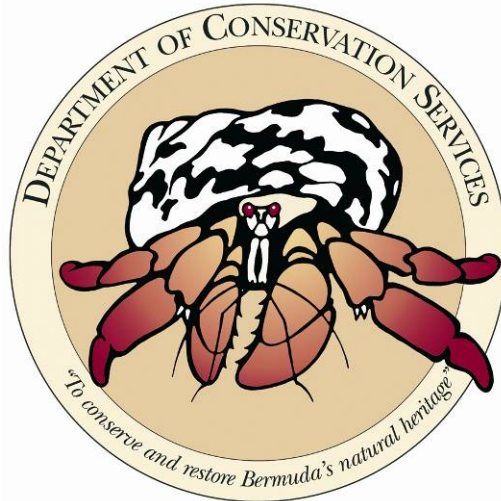


# **RECOVERY PLAN FOR THE BERMUDA PETREL (CAHOW) *Pterodroma cahow***



**Terrestrial Conservation Division  
Department of Conservation Services  
(Applied Ecology Section)  
Ministry of the Environment**

**BERMUDA GOVERNMENT**



**“To Conserve and Restore Bermuda’s Natural Heritage”**

## **BERMUDA PETREL (CAHOW) RECOVERY PLAN AND STATUS REPORT**

**Prepared in Accordance with the Bermuda Protected Species Act 2003**

**Cover photo: Detail of adult Cahow (*Pterodroma cahow*) by J. Madeiros**

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BERMUDA  
November, 2005***

## **Acknowledgements:**

Between late 2003 and November, 2005, Jeremy Madeiros (Govt. Conservation Officer, Terrestrial, Applied Ecology Section, Department of Conservation Services) prepared a Recovery and Action Plan for Bermuda's National Bird, the endemic and critically endangered Bermuda Petrel or Cahow, for the period 2005 – 2015.

This Recovery Plan is intended to function as a working document guiding management of the species for the coming decade. This includes the incorporation of relatively new and exciting techniques and technology such as the translocation of near-fledged chicks to establish new breeding colonies, and the future use of data loggers to gather information about the oceanic range of the Cahow, which at present is largely unknown. The Appendices included with the Plan also include much of the considerable historical accounts and information pertaining to the Cahow, as well as including a complete account of the conservation and management program for the species since its rediscovery in 1951 until 2005.

The production of this Recovery Plan is in accordance with the guidelines of the 2003 Bermuda Protected Species Act, which specifies the production of a Recovery Plan for a species within one year of the designation of that species as critically endangered.

The production of this document would not have been possible without the assistance of the following individuals:

Joseph Furbert, Leila Madeiros, Dr. Sarah Manuel, Dr. Annie Glasspool, Nicholas Carlile, Lisa O'Neill, Tammy Trott and Jack Ward.

The Department of Conservation Services gratefully acknowledges the financial contributions made by the Bermuda Zoological Society, The Bermuda Audubon Society and private donors towards the recovery of the Cahow.

Earlier Drafts of this document were improved by comments and input from Nicholas Carlile, Lisa O'Neill and Dr. Annie Glasspool.

## **Disclaimer**

This document does not necessarily reflect the opinion of the Bermuda Government. Any inaccurate information found to be contained in this document is the responsibility of the author. All efforts, however, have been taken to ensure its accuracy.

## *Executive Summary*

The Bermuda Petrel, or Cahow (*Pterodroma cahow*) is one of the rarest and most endangered seabirds on Earth, with a known breeding population in 2005 of 71 nesting pairs. The history of the Cahow is unique in ornithology; when first recorded, in 1609, it was initially abundant. It then went into such a rapid population decline due to the impacts arising from man's discovery and colonization of Bermuda, that by 1625 it was already presumed to have become extinct, a belief that was held for over 300 years. This was then followed by the surprise rediscovery in 1951 of 8 nesting pairs, and the slow recovery of the species through an intensive conservation program on the four small islets where it breeds.

The main threats to the Cahow are the lack of suitable available nesting locations, with the present sites subject to storm damage and erosion, and competition for available nest sites with the native White-tailed Tropicbird or Longtail. There is also the continuing danger of predation by rats and occasional migratory raptors (Birds of Prey). While the latter threats are currently being successfully managed, the ongoing erosion of the current nesting islets by storms and hurricanes poses the most serious threat to the recovery and survival of the Cahow, which in 2003 was declared the National Bird of Bermuda.

Despite the still precarious status of the Cahow, there is considerable potential through appropriate management for the recovery of the species to the point where it is out of immediate danger of extinction. This is considered feasible due to the following factors:

- **Control of threats;** the Recovery Program to date has demonstrated that it is possible to eliminate or control most of the threats affecting the Cahow, with the marked exception of the threat of continued storm erosion and storm damage to the present nesting islets;
- **Protection and security of habitat;** the status of all present breeding islets and most adjacent islands as Nature Reserves reduces the danger that changes of use will adversely affect the Cahow;
- **Possibility of providing improved nesting habitat;** there are opportunities for establishing additional, more secure breeding colonies on nearby larger, protected islands through the translocation of chicks from existing colonies and by sound attraction techniques.

### **Recovery Objectives: Short-term / long-term:**

The short-term objectives of the Cahow Recovery Plan seek to increase the number of breeding pairs of Cahow over the next five years to 85 pairs by 2010 and over the next ten years to 115 pairs by 2015. The intermediate-term objective seeks to increase the number of nesting pairs to 150 by the end of the present Recovery Plan. It should be noted that although this represents a considerable increase for the species since its rediscovery, these numbers still represent critically low numbers for the overall population. The long-term objective of the Recovery Program is therefore to build up the

population to the point where it can be considered to be out of immediate danger of extinction. Based in internationally established protocols for the recovery of critically endangered species, this will require increasing the breeding population to at least 1000 nesting pairs. The Recovery Plan also seeks to use existing and emerging technology and techniques to gain better understanding of the biology and ecology of the Cahow, in particular about the oceanic range of the species, where it forages for food at different times of the year and where it goes during the five-month non-breeding season. At present, almost nothing is known of their activities and whereabouts during this period.

**Potential Threats:**

Despite the success of the current management program in controlling threats to the survival and recovery of the Cahow, there are a number of threats which could have severe impacts on the species. These include the likelihood of further erosion and damage from hurricanes on the present low-lying nesting islets, which will be greatly increased by continuing sea-level rise accelerated by climate change. The impact of intense light sources from the nearby Bermuda International Airport and the Castle Harbour area, or from inappropriate development on the adjacent Coopers Island, could both become major threats to the successful nesting and recovery of the Cahow. Excessive human disturbance or the possibility of new invasive non-native species reaching the nesting islets also has the potential to disrupt the recovery of the species.

**Recovery Strategy:**

- All present management actions which have been proven to control threats to the Cahow are to continue under this Recovery Plan.
- Installation of artificial nest burrows will continue on appropriate nesting islets to provide a surplus of available nest sites in locations less liable to be affected by hurricane flooding and erosion.
- Banding (ringing) studies already being carried out will continue in order to provide data on aspects of Cahow breeding biology which are important for successful management of the species.
- The Recovery Plan seeks to utilize new research techniques such as the use of geolocational data loggers to discover and understand the foraging areas, oceanic range and migration routes of the species while at sea.
- In addition, the Recovery Plan seeks to establish new nesting populations of the species on one or more larger islands in the Castle Harbour Islands Nature Reserve by 2010. This will be carried out by the proven technique of translocation of near-fledged chicks, and the experimental use of sound attraction equipment.

This Plan also highlights the importance of Cooper's Island to the long-term survival and security of the Cahow; the education and involvement of the community about the historical significance of this species is also considered to be an important aspect of the Plan. The initial accounts of the Cahow, from Bermuda's first discovery and colonization, are documented in the appendices included in the Plan. The complete history of the conservation program from 1951 until 2005 is included to highlight management actions carried out since the rediscovery of the Cahow.

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# 1. INTRODUCTION:

The Bermuda petrel or Cahow *Pterodroma cahow* is one of the rarest and most endangered seabirds on Earth, with a total breeding population of 71 nesting pairs in 2005.

The history of the Cahow is unique in ornithology, with early records showing an apparent abundance at the time of Bermuda's discovery (with a population estimated at more than 500,000 birds), followed by a rapid population decline due to the impacts of man's arrival on Bermuda. Less than 20 years after human settlement, the Cahow was presumed to be extinct, a belief that persisted for over 300 years. This was followed by the surprise rediscovery of a small remnant population of Cahow, with 18 nesting pairs, and the slow but steady recovery of the species due to an intensive conservation program.

At the time of this Plan, future prospects for the Cahow are finally looking positive, largely due to the work of former Government Conservation Officer Dr. David Wingate, who until his retirement in 2000, carried out a management program for over 40 years to stabilize and then increase the Cahow population. This program continues under the direction of the present Government Conservation Officer (Terrestrial), Applied Ecology Section, Department of Conservation Services. Under this management program, the Cahow breeding population has increased from 18 nesting pairs producing a total of 8 fledged chicks in 1962, to the present peak of 71 nesting pairs producing 35 successfully fledged chicks in 2005. A number of threats endangering the Cahow have been encountered and addressed over the course of this program. These include predation by introduced rats, nest competition with the native Tropicbird, or Longtail, egg failure from thin eggshells caused by pesticide contamination, and shortages of suitable nest sites.

The Cahow, which is endemic or unique to Bermuda, only nests on four tiny rocky islets which total 3.4 acres (1.37 hectares) in area, located off the eastern coastline of Bermuda. It remains critically endangered and is subject to continuing threats from hurricane erosion, sea-level rise and the physical restraints of the present nesting islets, in addition to threats from natural and introduced predators.

This Recovery Plan details the history and current status of the Cahow and outlines the objectives of the recovery program over the next fifteen-year period.



**Figure 1:** Adult Bermuda petrel or Cahow *Pterodroma cahow* (Ian Fisher)

## **2. DESCRIPTION OF BERMUDA PETREL (CAHOW)**

### **2.1. Taxonomic Relationships.**

The Bermuda petrel or Cahow *Pterodroma cahow* (Figure 1) is a member of the Gadfly group of Petrels, a widely distributed genus confined mainly to tropical and subtropical seas (Warham 1990). There are approximately 26 species, all of which are pelagic, living and feeding on the open ocean, generally well out of site of land, which they only visit to nest, mainly in deep burrows. Their flight is fast and erratic, soaring for great distances on their long, narrow wings. Limited genetic studies indicate that the Cahow is closely related to other North Atlantic petrels, including the Black-capped Petrel or Diablotin (*Pterodroma hasitata*), which breeds in steep cliff-faces in the highest mountains of Haiti and the Dominican Republic, the Madeira or Zino's Petrel (*Pterodroma madeira*), which also nests on high mountain ledges in central Madeira, and the Fea's Petrel (*P. feae*), which nests on the Desertas Islands near Madeira and on the Cape Verde Islands off Northwestern Africa.



**Figure 2:** Adult Cahow in flight showing underwing pattern (Chris Burville)

## 2.2. Morphology:

The Cahow is a medium-sized seabird, having a body length of 38 cm (15 in.) and wingspan of 89 – 92 cm (35 – 36 in.). It had formally been listed as having an adult body weight of 250 grams, but weighing of adults initiated in 2002 indicates considerably higher body weights ranging from 285 grams up to 590 grams (mean = 340 grams). Their upper body, wings and tail are dark to medium brownish-grey in color with a crescent-shaped white band across the rump, although this is indistinct in some individuals. The undersides of the body and wings are white with dark edging to the leading and trailing edges of the wings and the wingtips, as well as a distinctive dark spot or carpal “thumbprint” on the outer third of the underside of the wing (Fig. 2). Both sexes are virtually identical, although males average slightly larger and heavier. The chicks are completely covered in long, dark grey fluffy down (Fig. 3), which is white on the underside in only about one-third of the chicks. This natal down is gradually rubbed off and lost as the adult feathers develop, however many chicks fledge and depart to sea with small amounts of down still present, especially on the underside and head.



**Figure 3:** 7-day old Cahow chick showing natal down (J. Madeiros)

## **3. ECOLOGY OF THE CAHOW**

### **3.1. Habitat Requirements:**

One characteristic of the Gadfly petrels is that they often have extremely restricted nesting habitat, with specific species often confined to a single island or island group. Cahows certainly share this characteristic, and have only been known to nest on the Bermuda islands. Like all Gadfly petrels, Cahows return to land only to breed, where they are strictly nocturnal in habitat, arriving and displaying over the nesting colonies in the dark of night. Cahows can only nest successfully in the complete absence of mammals (including rats, mice, cats, dogs, pigs etc.), because of the threat of predation on eggs, chicks or adults, or the danger of nest burrow collapse due to trampling.

Optimal habitat includes coastal hillsides overlooking the sea with fairly deep, sandy soil and grass or tree cover, so that the root systems provide reinforcing to prevent collapse of the burrows during heavy rains. Areas supporting mixed forest cover and open grassy clearings adjacent to cliff or beach areas are most likely ideal, but Cahows can also nest in suboptimal habitat such as boulder talus (commonly caused by cliff collapse), deep erosional holes or small deep solution caves on small rocky islets and coastal cliff areas.

### **3.2. Reproduction:**

Cahows have a very protracted nesting season, first returning to the breeding islands in mid to late October on dark nights, engaging in courtship activity, mating and building a nest together out of grass and other vegetation in an enlarged nest chamber at the end of the burrow. This continues until late November, after which they depart again to sea for a five to six-week pre-egg laying exodus through the month of December. This exodus is thought to involve a period of intensive feeding activity which enables the female to develop her single egg, which is white in color and quite large at 50 – 68 grams in proportion to the adult birds (see Figure 4). It also enables both adults to improve their body condition in preparation for long incubation periods, followed by intensive food collection trips to feed the hungry chick after hatching.

Cahows return from this exodus back to the nesting islands by early January, with the female laying her single egg almost immediately upon her return. All pairs have returned and laid their eggs by the beginning of February. The incubation period is 51 to 55 days, about average for a petrel of this size. Male and female both share incubation duties, with incubation shifts of up to 10 to 14 days without food or relief (see Figure 5). The chicks hatch from late February through late March, and are brooded by one adult for only the first 2 to 4 days while the other adult brings food. Thereafter, the chick is left alone with both adults sharing feeding duties, flying long distances (possibly 400 – 500 miles to the Gulf Stream), and making short nocturnal visits back to the nest burrow to feed the chick.





**Fig. 4:** Adult Cahow in burrow with large egg in nest (J. Madeiros)

Adult feeding visits to the chick drop off in frequency and may cease completely long before the chick is able to fly, since the fat reserves accumulated by the fledglings can provide enough energy to complete development of the flight feathers. This is termed the pre-fledging abandonment and is in common with all gadfly petrels. Abandonment of the chick by the adults up to 15 days before fledging is not unusual, although it has been observed that chicks tended by the adults right up to fledging exhibited particularly rapid growth, while those abandoned some time before fledging are more likely to develop more slowly and fledge later (Winter 1972; Warham 1990).

The young Cahows fledge to sea between mid-May to mid-June, following an exercise period during which the chicks emerge from their burrows at night to exercise their flight muscles and to explore, orient and imprint upon their surroundings. This period lasts from 3 to 15 nights (average = 5 nights), at the end of which the chick departs to the open ocean. The adults are absent for the entire exercising period and the chicks fledge entirely on their own (See Section 11, page 60 for breeding calendar). This exercise period is thought to be essential to enable a Cahow to eventually find its way back to the nesting islands when mature.

It is thought that young Cahows will spend five or more years at sea before maturing and returning to the breeding colonies, although other gadfly petrels have been proven to first

return from as young as two years of age. It may then take several additional years for returning birds to find or dig a suitable nest burrow and select a mate, and for a new pair to successfully produce a chick. Petrels generally mate for life and will usually also use the same nest burrow for life, until the death or disappearance of one of the adults. If this happens, the surviving adult will often try to attract a new mate to the same burrow.

### **3.3. Dietary Requirements:**

Cahow feed on the open ocean, generally well out of site of land. They appear to feed mainly on small squid and fish as well as shrimp-like crustaceans, probably through surface-skimming and short dives. During the breeding season, while the chicks are still young, adults collect food and process it into a partially-digested, oily vitamin-rich gruel which is fed to the young chick immediately upon return to the nest by the adult. As the chick grows, it is fed more solid food such as whole small squid, shrimp and anchovy-like fish, which have on rare instances been observed when spilled on the burrow floor. Like most other seabirds, Cahow nestlings will only eat food that is placed directly by the adult through bill to bill contact into the proventriculus. Feeding visits by the adults occur on average every 2 to 4 nights, but can be as often as every night, or as far apart as every 8 to 14 nights, apparently without harm to the chick, although growth can be somewhat retarded in the latter extreme. The chicks gain weight rapidly on the food delivered by the adults, developing fat reserves which can result in peak weights considerably greater than the adults at more than 500 grams (the record weight recorded to date being 563 grams).

### **3.4. Life Span:**

The lifespan of Cahows is unknown, but it is believed that individuals may live in excess of 30 years and that pairs may remain together for over 20 years, unless predation, natural mortality or severe hurricane events result in the loss of one or both partners. This is yet to be confirmed, but it is hoped that the ongoing banding program for the species, which was first initiated in 2002, will eventually provide concrete answers to these and other fundamental questions about the breeding biology of the Cahow. These questions include the age at which fledged chicks first return to the nesting islands as mature adults, and whether Cahows always return to the island of their birth.

### **3.5. Natural Predators:**

In common with all burrow-nesting seabirds, gadfly petrels are adversely affected by the presence of mammals on their breeding grounds, and usually nest on mammal-free islands or on steep mountainsides inaccessible to most mammalian predators. Another potential threat for the Cahow in Bermuda is predation by migratory raptors or birds of prey. This has been documented on at least two occasions; in 1986 a Snowy Owl *Nyctea*

*scandiaca*, normally found in Arctic regions, was blown to Bermuda by unusual weather conditions. It settled on the eastern islands of Bermuda, where it quickly discovered the Cahow nesting colonies, killing at least five adult birds before being shot by the conservation officer. In late 2000, a Peregrine Falcon *Falco peregrinus*, a frequent migrant through the Bermuda area during autumn (Wingate 1963, Amos 1986), overwintered on the island for the first time on record. This bird began to roost at night on one of the Cahow nesting islands, very close to a group of artificial nest burrows. At least one Cahow was predated, and there is evidence that the presence of the falcon on the island may have disrupted breeding of other nesting pairs of Cahows in the vicinity.

### 3.6. Associated Species:

There are at least two other animal species of note that associate with the Cahow on its breeding grounds and which are commonly found in Cahow nest burrows. The endemic **Bermuda Skink** *Eumeces longirostris* is a ground lizard up to 6" (155mm) in length, which has declined greatly in numbers on the larger islands of Bermuda. The Skink is considered to be endangered under the Bermuda Protected Species Act 2003. The largest remaining populations of this species are confined to several of the Castle Harbour Islands and it is also found on two of the Cahow nesting islets. On these islets, Skinks are regularly observed in the Cahow nest burrows during warmer periods, even when adult or fledgling Cahows are also present. The author has in fact several times observed large Skinks in nests with nearly fully fledged chicks, with each species tolerating each other's presence. It is thought that the Skink may in fact perform a useful service to the Cahows by scavenging broken eggs, spilled food, excreta, insects and chicks that have died in the burrows, helping to keep them clean and disease-free. This is evidenced by observations of up to 8 Skinks in a burrow at the same time scavenging an infertile, abandoned egg. This relationship deserves further study, especially in light of the fact that both of the islands identified as being suitable for the establishment of new Cahow nesting colonies (Nonsuch Island and Southampton Island) also have substantial Skink populations.

The **Red Land Crab** *Gecarcinus lateralis* is a common native resident of the coastal zone in Bermuda's southern coastline and is found on all of the Castle Harbour Islands. Although they usually dig their own burrows in sandy soil areas, it is not uncommon for one or more Land Crabs to establish burrows in sheltered corners inside Cahow burrows. The two species appear to mostly co-exist peacefully, although the Land Crabs, which are herbivores, can disturb nests with their burrowing activities, and large mature crabs, which sport strong defensive pincers, could conceivably pose a danger to younger Cahow chicks. For these reasons, they are normally removed from the burrows when possible.

In addition to these larger species, Cahow nest burrows are also usually inhabited by insects such as Cockroaches, Crickets, Sow Bugs and Ants. Two species of spiders, the native Brown House Spider and the Daddy Longlegs, are often found in burrows, preying on Cockroaches and ants respectively. It is unknown whether any of these pose a threat to the birds, but they undoubtedly provide an attraction to Bermuda Skinks as food.



## **4. CURRENT STATUS OF THE CAHOW:**

### **4.1. Global Distribution:**

The Cahow is endemic to the islands of Bermuda, located at 32 N, 64 W in the western North Atlantic Ocean. These islands consist of 8 main islands connected by bridges and about 150 smaller islands, mostly clustered closely to the main islands. They have a total combined land mass of just 55 Km<sup>2</sup> (5500 ha), with a dense human population of just under 70,000. Little was known about the oceanic range of the Cahow, and they have never been observed feeding in the Bermuda area. During the 1990s there were an increasing number of sightings from the waters offshore of North Carolina, by pelagic birding tours operating from the Cape Hatteras / Oregon Inlet area (Sibley, 1995). On the western edge of the Gulf Stream, interaction with the cooler coastal waters creates mixing zones and upwelling activity which brings nutrients to the surface and likely creates concentrations of plankton and prey species. It therefore seems probable that the Cahow travels to and feeds around the offshore waters of the Carolinas and Georgia along the edge of the warm Gulf Stream current, up into areas well to the northwest and north of Bermuda. It is also possible that the Cahow may feed in and around giant eddies which regularly break away from the eastern edge of the Gulf Stream, creating local upwelling and mixing and concentrating prey items such as squid, fish and crustaceans. This can occur anywhere over a huge area of ocean between the Gulf Stream and Bermuda.

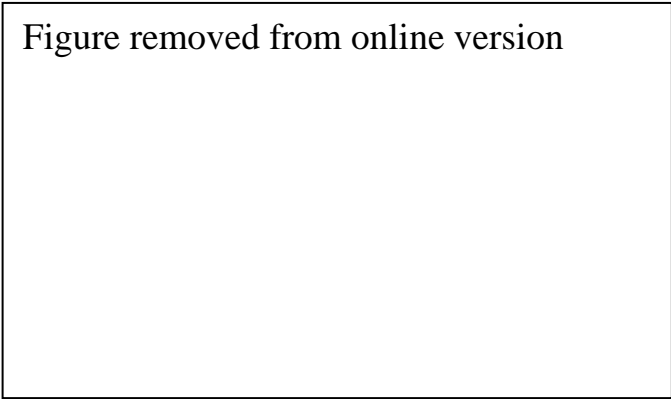
### **4.2. Distribution and Habitat in Bermuda:**

There are numerous sub-fossil remains of Cahow in sandy deposits and numerous limestone solution caves throughout the island (Schufeldt, 1916, 1922; Wetmore, 1962), as well as accounts of the earliest Spanish and Portuguese sailors that visited the island, that indicate that the Cahow was originally widespread and abundant throughout much of the main islands and many of the smaller islands of Bermuda.

Following the rediscovery of the Cahow breeding grounds in 1951, the species was originally confined to five small islets near Castle Harbour at the southeast end of Bermuda (Murphy and Mowbray 1951, Wingate 1985). One of these islets, Outer Pear Rock, originally supported 2 nesting pairs of Cahow, which were destroyed by an infestation of Brown Rats (*Rattus norvegicus*). These rats swam across from nearby Cooper's Island during the construction of the N.A.S.A. (North American Space Administration) tracking station that was being built at that location 1965-1967, evidently attracted by food and trash left by construction workers (Wingate pers. Com.). This island was never recolonized following the loss of all breeding adults. The remaining 4 islets (See Figure 5) have benefited from the ongoing conservation management, with the number of active nesting pairs of Cahow increasing from 18 in 1960 to a total of 71

nesting pairs during the 2004-2005 nesting season. The distribution of this population is detailed as follows:

Green Island 0.715 acres (0.289 ha) in size .....	19 nesting pairs
Long Rock 1.347 acres (0.545 ha) in size .....	9 nesting pairs
Horn Rock 0.795 acres (0.322 ha) in size .....	28 nesting pairs
Inner Pear Rock 0.544 acres (0.220 ha) in size .....	15 nesting pairs



**Fig. 5:** Castle Harbour Islands Nature Reserve showing Cahow nesting islets  
(Mandy Shailer)

Two of these islands, Green Island (Fig. 6) and Long Rock (Fig. 7), are composed of old, hard Walsingham and Town Hill limestone formations with deep crevices and small solution caves. Both are also very low-lying, with Long Rock having a maximum elevation of only 4m (12') and Green Island only 6m (19'), with most of the Cahow nest sites on these islands located considerably lower than their highest points. They have also both been heavily eroded and scoured by storm waves and rain and retain only residual pockets of red clay soil.

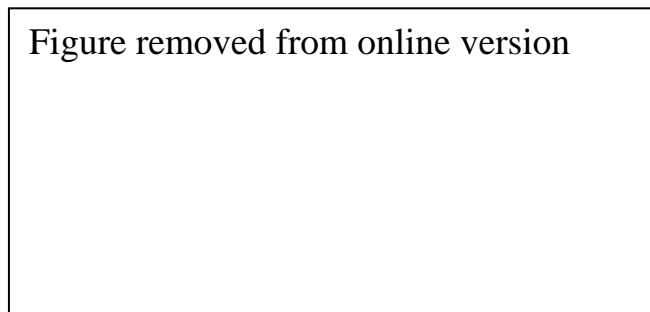
The other two islets, Horn Rock (Fig. 8) and Inner Pear Rock (Fig. 9) are composed of relatively recent, loosely cemented Aeolian limestone dune formations, which are higher in relief at 8m to 10m (24' to 31'), but which are very soft and prone to erosion. These islets are characterized by high, eroded shoreline cliffs rising up to elevated central areas, which in places retain a layer of thin, sandy soils. These two islets in particular have been very heavily damaged by hurricane activity since the late 1980s, with the central section of Inner Pear Rock almost completely collapsing, causing the loss of several active nest sites, during hurricane 'Fabian' in 2003.

Horn Rock has also been heavily eroded along its southern and northern sides, with the loss of five Cahow nest sites during hurricane 'Fabian'. It has also been partially undermined by continuing erosion and enlargement of several large sea-caves on the east and south sides of the islet.

Vegetation on the breeding islets is mostly limited to low bushy or prostrate coastal vegetation able to survive the salt spray, high winds and thin or nonexistent soils of such exposed locations. Native plant species dominate the plant cover, including Sea Lavender (*Mallotonia graphalodes*), Sea Ox-eye (*Borrchia arborescens*), Prickly Pear Cactus (*Oppuntia stricta* var. *dilenii*), Sea Purslane (*Sesuvium portulacastrum*), Seaside Goldenrod (*Solidago sempervirens*), Coast Spurge (*Euphorbia buxifolia*), Scurvy Grass (*Cakile lanceolata*) and West Indian Grass (*Eustachys petraea*). The endemic wildflowers Darrell's Fleabane (*Erigeron darrellianus*) and Bermudiana (*Sisyrinchium Bermudiana*) are common on Horn Rock and Inner Pear Rock. St. Augustine Grass (*Stenotaphrum secundatum*) is found in patches on Horn Rock, where it and West Indian Grass are often collected for nest material by Cahows when it grows in proximity to active nest burrows.

The easternmost nesting islet, Long Rock, differs somewhat in its vegetative cover probably due to the fact that it has the lowest elevation of any nesting islet, is exposed and is subject to severe flooding and over-washing by large storm and hurricane waves. Much of this island consists of barren, boulder-strewn wasteland devoid of most plant life except along the two highest points, where a low thicket of Buttonwood (*Conocarpus erecta*), much damaged and reduced by recent hurricanes, dominates in association with Sea Ox-eye and Coast Spurge. Inner Pear Rock is also distinguished by large patches of the tall native Switch Grass (*Panicum virgatum*).

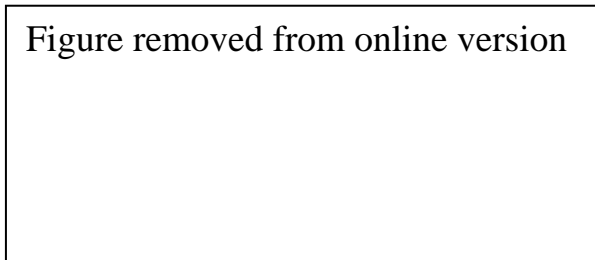
The vegetation on all of the breeding islets is generally low and patchy but on two of the islets forms low, thick continuous cover on some higher areas. It is also worth noting that the vegetation on all of the Cahow nesting islets is almost completely composed of native and endemic species, making them good reserves for indigenous coastal vegetation. The only non-native species which have become established on any of the nesting islets are the Long-leaf Plantain (*Plantago lanceolata*), White Beggar's Tick (*Bidens pilosa*) and Black Medic (*Medicago lupulina*), all found only on Horn Rock. Black Medic and Beggar's Tick are now actively culled out when found, and it is planned to eventually remove all non-indigenous plant species off this island to return the plant cover to a pure native/endemic status.



**Fig. 6:** Green Island – site of 19 active Cahow burrows in 2005 (Joseph Furbert)

Cahows now nest mainly in scattered groups in natural rock crevices, deep sandy pockets and small caves of sufficient depth that the nest chamber is in almost complete darkness. There are several historical accounts that state that Cahows originally burrowed their nests into sandy soils under vegetation in coastal areas “Like Conyes in a Warren” (Strachy, 1610 – See Appendix 1: Historical Information).

In recent decades, a large number of artificial burrows made on concrete have been constructed on the nesting islets as part of the conservation and management program. This was necessary to supplement the small number of natural nest sites meeting the requirements for the cahow, and therefore enable the tiny remnant population to increase (See Section 7.2.2: “Provision of artificial burrows to provide additional nest sites”; and Appendix 1: Section 2.4.1: “Development of artificial nest burrows”).



**Fig. 7:** Long Rock – site of 9 active Cahow burrows in 2005 (Joseph Furbert)

Figure removed from online version

**Fig. 8:** Horn Rock – Site of 28 active Cahow nest burrows in 2005  
(Joseph Furbert)

Figure removed from online version

**Fig. 9:** Inner Pear Rock – site of 15 active Cahow nest burrows in 2005 (Joseph Furbert)

### **4.3. Population Status:**

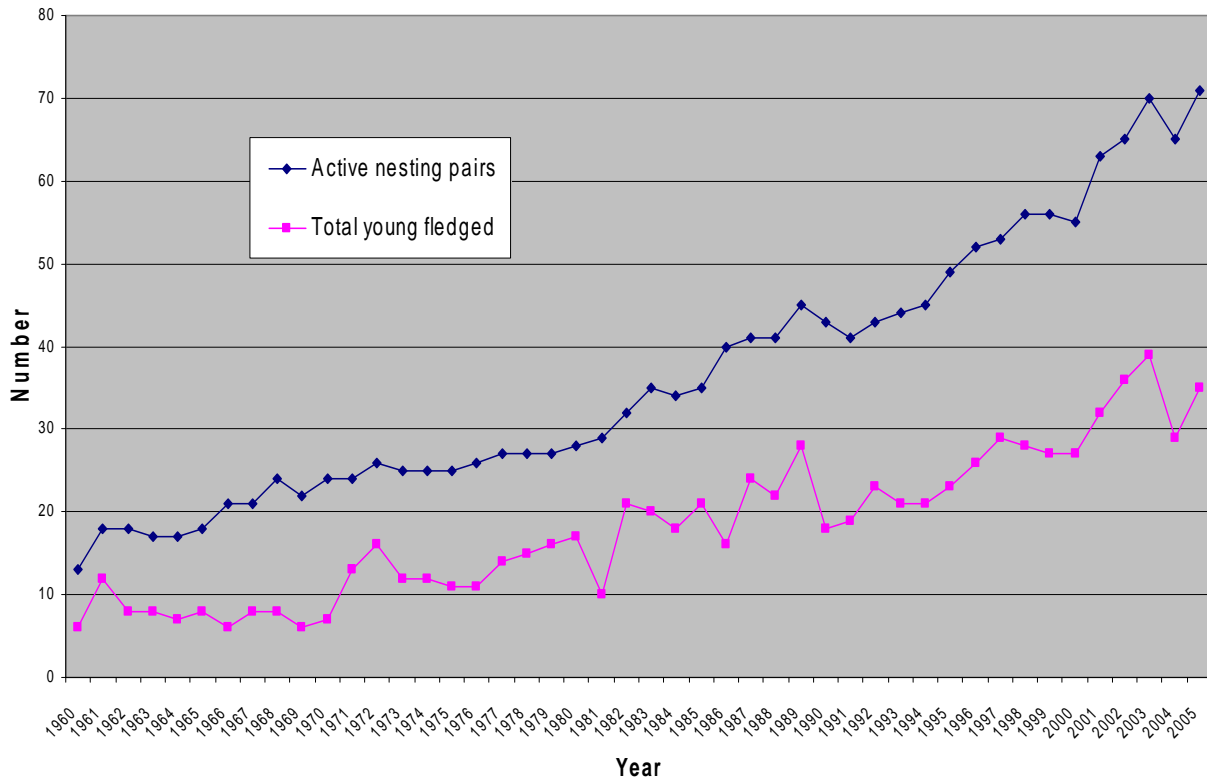
The conservation status of the Cahow has shown a slow, but steady improvement since management of the species commenced in the 1960s. The present status of the Cahow can be summarized as follows:

- The breeding population of the Cahow has increased from 18 nesting pairs in 1961 to the present total of 71 nesting pairs in 2005. The number of immature and non-breeding adults is unknown but anecdotal evidence suggests that the population has increased markedly in recent years.
- The rate of increase of the breeding population appears to be accelerating, with 8 new pairs established during the 2000/2001 nesting season, 5 new pairs during the 2002/2003 nesting season and 6 new pairs during the 2004/2005 nesting season.
- Numbers of successfully fledged Cahow chicks produced annually have also increased markedly, from a total of 8 in 1962 to a maximum of 39 in the 2003 nesting season (see Fig. 10).

- The breeding success of the Cahow has improved considerably to an average figure of 53 – 57% since the mid-1970s, compared with an average 37% breeding success rate over the first decade of management, 1960 – 1970.
- At present, there are sufficient unoccupied nest burrows available to accommodate further population growth for several years on all four of the present nesting islets. Over thirty new artificial burrows were built during the period 2002 – 2004. However, recent observations of adult Cahows attempting to access already occupied nest sites and ignoring nearby unoccupied nests suggests that some burrows may be undesirable to the birds due to unknown factors.
- Most of the serious land-based threats to the Cahow are now adequately controlled through the management program for the species (Section 7.1.). The Cahow however remains vulnerable to other threats, not all of which can be reduced through present management.

From these results, it can be seen that although the total number of established nesting pairs of Cahow have continued to increase fairly steadily over the last 30 years, the total number of successfully fledged chicks has not always increased to the same extent, and can vary considerably from year to year (Fig. 10).

Number of Active nesting pairs and Total Young Fledged for the Cahow from 1960-2005



**Fig. 10:** Numbers of Cahow breeding pairs and successfully fledged chicks over 45-year period of Cahow Recovery Program (Leila Madeiros)



#### **4.4. Conservation Status:**

The Cahow is listed in Bermuda Law as a critically endangered species under the local *Protected Species Act 2003*, which grants both the bird and its nesting habitat full protection. The Cahow is also classified as endangered by the United States Government, and both the bird and its breeding habitat are protected under the U. S. Endangered Species Act of 1973. This has been particularly relevant, as two of the nesting islets were included in the area leased to the United States for military bases from 1941 until 1996. One of these islets, (Inner Pear Rock) was also included in the area leased to the National Aeronautics and Space Administration (N.A.S.A.) as a downrange tracking station for the U. S. Space Program, until this facility was also closed in 2001.

In addition, the International Council for Bird Preservation (I.U.C.P.) Red Data Book (1994) classifies the Cahow as endangered under categories D1 (very small population) and D2 (very small/limited range). Recently, the Cahow was recognized by Birdlife International as a critically endangered species of international significance. The Castle Harbour Islands and Cooper's Island are being proposed as an International Important Bird Area (I.B.A.), because they are critical to the survival of both the Cahow and a large percentage of Bermuda's White-tailed Tropicbird nesting population.

#### **4.4. Legal Protection:**

The Cahow has full legal protection in Bermuda. The first proclamation against "the spoyle and Havock of the cahowes" was passed in 1616 (See Appendix 1: Historical Information), and a law protecting the species on its nesting grounds was enacted in 1612 – 1622, some of the first examples of environmental law to be seen in the western hemisphere. The Cahow is at present fully protected under the Bermuda Protection of Birds Act 1975, as follows:

##### ***Bermuda Protection of Birds Act 1975***

*Section 2 – any person who:-*

- a. takes a protected bird by any method whatsoever; or*
- b. takes the egg of a protected bird; or*
- c. (1) sells or exposes for sale; or*  
*(2) sends or causes to be sent out of Bermuda; or*  
*(3) has in their possession or under their control, a protected bird or the skin, plumage or egg of a protected bird, shall be guilty of an offence.*

In recognition of its unique status as Bermuda's only endemic seabird, in 2003 the Cahow was declared as Bermuda's official National Bird. The Cahow was also given further protection under the new Protected Species Act 2003, which will enable the nesting islands to be declared as critical habitat under the full protection of the law. This Act also specifies the creation of a Recovery Plan for the species within 1 year of designation, which this document has been produced to fulfill.

#### **4.5. Protection of Habitat:**

The Castle Harbour Islands are protected as Nature Reserves and listed as Class (A) Protected Areas under the Bermuda National Parks Act 1986. The sections of the Act which apply to the Cahow nesting habitat are detailed as follows:

##### ***Bermuda National Parks Act 1986***

##### ***Part II, Section 5 – Objectives of Protected Areas:-***

- a. to safeguard and maintain plants and animals as well as geological features and ecosystems of national and international significance where strict protection is required and human use is generally limited to scientific research and educational purposes in order to protect and preserve these special or fragile natural resources.*

As Nature Reserves, the Castle Harbour Islands are managed to protect their unique plant and animal communities, and limited public access (subject to protective regulations) is allowed only on the two larger, westernmost islands in the group, Castle and Charles Islands. Nonsuch Island is used for guided educational tours with an emphasis on school groups, in addition to one small eco-tour, limited to a maximum of 25 people, per week. The eco-tour is open to both visitors and residents and is led by either the conservation officer, or by specially trained guides. Special permits are required to visit Nonsuch and all other Castle Harbour Islands except for Castle and Charles. All Cahow nesting islets are completely off-limits to the public and can only be visited in the company of the Government Conservation Officer (Terrestrial) or with that officer's permission.

To conclude, the Cahow nesting islands, in addition to Nonsuch and Southampton Islands (both of which are potential translocation sites to establish new nesting colonies – See Appendix 3, - establishment of new nesting colonies) are effectively protected from land uses incompatible with the management and protection of the Cahow. This is not at present the case for the two eastern nesting islets (Long Rock and Inner Pear Rock). These islets are located a short distance from the former N.A.S.A. Tracking Station on Cooper's Island, which was recently (2001) handed back to the Bermuda Government. United States authorities at the military base had always co-operated well with the Cahow Recovery Program, permitting access to these islands for management and monitoring purposes and declaring them as restricted sites off-limits to Base personnel. N.A.S.A. officials had also co-operated on issues such as repositioning or turning off bright security lights at the Station that were interfering with Cahow courtship and new pair formation on the nearby nesting islets (D. Wingate, pers. Com.). There is some concern that with the recent departure of N.A.S.A. from this area, that security has been compromised, and that some of the uses which may be proposed for the site could be environmentally damaging and would threaten the recovery and survival of the Cahow.

## 5. CURRENT THREATS AFFECTING THE CAHOW:



**Fig. 11:** White-tailed Tropicbird (*Phaethon lepturus catsbyii*) in nest cavity on Nonsuch Island (J. Madeiros)

### 5.1. Habitat Loss:

#### *5.1.1. Marginalization as a result of human settlement:*

The Cahow is now restricted to the most isolated of the Castle Harbour Islands, which are effectively quarantined and managed to exclude all introduced mammal predators. Human visitation is also strictly controlled to avoid undue impacts or disturbance to the birds. All other locations on Bermuda are far too heavily developed, are too prone to human disturbance or to infestation by introduced predators, or are subject to excessive light pollution, to be viable for the re-introduction of Cahow nesting colonies. Even the present nesting islets are occasionally threatened by increasingly numerous and intense light sources from as far away as the Bermuda International Airport, over 2 miles distant.

#### *5.1.2. Storm damage to nest sites and nesting habitat:*

The impacts of storm and hurricane damage include erosion of the nesting islets, flooding, burrows being filled with debris, nest lids washed overboard and complete destruction of nesting sites. Severe hurricanes have been known to blow seabirds, including petrels, on to the North American mainland.

## **5.2. Predation or Competition by Introduced and Native Species:**

### **5.2.1. Predators:**

There is an ongoing threat to the Cahow of possible predation or disturbance by introduced mammal predators, including rats, cats, dogs, pigs and man. Of these, rats are by far the most likely to be able to swim unaided to the nesting islets, and this has been recorded as happening at least three times over the last 15 years. In each case, it has been relatively easy to quickly destroy all rats on the affected island by the use of anticoagulant rodenticide in bait-boxes, set out at roughly 25-m intervals over the island's surface. Predation of the Cahow is also possible by migratory birds of prey, with Peregrine Falcon and Snowy Owl being confirmed as causing predation in the past.

### **5.2.2. Competitors:**

Competition with White-tailed Tropicbirds (See Fig, 11) over nesting sites on the nesting islets (See Section 9.1.2.) has been well documented and has been effectively controlled by the use of exclusion baffles on all Cahow nest burrows as part of the recovery program. There is also the potential occupation of nest burrows by wild Honeybee (*apis*) swarms, resulting in the loss of the nest sites or possible death of adult Cahows through stinging (Appendix 1, Section 2.4.2.).

## **5.3. Effects of Climate Change:**

### **5.3.1. Global Warming and Sea Level Rise:**

There is now near unanimous agreement among the scientific community that climate change is occurring, and that it is being accelerated and augmented by the activities of man. These include the use of fossil fuels in vehicles and for power generation, and the clearing and burning of the tropical rain forests, which have caused steadily increasing levels of carbon dioxide (CO<sub>2</sub>) in the atmosphere. This is having a number of effects on world climate, which are complex and still poorly understood. It is also contributing to rising sea levels, both from thermal expansion of warming ocean waters and from increased melting of glaciers and polar ice caps. Tidal records kept by the Bermuda Biological Station for Research (B.B.S.R.) confirm that sea levels in Bermuda have risen by 8.9 inches since 1928 (about 12" per Century), and that the rate of rise seems to be accelerating. As the present Cahow nesting islets are so small and low in elevation, any rise in sea level brings an increased risk of storm erosion and flooding.

### **5.3.2. Increased Intensity and Frequency of hurricanes:**

Beginning in the late 1980s, the number of hurricane events causing damage and erosion to the Cahow nesting islets has increased greatly compared to the previous 30-year period that the species has been under management. Since 1989, there have been at least 7 hurricanes which have caused considerable erosion to nesting islets, damaging or destroying Cahow nest burrows and necessitating labor-intensive and difficult repairs and reinforcements to nest burrows and sections of the islets. A number of climatologists have theorized that increasing sea surface temperatures (s.s.t.) and long-term climatic

fluctuations are contributing to a significant increase in the number of severe hurricanes in the North Atlantic Ocean. This has obvious ramifications for the low-lying and exposed nesting islets that are the Cahow's only nesting locations, and is a primary reason for the ongoing program to establish new nesting colonies on the larger and more elevated Nonsuch Island Reserve.

## **6 MANAGEMENT ISSUES:**

### **6.1. Scientific Understanding of Biology and Ecology:**

The Cahow has been the subject of one of the longest continuous conservation programs of any procellariiform seabird species known. Frequent monitoring of essentially the entire breeding population has been carried out throughout each breeding season for the last 40 years, providing a wealth of knowledge about the behavior of the species on the breeding grounds (Wingate, 1984). Although some aspects of the breeding biology of the Cahow are well understood, there are still many gaps in knowledge that need to be filled. This information is critical for the effective conservation and future management of the species. For example, due to the fact that no banding or ringing of the Cahow was carried out prior to 2002, it has been difficult or impossible to prove scientifically that the same individuals return to the same nest sites every year for their breeding lifespan. It is also unknown whether pair bonds are longstanding, and what is the age of first return of sub-adult birds to the breeding grounds, or the age of birds at pair formation or first breeding. There is also no scientifically proven information on longevity or mortality rates. This information is essential for future management of the species. There is also no reliable information on the movement of the species away from the islands during the breeding season and the diet of the Cahow is largely unknown. Knowledge of these aspects of their ecology could possibly assist in the appropriate management of feeding grounds and identify any issues of prey availability over the long term. Additionally, there is currently no knowledge of the sex specific behavior of the species, if any, or what the sex ratio is. Other forms of scientific investigation (weighing, body measurements etc.) have been carried out since 2002 and the information gained has already provided valuable additional data. (See Sections 7.3.2; page 37 and 7.4.1; page 39)

Another aspect of the biology of the Cahow that is at present almost totally unknown is the oceanic range of the birds at all times of their breeding cycle. The only real information on this has come from occasional sightings of Cahow offshore of North Carolina, by pelagic birding tours coming out from Cape Hatteras and Oregon Inlet (Brinkely, 1989). This area most likely forms only a small part of their oceanic range, and there is particular interest in the following aspects; (1) where Cahows forage for food for themselves during the courtship and egg incubation periods (November to February), and for their chicks during the rearing period of their breeding season (March to early June), and (2) where the entire population goes to during the summer, non-breeding period of the year, which extends from mid-June to late October.

## 6.2. Social and Cultural Importance:

The Cahow has already played an important role in Bermuda's history and many Bermudians have heard of or are aware of its existence, even though most have little idea of what the Cahow looks like. The story of the Cahow is now taught in many of Bermuda's schools and this, together with newspaper and magazine articles and the publication of a book on the history of the Cahow ("Bermuda Petrel: the bird that would not die" –Francine Jacobs, William Marrow and Company, New York, 1981) has contributed to a growing public awareness of the species. The Cahow however remains a mysterious, little-known creature to the vast majority of Bermudians because of its nocturnal nature and rarity. This is in contrast to the White-tailed Tropicbird, or Longtail, which is active and highly visible in the daytime during the spring and summer months when public use of the coastline for recreational activities is at its greatest. The Longtail has therefore become an icon of Bermuda and is considered the local harbinger of spring when it first returns to the island at the start of its nesting season.

There have been increasing efforts to raise public awareness of the Cahow in recent years including the adaptation of the Cahow as the official emblem of the Bermuda Parks Department, regular articles and updates in the local media, magazines and other publications, and the recent designation of the Cahow as Bermuda's National Bird. These efforts, coupled with growing awareness in environmental protection and issues, both locally and internationally, have resulted in increased interest in the history of the Cahow and the success thus far of its recovery program. This interest has extended to overseas magazines and publications and to organizations and individuals involved in management and recovery programs for seabirds in general and gadfly petrel species in particular. There are also at present two separate film documentaries under production which highlight the Cahow Recovery Program, '*Rare Bird*' by Bermudian Lucinda Spurling and '*Bermuda's Treasure Isle*' by Dierdre Brennen and Irish wildlife filmmaker Eamon De Buttillear.

### **6.3. Economic Considerations and Potential**

During the last decade there has been an increase in requests to see Cahows and their breeding islands by visiting birders and birding groups vacationing on Bermuda. The critically endangered status of the Cahow and the difficult access, small size and fragility of their nesting grounds make them unsuitable for visits by large groups. Only individuals or small groups of no more than 3 or 4 people are allowed to accompany the Conservation Officer to the nesting islets at non-critical periods of the nesting season. This policy will be maintained under this Recovery Plan.

In the event that translocation efforts now being prepared (see Appendix 4) are successful and a new Cahow colony can be established on Nonsuch Island itself, it may become possible in the future for larger groups of people to observe the birds from an appropriate distance at Nonsuch. This possibility will be investigated some years hence, and would only be allowed if it is determined that there is no risk of disturbance to the birds.

There is also potential for birding or eco-tourism boat tours to be able to observe Cahows at sea off the east coastline of Bermuda. It is now known that Cahows congregate offshore just outside the reef line (1 to 4 miles offshore) during certain periods of the nesting season, while waiting for darkness to fall before visiting their nest sites. The Bermuda Audubon Society has organized several boat excursions to this area during the month of November, as have visiting foreign birding groups, most of which have been successful in seeing Cahows, sometimes at close range. These boat-based excursions are however dependent on the weather conditions, which are often too windy and rough to allow comfortable, or safe, observations at this time of the year.

An easier and less weather-dependent means of viewing the Cahow would be through the establishment of an observation post or viewing area on Cooper's Point, on the southeast point of Cooper's Island. A number of local and overseas birding groups and tours carried out observations from this point with the permission of N.A.S.A. before the area was handed back to the Bermuda Government in 2001. These have had success in spotting Cahows assembling offshore before nightfall, awaiting dark to return to their nesting islands. These observation activities would be compatible with the recent declaration of this site as a Nature Reserve by the Bermuda Government in 2005.

In addition, several active Cahow burrows could have infra-red cameras installed that could transmit live images from a nesting island to the Natural History Museum at BAMZ or to a live-link on an appropriate web site. Similar systems have been used successfully in the United States, Great Britain and other countries and have proven to be extremely informative and popular for educational and scientific purposes.

## 7. CURRENT MANAGEMENT ACTIONS:

### 7.1. Species Management:

#### *7.1.1. Preventing predation of Cahows by terrestrial or avian predators:*

At present, all domestic animals, such as cats or dogs, likely to present a threat to Cahows or any other native seabird or animal, are strictly prohibited from all of the Castle Harbour Islands. Rats are the most likely and serious threat to Cahows and are fully capable of swimming out to the nesting islands during periods of high population density on the mainland of Bermuda; therefore a constant watch for the presence of rats is kept on all of the Castle Harbour Islands. Monitoring for the presence of rats is carried out in several ways; (a) looking for signs of chewed Prickly Pear fruit or other vegetation; (b) inspection of bait boxes or rock cavities for rat nests; (c) inspection of sandy areas, caves or burrows for rat footprints; and (d) provision of blocks of paraffin wax mixed with oats/oatmeal or oatmeal soap blocks to inspect for distinctive rat chew marks. Particularly thorough checks should be made just before the start of nesting season as rats are more likely to swim out to the breeding islets (or nearby islands) during the calmer spring or summer months.

If rats are confirmed or suspected as being on any of the Castle Harbour Islands, immediate steps must be taken to eradicate all rats from the islands as quickly as possible. Durable lockable plastic bait boxes are purchased from the Government health Department for \$15.00 each. These boxes are installed approximately 100' apart on a grid pattern, ensuring that all corners of the island are covered. A grain-based anticoagulant rodenticide (at present the commonly used bait contains Difenacoum rodenticide) is obtained in bulk from the Health Department and all boxes are baited at the same time. Two to three days after the first baiting, all boxes should be checked for signs of rats eating the bait and rebaited as necessary. It is not unusual for rats to completely eat all bait in some boxes where their numbers are high, and they will almost always leave evidence in the form of excreta inside and around the bait boxes. It is very important to provide a large amount of bait in a short period so that all of the rats on an island quickly eat a lethal dose. If they eat a small amount which is not lethal and they survive, they may build up a resistance to that particular bait. In any case the variety of rodenticide used is changed every 3 to 4 years to prevent rat populations from building up natural immunity.

Avian predators, in particular large Owl and Falcon species, are a much less frequent threat to the Cahow but have caused mortality on at least 2 occasions (see Appendix 1, page 81; 'Predation by avian predators' for full details). Care is taken to look for the presence of large raptors, especially Owls, during the course of normal monitoring trips to the islands, and to discourage their roosting on the islands during nights when the Cahows are active. This requires occasional night visits to the islets, which are combined with banding and behavioral study visits. It is worth noting that the native Barn Owl (*Tyto Alba pratincola*) is not considered a threat to the Cahow.



### ***7.1.2. Minimizing nest competition by the White-tailed Tropicbird:***

The use of restrictive baffler plates at all Cahow nesting burrows has been an important part of the management of the species since the early days of the program (see Appendix 1 for full history of development of Tropicbird bafflers). The baffler is a wooden plate, cut to fit in the entrance of a nest burrow, usually out of ¾" or 1" thick planks of Spruce or Pitch Pine, containing a specially sized and shaped entrance hole. This entrance hole is oval in shape, measuring 127 mm wide by 57 mm high, with a small notch in the bottom centre (to accommodate the deep sternum or breast bone) an extra 2-3 mm deep. The baffle shape and entrance hole are most easily cut out by use of an electric jigsaw. The baffle takes advantage of the difference in size and shape between the larger, round-bodied Tropicbird and the slightly smaller, more oval-shaped body of the Cahow to prevent the Tropicbirds from gaining access, killing the Cahow chick and taking over the nest, an occurrence that resulted in the death of almost 70% of all Cahow chicks before baffles were routinely installed. All active nest burrows, in addition to those undergoing prospecting visits, have baffles made up and clearly marked with the island and nest number. The baffles are installed as soon as Tropicbirds begin to arrive in Bermuda's inshore waters, usually by the last week in February. The baffles then left in place through the spring and summer months, and are removed with the conclusion of the Tropicbird nesting season, usually by the beginning of October. Baffles must be fixed firmly into place with wooden wedges, which are hammered in between the baffle and the sides and/or top of the burrow entrance. The baffles are checked regularly to ensure that they do not become loose, otherwise the baffle could conceivably fall and trap a Cahow attempting to enter or leave the nest. Baffles are also checked every year before installation for signs of splitting or rotting and replaced when necessary.

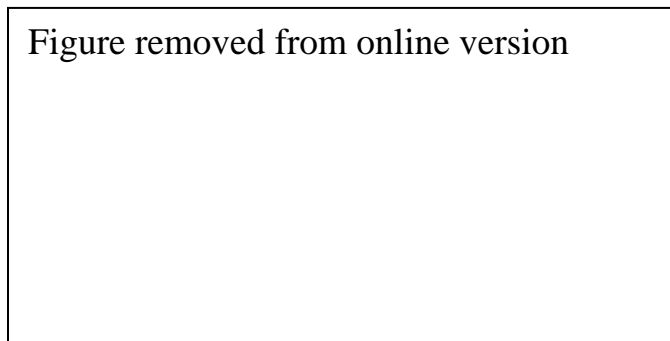
### ***7.1.3. Establishment and maintenance of new nesting colony on Nonsuch Island:***

The establishment of a new Cahow nesting colony on Nonsuch, which contains more suitable habitat and eliminates the constant threats of hurricane overwash, erosion and collapse of the present exposed nesting islets, is considered to be of critical importance to the establishment of a larger, self-sustaining population. The establishment of additional, more secure and easily managed breeding sites also provides more security from the threat of extinction through a single catastrophe (e.g. a slow-moving, intense hurricane causing severe damage to, or collapse of the present sites).

A translocation project to achieve this objective is presently in its second year of implementation at a site on the southern hillside on Nonsuch Island (see Appendix 3: Establishment of New Nesting Colonies; and Appendix 4: Proposal for Translocation of Chicks to Establish New Cahow Nesting Colony; for additional information and background). Briefly, this project has seen the establishment of a complex of 24 artificial Cahow nest burrows, of two designs, on the south side of Nonsuch Island (See Fig.12); using techniques used successfully in Australia and New Zealand to establish new colonies of Procellariiform seabirds (Priddel, Carlile and Wheeler, 2005), 14 Cahow chicks were moved from the present breeding islets to the translocation site in 2004 during the trial year of the project. These chicks were fed every other day on fresh

Anchovy and Squid until their wing chord length exceeded 250 mm and/or they developed full adult plumage. All chicks fledged successfully in good condition, albeit with slightly lower weights than control (naturally-fledged) chicks. In 2005, 21 out of a total of 35 Cahow chicks were moved to the translocation site (See Fig. 18), and were given slightly larger amounts of food. Again, all chicks fledged successfully, this time with departure weights essentially identical to that of control chicks (See section 9.1.3).

If this translocation project succeeds in establishing a new Cahow breeding colony on Nonsuch Island, the same techniques will be used to similarly establish an additional colony on Southampton Island, located a short distance west of Horn Rock (See Fig. 6).



**Fig. 12:** Nonsuch Island Nature Reserve showing artificial burrow locations at translocation site in 2005 (Joseph Furbert)

#### ***7.1.4. Care of abandoned or underweight Cahow chicks:***

Cahow chicks are occasionally abandoned prematurely by the adult birds, usually by new and inexperienced nesting pairs, which may not provide enough food for the chick to develop. The chick will then lose weight and die without intervention. This may also rarely be caused by the death of one of the adults during the feeding period, as one adult is unable to provide enough food for the chick to successfully fledge. Provided that this is detected before the chick's weight loss becomes critical, there is a good chance that an abandoned chick can be saved if it is removed from the burrow and taken to a site where it can be given daily feedings to enable it to complete development. Chicks to date have usually been taken to the Wildlife Rehabilitation Facility at the Bermuda Aquarium, Museum & Zoo (BAMZ) under the care of the head aquarist (formally Jennifer Gray until 2005 and now Patrick Talbot), where they have had a good survival and release record. Once the chicks have completed their development, they are taken out to their original nest site to fledge and depart to sea.

## **7.2. Habitat Management:**

#### ***7.2.1. Minimizing human induced disturbance and damage to Cahow nesting habitat:***

Because of the extreme sensitivity of the Cahow nesting islets to human disturbance, all are listed as restricted access Nature Reserves, off-limits to all public visitations. These islets can only be visited in the presence of the Government Conservation Officer by small groups with a maximum of 3 to 4 observers during non-critical parts of the breeding season. The two eastern breeding islets (Long Rock and Inner Pear Rock) are slightly easier to land on and closer to the Clearwater and Turtle Bay Public Beaches, and so have so have had "Restricted Access - No Landing" signs installed for many years. These signs are periodically swept away by hurricanes, most recently during hurricane 'Fabian' in 2003, and so must be replaced from time to time. The two western breeding islets (Green Island and Horn Rock), are much more difficult to land on and are easily observed from the warden's residence on nearby Nonsuch Island. Due to these factors, these two islets have never been signposted, to avoid focusing undue attention on the islets. The situation will continue to be monitored and these islets may also eventually have signs installed if it is felt to be necessary.

#### ***7.2.2. Provision of artificial burrows to provide additional nesting sites:***

The provision of artificial nest burrows has been an important part of the recovery program for the Cahow and has overcome the natural limitations of the present breeding islets. These lack soil cover that the birds can burrow into, and have only a very small number of natural rock crevices deep enough to be useable by the Cahow as nest sites. As of 2005, over 90 concrete burrows have been excavated into the higher, level areas of the breeding islets. They are constructed by digging trenches into the rock surfaces of the islands, 4' to 8' in length with a curve or bend along its length and an enlarged nest chamber at one end. This is roofed over with a 3" to 4" thick layer of concrete, poured over cut sheets of cardboard bent to shape over a filling of rolled-up balls of newspaper.

The section of trench that becomes the entrance tunnel is ideally at least 6" wide and 4" to 5" high and the bend along its length is important to prevent light from shining through to the nest chamber, which is about 18" in diameter and 8" to 10" high. A hole about 6" in diameter is left in the concrete roof of the nest chamber; when dry, a plastic sheet is placed over the top of the chamber and allowed to bulge slightly into the hole, then a ring of cardboard is placed on the sheet and a concrete lid poured over the sheet, inside the ring. The sheet and ring are removed once the concrete dries and the resulting heavy lid can be removed briefly to permit observation of the nest and if necessary, removal of the birds for banding, measurement etc.

The translocation site on Nonsuch Island has a mixture of the traditional concrete burrows and a new design of plastic nest box made in Australia and used successfully for nesting Petrels and Shearwaters. These boxes are designed for use in more sheltered areas with deeper soil and/or forest cover. They are made of recycled polyethylene and consist of a box with upper and lower chambers separated by a plastic dividing plate and topped with a plastic lid. This box is dug into the ground to within 4" or so of the lid. The bottom is removed for better drainage and the lower, nesting chamber of the box is connected to the surface by a 4" plastic pipe (preferably corrugated, for grip). A 4" by 6" wooden or concrete tunnel can also be used. Initial trial of these boxes over the first 2 years of the translocation project proved successful with the chicks readily accepting the boxes and experiencing no difficulties with moving in and out of the tunnels. The advantage of this design is much greater ease of installation in much less time than the concrete burrows, which typically require 400 to 800 lbs of concrete to make.

The success of the artificial burrow program is evidenced by the fact that over 70 % of all breeding Cahow pairs nest in artificial burrows. It is therefore important to continue building new burrows, both on the present breeding islets and the translocation site on Nonsuch, to accommodate and encourage an increasing Cahow breeding population.

### **7.3. Monitoring Activities (to be used in concert with Section 11):**

#### ***7.3.1. Annual monitoring program for nest sites with assistance of staff, volunteers and interns:***

Monitoring of all breeding islets and nest sites continues to be an important component of the management program and is carried out from one to three times a week throughout the nesting season. Several visits are carried out during late September and early October before the return of the breeding pairs to clear and unblock burrows. Quick visual checks are carried out to confirm the return of the birds to their nest sites in late October and November, and bags of St. Augustine Grass are collected on Nonsuch Island and taken out to the breeding islets to provide adequate soft material for the birds to build their nests. This is necessary because these islets, with the exception of some sections of Horn Rock, do not support enough suitable grass and vegetation cover for the birds to build proper nests, forcing them to use sticks and pebbles which may cause breakage of the

egg. Few monitoring visits are necessary during most of December, when adults are at sea for the pre-egg laying exodus. Regular visits should begin again shortly after Christmas to monitor the return of the adult birds for egg-laying and incubation activities. The female usually lays her single egg immediately after her return and it is important to record this as the hatching date can then be accurately predicted. The incubation period is also the best time to carry out banding and morphometric studies of the adult Cahows (Section 7.3.2). Monitoring then needs to be carried out through the hatching of the chicks in late February and March, and thereafter for the rest of the season to monitor the progress of the chicks and carry out weight and body measurements (**See Section 11; page 62 for breeding calendar of management activities**).

Rough conditions can frequently prevent landings on some or all of the nesting islets for up to several days, particularly through the period from late November to early March. First priority is always given to safety and landings are not attempted during heavy ocean swell or strong winds blowing onshore to the islets as there is a risk of personal injury and/or damage to the boat.

Monitoring visits during calmer periods is carried out by a single person experienced in knowledge of the anchoring and landing points for each islet. Visits during windier or rougher conditions should be carried out by at least 2 people (normally the Conservation Officer and a member of staff, intern or volunteer), as are visits involving the transport of equipment to or from the islets, or moving of Cahow chicks for purposes of translocation or relocation to the BAMZ rehabilitation facility because of premature abandonment by the adults.

### ***7.3.2. Banding (ringing) program for Cahow; protocols and methodology:***

By 2001, new information had become available that most procellariiform seabirds, including the Gadfly Petrels, are tolerant of limited handling and are not normally disturbed by banding or weighing activity, provided that certain protocols are followed. These protocols include no handling during the initial, courtship and nest-building phase of the breeding season, and limiting the time out of the burrows (for morphometric measuring and/or banding purposes) to 5 minutes or less.

Based on this information, in 2001 a decision was made to initiate a banding program for the cahow population, following initial handling trials in 2000 to confirm that handling had no measurable effect on breeding success. The main emphasis of the program is to band at least 75% of each breeding season's cohort of fledgling chicks (See Fig.13), although as many adult birds as possible from accessible nests will also be fitted with bands to confirm aspects of breeding biology and better understand the population dynamics of the Cahow (See Fig. 17).

With assistance from Alan Martin and Steve Rodwell of Porzana Ltd. (U.K. Wetlands Trust affiliation) the proper size for identification bands (or rings) specific to the Cahow was determined to be 5.25mm and a special order of Cahow bands was delivered in time

to be used for the 2002 nesting season. These bands have unique coding to make it possible to easily identify individual birds and are made of incoloy, a strong, light, corrosion-resistant alloy used for most seabird bands and able to last for the lifespan of even long-lived species. These bands also have a return address in Bermuda so that any person finding a live or dead banded Cahow, either locally or at an overseas location, can send details and the band number to the Recovery Program.

Adult Cahows are generally banded during February when they are brooding their eggs, by which time they are committed to the site and are extremely unlikely to abandon. Adults are not handled early in the nesting season during their courtship and nest-building periods. Once the eggs have hatched and the adults begin the feeding of chicks, it is rare for them to stay over in the nest during the day with the chicks, and they are also not banded or handled at these times. Adult breeding pairs that have failed (through egg loss, failure to hatch or not producing an egg), can be banded once failure has been confirmed for that year. Adult Cahows are banded by first looking into the nest chamber with a flashlight to identify which direction the bird is facing and their position in the nest chamber. The bander then reaches quickly in and firmly but gently grasps the back of the bird by both folded wingtips and the tail. The bird is therefore immobilized and can not open its long wings, which would make it difficult to extract from the nest. Holding the tail and wings like a handle, the bird is then eased carefully backwards out of the nest lid hole. The bird, upon careful extraction, is immediately placed in a cloth weighing bag, which usually quickly calms it. Adults that continue to struggle can be calmed by gently placing them on their backs in the bag. It is rare for a cahow to excrete while in the bag, although this is more likely to happen with aggressive birds. Any soiled bag is discarded and replaced with a clean one. All bags are regularly cleaned in hot water with an antibacterial soap to prevent any chance of transfer of infectious microbes. Once in the bag, the bird is then banded, weighed and/or measured as quickly as possible, taking care to keep the bird cool & shaded during hot periods. The nest lid should then be replaced, after which the adult Cahow is released head first into the entrance tunnel or baffle. It will then usually scurry quickly back up into the nest chamber. Rarely, a bird will linger at the entrance, but can be encouraged to move along with a gentle prod. The adult is always returned to the nest to resume brooding of the egg and should never be allowed to escape and fly away.

The process for removal and handling of fledglings for banding or measurement is essentially the same as that for the adults; with the important exception that they are replaced directly back onto the nest in the nest chamber (through the observation lid), instead of through the entrance tunnel.

As of January, 2005 a total of 184 Cahows had been fitted with bands by the fourth year of the program. This includes 111 fledglings, broken down as follows; 29 out of 36 chicks fledged during 2002, 33 out of 39 chicks fledged during 2003, 22 out of 29 chicks fledged during 2004 and 27 out of 35 chicks fledged during 2005. In addition, 73 adult birds had also been banded.



**Fig. 13:** Cahow chick being fitted with identification band (Andrew Dobson)

## **7.4. Scientific Research:**

### ***7.4.1. Study of chick growth rates:***

A study of the growth rates of Cahow chicks has been carried out since 2002, taking advantage of the presence of nest lids on most burrows which enable birds to be easily removed without undue stress to the birds (see Figure 20). Chicks chosen for the study are removed for weight measurement as soon as possible after hatching and thereafter every 3 to 4 days until they fledge. Some chicks are also weighed during night visits to the islets both before and after adult feeding visits if one is observed. This has helped to determine the amount of food provided to chicks by adult birds, information which was essential when feeding chicks moved to the new translocation site on Nonsuch Island.

This study has demonstrated that there is a wide variation in the maximum weights reached by individual chicks, which also affects the length of time that it takes for the chick to fledge. It has also provided advance warning of prematurely abandoned chicks before their weight loss and decline in body condition becomes fatal. Another interesting result of the study is that there are significant annual differences between average maximum weights of the entire chick population, indicating that prey items may be more plentiful in some years than others.

In addition to weight measurements, chicks have also been measured for wing chord (outer wing length) growth and plumage development. These are essential for determining the time to move chicks chosen for translocation.

#### ***7.4.2. Investigation of sound attraction techniques;***

A solar-powered sound attraction system was purchased during the 2003/2004 nesting season from Murremaid Sound Systems, U.S.A. and installed on Horn Rock, which experienced the largest loss of established nest sites during hurricane Fabian in Sep. 2003. The system was set up on the top of the islet in a new complex of nest burrows built after the hurricane to replace the original, low-lying sites, but located 5 to 6 m higher to make them more secure against hurricane overwash and erosion. The sound system was used to play back a CD of Cahow courtship calls recorded during November 2003 (see Appendix 2: Social Attraction through Playback of Sound Recordings). The sound system was used at this site between Jan 5<sup>th</sup>, 2004 and June 20<sup>th</sup>, 2005 during the breeding seasons. This technique was combined with the physical relocation of pairs of adult Cahows found in the remains of the destroyed nest sites, banded and released together into burrows at the new site. These measures were successful by March, 2005 in attracting pairs of Cahows to 3 of the burrows at this new site. The sound attraction system was due to be moved to the translocation site on Nonsuch Island by the end of 2005 to provide additional attraction to returning chicks fledged from this new site.

## **7.5. Public Awareness:**

### ***7.5.1. Provision of information through the Dept. of Conservation Services and the involvement of the local media:***

Although most Bermudians have heard of the Cahow, most have little knowledge of the bird's unique status, history or even the fact that the Cahow is Bermuda's official National Bird. There has been increased effort since 2001 to provide more information and photo opportunities on the Cahow recovery program and translocation project for the local media and press (daily and weekly newspapers, monthly magazines such as the Bermudian and RG Magazine, and television channels). In addition, the Department should continue to inform local schools, both private and public, that the Terrestrial Conservation Officer is available to give power point educational presentations on the



Cahow upon request. The Bermuda Audubon Society has also hosted public lectures on the Cahow as part of their long-standing support of the recovery program.

## **7.6. Species Protection:**

### ***7.6.1. Provision of increased legal protection for the Cahow:***

Full legal protection of the Cahow is proposed under the Protected Species Act 2003. This will make intentional injury to this species illegal and provides increased protection from disturbance or disruption in the form of greatly increased penalties and fines than was possible under the previous Bermuda Protection of Birds Act 1975. The species is also classified as endangered by the United States Government and both the bird and its breeding habitat are protected under the U.S. Endangered Species Act of 1973. This is not as relevant for the breeding habitat since the handing back of the former U.S. Base lands (including Coopers Island and the two eastern nesting islets) in 2000, but still holds importance for protection of the Cahow on what are thought to be its main feeding grounds off the coast of North and South Carolina in the southeastern United States.

### ***7.6.2. Prevention of disturbance by excessive light pollution;***

Intense light sources visible from nesting islands, even at distances of up to several miles, are known to be a hazard to Petrels and other nocturnally active birds. Fledgling Dark-rumped Petrels *Pterodroma phaeopygia* in Hawaii regularly crash into brightly lit buildings and street lights after becoming dazzled and disoriented. In Bermuda, bright security lights installed at Coopers Island and the nearby Naval Air Station during the early 1990s caused the failure of all new nest prospecting activity on the nearest breeding islets for two years (D. Wingate, pers. com). After urgent negotiations with the Base Commander that resulted in the turning off or repositioning of the offending lights, a flurry of new nest prospecting activity immediately ensued.

Intense lights pose a threat to the Cahows in the following ways:

- If light intensities at the breeding islets reach the equivalent of half-moon or brighter, the Cahows can be discouraged from carrying out courtship flying activity over the islets, which is necessary for successful breeding. New pair formation can also be inhibited.
- Single intense point light sources (e.g. halogen security lights or tall light poles at sports playing fields) can disorient night flying petrels under heavy rain or misty conditions when other visual reference points become invisible to the birds. They can then become attracted to the lights like moths and collide with the lights, or power lines or antenna in the area, causing injury or death to the birds.

- Fledgling Cahows just leaving their nest burrows for the first time can also become disoriented by intense light sources and fly inland rather than departing out to sea. They then are at great risk of either colliding with various obstacles, often with fatal results, or crashing on the mainland where they run the risk of predation by feral cats, dogs or rats.

Since 2000, new arrays of security lights at the Bermuda International Airport and the Ferry Reach Prison Farm have been intense enough and oriented high enough to potentially cause disruption to Cahows on their breeding islets on two occasions. Intervention by the Director of Conservation Services and the Terrestrial Conservation Officer resulted in co-operation from these facilities in re-aligning or fitting hoods on the offending lights to reduce light intensities at the breeding islets.

## **7.7. Habitat Protection:**

### ***7.7.1. Give increased protection to Cahow nesting habitat and adjacent areas:***

The Castle Harbour Islands are currently listed as Nature Reserves and as such receive complete legal protection. The Cahow nesting islands, and the other islands lying adjacent to them, are part of the Castle Islands Nature Reserve (Figure 6). All of these islands are managed and administered by the Terrestrial Conservation Division of the Department of Conservation Services (Applied Ecology Section), which in turn is part of the Ministry of the Environment. This Ministry falls under the responsibility of the Minister of the Environment. The Terrestrial Conservation Officer carries out regular patrols of the breeding islets to ensure that illegal landings are not taking place (the two western islets can in fact be monitored by binoculars from the warden's residence on Nonsuch Island). Additional assistance in the form of boat patrols of the islands, particularly during the busy summer period, is carried out upon request by Fisheries Officers from the Department of Environmental Protection and the Marine Police Section of the Bermuda Police Service.

## **7.8. Funding**

### ***7.8.1. Provision of funding for Cahow Recovery Program;***

Funding for the program is largely obtained through the regular operational budget of the Terrestrial Conservation Division. This addresses fuel, servicing, repair etc. costs for the Boston Whaler boat used to access the nesting islets and Nonsuch Island, the truck used by the Conservation Officer, wages and materials used to build new artificial nest burrows etc. Additional funding has been secured for particular aspects of the program from both the Bermuda Zoological Society (BZS) and the Bermuda Audubon Society (BAS). In addition, a number of private sources have also contributed donations to the program, usually through the BZS.

## 8. OBJECTIVES OF RECOVERY PLAN:



**Fig. 14:** Translocated Cahow chick outside artificial nest burrow on Nonsuch Island  
In June, 2004 (Nicholas Carlile)

### 8.1. Overall Objective:

The overall objective of the Cahow Recovery Plan is to ensure that the Cahow ceases to be critically endangered. To accomplish this objective, for the short term the Recovery Plan seeks to increase the number of established breeding pairs of Cahow over the next five years to 85 pairs in 2010, in ten years to 115 pairs by 2015, and in fifteen years to 150 pairs by 2020. It also seeks better understanding of the biology and ecology of the Cahow through banding (ringing) studies. To this end a minimum of 50% of all breeding adults and a minimum of 75% of each year's cohort of chicks will be banded. The Recovery Plan seeks to utilize proven research techniques to better understand the activities and range at different times of the year of the Cahow away from its breeding islands. The Recovery Plan also seeks to establish new breeding populations on one or more larger islands in the Castle Harbour Nature Reserve by 2015. This will be by the proven technique of translocation of chicks and the experimental trialing of sound attraction.

### ***8.1.1. Short-term Recovery Target (2010-2015)***

An immediate objective of the recovery plan is to assist an increase in the number of breeding pairs of cahow over the next five years to 85 pairs in 2010 and in the next ten years to 115 pairs by 2015. This objective is considered feasible due to the following factors:

- The recovery program has demonstrated that it is possible to eliminate or control most of the threats acting upon the species (with the exception of erosion and damage to the present nesting islets from hurricanes and storms;
- The status of the present nesting islets and most adjacent areas as Nature Reserves greatly reduces the danger that future changes of use of these areas will adversely affect the species;
- Projects to establish additional Cahow breeding colonies on nearby larger protected Nature Reserve islands through translocation and/or sound attraction techniques are already underway.

### ***8.1.2. Long-Term Recovery Target (2015-2030)***

It is obvious that full recovery of the Cahow to pre-colonial levels is not feasible due to the loss of most of its former nesting areas to human encroachment and development, the impact of introduced mammal predators (in particular, rats and cats), and the extremely high human population density on the larger islands of Bermuda (currently more than 3000/sq. mile). Therefore, the long-term objective of the Recovery Program is to increase the Cahow population to 1000 breeding pairs, with breeding distributed between 5 to 6 islands, a level at which the Cahow would be considered to be out of immediate danger of extinction. This figure may be achievable within the next 25 to 35 years (by 2030-2040), based on the experience with the similar Gould's Petrel recovery on Cabbage Tree and Boondelbah Islands, NSW, Australia.

## 9. RECOMMENDED ACTIONS:

### 9.1. Species Management:

#### *9.1.1. Control of Predators*

This will involve the continued control of mammal and avian predators on breeding and adjacent islands which could cause increased mortality of adult and nestling Cahows and nesting failure.

#### **Actions proposed:**

- Rats will continue to be excluded from the breeding and all adjacent islands by an ongoing program of monitoring and baiting when necessary with anticoagulant rodenticides.
- Monitoring will be carried out to watch for signs of predation by migratory raptors (there are no resident breeding raptors capable of causing Cahow mortality). If predation is detected, efforts will be made to drive the raptor away from breeding islands. If this is not successful, there may be no option but to shoot the raptor in question. This would only be carried out by the Government Conservation officer or a qualified Pest Control Officer after a thorough evaluation of the situation.
- Present regulations prohibiting dogs and all other domestic animals from being landed on any of the Castle Harbour Islands will continue to be strictly enforced. Public awareness advertisements may be needed so that people understand the importance of these regulations.

#### *9.1.2. Minimize nest competition with White-tailed Tropicbird (Longtail)*

Competition for nest sites with the White-tailed Tropicbird *Phaethon lepturus catsbyii* has long been recognized as a serious threat to the Cahow. This has been successfully controlled for many years with the use of wood ‘baffle’ plates that enable access to the nest burrow by Cahows while restricting entry by the larger Tropicbirds (Full accounts of this problem and the solution are given in Appendix 1, Section 2.2. page 77).

#### **Actions proposed:**

- To continue the program to install and maintain baffle plates on all natural and artificial Cahow nesting burrows. This involves the annual installation of baffles by the end of February to coincide with the first arrival of Tropicbirds around the nesting islands, but well before they begin nest prospecting activity. Once all Cahow chicks have fledged, the baffle entrances can be further blocked with rocks. These baffles must be removed during the first week of October at the end of the Tropicbird nesting season and before the first arrival of the Cahows around the 13<sup>th</sup> to 15<sup>th</sup> October. After removal they are dried if damp and are placed in storage on Nonsuch Island. The removal of the baffles during this period enables



- easier access by the adult Cahows during the prospecting, nest-building, courtship/mating and egg incubation periods.
- To increase the numbers of nest sites available for Tropicbirds and thereby reduce the prospecting pressure by this species towards the Cahow nest burrows, a continued program of artificial 'Igloo' Tropicbird nest installation will be carried out on the Cahow breeding islands.



**Fig. 15:** Translocated Cahow chick being moved to new colony site on Nonsuch Is. (Leila Madeiros)

***9.1.3. Establish and maintain a new Cahow nesting colony on Nonsuch Island using translocation techniques:***

Translocation is defined as the movement of living organisms from one area with free release in another area (IUCN Position Statement on Translocation of Living Organisms). Translocation has been undertaken as a recovery strategy for the Cahow as outlined in Appendix 4 (Proposal for Translocation of Chicks to establish new Cahow Nesting Colony). The objectives, feasibility, methodology and potential impacts on source and host environments as well as the Cahow are covered by this translocation proposal.

The initial trial year of this translocation project was completed during the 2003-2004 cahow nesting season. A total of 14 chicks were moved to the translocation site on Nonsuch Island from all 4 of the present nesting islands (see Fig. 6), as follows; Horn

Rock (4 chicks translocated); Green Island (4 chicks translocated); Inner Pear Rock (3 chicks translocated) and Long Rock (3 chicks translocated).

These chicks were fed every other day until they attained a minimum wing chord (outer wing length) of 250 mm. or had shed all of their natal down and attained adult plumage. The chicks were then monitored through their pre-departure exercise period, when they emerged from their burrows at night (See Fig. 14) to exercise their flight muscles and explore their surroundings, until their final departure out to sea. (See Appendix 5 for a full summary of the 2004 trial translocation year)

For the second year of the translocation project during the 2004/2005 season, a total of 21 chicks were moved from the nesting islets to the translocation site (See Fig. 15), taking advantage of an increased number of 35 chicks successfully fledged. Building on experience gained from the trial year, this second group of chicks were given slightly increased amounts of food, with feed weights averaging 50 – 60 grams (range 12 – 90 grams-See Fig. 16) Again, all translocated chicks fledged successfully, with weight and wing chord measurements indistinguishable from naturally fledged chicks.



**Fig. 16:** Translocated Cahow chick being fed fresh whole Squid on Nonsuch Island

All 35 Cahow chicks translocated to the Nonsuch site during the first 2 years of the project fledged successfully from the island within the parameters for weight, wing development etc. established for naturally fledging, non-translocated chicks over the previous three nesting seasons (2001-2004). New behavior by these chicks, never before

observed in Cahows, included chicks climbing up to 15' high into trees to exercise or fledge and chicks exercising under the cover of thick vegetation (mostly Bay grape *Coccoloba uvifera*) during early morning/late afternoon periods of the day. To summarize, the trial translocation year results appeared to confirm that the translocation project's basic methodology and timing are sound and that the translocated chicks accepted their new burrows, returning to the correct ones after exercise periods. The chicks also appear to have had no problems in adapting to their new, forested habitat, which is much closer to their habitat as described by the early settlers than the sparsely vegetated rock islets that they are now confined to.

**Actions proposed:**

- With the first two years of the translocation project now successfully concluded, it is proposed that the number of Cahow chicks translocated to the new breeding colony site on Nonsuch Island be maintained at 20 per year during the next 3 nesting seasons (2005/2006, 2006/2007 and 2007/2008). The eventual goal is to move a total of 95 Cahow chicks to the translocation site to fledge from Nonsuch Island over the five-year period 2004-2009. This number is considered the minimum necessary to ensure a reasonable number of adult Cahows returning to their departure points at the translocation site, assuming a loss rate of 50% or more of fledged chicks between their departure as inexperienced fledglings and their eventual return several years later as adults to choose mates and prospect for their own nest sites.
- Close monitoring of both translocated and control chicks, in addition to the numbers of breeding pairs on the breeding islets, should continue to be carried out to established criteria to ensure that the process is not causing undue detrimental effects to chicks or the overall population.

**9.1.4. Care & rehabilitation of abandoned or underweight chicks**

The monitoring of chicks in accessible nests, including recording of weights and wing measurements, has made it easier to detect chicks that have been prematurely abandoned or insufficiently fed to develop normally. Regular nest checks are also important for detecting when feeding visits have prematurely stopped to chicks in nest chambers that are not easily accessed or visible.

**Actions Proposed:**

- Monitor for signs of abandoned or underfed chicks; any chick more than 8 weeks of age weighing 200g or less should be collected in a secure cardboard box and moved to the rehabilitation facility at BAMZ for feeding to enable them to complete development. When ready, they should be moved to their original nest to fledge.



## **9.2. Habitat Management:**

### ***9.2.1. Provision of artificial nest burrows and control of invasive species***

The program to provide artificial nest sites has proven successful with prospecting Cahows readily accepting them. Over 70% of breeding pairs now use artificial burrows and there is the potential for at least 200 more to eventually be built on higher areas of the present nesting islands, in particular Green Island and Horn Rock. There are limitations involved with increasing the breeding populations on the two eastern nesting islets. Long Rock is of such low elevation and has been so heavily impacted by recent hurricane activity that the number of breeding pairs has not increased in 40 years, despite the building of large stone breakwaters and the construction of a number of artificial nest burrows. Inner Pear Rock has eroded badly since 1989 and suffered partial collapse during hurricane Fabian in 2003. These islets may be at or near carrying capacity and will continue to be degraded by rising sea levels and hurricane activity.

#### **Actions proposed:**

- Provision of additional artificial burrows at appropriate sites, in particular on the western breeding islets, to assist increase of Cahow breeding population.

## **9.3. Monitoring Program:**

### ***9.3.1. Continuation of annual nest monitoring program***

The yearly monitoring of nest sites has been carried out since the beginning of the management program and provides much valuable information on the progress of the breeding season for each nesting pair. It is envisioned that regular monitoring visits to the present breeding islets will continue to be necessary to check on the status of breeding pairs, record the progress of nesting activity, address problems and gather information on chick development and weight. This information will also be essential for such purposes as the selection and moving of chicks for the translocation project. As has been the case in the past, this work should be carried out with the assistance of staff from the Department of Conservation Services, particularly during rough or windy periods, when it is helpful to have assistance with boat handling and landing on the islands. There is also potential for using volunteers or student interns to assist in this work. It should be stressed that because of the level of experience required to land on and work around the breeding islands, and also due to the fragility of the habitat and dangerous soft rock and cliffs, that there should always be an experienced member of staff with knowledge in operating and anchoring boats around these locations.

#### **Actions proposed:**

- To continue to carry out regular monitoring visits to all nesting islands, ideally every 3 to 4 days during active periods depending on weather conditions.
- Install fiber optic infrared cameras with wireless relay antenna so nests can be monitored remotely or made accessible through internet connection.

### ***9.3.2. Continuation of Banding Program***

The current program to band fledgling Cahows results in known-age, easily identifiable birds that can be potentially be followed for their entire lifespan. This should enable information to be gathered on many aspects of breeding biology, including the following:

- (a) The age at which sub adults first return to the breeding grounds to prospect for nest sites and choose potential mates.
- (b) The number of years between first prospecting of nest sites and successful nesting.
- (c) Total lifespan of Cahows (currently believed to be 30+ years).
- (d) Whether Cahows return exclusively to nest on the particular breeding island from which they fledged, or if they can relocate to another breeding island.
- (e) Mortality rates for adults and each cohort of banded chicks.
- (d) The time necessary to establish new pair bonds if a bird loses its original mate.
- (e) Whether, when a pair bond is broken, the nest continues to be occupied by one of the original birds while attempting to attract a new mate.

In addition, the banding of adult Cahows (Fig. 20) will also make it much easier to determine what the population dynamics are on each breeding islet, for example, whether individual birds breed at one particular islet for their entire life and whether pairs are monogamous and stay together for their breeding lifespan. It can also help determine the productivity and breeding success of individual nesting pairs of Cahows.

#### **Actions proposed:**

- To continue the present banding program, retaining handling protocols as outlined previously. The existing banding target of 75% of all chicks fledged during each nesting season is to be maintained. Adult birds are to be banded when possible, with emphasis on banding both individuals of established breeding pairs from accessible nest sites.



**Fig. 17:** Adult Cahow removed from nest burrow for banding and measurement (Jack Ward)

## **9.4. Scientific Research:**

### ***9.4.1. Recording of chick growth rates:***

Since 2002, body measurements and weights of adult and fledgling Cahows have been carried out in order to fulfill the goal of filling in gaps in understanding of the species. This is already providing valuable information, some of which is included as follows:

- There is great variation in growth rates and maximum weights of fledgling Cahows, depending on how frequently they are fed by the adults. Maximum weights achieved vary from 250 to 563 grams (See Figures 21 and 22).
- Despite the substantial variation in both growth rates and maximum weights attained by different fledglings, almost all departed within a fairly narrow weight range, between 240 and 310 grams.
- There is a correlation between the maximum weight reached by individual chicks and the time it takes for those chicks to fledge. Chicks reaching maximum weights exceeding 450 grams have fledged up to 15 days before those reaching maximum weights less than 300 grams.
- Weighing of chicks on consecutive days and from both before and directly after adult feeding visits (carried out during night visits to the nesting islands) have recorded weight increases widely ranging from less than 10 grams to more than 100 grams.
- Weighing of adults has also provided some interesting information; for example, it has been found that adult Cahows can also vary considerably in body size and mass (weight), ranging from less than 250 grams up to 499 grams.

This information has obvious direct applications in the management of the Cahow. For example, weighing of chicks can identify individuals that are underweight or sickly because they are not being fed enough by the adults, enabling them to be brought under care with supplemental feeding before they become dangerously underweight. It can also indicate when the weights of chicks have peaked and they are in the final 'slimming-down' period prior to exercising and final departure. This information is essential for determining the optimum time to transfer chicks to their new burrows when translocation is being used to attempt to establish new breeding colonies.

### **Actions proposed:**

- To continue morphometric and weight measurements of adult Cahows when they are captured for banding, for the duration of the recovery plan;
- To carry out regular weight measurements (preferably every 2 to 3 days) of at least 50% of all Cahow chicks each nesting season, from the period when the adults first begin leaving the chicks alone to find food on feeding trips until final fledging;
- To carry out regular measurements of wing-chord length and development of adult plumage on chicks chosen for the translocation project once they reach 40 to 45 days of age, and of chicks chosen as controls (to ensure that translocation does not negatively impact on chick development).

#### ***9.4.2. Investigation of Sound Attraction Techniques***

Following the purchase and installation of a sound attraction system in 2004 (see Appendix 2: Social Attraction Through Playback of Sound Recordings), field-testing has been carried out during the 2003/2004 and 2004/2005 nesting seasons on Horn Rock, which suffered the loss of 7 long-established nesting burrows. Because of the heavy erosion at the original, low-lying locations of these nest burrows and the continued vulnerability of these areas to storm flooding, a new complex of nest burrows were built close to the original sites but approximately 15' (5m) higher in elevation. Because Gadfly Petrels like the Cahow exhibit such strong fidelity to their original nest sites, the decision was made to initially install the sound attraction system at the new burrow complex in 2003/2004 to encourage the displaced breeding pairs to investigate and occupy the new sites. If sound attraction proves to be a successful technique for attracting Cahows to new nest and colony sites, it may also be used to try to attract Cahows to a new colony location on Southampton Island. (See Appendix 4 for further details).

#### **Actions proposed:**

- To continue use of the Sound Attraction System at the new burrow complex site at Horn Rock during the 2005/2006 Cahow nesting season, and possibly during following seasons if the system appears to be attracting birds to the new burrows. The system may be transferred to the translocation site on Nonsuch Island during the 2006/2007 season to encourage the return of the chicks used in the Translocation Project as they begin to reach maturity and return to their points of departure.
- If the Sound Attraction System shows potential in attracting Cahows to the new burrow complexes on Horn Rock, consideration should be given to building a new complex of artificial burrows on Southampton Island. These can be a combination of concrete and plastic nest burrows, as used at the Nonsuch Translocation Site (see Section 7.1.3.). If sound attraction proves to be a viable option for establishing new nesting colonies, a second system may need to be purchased.

#### ***9.4.3. Increase understanding of biology and pelagic range of Cahow***

Monitoring and research work already carried out on the Cahow during the more than 40 years of the Recovery Project have provided a wealth of information on the behavior and breeding biology of the species while on the nesting grounds. There are still however significant gaps in knowledge of certain aspects of the breeding biology. Their pelagic range, foraging and other behavior while at sea, remains almost completely unknown.

#### **Actions Proposed:**

- **Deploying of burrow-scope techniques & equipment on natural Cahow burrows:** Approximately 14 natural (rock-crevice) Cahow burrows do not have direct visual access to the nesting chamber. Since monitoring began, it has not been possible to determine causes for nest or egg failure in these burrows. The

employment of Burrow-scope techniques, utilized in many overseas seabird programs should be investigated. Appropriate training should be sought for the correct employment of this equipment on any Cahow burrow. There is also the potential to utilize this equipment on scores of otherwise inaccessible Tropicbird nests on the Castle Harbour Islands and elsewhere on Bermuda.

- **Determination of the sex of the Cahow adult population:** Knowledge of the sex of individual birds is critical in small populations. The skewing of sex proportions can have a strong impact on the reproductive potential of any small group of animals. Several sexing techniques are available for use on the Cahow;
  - **DNA sexing:** Sexing from DNA material, such as feathers or blood samples, is standard practice in many intensive seabird studies. This is costly and analysis can take time
  - **Cloacal sexing:** Sexing by cloacal examination has been recently shown to be very reliable and gives immediate results. The application of any such techniques on the Cahow population would require an appropriately trained practitioner of the technique to be brought to Bermuda during the early to mid egg laying period of the Cahow nesting season to train local personnel. Verification of the technique would require a sample of birds being sexed by cloacal examination to have their sex already verified by DNA testing.
  - **Morphometric sexing:** Sexing of adult Cahows may be possible by the application of Discriminate Function Analysis (DFA) of morphometrics. This technique is usually only 70-80% successful in best-case populations where there appears to be a minimal range in most morphometric measurements of individuals.  
DNA sexing is also required of a sub-sample for verification.
  - It is proposed that these options be explored to enable a cost-effective method of sexing the Cahow to be introduced to the recovery Program.
- **Determination of the foraging range and foraging techniques used by the Cahow:** While protection of the Cahow at its breeding islands is assured, knowledge of the feeding range and foraging techniques used by the species, during both the breeding and non-breeding seasons are largely unknown. Identification of the foraging areas is critical to assuring the survival of the species. If inappropriate fishing techniques were to be/are being applied in the feeding areas of the species the impact on the Cahow population could be dire and swift, as witness the collapse of Albatross populations in the Southern Oceans following the introduction of long-line fishing. Further to this, knowing how the birds forage would also assist in determining the level of threat of any fishing technique that may be used in the areas where the Cahow feeds. For example, if the Cahow was known to dive to feed on squid and fish then the setting of long-lines or squid nets may be inappropriate in these feeding areas.

Miniature data-loggers have been successfully deployed on small Pterodroma species overseas. These loggers (weighing 8 - 9 grams) are usually affixed to the leg in the same manner as a leg band or temporarily mounted on the tail feathers

of the bird. They are typically attached for one or two months and then retrieved and the data downloaded onto a computer.

Foraging techniques can be easily determined by the attachment of depth tube recorders to the leg of a Petrel. These simple devices record the volume of water that encroaches into a flexible enclosed capillary tube. This, when measured upon removal from the bird, can give an accurate measure of the greatest depth the bird has been diving to during a feeding trip before returning to the nest. From this information, the foraging technique can be easily determined.

- It is proposed that these, and other proven techniques for assisting the gathering of information on the foraging of the Cahow, be investigated and applied where appropriate.

## **9.5. Public Awareness:**

### ***9.5.1. Increase community awareness by dissemination of information through the Dept. of Conservation Services and involvement of local media.***

The story of the cahow, its rediscovery and the work of the Recovery Program has generated interest by both local and international media, conservation and other magazines, and environmental filmmakers. In 2003 and 2004, for example, 7 local and at least 6 international newspaper articles, 2 radio interviews, 1 TV segment and 8 features in local and international magazines (including World Birdwatch, Wildlife Conservation, Bird Conservation, Awake Magazine and RG Magazine) featured the Cahow Recovery Program. There was particular interest in the effects of hurricane Fabian on the species and steps taken to help it recover. In addition, there are at present 2 film documentaries involving the Cahow and the Recovery Program 'Rare Bird' by Bermudian Lucinda Spurling and 'Bermuda's Treasure Island' by American Deidre Brennen and Irish wildlife filmmaker Eamon de Buitlear. Considerable effort has been made to engage the local media in covering the ongoing story of the Cahow and the recovery program in order to increase public awareness of Bermuda's National Bird.

#### **Actions proposed:**

- Continue to invite local media to cover progress of Recovery Program (e.g. on following translocation project as it develops).
- Publish annual Cahow nesting season progress report.
- Contact local schools to offer Cahow Power Point Presentations, talks etc.
- Develop burrow scopes to allow the public to view nest activity remotely



## 9.6. Species Protection

### 9.6.1. *Propose full legal protection under Protected Species Act 2003*

This Act will make intentional injury to this species illegal and punishable under law and provides much greater protection and penalties for infringements than formally allowed under the Bermuda Protection of Birds Act 1975.

#### **Actions proposed:**

- Declare the Cahow as a critically endangered species under the *Protected Species Act 2003*.

### 9.6.2. *Prevent disturbance of breeding Cahows by excessive artificial light*

It is now known that arrays of intense pole-mounted security lights, or those at sports fields or facilities to enable night playing, can and do cause problems with Cahow breeding activity. In particular, lights that are not hooded, are angled towards the horizon rather than towards the ground, or are oriented directly towards the Cahow breeding islets are particularly harmful. High-intensity light arrays, such as those already installed at the National Stadium and the Somerset Cricket Club for night games, if installed at east end sports venues such as the St. Georges or St. David's Cricket Fields, would be extremely disruptive to the Cahow during many periods of their breeding season. Such light arrays, if proposed, would need to be restricted in terms of their height, intensity and direction of orientation.

#### **Actions proposed:**

- All proposals for new high-intensity security or sports facility lights, particularly those mounted on tall posts or poles, within line of site of the Cahow breeding islets, should be brought to the attention of the Dept. of Conservation Services for consideration and input. This would enable them to be modified at an early stage so that they could still fulfill their function without causing interference to the breeding activity of the Cahow nesting population.
- Existing or potential sources of light close enough and intense enough to potentially impact on the Cahow breeding islets should continue to be monitored; these include the Bermuda International Airport, Ferry Reach Prison Farm, Grotto Bay Hotel, Duck's Puddle Playing Field and Tucker's Point Resort and Hotel (if built).



## **9.7. Habitat Protection**

### ***9.7.1. Identify the Castle Islands Nature Reserve as Critical Habitat.***

The *Bermuda Protected Species Act 2003* makes provision for the identification and declaration of critical habitat for species, populations and communities listed as endangered under the Act.

Declaration of critical habitat provides clear legal recognition of the significance of an area or areas or land for the ongoing survival of a species. Once declared, it becomes an offence to damage or disturb critical habitat and a Species Impact Report is required for all development activities proposed within critical habitat.

The Department of Conservation Services is responsible for identifying critical habitat and in doing so should prepare a recommendation report for the Minister of the Environment's consideration. Critical habitat is declared by the Minister of the Environment.

In order to identify critical habitat it is necessary that the distribution of a species and relative significance of the habitat are well understood. In the case of the Cahow, the Castle Harbour Islands, specifically the four present breeding islets, have been established as the sole breeding location for the species and it is improbable that any additional breeding sites will be discovered, although additional intensive searches of suitable offshore islands such as Outer Pear Rock, Grasbury's Island and Southampton Island will continue to be carried out.

As the Cahow effectively breeds at only one locality worldwide, it should be considered that the protection and maintenance of the present breeding habitat on the Castle Harbour Islands is crucial to their reproductive success and ultimate survival. Because of the physical limitations of the present small breeding islets and their present rapid erosion and vulnerability to over-washing during hurricanes, both Nonsuch and Southampton Islands should also be considered as critical habitat. These islands represent the only suitable locations for establishing additional new nesting sites secure from major storm damage and enabling the population to recover significantly.

The conservation and recovery of the Cahow should be enhanced by the declaration of the Castle Harbour Islands as critical habitat. Community education efforts and legislative protection will be strengthened by such a declaration. Given the need to provide for the present and future habitat requirements of the Cahow as well as providing a protective buffer zone around the breeding sites, all present and potential breeding islands should be declared as critical habitat for this species.

### **Actions proposed:**

- All four of the present Cahow breeding islets (Horn Rock, Green Island, Inner Pear Rock and Long Rock) should be declared as critical habitat, in addition to Nonsuch Island (site of the ongoing Translocation Project to establish a new breeding colony) and Southampton Island.
- The Department of Conservation Services, when reviewing this plan, should consider whether critical habitat should be extended beyond the already mentioned islands to the other islands in the Castle Harbour area, including the outer headland of Cooper's island, to provide a protective buffer zone.

#### ***9.7.2. Importance of Coopers Island to Cahow Recovery Program***

The importance of the Cooper's Island area to the Cahow recovery program and the Castle Harbour Islands Park and Nature Reserve cannot be overstated, and the co-operation and support of officials at the N.A.S.A. facility on the island was vital in the success to date of the cahow conservation program (See Figure 6, page 19; and Appendix 1: Historical records and management actions; pages 67-68). With the departure of NASA from this facility, the preservation and management of Cooper's Island as a Nature Reserve and/or a Wilderness/Natural Heritage area is considered to be absolutely vital to the continued survival and recovery of the Cahow. In addition, the value of this area for environmental tours and walks, native reforestation and habitat management projects, and as a superb bird and ocean observation area, with the Cahow as the flagship species, surpasses that of any other area remaining on Bermuda. As such, it offers great potential for both eco-tourism and environmental education purposes. This is becoming increasingly significant in light of the fact that bird watching, nature tours and other environmentally friendly vacation activities are the fastest growing segment of the tourism industry in the Caribbean and Central American area. Bird watching is also the #1 outdoor activity in the United States and one of the fastest growing hobbies in Canada and the United Kingdom, all of which provide the vast majority of visitors to Bermuda.

There is great potential for a viewing area at this site to be used for year-round observations of resident and migratory bird and sea life, especially seabirds. The best times for viewing Cahows are during November and the January to May period. From April until June, the site would also be ideal for viewing the huge spring migration of Shearwaters which fly past Bermuda just outside the reef line heading north towards their summering grounds. These include Greater Shearwaters *Puffinus gravis*; Cory's Shearwater *Calonectris diomedea*; Sooty Shearwater *Puffinus griseus* and Manx Shearwater *Puffinus puffinus* in addition to Jaegers *Stercorarius sp.*, South Polar Skuas *Catharacta maccormicki* and Arctic Terns *Sterna paradisaea*. Tens of thousands of these seabirds can pass close enough to Cooper's Island to be easily observed in one of the greatest migrations on earth, and Bermuda is one of the only locations where it can be observed from land. Finally, this site is also a good location during the spring and summer period for observing other local nesting seabirds such as the Longtail (or

White-tailed Tropicbird) and the Common Tern *Sterna hirundo*, in addition to offering close views of migrating Humpback Whales *Megaptera novaeangliae* outside the reef line and Green Turtles *Chelonia mydas* foraging just off the beaches in the sea-grass beds. An adult Loggerhead Turtle *Caretta caretta* nested on Well Bay Beach on Coopers Island during June, 2005, with 91 hatchlings successfully going to sea during August, highlighting the importance of Coopers Island's beaches as being most suitable and likely to be used for future sea turtle nesting.

**Actions proposed:**

- To provide a bird and whale-watching observation station on Coopers Point, either incorporating part of the N.A.S.A.-era radar building or as a purpose-built structure on the same location.
- Promote the value of Coopers Island as a bird/whale observatory, with the Cahow as a prime attraction, to local hotels and cruise visitors and by advertising in overseas birding magazines.

**9.7.3. Minimize human induced disturbance and damage to Cahow habitat**

Minimizing human disturbance and damage to Cahow habitat will continue to be a necessary part of management and may well become more challenging with the eventual opening of the southern half of Coopers Island to the public. The two eastern islands in particular are located close offshore to what may become public beaches (albeit zoned as nature Reserves). There will be a need to inform people of the sensitivity of these sites. All of the present Cahow nesting islands, in addition to all nearby islands, are already protected as restricted access Nature Reserves, with no landing allowed except by special permission. Most islands have had signs installed which either specifies that landing is not permitted, or in the case of Castle, Charles and Nonsuch Islands, list various protective regulations. These signs are however vulnerable to the high waves and tides experienced during hurricanes, with a total of six being lost from four islands during hurricane 'Fabian' in 2003. The islands are also warded by the Conservation Officer, who lives in the warden's residence on Nonsuch Island for much of the year, and regularly patrolled by the Marine Division of the Bermuda Police Department, and occasionally by Fisheries Officers from the department of Environmental Protection.

**Actions proposed:**

- All signs destroyed by hurricane activity during 2003 should be replaced (and, where possible relocated at a higher level so that they are not as vulnerable to high surf). The wording of the signs should also be updated to include new legislation.
- Maintain wardening presence on Castle Harbour Islands to prevent unregulated human disturbance, using Nonsuch Island as base; carry out regular patrols of all nesting islands at least 3-4 times weekly during nesting season as weather allows;

- maintain links with marine police and fisheries officers to include Castle Islands Nature Reserve areas in their patrols, informing them of landing restrictions etc. Also maintain links with Parks Department lifeguard service and Rangers to inform and prevent swimmers from Clearwater and Turtle Beaches from landing on nearby offshore islands.
- Educate public about the sensitivity of the area.

## 9.8. Funding:

Funding should continue to be provided primarily from the operating budget of the Terrestrial Conservation Division of the Department of Conservation Services, with substantial support from the Bermuda Zoological Society and the Bermuda Audubon Society.

### Actions proposed:

- Funding for specific projects within the Cahow Recovery Program, such as the use of data loggers to record movements of Cahows at sea away from the nesting islets, may be sought through the Overseas Territories Environmental Program (O.T.E.P.)

## 9.9. Budget for Cahow Recovery Plan:

Costings are calculated for the first five years of this plan and are based on 2004 prices (Bermuda/American dollars) and are indexed to CPI. This plan should be reviewed after five years and costings adjusted for inflation and management priorities.

Objectives	2004/5	2005/6	2006/7	2007/8	2008/9	2009/10	Total
Banding Program	\$300*	0	\$300*	0	\$350*	0	\$950
Growth rate data	0	\$250	0	\$250	0	\$300	\$800
Burrow-scope	0	\$3500**	\$4000**	0	0	\$500	\$8000
Sexing	0	0	\$500	\$5000	0	0	\$5500
Pelagic range data (Data loggers)	0	0	0		\$7000***	\$7000***	\$14,000
Translocation	\$23000	\$2500	\$2600	\$2600	\$2700	\$1000	\$33,400
Social Attraction	\$3000	\$250	\$3300	\$250	\$400	\$450	\$7650
Misc.	\$500	\$500	\$500	\$600	\$600	\$700	\$3400
Total	\$26800	\$7000	\$11,200	\$8700	\$11,050	\$9950	\$73,700

\* Costs include purchase of additional new bands, banding equipment, bags etc.

\*\* Includes purchase of burrow-scope 1st year, cost of bringing in instructor in use 2nd year.

\*\*\* Costs include purchase of data loggers & instruction in use

## 10. ACTION IMPLEMENTATION SCHEDULE

Action	Description	Schedule of Implementation	Possible sources of funding
<b>10.1</b>	<b>Species management</b>		
	Control of rats and avian predators	Ongoing-monitor & set bait as necessary	Operating budget
	Minimize nest competition with White-tailed Tropicbird	Ongoing-install baffles at Cahow burrow entrances	Operating budget
	Establish & maintain new nesting colony on Nonsuch Island using translocation techniques	Translocation of 20 chicks yearly 2006 to 2008 to site at Nonsuch Island	Operating budget/Audubon Society
<b>10.2</b>	<b>Habitat management</b>		
	Continuation of program to provide additional artificial nest burrows	Install 6 to 10 new burrows annually at nesting islets	Operating budget
<b>10.3</b>	<b>Monitoring</b>		
	Continue annual nest monitoring program	Carry out 2 to 3 checks per week each nesting season	Operating budget
	Continuation of banding program	Band 75% of chicks and adults in accessible nests	Operating budget
<b>10.4</b>	<b>Research</b>		
	Continuation of chick growth rate study	Record morphometrics of 15 to 20 chicks annually	Operating budget
	Continue investigation of sound attraction techniques	Use sound system at trans. Site annually until 2010	Operating budget/Audubon Society
	Increase understanding of biology and pelagic range of Cahow	Obtain burrow-scope 2006; trial use of data loggers 2009-2010	Bda Audubon Society / BZS OTEP grants
<b>10.5</b>	<b>Public awareness</b>		
	Invite local media to cover recovery program	Ongoing-arrange annual visits by media to trans. site	Operating budget
	Give school & public talks	Ongoing	
	Develop 'nest cam' with website	Proposed 2008	OTEP? BZS
<b>10.6</b>	<b>Species protection</b>		
	Designate Cahow as critically endangered species	Pursue designation by 2006	
<b>10.7</b>	<b>Habitat protection</b>		
	Identify Castle Islands as critical habitat	Pursue designation by 2006	
	Minimize human disturbance and damage to habitat	Install warning signs; carry out regular patrols	Operating budget
<b>10.8</b>	<b>Funding</b>		
	Identify all possible sources of funding for Cahow recovery program and make appropriate applications for said funding.	Ongoing; applications made as needed	

## 11. Calendar of Breeding Season and Management Activities

<b>Month</b>	<b>Activity</b>	<b>Management</b>	<b>Remarks</b>
<i>September</i>	No birds on breeding grounds	Bait islands for rats	Construction of new nest burrows
<i>October</i>	No birds on breeding grounds	Remove baffles, unblock burrow entrances; begin monitoring	Check all burrow entrances, tunnels for obstructions
	Return of breeding pairs		
<i>November</i>	Courtship of established breeding pairs	Continue monitoring; provide grass for nest-building; start operation of sound attraction system	Time to carry out night watches on islets to observe courtship activity of established pairs
<i>December</i>	Pre-egg-laying exodus of breeding pairs		Birds begin return at end of month
<i>January</i>	Return of breeding pairs and egg-laying	Monitor egg-laying; make new baffles as needed	Band checks of brooding adult birds
<i>February</i>	Brooding of eggs by adults	Install baffles at all burrow entrances; carry out banding of adults; continue monitoring	Peak of activity for prospecting adults; night checks to check prospecting birds for bands
<i>March</i>	Brooding of eggs/egg-hatching	Continue monitoring; begin weighing of chicks	End of prospecting activity; check spare nests for signs of occupation
<i>April</i>	Feeding of chicks by adults	Continue monitoring and weighing of chicks	Final preparation of Translocation site; check for rats
<i>May</i>	Feeding of chicks by adults; beginning of chick departure	Continue monitoring & weighing of chicks; begin translocation of chicks; begin banding of chicks	Translocation activities; night watches to monitor fledging chicks
<i>June</i>	End of chick departure by mid-month; final departure of adults to sea	Continue monitoring and translocation of chicks; band remaining chicks	Block burrows after departure confirmed
<i>July</i>	No birds on breeding grounds		Construction of new burrows
<i>August</i>	No birds on breeding grounds		Construction of new burrows

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~~Appendices are available as separate documents in the online version~~



## *Closing acknowledgements*

The success to date of the Cahow recovery program could not have been possible without the hard work, support and assistance of a large number of Department staff, student interns, volunteers and members of the public.

In recognition of this, the Conservation Officer (Terrestrial) would like to thank the following individuals that have assisted in various ways with different aspects of the program:

Department of Conservation Services Terrestrial Conservation Crew:  
Foreman: Barry Smith  
Conservation Workers: Hillgrove Iris, Kiwon Furbert and Marvin Jones

Department of Conservation Services Staff:  
Director: Jack Ward  
Joseph Furbert, Jennifer Gray, Patrick Talbot, Dr. Sarah Manuel, Pam Wade

Bermuda Biodiversity Project Staff:  
Dr. Annie Glasspool, Mark Outerbridge

Department of Environmental Protection staff:  
Tammy Trott, John Edmunds, Derrick Excell

All volunteers, student interns and assistants that assisted on night watches, monitoring checks etc.

Particular thanks to Dr. David Wingate, former Government Conservation Officer, who headed the Cahow conservation program for some 40 years until his retirement in 2000, and has continued to assist with advice, practical help and monitoring checks.

Photograph on back cover of nearly fully fledged Cahow chick by Dr. Annie Glasspool



# APPENDIX 1: HISTORICAL RECORDS AND MANAGEMENT ACTIONS

## 1. Historical Records

The islands of Bermuda were first discovered by Portuguese and Spanish sailors in the early 1500's. The islands were not settled for nearly a century because of the dangerous reefs and stormy weather associated with the islands and because of the belief that they were inhabited by devils and evil spirits. This belief seems to have come about because of the tremendous noise created by the large colonies of nocturnal seabirds nesting on the islands, such as the Cahow and the Audubon's Shearwater *Puffinus l'hermionii*. By 1630 the Cahow was no longer found or mentioned on the islands of Bermuda.

One of the earliest accounts was written by Diego Ramirez, the captain of a Spanish Galleon driven by a storm into Bermuda waters in 1603:

“The first night that I anchored in the bay, I sent a small boat to an inlet to look for water, but none was found. At dusk, such a shrieking and din filled the air that fear seized us. Only one variety of bird makes this noise, but the concerted yell is terrible, and standing out from it were individual voices shouting diselo! diselo! (tell'em, tell'em). One seaman said to me, “what is this devil trying to tell me? Out with it! Let's hear what it is!” I replied, “A la! These are the devils reported to be about Bermuda”.

When the Spanish sailors discovered that the noise was produced by seabirds, they also found that they could be attracted by lantern light. They killed the birds in great numbers to replenish their stores before they sailed; in one night alone they clubbed and took 4,000 birds.

The survivors of the English ‘Sea Venture’ shipwreck in 1609 on Bermuda and the first permanent settlers from 1612 onwards left several vivid accounts of the cahow which provide information about the breeding sites and numbers of the birds at this time. These accounts were detailed enough for there to be no doubt as to the identity of the species. This is indeed fortunate, as the cahow was almost completely exterminated within 10 years of settlement.

Because of the importance of these accounts, it is useful to include several which illustrate both the initial abundance and the swift near-elimination of the cahow.

The first account is contained in the official report on the ‘Sea Venture’ wreck and the survivor's stay on Bermuda by Thomas Gates, Admiral Sir George Sommers and Captain Newport, titled ‘A Discover of the Barmodas, now called the Sommers Islands, 1609-1610’.

The following excerpt states:

“Another Sea Fowle there is that lyeth in little holes in the ground, like unto Coney holes, and are in great numbers, exceeding good meate, very fat and sweet (those we had in the winter) and their eggs are white, and of that bigness, that they are not to be knowne from these (chicken) eggs.”

Much information about the cahow is also included in the detailed narrative by William Strachy, 1610 of the ‘Sea Venture’ wreck:

“A kind of webbe-footed Fowle there is, of the bigness of an English greene Plover or Sea-Meuwe, which all the summer wee saw not, and in the darkest nights of November and December (for in the night they only feed), they would come forth, but not flye farre from home, and hawering in the ayre, and over the sea, made a strange hollow and harsh howling. Their colour is inclining to Russet, with white bellies, as are likewise the long feathers of their wings Russet and White, those gather themselves together and breed in those islands which are high, and so farre alone into the sea, that the wilde hogges cannot swimme over (to) them, and there in the ground they have their Burrowes, like Conyes in a Warren, and so brought in the loose mould, though not so deep, which birds with a light bough in a darke night (as in our Lowbelling) wee caught. I have been at the taking of three hundred in an houre, and wee might have laden our boates. Our men found a prettie way to take them, which was by standing on the rockes or sands by the seaside, and hollowing, laughing, and making the strangest out-cry that possibly they could with the noise wherof the birds would come flocking to that place, and settle upon the very armes and head of him that so cryed, and still creepe neerer and neerer, answering the noyse themselves by which our men would weigh them with their hand, and which weighed heaviest they tooke for the best and let the others alone, and so our men would take twentie dozen in two hours of the chieftest of them; and they were a well relished Fowle, fat and full as a partridge. In January wee had great store of their egges, which are as great as an Hennes Egge, and so fashioned and white shelled, and have no difference in yolke nor white from an Hennes Egge. There are thousands of these Birds, and two or three islands full of their burrowes, whether at any time (in two hours warning) wee could send our cock-boat, and bring home as many as would serve the whole company. Which birds for their blindnesse (for they see weakly in the day) and for their cry and whooting, wee called the Sea Owle; they will bite cruelly with their crooked bills”.

Following the ‘Sea Venture’ shipwreck, accounts of the natural wealth of Bermuda and its suitability for colonization reached England, resulting in the dispatch of another ship which brought permanent settlers to the island in 1612. The next account referring to the cahow from the first years of colonization is included in: “A letter written from the Summer Islands,” dated Dec. 1614, by the Rev. Lewis Hughes, which states:

“Here is also plenty of sea foules, at one time of the yeare, as about the middle of October, birds which we call cahouze and pimlicoës (Audubon’s Shearwaters) come in.

The cahouze continue til the beginning of June in great abundance, they are bigger bodied than a pigeon and of a very firm and good flesh. They are taken with ease if one do but sit downe in a darke night and make a noise, there will more come to him than he shall be able to kill: some have told me that they have taken twelve or fourteen dozen in an hour.” (A. E. Verrill – The Bermuda Islands 1902).

The following extract is from the early part of Governor Butler’s “Historye” written about 1619:

“For the cahowe (for so sounds his voice), it is a night bird, and all the day long lies hidd in holes of the rocks, whence both themselves and their young are in great numbers extracted with ease, and prove (especially the young) so pleasing in a dish, as ashamed I am to tell how many of them have been devoured by some one of our northern stomachs, even at only one meale.”

Several years after the settlement of Bermuda, rats were accidentally introduced to the previously mammal-free island from a captured Spanish grain ship. These multiplied so rapidly that they quickly spread over the entire archipelago, swimming from island to island and eating all available food and crops. The resulting famine in 1615 among the colonists and the subsequent effect to the cahows was described in the following account, from Governor Butler’s “Historye”.

“Whilst this Pinnacle was on her way for England, scarcity and famine every day more and more prevayleinge upon the sickly colony, caused the governor to look well about him: in the beginning of the new yeare, therefore (1615), 150 persons of the most ancient, sick and weake, were sent into Cooper’s Iland, ther to be relieved by the comeinge in of the sea-birds, especially the Cahowes, where, by this half hunger-starved company, they are found in infinite numbers, and with all so tame and amazed they are, that upon the least howeteinge (shouting) or noise, they would fall down, and light upon their shoulders as they went, and leggs as they sat, suffering themselves to be caught faster than they could be killed. Wittness the general carriage and behavior of this company, who being thus arrived and gott up to a libertie and chouce of eating as much as they would, how monstrous was it to see, how greedily everything was swallowed downe; how incredible to speake, how many dozen of those poore silly creatures, that even offered themselves to the slaughter, were tumbled downe into their bottomless mawes, there upon (as the sore effect of so rank a cause, the birds with all being exceedingly fatt) then suddenly followed a general surfettinge, much sicknesse, and many of their deaths.”

In the “Plain and True Revelation” by the Rev. Lewis Hughes, London, 1621, there is also an account of the famine of 1615, which includes the following extract:

“The first night that I lay in the Iland, which you call Cooper’s Iland (whither the lazie starving crewe were sent, and with them some honest industrious persons, though then much out of heart, and now living and well, thanks unto God), when I saw in every cabin

pots and kettles full of birds boyling, and some on spits roasting, and the silly wilde birds coming so tame into my cabin and goe so familiarly betweene my feet, and round about the cabin, and into the fire, with a strange lamentable noyse, as though they did bemoan us, and bid us to take, kill, roast, and eate them.”

There are several references to the cahow and other seabirds in the early laws of Bermuda. Even as early as 1616, a law was passed restricting the taking of the bird and its eggs, because of the rapid decrease in its numbers. It is thus referred to in Governor Butler’s “Historye”:

“In the same month he held his second general Assize at St. Georges; as irregularly as the first, wherein not any matter of note was handled, only a proclamation (or rather article, as it was then termed) was published (but overlate) against the spoyle and havock of the cahowes, and other birds, which already were almost all of them killed and scared away very improvidently by fire, diggeing, stoneing, and all kinds of murtherings.”

Among the laws enacted by the Bermuda Company, 1612-1622, was the following: “The Governor and other officers shall take care for the preservation of the breed of birds, by reserving to them those islands whereunto they resort.” (See Section 7, Legislative Context/Protective Listings)

Captain John Smith in his General History of Virginia, etc. (Ed of 1629) states that the cahows and egg-birds (Terns) were “all gone” at that date.

The Cahow was not recorded again after this time for almost three hundred years, and was thought to be extinct. It was not until February 1906 that L.L. Mowbray found an unidentified petrel on Gurnet Head, Castle Island (possibly Gurnet Rock). This bird was recognized as being closely related to the Black-capped Petrel of the Caribbean, although slightly smaller. In 1916 it was given the scientific name *Pterodroma cahow*. In the same year the bird was compared with a reconstruction of the original Bermuda Petrel, made from bones and sub-fossil remains found in caves; it was proved beyond doubt that the new discovery was the original cahow that had been presumed to be extinct for so long.

Individual, freshly dead cahow specimens were found in 1935 and again in 1945, the first of which was a recently fledged chick that had flown into the St. David’s lighthouse, the other was a partially decomposed adult found washed up on a beach at Cooper’s Island (Murphy & Mowbray: *New Light on the Cahow, Pterodroma cahow*. 1951)

In 1951, the curator of the Bermuda Aquarium and Zoo, Louis Mowbray Jr. and the American ornithologist Dr. Robert Cushman Murphy, organized an expedition to find the breeding grounds where the cahow had survived in obscurity for hundreds of years. During the course of the search six occupied burrows were discovered on two tiny islands, Inner Pear Rock and Outer Pear Rock, off the eastern coast of Bermuda.

Also present on this expedition was David Wingate, who at the time was only 15 and had been invited along because of his interest in birds and natural history. Upon returning to Bermuda in 1957 after graduating from Cornell University, USA, Wingate began work with a new Cahow conservation program under Mowbray's direction, with funds provided by the New York Zoological Society. He went on to discover a number of additional nesting pairs of Cahow on 3 more small islets (Green Island, Horn Rock and Long Rock), bringing the number of known breeding pairs to 18 by 1959.

In 1966 Wingate took over the cahow program as head of the Bermuda Government's Conservation Division and until his retirement in 2000 directed an intensive management program with the following aims:

1. Improving breeding success
2. Identifying and solving threats and problems
3. Increasing the cahow breeding population
4. Restoring habitat suitable for the cahow on additional nearby islands

Under this program the cahow population has increased from 18 pairs with 8 young fledged in 1962 to 71 nesting pairs with 35 young successfully fledged in 2005 (Fig. 10).

From 1962 to 1970, established breeding pairs increased in number from 18 to 24, after reaching a low of 17 during 1963-1965. During this period, no more than 8 and as few as 6 chicks were successfully fledging annually. Breeding success during this period averaged only 37%, reaching a low of 27% in 1969 during the peak of the DDT pesticide crisis (this persistent pesticide was proven to concentrate in the food chain, causing problems with both terrestrial and oceanic bird species, including thin, easily broken eggshells).

Following this initial period of management, the situation improved greatly for the Cahow, helped by the banning of the DDT in North America after 1970 and the building of dozens of artificial nesting burrows on the breeding islands. Monitoring undertaken during the period 1971-1990 revealed that the number of breeding pairs rose from 24 in 1971 to 45 pairs in 1989. Breeding success during this period increased to an average of 53%, with greater than 60% success being recorded during some years, and the number of successfully fledged chicks rose from 13 in 1971 to a maximum of 28 in 1989.

The final period of management, from 1991 to 2005, was notable for at least two fluctuations in an otherwise steady increase in the number of established breeding pairs. These fluctuations, caused mainly by the sudden disappearance of adult Cahows resulting in the disruption of established pairs, appear to be connected to the movement of unusually severe hurricanes (Category 4 or 5, with sustained winds in excess of 135 mph) through the pelagic feeding grounds of the Cahow off the southeastern United States. Hurricane Fabian, a Category 3 hurricane that struck Bermuda on Sept. 5, 2003, destroyed a number of nest burrows and disrupted others, causing a noticeable decline in both active nest sites and fledged chicks in 2004 (see Section 5 - Current threats; 5.1.2).

storm damage to nest sites and Habitat; 5.3.2. :Increased intensity and frequency of hurricanes).

Despite these short disruptions, the number of established breeding pairs continued to increase from 41 in 1991 to a total of 71 pairs in the 2004-2005 breeding season (Figure 10); breeding success during this period averaged 51%. The total number of chicks successfully fledging during this period varied substantially from one year to another but generally rose from a low of 19 in 1991 to a high of 39 in 2003 (Figure 10).

Although the total number of established pairs has continued to increase fairly steadily over the last 30 years, the total number of successfully fledged chicks varies considerably from year to year.

As of the writing of this Recovery Plan, the cahow is continuing its slow recovery from what can only be described as the very edge of extinction. A continuing program of new nesting burrow construction on the present nesting islands, protection from disturbance and predators, and the use of newly developed translocation techniques (used successfully to establish a new colony of Gould's Petrel *Pterodroma leucoptera* off the coast of New South Wales, Australia (D. Priddel and N. Carlile, 1996 – See Appendix 4), promise to further increase the population on the present nesting islands and to establish a new colony on the nearby much larger and more suitable Nonsuch Island Nature Reserve.

## **2. History of Management Actions:**

### ***2.1. Initial management efforts: control of rats on nesting islets***

Initial efforts towards helping the Cahow following its rediscovery were somewhat sporadic and disjointed. The first recorded instance of management directed towards the species in this Century came in the early 1940's when an American Army officer, named Fred T. Hall, discovered a dead Cahow that had washed ashore on one of the beaches on Cooper's Island. He also came upon the remains of other cahows being eaten by rats. As a result, he put out rat poison, an act which may have contributed towards the survival of the small number of surviving pairs.

Following discovery of the breeding grounds of the Cahow in 1951, it was possible to launch a conservation program for the species. It was recognized that the key to the Cahow's survival was the existence of a few tiny offshore islands which had managed to remain free from human disturbance and larger mammalian predators such as pigs, dogs and cats since human settlement of Bermuda began in the early 17<sup>th</sup> Century. Initial emphasis in the conservation program was given to the control and eradication of rats (*Rattus rattus* and *R. norvegicus*), which can and did swim from the Bermuda mainland during years of high population peaks to colonize the breeding islands. These were



successfully eliminated by the use of warfarin, an anti-coagulant rodenticide, a technique used regularly ever since.

## **2.2. Identification of Tropicbird as Nest Competitor**

One of the first discoveries of the conservation program was that most cahow chicks were being killed by the relatively common White-tailed Tropicbird, or Longtail *Phaethon lepturus catsbyii*, (see Fig. 18), which returns to Bermuda for its nesting season soon after the Cahow chicks hatch. Almost all of the Cahow nest burrows were being invaded by nest-prospecting Tropicbirds, which killed the young chicks while the adult Cahows were away at sea foraging for food. The Tropicbirds then took over the nest sites as their own.

As soon as the extent of this problem was realized, finding a solution became the main focus of the conservation program. In 1954 Richard Thorsell was employed under a New York Zoological Society (NYZS) grant to work on the Cahow program with Louis Mowbray (Thorsell, unpublished data). Their first action was to eliminate Tropicbirds already occupying cahow nest sites. This extreme measure bought time to find a permanent solution, as it takes a number of years for new pairs of Tropicbirds to colonize vacant nest sites. This method was however undesirable because the Tropicbird is much admired by Bermudians and looked for as the harbinger of spring.



**Fig. 18:** Adult White-tailed Tropicbird flying over Cahow nesting islet (J. Madeiros)

### **2.3. Development of Tropicbird Baffler**

The solution to the problem of nest site competition with the Tropicbird was found when Richard Pough suggested a means which takes advantage of the size difference between the Cahow and the Tropicbird. Although they have similar wingspans, tropicbirds have larger, heavier bodies which are more round in cross-section than that of the Cahow. A wooden 'baffler' was installed at the burrow entrances with a specially sized entry hole that allowed Cahows to enter but prevented access by the larger Tropicbirds. Thorsell determined that an elliptical hole measuring 127mm wide by 57mm high cut in the baffle was ideal, with a very small margin of error. For example, holes of 127mm by 54mm were too small for most Cahows, while holes of 127mm by 64mm could be entered by most tropicbirds (Wingate, 1978). Thorsell installed baffles of the optimum size in 5 burrows on 2 islands before terminating his research in 1955.

### **2.4. Management and Recovery Efforts under Dr. David Wingate**

The involvement of David Wingate in the Cahow recovery program began in 1957 upon his return from college and was carried out with funds provided by the NYZS until 1966. At this time he took over the program as Government Conservation Officer in charge of the Government Conservation Division. He held this post until his retirement in 2000. Because he was unaware of Thorsell's unpublished data on the Cahow bafflers, Wingate first concentrated on repeating Thorsell's work to determine optimum baffler dimensions. He obtained identical results and began to install bafflers at all known nestsites. Part of this initial work also involved the elimination of tropicbird pairs that were already occupying Cahow nestsites. This was necessary because already established Tropicbirds had such a strong drive to re-enter their chosen nestsite that they would eventually succeed in squeezing through a baffler despite the smaller size.

The work of eliminating pre-established Tropicbirds and installing bafflers at all known nest sites was completed by late spring of 1961. This resulted in an immediate increase in the number of successfully fledged Cahow chicks. Wingate also deduced that there had to be a number of undiscovered Cahow nestsites for the species to have been able to survive. Using new information obtained from observations of the Cahow's breeding biology (Palmer, 1962), Wingate carried out extensive further searching on all islands in the area and by 1961 had found 11 new nesting pairs, of which 8 were free from tropicbird nest site competition.

#### ***2.4.1. Development of Artificial Nesting Burrows***

With the development of the baffler providing protection to the existing Cahow nest sites, the next priority was to provide additional nesting burrows. This was essential because the tiny nesting islands contained only a small number of natural nest sites which met the requirements of the Cahow. There was therefore little chance for new, prospecting pairs to find suitable new nests. Several artificial burrows were dug into cliffs adjacent to

occupied burrows during the period 1954 to 1960 and the fact that 3 of them were rapidly occupied indicated that lack of available sites was a major factor limiting the Cahow population. New, artificial nest burrows were constructed on each island so that new Cahow pairs would have a supply of unoccupied, suitable nest sites to choose from.

The artificial burrows were usually constructed in close proximity to existing active nest sites because it was thought that social facilitation is important in establishing new Cahow nest sites with new breeding pairs generally colonizing in close proximity to established, active nest sites (Wingate, 1978). Banding and recapture studies of the related Gould's Petrel *Pterodroma leucoptera* on cabbage Tree Island, New South Wales, Australia, have since shown that Petrels just reaching maturity and returning to the nesting grounds for the first time usually land near to (within a few meters) the same nests they originally fledged from (N. Carlile and D. Priddel, 2000, pers. Communication), rather than in proximity to active nests in general.



**Fig. 19:** Artificial concrete Cahow burrow showing entrance (foreground) and concrete nest chamber lid (background). (J. Madeiros)



By 1964 artificial burrows were being built on higher, more level areas on the nesting islands. These burrows more closely resemble a typical petrel nesting burrow than the rock crevices and caves which made up most of the nest sites being used by the birds. They were constructed by digging trenches into the rock surface of the islands after removing the soil. These trenches, and an enlarged nest chamber at the end, were roofed over with 3" to 4" of concrete (Figure 19), originally poured over a wire form but more recently over cardboard sheets bent to shape over a stuffing of leftover newsprint. It is also important that the section of trench that makes up the entrance tunnel to the nest has a bend or curve at some point along its length, to prevent light from shining through to the nest chamber. The entrance tunnel ideally is at least 6" wide and 4" to 6" high and angled up or has a high point, to prevent heavy rain or storm waves from running down into the chamber. A removable lid over the nest chamber allowed observation of the nest and, if necessary, removal of the birds. These lids are made out of heavy concrete to prevent them being blown off during storms and hurricanes.

In addition to allowing visual observation and physical access to the nest chamber, these artificial burrows have a further advantage in that it is possible to construct them on any fairly level area on the nesting islands that is high enough to be beyond the reach of most storm waves. By 2004 over 100 of these burrows had been constructed on the four nesting islands, with the majority having already been occupied by Cahows.

## **2.4.2. Management of Additional Threats:**

### ***Hurricane & Storm Erosion and Flooding:***

The most serious recent threat is undoubtedly the great increase in storm and erosional damage to the tiny nesting islands during the last 15 years. From at least the early 1950's until the late 1980's, storm flooding and major erosion of these islands occurred only on rare occasions. However, since 1989 there have been 7 major hurricane and storm events which have over-washed and severely eroded the nesting islands, washing nest lids overboard, filling nest burrows with rocks and debris, and, in the case of hurricane 'Fabian' on Sept. 5, 2003, physically destroying nest burrows and sections of the islands they were located on. After each storm the pouring of new concrete nest lids, clearing of burrows, and the rebuilding of eroded sections of some islands to protect nest sites had to be completed during the short period of time before the adult cahows begin to return to the nests by mid-October. Continuing rough weather conditions, common at this time of year, often made it very difficult to complete this work in time. Efforts were also made to prevent or reduce further damage by building breakwaters or walls in critical areas to deflect storm waves from nesting burrows or to reinforce eroded areas under burrow complexes. These walls were built from concrete blocks camouflaged with natural rocks and boulders. These have proven to be effective in reducing damage to nest burrows in all but the most severe storms, but are logistically difficult and labor-intensive to build.

Hurricane Fabian, a severe Category 3 storm, in 2003 destroyed or undermined 3 of these walls on Horn Rock and Inner Pear Rock, resulting in the destruction of 9 active nest burrows and damage to several others. Some of these were difficult or impossible to rebuild because of severe erosion of large sections of these islands, so a decision was made to build new burrows on a higher level above the original sites. Two new burrows were built on Inner Pear Rock to replace destroyed sites and 8 new burrows on Horn Rock, 12'-15' (4-5m) higher than the original nest sites. The new burrow complex on Horn Rock (designated as the "F" complex), was the location where a sound attraction system (see Cahow Recovery Plan: Section 7.4.2. page 38) was used in 2004 and 2005 in an attempt to attract Cahows which had lost nest sites during hurricane Fabian to a new, more elevated location. This was coupled with the physical translocation of adult birds found at the original sites of the destroyed nests, which were banded and released in the new nest burrows. These efforts were successful in attracting pairs of Cahows to colonize three of the new 'F' nest burrows by March, 2005.

***Predation by Migratory Raptors:***

Another potential threat encountered on at least two occasions is the predation of Cahows by raptors or birds of prey. In 1986 a Snowy Owl *Nyctea scandiaca*, which is normally found in Arctic regions, was blown to Bermuda by unusual weather conditions. It settled on the eastern islands of Bermuda, where it quickly discovered the Cahow nesting colony, killing at least 5 adult birds. Following numerous failed attempts to capture or tranquilize the owl, and with more cahows being killed on a nightly basis, Dr. Wingate decided to shoot the owl to prevent further damage to the Cahow population.

In late 2000, a Peregrine Falcon *Falco peregrinus*, a frequent migrant through the Bermuda area during autumn, overwintered on the island for the first time on record. This bird began to roost for the night on one of the cahow nesting islands very close to one of the largest burrow complexes. At least one Cahow was predated, and there is evidence that the presence of this falcon on the island may have disrupted the breeding of other pairs of Cahow. This problem was solved by going out to the island by boat at dusk and chasing and harassing the Peregrine away from the island so that it would have to find a new roost some distance away by night fall. This method was ultimately successful in forcing the Peregrine to roost elsewhere.

***Colonization of Nest Burrows by Wild Bee Swarms:***

One rare, but potential threat is that of swarms of wild European Honeybees *Apis mellifera*, colonizing nesting burrows. The potential for this to occur was first recognized when two Tropicbird nests on the Cahow nesting islands were colonized by swarms of wild bees during the 1990's. The Tropicbirds persisted on trying to enter their nest sites despite the presence of the bees, with the result that at least one pair of the birds were stung to death. In 2001, a swarm of bees colonized an active Cahow burrow (C11) on Horn Rock, filling the burrow entrance with honeycomb. This was fortunately discovered before the return of the birds for the nesting season, allowing enough time to destroy the swarm and remove the hive. The birds nested normally and successfully raised a chick, but this incident highlights the need for pre-season checks to prevent any recurrence.

### 2.4.3. Monitoring of Nest Sites

Regular monitoring of all nest sites during the Cahow breeding season has been carried out by the Conservation Officer and assistants since 1962. Monitoring visits are made to each nesting island every 3 to 4 days on average, from mid-October when the first adults arrive until mid June when the last fledglings depart.

Monitoring has included the inspection of Cahow adults and chicks inside nest chambers by means of removable lids, the removal or installation of baffles as required, recording of external evidence outside burrow entrances, and night watches on the nesting islands. Night watches have generally been carried out during May and June to observe Cahow fledglings during their final exercise period before they depart to sea. A smaller number of night watches are also carried out during November and February, mainly from boats moored off the nesting islands, to observe the peaks of courtship activity.

Monitoring has been able to establish the following information:

- The number of breeding pairs in any given year;
- The number of pairs laying eggs, egg failure rates and number of chicks produced in accessible nests;
- Chick mortality rates;
- Dates of annual return, length of pre-egg laying exodus and final departure of adults;
- Dates of egg laying;
- Length of incubation period;
- Approximate frequency of feeding visits by adults;
- Time to fledging;
- Approximate date of adult abandonment of fledglings;
- Length of exercise periods by fledglings;
- Date of final departures of fledglings.

Until 2002, there had been no banding (ringing) of Cahows and little ‘hands-on’ research work such as weighing, morphometric measurements etc. This was in accordance with a ‘non-disturbance’ policy that had been in effect in the conservation program under Dr. David Wingate, who believed that it was best to not carry out any activities which could cause disturbance to the Cahows and negatively affect breeding success during the period when the breeding numbers were still critically low.

With overwhelming evidence from research on *Pterodroma* Petrels world-wide over the last 30 years that they are not particularly sensitive to handling, a decision was made by Jeremy Madeiros to commence banding of fledglings and a percentage of adult birds, in addition to regular weight and body measurements of at least 50% of all fledglings (see Section 7.3.2. for full description of banding protocols and methodology). Since banding started in 2002, a total of 183 Cahows have been banded as of July, 2005.

### **3. Community Education and Awareness:**

There has been growing awareness and interest of the Cahow since its rediscovery, although ironically it probably remains better known to the international scientific community than to most Bermudians. In addition to a number of scientific papers and articles on the Cahow, there have been increasing efforts to raise local public awareness of Bermuda's only endemic seabird. These include the proclamation of the Cahow as Bermuda's National Bird by the Ministry of the Environment in 2003, the adaptation of the Cahow as the official logo of the Bermuda Parks Department, and the publication of a book on the history of the Cahow ("Bermuda Petrel; the bird that would not die"- Francine Jacobs, William Morrow and Company, 1981). The story of the cahow is now taught in many local schools and the Conservation Officer (Terrestrial) makes a number of school and public lectures and slide shows on various aspects of the Cahow recovery program each year.

With the advent of digital technology, the opportunity now exists to put together 'Power Point' presentations using digital photography and computer graphics that can be constantly updated and stored on Compact Disks for ease of transport, storage and preservation.

## Appendix 2: Social Attraction through Playback of Sound Recordings

(Written on February 10, 2004)

Sound attraction is a method by which recorded courtship calls of an established nesting bird colony are played back by means of a weatherproof sound system to attract birds to a particular site. (See Fig. 20)



**Figure 20:** ‘Murremaid’ sound attraction system on Horn Rock, Jan. 2004 (J. Madeiros)

The system is usually solar-powered to permit independent operation in remote locations, and can be set to automatically turn on and off at particular times. Weatherproof Speakers connected to the system are installed in a site where it is wished to attract birds to new nesting burrows or locations. Many species of seabirds, in particular those just reaching maturity and actively prospecting for new nest sites, are strongly attracted to the sound and activity of existing nesting colonies and are lured down to land near the speakers. Petrels such as the Cahow prospect for new nest sites on foot and can find the entrances to the new artificial nest burrows. This method usually is most effective during the early



part of the nesting season with nocturnal seabirds, when courtship among established pairs takes place and nest prospecting and attraction of mates is carried out by cohorts of young adults just reaching breeding age.

Sound attraction has been used to successfully establish a number of new nesting colonies of various seabird species. This includes diurnal species such as Terns, Murres and Puffins, and nocturnal species such as Shearwaters, Dark-rumped Petrels and Chatham Island Petrels. Most sound systems have been built by Murremaid Music Boxes, 11 Audubon Road, Bremen, Maine 04551.

### **Management Action Taken**

The idea of using sound attraction as a management technique for the Cahow recovery project was first proposed by Dr. David Wingate before his retirement in 2000.

Following research of social attraction techniques and consultation with various experts in this field, including Dr. Steve Kress (Director, Seabird Restoration Program, National Audubon Society), permission was obtained to purchase and install a 'Murremaid' sound system to assist in the establishment of new Cahow breeding colonies. Arrangements were made through Dr. Kress for builder and installer of the Murremaid system, Susan Schubel, to come to Bermuda in late November, 2003 with a unit of the sound system. This was assembled and installed on Horn Rock (See Figs.20 & 21). This location was chosen for initial testing to try to attract young, prospecting Cahows to a new complex of artificial nest burrows as well as adults disrupted by the destruction of their original, lower elevation nest burrows during hurricane Fabian. A total of 4 established nesting burrows were completely destroyed beyond repair on the north side of the island, completely disrupting these highly site-faithful birds.

With arrangements underway to obtain a sound attraction system, consideration had to be given to obtain a recording of Cahow courtship calls good enough to simulate the activity and number of birds vocalizing in a large nesting colony. All previous recordings only contained a limited amount of calls made by a small number of individuals, so it was clear that a new recording would have to be made. Contact was therefore made with the Macaulay Library of Natural Sounds, based at Cornell University, Ithaca, New York, which specializes in making high-quality digital recordings of wildlife and other natural sounds. Arrangements were made for the library to send a technician to make new recordings that could then be manipulated to simulate a larger colony with more individuals vocalizing to provide a greater social attraction for prospecting Cahows.



**Figure 21:** installation of sound attraction equipment by Susan Schubel (J. Madeiros)

Macaulay Library sound technician Mark Reaves arrived in Bermuda Nov. 15<sup>th</sup>, 2003 and, in a 7-day stay was able to get out to the nesting islets on 5 nights to make sound recordings. Recordings were made on 4 nights on Horn Rock and on 1 night at Green Island (see Fig. 22). The success of this recording trip was only possible because of a 1-week period of calm weather that fortuitously overlapped with the two visits. Conditions have otherwise been almost continuously windy and stormy from October 2003 until February 2004.

Mr. Reaves upon return to Cornell University was able to combine all of the best vocalizations from the 5 nights of taping (average 2 ½ hours taping per night) and double them to create an 80-minute CD of Cahow courtship calls. This disc was mailed to Bermuda, arriving in time for the first return of the breeding Cahows from their pre-egg laying exodus in the first week of January, 2004. The CD was installed in the Murremaid sound system on Horn Rock on Jan, 5<sup>th</sup>, 2004 and set to run from dusk to dawn (approx. 6.30 P.M. to 6 A.M.). Monitoring was carried out on Horn Rock of the sound system through January and February, including 4 night watches carried out on the island itself during the infrequent calm periods. The recorded courtship calls were seen to definitely attract the birds when played back at night, with Cahows repeatedly swooping low over the location of the speakers singly and in groups of 2 or 3 birds. Loud vocalizations on



**Figure 22:** Technician Mark Reaves setting up equipment to record Cahow vocalizations (J. Madeiros)

The sound system was often immediately answered with calls from birds circling over the site. At least one of the new artificial nest burrows in the new ‘F’ burrow complex (built to replace nests destroyed during hurricane Fabian) was visited twice, although the bird(s) did not stay over in the nest during the day. The nest burrow visited was located next to the westernmost of the two speakers from the sound system.

It is thought that most of the Cahows observed flying over and around the sound system on Horn Rock during January, 2004 were adult birds displaced from the burrows destroyed during hurricane Fabian. Young, prebreeding adults just reaching maturity and prospecting for nest burrows for the first time do not arrive over the nesting islets until the first week of February and do not peak until the end of the month. It is thought that there is a better chance of attracting these younger birds down to ground to investigate the new burrow complex as they are prospecting for the first time and the site will be monitored closely during this period. The sound system will probably be kept at this location until at least mid-May, when it may be moved to the translocation site on Nonsuch Island.

# **Appendix 3: Establishment of New Nesting Colonies**

(Submitted by Jeremy L. Madeiros 2002)

## **(2) Introduction**

There are major constraints in the carrying capacity of the present Cahow nesting islands, which are either low in elevation and prone to over-wash during hurricanes and storms, or are composed of soft rock and prone to rapid erosion. To safeguard against the threat of extinction or major setback to the recovery of the Cahow because of catastrophic storm events and continued sea level rise, a major objective of the recovery program is to establish viable new nesting colonies. This will be carried out on additional suitable islands in the Castle Harbour Islands Nature Reserve. To obtain the best possible chance of success in meeting this objective, at least two different methods used in the establishment of new colonies of various species of tubenose seabirds will be used to attempt the establishment of new Cahow nesting colonies. A summary of preparatory work and proposed methods are listed as follows:

## **2. Objectives and Methodology**

### **2.1. Selection of Sites for New Nesting Colonies**

The first stage in the establishment of new Cahow nesting colonies is the selection of suitable sites, which is essential for the success of the project. Ideally, any island selected for a new Cahow nesting colony should combine the following features:

- The absence of any mammal predators or other species which could negatively impact on the burrow-nesting Cahow.
- Be of sufficient area to be capable of supporting a large, viable population out of immediate danger of inundation by storm surge and waves.
- Be of sufficient elevation so that the nesting sites can be located out of danger of storm flooding and erosion.
- Have sufficient depth of soil so that Cahows will be able to excavate their own nesting burrows.
- Have enough vegetation cover that the root systems can reduce soil erosion and prevent soil nesting burrows from collapsing.
- Be secure against illegal or uncontrolled human landings.



There are at present only two potential islands which can meet most or all of the above criteria, Nonsuch Island and Southampton Island. The relative advantages and disadvantages of each island are covered as follows:

### **Nonsuch Island-Advantages/disadvantages as Location of New Nesting Colonies**

Home to the Nonsuch Island Living Museum, this island has been the site of an ecological restoration project since 1960 to re-create an example of Bermuda's pre-colonial indigenous plant and animal communities. It has the following advantages as a potential location for a new nesting colony:

- (1) Nonsuch is the largest island in the Castle Harbour Islands Nature Reserve at over 15 acres in area. This, coupled with a maximum elevation of over 60', provides sufficient safe nesting habitat to accommodate in excess of 1000 nesting pairs.
- (2) Nonsuch contains large areas with relatively deep sandy soil cover (up to 5' depth in some areas), ideal for Cahows to excavate burrows in. This soil layer supports thick vegetation cover, including an extensive restored inland native forest.
- (3) The island has been maintained free of mammal predators, and has been rat-free for at least 15 years. Moreover, its isolation and size make it possible to eradicate rats again in the event of infrequent recolonization from the mainland.
- (4) Nonsuch Island has a warden's residence with self-contained power generation. This not only greatly simplifies construction and maintenance of nesting burrows in the new colony, but enables close control of human access. Perhaps most importantly, it permits easy access and monitoring of the site even in adverse weather conditions that regularly prevent landings, sometimes for days at a time, on all other present and potential nest sites.

Disadvantages of using Nonsuch as a potential nesting site include (1) potential disruption of the colony by regular environmental tours of the island, and (2) the presence of the introduced exotic Suriname or Cane Toad *Bufo marinus*, which breeds in the freshwater pond on Nonsuch. These factors are not thought to represent a significant problem, for the following reasons:

- 1) Any potential disruption by tours and visitors can be easily prevented by restricting access to areas around the nesting colony during the nesting season. This method has been used successfully and routinely since the late 1980's to prevent disruption to nesting Yellow-crowned Night Herons *Nycticorax violaceus* on Nonsuch.
- 2) Methods to control the Suriname Toad on Nonsuch have been underway since 2001 with the installation of a polyethylene 'toad barrier' fence around the fresh pond which prevents access to the pond for toads outside the barrier. This has already isolated the only breeding location and enables easy collection of toads

at night when they gather at the barrier trying to reach the water to breed. Over 1200 toads have been collected in the last 3 years and transported to the mainland, greatly reducing their population density on the island. Collection of toads will continue and aim for eventual eradication or maintenance at very low levels. Even if the toads enter Cahow burrows, it is only a perceived threat with no evidence that it will have a negative effect on the birds. There is ample evidence that tubenose seabirds can live unaffected with large and sometimes poisonous reptiles in their burrows. This includes species such as venomous Golden-crowned Snakes and Gould's Petrel on Cabbage Tree Island, NSW Australia, Tuatara and Fairy Prions in New Zealand and Tiger Snakes and Short-tailed Shearwaters on the Bass Strait Islands in Australia. As of July, 2005, there have been no recorded incidences of toads entering Cahow burrows at the translocation site on Nonsuch Island. (\*Note: Suriname Toads were confirmed as being successfully eradicated on Nonsuch by 2009)

### **Southampton Island-Advantages/Disadvantages as Site of New Nesting Colony**

This island is the only other site which meets most of the criteria necessary to support a viable Cahow nesting colony. All other islands on Bermuda contain mammal predators, can be easily colonized easily by rats, or are vulnerable to human disturbance. It has the following advantages as the site for a new cahow nesting colony:

- (1) At 2.36 acres, this island is larger than any present nesting island and has a fairly large level area with sandy soil cover. Vegetation consists of a thick growth of low coastal shrubs and grasses and a few patches of low salt-tolerant trees.
- (2) Southampton Island is sufficiently isolated so that it is relatively difficult for rats to reach. It is also small enough to easily control any colonization by rats that do occur.
- (3) The island is of sufficient elevation at 25' to 30' to offer a considerable area safe from all but catastrophic storm flooding, which does, however occur at rare intervals (see following disadvantages).

Southampton Island has the following disadvantages as compared to Nonsuch Island for the establishment of a new Cahow nesting colony:

- (1) Access to Southampton Island is difficult or impossible during periods of strong winds or high surf.
- (2) The presence of a highly visible colonial fort on the west end of the island attracts illegal landings by boaters during the spring and summer months. This presents the potential of inadvertent or deliberate disturbance to a nesting colony late in the nesting season, when the burrows contain helpless chicks.

- (3) Southampton Island appears to be washed over at rare intervals, about once a century on average. During hurricane Fabian in 2003, waves of 35' washed over the entire western half of the island, partially destroying the colonial fort on the highest point. The island also contains a paleosoil layer at the base of the seaward side of the island which is easily eroded and results in frequent large cliff falls which steadily reduce the size of the island. Fabian caused particularly large cliff falls all along the coastline of the island. Continued sea level rise will undoubtedly increase the rate of over wash and erosion.

Based on these comparisons, it is submitted that Nonsuch Island is the best and obvious choice for establishment of a new Cahow nesting colony, and initial efforts should be concentrated there. Southampton Island also has considerable potential as a future site and colony establishment there can take advantage of experience gained at Nonsuch Island.

## **Appendix 4: Proposal for Translocation of Chicks to Establish New Cahow Nesting Colony (submitted by J. Madeiros 2003)**

### **Objectives and justification for translocation proposal**

The objective of this translocation proposal is to successfully establish a viable population of Bermuda Petrel, or Cahow, on a new island which is larger with higher elevation than the present small nesting islets, offers more safety during storms, and has the potential to host a larger population of the species. Viable in the context of this translocation project is defined as follows; that the translocated chicks fledge, depart the island and return when mature to successfully breed at the translocation site. Nonsuch Island appears to meet all requirements for selection as a suitable translocation site (See Appendix 3: page 80).

Translocation is proposed as a management strategy for the Cahow recovery program for the following reasons:

- The innate vulnerability of the species present breeding sites and the potential for continued sea level rise, coupled with the risk of a catastrophic late season hurricane destroying nest sites or decimating the population;
- Translocation is an established management technique used successfully to establish new colonies of tubenose and other seabirds. Sufficient information is available from other translocation programs to indicate that translocation is a feasible management strategy for the cahow;
- Sufficient information on key characteristics of the Cahow's breeding biology is now available to carry out the translocation project;
- The opportunity is available to undertake the translocation project within the context of a broader research and recovery program for the species;
- A suitable translocation site is available (i.e. Nonsuch Island). This island is considered suitable in both ecological terms (e.g. suitability of habitat, potential for accommodation of large population, absence of threatening processes) and in terms of habitat security (Nonsuch Island is a Nature Reserve with a warden's residence, enabling full-time monitoring);
- Opportunity is available to contribute to the wider body of scientific knowledge and literature on the translocation of endangered seabirds.

The conservation benefits of a translocation project for the Cahow include the following:

- Expanding the breeding area of this species and thus reducing the risk of extinction because of storm flooding etc.;
- Establishment of a new population safe from threatening processes affecting the species on its present breeding area and with better eventual potential for a large population;



- The development of expertise and experience with the translocation of this species. This also has the potential for spin-off benefits for the conservation or re-introduction of other endangered or extirpated seabirds (e.g. Audubon's Shearwater, *Puffinus l'hermionii*, which nested on Bermuda until the early 1970's).

The conservation problems that could arise from the translocation of Cahow chicks are the death of translocated individuals due to unforeseen factors, and the effect on new pair formation on the present breeding islands.

### **Implementation schedule and composition of transfer population**

The preliminary gathering of information necessary before undertaking the translocation project has already been carried out and is outlined as follows:

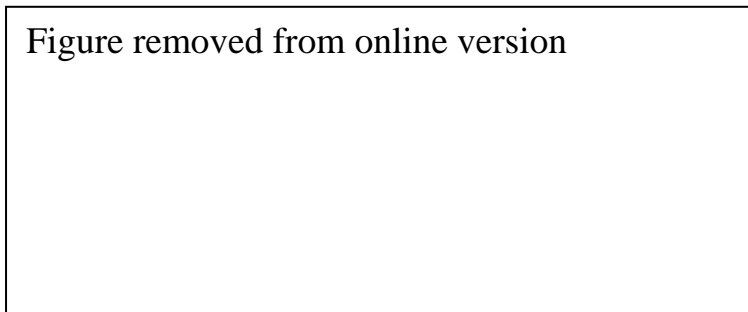
- In 2001, limited handling and weighing of 10 adult and fledgling Cahows was carried out to confirm that limited handling has no effect on breeding success;
- In 2002, 20 Cahow fledglings were weighed from hatching to departure, every 3 days on average, to determine variations in growth rates and use the growth curves to determine the number of days before the fledglings commenced exercising activity and eventual departure.
- In 2003, eighteen Cahow fledglings were weighed regularly until departure, coupled with measurements of wing chord (flattened) growth, to determine the optimum time of moving of fledglings for translocation purposes. Upon consideration of this data and consultation with other authorities on translocation techniques, the optimum time to move the fledglings before imprinting on the nest site location has begun, is believed to be approximately 14 to 18 days before fledging. This point is indicated when the wing chord (flattened) length reaches 190mm, and when the fledgling's weight has already peaked and is dropping in the final 'slimming down' period before exercising begins.

The next stage occurred during the 2004 nesting season, when initial trial transference of 14 fledglings was carried out from the present breeding islands to the translocation site on Nonsuch Island. This smaller initial number was proposed to enable any potential problems or fine-tuning of transfer age of fledglings to be worked out. If there are no major problems, then it is proposed that approximately 50% of the fledgling output be transferred annually for the next 4 years (2005 to 2008). This represents 16 to 20 fledglings at the present numbers of 32 to 39 fledglings between 2001 and 2004.

Approximately 95 Cahow fledglings will therefore be transferred from the four present breeding islands to Nonsuch Island over a 5-year period commencing 2004. Fledglings will be collected and moved from early May until mid-June, placed directly from their

nest burrows into closeable cardboard boxes (along with most nest material), and transferred by boat the short distance to Nonsuch Island , where they will be placed directly into their new burrows at the translocation site. Chicks will be transferred at 14 to 18 days prior to fledging to facilitate imprinting on the new site.

Translocated fledglings may require some additional feeding after being moved to their new sites, depending on their condition and weights. Feeding techniques have been refined in recent years by the taking in of prematurely abandoned, underweight chicks. These have been raised successfully to fledging with fairly good success with nightly feedings of human quality squid and fresh pilchards or anchovies. This continues until the fledgling begins to refuse further feedings.



**Figure 23:** West breeding islands, Nonsuch translocation site and sound attraction site.  
(Joseph Furbert)

## **Description of translocation site habitat**

Nonsuch Island is located approximately 300m northeast of Horn Rock and 100m (at the south point extremity) north of Green Island, the closest two Cahow breeding islets. These western islets also host the largest populations of Cahow breeding pairs, with 27 breeding pairs (before hurricane Fabian) on Horn Rock and 18 breeding pairs on Green Island. The two eastern breeding islets are located on the other side of the Cooper's Island peninsula, with Inner Pear Rock located 0.9 Km east of Nonsuch and Long Rock the most distant at 1.2 Km to the Northeast. These islets also have smaller numbers of nesting Cahows with 10 breeding pairs on Long Rock and 14 pairs on Inner Pear Rock.

Although potentially much of Nonsuch Island's area is probably suitable breeding habitat for Cahows, three areas of the island were chosen as being particularly suitable for possible translocation sites. These are: (1) the southwest point of the island; (2) a coastal hillside located south of the octagon building; and (3) the edge of the south hill of the island. Of these, (2) was chosen because it contains good coastal hillside habitat grading into forest, is relatively easy of access, and can be easily isolated from tours and disturbance (See Fig. 28). Vegetation cover at the lower edge of the translocation site is composed of thick low native coastal shrub/grass cover dominated by Sea Oxeye (*Borrchia arborescens*), Seaside Goldenrod (*Solidago sempervirens*), Bermudiana (*Sisyrinchium bermudiana*), Spanish bayonet (*Yucca aloifolia*), St. Augustine grass (*Stenotaphrum secundatum*) and West Indian Grass (*Eustachys petraea*). This grades into coastal forest at the more elevated section of the site, dominated by Bay Grape (*Coccoloba uvifera*), Buttonwood (*Conocarpus erecta*), Casuarina (*C. equisetifolia*) and Bermuda Cedar (*Juniperus bermudiana*).

## **Provision of artificial nest sites**

To accommodate the translocated chicks and provide potential nest sites in several years for a nucleus of returning birds as they reach maturity, a new complex of artificial nest burrows has been constructed on Nonsuch Island (See Fig. 24). These artificial burrows will mostly be of the usual proven concrete variety but a percentage of them will be polyethylene nest boxes obtained from the New South Wales National Parks and Wildlife Service, Australia. These boxes are similar to, but 40% larger than, those used with great success with the Gould's Petrel *Pterodroma leucoptera* on Cabbage Tree and Boondelbah Islands, N.S.W. Australia. (The boxes to be tested with the Cahows are adapted for use with Short-tailed Shearwaters, which are larger and heavier at 500 to 600 grams than the Cahow's 250 to 400 grams.

## **Chick Monitoring Requirements**

All Cahow fledglings involved in the translocation project will be monitored for weight and possibly wing chord length during the fledging period from shortly after hatching. These measurements have proven effective in determining when the weight of a fledgling has peaked and when feeding visits by the adults are coming to an end. All fledglings

involved in the translocation will also be banded (ringed) to allow for future assessment site fidelity, survival and return rates and future breeding success.

### **Potential for Community Participation**

The Cahow translocation program offers a unique opportunity of hands-on community involvement with a recovery program (under strict supervision). Members of Bermuda Zoological Society (BZS) and possibly the Bermuda Audubon Society could be involved in this project, once procedures have been worked out in the initial trial year. The translocation program is also likely to be of interest to the local media and could figure prominently in the community awareness component of the Cahow recovery plan.



**Figure 24:** Concrete Cahow burrows under construction at translocation site on Nonsuch Island (J. Madeiros)