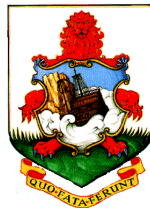


**CAHOW RECOVERY PROGRAM  
For Bermuda's Endangered National Bird  
2018 – 2019 Breeding Season Report**



**BERMUDA GOVERNMENT**

**Compiled by: Jeremy Madeiros, Senior Conservation Officer  
Terrestrial Conservation Division  
Department of Environment and Natural Resources  
*"To conserve and restore Bermuda's natural heritage"***

**RECOVERY PROGRAM FOR THE CAHOW**  
**(Bermuda Petrel) *Pterodroma cahow***

**BREEDING SEASON REPORT**  
**For the Nesting Season (October 2017 to June 2018)**  
**Of Bermuda's Endangered National Bird**



**Fig. 1: Adult Cahow (Bermuda petrel) photographed at sea 5 miles southeast of Nonsuch Island (photo by Kate Sutherland)**

Cover Photo: Pair of adult Cahows from Nonsuch Island R838 nest

# CONTENTS:

Page No.

---

**Section 1: Executive Summary: ..... 5**

## **Section 2:**

**(2a) Management actions for 2018-2019 Cahow breeding season: ..... 7**

**(2b) Cahow Recovery Program – summary of 2018/2019 breeding season: ..... 10**

**(2c) Collaborative GPS tagging and toxicology project with international partners: ..... 11**

**(2d) Breakdown of breeding season results by nesting island: ..... 16**

## **Section 3:**

**(3a) Update for new Cahow breeding colonies on Nonsuch Island: ..... 18**

**(3b) Summary of results for 2nd translocation project on Nonsuch island: ..... 21**

**(3c) Cahow Recovery Program – Public Outreach/Education: ..... 23**

## **Section 4:**

**(4a) Future management actions and research: ..... 25**

**(4b) Acknowledgements: ..... 27**

**(4c) References: ..... 28**

## List of Figures

Page no.

---

Cover photo: Pair of breeding adult Cahows from Nonsuch R838 nest: (Kate Sutherland)	
Fig. 1: Adult Cahow photographed at sea 5 miles SE of Nonsuch Island: .....	(2)
Fig. 2: Castle Harbour Islands Nature Reserve with Cahow nesting islands: .....	(7)
Fig. 3: Number of nesting pairs and fledged young over 57-year period: .....	(9)
Fig. 4: GPS tag being attached to tail feathers of adult Cahow, Jan. 2019: .....	(10)
Fig. 5: Monica Silva and Letizia Campioni fitting GPS tags to Cahow, Jan/Feb 2019: .....	(12)
Fig. 6: Map from GPS tag showing foraging trip to Georges Bank by male Cahow: .....	(13)
Fig. 7: Students at University of Lisbon using blood samples to sex Cahows: .....	(14)
Fig. 8: Foraging trips recorded by GPS tag for adult Cahow during chick-rearing: .....	(15)
Fig. 9: Tagged Cahow photographed leaving Nonsuch nest after feeding chick: .....	(15)
Fig. 10: Location of new Cahow nesting colonies on Nonsuch Island 2019: .....	(18)
Table 1: Breeding results at (A) Nonsuch Cahow nesting colony: .....	(19)
Table 2: Annual breeding success by nest at (A) Cahow nesting colony: .....	(20)
Fig. 11: Location & status of Cahow nests at (B) Nonsuch Cahow colony: .....	(21)
Fig. 12: Downy Cahow chick preened by adult, viewed through “CahowCam”: .....	(23)
Fig. 16: Cahow health check on Nonsuch Island with BZS school tour group: .....	(25)

- Cover photo and Fig. 1: Kate Sutherland; Figs 2,10 & 11: Mandy Shailer; Fig. 3: Leila Madeiros; Figs. 4, 5 & 12: JP Rouja; Fig. 6: Letizia Campioni; Fig. 7: Monica Silva; Figs 8 & 9: Carina Gjerdrum; Fig. 16: Camilla Stringer

## SECTION 1:

### 1(a): EXECUTIVE SUMMARY:

**Key Words: Burrow-cam, Cahow, New Colony, Nonsuch 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 (*Pterodroma cahow*), which is one of the rarest seabirds on Earth. **The primary objective** of this program is to increase the Cahow's breeding population through the control of threats to the species, construction of artificial nesting burrows, and the establishment of entirely new nesting colonies. **A secondary objective** is to promote public education and understanding of the importance of the Cahow to the history and environment of Bermuda.

The Recovery Program is managed and administered by the Senior Terrestrial Conservation Officer, through the Department of Environment and Natural Resources (DENR). As a critically endangered species, the Cahow and its nesting habitat are completely protected under the Protection of Species Act 2003 and **public access to all nesting islands is restricted by law**, except in the company of a member of the Recovery Team.

The Cahow is endemic to the Islands of Bermuda and was originally abundant, possibly numbering more than half a million breeding pairs. **It was catastrophically affected by the colonization of the island by English settlers in the early 1600s**, due to direct hunting by the settlers for food and by their introduction of mammal predators such as Rats, Cats, Dogs and Pigs. After less than 12 years of settlement, the Cahow by the 1620s was thought to be extinct, a belief that persisted for 330 years until the rediscovery in 1951 of a tiny remnant population on four small half-acre offshore islets (**Murphy & Mowbray, 1951**).

The Recovery Program has been in place since 1960 and has been successful in addressing most of the threats affecting the Cahow on the breeding islands on Bermuda. This program has enabled the breeding population to increase from only 18 pairs producing a total of 7 - 8 chicks annually in the early 1960s to a record number of 131 breeding pairs in 2019, producing a record total of 73 successfully fledged chicks (see Fig. 3).

Continuing threats to the Cahow include:

- 1) erosion and flooding of the original nesting islets from hurricane activity and sea-level rise;
- 2) predation by invasive Rats swimming from mainland Bermuda to the islets;
- 3) insufficient safe nesting habitat and suitable deep nest burrows or rock crevices;
- 4) nest-site competition with the Longtail or White-tailed Tropicbird *Phaethon lepturus catsbyii*;
- 5) human disturbance through illegal landings on the nesting islets, and interference with and vandalism of the nest burrows;
- 6) light pollution from the main islands of Bermuda, in particular from the area of the Bermuda International Airport.

Following are some of the highlights of the 2019 Cahow nesting season:

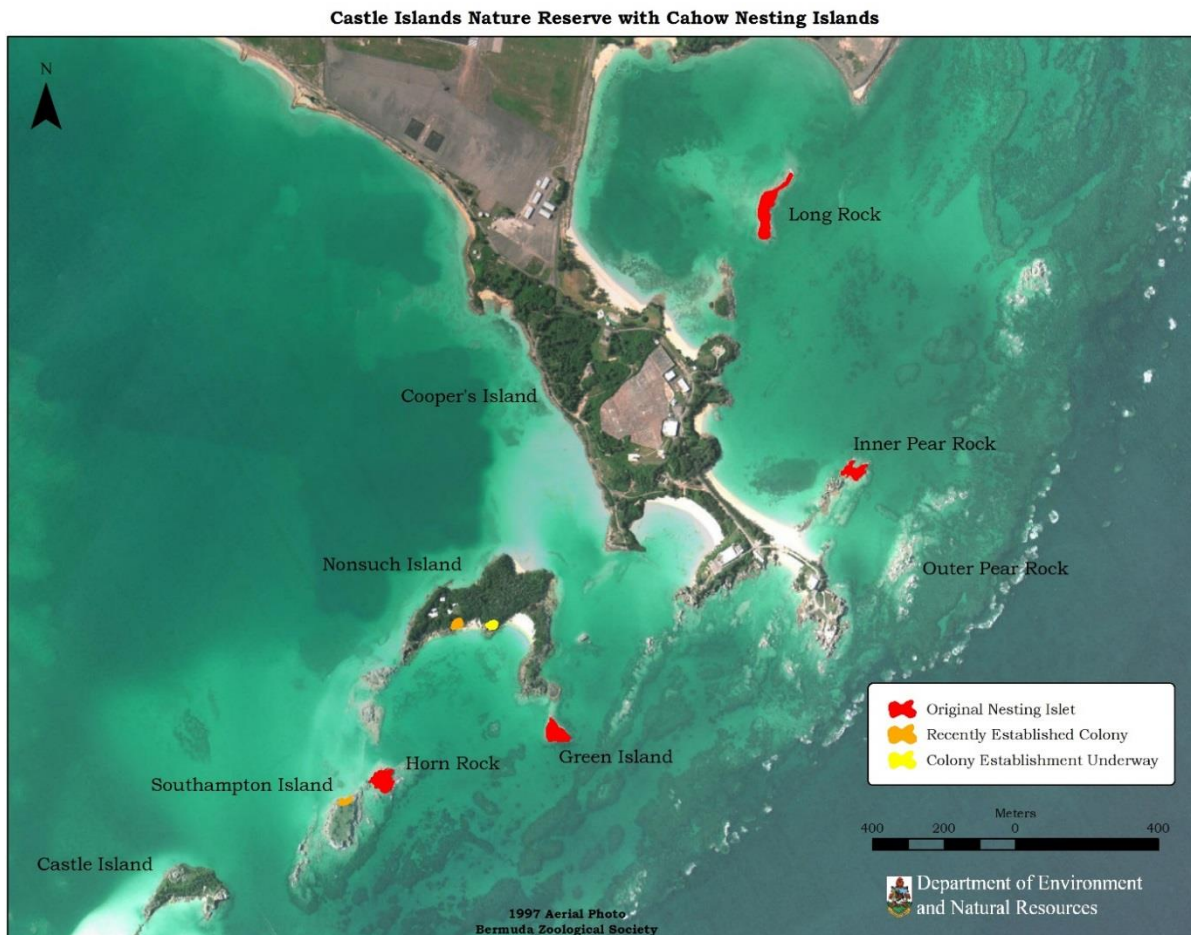
- **The two new nesting colonies of Cahows established on Nonsuch Island** by the translocation of chicks from the original small islets have continued to grow, with 19 breeding pairs now at the “A” colony, and 4 new breeding pairs at the “B” colony site (see Fig. 7).
- **The number of breeding pairs laying eggs at the second, ‘B’ translocation colony site on Nonsuch**, approximately 200m east of the ‘A’ colony site, increased to four, of which two produced successfully fledging chicks. These are the first chicks to be produced at this particular site. A total of 64 Cahow chicks were moved to, and fledged successfully from this site between 2013 and 2017.
- **A 2-year collaborative research project with international partners was initiated and its 1st field season was successfully carried out.** A total of 35 GPS tags, of two different types, were attached to breeding adult Cahows during the egg incubation and early chick-rearing periods, to investigate the oceanic movements and foraging areas of the adult birds during these periods. In addition, blood and feather samples were taken from almost 90 adult Cahows, to investigate toxicology, stable isotope analysis and sex.
- **The infrared “Cahow-cam”** developed by JP Rouja of LookTV with financial assistance from the Ascendant Group of Companies has been a resounding public outreach success, and was further improved in 2017 through **a new partnership with the Cornell Bird Lab**. This has involved the installation of new cameras which give much better views of the nesting birds, enabling school groups and the public to follow the nesting activity of Cahows in underground burrows on Nonsuch Island. **In 2019, a 2nd burrow-cam was installed** in another burrow, providing detailed viewing of the breeding activity of 2 separate pairs of Cahows, including courtship and chick-rearing activities. **In addition, a new “surface cam” was installed** which gives an external view of part of the nesting colony and the south coastline of Nonsuch Island. This website can be accessed at [www.nonsuchisland.com](http://www.nonsuchisland.com)

---

The Cahow Recovery Program has continued to meet both its primary objective of increasing the overall Cahow breeding population, and its secondary objectives of establishing new nesting colonies and increasing public outreach and education. This has only been possible due to regular annual monitoring and management of the entire breeding population, which is vital for the rapid identification and control of ongoing and potential threats to the Cahow as they arise.

Full details on the 2018 to 2019 breeding season are given in the following report, in addition to research and management proposals for the next two seasons.

## SECTION 2 (a): Management actions for 2018-2019 Cahow nesting season:



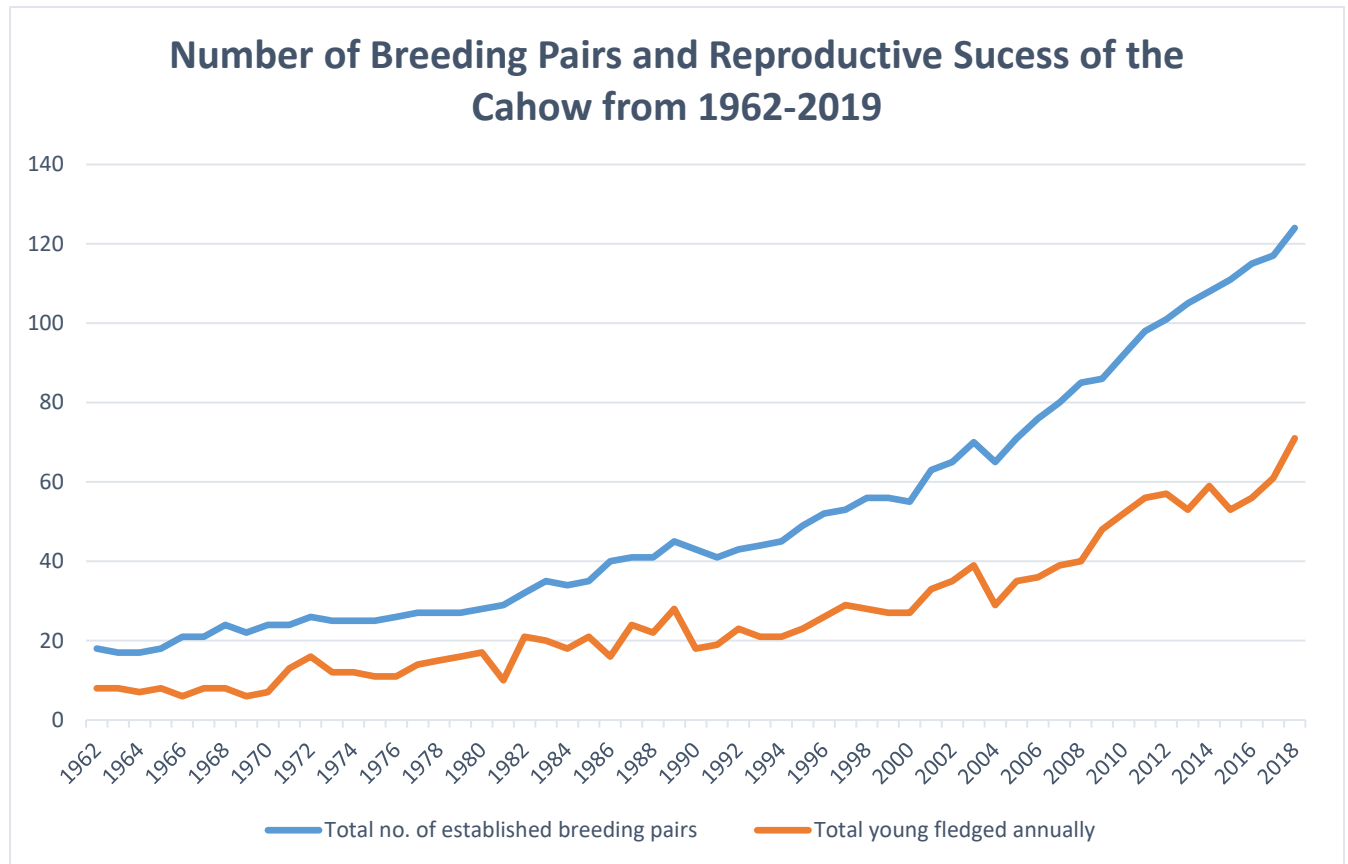
**Fig. 2: Castle Harbour Islands Nature Reserve with Cahow nesting islands and colony sites**

Following is a review of the events and management / research work carried out for the Cahow Recovery Program through the 2018-2019 breeding season:

- (1) The breeding season began with preparatory work for the upcoming Cahow nesting season in early October, including setting out rat bait on all nesting islands, unblocking nest burrows, and removing the entrance Tropicbird baffles, in addition to clearing out soil & stones carried into some burrows by the burrowing activities of Red Land Crabs (*Gecarcinus lateralis*), which are common on some of the nesting islands.
- (2) The first Cahows were recorded returning from the open ocean to their nesting burrows by the 20<sup>th</sup> October 2018, with all back by the second week of November. During late October and November 2018, a total of 74 adult Cahows were removed briefly from nests to check band numbers, body condition and weight.

- (3) The first Cahows returned to the nesting islands from a one-month pre-egg laying exodus by the beginning of January 2019, with the first eggs confirmed on the 8<sup>th</sup> January. During the egg incubation period, which lasts about 53 days, an additional 97 of the incubating adults were checked to determine sex, weight and band numbers. Candling was introduced to identify fertile eggs and follow embryo development.
- (4) The first Cahow chick hatched by the 22<sup>nd</sup> February 2019, with the last confirmed by the end of March. Once all chicks had hatched, 55 chicks in accessible nests were checked about once a week, weather conditions permitting, for weight, wing chord length, and plumage development. This information is essential in identifying when chicks chosen for translocation, are at optimal development to be moved to new nest sites. It can also be used to estimate the fledge dates of chicks and whether chicks are being fed normally.
- (5) 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 2018-2019 Cahow nesting season, a total of 52 chicks were fitted with identification bands, out of a total of 73 chicks which successfully fledged (71.2 % of all chicks).
- (6) The total number of active nesting pairs of Cahows increased to a record high of 131 pairs during the 2018/2019 nesting season, compared to 124 nesting pairs in the 2017/2018 season and 55 pairs in 2000/2001. A record total of 73 chicks successfully fledged from all nesting islands, compared to the previous record of 71 chicks fledged during 2018 (**See Fig. 3**).
- (7) The new (A) nesting colony on Nonsuch Island, established by the translocation of near-fledged chicks and sound attraction techniques between 2004 and 2009, has continued to grow. For the 2017-2018 breeding season, 19 nesting pairs laid eggs at the Nonsuch colony; from these, a total of 12 chicks hatched (**See Tables 1 & 2**), all of which fledged successfully out to sea, while 1 new pair of prospecting adult Cahows have established in a burrow at this colony (**See section 3(a)** for full details).
- (8) During this nesting season, four breeding pairs of Cahows laid eggs at the second, (B) translocation colony site (**See section 3(b)**). A total of 64 chicks were translocated to, and successfully fledged from, this site over a 5-year period between 2013 and 2017. Out of these four eggs, two chicks hatched and fledged successfully out to sea, making the first fledglings to be produced at this second Nonsuch colony. These newly established colonies are especially important for the species, as Nonsuch is considerably larger and higher in elevation than any of the original nesting islets. This makes these new nesting colonies more protected from hurricane flooding and erosion and sea-level rise, with the added potential for being able to support a much larger population of the species.





**Fig. 3:** No. of breeding pairs and fledged young of Cahow over 56-year period (Leila Madeiros)

The 2018/2019 nesting season also reached an important milestone concerning the new Cahow nesting colony on Nonsuch Island:

As of this year, the breeding colonies on Nonsuch Island have produced a total of 79 successfully fledged chicks. The final stage in the establishment of a new, self-sustaining seabird colony is for fledged chicks produced by the colony to return when mature, establish nest sites and choose mates to make new breeding pairs at the new site.

In the 2016/2017 season, the first 3 confirmed returning chicks were recaptured, including two male birds choosing empty burrows (R838 and R839) at the original translocation site on Nonsuch, and 1 female Cahow pairing up with a male bird on Green Island (#12 nest).

In the 2018/2019 season, the number of confirmed returning Cahows that had originally hatched and fledged from Nonsuch increased to 9, including 6 recorded in new nests on Nonsuch, and 3 in nests on other islands (Green Island # 12, Horn Rock C29, and Long Rock D9). Of these, one pair on Nonsuch (R838 nest) produced a chick that successfully fledged out to sea, fulfilling the final criteria needed for confirmation of the establishment of a new, self-sustaining nesting colony

**SECTION 2 (b):**  
**Overall summary of 2018 / 2019 Cahow nesting season:**

---

During the 2018-2019 Cahow nesting season, the Cahow population has increased to a new record high number of 131 breeding pairs, of which 73 produced successfully fledging chicks. This represents a breeding success rate of 55.7%, compared to 57.26% recorded in the 2017-2018 season. In addition, new prospecting or pre-breeding activity was recorded at 9 additional new nest sites, including 3 new nest sites on Nonsuch Island.

Following is a summary of the 2018-2019 nesting season results:

---

Total number of nest burrows with confirmed nesting activity: .....	131*
Number of new nest sites with prospecting activity: .....	9
Total number of confirmed successfully fledged chicks: .....	73*
Total number of active nest sites with unsuccessful nesting: .....	58
Number of failures from nest sites with observable nest chambers: .....	50
Number of failures from nest sites with non-observable nest chambers: .....	8

\* Indicates record high numbers

Breakdown for causes of breeding failure from observable nest burrows:

Chick died in 1st month of development: .....	1
Chick died later in development: .....	2
Chick died hatching: .....	2
Embryo died in egg at 0-30 days development: .....	7
Embryo died in egg at 30+ days development: .....	3
Eggs broken or pipped: .....	6
Non-hatching / infertile eggs: .....	12
Egg buried or knocked off nest: .....	6
Egg disappeared (Land Hermit Crab predation?): .....	4
Tropicbird nest competition/disruption: .....	3
Disruption due to death of adult: .....	1
Failure from unknown causes: .....	3

## SECTION 2 (c): Collaborative International GPS Tagging and Toxicology Project:

---



Fig. 4: GPS tag being attached to tail feathers of adult Cahow during egg incubation, Jan. 2019

The 2018-2019 Cahow breeding season included 2 collaborative research projects that have been undertaken by the Terrestrial Conservation Division of the Dept. of Environment and Natural Resources, with international partners. In this partnership, the Government Principle Terrestrial Conservation Officer worked with two separate groups on a multi-year program, which included a program of fitting adult Cahows and a few White-tailed Tropicbirds with 2 different types of advanced GPS tags, to accurately map oceanic foraging area use and range.

The first of these groups, consisting of researchers Letizia Campioni of Italy and Monica Silva of Portugal, representing MARE-IPSA and CE3C-FCUL respectively, arrived in Bermuda and spent several weeks in January and February 2019 with the Conservation Officer on Nonsuch Island and 3 other Cahow nesting islands, deploying 22 GPS units on the tail feathers of adult Cahows that were incubating eggs (Fig. ), to accurately map foraging area range and use during the egg incubation period. They returned to Bermuda again between March 26 and April 10 during the early chick provisioning (feeding) period for further GPS tag deployment and blood & feather sampling. Another 11 GPS tags were deployed on adult Cahows to record foraging trips carried out to gather food for the growing chicks. These tags record data for up to 5 to 6 weeks at a time and do not process or calculate location in real-time; instead, the units record the

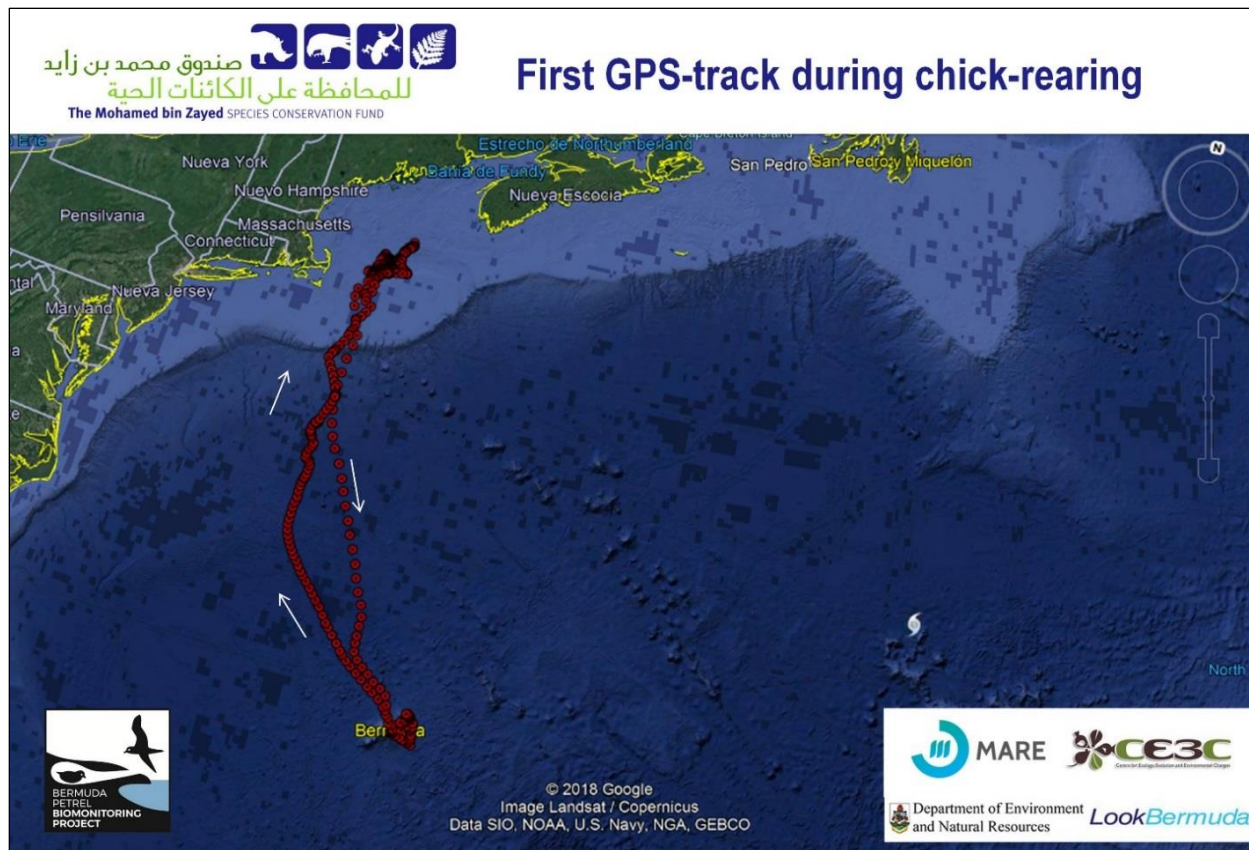


Fig. 5: Monica Silva (L) and Letizia Campioni (R) fitting GPS tags to Cahow, Jan/Feb 2020

time taken to contact the GPS satellites, which in turn is used to determine location every 30 minutes; the data is then archived by the tags until they are retrieved and the data downloaded. These location fixes are accurate to within a meter or two, and by not using a transmitter, the units are even lighter (and thousands of times more accurate) than the archival geolocators used a decade before, at only 3.3 grams in weight, compared with 4.6 grams for the geolocators.

Almost all of the deployed tags were eventually recovered from the birds, with detailed locational data recovered during “off-shift” feeding trips by the incubating adult Cahows (when their partners relieved them from egg incubation duties), and during feeding/provisioning trips out to sea to gather food for the growing chicks. Among other things, the data showed the birds flying at 25-35 mph on their outbound trips, and speeds of up to 40-50mph when returning from foraging areas. One of the first GPS tags recovered recorded a foraging visit to the Georges Bank, a well-known fishing ground 130 miles southeast of Boston, Massachusetts. The bird making this 800-mile trip was a male Cahow that incidentally was the first bird translocated as a chick in 2005, that was confirmed returning back to Nonsuch as an adult in 2008 (see Fig. 6).

Researcher Monica Silva also was using molecular tools to study the diet of the Cahow (in concert with similar studies of Desertas petrel and Zino’s petrel), based on samples of feces and spontaneous regurgitation. There was 1 spontaneous regurgitation from an adult Cahow (from nest # R837) that was handled during a chick feeding visit; at least 2 fish species were identified from this regurgitant: 1) *Argyrops aculeatus*, and 2) *Diaphus metopoclampus*. This is the first time that specific prey species in the diet of Cahows have been positively identified.



**Fig. 6:** Map from recovered GPS tag showing foraging trip to Georges Bank by male Cahow

In addition, Monica and Letizia collected 67 blood samples and 57 feather samples from adult Cahows during their two visits in January – February and March – April, as well as collecting hatched eggshells and failed eggs. These samples are being analyzed to investigate the following:

- 1) To identify the trophic niche of adult Cahows during the breeding season, by Stable Isotope Analysis of the blood and feathers;
- 2) To investigate whether birds are being exposed to Persistent Organic Pollutants integrated with diet (analyzing blood samples to determine levels of DDT, DDE, PFOs, PCPs etc.);
- 3) To understand whether the relatively high proportion of infertile, failed eggs is related to the concentration of bioaccumulated contaminants (e.g. DDT/DDE have toxic effects causing eggshell thinning) and/or to bird breeding experience (i.e. relatively high percentage of younger, inexperienced breeding adults).
- 4) To positively sex adult Cahows using sex chromosomes in blood samples (see Fig. 7).

Some of this analytical work is being carried out by students at the University of Lisbon, Portugal (see Fig. 7). Among other things, we are interested in comparing levels of DDT/DDE present in the birds to compare with samples collected many years ago (Wingate et al. 1968) to see if this persistent pesticide is still present in the North Atlantic food chain.

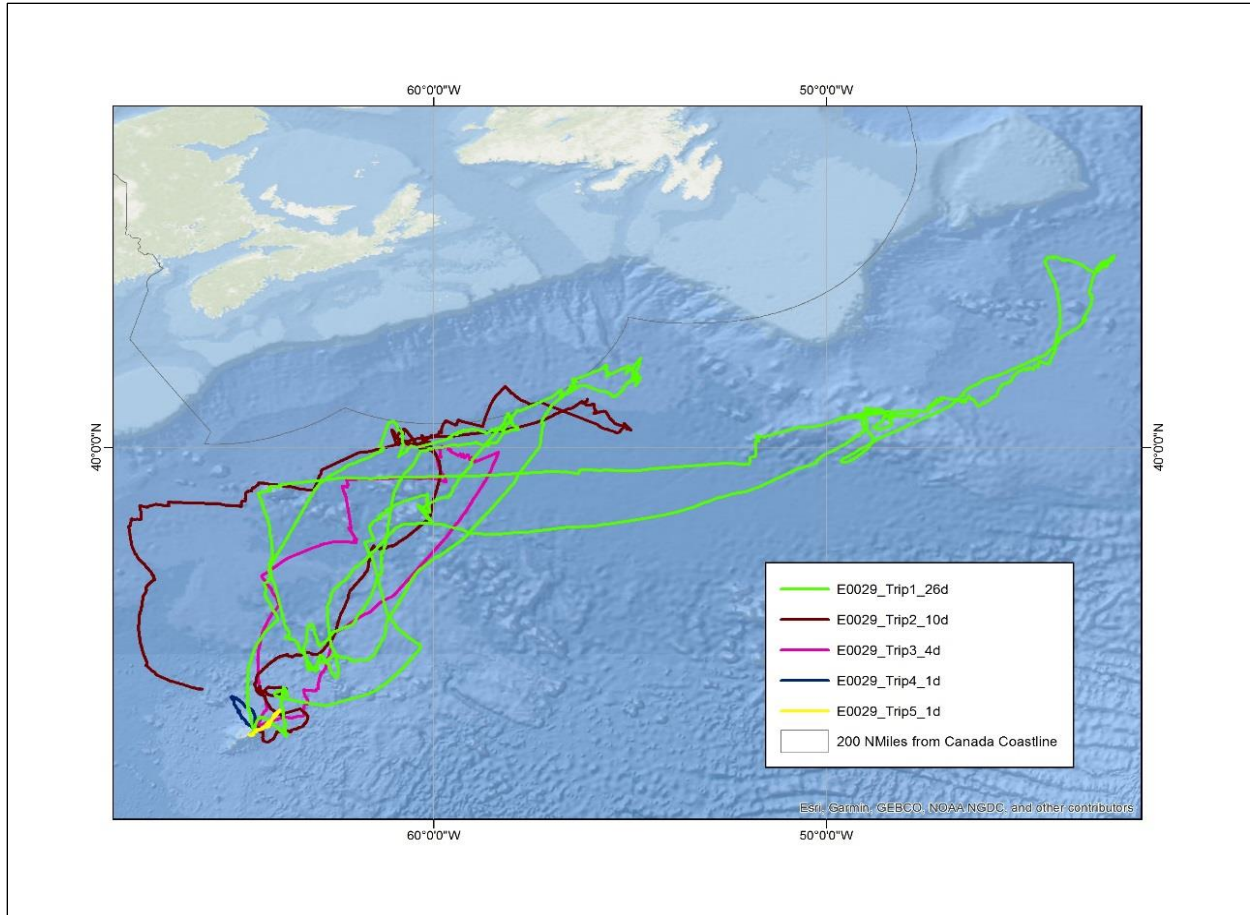


**Fig. 7:** Students at University of Lisbon using sex chromosomes in blood samples to sex Cahows

The second group consisted of Carina Gjerdrum of the Canadian department of Environment and Climate Change, and Andre' Raine of the Kauai Endangered Seabird Recovery Project, who also both visited Bermuda in April, staying on Nonsuch Island while they deployed slightly larger, 10-gram German-made GPS tags. These tags use small solar panels to extend battery life, so that tags can collect data for much longer periods of up to 4-6 months. They also transmit data directly to a base station unit set up on the ground at the nesting colony site, so that the tags do not have to be physically removed from birds to collect the data. A total of 6 tags were deployed by this team, with highly accurate locational data from chick feeding trips being received from 5 of them (see Fig. 8).

The data from both sets of GPS tags from both groups has already been of particular importance in confirming that Cahows forage within the Canadian Exclusive Economic Zone (EEZ), along the edge of the Canadian Continental Shelf south and east of Nova Scotia and Newfoundland as well as the Grand Banks. Not only does this confirm that the Cahow can be considered as a Canadian Species, but they regularly use the edge of the Nova Scotia Shelf, which is an area that has been designated for a considerable expansion in oil and gas exploration activities. These activities possibly pose a threat to not only the endangered Cahow, but also to the vast numbers of seabird species, from around the Atlantic Basin, that are known to regularly use this area as an important foraging habitat.

In addition, this team set out Reconyx motion-activated infrared trail cameras at the burrow entrances of all nest burrows where adult Cahows had been fitted with GPS Tags, on Nonsuch Island and Horn Rock. These cameras are activated by movement within their field of vision and can record photos day or night, recording feeding visits by adult birds to their chicks (see Fig. 9).



**Fig. 8:** Foraging trips recorded by GPS tag for adult male Cahow during chick-rearing



**Fig. 9:** Tagged Cahow captured on camera leaving Nonsuch R837 nest after feeding chick

## SECTION 2 (d):

### Breakdown of Breeding Season Results by Nesting Island:

---

Following is a breakdown of breeding results on all Cahow nesting islands for the 2018/2019 nesting season. Out of all nesting islets, both Green Island and Southampton Island had low breeding success, at 45.8% and 40 %. Inner Pear Rock, Horn Rock and Nonsuch Island had relatively normal breeding success rates at 55.0 %, 59.5 % and 57.1 % respectively. In contrast, Long Rock had the highest breeding success rate at 64.3 %.

#### **LONG ROCK: (64.3 % breeding success)**

Active nest burrows with nesting confirmed (eggs laid and/or chick hatched): .....	14
New nest burrow prospected by confirmed pair: .....	2
Nest burrows with successfully fledged chicks (# 12; B; C; D2; D3; D4; D8; D9; E1): .....	9
Nest burrows with confirmed failed nesting: .....	5
(A – cause unknown; D1 – cause unknown; D5 - egg disappeared – land hermit crab predation; D7 embryo died in egg in first 30 days development; E4 – egg undersize & infertile.	

#### **INNER PEAR ROCK: (55.0 % breeding success)**

Active nest burrows with nesting confirmed: .....	20
New nest burrows prospected by confirmed pairs: .....	2
Nest burrows with successfully fledged chicks: .....	11
(B1, B3, B4, B5, B7, B8, C4, D1, D2, D4, E1)	
Nest burrows with confirmed failed nesting: .....	9
(A1-chick died in 1 <sup>st</sup> month of development; B2-egg knocked out of nest & broken; B6-egg infertile; B8-unknown causes; B9-embryo died in egg in first 30 days of development; C1-unknown causes; C2- egg buried in nest; C3-egg knocked off nest; D1-disruption caused by Tropicbird nest competition).	

#### **GREEN ISLAND: (45.8 % breeding success)**

Active nest burrows with nesting confirmed: .....	24
New nest burrow prospected by confirmed pair: .....	2
Nest burrows with successfully fledged chicks: .....	11
(A1; D1; E1; F2; # 5; # 6; # 8; # 12; # 15; # 16; # 17)	
Nest burrows with confirmed failed nesting: .....	13
(F1 – possible Tropicbird nest competition; F3 unknown cause; # 2 – egg broken # 3 - egg infertile; # 3 / 4 – embryo died in egg at 0-30 days development; # 4 – embryo died in egg at more than 30 days development; # 4/5 - egg infertile; # 5-6 – chick died from parental neglect; # 9-embryo dies in egg at more than 30 days development; # 10 – egg infertile; # 11 – egg buried/knocked off nest; # 13 – chick died late in development; # 14 - egg knocked off nest)	



**HORN ROCK: (59.57 % breeding success)**

Active nest burrows with nesting confirmed: ..... 47  
New nest burrows prospected by confirmed pairs: ..... 3  
Nest burrows with confirmed successfully fledged chicks: ..... 28  
(B3; B5; B6; C4; C7; C8; C10; C11; C14; C16; C17; C18; C20; C21; C22; C23; C24; C25; C26;  
C29; C30; C31; D1; D4; F5; F6; F7; G3)  
Nest burrows with confirmed failed nesting: ..... 19  
(B7 – unknown causes; B8 – Tropicbird nest disruption; C5 – egg infertile; C6 – egg broken; C9  
– egg infertile; C12 – disruption due to loss of female; C13 – egg broken; C15 – egg buried &  
cracked; C19 – egg broken; C27 - egg broken; C28 – Chick died hatching; D3 – unknown  
causes; E1 - unknown causes; E2 – Tropicbird nest disruption; E3 – unknown causes; F2 - egg  
infertile; F3 – chick dies at 3 weeks; F4 – embryo dies early in development in egg; F8 - egg  
broken)

**NONSUCH ISLAND: (57.14 % breeding success)**

Active nest burrows with nesting confirmed: ..... 21  
New nest burrows prospected by confirmed pairs: ..... 4  
Nest burrows with confirmed successfully fledged chicks: ..... 12  
(R818; R819; R820; R821; R830; R832; R835; R836; R837; R839; B8; B9)  
Nest burrows with confirmed failed nesting: ..... 9  
(R816 – embryo died at 30+ days in egg; R817- embryo died at 0-30 days in egg; R822 – egg  
infertile; R831 – egg infertile; R833-chick died hatching; R834 - embryo died 0-30 days in egg;  
R838- infertile egg; B2- infertile egg; B12-embryo died at 0-30 days in egg)

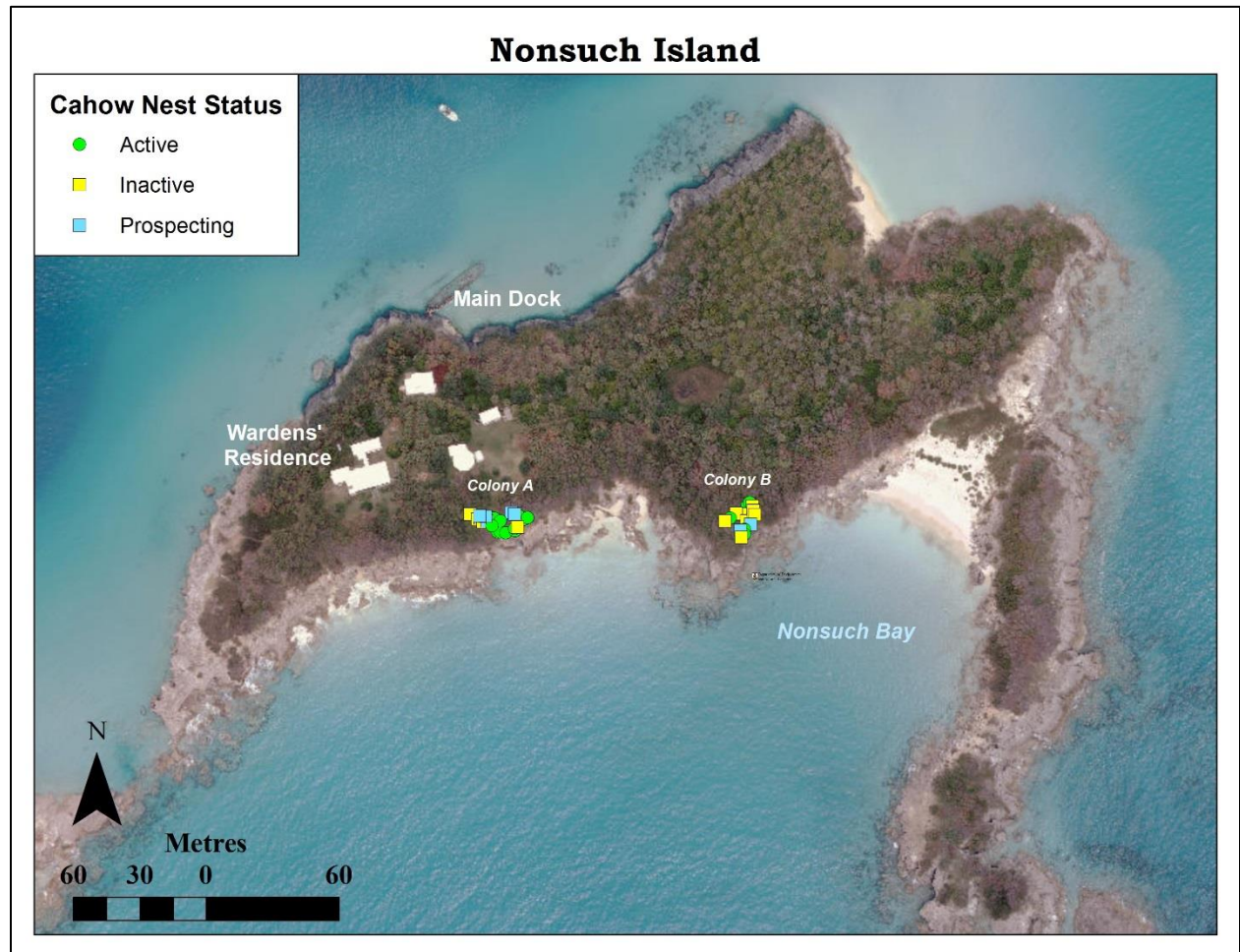
\* See Section 3(a), page 18 for a complete summary of breeding results at the 2 breeding colonies on Nonsuch Island.

**SOUTHAMPTON ISLAND: (40 % breeding success)**

Active nest burrows with nesting confirmed: ..... 5  
New nest burrows prospected: ..... 1  
Nest burrows with successfully fledged chicks: ..... 2  
(S3; S5)  
Nest burrows with failed nesting: ..... 3  
(S1; - cause unknown; S2 - cause unknown, S4 - egg buried by sand collapse)

**\* Overall breeding success for entire breeding population: ..... 55.7%**

## SECTION 3 (a): Update on New Nonsuch Translocation Colonies:



**Fig. 10:** Location of new Cahow nesting colonies on Nonsuch Island in 2019

**A primary objective of the Cahow Recovery project** has been to establish new nesting colonies on larger, more elevated islands with suitable habitat, that are less at risk from hurricane flooding and erosion, as well as safer from ongoing sea-level rise, than the original tiny nesting islets. It has involved moving (translocating) Cahow chicks approximately 18 days before fledging, from nests on the original nesting islets, to artificial burrows constructed on the much larger and higher elevation Nonsuch Island.

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*. Taking advantage of this tendency, a total of 105 Cahow chicks selected from all of the original nesting islets were moved to artificial nest burrows on Nonsuch Island over a five-year period between 2004 and 2008. On Nonsuch, they were hand-fed daily for 2 to 3 weeks on imported squid and locally sourced fresh Anchovies, and their weight, wing growth and plumage development recorded daily until they were fully developed. The chicks were fitted with identification bands, and monitored through their exercise period, when they emerge at night to exercise and imprint on their surroundings.

At the end of this period, they fledged to sea on their own, hopefully to return when mature to the translocation site. **A total of 102 translocated Cahow chicks fledged successfully from Nonsuch between 2004 - 2008 (Carlile et al. 2012).** By 2008, the first four translocated Cahows were recaptured back at the translocation site on Nonsuch (**now called the “A” colony site**), and their identities confirmed from their band numbers. The first real evidence that the effort to establish a new Cahow breeding colony on Nonsuch was succeeding occurred in **2009**, with the first pairs of Cahows nesting in burrows. **This resulted in the first chick known to have hatched on Nonsuch since the 1620s.**

**Between 2010 and 2018**, the number of established breeding pairs carrying out nesting activity at the new Nonsuch Island “A” nesting colony rose from 4 to 18, with the number of successfully fledged chicks produced annually by this colony increasing from 1 chick in 2010 to 13 chicks in 2018. The total number of returning adult Cahows on Nonsuch that had been translocated to the island as chicks rose to 28, one from the 2004 translocation cohort, eight from the 2005 cohort, eight from the 2006 cohort, six from the 2007 cohort and five from the 2008 cohort (**Madeiraso 2010, 2012, 2013 & 2014**). In addition, another 21 translocated chicks eventually returned to the four original nesting islets (Long Rock, Inner Pear Rock, Green Island and Horn Rock). The total number of confirmed returning translocated Cahow chicks was therefore 49, out of 102 that originally fledged from Nonsuch (representing a 48 % return rate).

**For the most recent 2018/2019 breeding season**, the total number of breeding pairs on Nonsuch was 21, of which 12 produced successfully fledging chicks (57.14 % breeding success). **The total number of Cahow chicks that have hatched and successfully fledged from the new Nonsuch nesting colony since 2009 increased to 79 by 2019 (See Tables 1 and 2).**

<b>TABLE 1: Breeding results at new translocation colonies on Nonsuch Island 2008/2009 to 2018/2019 breeding seasons</b>		
<b>Breeding season</b>	<b>No. of Breeding pairs</b>	<b>No. of fledged chicks</b>
<b>2008-2009</b>	<b>3</b>	<b>1</b>
<b>2009-2010</b>	<b>5</b>	<b>1</b>
<b>2010-2011</b>	<b>7</b>	<b>4</b>
<b>2011-2012</b>	<b>12</b>	<b>7</b>
<b>2012-2013</b>	<b>13</b>	<b>5</b>
<b>2013-2014</b>	<b>13</b>	<b>9</b>
<b>2014-2015</b>	<b>14</b>	<b>9</b>
<b>2015-2016</b>	<b>15</b>	<b>10</b>
<b>2016-2017</b>	<b>15</b>	<b>8</b>
<b>2017-2018</b>	<b>18</b>	<b>13</b>
<b>2018-2019</b>	<b>21</b>	<b>12</b>

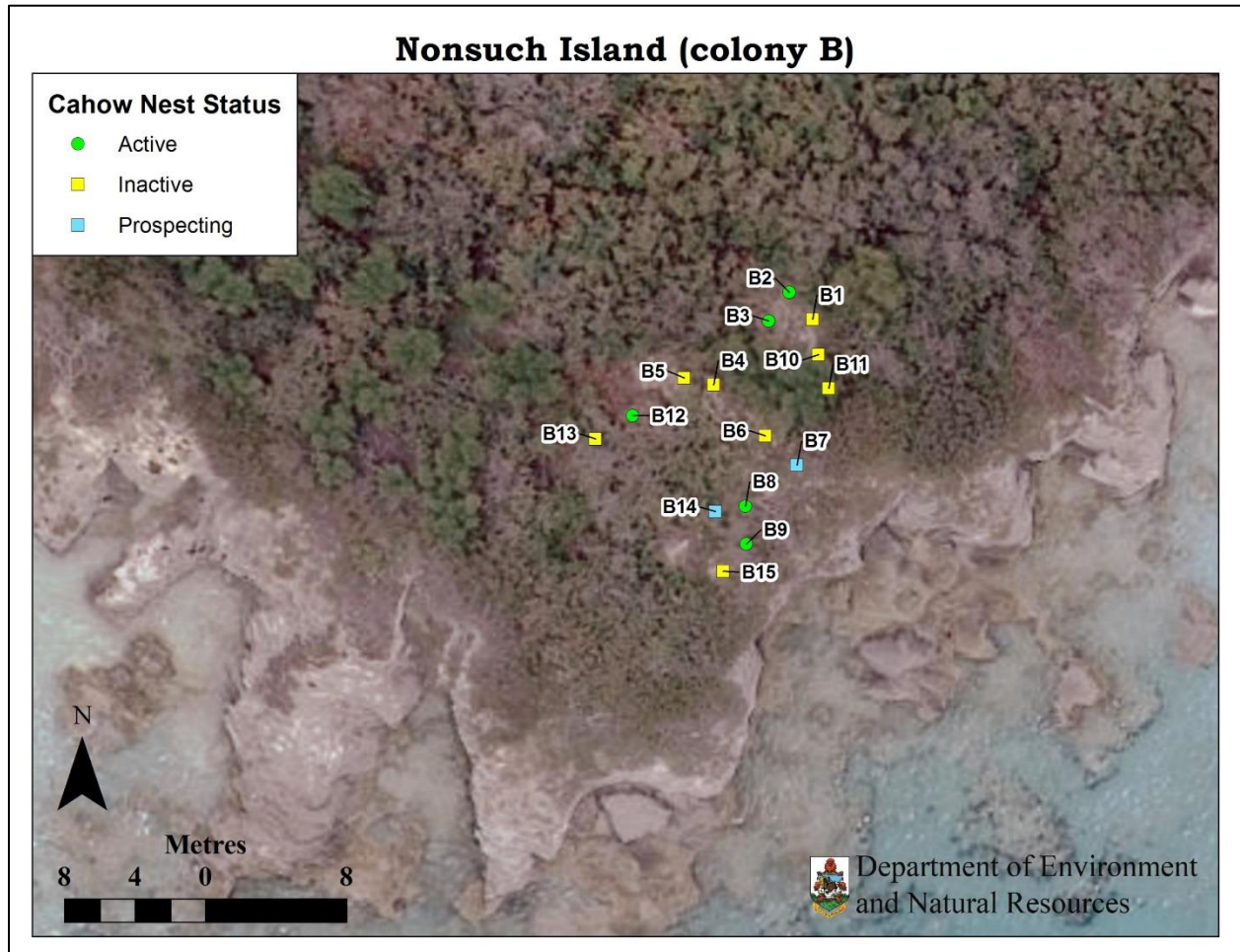
**Table 1:** Total numbers of breeding pairs & fledged chicks at translocation colonies on Nonsuch.

**Table 2:** Table showing the annual breeding success of all active Cahow nest burrows at the Nonsuch “A” and “B” nesting colonies from 2009, when the first pair of translocated birds returned to breed successfully, to 2019, when the number of breeding pairs increased to 21.

<b>NONSUCH ISLAND</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>	<b>2014</b>	<b>2015</b>	<b>2016</b>	<b>2017</b>	<b>2018</b>	<b>2019</b>
<b>Nest No. “A” colony</b>	<b>Breeding Success (Chick fledged = 1, failed = 0)</b>										
<b>R816</b>			<b>0</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>0</b>	<b>1</b>	<b>0</b>
<b>R817</b>			<b>1</b>	<b>1</b>	<b>0</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>1</b>	<b>0</b>
<b>R818</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>0</b>	<b>1</b>	<b>1</b>	<b>0</b>	<b>1</b>	<b>1</b>	<b>1</b>
<b>R819</b>						<b>1</b>	<b>1</b>	<b>1</b>	<b>0</b>	<b>1</b>	<b>1</b>
<b>R820</b>					<b>0</b>	<b>0</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>
<b>R821</b>							<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>
<b>R822</b>											<b>0</b>
<b>R830</b>				<b>1</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>0</b>	<b>1</b>	<b>1</b>
<b>R831</b>		<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>0</b>
<b>R832</b>		<b>0</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>0</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>
<b>R833</b>				<b>0</b>	<b>0</b>	<b>1</b>	<b>0</b>	<b>1</b>	<b>0</b>	<b>1</b>	<b>0</b>
<b>R834</b>		<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
<b>R835</b>					<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>0</b>	<b>1</b>
<b>R836</b>				<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>
<b>R837</b>			<b>1</b>	<b>1</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>1</b>
<b>R838</b>								<b>0</b>	<b>0</b>	<b>1</b>	<b>0</b>
<b>R839</b>										<b>0</b>	<b>1</b>
<b>“B” Cahow Breeding Colony Nests</b>											
<b>B2</b>											<b>0</b>
<b>B8</b>											<b>1</b>
<b>B9</b>										<b>0</b>	<b>1</b>
<b>B12</b>										<b>0</b>	<b>0</b>
<b>Total no. of chicks/year</b>	<b>1</b>	<b>1</b>	<b>4</b>	<b>7</b>	<b>5</b>	<b>9</b>	<b>9</b>	<b>10</b>	<b>8</b>	<b>13</b>	<b>12</b>

## SECTION 3 (b): Results and Update of 2<sup>nd</sup> Nonsuch Translocation Project

---



**Fig. 11: Location and status of Cahow nest burrows at “B” translocation colony on Nonsuch Island**

Following the success of the first translocation project, a **second translocation project** was carried out, **for the purpose of establishing a second (B) nesting colony site** at a different location on Nonsuch. This would ensure that the Cahow would have two separate footholds on this much larger island, which offers improved nesting habitat and safety from hurricane erosion and flooding. To accomplish this, a new complex of artificial nest burrows was constructed in 2012 – 2013 about 250 meters to the east of the original colony site. A total of 70 fledgling Cahows were moved over a 5-year period from nest burrows on all four of the original nesting islets to these new burrows, where they were fed and monitored daily until they fledged out to sea. This was done so they could imprint on the new site, returning when mature to choose their own nest burrows. The new burrow complex is located on top of a promontory formed by the south hill of Nonsuch and is situated at 35’ to 45’ above sea level, beyond the reach of hurricane waves and storm surge and future sea-level rise.

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 new Cahow nest burrows at the “B” translocation site. Additional nest burrows have since been constructed at this site by the terrestrial conservation crew and conservation officer. Both the traditional concrete artificial burrows and a new design of plastic burrows installed at this site have been readily accepted by the translocated chicks.

Out of the 70 Cahow chicks translocated to the “B” site over the 5-year translocation period, a total of 64 chicks fledged successfully out to sea, representing a 91.43 % success rate. Six of the chicks did not fledge successfully, due to the following reasons:

- 1 chick died just before fledging after its nest burrow was colonized by a wild swarm of European Honeybees (*Apis meliifolia*) which stung the chick to death;
- 2 chicks died from eating food that had spoiled due to the freezer being opened repeatedly by a work crew installing a new solar panel array on the island;
- 3 chicks died from undetermined gastric problems, rejecting or regurgitating all food fed to them.

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 in 2013 and 2017 consisted primarily of oil-rich and highly nutritious Anchovy *Sardinella anchovia*. The availability of Anchovies during those years made it unnecessary to include imported unfrozen squid, simplifying feeding and saving money. However, in 2014, 2015 and 2016, Anchovies were generally unavailable locally, making it necessary to use Threadfin Herring or Pilchards, which have a lower nutritional value. During these years, imported squid and supplemental vitamins were included to ensure that translocated chicks were receiving the necessary nutrition.

All Anchovies, Herrings and Pilchards used in the 2013-2017 translocation were netted locally and provided by Mr. Chris Flook, who had also provided fish for the original translocation project from 2004 to 2008. His contribution has been instrumental in the success of these two projects.

**In 2017, the first of the translocated Cahow chicks from the 2<sup>nd</sup> translocation project had begun to return as adults;** during the 2017/2018 breeding season, **2 new breeding pairs produced the first eggs recorded at this new colony site.** Although both eggs failed, this was a major milestone in the establishment of the 2<sup>nd</sup> Nonsuch colony. Another returned Cahow was recorded prospecting in a new nest at the (A) Nonsuch colony, and yet another was found in a nest burrow on Horn Rock.

During the 2018/2019 breeding season, a total of 6 Cahows translocated to the “B” site as chicks were recorded returning as adults, 4 at the B site, 1 at a nest in the “A” site, and 1 on other nesting islet. Four breeding pairs produced eggs at the “B” site, **two of which (in the B8 and B9 nest burrows) produced the first successfully fledging chicks at this new translocation nesting colony.**

### **SECTION 3 (c): Cahow Recovery Program – Public Outreach/Education:**

---

**One of the primary objectives of the Cahow recovery Program has been to increase public outreach and education about Bermuda’s National Bird**, and the broader conservation issues involved in its management. To help achieve this, a partnership was formed with Mr. J.P. Rouja of Look TV, who, funded by the Ascendant Group of Companies, developed an infrared “night vision” video camera. This was installed in a modified Cahow burrow, to provide video footage of the breeding activities of adult Cahows and the development of the single chick. This footage was available on-line mainly to local viewers.

This system was used successfully from 2013 – 2016, but the view from directly overhead was not ideal, and there was a need to use a higher-quality camera with better distribution to international viewers. Accordingly, a new partnership was formed with the **Cornell Lab of Ornithology Bird Cams project**, with project manager Charles Eldermire visiting Bermuda in 2016 to help set up the new camera and work out the details of the live-streaming system.



**Fig. 12: Downy Cahow chick being preened by adult, viewed by infrared “CahowCam”**

A new video camera, fitted with military-grade infrared lights that are completely undetectable by humans or animals, was installed for 2018, which gives an improved vantage point to see the nesting Cahows (see Fig. 12). This camera then live-streams video to the internet through the Cornell network, where it is seen by viewers in over 100 countries. This new partnership between the Bermuda Department of Environment and Natural Resources, the Cornell lab of Ornithology and Nonsuch Expeditions has contributed greatly to the objective of increasing public outreach and education, resulting in 600,000 views for a total of 8.5 million minutes of video being viewed by scientists, students and followers from around the world, through the website [www.nonsuchexpeditions.com](http://www.nonsuchexpeditions.com).

For the 2018-2019 breeding season, a second infrared video camera was set up in a second nesting burrow on Nonsuch Island, and connected to the “CahowCam” network. This was done to provide an alternative in case one of the burrows suffered nesting failure, and study any differences between nesting pairs in adult courtship, egg incubation and chick rearing behavior. The installation of this second camera proved fortuitous, as the egg failed to hatch in the CahowCam 1 (R831) nest, while the new, CahowCam 2 (R832) nest cam was able to follow the hatching, growth and eventual successful fledging to sea of the chick in that nest.

For two consecutive years in 2016 and 2017, a **Leach’s Storm-petrel** (*Oceanodroma leucorhoa*) prospected in the Nonsuch Island R831 nest burrow that the CahowCam was installed in, shortly after the Cahow chicks departed. This small seabird, although common offshore during the winter and spring months, had never been recorded on land before 2016 on Bermuda. In 2019, this bird again returned, this time to the adjacent R832 nest, returning nightly to share the nest with the growing Cahow chick, which weighed almost 10 times as much as the Storm-petrel. Neither the adult Cahow nor the chick seemed unduly concerned with the presence of the Storm-petrel, with the chick fledging normally after nearly three weeks of this unusual co-habitation.

The infrared CahowCams have proven to be a valuable asset for the Recovery Program, revealing previously unknown behavior and enabling the public to follow the development and behavior of the chick and adult Cahows, revealing the private life of Bermuda’s critically endangered National Bird to an international audience. It has promoted and used the concept of “citizen science”, where members of the public provide 24-hour viewing coverage (which is impossible for the project researchers to maintain!), leading to a number of valuable observations which would otherwise have been missed. In addition, the new partnership with the Cornell Lab of Ornithology is proving to be successful in highlighting the management efforts of the Bermuda Dept. of Environment and natural resources.

Other public outreach efforts relating to the Cahow Recovery Project have included guided tours and “Cahow encounters” at Nonsuch, in addition to PowerPoint presentations at schools (see Figs. 8 & 9) and the Bermuda Zoological Society’s Natural History Course. Warwick Academy and Saltus Cavendish School included the Cahow in their curriculum, with the latter again giving a very generous donation to the Recovery Project. A total of 21 tour groups, mostly from local middle and secondary schools and the Bermuda College, and totaling 334 people, were allowed



to see Cahows at close range on Nonsuch Island being assessed, measured and banded as part of the research program (see Fig. 11).



**Fig. 13: Cahow Chick health check with school tour group on Nonsuch island, June 2019**

## **Section 4 (a): 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 the continuation of projects and management work already underway, or that are newly proposed for the next two nesting seasons:

### **2019 – 2020 Breeding Season:**

- Continue banding program for adult and fledgling Cahows;
- Continue monitoring of nesting islands for the presence of rats; set out rodenticides when necessary;

- Continue to monitor for the return of translocated birds as adults to the two translocation colony sites on Nonsuch Island as well as all other nesting islands;
- Continue installation of additional artificial nest burrows at nesting colonies, including at the new colony on Southampton Island;
- Continue to work with international partners to deploy extremely accurate GPS loggers on Cahows to more accurately determine oceanic range and important foraging areas for the species. Engage with international partners to carry out this project and analyze data and findings.
- Engage with international partners to take & analyze blood and feather samples from adult breeding Cahows of varying ages to investigate bioaccumulation of man-made and natural chemicals and toxins, genetic and DNA variability and relationship of the Cahow to other North Atlantic Gadfly petrels, isotope analysis to look at prey items and tropic levels the birds are taking food from, etc.

#### **2020 – 2021 Breeding Season:**

- Switch from active translocation of chicks to monitoring of burrows for the return of birds at the two translocation colony sites;
- Continue monitoring, baiting and trapping program for continuing eradication of rats from Nonsuch and all nesting and adjacent islands in the Castle Harbour Reserve;
- 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;
- Working with international partners, to continue the deployment of extremely accurate GPS loggers on selected adult and fledgling Cahows, to determine major oceanic foraging areas and range.
- Again working with international partners, to continue to collect blood, feather and eggshell samples for analysis for Persistent Organic Pollutants and genetic factors etc.

## 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 2018 – 2019 breeding season:

Mr. Peter Drew, Conservation Officer, and Bermuda Biodiversity Officer Alison Copeland (Dept. of Conservation Services) as well as Camilla Stringer of the Bermuda Zoological Society Carla Marquardt and Lizzy Madeiros, for assistance in monitoring checks and feeding of translocated Cahow chicks; Ms. Mandy Shailer (GPS coordinator, Dept. of Conservation Services), who compiled maps of nesting islands and nest sites, Lynn Thorne, who provided electrolytes and equipment for rehabilitation of abandoned Cahow chicks, and Chris Flook, who agreed to once again provide fresh Anchovies for abandoned Cahow chicks. Also instrumental in furthering the project's objectives of public outreach & education are JP Rouja of Nonsuch expeditions, designer/installer of the infrared "Cahow burrow-cam," and Charles Eldermire, manager of the Cornell Bird Lab web cam project, to enable unobtrusive study of the behavior of the birds inside nest burrows and live-streaming video to schools and the general public.

The photos in this report were used with the kind permission of Kate Sutherland, J.P. Rouja, David Liittschwager, Letizia Campioni, Leila Madeiros Monica Silva and Camilla Stringer.

As always, I am deeply thankful to the Terrestrial Conservation Crew for their hard work in building concrete nest burrows and assistance in managing nesting habitat for the Cahows on both Nonsuch Island and the original nesting islets. The Crew consists of Kiwon Furbert (Foreman), Llewellyn Rewan, and Marvin Jones. Also, to recently retired foreman Barry Smith, who carried out much hard work on the project over a period of more than 20 years.

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 understanding of the oceanic range of the Cahow were purchased entirely through public donations, notably by Saltus Cavendish School and Paget Primary School. Mr. Robert (Bob) Flood of Scilly Pelagics, who is producing a series of multimedia seabird identification books in which the Cahow was prominently featured, and who also brings specialized birding groups to Bermuda specifically to see the Cahow, has also been an important supporter of the project. Special thanks also go out to the Ascendant Group of Companies, who have provided volunteers to construct new Cahow nest burrows and donated a new Boston Whaler boat and solar power system for the Cahow Recovery Project. We are deeply grateful for the interest and generosity shown by these and other essential donors.

Finally, I would like to thank Leila Madeiros and our children Seth and Elizabeth, whose support have made it possible for me to carry out this demanding project over the last 19 years.

Jeremy Madeiros,  
Senior Terrestrial Conservation Officer  
Dept. of Environment and Natural Resources

## 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](http://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., 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. & Wurster, C.F., DDT residues and declining reproduction in the Bermuda petrel, 1968.** *Science* 159 (3818): 979 – 981.

**Wingate, D. B. *Excluding Competitors from Bermuda petrel Nesting Burrows.* 1978. *Endangered Birds: Management Techniques for Preserving Threatened Species.*** The University of Wisconsin Press.

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

**Wingate, D.B., Hass, T., Brinkley, E. S., Patteson, J.B. *Identification of Bermuda petrel.* 1998. *Birding* 30 (1): 19-36. (BAMZ # 557)**