CAHOW RECOVERY PROGRAM
For Bermuda's Endangered National Bird
2017 – 2018 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 2017 to June 2018)
Of Bermuda's Endangered National Bird

Fig. 1: 80-day old Cahow (Bermuda petrel) fledgling with remnants of natal down (photo by David Liittschwager)

Cover Photo: drone photo of Green Island (foreground)
And Nonsuch Island in the Castle Islands Nature Reserve,
The sole breeding location of the Cahow (Patrick Singleton)

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- Cover photo and Figs. 17 & 18: Patrick Singleton; Fig. 1: David Liittschwager; Figs 2, 5, 6, 7, 8, 9, 10, 12 & 13: Mandy Shailer; Fig. 3: Carla Marquardt; Fig. 4: Leila Madeiros; Figs. 11 & 14: JP Rouja; Fig. 15: Cynthia Barnes; 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 to the Cahow. This program has enabled the breeding population to increase from only 18 pairs producing a total of 8 chicks annually in the early 1960s to a record number of 124 breeding pairs in 2018, producing a record total of 71 successfully fledged chicks (see Fig. 3).

Major 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 to the islets,
3) insufficient safe nesting habitat and suitable deep nest burrows or rock crevices, and
4) nest-site competition with the Longtail or White-tailed Tropicbird *Phaethon lepturus catsbyii*. **(Madeiros, 2005)**

Following are some of the highlights of the 2018 Cahow nesting season:

- **The "A" nesting colony of Cahows established on Nonsuch Island** by the translocation of chicks between 2004 and 2008 has continued to grow, with 18 pairs now established in nest burrows and laying eggs. In 2018, a record number of 13 chicks hatched, with all successfully fledging out to sea, bringing the total number of chicks produced by this colony since 2009, when the first chick was produced, to 67.

- **The total breeding population of the Cahow has increased to a record number of 124 nesting pairs** (pairs that produced an egg, whether it hatched or not), compared to 117 pairs in the 2016-2017 breeding season.

- **The number of successfully fledging chicks in 2018 increased to a record number of 71,** compared to 61 during the 2017 nesting season. This represents a full recovery from the loss of 5 established breeding pairs and widespread damage to nest burrows during hurricane "Gonzalo" on October 17th, 2014, which contributed to a small drop in the number of fledged chicks for the next 3 years (see Fig. 3).

- **Two breeding pairs colonized nest burrows and laid eggs at the second 'B' translocation colony site,** approximately 200m east of the 'A' colony site. Both male birds in these pairs were translocated to this site in 2013 and 2014. A total of 64 Cahow chicks were moved to and fledged successfully from this site between 2013 and 2017.

- **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 involved the installation of a new infrared camera which gave much better views of the nesting birds, enabling school groups and the public to follow the nesting activity of Cahows in an underground burrow on Nonsuch Island. In 2018, this burrow-cam again provided detailed viewing of the breeding activity of a pair of Cahows, including courtship and mating activities by the adults, and the hatching and development of the chick until it fledged out to sea around June 2nd. This website can be accessed at **www.nonsuchisland.com**

The Cahow Recovery Program has continued to meet both its primary objective of increasing the Cahow breeding population, and secondary objectives of establishing new nesting colonies and increasing public outreach and education. Regular annual monitoring of the entire breeding population has proved to be indispensable for rapid identification and management of ongoing threats to the Cahow as they arise.

Full details on the most recent, 2017 to 2018 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 2017-2018 Cahow breeding season:

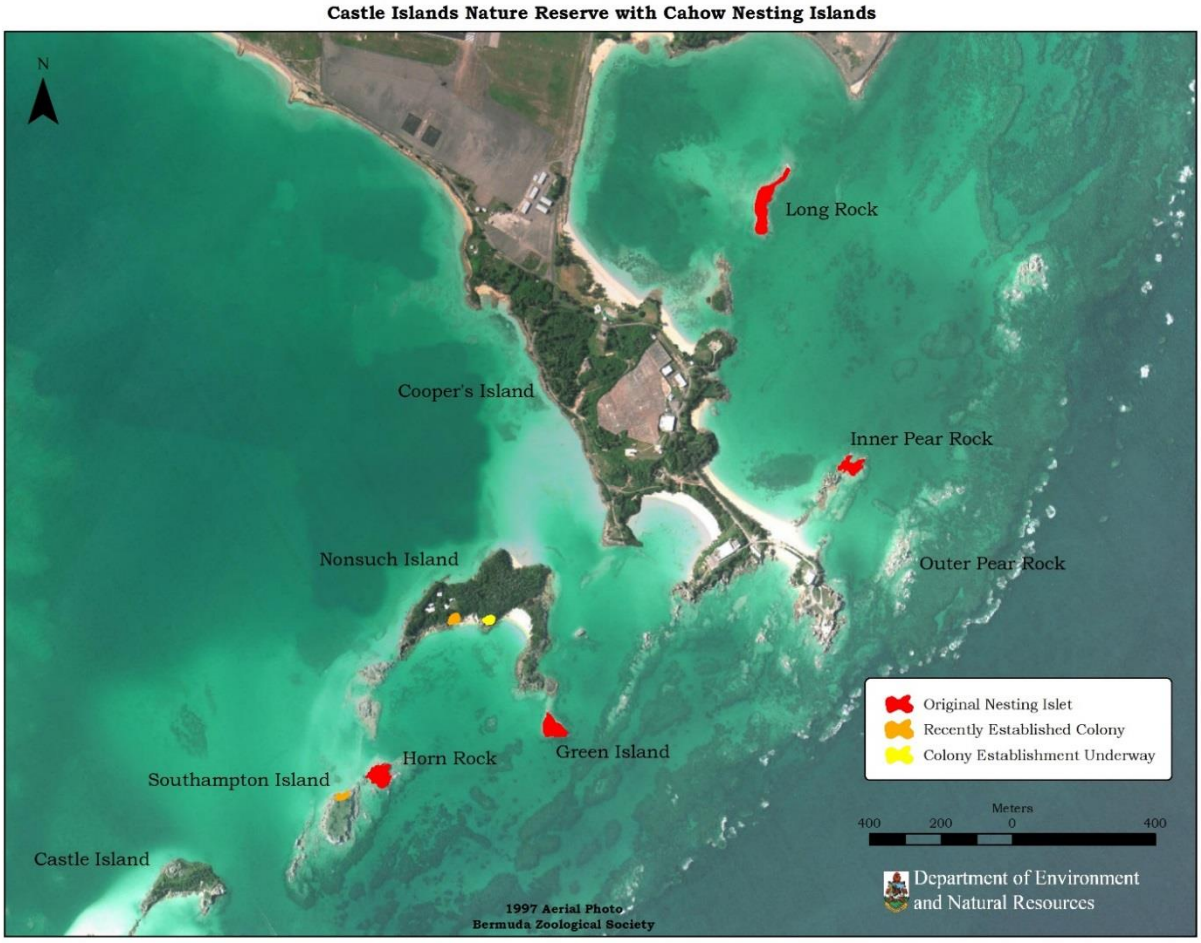

Fig. 2: Castle Harbour Islands Nature Reserve showing Cahow nesting islands and colonies

For the second consecutive year, Bermuda and the Cahow nesting islands were not affected by any Hurricane or Tropical Storm, providing a much-needed break from a recent series of four hurricane strikes between 2014 and 2016, which disrupted nesting and new pair formation and often required lengthy repairs to nest burrows on the smaller nesting islets.

Following is a review of the events and management / research work carried out for the Cahow Recovery Program through the 2017-2018 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 25th October 2017, with all back by the second week of November. During late October and November 2017, a total of 98 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 2018, with the first eggs confirmed on the 8th January. During the egg incubation period, which lasts about 53 days, an additional 57 of the incubating adults were checked to determine sex, weight and band numbers. Candling of egg was introduced to identify fertile eggs and follow embryo development.

(4) The first Cahow chick hatched by the 26th February 2018, with the last confirmed by the end of March. Once all chicks had hatched, a sub-sample of 40 chicks were chosen which were then checked at least twice weekly, weather conditions permitting, for weight, wing chord length, and plumage development. This information is essential in identifying when chicks chosen for translocation, are at the optimal stage of development to be moved to their new nest sites.

(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 2017-2018 Cahow nesting season, a total of 51 chicks were fitted with identification bands, out of a total of 71 chicks which successfully fledged (71.8 % of all chicks).

(6) The total number of active nesting pairs of Cahows increased to a record high of 124 pairs during the 2017/2018 nesting season, compared to 117 nesting pairs in the 2016/2017 season and 55 pairs in 2000/2001. A record total of 71 chicks successfully fledged from all nesting islands, surpassing by 10 the previous record of 61 chicks fledged during 2017 (**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, 16 nesting pairs laid eggs at the Nonsuch colony; from these, a record number of 13 chicks hatched (**See Tables 1 & 2**), all of which fledged successfully out to sea, while 2 new pairs of prospecting adult Cahows have established in additional nests **(See section 3(a)** for full details).

(8) During this nesting season, the first two 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. Although both eggs laid by these pairs failed to hatch, this marks a significant milestone in the attempt to establish a second nesting colony of Cahows on Nonsuch Island, which is considerably larger and higher in elevation than any of the original nesting islets. This makes these new nesting sites more protected from hurricane flooding and erosion, with potential for supporting a much larger population of the species.

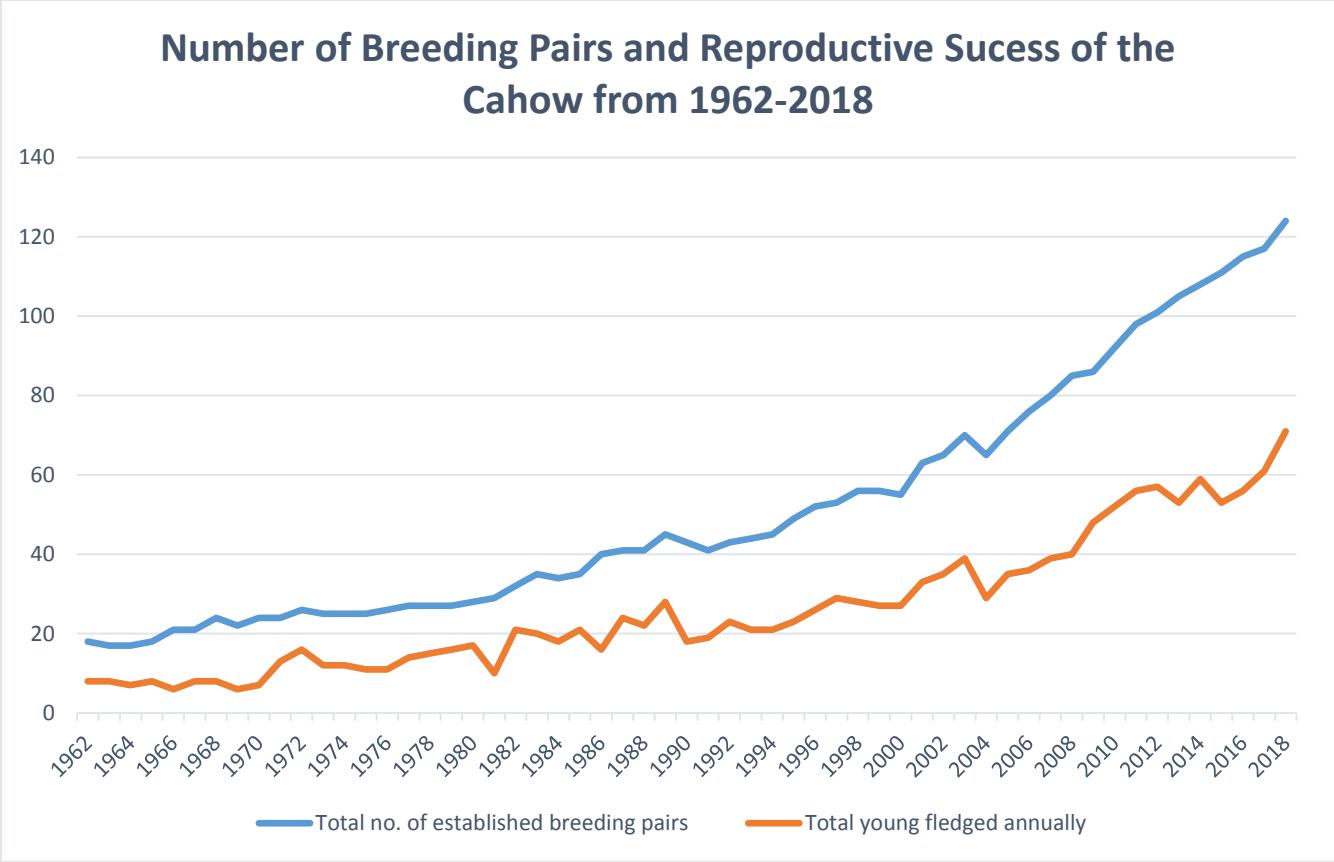

Fig. 3: No. of breeding pairs and fledged young of Cahow over 56-year period (Leila Madeiros)

The 2017/2018 nesting season also reached an important milestone concerning the new Cahow nesting colony on Nonsuch Island:

As of this year, the breeding colony on Nonsuch Island has produced a total of 67 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 2017/2018 season, the number of confirmed returning Cahows that had 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):
Use of candling to check Cahow egg fertility and embryo development

Fig. 4: Cahow egg from Nonsuch R831 nest being candled, with 7-day-old embryo visible within egg.

During January and February 2018, Ms. Carla Marquardt, who has extensive experience in the breeding of Parrots and Macaws, volunteered to candle accessible Cahow eggs, using a bright light placed against the air cell in the egg, during routine band checks carried out on adult Cahows carrying out egg incubation. During these checks, adults are briefly taken off their eggs in the nest burrows for individual identification by checking their band numbers, and also given a check of body weight and condition. While the adults are taken off their egg to be checked, Ms. Marquardt then candled the egg, usually without having to remove it from the nest at all.

Candling is a technique that can be used to confirm whether an egg is fertile, and to follow the development of the embryo inside the eggshell. By placing a small bright light against the large end (air cell) of the egg, the eggshell appears translucent and the inside contents of the egg are illuminated (see Fig. 3).

This technique has proven to be of such value, particularly in the early identification of infertile eggs and in following the growth of developing embryos, that it will be incorporated into future monitoring and management of the species.

SECTION 2 (c):
Overall Summary of 2017 / 2018 Cahow Nesting Season:

During the 2017-2018 Cahow nesting season, the Cahow population has increased to a new record high number of 124 breeding pairs, of which 71 produced successfully fledging chicks. This represents a breeding success rate of 57.26%, compared to 52.1% recorded in the 2016-2017 season. In addition, new prospecting or pre-breeding activity was recorded at a record number of 14 additional new nest sites, including 5 new nest sites on Nonsuch Island.

Following is a summary of the 2017-2018 nesting season results:

Total number of nest burrows with confirmed nesting activity: 124*

Number of new nest sites with prospecting activity: 14*

Total number of confirmed successfully fledged chicks: 71*

Total number of active nest sites with unsuccessful nesting: 53

Number of failures from nest sites with observable nest chambers: 45

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: 2
Chick died later in development: 1
Chick died hatching: 1
Embryo died in egg at 0-30 days development: 5
Embryo died in egg at 30+ days development: 1
Eggs broken or pipped: 14
Non-hatching / infertile eggs: 8
Egg buried or knocked off nest: 3
Egg disappeared (Land Hermit Crab predation?): 1
Tropicbird nest competition/disruption; 3
Egg broken in fight with prospecting subadult Cahow: 1
Egg failed from nest flooding in heavy rains: 1
Failure from unknown causes: 5

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 2017/2018 nesting season. Out of all nesting islets, only Long Rock had abnormally low breeding success, at 46.2%. Horn Rock and Green Island had slightly higher breeding success at 53.3 % and 50.0 % breeding success respectively. In contrast, both Inner Pear Rock and Nonsuch Island had much higher breeding success rates of 70.0 % and 72.2 % respectively.

LONG ROCK:

Active nest burrows with nesting confirmed (eggs laid and/or chick hatched): ……..... 13
New nest burrow prospected by confirmed pair: ……..... 2
Nest burrows with successfully fledged chicks (B, D1, D4, D8, E1, E4): ……..... 6
Nest burrows with confirmed failed nesting: 7
(A (tropicbird nest competition), C-cause unknown – possible flooding by heavy rains; D2– egg cracked; D3- chick died before 2 weeks; D5-egg broken in fight with prospecting subadult; D7 egg infertile.

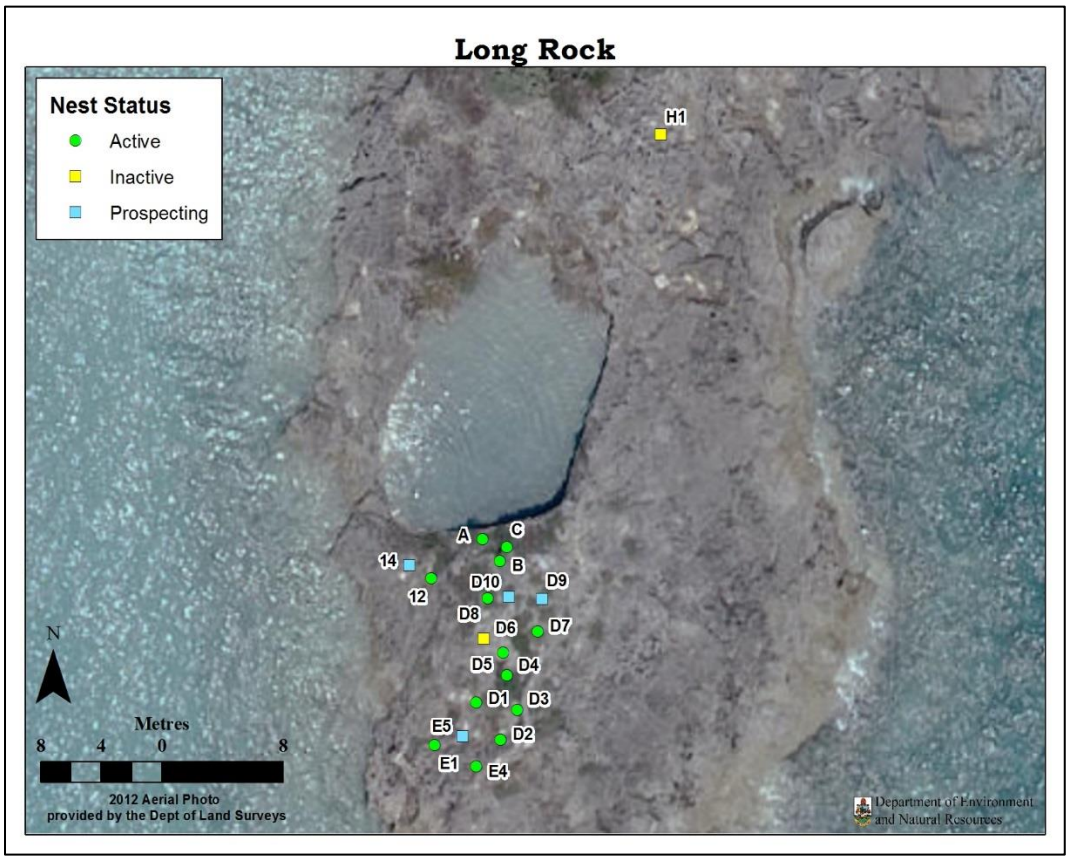

Fig. 5: Status of Long Rock Cahow nest burrows in 2018

INNER PEAR ROCK:

Active nest burrows with nesting confirmed: ……..... 20
New nest burrows prospected by confirmed pairs: ……..... 2
Nest burrows with successfully fledged chicks: ……..... 14
(A1, B1, B3, B4, B5, B7, B8, B9, B10, C4, D2, D3, D4, E1)
Nest burrows with confirmed failed nesting: …….……..... 6
(B2-egg infertile; B6-egg infertile; C1-unknown causes; C2- egg buried in nest; C3-egg knocked off nest; D1-disruption caused by Tropicbird nest competition).

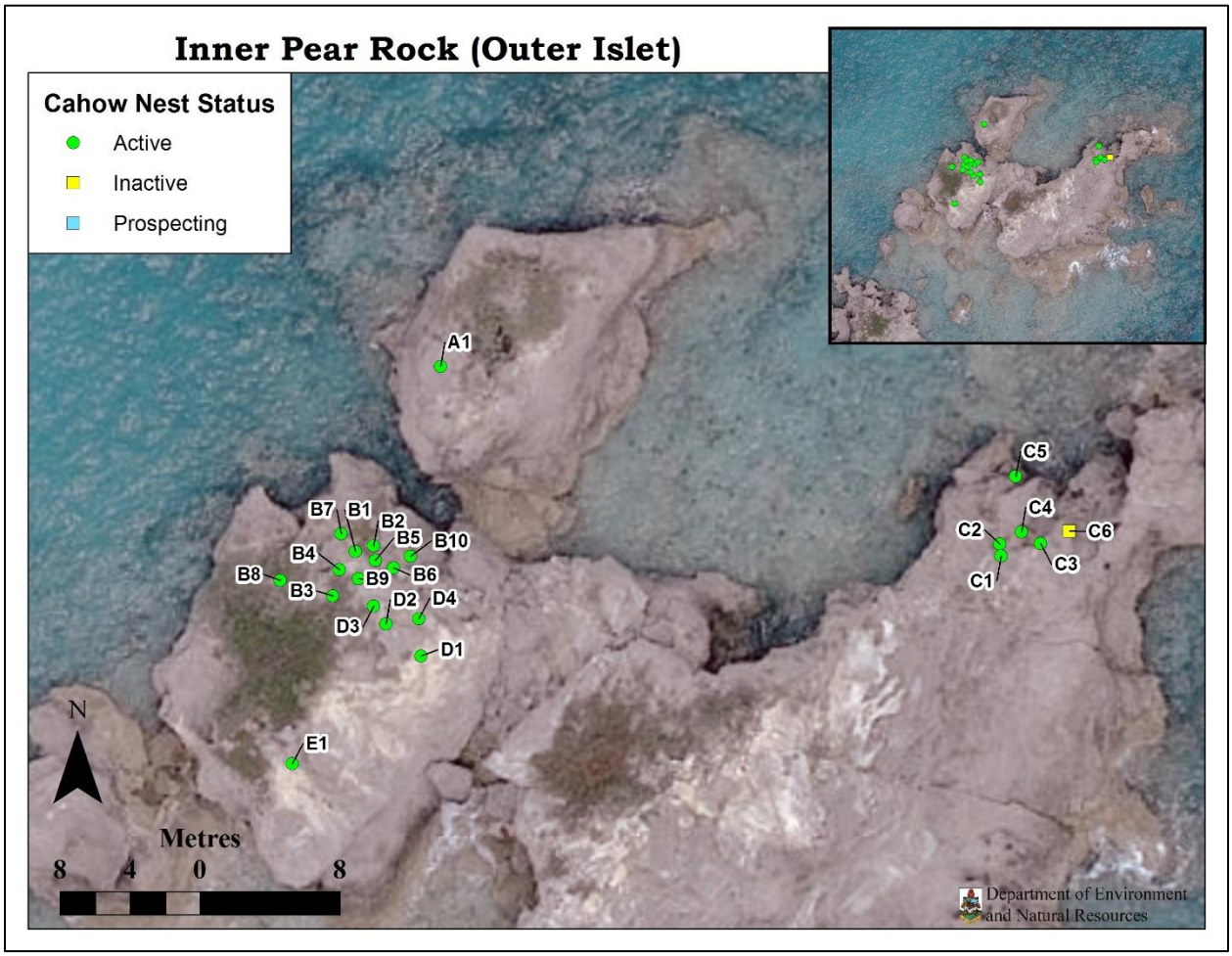

Fig. 6: Status of Cahow nest burrows on Inner Pear Rock in 2018

GREEN ISLAND:

Active nest burrows with nesting confirmed: 24
New nest burrow prospected by confirmed pair: 2
Nest burrows with successfully fledged chicks: 12
(A1; D1; # 2; #3; # 4; # 5; # 7; # 8; # 11; # 12; # 13; # 16)
Nest burrows with confirmed failed nesting: 12
(E1- cause of failure unknown; F1 – cause of failure unknown; F2 - egg broken/pipped; # 3-4 - egg cracked/buried in nest; # 4/5 - egg cracked; # 5-6 - egg infertile, # 6 - egg disappeared; # 9- embryo dies early in egg; # 10 - egg broken/cracked; # 14 - egg infertile; # 15 - egg infertile; # 17 – egg cracked)

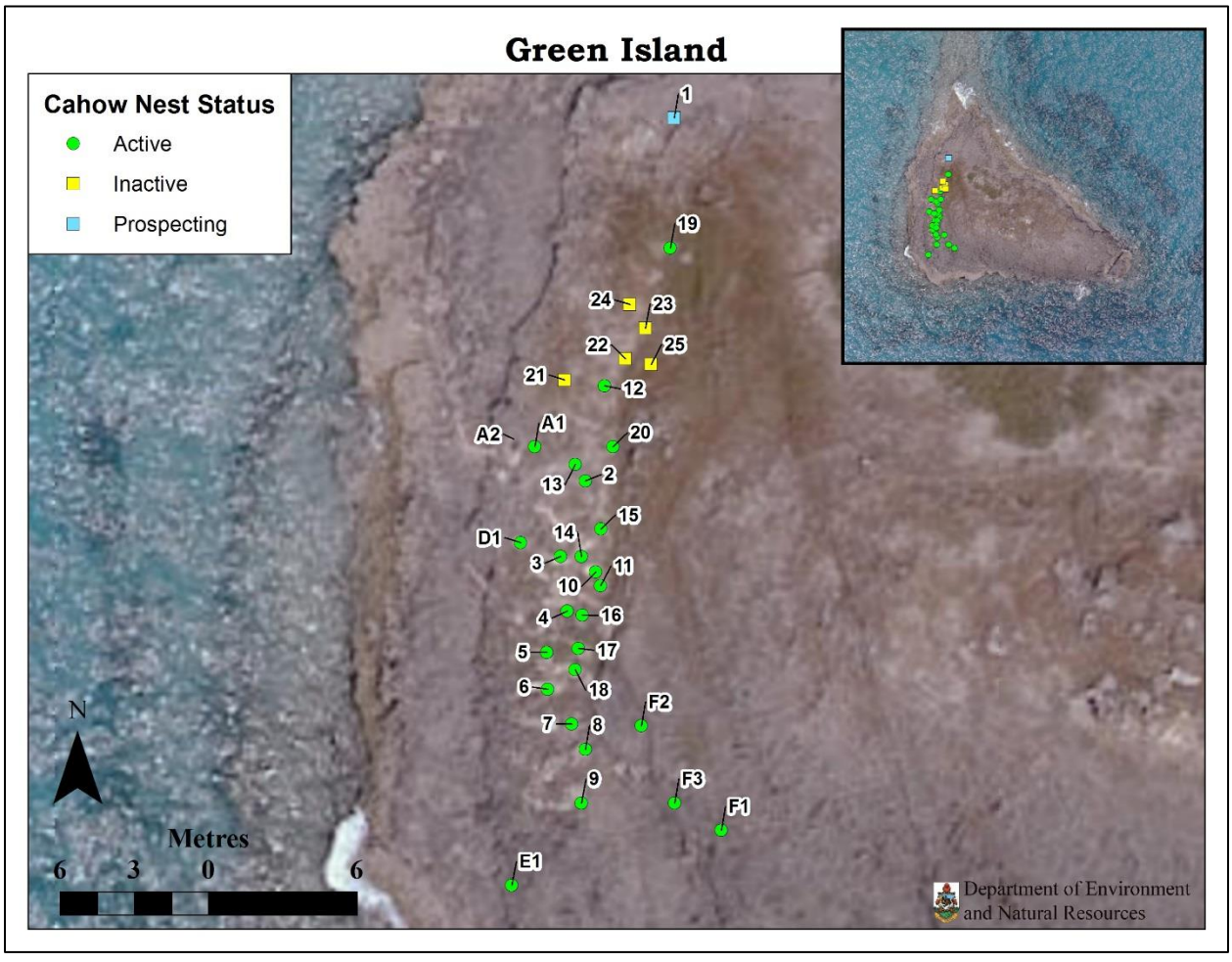

Fig. 7: Status of Cahow nesting burrows on Green Island in 2018

HORN ROCK:

Active nest burrows with nesting confirmed: ……..... 45
New nest burrows prospected by confirmed pairs: ……..... 3
Nest burrows with confirmed successfully fledged chicks: 24
(B6; B7; C4; C5; C7; C8; C9; C13, C14; C15; C18; C19; C20; C21; C22; C23; C24; C26; C29; C30; D1; F3; F6; F7; G3)
Nest burrows with confirmed failed nesting: ……..... 21
(B3 - egg knocked off nest/buried; B5 – unknown causes; B8 – Tropicbird nest disruption; C6 – egg broken; C10 – egg abandoned/broken; C11 – embryo died at 2 weeks in egg; C16 – egg pipped; C17- egg broken; C25 – egg disappeared-crab predation?; C27 - egg broken; C28 – Chick died hatching; D3 – unknown causes; D4 – unknown causes; E1 - unknown causes; E2 – Tropicbird nest disruption; F2 - egg infertile, F4 – embryo dies early in development in egg; F5 - chick died at 2 months of age, lack of parental care; F7 – chick died hatching; F8 - egg broken; G3 – Chick died at 2 ½ weeks, killed by prospecting Cahow?)

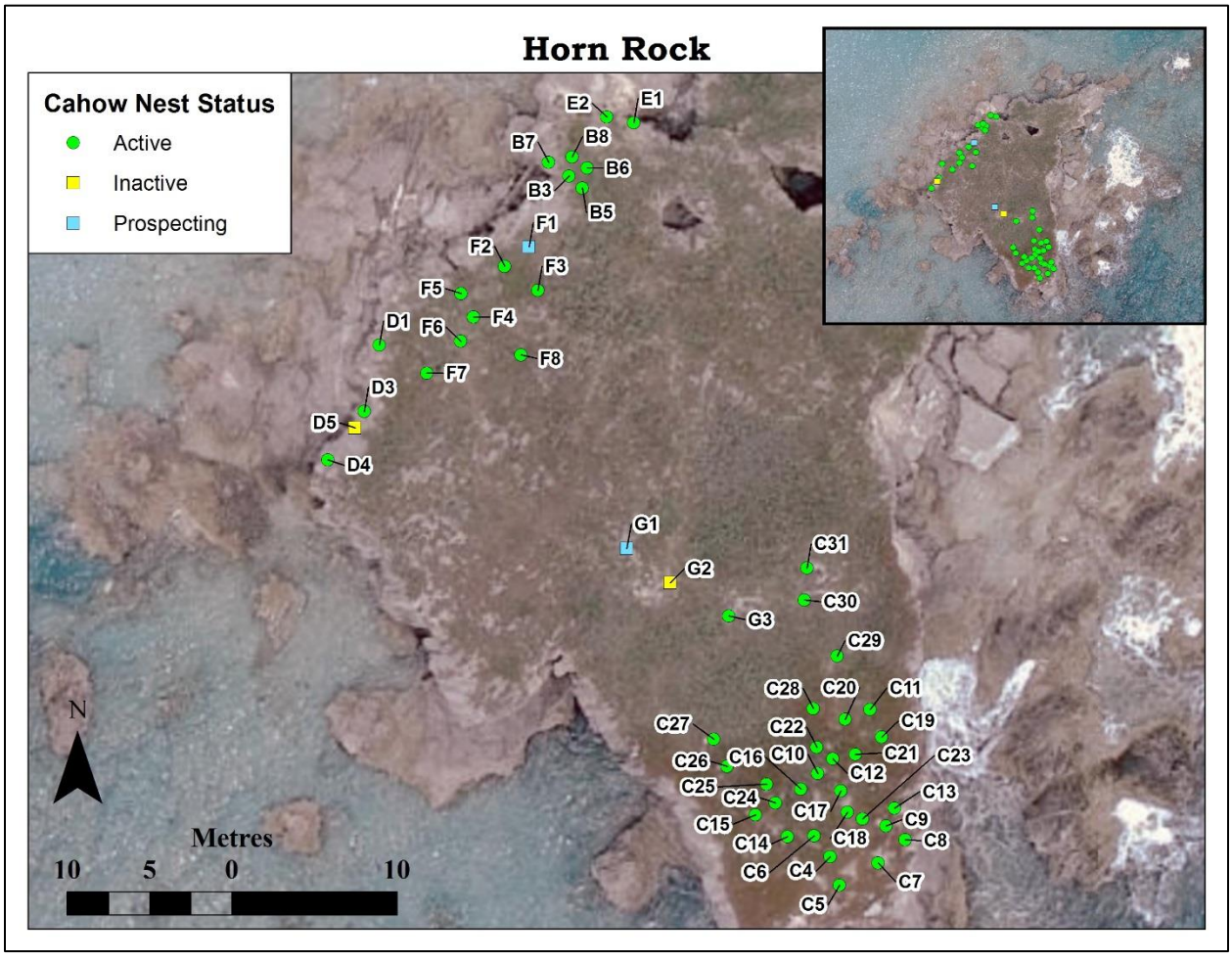

Fig. 8: Status of Cahow nest burrows on Horn Rock in 2018

NONSUCH ISLAND:

Active nest burrows with nesting confirmed: 18
New nest burrows prospected by confirmed pairs: 5
Nest burrows with confirmed successfully fledged chicks: 13
(R816; R817; R818; R819; R820; R821; R830; R831; R832; R833; R836; R837; R838)
Nest burrows with confirmed failed nesting: 5
(R834 - infertile egg; R835- embryo died in early development in egg; R839-egg crushed; B9-embryo died in egg 18-20 days old; B12-embryo died at 30-40 days in egg)

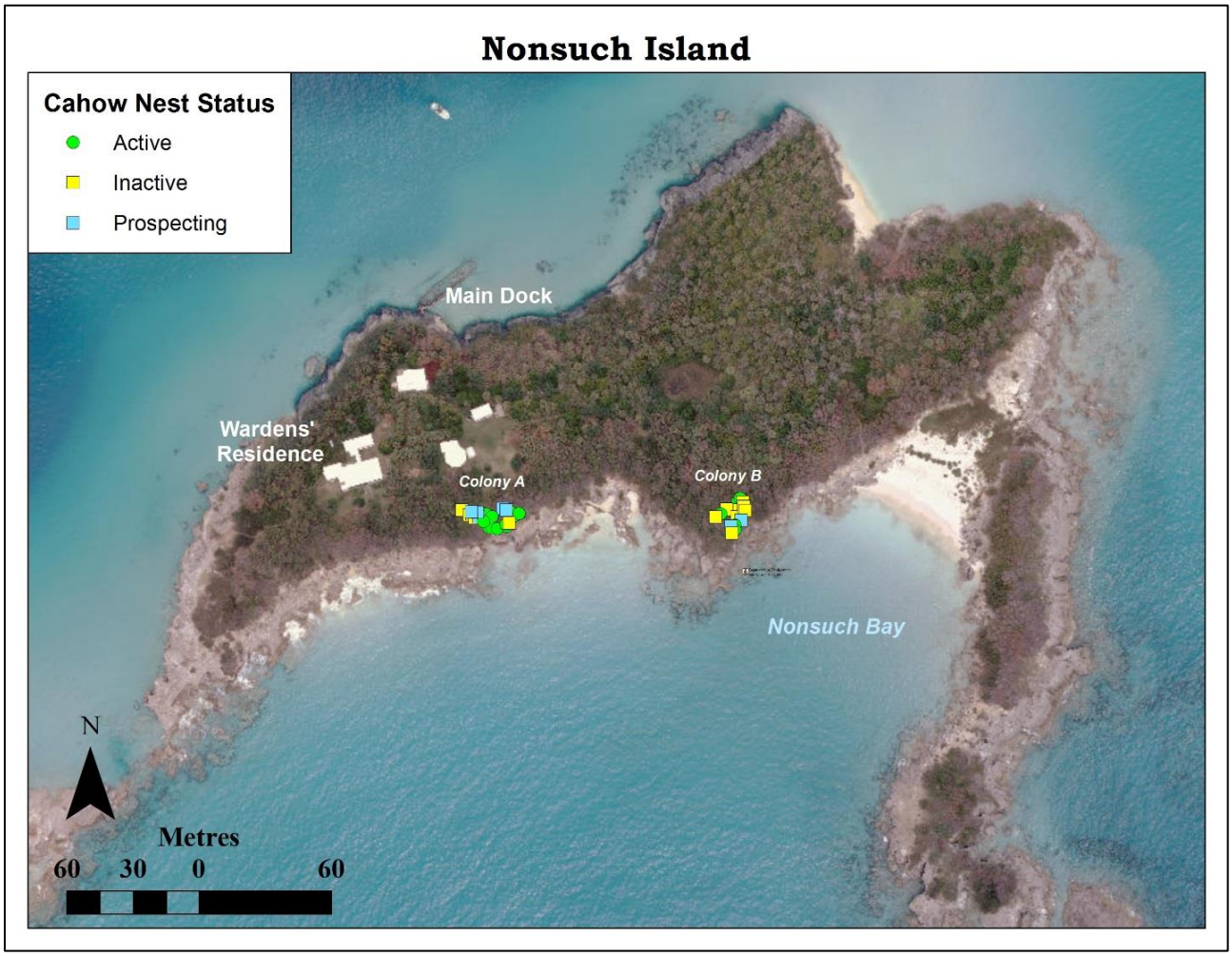

Fig. 9: Status of Cahow nesting burrows on Nonsuch Island in 2018

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

SOUTHAMPTON ISLAND:

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)

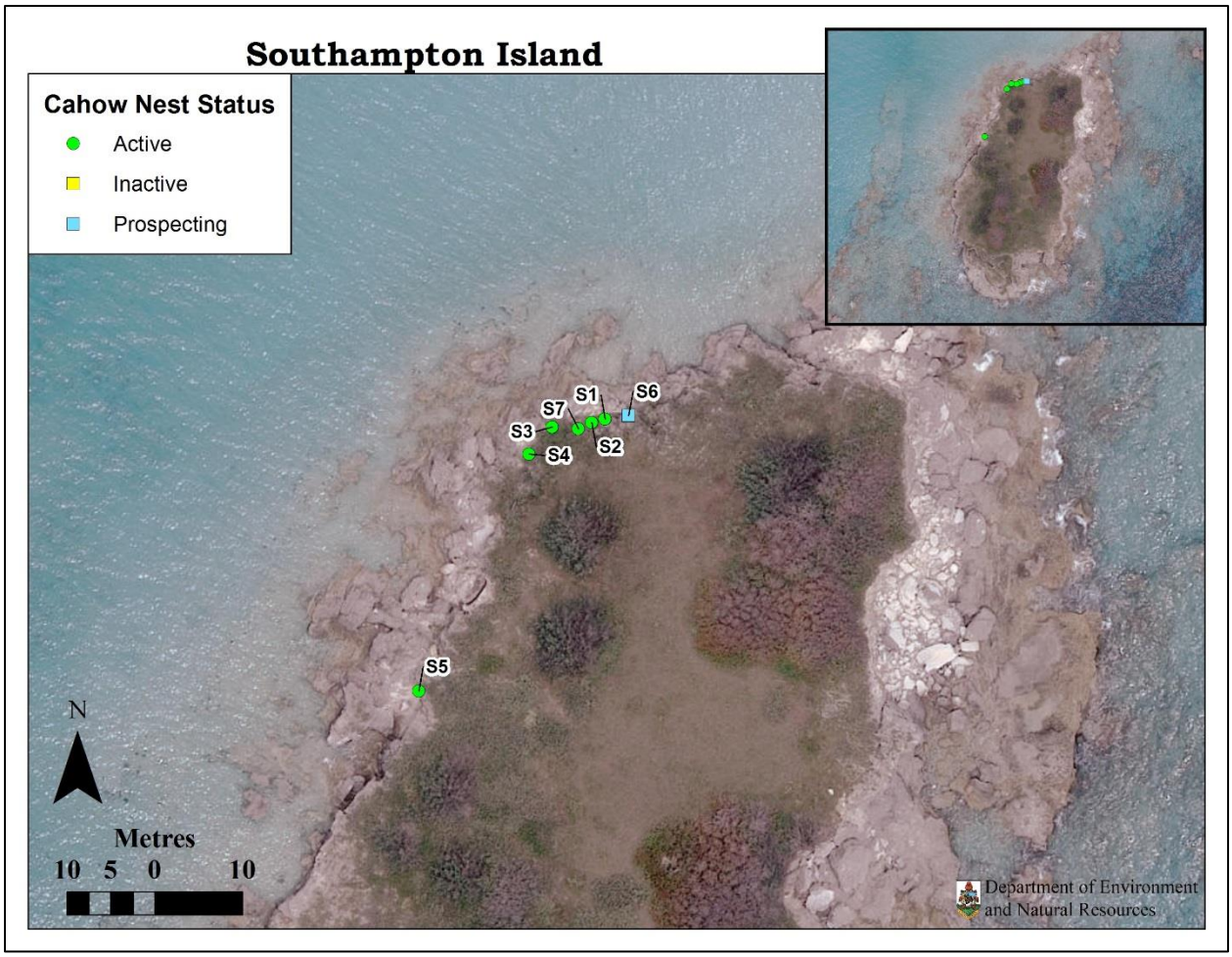

Fig. 10: Status of Cahow nesting burrows on Southampton Island in 2018

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

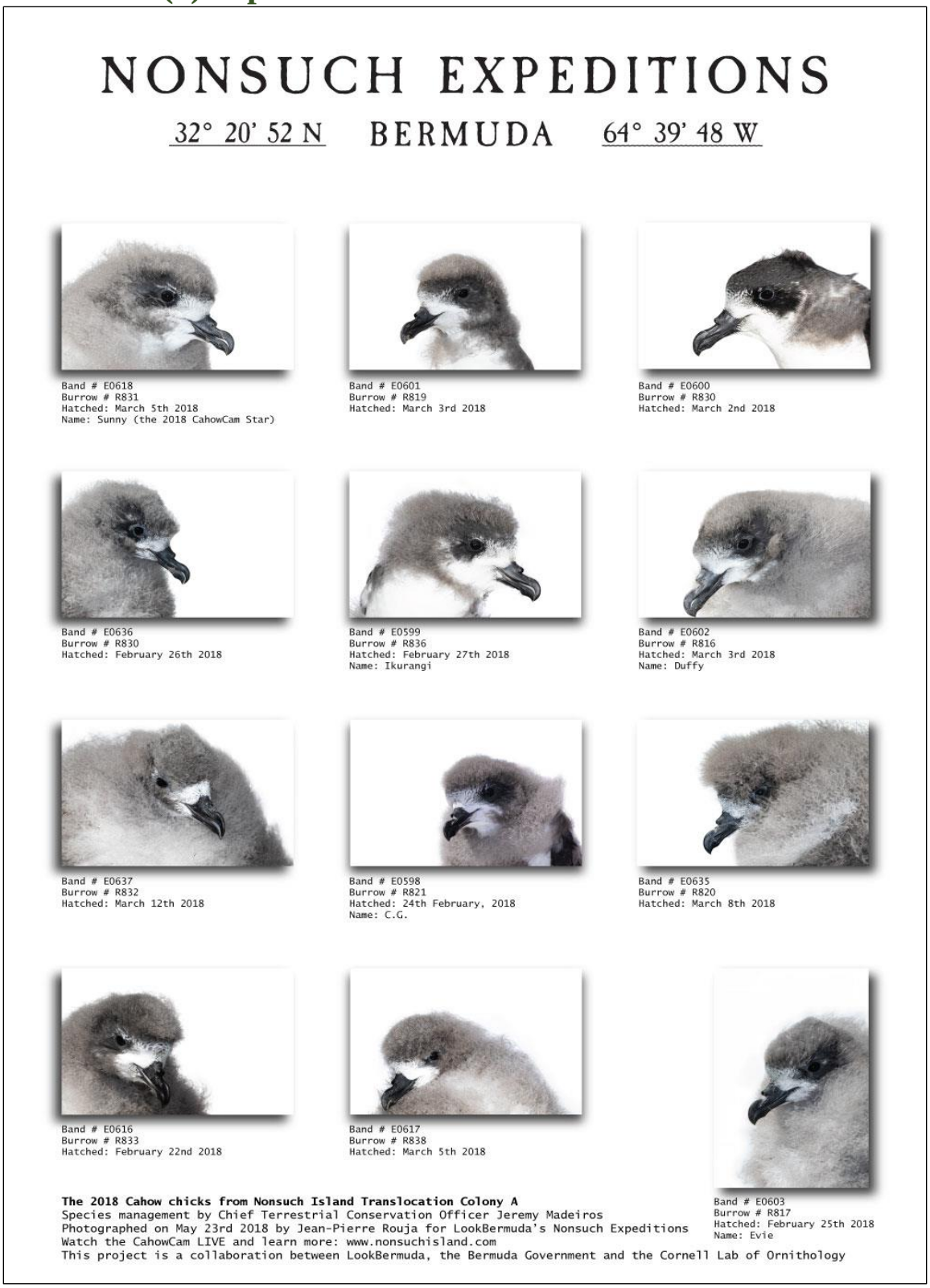

Fig. 11: "Class of 2018" portraits of 12 of the 13 Nonsuch Cahow chicks in 2018 (J. P. Rouja)

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 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 elevated 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 four of the original nesting islets were moved to a new group of 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 each 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, or rings, and monitored through their exercise period, when they emerge for several nights to exercise flight muscles and imprint on their surroundings.

At the end of this period, they fledge to 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, 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 hatched on Nonsuch since the 1620s. In addition, a total of 15 returned translocated Cahows were re-captured at the translocation site by the end of this season.

Between 2010 and 2016, the number of established breeding pairs carrying out nesting activity at the new Nonsuch Island nesting colony rose from 4 to 15, with the number of successfully fledged chicks produced annually by this colony increasing from 1 chick in 2010 to 10 chicks in 2016. 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 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 2017/2018 breeding season, the total number of breeding pairs on Nonsuch was 18, of which 13 produced successfully fledging chicks (72.2 % breeding success). The total number of Cahow chicks that have hatched and successfully fledged from the new Nonsuch nesting colony since 2009 increased to 67 by 2018 (**See Tables 1 and 2**).

During the 2017-2018 Breeding Season, the first Cahow chick to fledge to sea at the (A) translocation colony site did so during the night of May 27, 2018, while the last one fledged out to sea on the night of June 20th, 2018.

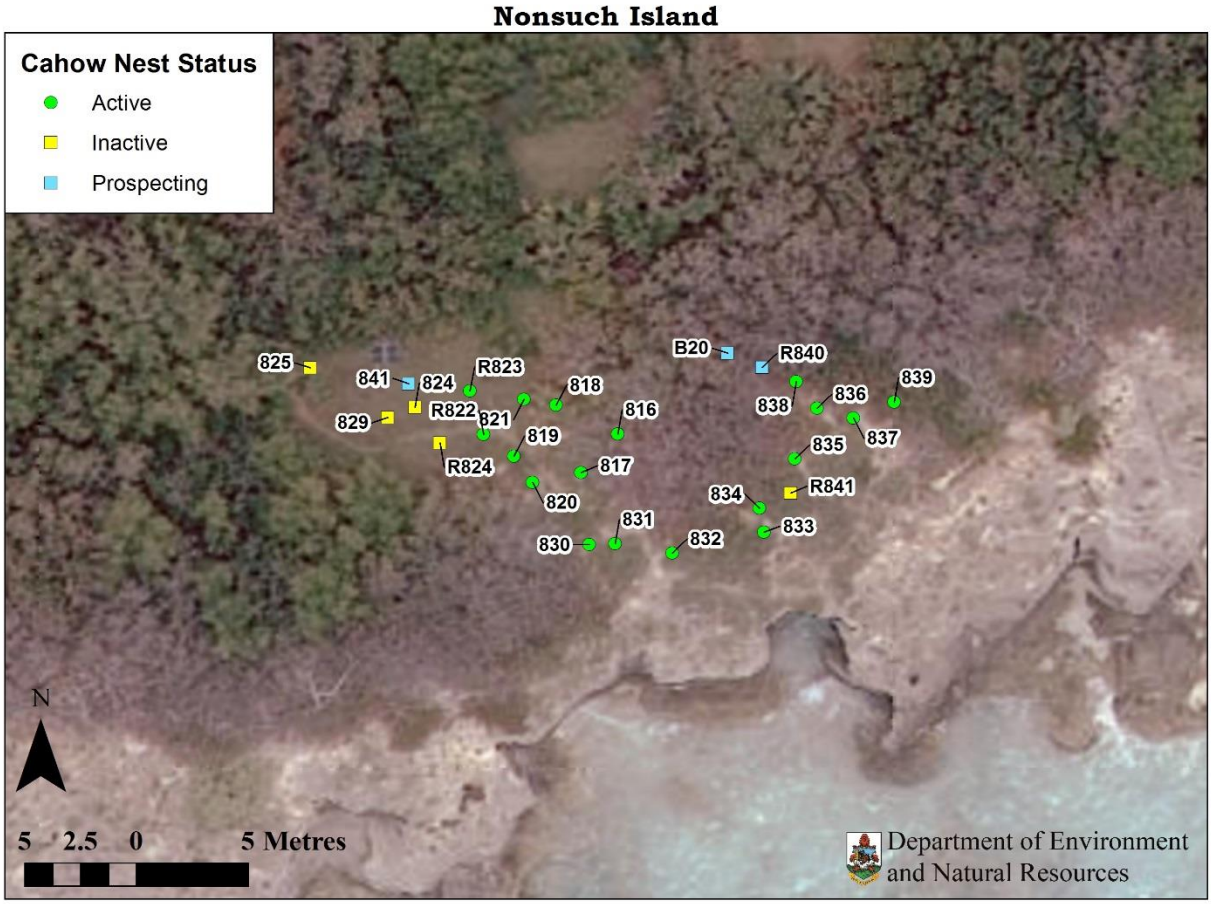

Fig. 12: Location & status of nest burrows at "A" Cahow translocation site on Nonsuch Island

TABLE 1: Breeding results at new translocation colony on Nonsuch Island 2008/2009 to 2016/2017 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**

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

Table 2: This table shows the annual breeding success of all active Cahow nest burrows at the Nonsuch "A" nesting colony between 2009, when the first pair of translocated birds returned to breed successfully, and 2018, with the number of breeding pairs increasing to 18.

NONSUCH ISLAND	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Nest No.	Breeding Success (Chick fledged = 1, failed = 0)									
R816			0	1	1	1	1	1	0	1
R817			1	1	0	1	0	0	1	1
R818	1	1	1	1	0	1	1	0	1	1
R819						1	1	1	0	1
R820					0	0	1	1	1	1
R821							1	1	1	1
R830				1	0	0	0	1	0	1
R831		0	0	0	0	1	1	1	1	1
R832		0	1	1	1	0	1	1	1	1
R833				0	0	1	0	1	0	1
R834		0	0	0	0	1	0	0	0	0
R835					1	1	1	1	1	0
R836				1	1	1	1	1	1	1
R837			1	1	1	0	0	0	0	1
R838								0	0	1
R839										0
B9										0
B12										0
Total no. of chicks/year	1	1	4	7	5	9	9	10	8	13

Annual Breeding Success of Cahow Pairs on Nonsuch Island, and New Pair Establishment

SECTION 3 (b):
Results of 2nd Nonsuch Translocation Project

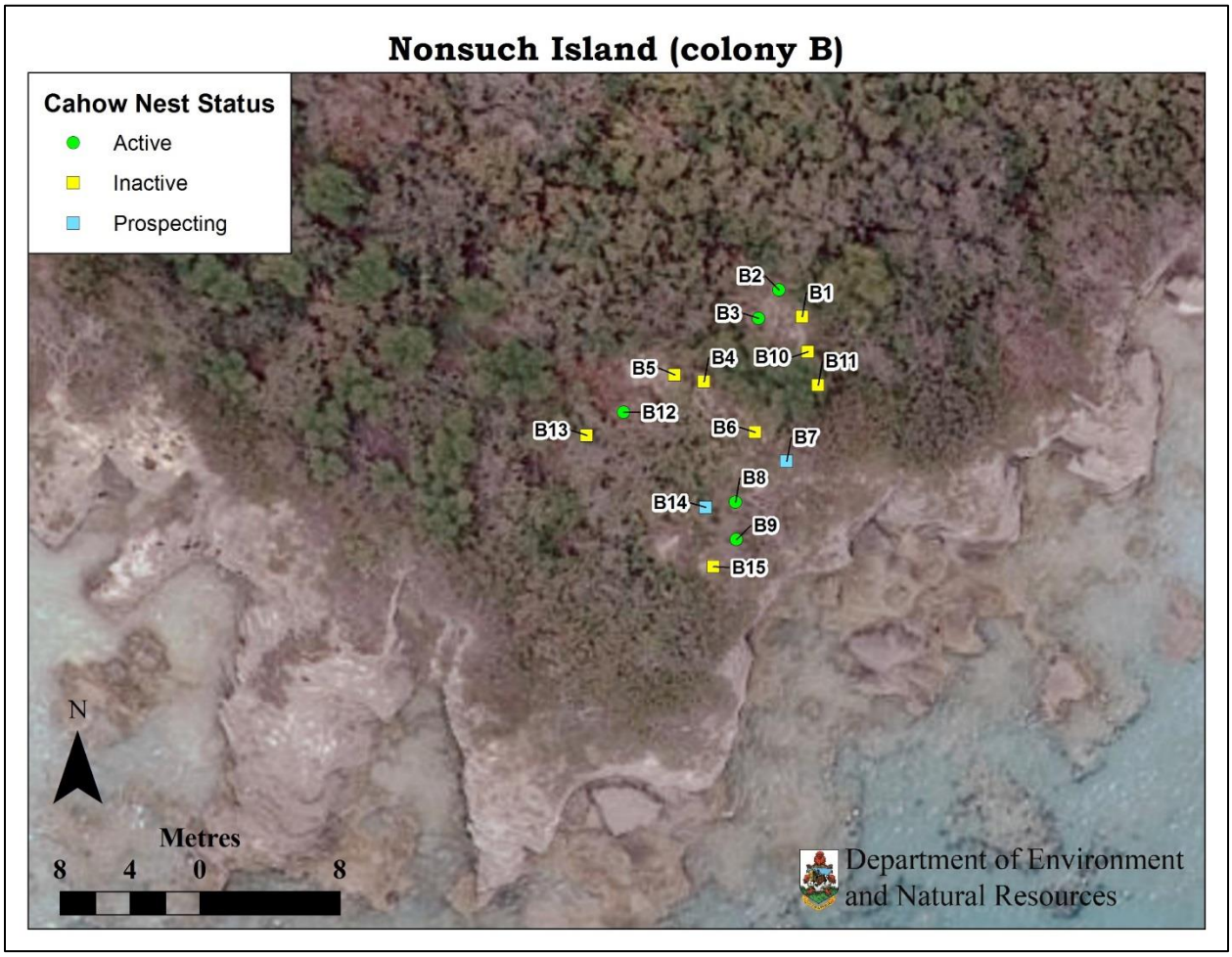

Fig. 13: Location and status of Cahow nest burrows at "B" translocation colony on Nonsuch Island

2017 was the fifth and final year of a second translocation project on Nonsuch Island. Following the success of the first translocation project, a second translocation project was carried out aimed at 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 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 could be fed and monitored daily until they fledged out to sea. In this way, they hopefully imprinted 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, well beyond the reach of hurricane waves and surge.

These new nest burrows were built with the assistance of volunteer groups from the Ascendant Group of Companies. Groups of volunteers from Ascendant came out to Nonsuch Island in 2012 and 2013 to assist in mixing and pouring concrete to make 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.

The final year in which Cahow chicks were translocated to the "B" colony site was in 2017, when fourteen Cahow chicks were moved from all four of the original nesting islets, with thirteen successfully fledging out to sea. Out of the successfully fledging chicks, 6 originated from nest burrows on Horn Rock (C4; C14; C21; C22; F6; F7), 3 from nests on Green Island (# 6; # 8; # 12), 3 from nests on Inner Pear Rock (D2, D3, D4), and 1 from Long Rock (D3)

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.

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, a total of 7 translocated chicks returned. Five of these were recaptured in nest burrows at the (B) translocation site, **with 2 new breeding pairs producing the first eggs recorded at this new colony site**. Although both eggs failed, this is 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.

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. 14: One-month old Cahow chick 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 which gives a view into the nest chamber from the side, providing an improved vantage point to see the nesting Cahows (see above). 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.

Some of the highlights that the CahowCam revealed during 2017/2018 include:

- nest-building, courtship & mating activity by the adult Cahows;
- the actual laying of the single egg on 12th January 2018 by the female bird;
- incubation shifts and changeovers by the two adults;
- the hatching of the chick on 3rd march, 2018;
- feeding visits by both parents to the chick;
- a nest invasion by a prospecting young Cahow, which aggressively attacked the chick before leaving the nest (the chick survived the attack uninjured);
- the growth and maturing of the chick until it fledged out to sea on the 28th May 2018.

For two consecutive years in 2016 and 2017, a **Leach's Storm-petrel** (*Oceanodroma leucorhoa*) prospected in the Nonsuch Island nest burrow that the CahowCam was installed in, shortly after the Cahow chicks departed. This small seabird, although common well offshore during the winter and spring months, had never been recorded on land before 2016 on Bermuda. This bird, evidently a male, visited the burrow almost nightly during June and July of those years, arranging nest material and calling loudly for hours at a time at the burrow entrance, trying to attract a mate. This Storm-petrel was not heard or sighted during 2018.

The infrared CahowCam has proven to be an 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. 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 and measured as part of the research program.

Fig. 15: Cahow Project talk being given to Saltus Cavendish Primary 1 group.

Fig. 16: Adult Cahow given health check with BZS Natural History Course tour group on Nonsuch island, November 2018

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:

2018 – 2019 Breeding Seasons:

- Continue banding program for adult and fledgling Cahows;
- Continue monitoring of nesting islands for the presence of rats; set out rodenticides when necessary;
- Switch from active translocation of Cahow chicks to Nonsuch Island to monitoring for the return of translocated birds as adults to the two translocation colony sites;
- Continue installation of additional artificial nest burrows at nesting colonies, including at the new colony on Southampton Island;
- Investigate and possibly initiate the potential deployment of 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.

2019 – 2020 Breeding Seasons:

- Switch from active translocation of chicks to monitoring of burrows for the return of birds at the two translocation colony sites;
- Possibly start use of Sound Attraction System at “B” colony site on Nonsuch;
- Continue banding program for adult and fledgling Cahows;
- Continue the installation of additional artificial nest burrows for the Cahow on suitable nesting islands and locations;
- Working with international partners, to carry out the deployment of extremely accurate GPS loggers on selected adult and fledgling Cahows, to determine major oceanic foraging areas and range.

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 2017 – 2018 breeding season:

Mr. Peter Drew, Conservation Officer, Bermuda Biodiversity Officer Alison Copeland (Dept. of Conservation Services) as well as Camilla Stringer of the Bermuda Zoological Society and Lizzy Madeiros, for assistance in monitoring checks and feeding of translocated Cahow chicks; Ms. Mandy Shailer (GPS coordinator, Dept. of Conservation Services), who has provided maps of nesting islands and nest sites, and compiled locational data from the geolocational data loggers to make the tracking and oceanic range maps, and Chris Flook, who agreed to once again provide fresh Anchovies for abandoned Cahow chicks. Also instrumental in furthering the project's objective 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).

The photos in this report were used with the kind permission of Patrick Singleton, J.P. Rouja, Carla Marquardt, David Liittschwager, Cynthia Barnes, Leila Madeiros 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 my children Seth and Elizabeth, whose support and patience have made this demanding project possible over the last 18 years.

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Fig. 17: Conservation Officer carrying out Cahow check on one of the original nesting islets.

Fig. 18: One of the four original Cahow nesting islets, with Nonsuch Island in background (both photos by Patrick Singleton)