

## STATUS AND DISTRIBUTION OF SEABIRDS IN BELIZE: THREATS AND CONSERVATION OPPORTUNITIES<sup>1</sup>

H. Lee Jones

*7 West Street, Punta Gorda, Belize; lee\_jones@att.net*

Philip Balderamos

*19/21 Turneffe Avenue, Belmopan, Belize; pbala@btl.net*

### ABSTRACT

The Belize cays and atolls offer a wealth of opportunities for seabirds. Indeed, seabird breeding colonies once proliferated off the coast of Belize. These colonies have been under near constant threat from a variety of sources as far back as the mid-Nineteenth Century, and some have long since vanished. But, how many remain? Where are they located? What are the current threats to their survival? Can some of the extirpated colonies be re-established on cays that are now protected? The answers to these questions are largely unknown. Before the nature and severity of continuing threats and potential future threats, such as those emanating from oil development and transport in Belize, can be adequately assessed, a comprehensive baseline inventory of existing colonies must be established. Only then can we determine the most appropriate measures necessary to preserve and expand these colonies and perhaps to re-establish some of the colonies that have been lost over the years. Does oil development loom as the next significant threat to what remains of the seabird populations in Belize? If so, what measures can be taken to minimize or compensate for this threat?

### INTRODUCTION

Seabirds play an important role in maintaining a healthy marine ecosystem. Most of the seabird species in Belize prey on small to medium-sized fish, and to a lesser extent on arthropods, mollusks, and other invertebrates. As important components of the marine ecosystem, seabirds are efficient tools for monitoring ocean conditions and, at least in some cases, as predictors of stocks of important fisheries (Cairns, 1992; Roth *et al.*, 2007). Because seabirds congregate in large flocks around schools of fish, they have been revealing optimal fishing locales ever since man took to the sea in his quest for food (Au and Pitman 1986, Erdman 1967, Johannes 1981). Additionally, tropical seabirds, especially those that nest in mangroves, enrich shallow-water fish nurseries with their nitrogen-rich excrement, or guano. Although it may seem counterintuitive, seabirds cull smaller and younger fish from schools, thereby reducing competition for food and allowing more fish to attain larger size—a benefit to sport fisheries that many modern-day fishers fail to recognize.

The collapse of seabird colonies around the world has had many causes, typically working in synergy. And while diminished seabird populations have frequently been concomitant with diminished or failed fisheries, it is often difficult to pin fisheries collapses directly on the collapse in seabird populations. Overfishing often goes hand in hand with over-harvesting of seabirds or their eggs, habitat conversion, and introduction of non-native predators as human populations expand beyond the capacity of the local resources to support them. For example, Christmas Island, part of the Republic of Kiribati in the western Pacific Ocean, had one of the largest seabird colonies in the world, with several million sooty terns and tens of thousands of 17 other species (Jones, 2000). Now, the numbers of seabirds there have been reduced by more than 90 percent, the result of rat infestations in their nesting colonies, poaching of their eggs for food, and in some cases the massacre of birds for both food and sport (Jones, 2000). At the same

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time, the human population of Christmas Island expanded from a few hundred people in the mid-20<sup>th</sup> Century to more than 5,000 people at the beginning of the 21<sup>st</sup> Century. Christmas Island's fisheries industry is now on the verge of collapse, but for reasons that are only partially related to the collapse of its seabird colonies. With increasing pressure on fish populations from overfishing and the introduction of dynamite, cyanide, and modern longline and gillnet fishing techniques, the latter of which have been stretched across narrow openings in the lagoon to catch bonefish as they head out to sea to spawn, the rapid demise of the industry was a foregone conclusion.

This scenario in Belize, while not as severe, has several parallels. Belize's human population has nearly doubled in the past three decades. Rats have been inadvertently introduced to nesting islands. Seabird eggs have been collected for food. Fish populations upon which the seabirds, as well as humans, depend have been decimated by insufficient or inadequately enforced regulations, especially with respect to the inappropriate use of gill nets and a steep increase in the number of commercial boats, both domestic and foreign, fishing Belize's waters. The result: fish populations in Belize are in serious decline and no longer sustainable at present levels of harvesting (see also Zeller *et al.*, this volume). While the general decline in fish populations has certainly had its impact on seabirds, the main direct cause of seabird declines in Belize has been the conversion of habitat for resorts, private residences, and seasonal fishing camps and the associated impacts caused by dogs, cats, and rats. Habitat conversion primarily involves mangrove cutting, removal of littoral forest and dredging of the seabed.

These problems are ongoing. They have not been resolved. With new threats on the horizon, including the cumulative effects of climate change and, possibly, contamination of the marine ecosystem from offshore oil extraction and transport, seabirds in the waters off Belize could soon be a thing of the past—unless the ongoing threats are diminished and the potential new threats are addressed proactively.

## MATERIALS AND METHODS

For the purposes of this paper, a seabird is any bird that nests on marine islands and forages in the marine environment. In Belize, that includes members of the Fregatidae, Sulidae, Phalacrocoracidae, Pelecanidae, Ardeidae, Threskiornithidae, Pandionidae, and Laridae. This paper provides a literature review of the past and current status of seabirds in Belize, along with an analysis of past, present, and perceived future threats to their continued presence in Belize. It also includes management and recovery recommendations designed to assure their survival, and in some cases, the re-establishment of populations that have been extirpated.

## RESULTS AND DISCUSSION

Credible information on seabird populations in Belize is sparse. Other than a few key publications that include brief synopses of seabirds (Oates, 1901; Russell, 1964; Jones, 2003) or largely anecdotal accounts (Salvin, 1864; Sclater and Salvin, 1869), most available information comes from the field notes and verbal accounts of biologists who have visited the cays, often only briefly. The one exception is Jared Verner's Master's thesis (1959) and subsequent publication (Verner, 1961) on the Red-footed Booby (*Sula sula*) colony on Half Moon Caye. Gaps in our knowledge in some cases span several decades, thus making it all, but impossible to determine any meaningful population trends over time. Almost nothing in the literature, or otherwise, documents anthropogenic threats to seabirds or the consequences of these threats. In short, we know very little about the past or current status of seabirds in Belize. We know that a few species that once nested in Belize have been extirpated or nearly so. We also suspect that a few species now nest in Belize that did not occur historically. A summary of seabirds found historically in Belize is presented in an Appendix at the end of this contribution (see also Paleczny, this volume).

### *Past and current status*

The first records of seabirds in Belize come from Osbert Salvin (1864) who spent two weeks in May 1862 on several of the Belize cays collecting seabirds and their eggs. We have very little information on Belize seabirds after 1862, until nearly a hundred years later when two ornithologists from Louisiana State University independently visited Belize: Jared Verner, whose studies pertained specifically to one species, the Red-footed Booby, and Stephen M. Russell who, from 1955 to 1961, conducted an inventory and literature review of all birds then known to occur in Belize (Russell, 1964). The Belize Audubon Society sponsored field trips to several of the cays, primarily in the 1980s and early 1990s, led mostly by W. Ford Young, Dora Weyer, Meg Craig, and Martin Meadows. Meadows and Lee Jones (unpublished notes)

visited most of the southern cays in late May 1998. Luz Hunter, Philip Balderamos, Erneldo Bustamante, and Tony Rath documented a significant mixed-species tern colony on Tobacco Caye in July 2002, but it has since vanished. In late February and early March 2007, Betty Ann Schreiber (unpublished notes) and Robert Fleischer visited many cays where seabirds were known to have nested in the past, but their visit was too early in the season to capture the breeding season of terns and a few other species. Thus, to date, the only efforts that even approach a comprehensive inventory of Belize seabirds was Salvin's two-week visit to the northern cays in 1862 and Jones' and Meadows' brief visit to the southern cays in 1998.

Salvin was the first to characterize the Red-footed Booby colony on Half Moon Caye, Magnificent Frigatebird (*Fregata magnificens*) colonies on Half Moon Caye and Man-O-War Caye, and significant colonies of Brown Noddy (*Anous stolidus*) and Black Noddy (*Anous minutus*) at Glovers Reef. He found Double-crested Cormorants (*Phalacrocorax auritus*), but not Brown Pelicans (*Pelecanus occidentalis*) nesting on Man-O-War Caye; whereas, when visited 94 years later Russell found the latter nesting, but not the former. Salvin also found Snowy Egrets (*Egretta thula*) nesting there, but no nesting of this species in Belize has been documented since. Small colonies of cormorants and pelicans have recently been found on several other cays.

Salvin estimated the presence of several thousand Red-footed Boobies on Half Moon Caye. The colony was already well known to Belizeans at that time, but the literature contains no specific references to this colony prior to the publication of Salvin's 1862 expedition in 1864. When next reported in the literature 96 years later, Verner (1959) counted 1,389 nests, but did not estimate total number of birds present. Belize Audubon Society (1992) similarly estimated 1,325 nests in late 1991. In 2007, however, Schreiber counted only 157 occupied nests, a number that is consistent with Jones' impressions from visits to the cay in 1999, 2004, and 2010. While numbers of Red-footed Boobies at Half Moon Caye appear to have decreased dramatically in the last two decades, Magnificent Frigatebird numbers appear to have remained relatively constant at around 60 to 80 pairs, although precise numbers are not available for any period. The same appears to be true for frigatebirds on Man-O-War Caye, where reported numbers have ranged from 60 to 100–110 occupied nests.

Although apparently known for a number of years previously, in early 1984 the Belize Audubon Society reported on a small Tricolored Heron (*Egretta tricolor*) and Reddish Egret (*Egretta rufescens*) colony on two small mangrove cays, Little Guana Caye and Cayo Pajaros, on the Chetumal Bay side of Ambergris Caye (Belize Audubon Society, 1984a). That year, Belize Audubon Society (1984a) also documented Great Egret (*Ardea alba*) nesting well to the south on Little Monkey Caye near the mouth of Monkey River. In 1990 and 1994, Meadows (Belize Audubon Society, 1991; and unpublished notes) found Tricolored and Reddish egrets, as well as Double-crested Cormorants, Great Blue Herons (*Ardea herodias*), and Roseate Spoonbills (*Platalea ajaja*) nesting on Cayo Rosario not far from Little Guana Caye and Cayo Pajaros, and found White Ibises (*Eudocimus albus*) nesting there in 1994. Estimates of the number of breeding birds or nests were not given in these brief accounts.

Several species of terns have been found nesting from time to time on various cays. In 1862, Salvin found "many thousands" of Brown Noddies nesting at Southwest Caye on Glovers Reef and others nesting at Ellen (now known as Carrie Bow), Curlew, and South Water cays. Although not recorded on later surveys at these three cays, they persisted on Southwest Caye in numbers exceeding 100 pairs at least through 1956 (Russell, 1964), and five birds (nesting status not mentioned) were seen there as late as 1986 (Triggs, unpublished notes). It apparently has not nested there in recent decades, and a resort now occupies most of the cay. Nearby Middle Caye was restored in the 1990s by the Wildlife Conservation Society and is uninhabited except for research facilities and a small staff at the north end, but no noddies or other seabirds currently nest there. In 2002, ten adults on Tobacco Caye were behaving as if they were nesting, but no direct nesting evidence was obtained. There are no other recent records of Brown Noddy nesting in Belize.

In addition to Brown Noddy, Salvin also found Black Noddy nesting on Southwest Caye in 1862 (Table 1), but he gave no estimate of its numbers. Berry (cited in Russell, 1964) also found it there and on Morgan Caye (now known as Northeast Caye, also at Glovers Reef) in 1907. We have not been able to find any definitive records of Black Noddy nesting in Belize since 1907; in fact, there are only a handful of credible reports of the species at all in Belize since then. Two other congeners, Sooty Tern (*Onychoprion fuscatus*) and Bridled Tern (*Onychoprion anaethetus*), have also nested in Belize. Salvin (1866) "only met with a few solitary" Sooty Terns in 1862, and it was not found nesting in Belize until 1958 when Verner (cited in

Russell, 1964) found a colony with nests containing eggs on Round Caye. In 1971, Henry Pelzel (unpublished ms) had 200-400 pairs on the Silk Cayes. Sometime later, a colony of similar size was discovered on Middle Snake Caye (first mentioned in the literature in 1990; Belize Audubon Society, 1991), but there have been no more confirmed reports from the Silk Cayes. The colony on Middle Snake Caye persisted until around 2008, but was recently abandoned. It is reported to now be on Tom Owens Caye, but this has not been confirmed.

**Table 1.** Nesting history of Brown and Black noddies in Belize.

Cay	1861–1910	1911–1960	1961–2010
Morgan (=Northeast)	Black nested in considerable numbers (Salvin, 1864)	–	–
Southwest	1,000s of Brown, unknown number of Black	Brown nested in the hundreds	5 Brown “present” in 1986
Ellen (=Carrie Bow)	A few Brown nested	–	–
Curlew	A few Brown nested	–	–
Pompion	Not visited	Brown nested	–
Tom Owens	Black may have nested	–	–
Tobacco	–	–	10 Brown behaving as if nesting in 2002

Salvin found nesting colonies of Bridled Tern on Saddle, Ellen, and Curlew cays, and possibly South Water Cay in 1862 (Salvin, 1864; Russell, 1964), but it was not reported again from Belize until April 1994 when Meadows (personal communication) observed six pairs attempting to nest on a small artificial cay between Caye Caulker and Ambergris Caye. Four years later, Jones (unpublished notes) and Meadows found a few pairs nesting on several cays along the reef off southern Belize. Lastly, 12 adults were observed by Luz Hunter and her colleagues behaving as if they had nests on Tobacco Caye in July 2002 (Jones, 2002).

Laughing Gull (*Leucophaeus atricilla*) and Sandwich Tern (*Thalasseus sandvicensis*) are both common along the coast and cays of Belize, but there are few confirmed records of either species breeding in the country. Although Laughing Gull was rumored to nest in Belize for many years, no direct evidence was obtained until May 1998 when Jones (unpublished notes) and Meadows found about 20 nests with eggs on Lawrence Rock at Seal Caye and one nest with eggs on Black Rock. Although never documented, Laughing Gulls almost certainly nested on Laughing Bird Caye before the island was decimated by Hurricane Greta in 1978 and ultimately driven away, presumably by egg collectors, fishers, and tourists, about ten years later (Malcolm Young, personal communication to Lee Jones). It has not nested there since the island, associated reefs, and surrounding waters were designated a national park in 1991.

Although Sandwich Tern eggs were collected by Salvin on Northern Two Cayes presumably in 1862 (Oates, 1901), the species was not recorded in Belize again until the early 1960s when a few were seen in Chetumal Bay and Belize Harbor (Russell, 1964). The species has increased dramatically in number since then, but primarily as a non-breeding visitor. Jones and Meadows found about 100 pairs nesting in a dense colony on a small sandbar near North Spot (coordinates 16°15' N, 88°12' W) in 1998. The only other record of nesting in Belize comes from Tobacco Caye where Luz Hunter and her colleagues found 50 birds with large chicks and fledglings in July 2002 (Jones, 2002).

Roseate Tern (*Sterna dougallii*) has also nested in Belize, although little information on this species is available. In 1862, Salvin collected a male from three to four birds present on Grassy Caye where he thought they were “preparing to breed”. Luz Hunter and her colleagues counted roughly 200 chicks on Tobacco Caye 140 years later (Jones, 2002), and L. Cottle (*vide* Betty Ann Schreiber) found Roseate Terns breeding at two sites on the Grassy Caye Range in June 2006. They do not currently breed on Tobacco Caye as confirmed by Philip Balderamos, and their current status on the Grassy Cayes is not known. Roseate Tern is a threatened species in the Caribbean (USFWS, 1987). Belize could play a significant role in its recovery based on the fact that it is occasionally seen in Belizean waters in numbers that exceed 100 birds, has bred as recently as 2006, and may currently be breeding, but undetected.

Although seldom documented, Least Tern (*Sternula antillarum*) is known to nest at various locations along the mainland coast, as well as on a few cays. Salvin found a few pairs ready to lay on Long Caye and “above a hundred pairs” nesting on Grassy Caye in 1862 (Salvin, 1864). According to Belize Audubon Society (1984b), it nests (or nested) on one of the Drowned Cayes near Gallows Pt. Reef 11-12 miles (18-19 kilometers) east of Belize City. Meadows (unpublished notes) found 70 birds and 12 nests with eggs and

chicks in Bella Vista outside Belize City in May 1988 where they are now reported to nest annually. He also found about ten grown juveniles on a small sandbar near Cayo Rosario in July 1994. Hunter *et al.* found 20 large chicks on Tobacco Caye in July 2002 (Jones, 2002). Schreiber (unpublished notes) reported that L. Cottle found Least Terns nesting at two sites on the Grassy Caye Range in June 2006, and Jim and Dorothy Beveridge (personal communication) believe that it nests each summer north of the airstrip on the lagoon side of Caye Caulker, although they have not been able to access the site and have not observed eggs or chicks.

According to the definition used in this paper, Ospreys of the subspecies *Pandion haliaetus ridgwayi* that is endemic to the Caribbean are seabirds. In Belize and elsewhere in the Caribbean, they nest exclusively on cays and feed on fish that they catch in nearshore waters. These Ospreys have shown a remarkable ability to adapt to human activities, and one or more pairs nest on most of the cayes, even those that have long been inhabited. We could find no evidence that numbers of this species have declined in Belize, although, as with other seabird species in Belize, specific nesting information is scant and no definitive conclusions can be drawn.

### *Historical and ongoing impacts*

Anthropogenic impacts on seabirds in Belize have included deliberate intervention in the form of egg collecting, shooting, and vandalism, along with unintentional impacts resulting from tourists, fishers, and others repeatedly entering breeding colonies and causing abandonment. Less direct, but equally destructive, and often much longer lasting impacts have included dredge-and-fill operations, along with replacement of mangroves and littoral forest, for coconut plantations, fishing camps, private homes, and resorts. An inevitable result of repeated human visitation and habitation has been the introduction of non-native predators such as cats, dogs, and rats.

While there is no evidence that the limited amount of specimen and egg collecting in the past has resulted in colony failure, persistent shooting, vandalism, and egg harvesting by local fishers, recreational boaters, and others have certainly played a major role in the demise of seabird colonies in Belize. Although potentially severe, these impacts usually do not result in permanent abandonment. Elimination of breeding habitat, on the other hand, does result in permanent loss of breeding colonies. An example of this may be Middle Caye on Glovers Reef. When Salvin visited Glovers Reef in 1862, he found terns nesting on all the cays except Middle Caye, which must have had nesting seabirds in the past, but was already inhabited by the mid-1800s. The native vegetation had been cleared to make way for a coconut plantation, undoubtedly the reason seabirds were no longer breeding there in the 1860s. Now, 150 years later, the coconut plantation is gone and the native vegetation has been restored. The island has a small marine station at its northern end and is fully protected. Yet, there are still no seabirds breeding on the island. Permanent developments and associated habitat conversion have replaced seabird colonies on the other three cays at Glovers Reef and at South Water Caye, Round Caye, Pompion Caye, and perhaps a few others where seabird colonies were never documented prior to their development.

Associated with human habitation on many islands are domestic dogs and cats and, unintentionally, rats of the genus *Rattus*. Introduced non-native species are a leading cause of extinctions in island communities (Atkinson, 1985). Rats, alone, are responsible for 40 to 60 percent of all recorded bird and reptile extinctions worldwide. Although rats have not been implicated in the loss of any seabird colonies in Belize, they have surely played a role, along with other, more direct, human intervention. Black Rats (*Rattus rattus*) are a suspected culprit in the decimation of the Red-footed Booby colony on Half Moon Caye. Although booby colonies worldwide have tended to survive rat infestations, rat depredation has been mentioned as a possible cause of depletion of all three booby species that occur in the Caribbean (Nelson, 1978; del Hoyo *et al.*, 1992; Priddel *et al.*, 2005).

Lastly, climate change is likely to have impacts of uncertain magnitude on seabird colonies in Belize and worldwide in coming decades. The warming of the oceans has already been demonstrated to have had a profound effect on both the intensity and frequency of tropical storms, including hurricanes, and prolonged droughts in many regions of the world. Recent studies have also demonstrated that the oceans have become more acidic as they absorb human-generated carbon dioxide from the atmosphere, and more oxygen-deprived as they absorb agricultural runoff, factors that in turn will further accelerate climate change (Rogers and Laffoley, 2011).

### *Potential impacts of oil extraction and transport*

If we are to be in a position to assess the potential impacts from oil development on seabirds we need to first know what species still breed in Belize, where they breed, and how large their colonies are. This will require a comprehensive survey of all known sites, past and present, and perhaps other sites where seabirds may be breeding, but as yet undetected. We also must be able to document the nature and extent of existing threats and the degree to which these threats can be rectified or managed. Only then will we have the tools necessary to evaluate the nature and extent of future impacts and to devise effective measures to avoid, eliminate, reduce, or compensate for those impacts. More specifically, we need to determine what the threat of oil development is, relative to existing threats, and design management and conservation programs that place these ongoing and perceived future threats in perspective.

If oil development in Belize poses potentially catastrophic threats to the marine ecosystem in the Gulf of Honduras, as some have asserted, then every effort should be directed toward rethinking the extraction and transport process. The relative benefits and costs of oil development should be carefully weighed against the potential costs to Belize's precious marine resources and the economic and cultural benefits that derive from their protection. If, on the other hand, the amount of oil ultimately extracted from and transported through Belizean waters is relatively small and can be extracted and handled safely with proper precautionary measures in place and being enforced, then conservation efforts should perhaps be focused elsewhere where they can be of greater benefit.

Different groups of birds, depending on their specific foraging behavior, nesting substrates, and other factors, have differing degrees of vulnerability to oil contamination. Of the seabirds that breed or otherwise reside in Belize, Double-crested Cormorant, Brown Pelican, and Laughing Gull are most vulnerable to offshore oil contamination, as these species spend much of their time in the water. They are all locally abundant near the mainland coast and around the cays and essentially absent beyond the reef and atolls. Boobies spend less time on the water, and terns spend essentially no time on the water, but both groups feed by plunging into the water from the air. Boobies detect fish by sight and, as fish cannot be seen through oily waters, they generally avoid foraging in or landing on oil slicks (del Hoyo *et al.*, 1992).

Terns, like boobies, are plunge divers, but unlike boobies they do not rest on the water. Whether or not terns will forage in an oil slick is not known to us, but because most species nest on the ground often just above the high tide line, they could be vulnerable to contamination from oil that washes up on beaches, especially during spring tides. The most common tern species in Belize are the Sandwich Tern and Royal Tern, although only Sandwich has bred in Belize and documented instances are few. Both are common in nearshore waters, including near and at the cayes, where they would be most vulnerable. Least tern is seasonally common along the mainland coast from March to October and breeds (or has bred) locally on several cays. It does not typically venture far from shore, however, and would be most vulnerable to spills near land.

Several other species of terns breed or formerly bred on the outer cays, but most of these are now rare or absent or their current status is not known. Sooty Tern can be seasonally abundant near its breeding colonies, but its current status in Belize is unclear. Outside the breeding season (roughly September to March) it is found far offshore over deep waters in the Caribbean. Very little is known about the current breeding status of three other species: Brown Noddy, Bridled Tern, and Roseate Tern. Black Noddy is no longer part of the regularly occurring Belize avifauna.

It is unknown if the long gaps between breeding or suspected breeding of many of the terns in Belize are due to their absence or near absence in the western Caribbean during these periods or if they have simply been overlooked. With the paucity of visits to many of the small outer cays where most species are most likely to breed, the latter is certainly feasible. Because so little is known about these species, it would be impractical to assess their vulnerability to oil spills in Belize waters at this time. In the overall scheme of things, however, their vulnerability must be small because they are so rare and/or local in the country and only seasonally present, not year-round inhabitants.

Ospreys typically grab fish at the surface with their talons, but occasionally plunge into the water to catch their prey. Like terns, they do not rest on the water, and like boobies they are not likely to forage over oil slicks; thus, their vulnerability to oil contamination must be minimal.

Magnificent Frigatebirds generally are not susceptible to oiling, although they may ingest some oil with their prey. They do not land on the water and catch their prey either by pirating it from other birds in flight or picking it off the water's surface with their bill while in flight.

Hérons, ibises, and spoonbills are long-legged wading birds that feed in shallow water. Only those species that nest in colonies on the cays are considered in this paper. Members of this group rarely if ever swim or float in water. They are most vulnerable to oil contamination along inshore waters where feeding groups congregate, and near their rookeries. While they are not as likely to have their plumage saturated with oil from direct contact, they are vulnerable to the toxic effects of ingesting oil that may be present in or on their prey. They may also transfer small amounts of oil from their beaks and feet to their feathers when preening or scratching.

### *Conserving what we have and restoring what we have lost*

As discussed above, many of the cays that supported seabird colonies in the past are now developed and have few or no remaining seabirds. Others like Middle Caye (Glovers Reef), Laughing Bird Caye, and Middle Snake Caye are now ostensibly protected, but have no nesting seabirds, although Sooty Terns may return to the latter as they have in the past. Some, like Tom Owens Caye, are either developed or support fishing camps, but still have small numbers of breeding seabirds. For many others, we have no recent information or seabirds tend to nest on them only sporadically, perhaps due to periodic disturbance by fishers, tourists, and vandals. Very few cays with seabird colonies are both protected and patrolled regularly. Half Moon Caye may be the only example. But, being protected and patrolled is often insufficient. On Half Moon Caye, Black Rats are abundant. They readily climb trees and are well known predators on the eggs and young of unattended nests of many species, although little information has been published on their effect on boobies.

Regular patrols, coupled with increased enforcement of existing laws will, however, help in reducing poaching, vandalism, wanton habitat destruction, and unauthorized access to sensitive seabird areas. But, patrolling an area as vast as the Belize cays necessitates a considerable increase in personnel, patrol boats, equipment, and training and a considerable expenditure of money. Educational programs in the schools and community centers of Belize would also go a long way toward altering the mindset of those who may not otherwise appreciate the economic value and benefits that accrue from responsible management and conservation of Belize's seabirds and other natural resources. Such benefits include an increase in ecotourism, a cleaner, healthier marine environment, and improved commercial and recreational fisheries.

In the last few decades, rats have been successfully eradicated from several hundred islands around the globe (Taylor and Thomas, 1993; Howland *et al.*, 2007; Fischer and Dunlevy, 2010), including some much larger than Half Moon Caye. In case after case, seabirds that had been eradicated or nearly eradicated from these islands by rats (and sometimes cats) have returned and are now flourishing (Seniloli, 2008). The same could be accomplished on Half Moon Caye at modest expense.

Recent successes in attracting seabirds back to islands where they once bred have also met with success (Kress, 1983, 1998; Kress and Nettleship, 1988; Parker *et al.*, 2007). Typically, decoys and broadcast calls of the target species are set up on the desired island at the onset of the breeding season, and if birds are in the area, they may settle in and form the nucleus of a new colony. But, beforehand, all rats, cats, and other non-native predators must be removed if any new colony is to have a chance of succeeding. Middle Caye on Glovers Reef is ideally suited for this purpose. Suitable habitat for both Brown Noddy and Black Noddy is present, and they both formerly nested in large numbers at Glovers Reef. Economic incentives abound for re-establishing seabird colonies in Belize. Ecotourism is an obvious one. The oil industry can play an important role in assuring that these once flourishing colonies return. With the implementation of proven measures designed to prevent oil leakage and spills during the processes of extraction, handling, and transport, the threat of further damage to the already decimated seabird populations in Belize can be all but eliminated.

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APPENDIX: GAZETTEER OF HISTORICAL SEABIRD COLONY SITES IN BELIZE

Chetumal Bay

Shipstern Caye:	White Ibis
Cayo Rosario:	Double-crested Cormorant, Great Blue Heron, Tricolored Heron, Reddish Egret, Roseate Spoonbill, Least Tern (nearby) , Wood Stork(?), Brown Pelican(?)
Little Guana Caye:	Tricolored Heron, Reddish Egret, White Ibis
Cayo Pajaros:	Tricolored Heron, Reddish Egret, White Ibis
Unspecified cayes:	Wood Stork, Roseate Spoonbill, Bridled Tern(?)

Inner Cayes

Northern Inner Cayes

Hick's Cayes:	Brown Pelican
Drowned Cayes	Least Tern

Southern Inner Cayes

Laughing Bird Caye	Laughing Gull (never confirmed, but almost certainly nested there)
Little Monkey Caye	Great Egret
Middle Snake Caye	Sooty Tern, Bridled Tern(?)
East Snake Caye	Brown Pelican
Mangrove Cayes	Brown Pelican, Great Blue Heron

Outer Cayes

Caye Caulker	Least Tern(?)
Sergeant's Caye	Brown Noddy specimen taken here
Man-O'-War Caye	Magnificent Frigatebird, Double-crested Cormorant (1862), Brown Pelican, Snowy Egret (?), Brown Booby allegedly
Tobacco Caye	Least Tern, Roseate Tern, Sandwich Tern, Brown Noddy(?), Bridled Tern(?)
South Water Caye	Brown Noddy, Bridled Tern (?)
Carrie Bow Caye	Brown Noddy, Bridled Tern
Curlew Caye	Brown Noddy, Bridled Tern
Tarpum Caye	Important roosts of Magnificent Frigatebird and Brown Pelican
Silk Cayes	Sooty Tern
Round Caye	Brown Noddy, Sooty Tern, Bridled Tern
Pompion Caye	Brown Noddy; Bridled Tern
North Spot	Sandwich Tern
Red Rock and Black Rock	Laughing Gull, Bridled Tern
Tom Owen's Caye	Bridled Tern, Sooty Tern(?), Black Noddy(?)
Lawrence Rock	Laughing Gull, Bridled Tern

Atolls

Lighthouse Reef	
Northern Two Cayes	Sandwich Tern
Saddle Caye	Bridled Tern
Half Moon Caye	Magnificent Frigatebird, Red-footed Booby

Turneffe Islands

Mauger Caye	Brown Booby allegedly
Grassy Caye	Least Tern, Roseate Tern, Great Egret(?), White Ibis(?)
Unspecified cayes	Great Blue Heron

Glovers Reef

Northeast Caye	Black Noddy
Long Caye	Least Tern
Middle Caye	Apparently there are no historical records of seabirds breeding on this now protected and restored cayes
Southwest Caye	Brown Noddy, Black Noddy