and Mejías, unpubl. data). Because terns have high nest site fidelity, these structures function annually as an "ecological trap"; a nesting environment consistently used by breeders that compromises their breeding success (Schlaepfer et al. 2002). Such habitats, like these navy buoys, appear to mimic typical nesting sites for Common Terns, effectively misleading breeders.

Figure 9. A Common Tern adult with a clutch of four eggs resting on top of a pile of hot, rust debris, on an abandoned barge in the Little Sound. Note fish bones used as nest material. Photo by Dr. Andre Raine.

Figure 10. A male-female nesting pair of Common Terns with a single egg laid on the bare metal and fiber glass surface of an abandoned navy buoy in the Little Sound. The egg in photo is depicted within the red circle. Photo by Lynn Thorne.

Invasive vegetation
Breeding tern islets are also threatened by overgrowth from invasive vegetation, most notably, the Casuarina. These trees grow rapidly, creating tall stands. These discourage terns from nesting because their view is obstructed.

Reduction of baitfishes in nearshore waters
Anecdotal evidence suggests that the heavy exploitation of baitfish on Bermuda could be a constraint that could limit the recovery of Bermuda's Common Tern population. In Bermuda, baitfish school in nearshore and inshore environments, which are favored hunting areas by Common Terns (M.M. pers. obs.). Unfortunately, inhabiting shallow waters make baitfish readily vulnerable to net fishermen. Excessive hunting pressure on baitfish by net fisherman can not only directly reduce baitfish abundance, but also the numerous species that rely on them as a food source, including the Common Tern.

G. Current conservation action

Annual nesting surveys are still being undertaken, during which adults, eggs and chicks are counted. Egg and chick morphometrics are also performed. Furthermore, tern adults and chicks are continually being banded (see Figure 11) to provide data on rates of recruitment to the nesting population, site fidelity, and annual adult survival. Tern pairs nesting on artificial structures that are deemed poor-quality nesting habitat are provided with wooden or plastic boxes filled with sand for their eggs to be placed on. Terns nesting on unstable buoys are also provided nesting substrate (i.e. beach sand) and a protective barrier (i.e. bricks) to prevent eggs and chicks from falling overboard (Figure 12). Such modifications have proven to be highly effective; as illustrated by 100% fledging success in 2017 after buoy improvements (Wingate and Mejías, unpubl. data). Monitoring for rat re-invasion of the islets is undertaken annually and should ideally be done before the nesting season begins in March or April, either by setting out live traps or by prophylactic baiting with rodenticides (e.g. Hawk, Contrac Blox, Havoc, Tomcat). The erection and maintenance of no landing signs is an ongoing activity (see Figure 12).

Exploratory research on boosting nest success
In May 2016, the first trial of tern egg translocation began, which saw a fertile clutch (n = 4 eggs) taken a few days after clutch completion, from a male-female pair on the St. George's buoy, and given to a female-female pair on Dumpling East, for incubation and chick rearing (the infertile clutch of the latter pair was removed and deposited with the Bermuda Natural History Museum). The male-female pair subsequently laid a replacement clutch of three eggs ca. 11 days later. All four translocated eggs produced four fledglings, under the care of the female-female pair. Although all three eggs from the replacement clutch of the male-female pair on the St. George's buoy hatched, only one chick survived to fledging because the other two chicks fell overboard, before the nesting buoy was improved (Wingate and Mejías, unpubl. data). This was the very first trial of cross-fostering fertile eggs from a male-female pair to a female-female pair and it won't be known if the procedure will effectively boost the population until there is proof that the cross-fostered chicks have survived. It is possible that the fledglings migrated south with the females too early before they were strong enough to survive the migration, a concern that is supported by the observation that they vanished from Bermuda immediately after fledging

despite exhaustive searches for them across the Bermuda Platform (note the four cross-fostered chicks were double banded to facilitate easy recognition in the field). It is expected to take 2-3 years before these individuals will return to Bermuda.

Figure 11. A Common Tern chick being fitted with a metal identification ring, on the right leg, by the author on Rickett's Island, the Great Sound. Photo by Lynn Thorne.

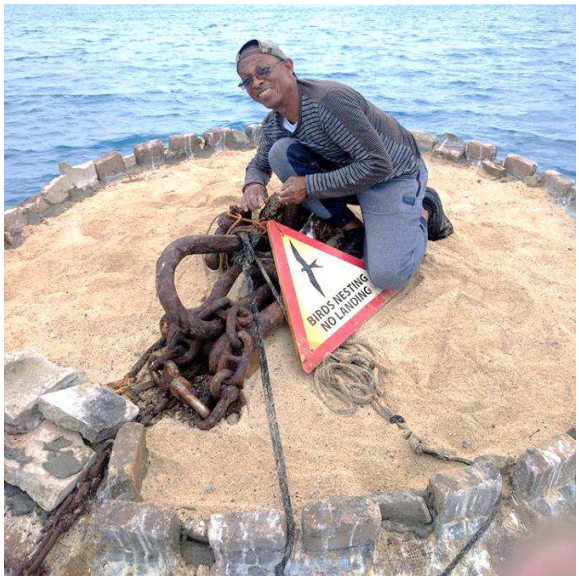

Figure 12. The author's father, Pedro Mejías, on a navy buoy in St. George's Harbor which was modified to increase the nesting success of terns. Note the cemented bricks around buoys periphery, abundant nesting sand and the "no landing" sign.

PART II: RECOVERY

A. Recovery goal

This Recovery Plan highlights specific action steps deemed necessary to increase the abundance and distribution of Bermuda Common Terns. It is divided into short term (i.e. five years) and long term (i.e. 30 years) goals. Short term goals include the removal of invasive vegetation on nesting islets, the modification or removal of artificial structures deemed hazardous to nesting terns and to spread island-wide awareness of the Common Terns. Long term goals (i.e. 30 years) are to increase the Bermuda Common Tern population such that at least half of previously occupied breeding islets are re-colonized by male-female nesting pairs.

B. Recovery objectives and criteria

Down listing of Common Terns in Bermuda will be considered when:

- More than half of the historically occupied islets each support one or more male-female nesting tern pairs.
- The annual number of male-female pairs exceeds 25.
- Artificial structures in bays and harbors that could potentially attract prospecting terns are modified in order to increase breeding success.
- Casuarinas are removed from historically occupied and/or otherwise suitable nesting islets for terns.
- Suitable artificial nesting environments (i.e. large nesting rafts) have been installed in appropriate locations.

These overall objectives translate into specific targets outlined below:

Short term target (five years): Short term objectives are focused largely on the restoration of previously known and new potential nesting islets, as well as ensuring said sites all have clearly posted “no landing” signs, and modify artificial structures to promote increased nesting success. Short-term goals also include eliminating rats on small nesting islets.

Long term target (30 years): Long term objectives involve stimulating population growth and studying the movement and distribution of non-breeding Common Tern adults and fledglings that have departed Bermuda. The continued translocation of fertile, first clutches from male-female pairs to female-female pairs is expected to increase fledging rates. Identifying the pelagic distribution of Bermuda Common Terns outside the breeding season will be important for recognizing specific areas birds may be vulnerable during other stages of their life cycle. To accomplish this, adults and fledglings can be captured and fitted with light-based geolocators and smaller, satellite tags, when such technology is readily available (Mejías et al. 2017).

C. Recovery strategy

This Plan recognizes that the recovery and stability of Bermuda's tern population is limited, and influenced, by the frequency and severity of hurricanes over which we have no control. Although modifications of nesting sites to act as a buffer against hurricanes is not feasible, increasing tern breeding productivity, thus improving their long-term persistence, is the focal strategy of Bermuda tern recovery. It is also vital that tern pairs breeding on unsuitable, artificial structures are provided with nesting substrate and shade cover (i.e. shade boxes) for the chicks. The continued translocation of fertile tern eggs to female-female nesting pairs during each breeding season is presently experimental and will not be considered part of routine management until such a time as it is proven to be an effective population boosting activity.

D. Tools available for strategy

The methodology for surveying nesting terns in Bermuda have been established and refined since the 1970s by Dr. David Wingate. Improvements to survey protocols, including trapping adults, taking blood samples and banding captured birds, are reported in Nisbet et al. (2010). Additional information regarding general biology, threats and strategic actions involving the Common Tern can be found in other action plans for this species (see U.S. Fish and Wildlife Service 1989 and Pfannmuller and Martell 2014).

E. Step-down narrative of work plan

Abbreviations used in section E and F:

DW: David Wingate
MM: Miguel Mejias
BAMZ: Bermuda Aquarium Museum and Zoo
BAS: Bermuda Audubon Society
DENR: Department of Environment and Natural Resources
BZS: Bermuda Zoological Society

The actions needed to achieve recovery are as follows:

1. Continued population monitoring.
2. Sign posting of all nesting islets.
3. Modification of artificial tern nesting structures.
4. Removal of invasive vegetation from nesting islets.
5. Control rats on nesting islets.
6. Amend fisheries regulations to better manage Bermuda's baitfish stocks.
7. Identify the non-breeding range of Bermuda's Common Terns.
8. Promote island wide awareness of Common Terns on Bermuda.

1. Continued population monitoring.

Actions proposed:

- Continue annual monitoring at current nesting locations,
- Monitor historically used nesting sites for new nesting activity,
- Continue with the capture and banding of tern adults and chicks.

Work team: DW and MM
Team Leader: DW
Assistance: Staff from DENR, volunteers from BZS and the BAS
Outputs: Additional data on Bermuda tern breeding productivity and distribution
List of equipment required: Boat, bird banding/ringing experience, field book, bird banding license, bird rings, calipers, cotton weighing bags, spring balance scale, wing chord ruler, and plyers to attach or remove bird rings

2. Sign posting of all nesting islets.

Actions proposed:

- Create additional "no landing" signs,
- Erect on select breeding islets/structures when needed.

Work team: MM
Team Leader: MM
Assistance: Staff from DENR, volunteers from BZS and the BAS
Outputs: All of the nesting locations actively used by terns are clearly marked with signs advising the public not to land.
List of equipment required: Boat, signs

3. Modification of artificial tern nesting structures.

Actions proposed:

- Assess the integrity of structures presently used by nesting pairs,
- Provide beach sand for tern clutches to be laid on,
- Ensure there is sufficient shade cover for chicks,
- Cement bricks or pieces of timber around the periphery of existing structures (note materials should not be higher than five inches to ensure that terns can see over barricade),
- Provide an alternative perch at sea level on existing structures for young chicks that fall into the sea,
- Contact the Bermuda Marine and Ports Services and seek the removal of structures deemed poor-quality and unsuitable for nesting,
- Identify new locations where artificial structures could potentially be installed to attract prospecting terns,
- Install new structures where appropriate.

Work team: DW, MM and Marine and Ports Services

Team leader: DW
Assistance: Staff from DENR, volunteers from BZS, the BAS and the general public
Outputs: Increased nesting success on human-made structures
List of equipment required: Boat, beach sand, cement, bricks, wood.

4. Removal of invasive vegetation from nesting islets.

Actions proposed:

- Remove Casuarinas from all suitable tern nesting islets, giving priority to locations presently being used.

Work team: DW and MM
Team Leader: DW
Assistance: Staff from DENR, volunteers from BZS, the BAS and the general public
Outputs: Restoration of suitable nesting islets for terns
List of equipment required: Boats, chainsaws, rope, helmets, first-aid kits, weed wrenches, herbicide (i.e. Garlon or Tordon)

5. Control rats on nesting islets.

Actions proposed:

- Survey nesting islets annually for the presence of rats before the nesting season begins,
- Use a combination of rodenticides in bait boxes and live cage traps to remove rats when discovered.

Work team: DW and MM
Team Leader: DW
Assistance: Vector control, staff from DENR, volunteers from BZS, the BAS and the general public
Outputs: Increased fledging success
List of equipment required: Boats, poison bait boxes, poison bait blocks, live rat traps and bait for live traps (i.e. cheese or peanut butter).

6. Amend fisheries regulations to better manage Bermuda's baitfish stocks.

Actions proposed:

- Assess the abundance and distribution of baitfishes within Bermuda's inshore and nearshore waters,
- If necessary create additional fisheries regulations to promote the suitable use of the various baitfishes within Bermuda's territorial waters.

Work team: Staff from DENR
Team leader: DENR
Assistance: Commercial and recreational fishermen
Outputs: A healthier population of baitfishes in Bermuda's territorial waters

List of equipment required: To be determined.

7. Identify the non-breeding range of Bermuda's Common Terns.

Actions proposed:

- Deploy geolocators and satellite tags to track the seasonal movements of Common Tern adults and fledglings,
- Collate and analyze data,
- Publish findings.

Work team: DW and MM
Team Leader: DW
Assistance: Staff from DENR, volunteers from BZS, the BAS and the general public
Outputs: Better understanding of habitat use and life history traits of Bermuda's Common Terns.
List of equipment required: Boat, net gun, live cage traps, decoy tern eggs, geolocators, satellite tags, leg rings, darvick bands, zip ties and marine epoxy.

8. Promote island wide awareness of Common Terns on Bermuda.

Actions proposed:

- Give public lectures and create printed media,
- Install appropriate signage on actively used tern nesting sites,
- Create a short television documentary.

Work team: DW and MM
Team Leader: DW
Assistance: Media outlets
Outputs: Increased island wide awareness of breeding Common Terns on Bermuda and the threats they face.
List of equipment required: Computer, projector screen, suitable lecture space, "no landing" signs.

F. Estimated date of down listing

Most of the proposed recovery actions will have to be practiced on a long-term basis, such as population monitoring, rat control, baitfish research, tracking terns and spreading island wide awareness. Whereas the recovery actions of Casuarina removal and the modification or removal of abandoned, artificial structures are short term goals. However, Common Terns are a long-lived species, with slow maturation. Therefore, recovery plans geared towards a severely small tern population, like Bermuda's, will involve extremely long delays, before the desired response is achieved. Re-assessment of the species following long-term of recovery actions, should be carried out every ten years.

PART III: IMPLEMENTATION

Priority 1: An action that must be taken to prevent extinction or to prevent the species from declining irreversibly.
Priority 2: An action that must be taken to prevent a significant decline in the species population/habitat quality, or some other significant negative impact short of extinction.
Priority 3: All other action necessary to provide for full recovery of the species.

Priority #	Task #	Task description	Task duration	Responsible party
1		**Manage unsuitable human-made nesting structures**		
	1	Modify or remove the old navy buoys	24 months	DW, MM
1		**Predator Control**		
	2	Place live rat traps and poison bait boxes on tern sites	On going	DW, MM
2		**Continued population monitoring**		
	3	Monitor all tern nesting sites	On going	DW, MM
2		**Restore tern nesting islets**		
	4	Remove Casuarinas from tern islets	2 years	MM, DENR
	5	Erect no landing signs		
3		**Island wide awareness**		
	6	Give presentations at businesses, schools; publish articles in Royal Gazette.	10 years	DW, MM
3		**Identify non-breeding range of Bermuda terns**		
	7	Capture and fit geolocators onto adult Common Terns	4 years	DW, MM, DENR
	8	Capture and fit satellite trackers onto fledgling Common Terns	4 years	DW, MM, DENR
3		**Manage baitfish stocks**		
	9	Amend legislation for catching baitfish	10 years	BZS, DENR

APPENDIX

Table 1. Summary of the breeding activity of male-female Bermuda Common Terns between 2011 and 2017. Metrics include hatching success (the total number of eggs hatched from the total number of eggs produced) and fledging success (the total number of chicks fledged from the total number of eggs produced). Only hurricanes which made landfall on Bermuda are reported.

Year	Number of breeding pairs	Total # of eggs	Hatching Success (%)	Fledging Success (%)
2011	3	8	8 (100%)	8 (100%)
2012	2	5	5 (100%)	5 (100%)
2013	3	12	8 (67%)	7 (88%)
2014[a]	3	10	5 (50%)	4 (80%)
2015	3	11	7 (64%)	5 (71%)
2016[b]	3	10	10 (100%)	8 (80%)
2017	3	9	9 (100%)	9 (100%)

[a] Hurricanes Fay (Cat 1) and Gonzalo (Cat 2)

[b] Hurricane Nicole (Cat 3)

REFERENCES

Amos, E. J. 1991. The birds of Bermuda. Island Press: Bermuda.

BirdLife International. 2016. *Sterna hirundo*. The IUCN Red List of Threatened Species 2016: e.T22694623A86784385. http://dx.doi.org/10.2305/IUCN.UK.2016-3.RLTS.T22694623A86784385.en. Downloaded on 10 August 2017.

Braasch, A., C. Schauroth, and P.H. Becker. 2009. Post-fledging body mass as a determinant of subadult survival in common terns Sterna hirundo. Journal of Ornithology 150: 401-407.

Burger, J. and J. Shisler. 1978. Nest site selection and competitive interactions of Herring and Laughing Gulls in New Jersey. Auk: 252-266.

Burger, J., and M. Gochfeld. 1988. Nest-site selection and temporal patterns in habitat use of Roseate and Common Terns. Auk: 433-438.

Burger, J., and M. Gochfeld. 1991. The Common Tern: it's breeding biology and social behavior. Colombia University Press: New York City. USA.

Chan, K., and J. Dening. 2007. Use of sandbanks by terns in Queensland, Australia: a priority for conservation in a popular recreational waterway. Biodiversity and Conservation 16: 447-464.

Del Hoyo J, A. Elliott, and J. Sargatal. 1996. Hoatzins to auks. Handbook of birds of the world, Vol. 3Barcelona: Lynx Editions

Dobson, A.F., and J.L. Madeiros. 2008. Threats facing Bermuda's breeding seabirds: measures to assist future breeding success. In Tundra to tropics: connecting birds, habitats and people. Proceedings of the 4th International Partners in Flight Conference: pp. 13-16.

Emanuel, K. A. 2005. Increasing destructiveness of tropical cyclones over the past 30 years. Nature 436: 686–688.

Floyd, T. 2008. Smithsonian Field Guide to the Birds of North America. Harper Collins: New York City, USA.

Glasspool, A. F. 2008. The Impact of Climate Change on Bermuda. Report Prepared for the Bermuda National Trust. pp. 190.

Goldenberg, S. B., C.W. Landsea, A.M. Mestas-Nuñez, and W.M. Gray. 2001. The recent increase in Atlantic hurricane activity: Causes and Implications. Science 293: 474-479.

González-Solís, J., H.Wendeln, and P.H. Becker. 1999. Within and between season nest-site and mate fidelity in Common Terns (*Sterna hirundo*). Journal of Ornithology 140: 491-498.

Gross, A. O. 1912. Observations on the Yellow-billed Tropic-bird (*Phaethon americanus* Grant) at the Bermuda Islands. The Auk: 49-71.

Haymes, G. T. and H. Blokpoel. 1978. Seasonal distribution and site tenacity of the Great Lakes Common Tern. Bird-Banding: 142-151.

Jones, J. M. 1859. The naturalist in Bermuda. Reeves & Turner, London. 200pp.

Lefroy, J. H. 1877. Memorials of the discovery and early settlement of the Bermudas or Somers Islands 1515–1652. Compiled from the colonial records and other original sources. Vol. 1. London: Longmans, Green and Co.

Mejías, M. A., Y.F. Wiersma, D.B. Wingate, and J.L. Madeiros. 2017. Distribution and at-sea behavior of Bermudan White-tailed Tropicbirds (*Phaethon lepturus catesbyi*) during the non-breeding season. Journal of Field Ornithology 88: 184-197.

Natural England Technical Information Note TIN138, Common tern: species information for marine Special Protection Area consultations. First edition 28 November 2012. www.naturalengland.org.uk. Downloaded on 10 August 2017.

Nisbet, I. C. and E. Cam. 2002. Test for age-specificity in survival of the common tern. Journal of Applied Statistics: 29: 65-83.

Nisbet, I. C., D.B. Wingate, and P. Szczys. 2010. Demographic consequences of a catastrophic event in the isolated population of common terns at Bermuda. Waterbirds 33: 405-410.

Nisbet, I. C., P. Szczys, C. S. Mostello, and J.W. Fox. 2011. Female Common Terns *Sterna hirundo* start autumn migration earlier than males. Seabird 24: 103-106.

Nordström, M. and E. Korpimäki. 2004. Effects of island isolation and feral mink removal on bird communities on small islands in the Baltic Sea. Journal of Animal Ecology 73: 424-433.

O'Connell, T. J. and R.A. Beck. 2003. Gull predation limits nesting success of terns and skimmers on the Virginia barrier islands. Journal of Field Ornithology 74: 66-73.

Palmer, R. S. 1941. A Behavior Study of the Common Tern: (*Sterna Hirundo Hirundo L.*). Boston Society of Natural Histor 42:1-119.

Pfannmuller, L.A. and M. Martell. 2014. Common Tern Minnesota Conservation Plan. Audubon Minnesota.

Ramos, J.A., and A.J. del Nevo. 1995. Nest-site selection by Roseate Terns and Common Terns in the Azores. Auk: 580-589.

Richards, A. 1990. Seabirds of the northern hemisphere. Dragon's World Ltd. Limpsfield: United Kingdom.

Rowan, M. K. 1962. Mass mortality among European common terns in South Africa in April-May 1961. British Birds 55: 103-114.

Safina, C. and J. Burger. 1985. Common tern foraging: seasonal trends in prey fish densities and competition with bluefish. Ecology 66: 1457-1463.

Safina, C., R.H. Wagner, D.A. Witting, and K.J. Smith. 1990. Prey Delivered to Roseate and Common Tern Chicks; Composition and Temporal Variability Journal of Field Ornithology 61:331-338.

Sibley, D.A. 2003. The Sibley Field Guide to Birds of Eastern North America. Knopf: New York City. USA.

Smith-Vaniz, W.F., B.B. Collette, and B.E. Luckhurst. 1999. Fishes of Bermuda: History, Zoogeography, annotated checklist, and identification keys. Allen Press Inc. : USA.

Snow, D. W. and C.M. Perrins. 1998. The birds of the western Palearctic, vol. II. Oxford University Press: United Kingdom.

Szczys, P., I.C. Nisbet, and D.B. Wingate. 2012. Conservation genetics of the Common Tern (*Sterna hirundo*) in the North Atlantic region; implications for the critically endangered population at Bermuda. Conservation Genetics 13: 1039-1043.

Schlaepfer, M. A., M.C. Runge, and P.W. Sherman. 2002. Ecological and evolutionary traps. Trends in Ecology & Evolution 17: 474-480.

Taylor, I. R. 1979. Prey selection during courtship feeding in the Common Tern. Ornis Scandinavica 10: 142-144.

U.S. Fish and Wildlife Service. 1989. The Gulf of Maine Tern Management Plan.

Wingate, D.B. Unpublished data. Personal handwritten diaries: 1950s – 2017.

Wingate, D.B. 2007. Research on Bermuda's endangered Common Tern. Bermuda Audubon Newsletter 18(1):15-17.