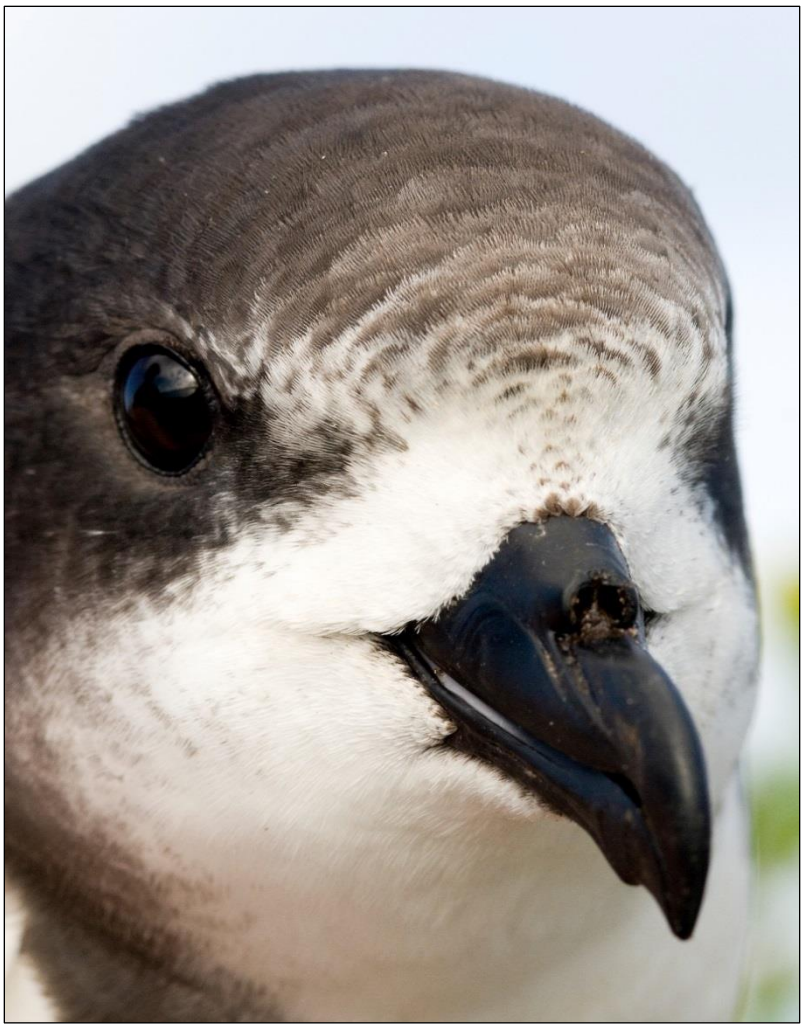
# CAHOW RECOVERY PROGRAM

## For Bermuda's Endangered National Bird

## 2019 – 2020 Breeding Season Report



## BERMUDA GOVERNMENT

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**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 2019 to June 2020)
## Of Bermuda's Endangered National Bird


Fig. 1: Nonsuch Island and other Cahow nesting islands, Castle Harbour, Bermuda (photo by Patrick Singleton)

Cover Photo: Close-up of adult Cahow from Horn Rock C8 nest burrow (Chris Burville)

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- Cover photo: Chris Burville; Fig. 1: Patrick Singleton; Figs 2,7 & 8: Mandy Shailer; Fig. 3: Leila Madeiros; Figs. 4, 5, 9 & 10: JP Rouja; Fig. 6: Letizia Campioni; Fig. 7: Monica Silva.

# SECTION 1:
# 1(a): EXECUTIVE SUMMARY:

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

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The Cahow Recovery Program is a long-term management, research and recovery program for Bermuda's National Bird, the 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 Principle Scientist – Terrestrial Conservation Division, 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 was originally administered by Dr. David Wingate between 1960 and 2000. It has been successful in addressing most of the threats affecting the Cahow on the breeding islands on Bermuda, enabling the breeding population to increase from only 18 pairs producing a total of 7 to 8 chicks annually in the early 1960s to a record number of 135 breeding pairs in 2020, producing a total of 69 successfully fledged chicks (see Fig. 3).

The Cahow continues to face a number of threats, which 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 2020 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 5 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 five, of which two produced successfully fledging chicks. This is only the second year that chicks have been produced at this new site. A total of 64 Cahow chicks were moved to, and fledged successfully from this site between 2013 and 2017.

- **The second field season of a 2-year collaborative research project with international partners was partly carried out, although the second tag deployment was cancelled due to the Covid-19 pandemic.** Between Jan 22nd and Feb 13th , 2020, 24 GPS tags were attached to breeding adult Cahows during the egg incubation period, to investigate the oceanic movements and foraging areas of the adult birds during these periods. In addition, blood and feather samples were taken from 37 adult Cahows, to investigate toxicology, stable isotope analysis and sexing.

- **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 through **a new partnership with the Cornell Bird Lab.** This included the installation of new cameras which give improved 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 2020, chicks hatched and fledged successfully at both nests fitted with burrow-cams**, 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**

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The Cahow Recovery Program continues to meet both its primary objective of helping the Cahow breeding population to recover from near-extinction, and its secondary objectives of establishing new nesting colonies and increasing public outreach and education. This has only been possible due to regular monitoring and management of the entire breeding population and their nesting habitat. This has proven vital for the identification and control of potential threats to the Cahow as they arise.

Full details on the 2019 to 2020 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 2019-2020 Cahow nesting season:

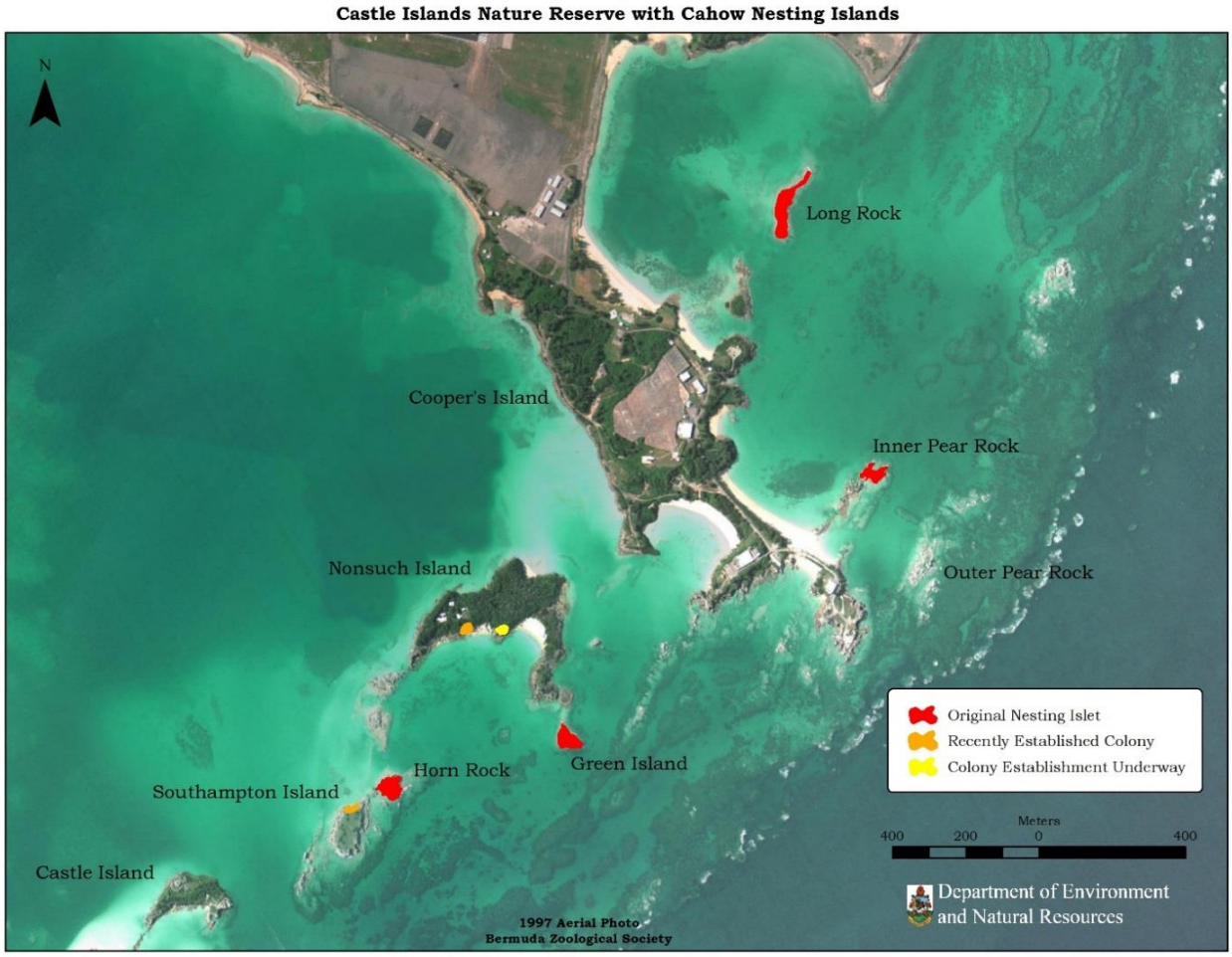


**Fig. 2: Castle Harbour Islands Nature Reserve with Cahow nesting islands and colony sites**

Following is a review of the events and management / research work carried out for the 2019-2020 Cahow breeding season:

(1) The breeding season began with repair work following the impact of Hurricane "Humberto" on September 16, 2019, which passed 70 miles north of Bermuda as a strong Category 3 storm. Winds gusted from 116mph to 130 mph in exposed areas, but damage at the exposed Cahow nesting islands was less than expected due to the hurricane passing to the north side of the island at low tide, which diminished the height of the storm surge.

(2) The first Cahows were recorded returning from the open ocean to their nesting burrows by the 20th October 2019, with all back by the second week of November. During late October and November 2019, 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 early January 2020, with the first eggs confirmed on the 8th 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 carried out by Carla Marquardt to identify fertile eggs and follow embryo development.

(4) Researchers Letizia Campioni, from Italy, and Maria Silva (U.K. Birdlife International) travelled to Bermuda from 22nd Jan to 13th Feb for the beginning of the 2nd year of the 3-year research program for the Cahow, combining tagging of birds with archival GPS tags to investigate at-sea movements of the birds during the egg incubation stage, and the collection of blood and feather samples from Cahow to investigate toxicology, sex through DNA analysis, and investigation of Tropic levels.

(5) The first Cahow chick hatched by the 22nd 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.

(6) The rapid spread of the Covid-19 virus into a world-wide pandemic, resulting in country-wide lockdowns and suspension of air and sea travel, prevented researcher Letizia Campioni from travelling to Bermuda for the second field period in March/April. The Terrestrial Conservation Officer recovered all deployed GLS tags and sent the data via internet to Letizia, enabling all collected data to be processed.

(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 2019-2020 Cahow nesting season, a total of 50 chicks were fitted with identification bands, out of a total of 69 chicks which successfully fledged (72.5 % of all chicks).

(8) The total number of active nesting pairs of Cahows increased to a record high of 135 pairs during the 2019/2020 nesting season, compared to 55 pairs in 2000/2001. A total of 69 chicks successfully fledged from all nesting islands, compared to the previous record of 73 chicks fledged during 2019 (**See Fig. 3**).

(9) The new nesting colonies on Nonsuch Island, established by the translocation of near-fledged chicks and sound attraction techniques between 2004 and 2017, have continued to grow. For the 2019-2020 breeding season, 19 nesting pairs laid eggs at the original "A" colony, with 5 more pairs at the second, "B" colony; from these, a total of 11 chicks hatched (**See Tables 1 & 2**), 10 of which fledged successfully to sea, while 5 new pairs of prospecting Cahows are establishing in burrows at both colonies **(See section 3(a)** for full details).

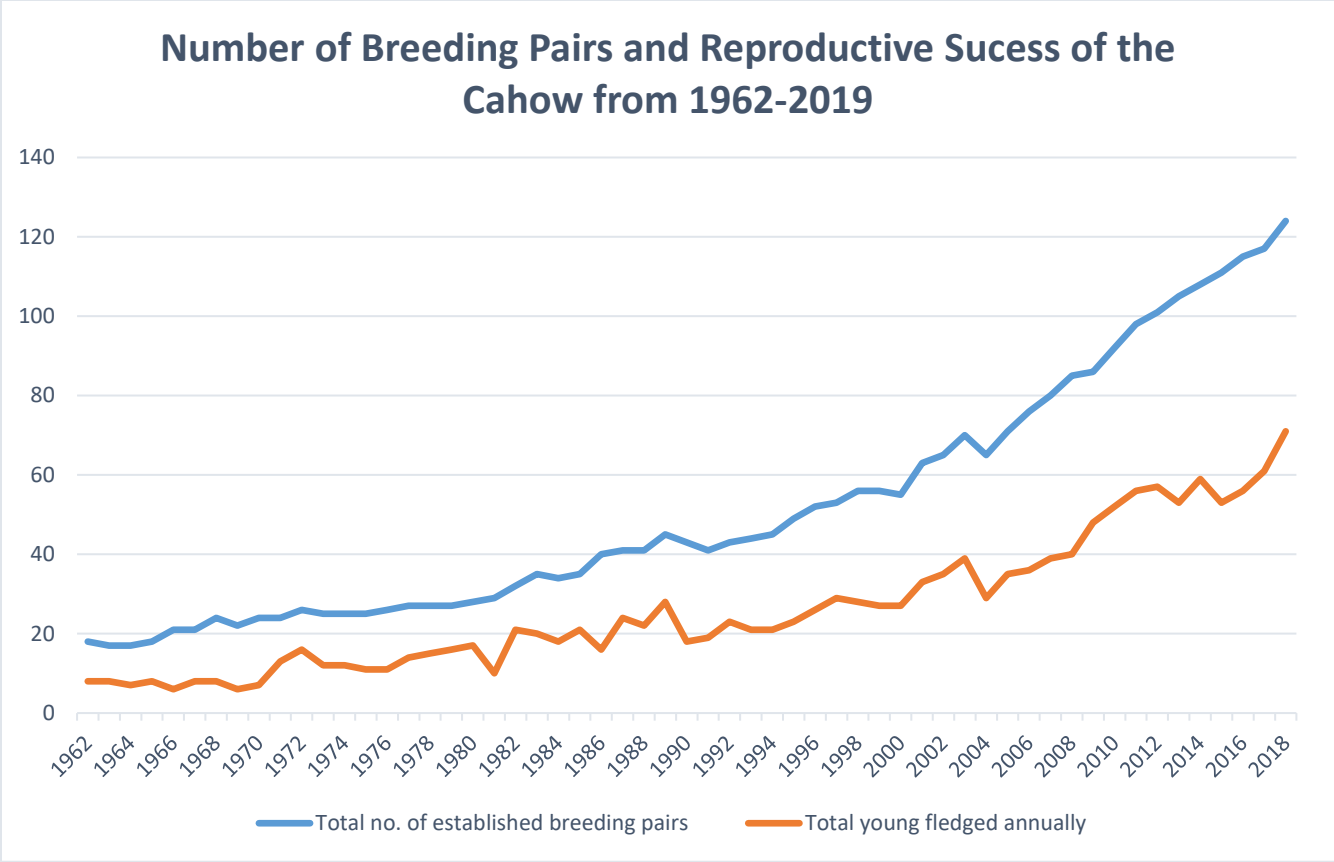


**Fig. 3:** No. of breeding pairs and fledged young of Cahow over 56-year period (Leila Madeiros)

The 2019/2020 nesting season also reached an important milestone concerning the new Cahow nesting colonies on Nonsuch Island:

As of this year, the breeding colonies on Nonsuch Island have produced a total of 89 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. The new colony can then be considered to be self-sustaining at this point.

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).

By the 2019/2020 season, the number of confirmed returning Cahows that had originally hatched and fledged from Nonsuch increased to 13, including 9 recorded in new nests on Nonsuch, and 4 in nests on other islands (Green Island # 12, Horn Rock F6, and Long Rock D9 and D10 nests). Of these, three pairs on Nonsuch (in the R822, R838 and R839 nests) have so far produced successfully fledging chicks, fulfilling the final criteria needed for the establishment of a new, self-sustaining nesting colony.

## SECTION 2 (b):
## Overall summary of 2019 / 2020 Cahow nesting season:

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During the 2019-2020 Cahow nesting season, the Cahow population has increased to a new record high number of 135 breeding pairs, of which 69 produced successfully fledging chicks. This represents a breeding success rate of 51.1%, compared to 55.7% recorded in the 2018-2019 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 2019-2020 nesting season results:

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Total number of nest burrows with confirmed nesting activity: ..... 135*

Number of new nest sites with prospecting activity: ..... 9

Total number of confirmed successfully fledged chicks: ..... 69

Total number of active nest sites with unsuccessful nesting: ..... 66

Number of failures from nest sites with observable nest chambers: ..... 50

Number of failures from nest sites with non-observable nest chambers: ..... 16

* 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 disappearance 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. 2020

Two collaborative research projects were undertaken by the Terrestrial Conservation Division of the Dept. of Environment and Natural Resources, with international partners over the last two years (2019 – 2020). In this partnership, the Government Principle Terrestrial Conservation Officer worked with two separate overseas 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.

**Year 1: 2019 Breeding Season Research Work**

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. 4), 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


**Fig. 5:** M. Silva and L. Campioni collecting blood samples from leg of Cahow, Jan/Feb 2020

weeks at a time and do not process or calculate location in real-time; instead, the units record the 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 the units are even lighter (and much 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.

All deployed tags were eventually recovered from the birds, with locational data recovered during "off-shift" feeding trips by adult Cahows and during provisioning trips out to sea to gather food for the growing chicks. 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 was translocated as a chick in 2005, returning to Nonsuch to breed by 2008.

The use of molecular tools was carried out by researcher Monica Silva 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 mesopelagic fish species were identified from this regurgitant: 1) Argyropelecus aculeatos, and 2) Diaphus metopoclampus. This is the first time that specific prey species in the diet of Cahows have been positively identified.

In addition, Monica and Letizia collected 67 blood samples and 57 feather samples from adult Cahows (see Fig. 5) 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:

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1. To identify the trophic niche of adult Cahows during the breeding season, by Stable Isotope Analysis of the blood and feathers;
1) 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.);
2) 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).
3) To positively sex adult Cahows using sex chromosomes in blood samples (see Fig. 7).

Some of this analytical work was carried out by students at the University of Lisbon, Portugal. 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.

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 both visited Bermuda in April 2019, staying on Nonsuch Island while they deployed 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, and 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 accurate locational data from chick feeding trips being received from 5 of them.

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 not only to the endangered Cahow, but also to vast numbers of seabirds, from the entire Atlantic Basin, that regularly use this area as important foraging habitat.

These projects provide the data necessary for possible inclusion of the Cahow on the Canadian Endangered Species List, which will be essential for mitigating possible impacts to the species in Canadian waters.

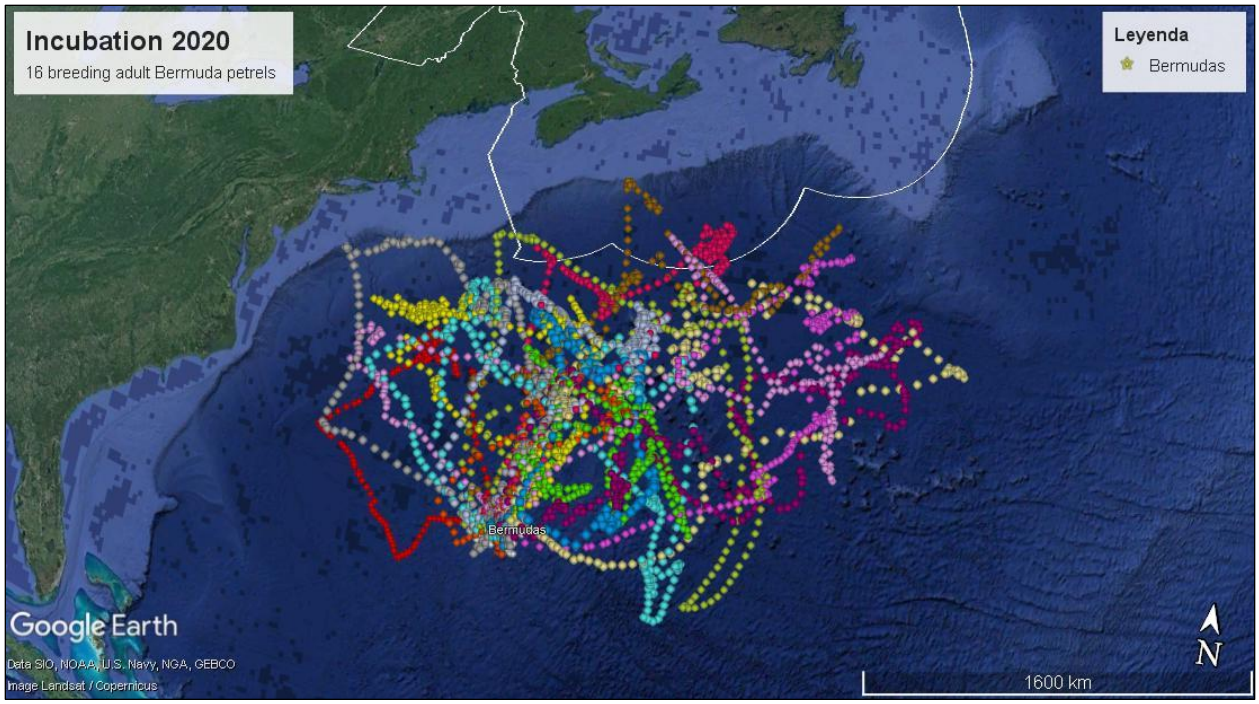


**Fig. 6: Map from recovered GPS tags showing foraging trips during egg incubation (Jan – Feb 2020) by "off-duty" Cahows**

**Year 2: Cahow Breeding Season Research Work**

For the second season of this project, Letizia Campioni returned with Maria Diaz between January 22nd and February 13th 2020 to continue work started out during last year's breeding season. During this period, the Terrestrial Conservation Officer assisted them in fitting a total of 26 GPS tags to the tail feathers of incubating adult Cahows (see Fig. 6), on four of the nesting islands, as follows:

NONSUCH ISLAND: ..... 6 adult Cahows fitted with GPS Tags

LONG ROCK: ..... 4 adult Cahows fitted with GPS Tags

GREEN ISLAND: ..... 5 adult Cahows fitted with GPS Tags

HORN ROCK: ..... 11 adult Cahows fitted with GPS Tags

Eventually all GPS tags were recovered from the birds after deployment periods ranging from 10 days to 25 days, with 18 of the tags being recovered by Letizia Campioni and Maria Diaz before they departed Bermuda on 13th February. The remaining 8 tags were recovered by the Senior Terrestrial Conservation Officer by the 25th February. In the latter case, the tags were delivered to J.P. Rouja. Who downloaded the information collected by the tags and sent it on to Letizia Campioni. The data downloaded from these tags showed that the tagged Cahows foraged generally closer to Bermuda during the egg incubation stage in 2020 than was the case in the 2019 nesting season (see Fig. 6).

**TABLE 1: Adult Cahows fitted with GPS Tags in Jan/Feb 2020 showing dates that tags were attached & retrieved, Nesting Island, nest no. and identity & sex of birds**

| Date Tagged | Nesting Island | Nest No. | Bird Band No. | Sex | Date Tag Removed |
|---|---|---|---|---|---|
| | | | | | |
| 25/Jan/2020 | NONSUCH IS. | R816 | E0214 | M | 04/Feb/2020 |
| 25/Jan/2020 | NONSUCH IS. | R819 | E0368 | M | 11/Feb/2020 |
| 25/Jan/2020 | NONSUCH IS. | R833 | E0215 | F | 17/Feb/2020 |
| 25/Jan/2020 | NONSUCH IS. | R835 | E0220 | M | 04/Feb/2020 |
| 25/Jan/2020 | NONSUCH IS. | R837 | E0454 | M | |
| 26/Jan/2020 | LONG ROCK | D2 | E0170 | M | 10/Feb/2020 |
| 26/Jan/2020 | LONG ROCK | D4 | E0230 | F | 10/Feb/2020 |
| 26/Jan/2020 | LONG ROCK | D7 | C1033 | M | 10/Feb/2020 |
| 26/Jan/2020 | LONG ROCK | D8 | E0026 | M | 10/Feb/2020 |
| 30/Jan/2020 | GREEN IS. | # 3 | E0352 | F | 13/Feb/2020 |
| 30/Jan/2020 | GREEN IS. | # 3/4 | E0076 | F | 13/Feb/2020 |
| 30/Jan/2020 | GREEN IS. | # 5 | E0103 | M | 18/Feb/2020 |
| 30/Jan/2020 | GREEN IS. | # 12 | E0226 | M | |
| 30/Jan/2020 | GREEN IS. | # 13 | E0141 | F | 11/Feb/2020 |
| 30/Jan/2020 | GREEN IS. | # 15 | E0311 | F | 13/Feb/2020 |
| 31/Jan/2020 | HORN ROCK | F3 | C1038 | F | 25/Feb/2020 |
| 31/Jan/2020 | HORN ROCK | F6 | E0178 | F | 13/Feb/2020 |
| 31/Jan/2020 | HORN ROCK | F8 | E0407 | F | 18/Feb/2020 |
| 31/Jan/2020 | HORN ROCK | G3 | E0021 | M | 06/Feb/2020 |
| 31/Jan/2020 | HORN ROCK | C4 | E0489 | M | 13/Feb/2020 |
| 31/Jan/2020 | HORN ROCK | C6 | E0151 | F | 13/Feb/2020 |
| 31/Jan/2020 | HORN ROCK | C8 | E0228 | M | 13/Feb/2020 |
| 31/Jan/2020 | HORN ROCK | C13 | E0175 | F | 13/Feb/2020 |
| 31/Jan/2020 | HORN ROCK | C15 | E0035 | F | 13/Feb/2020 |
| 31/Jan/2020 | HORN ROCK | C28 | E0053 | F | 25/Feb/2020 |
| 31/Jan/2020 | HORN ROCK | C30 | E0265 | F | 25/Feb/2020 |
| 05/Feb/2020 | NONSUCH IS. | B9 | E0552 | F | 25/Feb/2020 |

In addition to the deployment of GPS tags during the 2019-2020 nesting season, a total of 38 additional blood and feather samples were collected from breeding adult Cahows, 18 from male birds, and 20 from female birds. In addition, several eggshells from failed or hatched eggs were also collected. These samples were taken back to Monica Silva in Portugal to be analyzed for persistent organic pollutants, sex chromosomes, genealogy etc.

Some of the Bioanalysis and DNA sequencing work was carried out by students at the University of Lisbon, while more was carried out by the Biosciences Laboratory (Dept. of Biology) at Queen's University, Kingston, Ontario; to check the genetic variation of the Cahow given its demographic history, and look at levels of inbreeding, and possible relation with egg infertility,

## 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 2019/2020 nesting season. Out of all nesting islets, Long Rock had the highest breeding success rate at 78.6%. Nonsuch Island, which normally enjoys the highest breeding success, had a relatively bad year at only 41.6% breeding success. Inner Pear Rock also had a low breeding success rate of 42.8%. Green Island, Horn Rock and Southampton Island all had average breeding success rates of 52.2%, 51.06% and 50% respectively.

### LONG ROCK: (78.6 % 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 w/successfully fledged chicks (# 12; B; C; D1; D2; D3; D4; D7; D8; D9; E1): ..11
Nest burrows with confirmed failed nesting: ..... 5
(A – cause unknown; D5 - egg disappeared – Egg destroyed in fight with prospecting Cahow; E4 – egg infertile.

### INNER PEAR ROCK: (42.8 % breeding success)

Active nest burrows with nesting confirmed: ……..... 21
New nest burrows prospected by confirmed pairs: ……..... 1
Nest burrows with successfully fledged chicks: ……..... 9
(B3, B5, B8, B10; C6, D1, D2, D4, E1)
Nest burrows with confirmed failed nesting: ……..... 12
(A1- Tropicbird nest invasion; B1-unknown causes; B2-whole egg abandoned, infertile?; B4-egg broken; B6-egg infertile/broken; B7-egg broken; B9-embryo died in egg in first 30 days of development; C1-unknown causes; C2- unknown causes; C3-unknown causes; C4-egg broken; D3-egg infertile).

### GREEN ISLAND: (52.2 % breeding success)

Active nest burrows with nesting confirmed: ..... 23
New nest burrow prospected by confirmed pair: ..... 2
Nest burrows with successfully fledged chicks: ..... 12
(A1; D1; F1; F2; # 2; # 5; # 6; # 8; # 12; # 15; # 16; # 17)
Nest burrows with confirmed failed nesting: ..... 11
(F1 – possible Tropicbird nest competition; # 2 – egg broken; # 4 – embryo died in egg at more than 30 days development; # 4/5 - egg infertile; # 5-6 – egg broken; # 9-embryo dies in egg at more than 30 days development; # 10 – egg infertile; # 11 – egg knocked off nest; # 13 – egg infertile; # 14 - egg knocked off nest; # 15-embryo died in early devpt.)

## HORN ROCK: (51.06 % breeding success)

Active nest burrows with nesting confirmed: ……..... 47
New nest burrows prospected by confirmed pairs: ……..... 3
Nest burrows with confirmed successfully fledged chicks: ..... 24
(B5; B6; B7; C5; C7; C13; C17; C18; C19; C20; C21; C25; C29; C30; C31; D1; D4; E1; E3; F3; F6; F7; F8; G3)
Nest burrows with confirmed failed nesting: ……..... 23
(B3-egg buried in nest; B8–unknown causes; C4–chick died in 1st month of devpt.; C6–embryo died in early devpt; C8–embryo died in early devpt; C9–egg infertile; C10–embryo died in late devpt; C11-egg infertile; C12–disruption due to loss of female; C14–egg infertile; C15–chick died hatching; C16– egg broken; C22-egg infertile; C23-newly hatched chick killed by prospecting Cahow; C24-egg infertile; C26-egg broken; C27-egg disappeared; C28–Chick died hatching; D3–unknown causes; E2–Tropicbird disruption; F2–embryo died in earl devpt; F4–egg infertile; F5-egg broken)

## NONSUCH ISLAND: (41.6 % breeding success)

Active nest burrows with nesting confirmed: ..... 24
New nest burrows prospected by confirmed pairs: ..... 6
Nest burrows with confirmed successfully fledged chicks: ..... 10
(R818; R820; R821; R822; R831; R832; R836; R837; B8; B9)
Nest burrows with confirmed failed nesting: ..... 14
(R816–chick died at 2 weeks age; R817- embryo died at 0-30 days in egg; R819-chick died hatching; R823 – egg infertile; R830 – embryo died 30+ days in egg; R833-embryo died 0-30 days in egg; R834 – egg infertile; R835-chick died 2-3 days after hatching; R838-chick died at 3 weeks of age; R839-egg rolled off nest into tunnel; R840-infertile egg; B1-undersize, infertile egg; B2-embryo died at 30+ days devpt; B12-egg broken)

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

## SOUTHAMPTON ISLAND: (50 % breeding success)

Active nest burrows with nesting confirmed: ..... 6
New nest burrows prospected: ..... 1
Nest burrows with successfully fledged chicks: ..... 3
(S1; S3; S6)
Nest burrows with failed nesting: ..... 3
(S2-cause unknown; S4-cause unknown, S5-egg buried by sand collapse)

## * Overall breeding success for entire breeding population: ..... 51.1 %

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

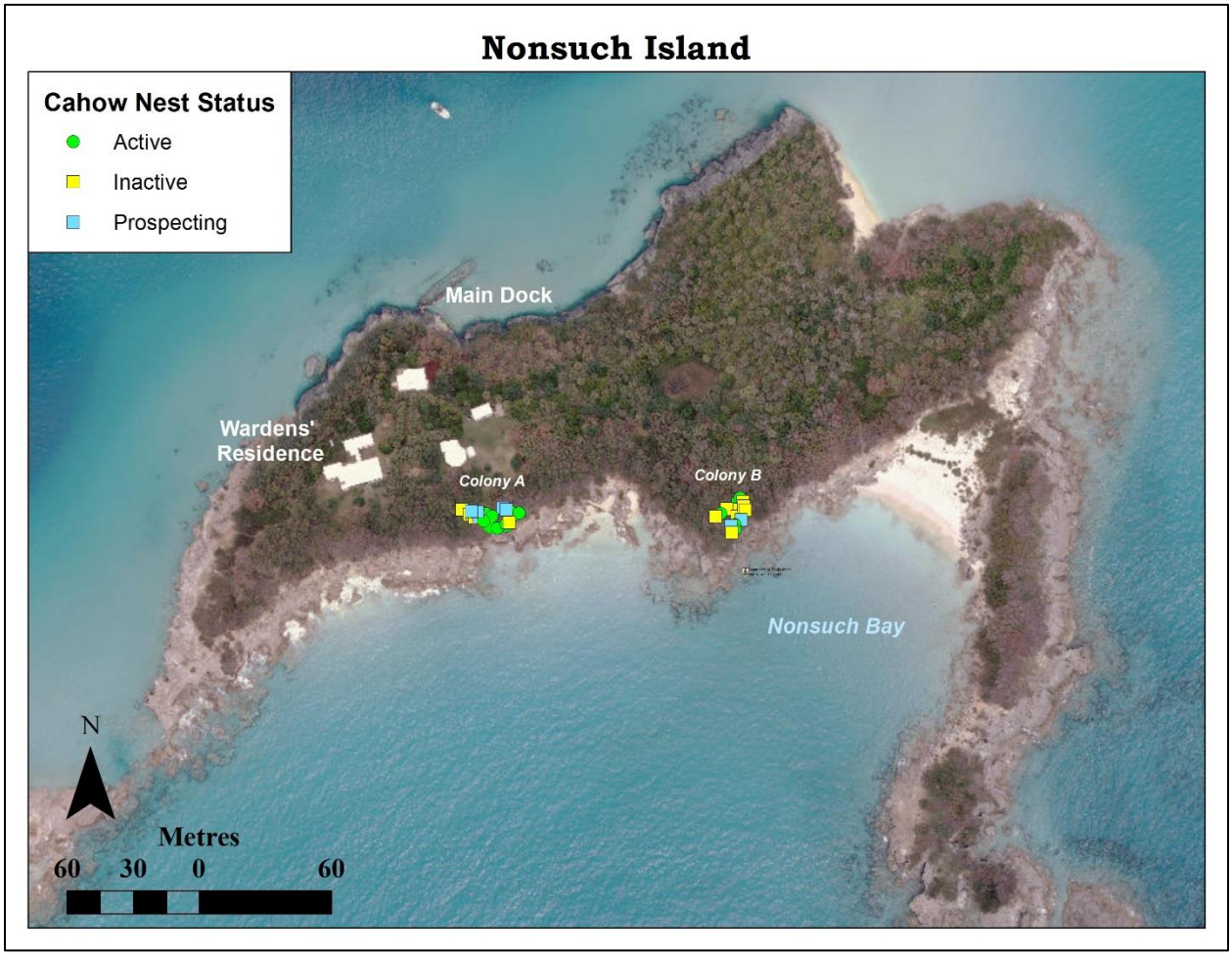


**Fig. 7:** Location of new Cahow nesting colonies on Nonsuch Island in 2020

**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, and safer from ongoing sea-level rise, than the original tiny nesting islets. It has involved moving (translocating) Cahow chicks approximately 18-21days 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 4 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. **By March, 2009, this resulted in the first chick known to have hatched on Nonsuch since the 1620s.**

**Between 2010 and 2020**, the number of established breeding pairs carrying out nesting activity at the new Nonsuch Island "A" nesting colony rose from 4 to 24, 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 (**Madeiros 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 returning Cahow chicks from the first translocation was therefore 49, out of 102 that originally fledged from Nonsuch (representing a 48 % return rate).

**For the most recent 2019/2020 breeding season,** the total number of breeding pairs on Nonsuch was 24, of which 10 produced successfully fledging chicks (41.6 % breeding success). This is down notably on preceding years, such as the 72.2% breeding success achieved in 2018. **The total number of Cahow chicks that have hatched and successfully fledged from the new Nonsuch nesting colonies since 2009 has increased to 89 by 2020** (**See Tables 1 and 2**).

**TABLE 2: Breeding results at new translocation colonies on Nonsuch Island 2008/2009 to 2019/2020 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 | 13 | 9 |
| 2014-2015 | 14 | 9 |
| 2015-2016 | 15 | 10 |
| 2016-2017 | 15 | 8 |
| 2017-2018 | 18 | 13 |
| 2018-2019 | 21 | 12 |
| 2019-2020 | 24 | 10 |

**Table 2: Total annual numbers of breeding pairs & fledged chicks at translocation colonies on Nonsuch Island.**

**Table 3: Table showing annual breeding success of 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 2020, when the number of breeding pairs increased to 24.**

| NONSUCH ISLAND | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| "A" Colony Nest Numbers | (Chick fledged = 1, failed = 0) | | | | | | | | | | | |
| R816 | | | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 |
| R817 | | | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 |
| R818 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 |
| R819 | | | | | | 1 | 1 | 1 | 0 | 1 | 1 | 0 |
| R820 | | | | | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| R821 | | | | | | | 1 | 1 | 1 | 1 | 1 | 1 |
| R822 | | | | | | | | | | | 0 | 1 |
| R823 | | | | | | | | | | | | 0 |
| R830 | | | | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 |
| R831 | | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 |
| R832 | | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| R833 | | | | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 |
| R834 | | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| R835 | | | | | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 |
| R836 | | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| R837 | | | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| R838 | | | | | | | | 0 | 0 | 1 | 0 | 0 |
| R839 | | | | | | | | | | 0 | 1 | 0 |
| R840 | | | | | | | | | | | | 0 |
| "B" Cahow Breeding Colony Nests | | | | | | | | | | | | |
| B1 | | | | | | | | | | | | 0 |
| B2 | | | | | | | | | | | 0 | 0 |
| B8 | | | | | | | | | | | 1 | 1 |
| B9 | | | | | | | | | | 0 | 1 | 1 |
| B12 | | | | | | | | | | 0 | 0 | 0 |
| Total no. of chicks/year | 1 | 1 | 4 | 7 | 5 | 9 | 9 | 10 | 8 | 13 | 12 | 10 |

## SECTION 3 (b):
## Results and Update for 2nd Nonsuch Translocation Project (B Colony)

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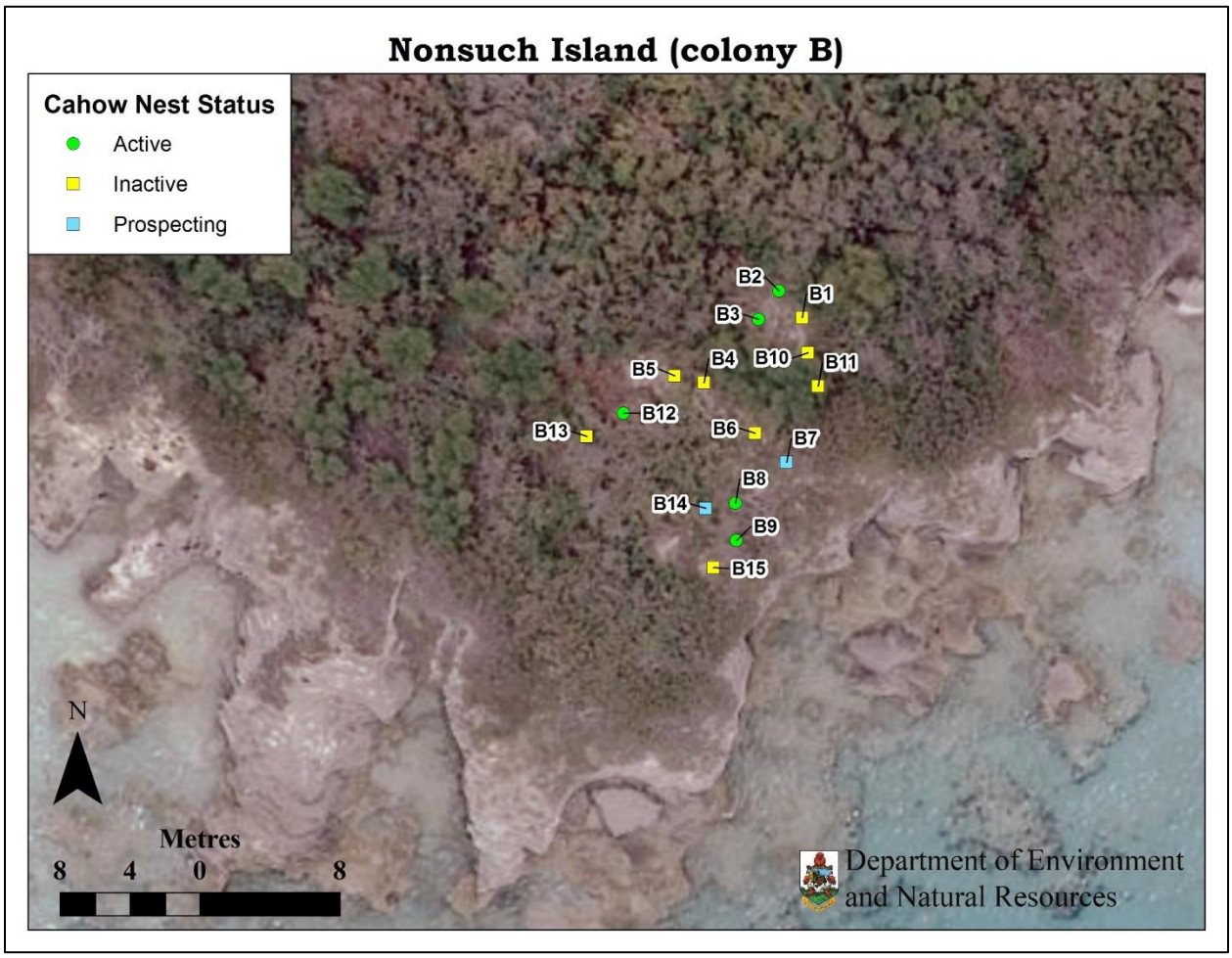


**Fig. 8: Location and status of Cahow nest burrows at "B" translocation colony on Nonsuch Island**

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 predicted 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 meliofolia*) 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 2nd 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 2nd 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 another nesting islet. Four breeding pairs produced eggs at the "B" site, **two of which (in the B8 and B9 nest burrows) produced successfully fledging chicks at this new translocation nesting colony.**

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

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**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. 9: Adult Cahow incubating egg in nest burrow, viewed by infrared "CahowCam"**

A new video camera, fitted with military-grade infrared lights that are completely undetectable by humans or animals, was installed by JP Rouja in 2018, giving an improved vantage point to see the nesting Cahows (see Fig. 9). 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.

For the 2019 breeding season, a second infrared video camera was set up in a 2nd 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 eggs hatched in both nests, enabling the public to follow the hatching, growth and eventual successful fledging to sea of chicks in both nests.

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 both 2019 and 2020, this bird again returned, this time to the adjacent R832 nest, sharing the nest nightly with the growing Cahow chick, which eventually weighed 10 times as much as the Storm-petrel. Neither the adult Cahow nor the chick seemed concerned with the presence of the Storm-petrel, with the chick fledging normally after 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 to an international audience.

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 and the Bermuda Zoological Society's Natural History Course. Warwick Academy and Saltus Cavendish School have included the Cahow in their curriculum, with the latter again giving a very generous donation to the Recovery Project. A total of 20 tour groups, mostly from local middle and secondary schools and the Bermuda College, and totaling 370 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). However, as of April 2020, all tours to Nonsuch Island were discontinued for the rest of the year due to the developing world-wide Covid-19 pandemic, and lockdown measures put in place for some months by the Bermuda Government to contain and reduce the spread of the virus.

The ban of tours to Nonsuch Island has continued through the rest of the year, due to the risk of large groups crowded together onto boats to Nonsuch, and also due to uncertainly whether Covid-19 was transmissible between humans and critically endangered species such as the Cahow.

The Terrestrial Conservation Officer received a special permit from the Government to continue travelling out to the nesting islands to carry out work. Out of an abundance of caution, he underwent frequent Covid-19 testing and practiced basic anti- transmission guidelines (wearing surgical gloves, facial masks, and regularly washing hands, weighing bags and measurement equipment with an antiseptic wash).

**Fig. 10: Cahow Chick health check with school tour group on Nonsuch island.**

As of the production of this report, the Covid-19 pandemic is still considered a Global Health Emergency, and it appears that new variants or strains of the virus are continuing to develop, some of which are spread more easily and are more contagious than the original. Although Research and Management work will continue on Nonsuch and the other nesting Islands, public tours will not be carried out until the situation stabilizes.

Fortunately, the nonsuch expeditions website, with its resources of live-streaming webcams and short videos produced to show monitoring and research work on species which nest on Nonsuch Island, such as the Cahow and the White-tailed Tropicbird, has been able to provide a continuing resource to continue public outreach and education. The value of having such a resource has certainly been highlighted during the ongoing pandemic.

## 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:

**2020 – 2021 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.

**2021 – 2022 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.
- In partnership with international researchers, continue to collect blood, feather and eggshell samples to 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 2019 – 2020 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, egg candling etc.; Lynn Thorne, who provided electrolytes and equipment for rehabilitation of abandoned Cahow chicks, and Chris Flook, who once again provided 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 Tim Smith.

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 and management work carried out by the Cahow Recovery Program has been possible only because of donations by schools, businesses and members of the public. For example, the geolocational loggers which 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 produced 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 20 years.

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

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