

CAHOW RECOVERY PROGRAM 2013 – 2014 Breeding Season Report



Compiled by: Jeremy Madeiros, Senior Conservation Officer
Terrestrial Conservation Division
Department of Conservation Services
“To conserve and restore Bermuda’s natural heritage”

BERMUDA GOVERNMENT

2013/2014 Cahow Breeding Season Report
Cahow Recovery Program
Compiled by: Jeremy Madeiros
Senior Terrestrial Conservation Officer

**RECOVERY PROGRAM FOR THE CAHOW
(BERMUDA PETREL)**
Pterodroma cahow

BREEDING SEASON REPORT
For the Nesting Season October 2013 to July 2014
Of Bermuda's Endangered National Bird



**Fig. 1: Adult Cahows on ground at (A) Translocation Colony site, Nonsuch Island,
26 November, 2013 (J. Madeiros)**

Cover photo: Kirk Zufelt

CONTENTS:

Page No.

Section 1:

(1a) Executive Summary:	5
(1b) Objectives of Cahow Recovery Program:	7
(1c) Methodology and Protocols used in Cahow Recovery Program:	8

Section 2:

(2a) Introduction:	10
(2b) Cahow Recovery Program – Summary of 2013/2014 Nesting Season:	12
(2d) Breakdown of Breeding Season Results by Nesting Island:	16

Section 3:

(3a) Update on New Nesting Colony (A) on Nonsuch Island:	19
(3b) Second Year of 2nd Translocation project to “B” Site on Nonsuch island:	23
(3c) Outbreak of Black Rats on Nonsuch Island and eradication efforts:	28
(3d) First live-streaming of infrared “Burrow-cam” in Cahow nest burrow.....	30
(3e) Update on Cahow Banding Program for 2013/2014:	33

Section 4:

(4a) Planned Future Management Actions and Research:	34
(4b) Acknowledgements:	35
(4c) References:	36

List of Figures

Page no.

Cover photo: Adult Cahow at sea off east end of Bermuda:	(Kirk Zufelt)
Fig.1: Adult Cahows on ground on Nonsuch Island, 26 th Nov. 2013:	(2)
Fig.2: 1-week old Cahow chick removed from burrow for weighing:	(10)
Fig. 3: Adult Cahow climbs on Conservation Officer at Nonsuch Is:	(12)
Fig. 4: Chart showing no. of breeding pairs and fledged Cahow chicks: ...	(14)
Fig. 5: 2013 Map of Cahow nesting Islands at Castle Harbour Reserve ...	(15)
Fig. 6: Pair of adult Cahows at night over Nonsuch nesting colony:	(19)
Table 1: Breeding results at new nesting colony on Nonsuch since 2009: ..	(21)
Table 2: Origins of Cahows comprising nesting pairs at Nonsuch in 2014: ..	(22)
Fig. 7: Translocated Cahow chick being fed on Nonsuch Island:	(23)
Fig. 8: New prefabricated polyethylene Cahow nest burrows on Nonsuch: ..	(24)
Table 3: Summary of information for translocated Cahow chicks in 2014: ..	(25)
Fig. 9: Translocated Cahow chick exercising outside burrow at night:	(27)
Fig. 10: Black rats caught in traps over 2-day period on Nonsuch:	(28)
Fig. 11: Black rat in live-trap on Nonsuch Island, May 2014:	(29)
Fig. 12: Infra-red Cahow “Burrow-Cam” developed by J.P. Rouja:	(30)
Fig. 13: Adult Cahow in nest burrow with recently hatched chick:	(32)

- Cover photo Kirk Zufelt; Fig. 3: Philippe Rouja; Fig. 4: Leila Madeiros; Fig. 5: Mandy Shailer; Fig. 12: JP Rouja. All other photos: Jeremy Madeiros

SECTION 1:

1(a): EXECUTIVE SUMMARY:

Key Words: Burrow-cam, Cahow, New Colony, Nonsuch Island, Southampton Island, Translocation.

The Cahow Recovery Program is a long-term management, research and recovery program for Bermuda's National Bird, the critically endangered Cahow, or Bermuda petrel. This program is focused on increasing the breeding population through the control or elimination of threats to the species, provision of additional artificial nesting burrows, and the establishment of entirely new nesting colonies.

The Cahow nests only on the Islands of Bermuda and was thought to have originally numbered more than half a million birds, but was catastrophically affected by the arrival of humans on the island in the early 1600s. This was due both to direct hunting by the settlers and by invasive predators introduced by man, such as Rats, Cats, Dogs and Pigs. After less than 20 years of settlement, the Cahow by the 1620s had declined to the point where it was thought to be extinct, a belief that persisted for almost 350 years until the rediscovery in 1951 (Murphy & Mowbray, 1951) of a tiny remnant population on four tiny offshore islets.

Since 1960, a conservation and recovery program has been in place that has addressed and controlled most threats to the species. This program was administered by Dr. David Wingate until his retirement in 2000, since which it has been administered by the author of this report. This program has enabled the breeding population to begin a slow, but accelerating increase from only 18 pairs producing a combined 8 chicks annually in the 1960s to a new record number of 108 breeding pairs in 2014, producing a record total of 59 successfully fledged chicks. Increased knowledge and public interest in the Cahow has been brought about from several films, documentaries and books that have been completed highlighting the conservation and recovery work being carried out on the species.

The main threats to the Cahow include the erosion and flooding of the present nesting islets by storm activity and continuing sea-level rise, predation by Rats and other invasive species swimming to these islets, a lack of sufficient numbers of suitable nest burrows or rock crevices, and nest-site competition with the Longtail or White-tailed Tropicbird *Phaethon lepturus catsbyii*.

Following are some of the highlights for the 2014 Cahow nesting season:

- The new nesting colony of Cahows established on Nonsuch Island by the translocation of chicks between 2004 and 2008 continues to grow, with 13 pairs established in nest burrows and laying eggs. From these, nine chicks hatched and successfully fledged out to sea, a record number for Nonsuch. New pairs and prospecting activity was noted in 1 additional nest, and a total of 29 of the translocated birds have so far returned to Nonsuch as adults, in addition to 9 non-translocated Cahows attracted to the new colony.

- The total breeding population of the Cahow has increased to 108 nesting pairs (pairs that produced an egg, whether it hatched or not), compared to 105 pairs in the 2012-2013 breeding season.
 - The number of chicks that successfully fledged in 2014 rose to a record number of 59, compared to 53 during the 2012-2013 nesting season.
 - Because of a quiet 2013 North Atlantic hurricane season, little to no erosion to nesting islands was noted, and this appears to have had a beneficial effect on breeding success for the 2013-2014 breeding season.
 - The second translocation of Cahow chicks to Nonsuch continued at the ‘B’ translocation site, approximately 200m east of the ‘A’ colony site. A total of 20 Cahow chicks were translocated from the four original nesting islets to artificial nest burrows at the B site and hand-fed on fresh Anchovies and Squid. 19 of these chicks fledged successfully out to sea. Coupled with the 14 Cahow chicks translocated to and fledging from this site in the 2013 nesting season, a total of 33 Cahow chicks have now fledged successfully from this site after translocation.
 - Nesting Cahows were recently discovered on Southampton Island in 2013, using deep rock crevices near the northern end of the Island. These nests were fitted with Tropicbird exclusion baffles and monitored through the 2013-2014 breeding season. Three established nesting pairs on this island produced two successfully fledging chicks.
 - An infrared “burrow-cam” developed by JP Rouja of LookTV and first tested during 2013 was installed in one of the Cahow nest burrows on Nonsuch Island and video was “live-streamed” for the first time on a website. This allowed school groups and the public to follow the development of a Cahow chick, named “Lightning”, from hatching in early March to departure out to sea around May 28th. In addition, this website at www.nonsuchisland.com included weekly checks of the chicks, visits by tour groups, and “virtual tours” showing panoramic vistas of the breeding colony and other sites on Nonsuch Island, as well as images of additional terrestrial and marine plant and animal species from Nonsuch and the surrounding marine habitats.
-

The Recovery Program continues to achieve its primary objective of increasing the Cahow breeding population and the number of successfully fledged chicks being produced, and secondary objective of establishing new nesting colonies.

Increasing public and scientific interest in the Cahow and the Recovery Program has been helped by newspaper articles and the establishment of a new website for Nonsuch Island. In addition, a paper on the “Conservation and At-Sea Range of Bermuda Petrel” by Jeremy Madeiros, Bob Flood and Kirk Zufelt, was published in *North American Birds* in October, 2014.

Full details on the 2013 – 2014 breeding season are given in the following report, in addition to research and management proposals for the next two seasons.

Section 1 (b): Objectives of Cahow Recovery Program:

The Cahow Recovery Program was set up to co-ordinate management and research efforts for the Bermuda petrel or Cahow *Pterodroma cahow*, which is recognized as one of the rarest seabirds on earth and is endemic to the islands of Bermuda, nesting nowhere else on Earth.

This program has a number of short and long-term objectives, which are covered in full in the Cahow Recovery Plan (Madeiros, 2005); briefly put, these objectives are:

- (1) To prevent nest-site competition with the White-tailed Tropicbird (*Phaethon lepturus catsbyii*) through the use of wood “baffle plates” at the entrances of all Cahow nest burrows to prevent Tropicbirds from entering.
- (2) To regularly monitor all nesting and nearby islands for the presence of rats (*Rattus rattus* and *R. norvegicus*) and, when their presence is detected or suspected, to eradicate them by use of anticoagulant rodenticides, using bait and boxes provided by or purchased from the Health Department.
- (3) Carry out a program for the construction of additional artificial nest burrows at all appropriate nesting islands, and at locations where new nesting colonies are being established, to support a continued increase in the breeding population.
- (4) To establish new nesting colonies of Cahows on larger, more elevated islands free of mammal predators, and which are safer from hurricane erosion and have the potential of supporting larger populations of the birds; this has already been achieved on Nonsuch Island with the establishment of one colony, and is also presently underway at a second location on Nonsuch.
- (5) To learn more about the biology of the species through an ongoing banding program initiated in 2002; also through developmental studies of Cahow chicks and morphometric measurements of adult Cahows.
- (6) To carry out studies of the oceanic range of Cahows using archival geolocational data loggers attached to individual birds, which record daily position fixes for periods of up to 2 years. These have already been successful in recording foraging areas and migration routes used by Cahows, both during the breeding season, and during the summer, non-breeding season.
- (7) To use presentations, the media, scientific publications and new technology such as infrared “burrow-cams” to increase public knowledge and appreciation of the Cahow and its place in Bermuda’s history.

SECTION 1(c): Methodology and Protocols used in Cahow Recovery Program

Due to the status of the Bermuda petrel (Cahow) as a critically endangered species, the Recovery Program stipulates that a number of different methods and protocols are to be used in the management of the species.

The most fundamental management aspect of the Cahow Recovery Project is regular monitoring of the entire breeding population on all breeding islets during the breeding season, from late October until mid to late June. This is carried out for the following purposes: (1) to confirm breeding success rates in all active nests; (2) to check for potential problems so that remedial action can be taken; (3) to carry out banding and morphological measurements of both Cahow chicks and adult birds; (4) to record the frequency of adult prospecting and feeding visits.

Checks of the nesting islets are carried out at least 2 to 3 times weekly (every 3 to 4 days), depending on weather conditions. These checks are carried out in the Terrestrial Conservation Division's 17' Guardian Boston Whaler boat, which is light and agile enough to make the close approaches to the islets, over shallow, submerged rocks and reefs, which are required for landings.

Due to the exposed nature of the breeding islets, they are often exposed to strong ocean swell and waves, which, along with strong winds, may make landings on the islets impossible for up to several days at a time. The protocols for landings stipulate that sustained winds exceeding 20-25 knots render landings unsafe, although this is somewhat affected by wind direction. Landings on the western islands (Horn Rock, Green Island and Southampton Island) are not safe with southerly or southwesterly winds over 20 knots, or with northwesterly or northerly winds over 16-18 knots, although it is still possible at these times to land on the two easterly islands (Long Rock and Inner Pear Rock) because they are sheltered by Coopers Island during these wind directions. It also may not be possible to land on the two eastern islands with strong northeast or easterly winds exceeding 20 knots. Stronger southeasterly winds or ocean ground swell from hurricanes passing to the south or east of Bermuda usually render it unsafe to land on any of the islets or to travel around the southeast tip or headland of Coopers island (Coopers Point). This is true even if a hurricane is 500 or more miles distant, as large deadly breakers, which could overturn a boat or drive it into the coastal cliffs, may form without warning between the reef line and the headland. Extreme caution should be exercised at these times.

During landings, a quick check of the island is made, followed by systematic inspection of all active and potential nesting burrows. Almost 80% of all nest burrows now have removable concrete observation lids, which enable inspection of the birds in the nest chambers. These lids are removed for a brief time (no more than 30 seconds to 1 minute) and a note made of the number of adults present (if any), nest-building activity, and/or the presence of an egg or chick. It is particularly important to determine the dates of egg-laying

and egg-hatching, as these will help to determine when the chick will be ready to fledge (or to be translocated, if it has been chosen for such). The nests are also checked for the presence of rocks or stones knocked in by the adults during burrowing activities, as these can cause egg breakage, which is still a significant cause of breeding failure. Any rocks or stones detected should be carefully removed.

Adult Cahows can be carefully removed from the nest chambers through the hole where the observation lid sits and placed in a cloth weighing bag for morphometric measurement and checking of band (ring) numbers. If unbanded, birds are fitted with an identification band (see section 3d). The bird should not be removed for more than 5 minutes, and these checks are best carried out during the nest-building stage of the breeding season, in November. It can also be carried out during egg brooding in February, but extreme care should be taken to prevent accidental breakage of the egg during removal and replacement of the bird. Upon completion of the check, the nest lid should be replaced and the adult bird should be replaced back into the nest entrance, ensuring that the front half of the bird is well into the entrance before release. Extreme care should be taken to prevent the escape of the adult birds during these checks, as this would lead to egg abandonment and breeding failure. Only single birds are usually chosen for removal, with pairs of adults being generally left alone unless an assistant is present.

After hatching, chicks are also weighed and measured as part of an ongoing growth study and in support of the ongoing translocation project (see sections 3a and 3b). Chicks are only removed from their nests if no adults are present, to avoid undue distress and disturbance to the birds. Chicks are measured weekly from the earliest time after hatching that they are left alone in the nests, until their final departure out to sea. Chicks are generally measured for mass (weight) and plumage development, and when they begin to develop flight feathers at the half-fledged stage, their wing chord (outer wing length) and sometimes tarsus length and bill length are also measured. After being checked, chicks should be replaced right back onto the nest through the lid hole, rather than through the burrow entrance like the adults. All chicks selected for translocation have to be monitored in this way as there is only a brief window of opportunity in which to move them, being about 18-21 days before fledging. In addition, a smaller number of chicks being raised normally to fledging by the adult birds are also weighed through their development, as a control to ensure that the translocated chicks are fledging at the same weight, wing length and body condition as non-translocated chicks. Chicks are also banded, generally at the two-third fledged stage (about two months after hatching).

Although it is not necessary to be present at the final departure of chicks, an effort is made to carry out a number of night watches, both on Nonsuch Island and on the nesting islets during the exercise period, when chicks come out of their burrows at night to exercise their wing muscles and imprint on their surroundings. The nesting islet night watches are useful for capturing chicks from natural nest burrows that are not accessible, and enable banding and morphometric measurements to be carried out. The night watches at the translocation sites are mainly carried out to enable study of the behavior of the chicks in their new habitat during the exercise and departure stage of their development.

SECTION 2: 2 (a): Introduction:



Fig. 2: 1-week old Cahow chick removed from burrow for weighing (J. Madeiros)

The 2013-2014 Nesting Season of the endemic and critically endangered Bermuda petrel or Cahow (*Pterodroma cahow*), Bermuda's national bird, began in late October 2013 and ended in mid-July 2014 with the departure of the last fledglings out to the open ocean from their nesting burrows. This nesting season has been highlighted by the continued increase in the nesting population of Cahows, with a **record number of 108 breeding pairs** nesting on the original nesting islets, at the new colony site on Nonsuch Island, and at the new breeding location on Southampton Island, **and a record total of 59 chicks successfully fledging out to sea**. These are up from a total of just 18 nesting pairs and 8 fledged chicks when the recovery program began in 1960.

The Cahow breeding population is subject to continuing pressure from a number of threats and limiting factors, including nest competition from the native White-tailed Tropicbird, the threat of introduced mammal predators (especially rats) swimming out to the nesting islets (see section 3(c), lack of suitable nesting sites at the present islets, and the annual threat of massive erosion and damage to the islets from hurricane waves and storm surge. Much of the present management carried out on the Cahow through the Recovery Program has been focused on addressing and overcoming these various threats to the species, with a high degree of success.

One of the single most important threats to the Cahow is considered to be damage and major erosion to the nesting islets from **severe hurricanes and storms**, coupled with accelerating sea-level rise. After a thirty-five year period (early 1950s to late 1980s) with few to no major impacts from hurricane waves and storm surge, there have been no fewer than ten major hurricane impacts to the nesting islets from hurricanes between 1989 and 2012 (hurricanes “Dean” in 1989; “Lily” in 1991; “Felix” in 1995; “Gert” in 1999; “Fabian” in 2003, “Florence” in 2006; “Bill” in 2009; “Igor” in 2010; “Katia” in 2011, and “Rafael” in 2012.

The impacts from these hurricanes have included the undermining and collapse of large sections of the islands, and breaking away of large chunks of limestone and cliff face, coupled with overwashing of the smaller islets, when large waves break completely over the island. This has resulted in both complete destruction of many of the original nesting burrows used by Cahows, and in damage to and filling in by rocks and debris of much of the remainder. A great deal of dangerous and labor-intensive work was needed to repair nests at the end of the hurricane season in many years, before the Cahows return for their nesting season. It is important to repair as many of the original nests as possible, as their loss will result in long-established pairs breaking up and needing several years to re-establish new nests with new mates.

To address this threat, **a major component of the recovery program has been to establish new nesting colonies** on islands that are both larger and more elevated than the original tiny nesting islets, which are generally only half an acre (0.2 Ha) in area each (See Fig. 5). This has already been accomplished on Nonsuch Island, which at 16.5 acres is the largest isolated island in the Castle Harbour area, and is maintained rat-free as part of the Living museum ecological restoration project. **A new colony has been established** with 13 active nest burrows now occupied by returned Cahows which had originally been translocated as chicks to Nonsuch Island. **102 chicks were translocated** between 2004 and 2008, and were then hand-fed until they fledged out to sea, imprinting on Nonsuch Island in the process. By 2014, a total of 47 of the translocated Cahows had been confirmed returning as adults, of which 29 have been recaptured in nests back on Nonsuch Island.

As this first effort to establish a new Cahow nesting colony has proven to be successful, **work is now underway in establishing a second colony site at another location on Nonsuch Island** (see Section 3(b), so that the Cahow has a second foothold on this much larger, more elevated island. During the last two years, a total of 36 near-fledged Cahow chicks have been translocated to this second colony site, of which 33 have fledged successfully out to sea.

Ironically, the only other offshore island in Bermuda that has been determined to be suitable for the establishment of a new Cahow nesting colony, Southampton Island, was re-colonized naturally by the 2012-2013 breeding season by the expanding Cahow population. In the 2013-2014 breeding season, three breeding pairs of Cahows on this island produced two successfully fledging chicks.

2 (b): Review of 2013/2014 Cahow Nesting Season and Management Actions:



Fig. 3: Adult Cahow climbs on Conservation Officer on Nonsuch Island, November 2013. (P. Rouja)

Following is a review of events and management / research work carried out for the Cahow Recovery Program through the 2013-2014 breeding season:

- (1) Preparatory work for the upcoming Cahow nesting season began in early October, 2013, with the unblocking of nest burrows, removal of entrance baffles, used to prevent nest invasions by Tropicbirds during the spring and summer months, and the placing of rat poison in bait boxes on all nesting islands.
- (2) Despite predictions of an active hurricane season in 2013, conditions in the North Atlantic Ocean became unfavorable for the formation of such storms and Bermuda experienced no impacts from hurricanes or tropical storms.
- (3) The first Cahows were recorded returning from the open ocean to their nesting burrows on the 24th October, with nearly all back by the first week of November. During late October and November, 2013, a total of 98 adult Cahows were removed briefly from nests to check band numbers, body condition and weights.
- (4) During most of December, 2013, the Cahow breeding population returned out to sea for their pre-egg laying exodus. This period occurs because both partners of a nesting pair need to carry out a 4 to 5-weeks of intensive feeding at sea, the female

- to develop her single large egg and the male to accumulate enough fat reserves for the first long shift of egg incubation, lasting up to 21 days with no food, while the female returns to sea to feed and recover after laying an egg which can mass up to one-quarter of her total body weight.
- (5) The first Cahows returned to the nesting islands from their pre-egg laying exodus at the beginning of January 2014, with the first eggs confirmed on the 5th January. The egg incubation period, which lasts about 53 days, is the main period in which incubating adults are checked to determine sex and band numbers and which birds are returning to which nests. Checks to the nesting islands were made impossible at times, especially during the period 5th to 17th February, by gale-force winds gusting to 58 knots (67 mph) as winter storm systems passed over the Bermuda area. Strong to gale-force winds also occurred on 10 days during the month of March.
 - (6) The first Cahow chick hatched on the 28th February, 2014, with more than 35 confirmed by March 6th. By the end of March, over 60 chicks had hatched, some of which had to be confirmed in the deeper natural nests by the use of infra-red “burrow-scope” equipment. Once the chicks had hatched, a sub-sample of 42 chicks was chosen which were then checked at least twice weekly, weather conditions permitting, for weight, wing chord length, and plumage development. This information is being used for a study of chick growth rates, but also has practical application in identifying chicks that are neglected or abandoned prematurely by the adults and need to be taken into care. Most importantly, it is also essential in identifying when chicks that are being translocated are at the optimal stage of development to be moved to their new nest sites. Checks of chick growth rates continued until they all departed to sea between late May and early July.
 - (7) All accessible chicks were fitted with identification bands on their left legs once their adult plumage covered more than half their body, usually at 70 days of age or older (adult birds whose ages are not known have their bands fitted to their right legs). During the 2013-2014 Cahow nesting season, a total of 38 chicks* were fitted with identification bands, out of a total of 59 chicks which successfully fledged (64.4 % of all chicks). *See section 3(e) for complete information on the Cahow Banding Program.
 - (8) The total number of active nesting pairs of Cahows increased to a record high of 108, compared to 105 nesting pairs in the 2012 – 2013 nesting season and 55 pairs in the 2000 – 2001 seasons. A record number of 59 chicks successfully fledged from all nesting islands, compared to 53 chicks that were fledged in the 2012 – 2013 nesting season (See Fig. 4).
 - (9) The new nesting colony on Nonsuch Island, which was established by the translocation of near-fledged chicks and sound attraction techniques between 2004 and 2009, has continued to grow. As of June 2014, a total of 29 of the translocated

Number of Cahow Breeding Pairs and Fledged Chicks 1961-2014

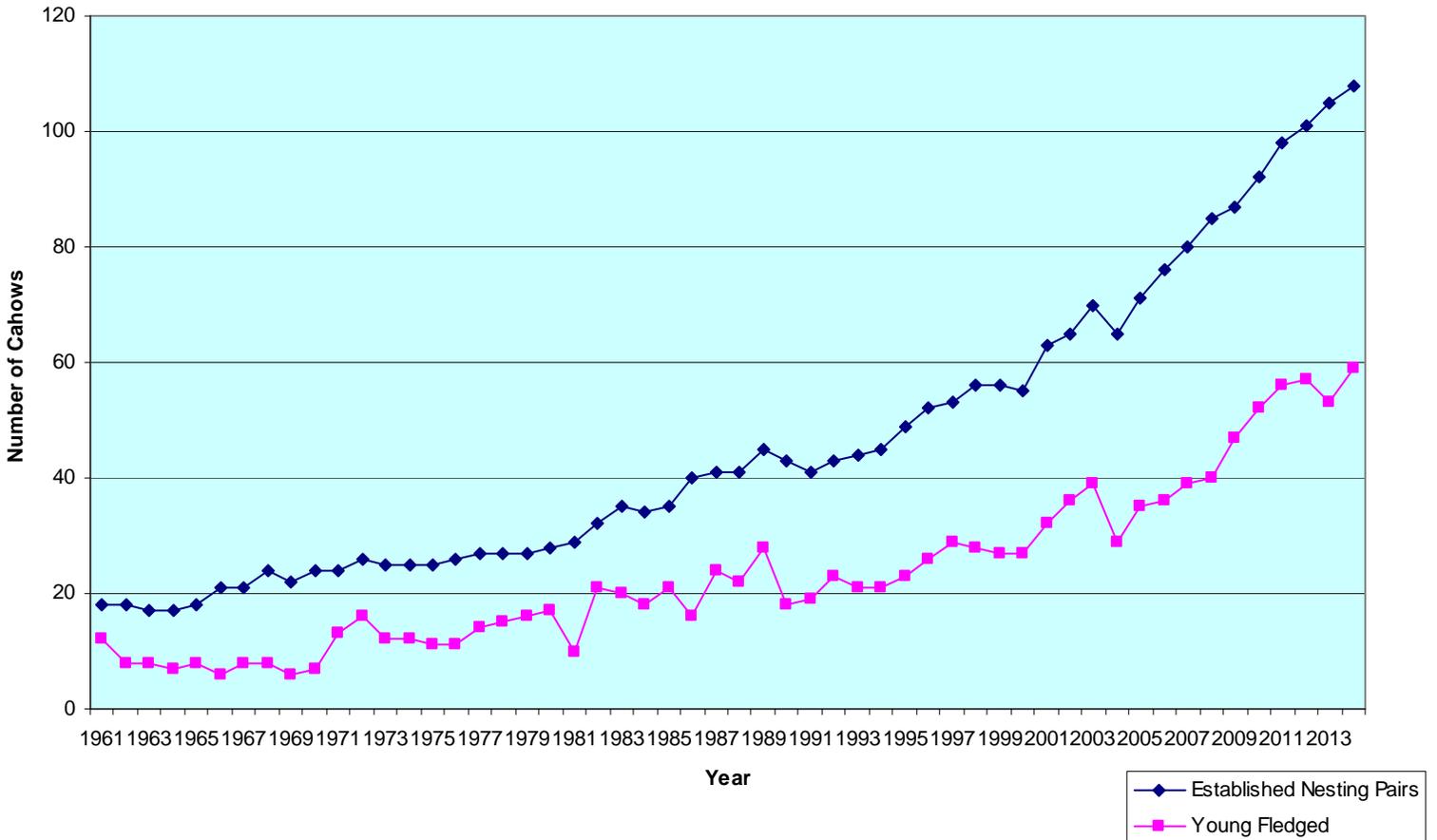


Fig. 4: Number of breeding pairs and fledged young Cahow over 53-year period (L. Madeiros)

birds have returned to Nonsuch Island as adults, with 13 nesting pairs laying eggs in 2014. From these, a record number (for the Nonsuch colony) of nine chicks hatched and fledged successfully out to sea, while a new pair of prospecting adult Cahows has established themselves in one additional nest. This means that a total of 14 nest burrows on Nonsuch Island now have nesting or pre-nesting activity. (See section 3(a) for full details).

- (10) During May and June, a total of twenty Cahow chicks were translocated from the four original nesting islets to a second site on Nonsuch Island (See Fig. 5). nineteen of these chicks eventually fledged successfully from this new site, termed the ‘B’ site. This makes a total of 33 chicks that have fledged to sea successfully over the last two breeding seasons from the ‘B’ translocation site. This new translocation effort starts five years after the first successful translocation project, which has been successful in establishing a new Cahow breeding colony on Nonsuch. It is planned to eventually move 80-90 chicks to this new location over a 4-year period (See section 3(d) for full details). The last Cahow chick fledged at the unusually late date of 8th July.

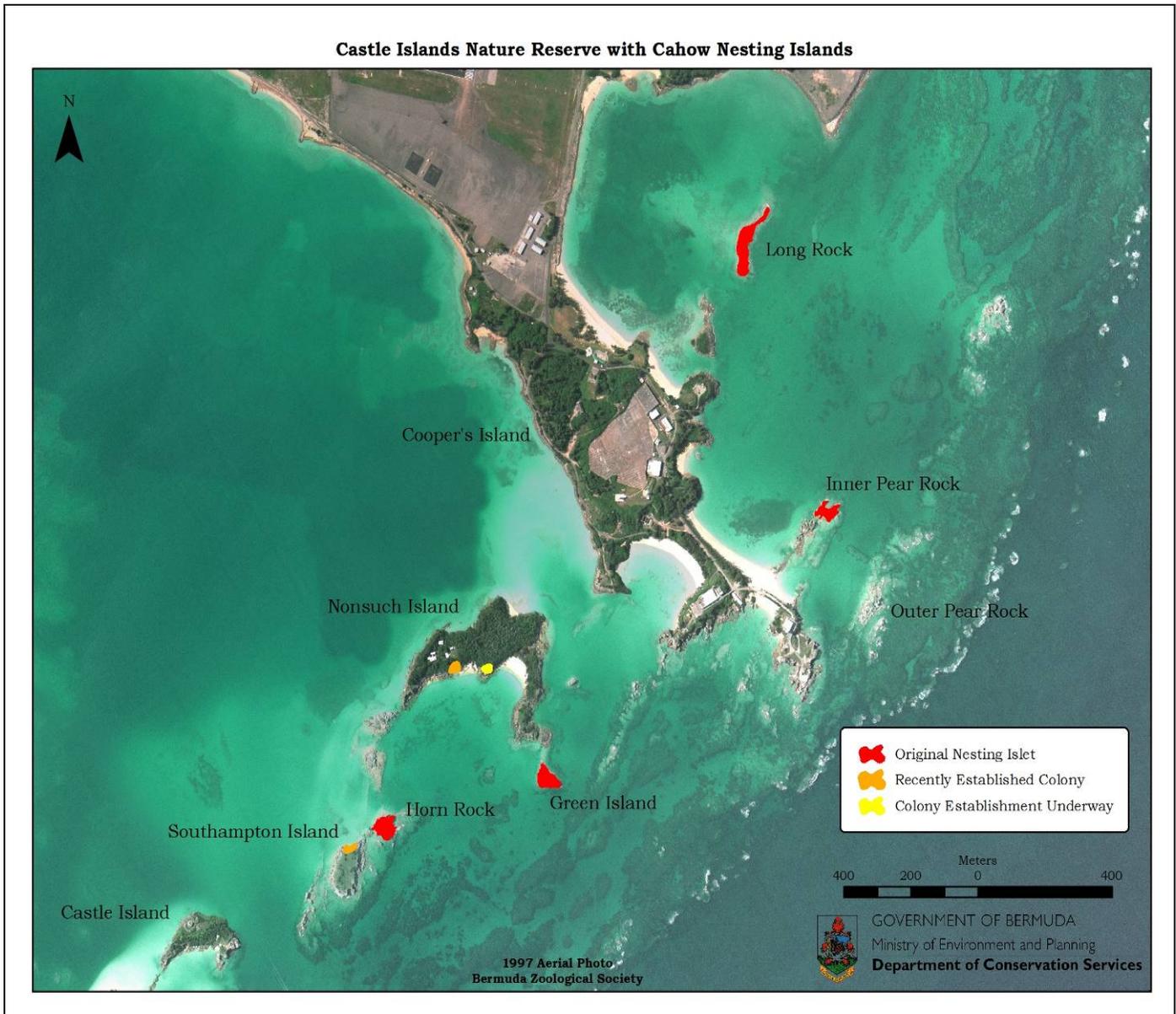


Fig. 5: 2013 Map of Cahow Nesting Sites on the Castle Harbour Islands Reserve
(M. Shailer)

2(c): Summary of 2013 - 2014 Cahow Nesting Season:

This Cahow nesting season has been highlighted by (a): an increase in the number of breeding pairs; (b): a record number of successfully fledging chicks and (c): by the continued growth of the new nesting colony that has been established on the Nonsuch Island Nature Reserve.

The Cahow population has increased to a new record high number of 108 breeding pairs, of which 59 produced successfully fledging chicks. This represents a breeding success rate of 54.6 %, which is slightly more than the 50.4 % recorded in the 2012-2013 nesting season. In addition, new prospecting or pre-breeding activity was recorded at 5 additional nest sites, including 1 new nest site on Nonsuch Island.

Following is a summary of the 2013-2014 nesting season results:

Total number of nest burrows with confirmed nesting activity:	108*
Number of new nest sites with prospecting activity:	5
Total number of confirmed successfully fledged chicks:	59*
Total number of active nest sites with unsuccessful nesting:	49
Number of failures from nest sites with observable nest chambers:	43
Number of failures from nest sites with non-observable nest chambers:	6

Breakdown for causes of breeding failure from nests where observation of nest chambers was possible:

Chick died hatching:	1
Chick died within one month of hatching:	1
Chick died later in development:	2
Eggs broken or pipped:	18
Egg broken during nest check:	1
Non-hatching / infertile eggs:	15
Egg buried or knocked off nest:	5
Egg washed off nest by storm waves:	0

* Indicates record high numbers

2 (d): Breakdown of Breeding Season Results by Nesting Island:

LONG ROCK:

Active nest burrows with nesting confirmed (eggs laid and/or chick hatched): 12
New nest burrow prospected by confirmed pair: 1
Nest burrows with successfully fledged chicks: 5
(B, C, D1, D8, E4)

Nest burrows with confirmed failed nesting: 7
(A (cause unknown), D2 (egg infertile?), D3-egg broken, D4-egg infertile, D5-chick died shortly after hatching, D7-egg infertile, E1-egg knocked off nest, H1-egg knocked off nest & buried)

INNER PEAR ROCK:

Active nest burrows with nesting confirmed: 18
New nest burrows prospected by confirmed pairs: 0
Nest burrows with successfully fledged chicks: 9
(A1, B1, B3, B5, B8, B10, D1, D2, E1)

Nest burrows with confirmed failed nesting: 9
(B2-egg broken, B4-chick died after translocation, B6-egg broken, B7-egg broken, B9-egg broken, C2-egg buried in nest, C3-egg knocked off nest, C4-egg broken, D4-egg infertile).

GREEN ISLAND:

Active nest burrows with nesting confirmed: 23
New nest burrow prospected by confirmed pair: 1
Nest burrows with successfully fledged chicks: 12
(A1, # 2, # 3-4, # 4, # 4-5, # 5, # 6, # 8, # 9, # 11, # 12, # 13,)

Nest burrows with confirmed failed nesting:11
(A2-broken egg, D1-infertile egg, F1 – cause of failure unknown, F2-egg broken, F3-egg infertile, # 1-egg broken, # 5-6-egg infertile, # 7-egg broken, # 10-egg broken, # 14-egg broken, # 15-egg infertile)

HORN ROCK:

Active nest burrows with nesting confirmed: 37
New nest burrows prospected by confirmed pairs: 1
Nest burrows with confirmed successfully fledged chicks: 22
(B3, B6, C7, C8, C10, C12, C13, C14, C17, C20, C22, C23, C24, C25, C26, C28, D3, F5, F6, F7, F8, G3)
Nest burrows with confirmed failed nesting: 15
(B5-egg infertile, C4-chick died shortly after hatching, C5-infertile egg, C6-infertile egg, C11-broken egg, C15-broken egg, C16-broken egg, C20-infertile egg, C21-chick died at 10-11 weeks; parental neglect, C27-egg crushed, D1-unknown, D4-egg buried on nest, E1-unknown, F2-egg infertile, F3-egg broken)

NONSUCH ISLAND:

Active nest burrows with nesting confirmed: 13
New nest burrows prospected by confirmed pairs: 1
Nest burrows with confirmed successfully fledged chicks: 9
(R816, R817, R818, R819, R831, R833, R834, R835, R836)
Nest burrows with confirmed failed nesting: 4
(R820-broken egg, R830-infertile egg, R832-infertile egg, R837-egg broken accidentally during check)

SOUTHAMPTON ISLAND (New):

Active nest burrows with nesting confirmed: 3
New nest burrows prospected: 1
Nest burrows with successfully fledged chicks: 2
(S2, S3)
Nest burrows with failed nesting: 1
(S1-cause unknown)

Section 3(a): Update on New Nesting Colony at Nonsuch Island:



Fig. 6: Pair of adult Cahows at night over Nonsuch translocation colony (J. Madeiros)

The Cahow Translocation Project is an ongoing project to establish new nesting colonies of the Bermuda petrel on higher, more elevated islands that have been chosen as suitable habitat and can also be managed to exclude introduced mammal predators and control human access. It involves moving, or translocating near-fledged Cahow chicks approximately 18 days before fledging from their nests on the four original nesting islets to new complexes of artificial burrows constructed on the chosen islands.

Since the original nesting islands range only between 0.5 to 1.0 acres in size, with maximum elevations ranging from 15' (5m) to 32' (10m), Nonsuch Island, which is both much larger at 15.5 acres (6.5 Ha) and of higher elevation at up to 60' (19m) was chosen for the first of these translocations. It offers much greater protection both from storm flooding and erosion, and also has a much larger area to allow for growth of the Cahow breeding population to a more self-sustaining level, containing adequate soil and forest cover (Wingate, 1985) to enable the Cahows to dig out their own nest burrows.

Gadfly petrels such as the Cahow generally return when mature to the same area that they originally departed from as fledglings, a trait known as *site faithfulness*. To this end, a total of 105 Cahow chicks selected from all four of the original nesting islets were moved to the new nest burrow complex on Nonsuch Island over a five-year period between 2004 and 2008, banded and fed daily on imported squid and locally sourced fresh Anchovies and Pilchards, and their weight, wing growth and plumage development recorded daily until they were fully developed. The chicks were fitted with identification bands, or rings, and then monitored through their exercise period, when they emerge for several nights to exercise flight muscles and imprint on their surroundings. At the end of this period they fledge to the open ocean on their own. A total of 102 translocated Cahow chicks eventually fledged successfully from Nonsuch by 2008 (Carlile et al. 2012).

In addition, a solar-powered sound attraction system was set up at the translocation site in 2008 to help attract returning birds to land and prospect for new, empty nest burrows. This was carried out as although Gadfly petrels tend to return to their original fledging site, they also prefer to nest close to already active nest sites, a trait known as *social attraction*. Until a nucleus of nesting pairs was established on Nonsuch Island, the sound system broadcasted a recording of Cahow courtship calls automatically at night to encourage returning, newly matured translocated birds to prospect for new nest burrows on Nonsuch.

By 2008, the first four returning Cahows translocated three years earlier to Nonsuch were recaptured back at the translocation site on Nonsuch, and their identities confirmed from their band numbers. By the end of that year's nesting season, some of these birds had already been seen prospecting nest burrows at the translocation site. The first real evidence that the effort to establish a new Cahow breeding colony on Nonsuch was succeeding was during the following, **2009 nesting season**, with the first pairs of Cahows establishing in nest burrows on Nonsuch. This culminated in the first egg laid and chick hatched on this Island since at least the 1620s. This chick fledged successfully to sea on the 17th June, 2009. In addition, a total of 15 returned translocated Cahows were re-captured back at the translocation site by the end of this season.

Between 2010 and 2013, the number of established breeding pairs carrying out nesting activity and laying eggs rose from 4 to 12, with the number of successfully fledged chicks varying from 1 in 2010 to 7 in 2012. The total number of returning birds on Nonsuch Island that had been translocated as chicks rose to 22, one from the 2004 translocation cohort, eight from the 2005 cohort, seven from the 2006 cohort and six from the 2007 cohort (Madeiros 2010 & 2012).

For the most recent, 2013-2014 breeding season, the number of breeding pairs of Cahows rose to 13, with another nest burrow being prospected by a newly returning pair. All thirteen nesting pairs produced eggs, but one of these eggs was accidentally cracked during a check of the adult birds for band numbers and body condition. Despite this, a record number of nine eggs hatched, with all chicks successfully fledging out to sea three months later. The total number of Cahow chicks that have hatched and successfully fledged from the new Nonsuch nesting colony since 2009 has now risen to 27 (**See Table 1**)

TABLE 1: Breeding results at new translocation colony on Nonsuch Island 2008/2009 to 2013/2014 breeding seasons		
Breeding season	No. of Breeding pairs	No. of fledged chicks
2008-2009	3	1
2009-2010	5	1
2010-2011	7	4
2011-2012	12	7
2012-2013	13	5
2013-2014	14	9

A comparison was made of the origins and sex of all Cahows now comprising the nesting pairs breeding at the new Nonsuch Island colony site. Sex of birds was determined by external cloacal examination on adults immediately following egg-laying. A total of 8 of the nesting pairs on Nonsuch have both adult birds originating from the 2004-2008 Translocation Project. Another 6 pairs are comprised of one adult from the Translocation Project, and one non-translocated bird. It is worth noting that in all six pairs with adults of mixed origin, that the male birds were in every case translocated to Nonsuch as chicks, but they have all attracted non-translocated female birds fledging from all 4 of the original nesting islets (See Table 2).

This provides additional evidence that male Pterodroma petrels are much more likely to return to their natal nesting and fledging sites, whereas female birds are far more likely to be attracted to nesting areas other than those that they fledged from, in search of potential mates. Banding studies of the Cahow have now shown that this is true for both translocated and non-translocated (naturally fledging) chicks.

For the 2013-2014 nesting season, the R831 nest burrow on Nonsuch was fitted with an infrared “Burrow-Cam” developed by Mr. J.P. Rouja which could live-stream video footage from inside the burrow’s nest-chamber via an antenna mounted on the chimney of the warden’s residence. This was transmitted by North Rock Communications and featured on the www.nonsuchisland.com website, where it can be viewed live by the general public. This video feed documented the growth of the Cahow chick, named “Lightning”, from hatching until its eventual departure out to sea three months later. Observations captured by the burrow-cam included numerous feeding visits by the adult birds to the chick, and exercising and preening activities by the chick. This chick fledged successfully out to sea on the night of 28th May, 2014 (See section 3(d), page 30 for full details).

Overall, for the 2013-2014 Breeding Season, the first Cahow chick to fledge to sea at the (A) translocation colony site did so during the night of May 23, 2014, while the last one fledged out to sea on the night of June 29th, 2014.

Table 2 shows the breakdown of all translocated and other Cahows that comprise nesting pairs at the Nonsuch “A” nesting colony as of June, 2014 (Note: all translocated birds fledged from Nonsuch):

NONSUCH ISLAND Nest No.	Birds Translocated or non-translocated	Band Numbers and Sex of Birds	Origin and Age of Birds (Year fledged)
R816	Both Birds Translocated	E0214 (Male) E0264 (Female)	Translocated 2006 Translocated 2007
R817	Both Birds Translocated	E0162 (Male) E0180 (Female)	Translocated 2005 Translocated 2005
R818	Both Birds Translocated	E0163 (Male) E0159 (Female)	Translocated 2005 Translocated 2005
R819	1 Bird Translocated (M) 1 Non-Translocated (F)	E0368 (Male) E0325 (Female)	Translocated 2010* Non-translocated, Horn Rock C14 2009
R820	1 Bird Translocated (M) 1 Non-translocated (F)	E0243 (Male) E0487 (Female)	Translocated 2007 Unknown origin
R821	1 Bird Translocated (M) 1 Non-translocated (F)	E0296 (Male) E0490 (Female)	Translocated 2008 Unknown origin
R830	Both Birds Translocated	E0204 (Male) E0280 (Female)	Translocated 2006 Translocated 2008
R831	Both Birds Translocated	E0212 (Male) E0197 (Female)	Translocated 2006 Translocated 2006
R832	Both Birds Translocated	E0174 (Male) E0172 (Female)	Translocated 2005 Translocated 2005
R833	1 Bird Translocated (M) 1 Non-translocated (F)	E0276 (Male) E0215 (Female)	Translocated 2008 Non-translocated, Horn Rock D4 2006
R834	1 Bird Translocated (M) 1 Non-translocated (F)	E0161 (Male) E0182 (Female)	Translocated 2005 Non-translocated Inner Pear Rock B8 2005
R835	Both Birds Translocated	E0220 (Male) E0283 (Female)	Translocated 2006 Translocated 2008
R836	1 Bird Translocated (M) 1 Non-translocated (F)	E0171 (Male) E0401 (Female)	Translocated 2005 Non-translocated; unknown origin
R837	Both Birds Translocated	E0208 (Male) E0265 (Female)	Translocated 2006 Translocated 2007

* Though not part of the original 2004-2008 translocation, this bird was translocated to the Nonsuch translocation site in 2010 because of premature abandonment by the adult birds.

3 (b): Second Year of Second Translocation Project at Second (B) Location on Nonsuch



Fig. 7: Translocated Cahow chick being fed on Nonsuch Island

2014 marked the second year of a second translocation project aiming to establish a second foothold for the Cahow on Nonsuch Island. With the first translocation project proving to be successful in establishing a new breeding colony on the southern coastal hillside of Nonsuch, the concept was to build and improve on that success by building a new complex of artificial nest burrows about 200 meters to the east of the original colony site. The new burrow complex is located on top of a promontory formed by the south hill of Nonsuch, overlooking the main, south beach, and is situated at 35' to 45' above sea level, beyond the reach of hurricane waves and surge.

These new nest burrows were built with the assistance of volunteer groups from the Ascendant Group of Companies. Groups of volunteers from Ascendant came out to Nonsuch Island in 2012 and 2013 to assist in mixing and pouring concrete to make 9 new Cahow nest burrows at the new translocation site (See Fig. 10). Another six artificial burrows of a new design developed by former Conservation Officer Dr. David Wingate,

and made of heavy sunlight-resistant polyethylene, were also installed at this site on a trial basis, bringing the total number of burrows at this site to fifteen (Fig.10).



Fig. 8: New prefabricated polyethylene Cahow nest burrows at “B” translocation site.

In the event, both the traditional concrete artificial burrows and the new design plastic burrows seemed to work well, being readily accepted by the translocated chicks during the approximately two to three-week period when they were in residence at the Nonsuch translocation site before they fledged to sea.

A total of 20 chicks were translocated from all four of the original nesting islets to artificial burrows at the (B) site on South Hill, overlooking the South Beach of Nonsuch Island. Of these, a total of 19 chicks fledged successfully out to sea, while one chick, from the Inner Pear Rock B4 nest, succumbed due to undetermined gastric difficulties. Out of the total of 19 successfully fledging chicks, 9 originated from nest burrows on Horn Rock (C10, C12, C14, C17, C19, C22, C25, C26, F8), 6 from nests on Green Island (# 3/4, # 4, # 4/5, # 6, # 8, # 11), 2 from nests on Inner Pear Rock (IPO A1, IPO D2) and 2 from nests on Long Rock (LONG D8, LONG E4) (see Figure 6).

The first Cahow chicks (from the Horn Rock C12 and C17 nests and the Green Island # 4/5 nest) were translocated to Nonsuch Island on the 8th May, 2014. The Horn Rock C12 chick also became the first chick to successfully fledge out to sea, on the 20th May, after 12 days in its translocation burrow on Nonsuch. The final chick was not translocated until the 25th June, fledging out to sea at the very late date of 8th July. The median date for translocation of chicks was the 25th May, while the median date for fledging of chicks was the 3rd June. The age of chicks at their translocation ranged from 70 to 103 days after hatching (mean age = 81 days). (See Table 3 for full translocation results and figures).

TABLE 3: 2014 Bermuda Petrel Translocation Project

Date of Translocation of Bermuda Petrel Chicks to Nonsuch Island, Age at Translocation, Number of Feeds and Total Feed Weight, Period of Emergence to Fledging, Date of Fledging, and Age, Weight and Wing Chord (Length) at Fledging.

Individual (Origin – Island & nest No.)	Translocation		Number of Feeds		Emergence to fledging (days)	Fledging			
	Date moved (2014)	Age when moved (days)	No. of feeds after moving	Total Feed weight (grams)	(Exercise period)	Date fledged (2014)	Age from hatching (Days)	Weight (grams)	Wing Chord (mm)
HORN C12	8 May	72	8	408g	2	20 May	84	268g	242mm
HORN C17	8 May	71	9	392g	3	23 May	86	289g	250mm
GREEN 4/5	8 May	70	9	436g	2	24 May	86	242g	242mm
GREEN 3/4	11 May	74	6	284g	3	23 May	86	269g	237mm
HORN C10	15 May	75	8	314g	3	31 May	91	254g	257mm
GREEN 4	16 May	73	11	368g	3	1 June	90	210g	245mm
IPO A1	16 May	76	7	274g	3	27 May	87	269g	246mm
LONG D8	19 May	80	7	382g	4	1 June	93	291g	259mm
GREEN 11	20 May	80	7	367g	3	1 June	92	280g	250mm
HORN C22	20 May	79	7	448g	4	3 June	93	267g	261mm
HORN C26	26 May	77	9	268g	5	7 June	89	311g	255mm
GREEN 6	28 May	81	8	238g	4	7 June	91	275g	260mm
IPO D2	2 June	88	8	466g	3	13 June	99	284g	261mm
LONG E4	2 June	88	5	210g	5	12 June	98	266g	268mm
HORN C25	4 June	81	10	403g	8	18 June	95	307g	270mm
HORN F8	9 June	90	13	626g	6	22 June	103	261g	257mm
HORN C14	10 June	88	5	235g	3	15 June	93	213g	264mm
GREEN 8	17 June	103	9	500g	2	25 June	111	267g	234mm
HORN C19	25 June	97	11	655g	4	8 July	110	223g	238mm
Median	20 May					3 June			
Mean		81.2	8.26	383g	3.68		93.5	265.58g	252.4mm

While at their translocation burrows, the chicks were hand-fed either every other day, or daily if the chick was considered below optimum weight. Food provided to the chicks consisted of human-quality fresh unfrozen squid (*Loligo sp.*) obtained from Miles Supermarket, Pitts Bay Rd. Pembroke. In addition, fresh fish were netted locally and provided by Mr. Chris Flook, who had also provided fish for the original translocation project from 2004 to 2008. Fish provided were mainly Anchovy (*Sardinella anchovia*), but also included Atlantic Threadfin Herring (*Opisthonema oglinum*). A typical meal for one

Cahow chick consisted of 1 or 2 Squid bodies (with or without heads) and 5 to 6 Anchovies or equivalent.

The number of meals given to each translocated Cahow chick before fledging ranged from 5 – 13 meals (mean = 8 meals), and individual meal weights usually ranged from 40 grams to 70 grams (extreme ranges 14 grams – 94 grams). The total amount of food from all meals given to each chick also varied widely from a low of 210 grams to a high of 655 grams (mean = 383grams).

The number of nights that the chicks emerged to exercise before fledging ranged from 2 to 8 nights (mean = 3.68 nights), with chicks fledging to sea between the 20th may and the 8th July (median fledging date = 3rd June).

The weight of the chicks at fledging ranged from a high of 311 grams to a low of only 210 grams, considered to be well below the target weight of 250-280 grams. The mean fledging weight was 265.58 grams however, which is considered to be just about ideal.

The wing chord (outer wing length from the wrist joint) of fledging chicks ranged from 234mm to 270mm (mean = 252.4 mm).

The total age from hatching of the translocated chicks by the time they fledged ranged from 84 days to 111 days (mean = 93.5 days).



Fig. 9: Translocated Cahow chick exercising outside nest burrow at night on Nonsuch

Certain difficulties were encountered during the first year (2013) of translocation of Cahow chicks to the second, (B) colony site on Nonsuch. These included the following:

- (1) The spoiling of fish stored in the refrigerator at the main house on Nonsuch Island and used for feeding the translocated chicks, due to frequent use and opening of the refrigerator door by workers and volunteers carrying out projects on the island during the translocation period. The fact that the food was spoiled was not detected for three days, by which time five of the translocated chicks had become ill. Although three of these chicks were nursed back to health, two chicks did expire.
- (2) A number of the translocated chicks fledged from Nonsuch Island at weights below what is considered the optimum minimum weight (250-270 grams) for fledging Cahows. This is partly due to the fact that there were a large number of underweight chicks, including those selected for translocation, in the population during the 2012-2013 breeding season, possibly due to a shortage of food species for adult birds to bring back to the chicks.
- (3) A number of large work projects and tours were being carried out on Nonsuch Island immediately before and during the translocation project period, involving relatively large numbers of workers and/or volunteers. These projects included the installation of a large concrete pad to hold a new solar power panel array, involving the landing of about five tons of building sand, cement and equipment by barge on the island, transport of this material up to the work site at the main house, and use of heavy equipment to mix and lay down the cement. A large solar panel array and associated power lines and associated equipment were then installed, as was almost a ton of large, high-capacity storage batteries. The heavy work schedule and transportation needs etc. for the workers made it difficult at times to provide proper feeding and monitoring of the translocated Cahow chicks on Nonsuch Island.

These problems were all addressed and largely solved during the 2013/2014 Cahow translocation season, as follows;

- (1) An additional eight artificial nest burrows were installed at the 'B' translocation site to accommodate more translocated Cahow chicks;
- (2) the spoiling of food was prevented by storing all food in a freezer ashore, and only bringing what food was needed for each day out to the island in a freezer container;
- (3) only Cahow chicks in good body condition, with weights of 300 grams or more, were generally chosen for translocation to Nonsuch Island, except for a few late fledging chicks or chicks which had obviously been abandoned prematurely by the adult birds;
- (4) Care was taken not to schedule any major work and/or volunteer projects on Nonsuch during the period when the translocation project was underway; the number of tours scheduled for Nonsuch Island during this period was also reduced to manageable levels.

3(c): Outbreak of Invasive Black Rats on Nonsuch Island



Fig. 10: Black Rats caught in traps over a 2-day period on Nonsuch Island, April 2014.

Every breeding season seems to bring new threats and challenges to the recovery of the Cahow and the 2013-2014 breeding season was no exception. **In early April, it was discovered that for the first time since 2005, Black Rats (*Rattus rattus*) were able to colonize Nonsuch Island**, most likely by swimming over from Coopers Island, which is located only 300m northeast of Nonsuch. There is also a possibility that the rats were able to “hitch-hike” on a boat or barge to the island.

It goes without saying that rats pose an extreme threat to many aspects of the Nonsuch Living Museum Project, in that they eat and destroy the seed/fruits of many endemic and native plant species, as well as posing an extreme threat to the eggs and young of seabirds like the Bermuda petrel and White-tailed Tropicbird, and land birds like the White-eyed Vireo, Catbird, European Goldfinch, Mourning Dove and Ground Dove.

By the time the presence of the rats was confirmed (by evidence of droppings and chewed Olivewood and Bay-Grape seeds), they had already built up a substantial population, primarily around the buildings and down towards the fresh water pond. In the past, rats had been controlled on Nonsuch by the use of anticoagulant rodenticides, but as Barn owls (*Tyto alba pratincola*) had been observed feeding on the island, therefore helping in the control of the rats, and are vulnerable to secondary poisoning, “live-traps” were used to try and eradicate the rodents. “Break-neck” spring traps were not used because of the danger they pose to ground-foraging native birds such as the Catbird (*Dumetella carolinensis*). Up to 14 live-traps were set at a time around Nonsuch Island, checked and any rats euthanized,

and the traps re-set with fresh bait daily for more than three months, with well over 100 rats eventually trapped and destroyed (see Figs. 10 and 11). This brought rat numbers down to almost undetectable levels, but in August more rats turned up and by late September another 29 rats had been trapped and destroyed.



Fig.11: Black Rat caught in live-trap on Nonsuch Island, May 2014

A number of other, non-target species were also found in the live-traps; the most common was the native Catbird, which has a large population on Nonsuch Island, especially during the spring breeding season. A total of 12 Catbirds were found in live-traps, all of two of which were released without harm. Unfortunately, two Catbirds died due to heat exhaustion and/or stress. In addition, large Red Land Crabs (*Gecarcinus lateralis*) were found twice in traps, and a Land Hermit Crab (*Coenobita clypeatus*) was found once in a trap. All of these were also released without harm.

All of the evidence supports the conclusion that **traps alone can bring rat numbers down and achieve temporary control, but can not completely eradicate them** on an island as large and heavily vegetated as Nonsuch. This is largely due to the fact that a small number of rats are “trap-shy” and will not enter traps at all. There is also the problem that rats now have abundant alternative supplies of other food, such as Palmetto, Olivewood and Bay-grape berries, prolifically available on the island at different times of the year.

As a result, during the next “window” from January through February 2015, when plant fruits and berries are not available and there are few alternate food resources available for the rats, **anticoagulant rodenticide will be set out in approximately 90 bait boxes over the whole of Nonsuch Island.** This is the only practical way of achieving the complete eradication of rats on Nonsuch Island, and was the method used successfully to eradicate rats the last time they colonized Nonsuch in 2005.

3 (d): First Live-streaming of Infrared Cahow Burrow-cam

2013 had marked the first time that an infrared “night vision” video camera was used in a Cahow nest burrow to record video footage of the late egg incubation stage, egg hatching and the development of a chick from 1 week of age to fledging. Video clips of the development of the chick, which came to be called “Backson”, was provided free to the public over the LookTV website as follows: <http://lookbermuda.com/CahowCam>. This project, which was funded entirely by the Ascendant Group of Companies, involved the modification of several of the concrete nest lids with 4” PVC electrical conduit pipes so that a customized “Go Pro 2” camera modified by Mr. JP Rouja so be sensitive to infrared light (See Fig. 12) could be installed to take video footage of the Cahow adults and chicks inside their burrows, which are completely dark.

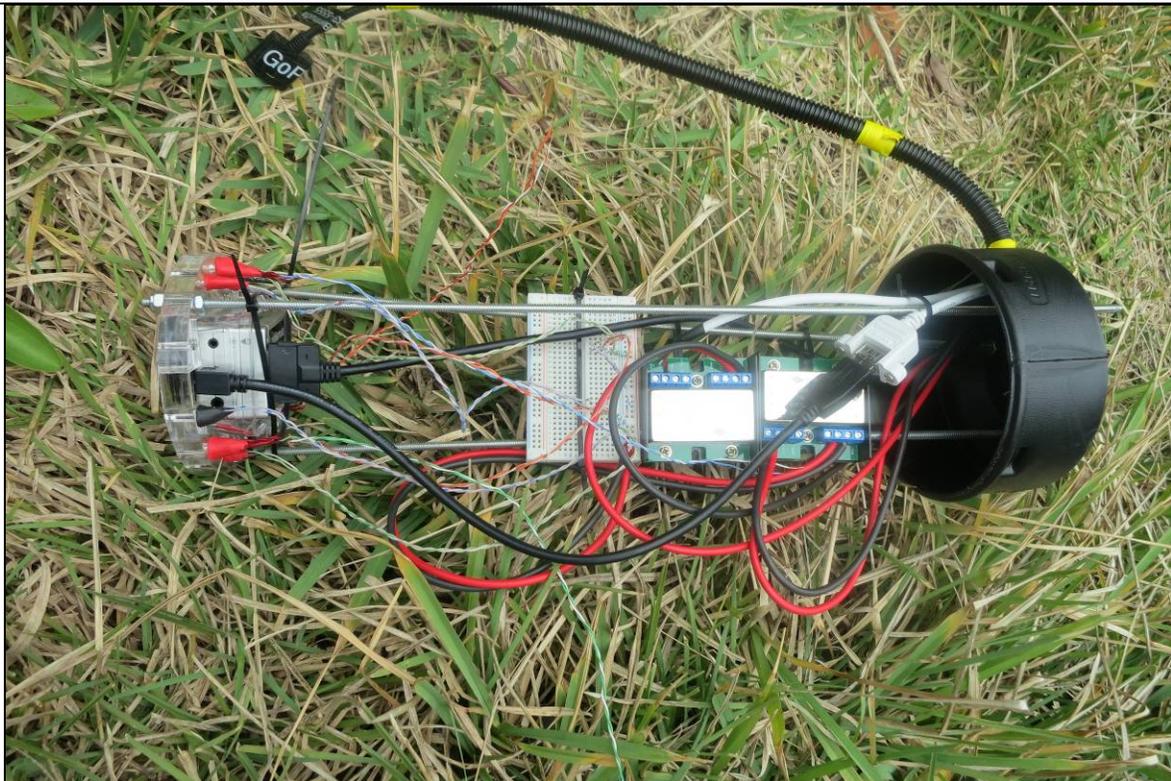


Fig. 12: Infra-red Cahow “Burrow-cam” developed by Mr. JP Rouja.

This video camera, fitted with military-grade infrared lights that are completely undetectable by humans or animals, enables high-definition video footage to be taken whenever power is available at the colony site. The CahowCam has the great advantage of making observations of these critically endangered birds available to the public at any time, without causing disturbance to the birds or threatening their breeding success in any way.

Another advantage that this system brings is that it allows the managing researcher to check on the progress of egg incubation, growth of the chicks etc. in the nest without causing any disturbance to the birds. In addition, breeding, courtship and nest-building behavior of the adult birds, as well as chick behavior, can be observed in a totally non-obtrusive manner for the first time. This not only has great benefits for behavioral and breeding biology research, but also can be provided to the public, who can participate in the “citizen science” aspect by seeing new behavior at the same time as the researchers.

Although live-streaming of CahowCam footage was not possible during the 2013 Cahow breeding season because of the lack of electrical supply on Nonsuch Island, the installation of a new Solar Power System was carried out by PUREENERGY RENEWABLES LTD. and volunteers from the Ascendant Group of Companies, Dept. of Conservation Services, Dept. of Public Works and Bell Landscaping during June, 2013. This development allowed live-streaming to be carried out from Nonsuch Island for the first time during the 2013-2014 breeding season. The CahowCam was installed in the R831 Cahow burrow for this season, and allowed the growth of the chick (named “Lightning”) in the completely dark burrow to be followed from just after hatching (Fig. 13) until the chick fledged out to sea.

Following are some of the findings that the CahowCam has revealed:

- (1) Cahow chicks from a young age seem to spend much time building up and re-arranging the nest material around or under them, suggesting that nest-building is an innate or instinctual behavior.
- (2) When not sleeping, chicks spend much of their waking time preening their down and feathers, especially around the growing wings. They also frequently spread, stretch and briefly exercise their wings in the nest chamber, especially during the last month of development. It was previously thought that their wingspan (up to 1 meter) was too long for them to open their wings inside the nest, but as the wings lengthen, they often spread them out one wing at a time to fit in the restricted space of the nest chamber.
- (3) When the adult Cahows carry out a feeding visit to the chick, it usually only lasts an hour or two before the adult flies back out to sea. The chick is often so hungry when the adult bird arrives that it swarms over and pecks at the adult bird, making feeding impossible. The adult will usually preen the chick around its face and head for about 10 minutes, which seems to calm down the chick enough so that successful feeding can take place.
- (4) The chick inserts its bill crosswise into the bill of the adult bird, which regurgitates the food in a series of 16 to 25 very brief feeding periods, each lasting only 3 to 5 seconds, over about a 10-minute period. Once the feeding is completed, the adult then often intensively preens the head and body of the chick, followed by a rest period where the adult sleeps cuddled next to the chick for an hour or more. The chick is often restless during this period, and the adult will sometimes wake up and preen the chick again for a brief period to calm it down before returning to sleep.

- (5) The adult bird after an hour or two will wake up, and sometimes completely pull apart the nest, throwing grass and leaves over the chick, which does not appear to be alarmed by this strange behavior. The adult may then feed the chick 1 or 2 more times before finally leaving the nest and flying back out to sea to begin another foraging trip. The chick then spends a couple of hours pulling the scattered nest material back together and rebuilding the nest. This behavior may represent “turning over the bedsheets”, aerating the nest material to prevent it from decomposing or building up insect or parasite population loads. This behavior is still not fully understood.
- (6) During the last 2 or 3 weeks that the chick is in its burrow before fledging, it spends an increasing amount of time away from its nest and in the long entrance tunnel leading from the nest entrance to the nest chamber. This can occur both during the day and at night, with the chick sometimes spending several hours in the tunnel out of sight of the CahowCam.

The infrared CahowCam has already proved its value, both in revealing previously unknown behavior and in public outreach. It has enabled the public to follow the development and behavior of the chick and adult Cahows at the same time as researchers, and has revealed the private life of Bermuda’s critically endangered National Bird to an international audience over the internet. For the next, 2014-2015 breeding season, it is planned to live-stream the video from the CahowCam from the beginning of the nesting season in November, to follow the return, nest-building and courtship phase of the season by the nesting adults.



Fig. 13: Adult Cahow in nest with recently hatched chick (eggshell at lower left)

3 (e): Update on Cahow Banding Program for 2014:

The Cahow banding program has been a key component of the Cahow Recovery Program since 2002, with 5.5 mm metal bands made of a strong, corrosion-resistant alloy called incoloy being fitted to the right legs of adult Cahows and the left legs of fledgling birds. These bands can last for the life of the birds and are imprinted with a unique code and a return address. The bands are vital for allowing easy, positive identification of individual Cahows in the field, and enable researchers to follow these birds for essentially their entire breeding lifespan through recaptures over successive years.

The Cahow Banding Program has now been underway for thirteen years, As of June, 2014, a total of 546 Cahows have been fitted with identification bands, the majority of which have been fledgling birds* This includes 140 birds banded as breeding adults, and 406 birds banded as chicks before fledging to sea. In other terms, these numbers represent almost 65 % of the current adult breeding population, and about 85% of all chicks to have fledged since 2002. (*This does not represent the total population of Cahows, as only about a third of fledglings survive their first years at sea before returning as adults; the total world population of the species is conservatively estimated at between 300 and 325 individuals, including immature or non-breeding birds).

Banding of Cahow chicks is of particular value due to the fact that it enables the easy identification and study of individual birds whose age is accurately known, as well as the nest and island that they originated from. These known-age birds have already given a wealth of previously unknown information on many aspects of behavior and breeding biology, including the following:

- 1) The survival rates of chicks during the period between fledging to sea and their first return to the nesting grounds as sexually mature young adults;
- 2) The differences in survival rates of naturally-fledged birds (raised entirely by the adults), as compared to those that have been translocated (raised partly by adult birds, partly by humans).
- 3) The age of chicks upon their first return to the nesting grounds, and whether this differs between male and female birds;
- 4) The period of time between the first return of the young birds, to the choosing of nest sites and mates, and the first nesting attempts;
- 5) Whether young Cahows always return to their exact point of departure, or whether they can return also to other islands/nesting colonies; the banding program has confirmed that this differs between male and female birds.

In addition, the banding of adult Cahows is providing concrete data on breeding success rates, site faithfulness and pair faithfulness, and eventually on the longevity of individual birds (Madeiros et al. 2012). The information gathered by the Cahow banding project will continue to increase in value the longer that the banding project and annual recapture and band checks of the birds, continues into the future.

Section 4 (a): Planned Future Management Actions and Research:

A number of the projects and proposals recommended in past yearly Nesting Season Reports have now either been successfully completed or are well underway; following are the most important recommendations for continuing projects and management work already underway, or that are proposed for future nesting seasons:

2014 – 2015 Breeding Seasons:

- Continue translocations of near-fledged Cahow chicks from nesting islands to “B” colony site on Nonsuch Island, moving 20 – 25 chicks annually until a target figure of 75 to 90 chicks have been moved and have fledged from Nonsuch;
- Install 2nd sound attraction system at new “B” colony site on Nonsuch Island and play disc of recorded Cahow courtship calls and cries during breeding season; discontinue use of sound attraction system at “A” translocation site on Nonsuch;
- Continue banding program for adult and fledgling Cahows;
- Continue monitoring of nesting islands for the presence of rats; set out rodenticides when necessary;
- Continue installation of additional artificial nest burrows at nesting colonies, including at the new colony on Southampton Island.
- Deploy more archival geolocators on the legs of both individuals of selected breeding pairs of Cahows, to determine whether male and female birds forage for food and spend the non-breeding season in different oceanic locations.

2015 – 2016 Breeding Seasons:

- Continue translocating 20 – 25 near-fledged Cahow chicks from the original nesting islands to the “B” colony site on Nonsuch Island;
- Continue use of Sound Attraction System at “B” colony site on Nonsuch;
- Continue banding program for adult and fledgling Cahows;
- Continue the installation of additional artificial nest burrows for the Cahow on suitable nesting islands and locations;
- Investigate the possible deployment of extremely accurate GPS loggers on selected adult and fledgling Cahows.

Section 4 (b): Acknowledgements:

I would like to acknowledge with thanks the following Departmental staff, volunteers, organizations, schools and members of the public for their assistance in the Cahow Recovery Project during the 2013 – 2014 breeding season:

Mr. Drew Pettit, Director, Dept. of Conservation Services, Mr. Peter Drew, Conservation Officer, Dr. Mark Outerbridge, Ecologist and Alison Copeland (all Dept. of Conservation Services) for assistance in monitoring checks and feeding of translocated Cahow chicks; Ms. Mandy Shailer (GPS coordinator, Dept. of Conservation Services), who has provided maps of nesting islands and nest sites, and compiled locational data from the geolocational data loggers to make the tracking and oceanic range maps, Nicholas Carlile and Dr. David Priddell, (New South Wales Department of the Environment and Climate Change, Australia), who have provided guidance on various aspects of the recovery program and collaborated in the writing of two scientific papers on the breeding biology of the Cahow and the Cahow translocation project; Chris Flook, who kindly agreed to again provide fresh Anchovies and Herring for the translocated Cahow chicks, and JP Rouja of LookTV (designer and installer of the infrared “Cahow burrow-cam” to enable both researchers and the public to unobtrusively study the behavior of the birds inside nest burrows).

As usual, I am deeply indebted to the Terrestrial Conservation Crew for their hard work in building artificial concrete nest burrows for the Cahows on both Nonsuch Island and the original nesting islets. This work has included mixing and transporting thousands of pounds of concrete out to the isolated nesting islands, landing it in buckets in generally rough conditions, and carrying it to the top of the islands. The Terrestrial Conservation Crew consists of Barry Smith (Foreman), Hillgrove Iris, Kiwon Furbert and Marvin Jones.

The research work carried out by the Cahow Recovery Program has been possible only because of donations by schools, businesses, organizations and members of the public. For example, the geolocational loggers which have revolutionized the understanding of the oceanic range of the Cahow were purchased entirely through public donations, notably by Saltus Cavendish School and Paget Primary School. Special thanks also go out to the Ascendant Group of Companies, who have supported and provided volunteers to construct new Cahow nest burrows and a new solar power system for the Cahow Recovery Project, in addition to painting buildings and control of invasive Casuarina trees on Nonsuch Island. We are deeply grateful for the interest and generosity shown by these and other donors.

In conclusion, I would like to acknowledge my wife, Leila Madeiros, and children Seth and Elizabeth, without whose support and patience I would not have been able to carry out this demanding and time – consuming project over the last 14 years.

Jeremy Madeiros,
Senior Terrestrial Conservation Officer

Section 4 (c): References:

Carlile, N., Priddel, D., & Madeiros, J. 2012. Establishment of a new, secure colony of Endangered Bermuda Petrel *Pterodroma cahow* by translocation of near-fledged nestlings. *Bird Conservation International*, available on Cambridge Journals Online Doi: 10.1017/S0959270911000372.

Flood, R., & Fisher, A. Multimedia Identification Guide to North Atlantic Seabirds; *Pterodroma* Petrels. 2013. Pelagic Birds & Birding Multimedia Identification Guides in association with www.scillypelagics.com ISBN 978-0-9568867-1-2. 4edge Ltd, Hockley, Essex

Madeiras, J. 2005. *Recovery Plan for the Bermuda Petrel (Cahow) Pterodroma cahow*. Department of Conservation Services, Bermuda.

Madeiras, J. 2010. Cahow Recovery Program. *Establishment of a New Breeding Colony of Bermuda Petrel Pterodroma cahow on Nonsuch Island, Bermuda, by the Translocation of Near-fledged Chicks and Social Attraction*. Department of Conservation Services, Bermuda.

Madeiras, J. 2012. *Cahow Recovery Program: Breeding Season Report for 2011-2012*. Department of Conservation Services, Bermuda.

Madeiras, J., Carlile, N., & Priddel, D. 2012. Breeding biology and population increase of the endangered Bermuda Petrel *Pterodroma cahow*. *Bird Conservation International* 22: pp. 34 – 45.

Madeiras, J., Flood, R., & Zufelt, K. 2014. *Conservation and At-sea Range of Bermuda Petrel (Pterodroma cahow)*. *North American Birds*, pp. 546-557. Quarterly Journal of Ornithological Record Published by the American Birding Association. Volume 67: No. 4, 2014

Murphy, R. C., & Mowbray, L. S. 1951. *New Light on the Cahow (Pterodroma cahow)*. *The Auk*, Vol. 68, pp.

Wingate, D. B. 1985. The restoration of Nonsuch Island as a living museum of Bermuda's pre-colonial terrestrial biome. In: Moors, P.J. (ed.), *Conservation of Island Birds*, pp. 225-238. ICBP Technical Publication No. 3. International Council for Bird Preservation, Cambridge.