

**Species Status Assessment Report  
for the  
Black-capped petrel (*Pterodroma hasitata*)**

**Version 1.1**



Black-capped petrel (photo credit: Kate Sutherland)

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**U.S. Fish and Wildlife Service  
Region 4  
Atlanta, GA**



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## **Summary of Version Updates**

Differences between Version 1.0 (April 2018) and Version 1.1 (June 2018) of the Black-capped petrel SSA are minor and do not change the SSA analysis. The changes include the following:

- 1) Addition of Gulf of Mexico BCPE sightings map to the Appendix A.
- 2) Additional wording in Section 2.9.6 acknowledging recent inland wind farms established near BCPE nesting areas on Hispaniola.
- 3) Additional wording in Section 2.9.7 acknowledging potential exposure of Black-capped petrel in Gulf of Mexico to chemical contaminants.

## Executive Summary

The Black-capped petrel (*Pterodroma hasitata*; Kuhl 1820) is a pelagic seabird that breeds on Caribbean islands and travels long distances to foraging areas in the western Atlantic and southern Caribbean basins, and perhaps the northern Gulf of Mexico. The U.S. Fish and Wildlife Service (Service), was petitioned to list the Black-capped petrel as endangered or threatened under the Endangered Species Act of 1973, as amended (ESA) on September 1, 2011, by WildEarth Guardians. In June of 2012, the Service found that the petition presented substantial scientific or commercial information indicating that the listing of the species may be warranted. This Species Status Assessment (SSA) for the Black-capped petrel is intended to provide the biological support for the decision on whether to propose to list the species as threatened or endangered and, if so, whether to and where to propose designating critical habitat. As such, this SSA provides a thorough assessment of Black-capped petrel biology and natural history and assesses demographic risks, threats, and limiting factors in the context of determining the viability and risks of extinction for the species.

We used the best available information to assess the current and predicted future condition of the Black-capped petrel relative to its continued viability as a species. In doing so, we considered all recognized threats to the species and how and why they may impinge upon species viability. In the process, we observed that the numerous distinct threats shared common underlying drivers, and of these, the two which encompassed virtually all threats were 1) regional climate change, and 2) human population growth – particularly on the island of Hispaniola (Haiti; Dominican Republic) where all currently known nesting by the petrel occurs.

For the purpose of this assessment, we generally define viability as the ability of the Black-capped petrel to sustain populations on breeding and foraging grounds beyond a biologically meaningful timeframe, in this case, 50 years. Fifty years is within the range of available climate change model forecasts and human population growth models, and it corresponds roughly to the length of time since the species was rediscovered in Haiti, thereby providing a temporally equivalent and empirically-based frame of reference for predicting future conditions.

We also predicted factors affecting Black-capped petrel status at two intermediate time frames, 10 and 25 years, and chose 50 years as the end of our predictive time horizon. To assess the influence of human population growth on petrel nesting habitat on Hispaniola, we considered three (3) different scenarios. The three scenarios correspond to baseline, plus 20%, and minus 20%, of current United Nations population growth projections for Haiti and the Dominican Republic. By “bracketing” our projections, we were attempting to account for inherent uncertainties that can arise from long-term projections. By accounting for potential variation, we increased our confidence that the “true” population growth, and its subsequent effects on Black-capped petrel nesting habitat, was captured within the range of our scenarios.

The results of our assessment reflect that the Black-capped petrel has experienced a progressive reduction in two key demographic parameters over (at least) the past five centuries: 1) population size and, 2) number of breeding populations. Historical information also suggests that reductions were – and continue to be – primarily a result of human activities on the Caribbean islands which historically hosted Black-capped petrel breeding populations. The cumulative actions of human populations on Caribbean islands have progressively reduced the overall extent of known Black-capped petrel breeding populations from that of at least seven (7) populations on four different islands, to four (4) current populations, all located on one island (i.e. southwestern Hispaniola). Geographic isolation has the associated effect of increasing the vulnerability of the species to catastrophic events, such as major hurricanes. Our estimates of little to no redundancy and representation are reflective of the species vulnerability to such events.

Once breeding populations of the Black-capped petrel became geographically limited to southwestern Hispaniola, a suite of additional factors began to work synergistically to further reduce the overall population of the species. Among these, habitat loss and degradation is considered to have been, and continue to be, the most pernicious. Anthropogenic habitat loss and associated factors threaten the remaining breeding populations on Hispaniola and have almost certainly contributed to the substantial decline in overall numbers of the Black-capped petrel over the past 50 years. There has also been an apparent concomitant decrease in petrel numbers within most individual breeding populations. Our estimate of low resiliency for the Black-capped petrel reflects extensive nesting habitat loss and degradation and subsequent declines in petrel population size.

As the human population on Hispaniola increases, the attendant anthropogenic factors which currently influence species viability are virtually certain to increase concomitantly. In particular, the overwhelming dependence of the human population of Haiti on wood-based cooking fuels (e.g., charcoal and firewood) has resulted in substantial deforestation and forest conversion in both Haiti and adjacent regions of the Dominican Republic. Future increases in the human population of Haiti will almost certainly result in increased deforestation rates throughout Black-capped petrel nesting areas, both for production of charcoal and necessary agricultural products and building materials.

In the case of regional climate regimes, the best available information suggests a hotter and drier future climate within the specific area where Black-capped petrels currently nest along with a steady increase in the number of intense (Category 3-5) hurricanes across the region over the next century. Although major hurricanes were likely not an existential threat to the Black-capped petrel under their historic (i.e. pre-Columbian) population conditions, the combination of fewer and smaller breeding populations, ongoing nesting habitat loss and degradation, and more frequent and intense tropical storms will likely result in adverse effects to the petrel from these stochastic atmospheric phenomena. Based on past trends and evidence, these adverse effects will likely also include increased mortalities of adults on the western Atlantic foraging grounds due to increased frequency of hurricane-induced inland strandings.

Finally, given the best available science at the time of this analysis, it is certain that the future viability of the Black-capped petrel is inextricably linked to the complex and challenging socioeconomic and environmental landscape that is Haiti. Up to as many as 90-95% of all known Black-capped petrel nest sites occur in what is internationally recognized as the poorest, least developed and most environmentally degraded country in the western hemisphere. And while there are, and will continue to be, numerous successful initiatives by both local and international conservation and humanitarian organizations to provide needed financial and technical support for environmental conservation in Haiti, these efforts are nonetheless subject to the vicissitudes of donor funding in an ever unpredictable global financial setting. In the end, the future of the Black-capped petrel will depend in large measure on the long-term effectiveness of ongoing and future conservation efforts in Haiti.

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## Chapter 1. Introduction and Analytical Framework

The Black-capped petrel (*Pterodroma hasitata*; Kuhl 1820) is a pelagic seabird that breeds on Caribbean islands and travels long distances to foraging areas in the western Atlantic and southern Caribbean basins, and perhaps the northern Gulf of Mexico. The U.S. Fish and Wildlife Service (Service), was petitioned to list the Black-capped petrel as endangered or threatened under the Endangered Species Act of 1973, as amended (ESA) on September 1, 2011, by WildEarth Guardians. In June of 2012, the Service found that the petition presented substantial scientific or commercial information indicating that the listing of the species may be warranted. The Species Status Assessment (SSA) is intended to be an in-depth review of the species' biology and threats, an evaluation of its biological status, and an assessment of the resources and conditions needed to maintain long-term viability. The intent is for the SSA to be easily updated as new information becomes available and to support all functions of the Endangered Species Program from Candidate Assessment to Listing to Consultations to Recovery. As such, the SSA will be a living document upon which other documents, such as listing rules, recovery plans, and 5-year reviews, would be based if the species warrants listing under the ESA. This SSA for the Black-capped petrel is intended to provide the biological support for the decision on whether to propose to list the species as threatened or endangered and, if so, whether to and where to propose designating critical habitat. Importantly, the SSA does not result in a decision by the Service on whether this taxon should be proposed for listing as a threatened or endangered species under the ESA. Instead, this SSA provides a review of the best available scientific and commercial information strictly related to the biological status of the Black-capped petrel. The listing decision will be made by the Service after reviewing this document and all relevant laws, regulations, and policies, and the results of a proposed decision will be announced in the Federal Register, with appropriate opportunities for public input. For the purpose of this assessment, we generally define viability as the ability of the Black-capped petrel to sustain populations on breeding and foraging grounds beyond a biologically meaningful timeframe, in this case, 50 years. Fifty years is within the range of available climate change model forecasts (see Bender et al. 2010, entire; Garner et al. 2013, entire) and it corresponds roughly to the length of time since the species was rediscovered in Haiti (Wingate 1964, entire), thereby providing a temporally equivalent and empirically-based frame of reference for predicting future conditions. Additionally, the estimated generation time of the Black-capped petrel is 5 years (Goetz et al. 2012, p. 5; Simons et al. 2013, p. S22), so 50 years encompasses approximately 10 generations, which we believe is an appropriate time horizon to realize predicted effects of factors acting on species viability. However, we also predicted factors affecting species viability at shorter time intervals (10 and 25 years), corresponding to approximately 2 and 5 Black-capped petrel generations, so that we could understand dynamics affecting the species from current condition to the end of the predictive time horizon. Using the SSA framework (Figure 1.1), current and future species viability was assessed by characterizing the status of the species using the

conservation biology concepts of resiliency, redundancy, and representation (Wolf et al. 2015, entire).

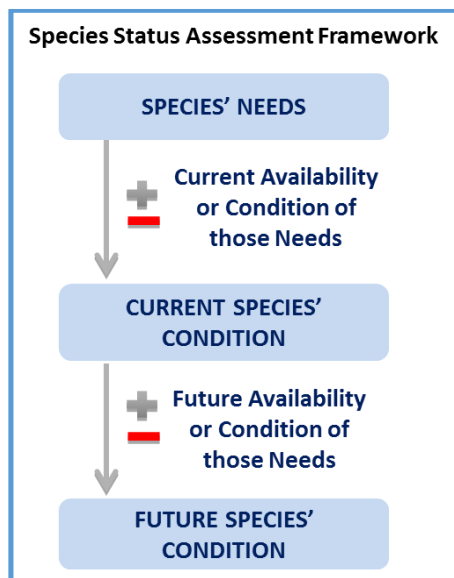


Figure 1.1 Species Status Assessment Framework

- **Resiliency** reflects a species' ability to withstand stochastic events (arising from random factors). Resiliency is measured at the population-level using metrics that characterize population health such as demographic rates and population size. Resilient populations are better able to withstand perturbations associated with demographic stochasticity (e.g. fluctuations in birth or mortality rates), environmental stochasticity (e.g. variations in precipitation or temperatures), and anthropogenic activities.

- **Redundancy** is having a sufficient number of resilient populations, which are distributed in such a way, for the species to withstand catastrophic events (such as a rare destructive natural event or episode involving many populations). Redundancy is about spreading the risk and is measured by the number and distribution of

populations across the species' range. The greater the number of populations a species has distributed over a larger landscape, the better it can withstand catastrophic events.

- **Representation** is a reflection of a species' adaptive capacity. Representation can be measured through the genetic diversity within and among populations and the ecological diversity (also called environmental variation or diversity) of populations across the species' range. The more representation, or diversity, a species has, the more it is capable of adapting to changes (natural or human caused) in its environment.

To evaluate the current and future biological status of the Black-capped petrel, we assessed a range of conditions that reflect the species' resiliency, redundancy, and representation (together, the "3Rs"). This SSA provides a thorough assessment of Black-capped petrel biology and natural history and assesses demographic risks, threats, and limiting factors in the context of determining the viability and risks of extinction for the species.

The format for this SSA includes: (1) an assessment of individual and population-level resource needs (Chapter 2); (2) a description of the Black-capped petrel's historical and current distribution and an estimate of what the species' needs (in terms of distribution of resilient populations) to remain viable (Chapter 3); (3) a review of the likely causal mechanisms underlying estimated and predicted current and future status (Chapter 4); and (4) a summary of overall species' viability (Chapter 5). This document is a compilation of the best available

scientific and commercial information and a description of past, present, and likely future risk factors to the Black-capped petrel.

## **Chapter 2. Species Life History and Ecology**

In this chapter, we provide a concise summary of the species' taxonomy, life history characteristics, and basic ecology. While not an exhaustive review of all extant literature, it provides a fundamental understanding of the species ecology to facilitate analyses of resiliency, representation, and redundancy.

### **2.1 Species taxonomy and nomenclature**

The genus *Pterodroma* consists of about 30 widely distributed species, known as gadfly petrels (Simons et al. 2013, p.S4), of which the Black-capped petrel (*P. hasitata*) is the only such species known to currently breed in the Caribbean region. Although records and specimens exist of an additional native gadfly petrel in the Caribbean (*P. caribbaea*), that species is now considered extinct (Goetz et al. 2012, p. 3; Simons et al. 2013, p. S19). Formerly in the genus *Procellaria*, as were all other gadfly petrels, the species *hasitata* was reclassified and named within the genus *Pterodroma* by Bonaparte in 1856, although common usage of the updated nomenclature did not occur until a reconfirmation by Loomis in 1918 (Simons et al. 2013, p. S5). Although sympatric with the Cahow (*P. cahow*), helicoidal twist counts of intestines indicate that the Black-capped petrel is distinct from the Cahow (Simons et al. 2013, p. S6). Interestingly, the type locality for the Black-capped petrel was never stated, and is presumed to be Dominica (Simons et al. 2013, p. S5).

Officially known as the “Black-capped petrel” in current ornithological literature, it is also known by several distinct common names throughout its range. While the name “*diablotin*” is most common among both French and Spanish-speaking range states, the petrel is also known as “*chathuant*” (Haiti) and “*bruja*” or “*chanwan*” (Cuba). Many authors including Simons et al. (2013, p. S5) advocate a return to the more traditional and widely-recognized (among range states) common name of “*diablotin*”.

### **2.2 Morphological and genetic variability**

Field observations and examination of museum skins have revealed wide variations in both size and coloration of the Black-capped petrel (Simons et al. 2013, pp. S7-S10). Birds captured off the southeastern coast of the United States (n = 68) have ranged in weight from more than 500g to slightly over 300g, with males averaging approximately  $439 \pm 8.8$  g, and females  $419 \pm 12$  g (Simons et al. 2013, pp. S8-S9). Weight differences were not related to sex, age, or molt stage. Notably, smaller birds also display less areas of white plumage (Simons et al. 2013, p. S10). A “light” and “dark” color form of this species has been recognized for centuries (see review in Simons et al. 2013, entire).

Relatively little work has been done examining the degree of genetic variability or differentiation within *P. hasitata* (see review in Simons et al. 2013, entire). However, the most recent and comprehensive was that of Manly et al. (2013, entire), who used amplified mitochondrial cytochrome oxidase 1 (CO1) sequences to look for genetic variations among plumage variants. Manly et al. (2013, p. 228) reported a 1.2% fixed genetic difference between light and dark color variants of the Black-capped petrel. Their findings and conclusions suggest potential isolation (seasonal or breeding) of the two color forms. While these findings could also suggest possible existence of two distinct species or subspecies (Howell and Patteson 2008, entire, Goetz et al. 2012, p. 3), additional data on genetic structure of known nesting colonies is needed to refute or confirm such hypothesis (Manly et al. 2013, entire, Simons et al. 2013, p. S6).

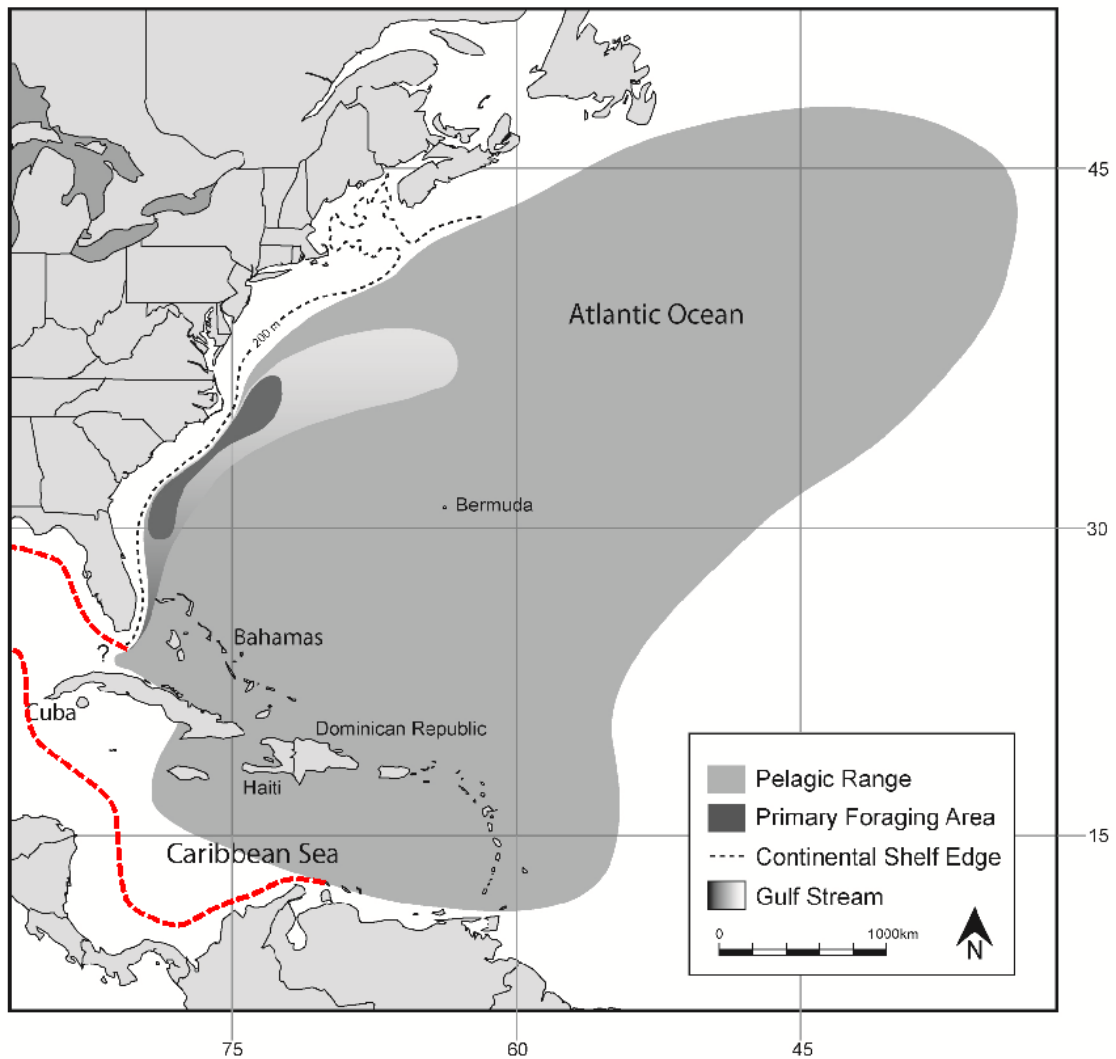
## **2.3 Geographic range and habitat affinities**

### ***2.3.1. Marine habitat***

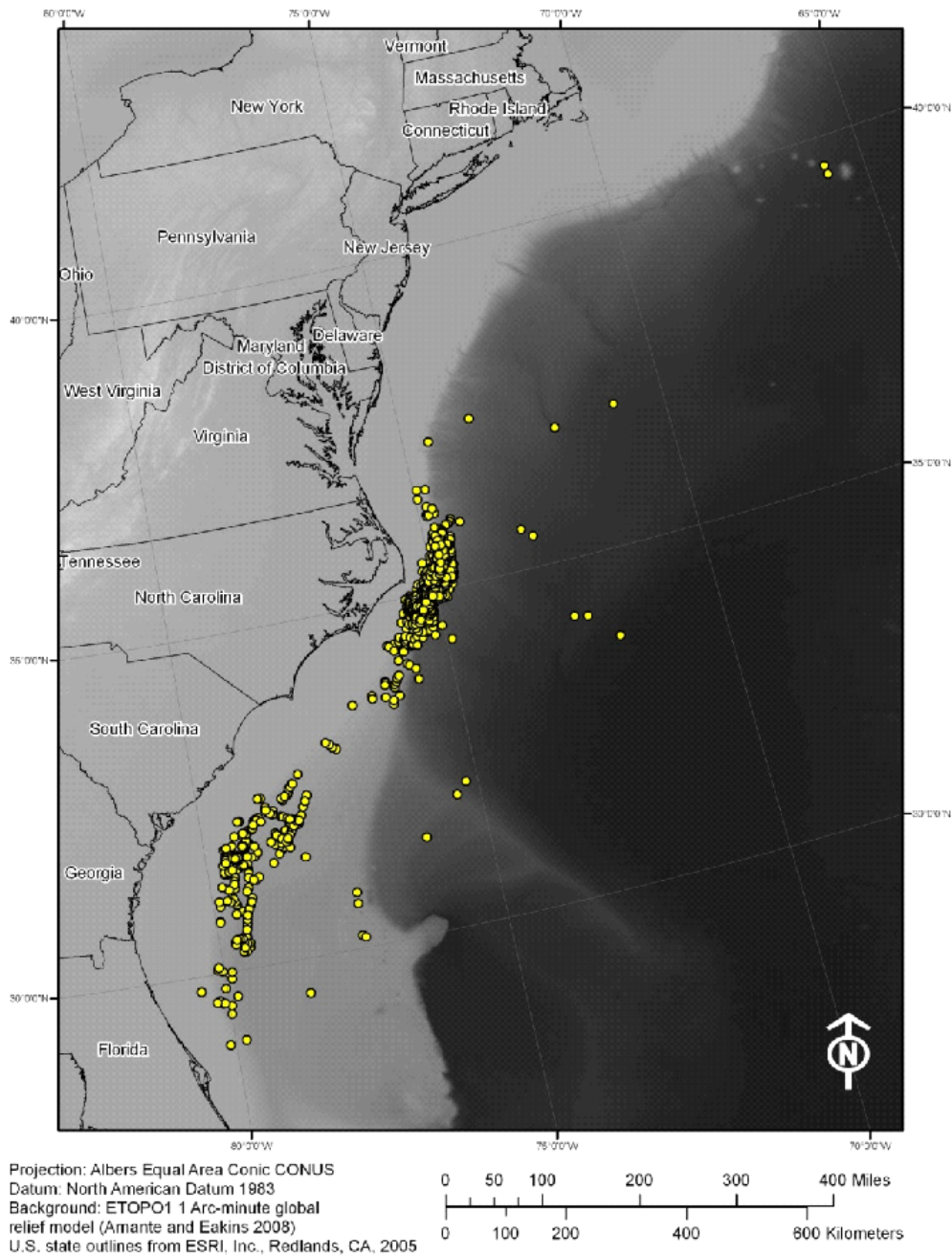
As a pelagic seabird, the Black-capped petrel spends the majority of its life over open seas (Haney 1987, p. 153; Goetz et al. 2012, p. 4; Simons et al. 2013, p. S22), venturing inland only to nest, which it does in ground burrows and deep rocky crevices and caves. Use of marine habitats is largely confined to tropical and subtropical waters from 10°-45°N latitude (Haney 1987, p. 153; Simons et al. 2013, p. S22; Jodice et al. 2015, entire; Fig 2.1). Moreover, the vast majority of offshore occurrences of the species have also been either near Caribbean islands, or those areas bathed by the Gulf Stream from southern Florida to the mid-Atlantic region of the United States (Haney 1987, p. 155). According to Simons et al. (2013, p. S22), this offshore region from southern Florida to Cape Hatteras, North Carolina is the only marine area where regular and sizable concentrations of the species occur (Fig 2.2). Simons et al. (2013, p. S23) stated further that apparently most of the world's population of Black-capped petrels forages off the coast of the southeastern United States, making this area important for the survival of the species. However, recent satellite tracking of a few (n = 3) individual petrels suggests that use of near-shore waters off the northern coast of Central and South America for foraging by Black-capped petrels during the breeding season may have previously been overlooked or underestimated (Jodice et al. 2015, entire). Isolated accounts and sightings of the species in the Gulf of Mexico have usually been presumed to be of individual vagrants or strays driven by storms (Simons et al. 2013, p. S23). However, recent additional sightings of individual petrels (but no pairs or flocks) in the central and northeastern Gulf of Mexico suggest perhaps more use of this marine region by Black-capped petrels than previously believed (J. Haney, in litt.).

At sea, the primary habitat of the Black-capped petrel is generally (but not exclusively) that of deep waters (e.g. 200-2000 m depths). In such areas, Haney (1987, p. 158) reported that Black-capped petrels were most common near seamounts, submarine ridges, and other benthic landscapes that promoted vigorous current mixing and deep upwelling, which typically bring food items to the surface. Areas of the strongest and most persistent upwelling are where greatest numbers of petrels are found, especially in the deeper offshore zone near southern South

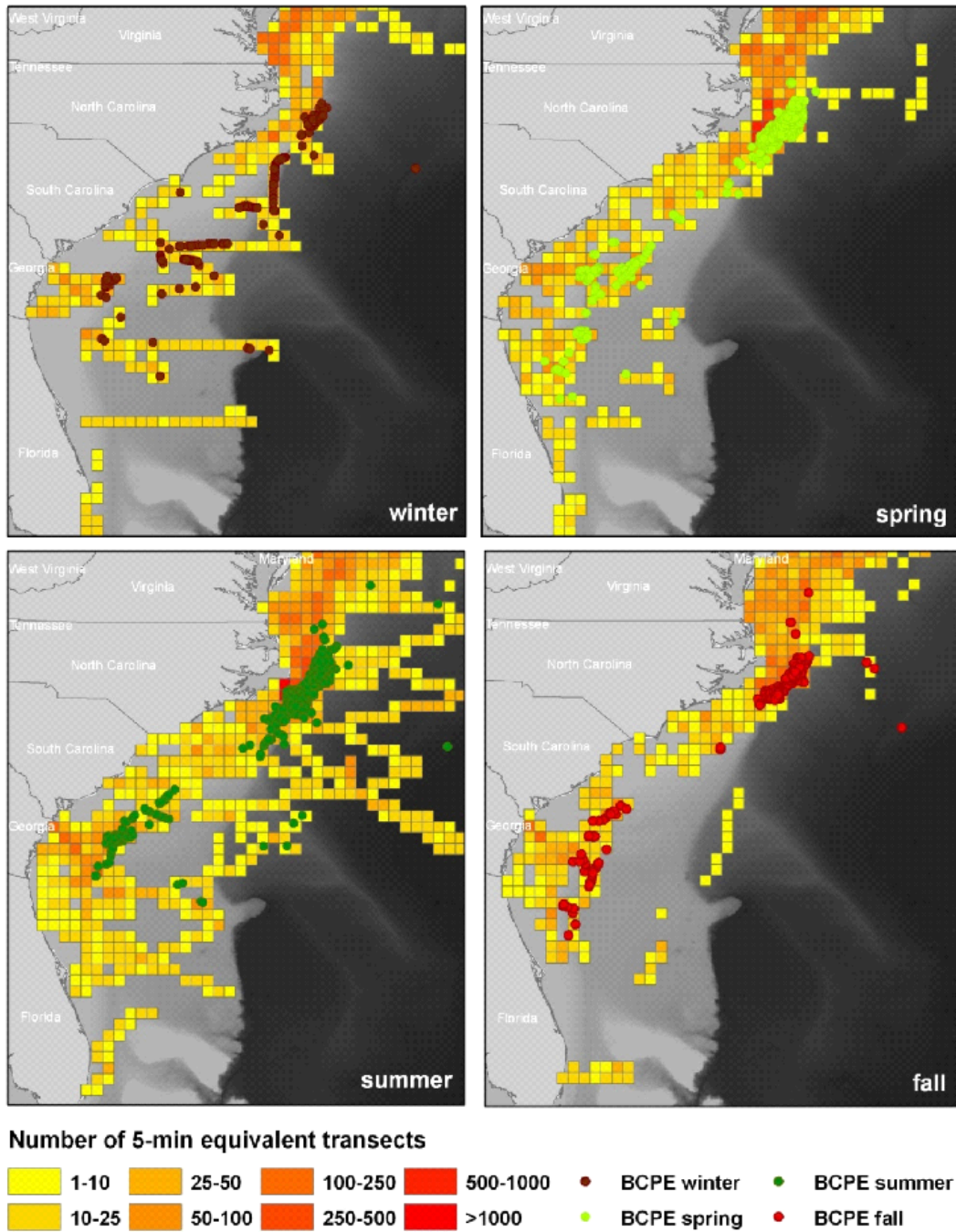
Carolina and northern Georgia, and the Cape Hatteras, North Carolina region (Fig 2.2; see also Jodice et al. 2015). More specifically, Black-capped petrels are most abundant in the immediate frontal region between current eddies (Simons et al. 2013, p. S25), and relatively scarce in shallower continental shelf areas. Other researchers have noted that the petrels track the western edge of the Gulf Stream in this region (Hass 2012, p. 227), with abundances peaking during the spring (April-June) and fall (October-November; Haney 1987, p. 157; Fig. 2.3). Although sea surface temperatures of areas used by petrels most often correspond to the 28° C and 29° C isotherms, neither sea surface temperatures nor depth alone are considered absolute predictors of petrel use (Haney 1987, p. 160). For example, off Florida, petrels have been found in shallower waters and nearer to shore than in the mid-Atlantic region. Thus, exact locations of petrel abundance can be unpredictable, given the annual, seasonal and latitudinal dynamic nature of Gulf Stream flows (Simons et al. 2013, p. S25; Fig. 2.3). Interestingly, Lee (1977, p. 1), during 20 days of monitoring shallower continental shelf waters off the coasts of Virginia and North Carolina, did not report a single Black-capped petrel. Apparently, petrels possess behavioral and physical adaptations that allow efficient exploitation of ocean niches with deep water and scarce prey. For example, their low wing loadings allow efficient gliding, making long distance foraging flights more energetically efficient (Simons et al. 2013, pp. S28-S29).



**Figure 2.1.** Marine range of the Black-capped petrel in the Atlantic Ocean. Figure adapted from Simons et al. (2013), and used with permission of lead author. Dotted red line indicates additional marine areas (i.e. southeastern Caribbean, Gulf of Mexico) used by the Black-capped petrel based on recent (2010-2018) satellite-tracking and visual observations. Westward extent of the Gulf of Mexico range of the Black-capped petrel remains uncertain at current time.



**Figure 2.2.** Reports of Black-capped petrel location at sea off the eastern USA in relation to slope and bathymetry of the continental shelf. Data based on that compiled by O’Connell et al. (2009) from numerous sources. Figure adapted from Simons et al. (2013), and used with permission of lead author.



**Figure 2.3.** Seasonal distribution of Black-capped petrels off the coast of the southeastern USA in relation to survey effort and coverage. Dots represent the detection of at least one Black-capped petrel within the grid cell. Data compiled by O’Connell et al. (2009) from numerous sources. Figure adapted from Simons et al. (2013) and used with permission of lead author.





**Figure 2.4.** Locations of known nesting areas of the Black-capped petrel on the island of Hispaniola. Locations indicated by red dots. From left to right these are: Pic Macaya (Haiti); Pic Visite (Haiti); Morne Vincent/Sierra de Bahoruco (Haiti/Dominican Republic); Valle Nuevo (Dominican Republic).

### 2.3.2 Terrestrial habitat

Black-capped petrels use terrestrial habitats only for nesting. Currently, the only confirmed active nesting areas are just inland from the southwestern coast of the island of Hispaniola (Fig. 2.4), a landmass shared by the countries of Haiti (36%) and the Dominican Republic (64%). However, there are past anecdotal accounts and recent indirect indications of the possible existence of additional nesting areas on Cuba and the island of Dominica (Goetz et al. 2012, p. 13; Simons et al. 2013, p. S15; Brown 2015, entire). The current known nesting areas are topographically characterized by steep, mountainous terrain dominated by *Pinus occidentalis*, sparse and open understory vegetation, and loose soils or decaying vegetation conducive to burrow excavation (Wingate 1964, p. 151; Simons et al 2013, p. S20). In fact, most reported Black-capped petrel nests have been found along or near steep, virtually inaccessible cliffs; particularly those composed of dolomitic limestone or other karst materials which provide abundant holes, caves, and crevices (Wingate 1964, p. 151; Rupp et al. 2011, entire; Simons et al. 2013, p. S20; J. Goetz, pers. comm.). According to Wingate (1964), most nest sites are also found at elevations from 1500 to 2000 m above sea level (ASL). These nesting sites are in most cases also found less than 30 km from the coast (see Goetz et al. 2012, pp. 4-5), although there are anecdotal accounts of nests further inland. However, little data exist on specific characteristics of historical nesting sites. Given the numerous historical accounts of large numbers of petrels harvested for food at breeding colonies (see extensive review in Simons et al.

2013, entire), past nesting areas may likely have occurred in much more accessible areas than those of contemporary nests. Thus, it is unclear whether current nesting areas and sites constitute those preferred by the species, or are simply those to which the species has been relegated due to the combined cumulative pressure from habitat loss, harvesting by humans, and invasive predators in potentially more optimal areas (Simons et al. 2013, p. S20).

## 2.4 Population estimates

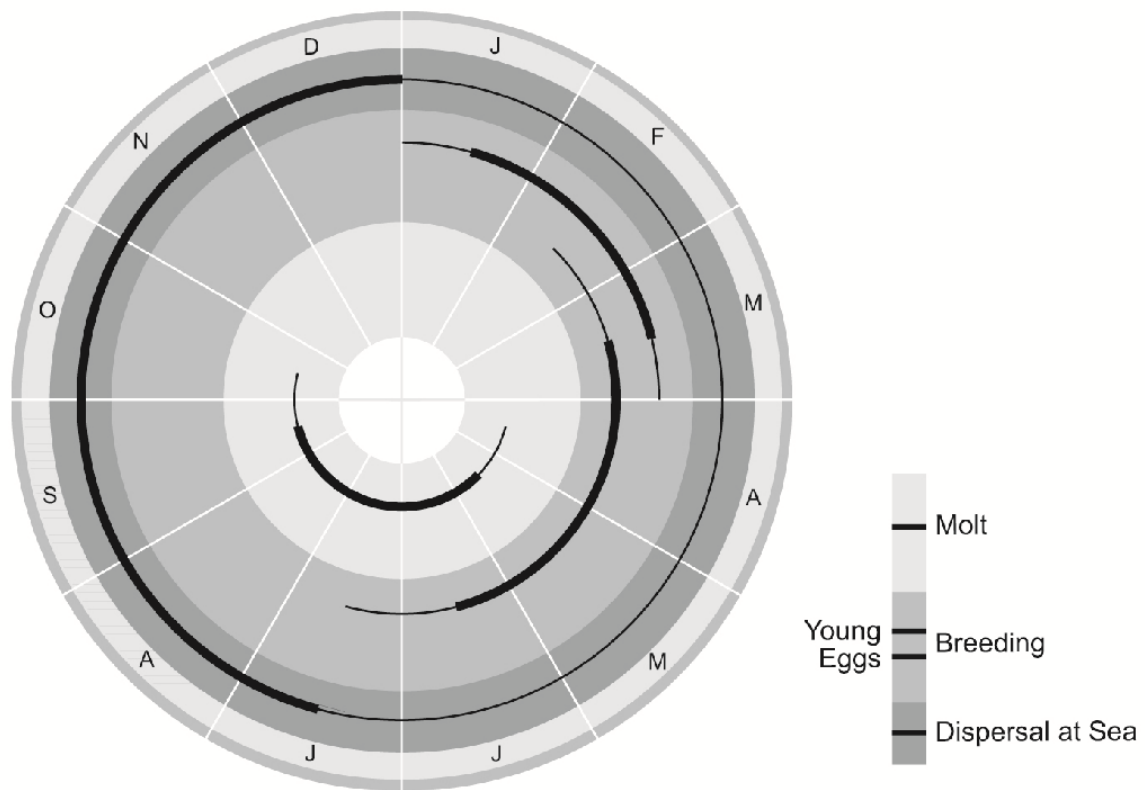
Although the actual population size of the Black-capped petrel is unknown, published estimates range from approximately 2,000 to 4,000 birds, among which are perhaps 500-1,000 breeding pairs (Simons et al. 2013, p. S22). If accurate, this suggests that breeding birds comprise approximately 50% of the total population. Population models for the closely related Dark-rumped petrel (*P. phaeopygia sandwichensis*) also projected that pre-breeding birds comprised approximately 50% of the total population for that species (Simons 1984, entire). And while population trends are likewise unknown, the historical population estimates of Wingate (1964, entire) suggested a total population of approximately 8,000 birds. Wingate's 1964 estimate compared to Simons et al. 2013 estimate suggests a decline in abundance of approximately 50-75% over the last 50 years. Historic estimates should generally be considered conservatively (i.e., as minimum estimates) because older survey techniques did not account for factors such as detection probability. A major cause of the uncertainties surrounding population estimates and trends for this species is the inherent difficulty of conducting accurate counts, particularly at breeding sites, where all current counts have been conducted. The high mobility of petrels combined with their cryptic and strictly nocturnal breeding and nesting behavior, makes detection and discrimination of individual birds challenging, and in some cases, virtually impossible. Moreover, temporal variations in calling behavior (by which birds are detected) are related to sex, age, and breeding status of individual birds (Simons 1985, p. 238). Further complicating population size estimation is an uncertain relationship between numbers of calling birds, breeding chronology and breeding population size (Simons et al. 2013, p. S22).

Though uncertain, recent estimates suggest that the numbers of breeding pairs at sites in the Dominican Republic may be currently be in the 10s to 100s (Simons et al. 2013, p. S22), while those in neighboring Haiti may range from approximately 500-1,500 (Goetz et al. (2012, pp. 4-5) and both Simons et al. (2013, p. S23) and Goetz et al. (2012, pp. 4-5) suggested that nesting areas in Haiti may contain up to 95% of currently known nest sites for this species. Using recent advances in detection methodology, specifically digital acoustic monitoring, McKown (2014, entire) found evidence of approximately 60 active nest sites in the nesting areas of southwestern Dominican Republic. McKown's more recent estimate is consistent with estimates of Simons et al. (2013). Using radar surveys, Brown (2013, entire) detected 64-320 "petrel-like targets" (i.e. consistent with size and speed of petrels) across eight sites in the Dominican Republic (including three potential new nesting areas), and detections ranging from 6-1,570 individuals across an additional eight sites in Haiti. Similar radar surveys on Dominica (Brown 2015, entire) detected a

total of 968 “petrel-like targets” across 17 locations while also visually confirming at least eight individuals. Most (63%) of the detections were at four locations: Morne Diablotin (205), Morne Anglais (168), Morne Micotrin (127) and Morne Trois Piton (106). Because it is unknown whether the Black-capped petrels detected on and near Dominica pertain to the same population as estimated by Simons et al. (2013), it is therefore unknown whether these individuals represent an addition to prior abundance estimates (i.e. those of Goetz et al. 2012, Simons et al. 2013). There are no currently known populations of the Black-capped petrel in other range states (Goetz et al. 2012, pp. 12-14).

## **2.5 Biology of nesting populations**

Although the overall breeding biology of the Black-capped petrel is poorly understood (Simons et al. 2013, p. S19), it is believed that they typically nest during January-July; with egg-laying occurring from mid- to late January, chicks hatching during mid- to late March, and chicks leaving nests from mid-June to mid-July (Simons et al. 2013, pp. S19-S20; ABC 2014, entire). For example, ABC (2014, entire) reported that among 35 nests with nestlings, 25 (71%) had fledged by July 11. However, prior to laying eggs, Black-capped petrels may spend considerable time (up to 2 months) entering and preparing nest burrows and crevices; thus, the actual “nesting season” is quite lengthy and may encompass up to 9 months in its entirety (Simons et al. 2013, pp. S19-S20; see also Fig. 2.5). Nest burrows are typically lined with material such as pine needles and small twigs brought into the burrow by the nesting pair (Simons et al. 2013, p. S20). Although females usually spend lengthy periods of time away from the nest site before egg-laying - ostensibly foraging and acquiring sufficient nutritional reserves for egg production - males will frequently enter nests during this time in anticipation of the female’s return. Once eggs are laid, both sexes engage in incubation and care and feeding of nestlings. Only a single egg is laid by the Black-capped petrel, as is also the case with the sympatric Cahow (*P. cahow*) of Bermuda (Simons et al. 2013, pp. S19-S21). Thus, productivity and fecundity are inherently low. Assuming similar nesting biology as the Cahow (see Simons et al. 2013, pp. S19-S21), the incubation period is likely 50-53 days, with chicks undergoing a lengthy nestling period of 80-85 days. However, following their initial exit from the nest burrow, fledglings spend yet an additional 4 to 15 days both inside the burrow and just outside the burrow entrance, engaging in nightly bouts of wing and flight musculature exercise before finally taking flight and abandoning the nest site. Thereafter, the nest sites remain vacant until approximately mid-October, when the next nesting cycle begins. Although age at first breeding likewise is unknown for the Black-capped petrel, it is thought to be similar to that of the Cahow. For that species, birds begin breeding at five to eight years of age, with established pairs persisting for perhaps 10-20 years (Simons et al. 2013, p. S22). Active nest burrows may remain in use by the same pair year after year, although burrows are sometimes abandoned after death of one member of the pair.



**Figure 2.5.** Annual activity cycle of the Black-capped petrel. Figure adapted from Simons et al. (2013), and used with permission of lead author.

## 2.6 Survival and longevity

There is virtually no information on age-specific survival or individual longevity of Black-capped petrels. However, Rupp et al. (2012, entire) monitored 30 Black-capped petrel nests – half in Haiti and half in the Dominican Republic – and reported overall nesting success of 76.7%, with 23 of 30 nests fledging chicks (Simons et al. 2013, p. S21). Because the petrel produces only one chick/nest, overall nesting success thus equals nestling survival rate. ABC (2014, entire) also located and monitored 47 active nests within the same nesting areas as Rupp (2012), and reported nesting success of 75% and 74% for nests in Haiti ( $n = 20$ ) and Dominican Republic ( $n = 27$ ), respectively. Similar nest success has been reported for the closely-related Cahow (Madeiros 2012, entire). According to Simons et al. (2013, p. S21), this approximates the maximum fecundity reported for other similar species (based on Simons 1984, entire, Madeiros et al. 2012, entire), and likely sufficient to maintain an equilibrium population. However, currently there are no data on whether the observations of Rupp et al. (2012, entire) and ABC (2014, entire) represent the norm for the species, or if there are significant temporal (interannual) or spatial variations in nesting success and productivity. While adult survival and

longevity of the Black-capped petrel is also unknown, long-term observations by D. Wingate (cited as personal communication in Simons et al. 2013, p. S21) estimated annual adult mortality of 5% for the sympatric and ecologically similar Cahow. Thus, Black-capped petrel adults may potentially live for up to 20 years, although Goetz et al. (2012, p. 5) suggested longevity of possibly up to 40 years. For many long-lived seabirds, high adult survival rates and longevity tend to compensate for inherently low reproductive rates.

## **2.7 Diet, feeding and foraging**

As with survival and longevity, little data are available regarding the diet of the Black-capped petrel (Simons et al. 2013, p. 30). Three petrel stomachs collected off the coast of Georgia and examined by Haney (1987, entire) contained fish (a single *Monocanthus hispidus*), squid, and *Sargassum* algal blades in addition to small pieces of petroleum residue and paper in one stomach. Moser and Lee (1992, p. 85) also examined contents of 57 Black-capped petrel stomachs collected off North Carolina and found (in order of occurrence) squid (93.0%), fish (49.1%), unidentified items (17.5%), *Sargassum* fragments (14.0%), crustaceans (3.6%), and fragments of plastic in 1.8% of all stomachs. Moreover, they (Moser and Lee 1992, p. 85) reported that while weights of stomach contents were as high as 35g, 4.0% of the stomachs examined were empty. Apparently, squid and fish make up the bulk of the petrels diet, although Simons et al. (2013, p. 30) cautioned that occurrence of squid can be overestimated from stomach contents, due to the persistence and accumulation of beak fragments in crops. The presence of *Sargassum* and plastic fragments in crops is believed due to incidental ingestion while feeding on items at the sea surface (Simons et al. 2013, p. S30). The file fish (*Monocanthus hispidus*) found in one stomach is a species closely associated with floating *Sargassum* mats. Overall, Black-capped petrels appear to ingest fewer incidental fragments of plastic or other extraneous items, compared to other seabird species (Moser and Lee 1992, pp. 89-91; Simons et al. 2013, p. S30).

Based on the time of collection and degree of digestion of stomach contents, Black-capped petrels feed mainly during nighttime or early morning hours (Simons et al. 2013, p. S28), although there are also observations of diurnal feeding activity. According to Haney (1987, p. 153), although the petrel exhibits some activity during all daylight hours, diurnal activity peaks from 0700-0900 h and 1700-1900 h, with all observed diurnal feeding activity either prior to 0900 h or after 1500 h. As reported in Simons et al. (2013), diurnal feeding activity associated with chum-feeding experiments occurred only after 1500 h. The petrel's exploitation of diel, vertically-migrating, mesopelagic nekton suggests adaptation for nocturnal or crepuscular feeding (Imber 1985, p. 225; Simons et al. 2013, p. S30).

Foraging by Black-capped petrels occurs mainly (96%) in flocks, with 88% of observed feeding flocks comprised also of other avian species (Simons et al. 2013, p. S28). At times such flocks may contain up to 65 Black-capped petrels (Haney 1987, p. 159). Schools or congregations of baitfish or marine invertebrates have reportedly attracted petrels in feeding assemblages of up to

12 other seabird species, with individual feeding bouts typically ranging from 2-8 accompanying species (Simons et al. 2013, p. S28). These mixed species foraging flocks are most commonly comprised of Cory's shearwaters (*Calonectris diomedea*), Audubon's shearwaters (*Puffinus iherminieri*), Greater shearwaters (*P. gravis*), and Pomarine jaegers (*Stercorarius pomarinus*) during summer, and Black-legged kittiwakes (*Risa tridactyla*) and Herring gulls (*Larus argeniatus*) during the winter (Simons et al. 2013, p. S28). In general, Black-capped petrels are not known to be attracted to feeding activities or assemblages of marine mammals.

Black-capped petrels may also be attracted to waste discarded from ships and fishing vessels, as evidenced by their being attracted to chum. However, it is believed that such attraction may be greatest in times of low or unpredictable natural food abundance (Simons et al. 2013, p. S28). Apparently, Black-capped petrels do not rely exclusively on olfaction for locating food sources, as petrels have been observed arriving from upwind to investigate active feeding sites of other seabirds. According to Haney et al. (1992, p. 52), Black-capped petrels may be able to visually detect food items and feeding sites from distances up to 0.7-6.2 km, possibly more. According to Simons et al. (2013, p. S28), their high, arching flight pattern likely facilitates visual detection of potential feeding sites.

## **2.8 Parasites and diseases**

Scant information exists regarding parasites and diseases of the Black-capped petrel. Simons et al. (2013, p. S29) reported, based on a sample of 20 petrels taken off the coast of North Carolina, the presence of several ectoparasitic lice (Phthiraptera) species. These lice were classified in the families of Philopteridae (3 species) and Menoponidae (1 species), with the latter species (i.e. *Austromenepon popellus*) being widespread and common among the petrel genera *Pterodroma*, *Procellaria*, *Lugensa*, and *Pseudobulweria* (Simons et al. 2013, p. S29). Potential internal parasites or pathogens (fungal, bacterial, viral) which may also affect the Black-capped petrel are currently unknown, as they apparently have not been investigated.

## **2.9 Current threats**

### ***2.9.1 Deforestation***

Goetz et al. (2012, entire) considered deforestation and associated loss and degradation of nesting habitat to be the most significant current threat to the Black-capped petrel. In fact, many of the Caribbean islands where petrels were historically reported have experienced extremely high rates of forest conversion and loss since European colonization (Goetz et al. 2012, entire; Simons et al. 2013, p. S31), although the petrel was likely extirpated from Martinique in pre-Columbian times (Simons et al. 2013, p. S11). Primary mechanisms of deforestation in the region include urbanization, clearing of land for pastures or agriculture, felling of trees for building materials, and charcoal production. On Hispaniola, where all known currently active petrel nesting sites occur, estimates of current deforestation range from over 90% (and

increasing) for the Haitian portion (but see Churches et al. 2014, entire), to slightly less than 90% for the Dominican Republic portion (Castro et al. 2005, entire; BirdLife International 2010, entire, Simons et al. 2013, p. S31). Deforestation in the Haitian nesting areas (Figs. 2.6,2.7) is particularly significant for the petrel, given that up to 90% of all active nest sites of the species may occur there (Goetz et al. 2012, p. 5; J. Goetz, pers. commun.). Although deforestation in petrel nesting areas of the Dominican Republic has been comparatively lower than in those of neighboring Haiti, recent increases in forest clearing for subsistence agriculture and charcoal production in the Sierra de Bahoruco and other areas adjacent to the Haitian border have resulted in concomitant increases in nesting habitat loss and degradation there (Checo 2009; entire, Grupo Jaragua 2011; entire, Goetz et al. 2012, p. 7; Simons et al. 2013, p. S31; see Figs. 2.8, 2.9, 2.10). Meanwhile however, the island of Dominica – a potential petrel nesting area – remains largely forested, with over 60% of native forests remaining. Cuba, likewise another potential petrel nesting site, currently retains approximately 24% of native forest cover (BirdLife International 2010, entire).

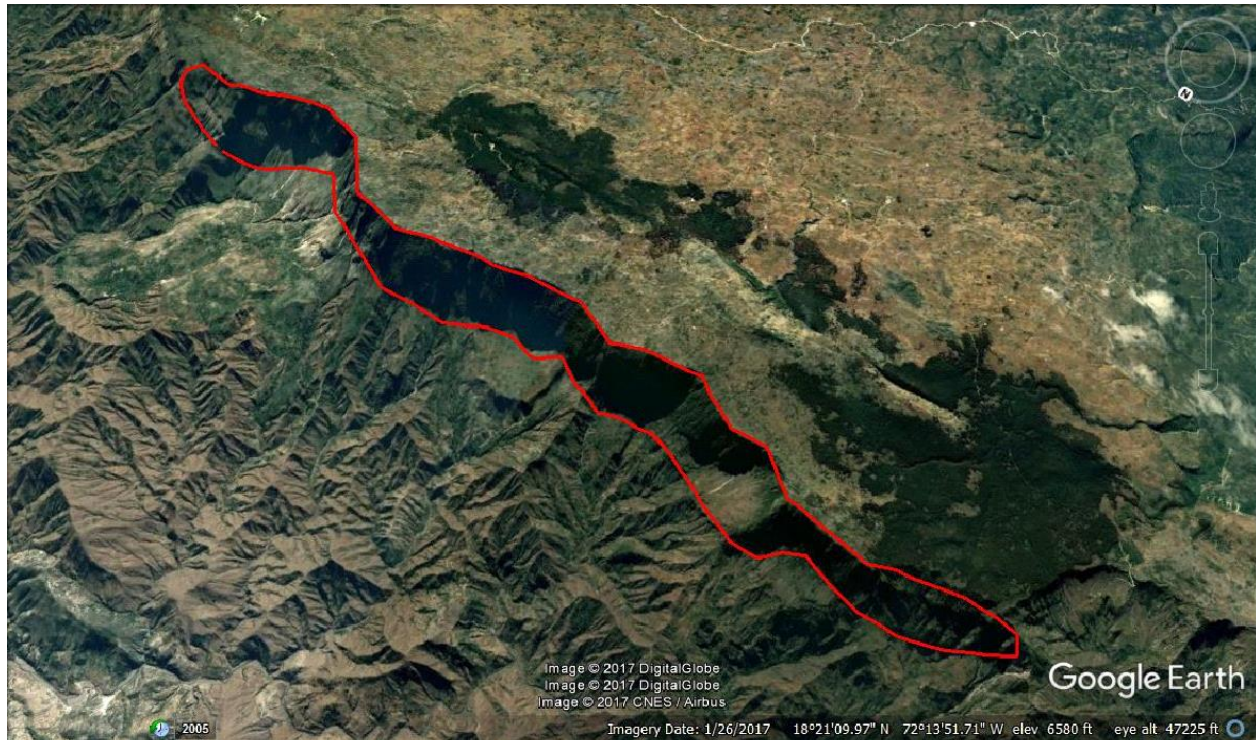
### ***2.9.2 Human predation***

The harvesting of petrels – both adults and nestlings – from nest burrows for human consumption has occurred for literally centuries (see review in Simons et al. 2013, pp. S10-S19). Historical accounts of large numbers of petrels taken for food on the islands of Jamaica, Guadeloupe, and Dominica likely (in conjunction with habitat loss) contributed to the eventual extirpation of the species from those areas (Simons et al. 2013, pp. S11-S12). The petrel is thought to have been eliminated from the island of Martinique by harvesting for food by the pre-Columbian Carib Indian population (Simons et al. 2013, p. S11). Today however, due both to the scarcity of the petrel, and its use of remote and largely inaccessible areas to nest, human predation is considered incidental and opportunistic (Goetz et al. 2012, p. 8; Simons et al. 2013, p. S30).

### ***2.9.3 Forest fires***

Because the Black-capped petrel is primarily a pelagic species, forest fires only directly affect the species during the nesting season. However, effects may be significant and potentially long-term, as fires set to clear land for agriculture can result in substantial loss and conversion of forested nesting habitat. Moreover, fires during the incubation and brooding phase can jeopardize adults and nestlings within nest burrows. The incidence of anthropogenic fires has been positively associated with increases in human populations (Wingate 1964, p. 154; Simons et al. 2013, p. S31). Although natural fires resulting from lightning strikes also occur, these tend to occur mainly during the wetter summer months (Robbins et al. 2008, entire). Naturally-occurring fires have been attributed to helping maintain open, park-like pine savannahs at higher elevations which may be more accessible to petrels (Simons et al. 2013, p. S31). In contrast, most anthropogenic fires occur during the winter dry season, when petrels are actively nesting (Simons et al. 2013, p. S31) and thereby constitute more of a direct threat. Dry season fires also

tend to be more intense, delaying or inhibiting forest recovery due to destruction of seed banks and organic humus layers (Fig. 2.11; see also comments in Rupp and Garrido 2013, entire). Fires can also have indirect effects on petrel nesting habitat, by increasing erosion and mudslides following elimination of previously existing vegetation and ground cover. In fact, Woods et al. (1992, pp. 196-205) and Simons et al. (2013, p. S33) suspected that increased erosion of cliffs used for nesting by petrels in the Massif de la Selle in Haiti was a result of fires deliberately set to facilitate clearing of land and for fuel wood harvesting. For years such fires have also denuded large swaths of forest cover in the petrel nesting areas of Pic Macaya in the Massif de la Hotte of Haiti (Sergile et al. 1992, pp. 5-12). In the petrel nesting areas of the Dominican Republic, fires are also at times deliberately set in retaliation for actions taken by government officials to evict or otherwise deter Haitian migrants engaged in illegal land-clearing activities (Rupp and Garrido 2013, entire).



**Figure 2.6.** Approximate nesting area of the Black-capped petrel (outlined in red) in the area of La Visite National Park of Haiti. Note extensive deforestation throughout surrounding landscape.





**Figure 2.7.** Approximate nesting area (outlined in red) of the Black-capped petrel in the Pic Macaya National Park of Haiti. Note extensive deforestation throughout surrounding landscape.



**Figure 2.8.** The border region between Haiti (left of red line) and the Dominican Republic (right of red line) adjacent the Sierra de Bahoruco of the Dominican Republic. Note heavy deforestation on Haitian side, and dispersed areas of deforestation on the Dominican Republic side.



**Figure 2.9.** Location of the first active Black-capped petrel nest site described by Simons et al. (2002) in relation to proximity of the Haitian/Dominican Republic border (in red). Note scattered areas of deforestation near nest location.



**Figure 2.10.** Charcoal production on the island of Hispaniola. Upper image depicts forested area cleared both for agriculture and to obtain wood for charcoal. Active charcoal pit-oven is visible in right center of image. Lower image depicts an actual charcoal pit-oven in use. Photos by T. White.



**Figure 2.11.** Burned area near the Black-capped petrel nesting area of Morne Vincent, Haiti. Photo by J. Goetz.

#### ***2.9.4 Introduced mammals***

Like most native Antillean species, the Black-capped petrel evolved in the absence of mammalian ground predators. However, following European colonization, many Caribbean islands quickly (in an evolutionary context) became host to populations of introduced black rats (*Rattus rattus*), Norway rats (*Rattus norvegicus*), domestic dogs (*Canis familiaris*), feral pigs (*Sus scrofa*) and domestic cats (*Felis domesticus*). More recently, the deliberate introduction of the small Indian mongoose (*Herpestes javanicus*), which began first in Jamaica in 1872, has also resulted in apparently uncontrollable populations on all islands – except Dominica – where the petrel is known or suspected to nest or have once nested (Barun et al. 2011, pp. 19-20; Simons et al. 2013, p. S31). Following initial introduction to Jamaica, the mongoose was promptly introduced to Cuba (1882), Hispaniola (1895), Martinique (1889), and Guadeloupe (1880-1885; Simons et al. 2013; p. S31). Although introduced also on Dominica during the 1880s, that introduction was apparently unsuccessful (Henderson 1992, p. 4). While all of these introduced mammals have negatively affected other native Caribbean species (e.g. Henderson 1992, entire;

White et al. 2014, pp. 35-38), their current impact on the Black-capped petrel is largely unknown (Goetz et al. 2012, p. 7; Simons et al. 2013, p. S31). Nevertheless, rats in particular are known nest predators and have been observed at entrances to petrel nest burrows (Goetz et al. 2012, p. 7), thus the potential clearly exists for rat predation on petrel nests. The mongoose, rats and dogs likely played a major role in the extirpation of the Jamaican petrel (*P. caribbaea*) (Lewis et al. 2010; p. 2, Goetz et al. 2012, pp. 13-14 and Simons et al. 2013, pp. S16-S17). Dogs are commonly kept by security personnel and allowed to roam free at night at communication towers near petrel nest sites in the Dominican Republic (Rupp et al. 2011, entire), and may excavate petrel nest burrows or prey on fledgling or adult petrels at or near nest entrances (Woods 1987, pp. 196-205; Goetz et al. 2012, p. 7). In fact, there are historical accounts of local inhabitants on Guadeloupe using trained dogs to assist in harvesting petrels for food (Simons et al. 2013, p. S12). Feral cats have also been documented at elevations up to 2100 m in the Sierra de Bahoruco of the Dominican Republic at the base of petrel nesting cliffs (Simons et al. 2013, p. S31). Feral cats are known to be significant predators of Hawaiian petrels and of Great-winged petrels (*P. macrotus*) on Kerguelen Island (Simons et al. 2013, p. S31), as well as of Barau's petrels (*P. baraui*) on Reunion Island (Faulquier et al. 2009, entire). Accordingly, any feral cats within Black-capped petrel nesting areas should be considered potential threats. And while these introduced species currently appear to be relatively scarce and at low densities near known Black-capped petrel nest locations, even low numbers of these avian nest predators could have a significant impact on the few active nests that currently exist, particularly those in more accessible sites (Simons et al. 2013, pp. S31-32). For example, a pack of only three free-ranging dogs reduced a breeding colony of White-tailed tropicbirds on a Bahamian island by 80% in only four years (Simons et al. 2013, p. S32). It is not known whether current nest site selection by the Black-capped petrel reflects the historic optimum or is the product of increased predation pressure (Simons et al. 2013, pp. S31-32).

### ***2.9.5 Communication towers and artificial lighting***

Recent years have seen the proliferation of telecommunication towers throughout the Caribbean islands. These towers are typically located on high mountain ridges, hills, and other prominent topographic features and the structures extend several meters above canopy level. Many of the tallest are also secured by numerous guy wires (Fig. 2.12; Longcore et al. 2008, entire; Simons et al. 2013, p. S32). Because of the nocturnal habits of the Black-capped petrel, combined with the high speed at which they fly, they are highly vulnerable to aerial collisions with these unseen structures, especially on foggy nights typical of the petrel nesting season (Goetz et al. 2012, p. 8; Longcore et al. 2013, entire; Simons et al. 2013, p. S32). There have been numerous documented cases of Black-capped petrels being killed or injured by aerial collisions with these structures in or near their breeding areas (see Fig. 2.13; Goetz et al. 2012, p. 8; Simons et al. 2013, p. S32).



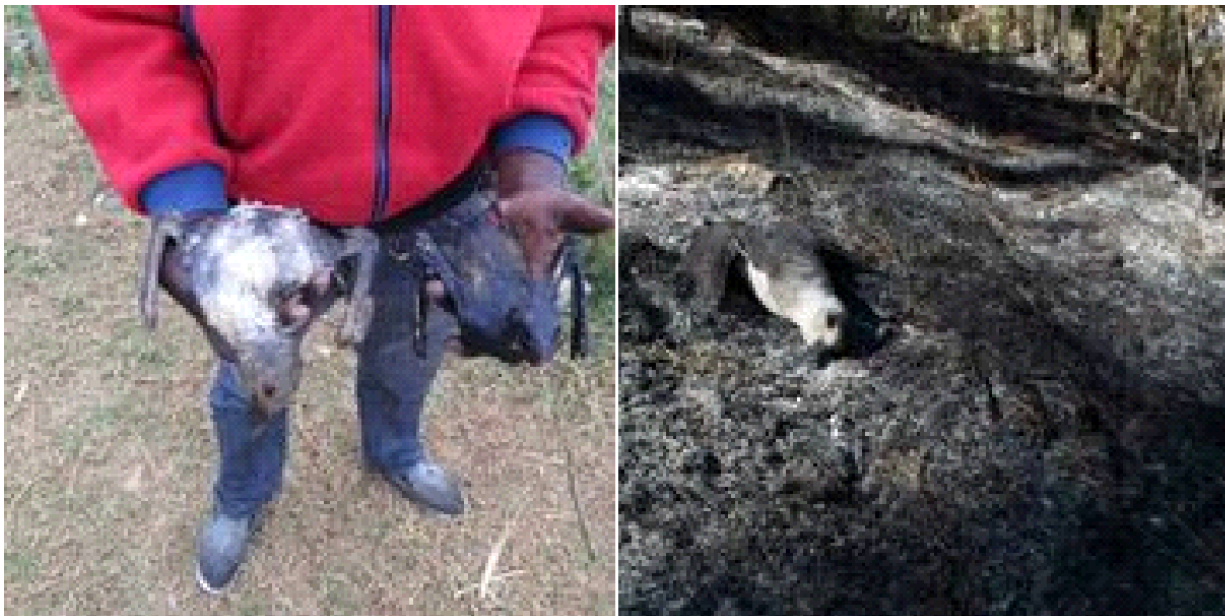
**Figure 2.12.** Communication towers near Black-capped petrel nesting areas on Hispaniola. Height of structures and associated guy wires depicted in left image; nighttime security lights depicted in right image. A disoriented and grounded Black-capped petrel also being recovered from the ground in right image. Photos by J. Goetz.



**Figure 2.13.** Black-capped petrels injured from nocturnal aerial collisions with communication towers near nesting areas on Hispaniola. Photos by J. Goetz.

Such losses are particularly significant in terms of petrel population dynamics as they most likely also represent losses of breeding adults (Simons 1984, entire; Saether and Bakke 2000, entire; Simons et al. 2013, p. S19). Moreover, many such towers are also equipped with bright lights to provide security (Fig. 2.12) which also can fatally disorient flying petrels (Le Corre et al. 2002,

p. 390; Longcore et al. 2008, entire). Tower lights may also disrupt aerial courtship activities of petrels (Goetz et al. 2012, p. 8). Petrels – particularly inexperienced fledglings and juveniles – are especially sensitive to artificial lights, likely due to a dependence on visual cues such as moonlight and starlight for nocturnal navigation (see Imber 1975, entire; Le Corre et al. 2002, p. 390; Rodriguez and Rodriguez 2009, entire). Moreover, at many tower sites the security personnel maintain fires during the night, both for light and warmth, and these fires may serve to further disorient breeding petrels, similar to the historic use of “sen-sel” fires (i.e. large nighttime bonfires) to attract and harvest petrels by inhabitants of Haiti in years past (Wingate 1964, p. 154; Goetz et al. 2012, p. 8; Simons et al. 2013, p. S30). Petrels will often fly directly into such fires with fatal results (Fig. 2.14). Petrels that nest in burrows or cavities are affected by artificial lighting greater than ground-nesting species due to their inherent nature to associate light with food (Imber 1975, entire). Anthropogenic lighting-induced mortality of Black-capped petrels may be an unquantified, yet important, cause of mortality both for breeding adults and juvenile fledglings.



**Figure 2.14.** Black-capped petrels killed by fires near nesting areas on Hispaniola. Photos by J. Goetz.

### ***2.9.6 Wind farms***

According to Simons et al. (2013, p. S32), the increasing use of wind farms on and near Caribbean islands may constitute a potential threat to flying petrels. As with communication towers, land-based wind farms tend to be located on higher ground, where winds are higher and more constant. Threats are not only associated with collisions with fan blades, but also disorientation from associated lights with which such structures are equipped. Offshore wind farms can cause localized upwelling of marine currents, thereby attracting potential food sources of petrels and further attracting them to such sites. Collisions with wind turbines is a potential concern and displacement from offshore wind farm areas have also been documented (Garthe et

al. 2017, entire). However, most such proposed sites are located nearer to shore than the pelagic areas typically used by petrels for feeding, so this specific threat appears comparatively low (Simons et al. 2013, p. S32). Recent construction of inland wind farms near petrel nesting areas on Hispaniola (P. Jodice, in litt.) may constitute a yet additional and unquantified threat, given that there are currently no data on flying height of Black-capped petrels when approaching nesting areas.

### ***2.9.7 Offshore oil and gas***

Proposed exploratory test drilling for oil along the edge of the continental shelf off the coast of North Carolina (Simons et al. 2013, p. S32) may result in future threat to Black-capped petrels. The discovery of petroleum reserves in this zone, and within the main foraging area of the petrels (Fig. 2.1), would most likely result in establishment of drilling and production structures. Petroleum residues or other contamination from such activities could potentially increase the probability of incidental ingestion of petroleum fragments by surface-feeding birds (Simons et al. 2013, p. S32), as well as fouling of plumage from floating residues. Although a Black-capped petrel was once reportedly found with oil-fouled feathers, as well as one with petroleum fragments in the crop (Simons et al. 2013, p. S32), such incidents are relatively few and the genus *Pterodroma* is considered by some (e.g. Clapp et al. 1992, p. 1) to be less vulnerable to such exposure, although there are few data regarding the validity of this assertion (Simons et al. 2013, p. S32). Such structures are also typically well-lighted, and lights are known to disorient flying petrels, especially on foggy nights (see previous discussion in 2.9.5). Moreover, helicopters are frequently used to transport crew and equipment to offshore production facilities, and the effects of these low altitude overflights on foraging petrels is unknown. Regardless, because most petrels which forage in this area are adults (Simons et al. 2013, pp. S23-S28), any increase in losses from threats on the foraging grounds would disproportionately affect the adult segment of the population. Loss of adults has greater implications for long-lived K-selected species, as time for demographic recovery is inherently longer (Simons 1984, entire; Saether and Bakke 2000, entire). Although some Black-capped petrels have also been sighted recently in the central and northeastern Gulf of Mexico where oil and gas activities are ongoing, it is not known whether they are using this area for foraging, nor the age class of individuals sighted. Seabirds that are using the northern Gulf of Mexico are at a greater risk of being affected by offshore oil and gas as there is more petroleum activity there than along the eastern coast of the United States; this results in a greater risk associated with oil spills, interactions with platform lighting, flaring and other potential impacts.

### ***2.9.8 Mercury and plastic pollution***

In a long-term study of plastic ingestion by seabirds off the coast of North Carolina, Moser and Lee (1992, entire) reported presence of plastic in stomach contents of over 55% of 38 species sampled. However, only 1.8% of 57 Black-capped petrels sampled during the study contained plastic. According to Simons et al. (2013, p. S33), Black-capped petrels appear far less likely to



incidentally ingest plastic fragments than many other seabirds. Black-capped petrels do not forage heavily in areas along current edges where such residue and flotsam tend to collect, but rather in areas of current upwelling where nutrient-rich waters promote increased abundance of primary producers and prey species. Simons et al. (2013, p. S33) believed this aspect of Black-capped petrel foraging behavior may make them less vulnerable to incidental ingestion of such material. However, Black-capped petrels have been reported with relatively high concentrations of mercury (Simons et al. 2013, p. S33), with amounts up to seven to nine times higher than that of most other pelagic species sampled. Such high levels have been associated with reduced reproductive output and neurological damage in other avian species (Simons et al. 2013, p. S33). In fact, Procellariiforms are known to be particularly susceptible to heavy metal bioaccumulation, compared to other seabirds (Kim et al. 1996, pp. 262-265; Kojadinovic 2007a, entire; Kojadinovic 2007b, entire). It is speculated that increases in offshore oil drilling may increase such levels of contamination, via direct release of mercury and other heavy metals into the marine food chain (Simons et al. 2013, p. S33). Any Black-capped petrels potentially foraging in the northern Gulf of Mexico may already be exposed to such contaminants. Although current implications of these findings for the Black-capped petrel remain unknown, because of the well-documented adverse effects of mercury contamination and accumulation for wildlife species, any increases in such levels would logically not bode well for the Black-capped petrel, which is apparently already exposed to higher than normal levels of this contaminant.

#### ***2.9.10 Marine fisheries***

Marine fisheries contribute to mortality of seabirds through injury and mortality due to entanglement in clear monofilament fishing lines or getting caught in hooks (Furnuss 2002, entire, Li et al. 2003, p. 563). Because of the surface-feeding habits of the Black-capped petrel, the species is not considered particularly vulnerable to effects of either long-line or pelagic gill net commercial marine fisheries (Simons et al. 2013, p. S33). There are no known reports of *Pterodroma* bycatch in any marine fisheries of the northern Gulf of Mexico, Atlantic, or Caribbean fisheries. There is little information from foreign fishing fleets regarding the impacts from fisheries (Simons et al. 2013, p. S33). Petrels tend to concentrate foraging activities in deep pelagic zones, rather in areas of the continental shelf where most inshore fisheries occur. Thus, marine fisheries and associated activities are considered only a minor (albeit unquantified) threat to the Black-capped petrel (Simons et al. 2013, p. S33).

#### ***2.9.11 Climate change***

Under current projections of climate change, the Black-capped petrel faces potential effects on both the foraging and breeding areas (Simons et al. 2013, p. S33), although by different mechanisms. First, the observed very strong association of the Black-capped petrel with Gulf Stream waters and associated current upwelling off the coast of the southeastern USA makes it vulnerable to any climate-induced changes to existing marine hydrology in this zone. Changes in either the direction(s) or temperature of these marine currents could significantly alter the

foraging ecology of the species. However, because there are currently no specific projections of climate-induced changes or reversal of either the Florida Current or Gulf Stream proper, the threat to the petrel from this aspect of climate change is believed to be low (Simons et al. 2013, p. S33). However, Hass et al. (2012, entire) predicted that projected climate-related increases in the frequency and intensity of Atlantic hurricanes over the next century could substantially increase the numbers of Black-capped petrels driven inland and stranded by these storms, thereby increasing mortality.

In contrast, threats from climate change for the terrestrial aspects of Black-capped petrel ecology are considered greater (Simons et al. 2013, p. S33). Among the projections for categorical climate-induced changes for the Caribbean basin are primarily sea level rise and increased temperatures. Because of the petrels' use of high elevation areas for nesting, changes in sea level are not considered to threaten the species. However, predicted temperature increases (Campbell et al. 2011, entire; Karmalkar et al. 2013, entire) may manifest in numerous ways that could likely affect the petrel. First, associated changes in precipitation may result in increased episodes of heavy rainfall which, under current landscape conditions, would likely result in increased erosion and the flooding and loss of nesting burrows and nesting sites (Simons et al. 2013, p. S33). On the other hand, decreases in precipitation combined with higher temperatures (Campbell et al. 2011, entire; Karmalkar et al. 2013, entire) may increase frequency of drought and attendant susceptibility of breeding areas to forest fires. Increased intensity of hurricanes and tropical storms (Hass et al. 2012, entire) may also adversely affect the petrel by further accelerating erosion and degradation of nesting areas (Simons et al. 2013, p. S33). Finally, increased temperatures may likely also increase incidents of new invasive or vector-borne diseases. Black-capped petrels may be immunologically vulnerable to such pathogens (Simons et al. 2013, pp. S33-S34); thus, these may pose an additional climate-induced risk for the species.

## **2.10. Conservation efforts**

Over at least the past decade, the threats to continued viability of the Black-capped petrel have become well-known both locally (i.e. on Hispaniola) and internationally, and there are currently several non-government organizations (NGOs) working in both Haiti and the Dominican Republic in an effort to reduce or otherwise mitigate severity of these threats. These NGOs include international organizations (e.g. BirdsCaribbean, Environmental Protection in the Caribbean, Plant with Purpose, American Bird Conservancy, International Black-capped petrel Conservation Group) as well as local (e.g. Grupo Jaragua, Société Audubon Haiti). Because most of the threats to the Black-capped petrel are directly the result of anthropogenic activities (see section 2.9), these NGOs have been providing technical assistance and education on sustainable agricultural practices, watershed management, and reforestation of previously deforested and degraded areas in the regions where petrels nest. These actions are in addition to “traditional” conservation efforts such as environmental education and heightened awareness of, and appreciation for, the Black-capped petrel at the local level. For example, in the community

of Boukan Chat, Haiti (adjacent the Morne Vincent petrel nesting area), NGOs have developed Black-capped petrel educational programs for local schoolchildren, provided financial and technical assistance with construction of freshwater cisterns, and provided tree seeds and technical assistance for local reforestation projects. Some residents of Boukan Chat have also been hired specifically to work toward improving community awareness of the Black-capped petrel and its plight, and of how sustainable land management can be mutually beneficial to both the community and the petrel. Other such NGO efforts include recent production of a documentary video entitled “Save the Devil” detailing local efforts to save the species, active monitoring for forest fires near petrel nesting areas, continued monitoring of petrel nest success in the Morne Vincent/Sierra del Bahoruco nesting area, continued radar and bioacoustical monitoring for petrel detections, and working with owners of a local communication tower to reduce nocturnal lighting intensity as a means to reduce Black-capped petrel collisions with these structures (Brown 2016, entire; IBPCG 2016, entire; 2017, entire). However, these NGO efforts, albeit locally successful, are still relatively limited in both geographic scope and funding, and there are yet other areas of Hispaniola which harbor Black-capped petrel nesting colonies (e.g. Pic Macaya, Pic La Visite) that could likely benefit from similar efforts. Figure 2.15 depicts the interactions and relationships between the aforementioned threats (section 2.9) and conservation efforts, and their influence on Black-capped petrel viability.

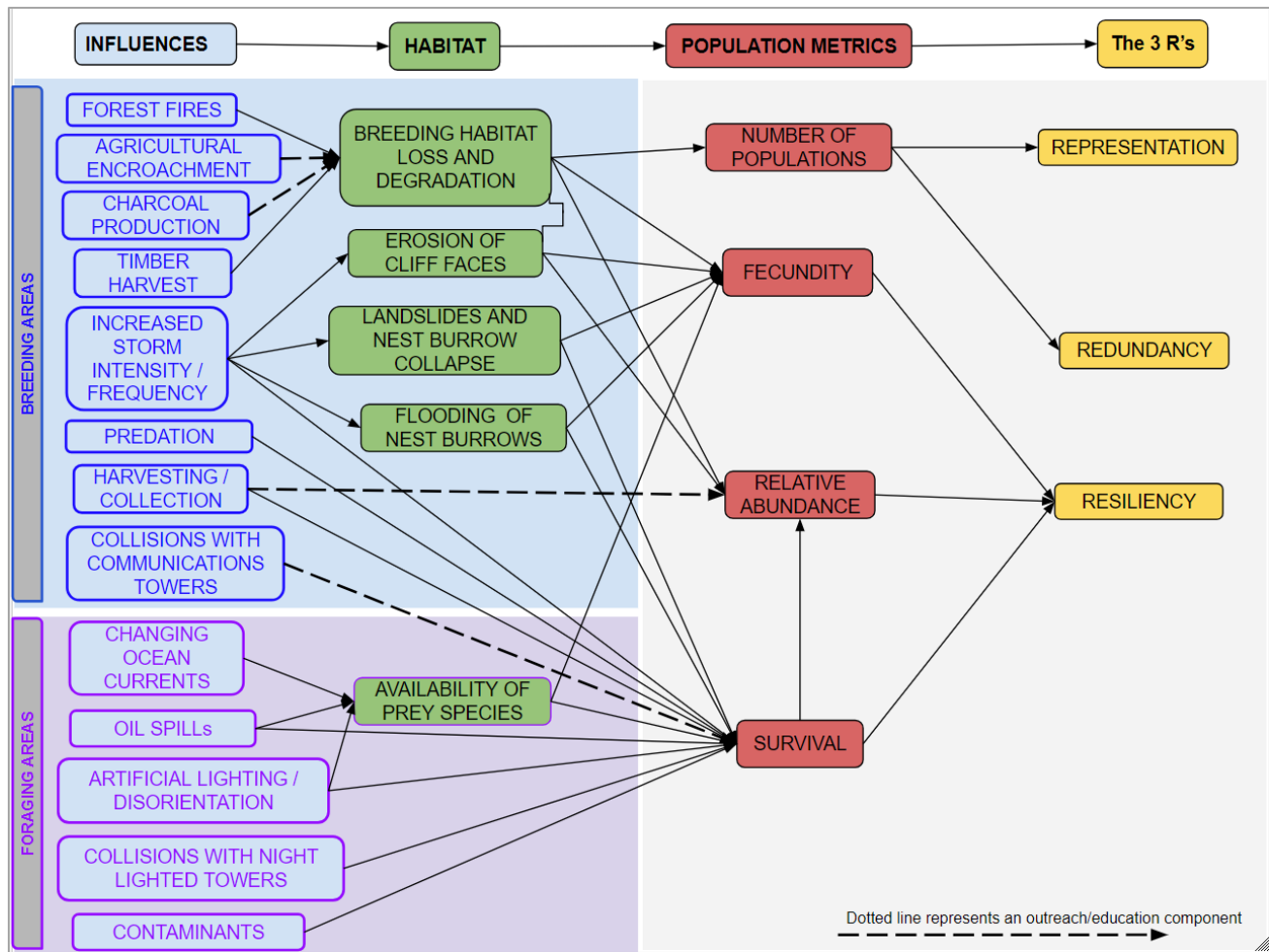


Figure 2.15. Influence diagram depicting interactions and relationships between factors influencing Black-capped petrel viability.

## Chapter 3. Population-level current conditions

In this chapter we review the Black-capped petrel’s historical and current condition by considering species needs in terms of the distribution of resilient populations across its range. First, we review the historical information on the range and distribution of the species. We next consider the needs of the species at population (for resiliency) and species-levels (for redundancy and representation). Finally, we combine the results of assessing the 3Rs into a characterization of current, species-level viability.

### 3.1. Range and Distribution

According to Simons et al. (2013, pp. S10-S11), the range of the Black-capped petrel is likely related to the geological history of the Caribbean Region. Colonization of at least one of the larger islands (e.g. Cuba, Hispaniola) by non-migrating and winter-breeding *Pterodroma* most likely occurred during the Pleistocene, perhaps even earlier. Other Caribbean islands (e.g. the

Lesser Antilles) were subsequently colonized and re-colonized over time. Current evidence suggests that the original colonizing stock of the birds that would become Black-capped petrel originated from South Atlantic petrel populations following the closure of the Panama isthmus (Simons et al. 2013, pp. S10-S11; see also Imber 1985, entire). Once established, the geographic distribution of breeding populations has remained stable due to the inherently strong philopatry exhibited by *Pterodroma* spp. (Simons et al. 2013, pp. S19-S22).

Currently, breeding populations of Black-capped petrels are found mainly along the geologic suture zone between the ancient islands of North and South Hispaniola, which later fused to form the current island of Hispaniola. Simons et al. (2013, p. S10-S11) believed that the Black-capped petrel or its ancestors also colonized some geologically older islands (e.g. Puerto Rico) but were extirpated, likely due to either human harvesting or competitive interactions and incompatibility with maturing island biotas. Because the Lesser Antilles (e.g. Guadeloupe, Dominica) are younger than the Greater Antilles, the petrel most likely colonized and re-colonized those islands from stocks originating in the Greater Antilles (Simons et al. 2013, pp. S10-S11).

Stochastic disturbances, such as volcanic activity, hurricanes and earthquake-induced landslides, may have resulted in periodic localized extirpations of Black-capped petrels from some of the smaller islands it is once presumed to have inhabited. For example, the 1847 earthquake on Guadeloupe is believed to have caused the disappearance of the petrel from that island (Simons et al. 2013, p. S11-S12). Such events may also have facilitated colonization by enhancing habitat used for nesting (Simons et al. 2013, p. S11). Mudslides resulting from hurricanes and tropical storms create natural openings within disturbed soils which is a characteristic favorable for excavation of petrel nest burrows. This shifting availability of suitable nesting sites may have caused nesting colonies to move or become relict. Simons et al. (2013, p. S7) hypothesized that the cycle of ancient colonization and extirpation may have promoted the observed polymorphism exhibited by the species. While a definitive assessment of the extent to which historic populations depended on forested habitats is not possible (Simons et al. 2013, pp. S10-S13), stable forest systems appear important for contemporary populations of the Black-capped petrel (Simons et al. 2013, pp. S10-S13).

Historical occurrences of breeding *Pterodroma* have been documented on only five of the Caribbean islands: Martinique, Guadeloupe, Dominica, Jamaica and Hispaniola. Below we summarize the historic and current condition of those occurrences, according to Simons et al. (2013, pp. S10-S13). Although breeding by petrels is suspected to occur in Cuba, there are no empirical data to support this suspicion.

### ***3.1.1. Martinique***

Black-capped petrel was likely eradicated from the island of Martinique by the resident Carib Indians who harvested the bird for food during pre-Columbian times (Simons et al. 2013, p. S11). Nevertheless, lingering reports of the species on Martinique occurred up to and during the

19<sup>th</sup> century (Simons et al. 2013, p. S11; see also Wetmore 1952, entire). However, today Martinique is mostly deforested and no reports of nesting petrels have originated from there since before the 1902 eruption of Mount Pelée (Simons et al. 2013, p. S11).

### **3.1.2. Guadeloupe**

Former nesting by the Black-capped petrel on Guadeloupe is well-documented, at least during the 18<sup>th</sup> and first half of the 19<sup>th</sup> centuries (Simons et al. 2013, pp. S11-S12). Detailed accounts exist of local hunting parties harvesting large numbers of Black-capped petrel adults and nestlings for food during those times. However, massive landslides caused by a large earthquake in 1847 reportedly destroyed the only known nesting area on the island, and nesting birds are believed to have disappeared from the island by approximately 1850 (Simons et al. 2013, p. S12). Subsequent island-wide deforestation and habitat conversion (e.g., forest to agriculture) also may have played a role in inhibiting re-colonization of the island by the petrel during the late 19<sup>th</sup> and 20<sup>th</sup> centuries. No petrels have been documented on Guadeloupe since their extirpation in the mid-1850s.

### **3.1.3. Dominica**

Allegedly the site of the first type specimen of the Black-capped petrel, Dominica is believed to have once harbored the majority of the breeding population of the species (Simons et al. 2013, pp. S12-S13). French colonists on Dominica once exported large numbers of the birds as food for colonists on other islands. Although still numerous on the island during the early 19<sup>th</sup> century, the last confirmed nesting of the petrel on Dominica was in 1862 (Simons et al. 2013, pp. S12-S13). Nevertheless, subsequent sightings and collections of the petrel on Dominica (e.g. in 1932, 1977, 2007) suggest the possibility that nesting by the Black-capped petrel yet occurs (Goetz et al. 2012, pp. 12-13; Simons et al. 2013, pp. S12-S13). Recent nocturnal radar surveys for the petrel on Dominica have identified numerous “petrel-like” targets that further suggest potential presence (Brown 2015, entire). Although several recent ground-based searches for petrel nests, as well as nocturnal acoustic surveys for vocalizing birds have yet to yield conclusive evidence of nesting, there remains an uninhabited and largely inaccessible area of approximately 388 km<sup>2</sup> in the interior of the island where surveys have not been adequately conducted (Brown and Collier 2001, entire; Simons et al. 2013, pp. S12-S13). Thus, current nesting by the Black-capped petrel on Dominica remains speculative and unknown.

### **3.1.4. Jamaica**

Jamaica once hosted an endemic species (or subspecies) of *Pterodroma* – the allegedly now extinct Jamaican petrel (*Pterodroma caribbaea*) – but there are no substantiated records or documentation of the Black-capped petrel nesting on Jamaica (Simons et al. 2013, pp. S17-S19). Although the Jamaican petrel was well-known on the island up until the 19<sup>th</sup> century, the introduction of the mongoose in 1872 is believed to have caused the complete eradication of the species. No signs have been found of the current existence of either the Jamaican or Black-

capped petrel on Jamaica, despite extensive survey efforts over the last century and apparently suitable areas of nesting habitat, specifically in the Blue Mountains and John Crow Mountains in the northeastern portion of the island (Simons et al. 2013, pp. S17-S19).

### **3.1.5. Cuba**

According to Simons et al. (2013, pp. S15-S17.), the first reports of the Black-capped petrel on Cuba date from the 1970's (see also Goetz et al. 2012, p. 13). These initial reports were allegedly of birds (n = 6) collected on Cuba. However, it was later revealed that the petrels had been collected at night from boats located several kilometers from the coast indicating that they were most likely foraging birds originating from breeding colonies on nearby Hispaniola (Simons et al. 2013, pp. S15-S17). The birds were collected in an area of strong upwelling currents, similar to that of the deep-water areas off the southeastern coast of the United States where petrels are known to congregate and feed. Moreover, the Cuban offshore upwelling site is only 500 km from the breeding areas on Hispaniola which is well within the normal foraging range of the species (Simons et al. 2013, pp. S15-S17; Jodice et al. 2015, entire). There have also been recent sightings of Black-capped petrels flying inland near La Bayamesa National Park in southeastern Cuba (E. Iñigo-Elias, in litt.). However, definitive evidence of nesting by the Black-capped petrel on Cuba has yet to be acquired (Simons et al. 2013, pp. S15-S17; J. Goetz, pers. comm.).

### **3.1.6. Hispaniola (Haiti, Dominican Republic)**

The island of Hispaniola, comprised of the nations of Haiti (western third) and the Dominican Republic (eastern two thirds), is, to-date, the only confirmed area in which the Black-capped petrel is currently known to breed (Goetz et al. 2012, pp. 9-10; Simons et al. 2013, pp. S13-S15). Current estimates of the total breeding population is 500-1,000 pairs (Simons et al. 2013, p. S22) distributed among four distinct, albeit ecologically similar areas. Two of the breeding areas are entirely in Haiti (Pic Macaya, Pic La Visite), the third is located entirely in the Dominican Republic (Valle Nuevo), and the fourth spans the Haiti-Dominican Republic border (Sierra de Bahoruco-Morne Vincent; see Fig. 2.4). Despite the relative close proximity (Figs. 2.4) and ecological similarities of all known nesting areas (Goetz et al. 2012, pp. 9-11; Simons et al. 2013, pp. S13-S15; E. Rupp, in litt.), we consider the current breeding individuals to constitute four (4) distinct breeding populations, each occupying one of the four breeding colonies. This is because *Pterodroma* breeding populations tend to spatially isolate themselves more than most other marine birds (T. Simons, in litt.). That said, there is no empirical data regarding the genetic composition of Black-capped petrel breeding colonies, so we cannot make definitive conclusions regarding the interchange of genetic material among colonies (T. Simons, in litt.).

Common characteristics of all four known breeding colonies include the following (Goetz et al. 2012, Simons et al. 2013, E. Rupp, in litt.):

1. Elevations at or exceeding 1500 m (4900 ft) ASL

2. Open canopy montane broadleaf or pine (*Pinus occidentalis*) forest
3. Loose soil, talus or decaying herbaceous vegetation on or near steep slopes and cliff faces, and/or
4. Rocky crevices and limestone solution caverns on cliff faces

Below, we describe the current conditions and threats at each of the four known breeding colonies, according to the most recent information from Rimmer et al. (2010, entire), Goetz et al. (2012, entire), Simons et al. (2013, entire), McKown (2014, entire), Brown (2016, entire) and IBCPWG (2017, entire); see also Table 3.1). Although the Sierra de Bahoruco-Morne Vincent colony is considered a single breeding colony, its unique feature of being the only international colony requires separate descriptions of the portions in Haiti and the Dominican Republic. This is because of distinct differences in habitat quality and associated threats between the two portions of this binational colony.

#### **3.1.6.1. Pic Macaya, Haiti (Figs. 2.4, 2.7)**

The most westerly of the known breeding colonies (Fig. 2.4), Pic Macaya, is located in a national park (Sergile et al. 1992, entire), but there is no legal delineation of its boundaries nor control of human access into the park (Goetz et al. 2012, pp. 9-10). As a result of past and current deforestation, the area of forest at Pic Macaya is currently estimated at approximately 20 km<sup>2</sup> (Goetz et al. 2012, p. 5), but the petrel nesting area (Fig. 2.7) is limited to just under 5 km<sup>2</sup>. Hosting an estimated 5% of the total breeding population of the Black-capped petrel, the Pic Macaya breeding colony faces threats primarily from fires, invasive mammals, (continued) deforestation, and habitat loss (Table 3.1; see also Goetz et al. 2012, p. 5). Little (if anything) is known regarding nest abundance or nesting success by Black-capped petrel because of the logistical difficulties of accessing Pic Macaya (Figs. 2.4). A survey of this colony approximately thirty years ago (Woods 1987, entire) suggested a 40% decline in the local petrel population since the time of Wingate's original survey in 1964 (Simons et al. 2013, p. S22). More recent estimates (i.e. 1994) suggest continued declines in numbers of breeding petrels at this site (Simons et al. 2013, p. S22). No petrels were detected during a more recent single-day survey of Pic Macaya on February 10, 2005 (Simons et al. 2013, p. S22), although Goetz et al. (2012, p. 10) reported that six petrels were detected flying and vocalizing on the southern slopes of Pic Macaya in December 2010. There is no information on the current number of breeding pairs in this colony.



### ***3.1.6.2. Pic La Visite, Haiti (Figs. 2.4, 2.6)***

The most significant breeding colony of the Black-capped petrel contains an estimated 80-90% of the total known breeding population (Goetz et al. 2012, pp. 9-10; J. Goetz, pers. comm.). Unfortunately, the Pic La Visite colony is also one of the most threatened. Although Pic La Visite – like Pic Macaya – is technically a national park, Rimmer et al. (2010, entire) reported substantial loss of Black-capped petrel habitat in the La Visite area due to deforestation (for agriculture) of both higher elevation pine forest and also steeper slopes at the foot of cliffs (Fig. 6). Based on their surveys during late 2005 and early 2006, they concluded that the breeding population of petrels at La Visite had declined greatly since the earlier surveys of Wingate (1964) who estimated the local breeding colony at that time to contain a total of 500-600 pairs (Collar et al. 1992, entire). Woods (1987, pp. 196-205) reported even earlier that the overall population of Black-capped petrels in Haiti had declined by 40% from the numbers reported by Wingate in 1964. Subsequent surveys at La Visite in late 2008 and early 2009 by J. Goetz recorded several groups of up to 24 petrels vocalizing in the area (Simons et al. 2012, entire). According to observations by Goetz in 2009, the remaining forested areas of the breeding colony had been degraded considerably due to charcoal production (e.g. Fig. 2.10), logging, and conversion to pasture and agricultural lands resulting in the loss of much of the confirmed breeding area (Simons et al. 2013, p. S13). Based on Goetz (2012, p. 5) and Simons et al. (2013, p. S13), the only tract of nesting habitat remaining in the La Visite area is less than 230 ha (Fig. 2.6; see also Table 3.1). However, there remains an approximately 20 km escarpment in the nearby Pic La Selle (the highest point in Haiti at over 2700 m elevation) that has not been surveyed for petrel nesting activity (Goetz et al. 2012, p. 10). While the total number of active petrel nest sites and associated nest success in the greater La Visite area remains uncertain (Figure 3.1), it is clear that the La Visite petrel nesting stronghold has and continues to experience precipitous declines in both habitat availability and, subsequently, breeding pairs.

### ***3.1.6.3. Morne Vincent, Haiti (Fig. 2.4)***

Due to its proximity to the border of the Dominican Republic (<3 km), which facilitates ingress and egress to the area by researchers, Black-capped petrel nesting activities in Morne Vincent are better documented than in other Haitian colonies. For example, ABC (2014, entire) identified 36 active nests in the area of which 20 were accessible to researchers who documented nest success of 75%. Similar estimates were also reported by Rupp (2012, entire) who documented nearly 77% success based on 30 active nests monitored (i.e. 15 in Morne Vincent; 15 in the Dominican Republic). The size of the Morne Vincent nesting area is estimated at approximately 200 ha (E. Rupp, in litt.), and the primary cause of nest failure is apparently predation and human harvest (ABC 2014, entire). Human harvest of petrel nests appears opportunistic, occurring mainly when local residents are clearing land or searching for wild yams in the nesting area (ABC 2014, entire). Like the other breeding colonies in Haiti, the Morne Vincent area also faces significant pressure from land clearing activities and conversion of forests to cattle pastures (Fig. 3.1). The Morne Vincent portion of the nesting colony is not within any officially protected zone, and woody vegetation in the area has been replaced by shrubs and bushes due to deforestation of larger trees (ABC 2014, entire). As with the other breeding colonies, the total number of breeding petrels in this portion of the range is highly uncertain (Fig. 3.1).

Table 3.1. Summary of habitat status and threats to Black-capped petrel at known and potential breeding locations. (Table adopted from Goetz et al., 2012)

| Location  | Official/de facto Protection Status | Estimated percent of known breeding population | Extent of forest (km <sup>2</sup> ) | Habitat loss | Invasive mammals | Towers/Lights | Direct harvest | Fires |
|---|-------------------------------------|--|-------------------------------------|--------------|------------------|---------------|----------------|-------|
| <b>Confirmed breeding locations</b>   |                                     |  |                                     |              |                  |               |                |       |
| Macaya, Haiti   | Park/open access                    | 5%<br>(n=600-2000 pairs)                       | 20                                  | 3            | 4?               | 0             | 0              | 4     |
| La Visite, Haiti  | Park/open access                    | 90%<br>(n=600-2000 pairs)                      | <2.3                                | 5            | 4?               | 0             | 1              | 3     |
| Loma del Toro, Dominican Republic   | Park/protected                      | 5%<br>(n=600-2000 pairs)                       | >20                                 | 0            | 4?               | 4?            | 0              | 2     |
| <b>Historical and unconfirmed locations<sup>2</sup></b>   |                                     |  |                                     |              |                  |               |                |       |
| Mountainous areas of Dominica   | Parks/protected                     |  | ~98                                 | 0            | 4?               | 0             | 0              | 0     |
| Valle Nuevo, Dominican Republic   | Park/protected                      |  | >20                                 | 2            | 4?               | 4             | 0              | 1     |
| Sierra Maestra, Cuba  | Park/protected                      |  | >20                                 | 0            | 4?               | 0             | 0              | 0     |
| <sup>1</sup> Threat estimate codes: 0=no significant threat; 1 to 5= low to extremely high. ?=uncertain estimate; blank cells = insufficient data for estimate.<br><sup>2</sup> The high level of uncertainty surrounding Black-capped Petrel distribution precludes including other historical or unconfirmed locations. |                                     |  |                                     |              |                  |               |                |       |



**Figure 3.1.** Land cleared for agriculture and livestock grazing just below the Morne Vincent nesting area. Photo by J. Goetz.

#### ***3.1.6.4. Sierra de Bahoruco, Dominican Republic (Figs. 2.4, 2.8, 2.9)***

One of the two currently known Black-capped petrel nesting areas in the Dominican Republic occurs in the Sierra de Bahoruco, a generally east-west oriented mountain range. Sierra de Bahoruco also extends into neighboring Haiti where it is physiographically contiguous with the petrel nesting areas of Pic La Visite and Morne Vincent (Fig. 2.4). Like Morne Vincent, the petrel nesting activities in the Sierra de Bahoruco are better known than in the other two colonies in Haiti. Moreover, due mainly to differences in political and socioeconomic conditions between Haiti and the Dominican Republic, the habitat and forests in the Sierra de Bahoruco are in better overall condition than those of the petrel nesting areas of Haiti (Goetz et al. 2012, p. 11; Simons et al. 2013, pp. S13-S14). The Sierra de Bahoruco is also part of the UNESCO Jaragua-Bahoruco-Enriquillo Biosphere Reserve which was established to protect over 1000 km<sup>2</sup> of mainly montane forest in southwestern Hispaniola (Gallagher 2015, entire). The petrel nesting area consists of a single, 120 m cliff that extends southeast approximately 8 km from Loma de

Toro and at an elevation of 2200 m (Simons et al. 2013, pp. S13-S15). The areal extent of the nesting area is approximately 96 ha or approximately 1 km<sup>2</sup>. Thus, the total area encompassed by this nesting colony in both countries is approximately 300 ha. Habitat at this site consists mainly of large open canopy stands of Hispaniolan pine (*Pinus occidentalis*). However, there have recently been increasing amounts of deforestation and habitat degradation in the Sierra de Bahoruco and surrounding region (Grupo Jaragua 2011, entire; Goetz et al. 2012, p. 5; Simons et al. 2013, pS31). As of 2013 there was an estimated loss of nearly 80 km<sup>2</sup> of forest in the area, primarily due to illegal clearing of forest for agricultural activities (Gallagher 2015, entire). Some deforestation occurred, and continues to occur, in the vicinity of the known Black-capped petrel nesting area (Figs. 2.8, 2.9).

The size of the breeding population in the Sierra de Bahoruco colony was estimated as less than 200 pairs (Simons et al. 2013, p S19). Recent monitoring efforts of 27 active petrel nests, and resulting estimates of nest success (74%), suggested that success rates are similar to that of the nearby portion in Morne Vincent, Haiti (ABC 2014, entire). Subsequent monitoring of petrel nests in this same colony during the 2016 nesting season reported success of around 64% (7/11) for nests in the Haitian portion, and 84% for nests (16/19) in the Dominican portion (IBCPWG 2017, entire). Estimates of petrel nest success (in Haiti and the Dominican Republic) are based on only five years of recent data (i.e. Rupp 2012, entire; ABC 2014, entire; IBCPWG 2017, entire) and may not reflect potential inter-annual or other longer-term cyclical variations. Likewise, no historical estimates of nest success are available for comparison to times prior to the the introduction of exotic mammals into Black-capped petrel habitat.

### ***3.1.6.5. Valle Nuevo National Park, Dominican Republic***

Though previously suspected (see Goetz et al. 2012, p. 5; Brown 2013, entire; McKown 2014, entire), nesting by the Black-capped petrel in the Valle Nuevo National Park was first documented in June 2017 (E. Rupp, in litt.). To date however, only one confirmed Black-capped petrel nest has been identified (E. Rupp, in litt.). The nest site was at an elevation of 2000 m ASL in an area of secondary broadleaf forest (e.g. *Brunellia comocladifolia* and ferns). Valle Nuevo National Park is part of the Cordillera Central mountain range of Hispaniola which is a different physiographic region than the areas hosting other nesting colonies on Hispaniola (Fig. 2.4). The actual nest burrow was excavated from a dense mass of decomposing terrestrial herbaceous vegetation and leaf litter (Fig. 3.2). Given the apparent similarities of the habitat at Valle Nuevo to that of other known petrel nesting colonies on Hispaniola, the tendency of petrels to form nesting colonies, and the extremely remote and difficult access to the area, it is not improbable that additional petrel nests exist in this area. Alternative to other nesting colonies, only one nest documentation has been confirmed to-date, so the extent and degree to which Black-capped petrels use Valle Nuevo National Park (and the Cordillera Central in general) for nesting remains unknown. Further, as with all other Black-capped petrel nesting colonies, petrels nesting in Valle Nuevo face the threats of invasive mammals, habitat loss, and presence of communication towers (Table 3.1; see also Goetz et al. 2012, p. 5).



**Figure 3.2.** Black-capped petrel nest burrow discovered in the Valle Nuevo area of the Cordillera Central of the Dominican Republic, June 2017. Photo courtesy of Grupo Jaragua, Santo Domingo, Dominican Republic.

### **3.2. Black-capped petrel Current Condition**

As explained in Chapter 1, for this assessment we define viability as the ability of the species to sustain wild populations, both across its range and among representative units beyond a biologically meaningful timeframe. For the Black-capped petrel, a biologically meaningful timeframe was defined as 50 years into the future because it corresponds roughly to the length of time since the species was rediscovered in Haiti (i.e. Wingate 1964), thereby providing a temporally equivalent and empirically-based frame of reference for predicting future conditions. Additionally, the estimated generation time of the Black-capped petrel is 5 years (Goetz et al. 2012, p. 5; Simons et al. 2013, p. S22), so 50 years encompasses approximately 10 generations which we believe is an appropriate time horizon to realize predicted effects of factors acting on species viability. However, we also examined factors affecting species viability at shorter time intervals (10 and 25 years), corresponding to approximately 2 and 5 Black-capped petrel generations, so that we could understand dynamics affecting the species from current condition to the end of the predictive time horizon. Above, we characterized the resiliency of BCP at the

population-level. In this chapter, we scale-up to characterize species viability in terms of resiliency, redundancy, and representation at the species-level.

### 3.2.1. Population Resiliency

For the purposes of this assessment, resiliency is defined as the ability of the species to withstand normal environmental variation and stochastic disturbances to maintain wild populations over time. For the Black-capped petrel, examples of stochastic disturbances that may affect individual populations include climatic factors such as severe droughts (and associated fires), hurricanes, and excessive rainfall. These disturbances can reduce habitat quality and nesting success on the breeding grounds, and as such, may negatively affect population growth. The inherently low reproductive output of the strongly K-selected Black-capped petrel (e.g. 1 egg/nest/year) may further exacerbate negative ramifications of any species-wide reductions in nesting success due to stochastic climatic aberrations (Simons 1984, entire).

Resiliency, measured at the population-level, is best characterized by the number of individuals per breeding population and nest success (Tables 3.2, 3.3). A resilient petrel population requires multiple areas of suitable nesting habitat and consistent and adequate pelagic food resources in traditional feeding areas. There are currently an estimated total of 500-1000 breeding pairs across the species' range given data and observations over the past 10-15 years (Simons et al. 2013, p. S22). Though the number of breeding pairs have declined precipitously from historic to cotemporary times, the success of existing nests is relatively high (5-year mean of 75%; n = 175 nests). Nevertheless, after correcting for search effort, the average number of Black-capped petrels seen annually along defined transects, from year 1979 to 2016, on foraging grounds in the western Atlantic region is relatively low (Figure 3.3).

Table 3.2. Relative condition of factors used to determine Black-capped petrel resiliency.

| <b>POPULATION RESILIENCY FACTOR</b>                             | <b>HIGH</b>    | <b>MEDIUM</b>  | <b>LOW</b>     |
|---|----------------|----------------|----------------|
| <b>ACOUSTIC DETECTIONS / MINUTE IN NESTING AREA<sup>1</sup></b> | <b>&gt;4</b>   | <b>1-4</b>     | <b>&lt;1</b>   |
| <b>RADAR DETECTIONS / NIGHT<sup>1</sup></b>                     | <b>&gt;500</b> | <b>100-500</b> | <b>&lt;100</b> |
| <b>NEST SUCCESS (% nests fledging young)<sup>2</sup></b>        | <b>&gt;67%</b> | <b>29-67%</b>  | <b>&lt;29%</b> |

<sup>1</sup> During January-February activity peak

<sup>2</sup> Value ranges based on Wurster and Wingate 1968, Simons 1984, and Madeiros 2012.

Table 3.3. Current conditions of known Black-capped petrel breeding populations relative to Resiliency factors 1-3.

| CURRENT CONDITIONS OF BLACK-CAPPED PETREL BREEDING POPULATIONS<br>(Based on resiliency factors 1-3) |              |               |              |                   |
|---|--------------|---------------|--------------|-------------------|
| POPULATION  | CALLS/MINUTE | RADAR TARGETS | NEST SUCCESS | OVERALL CONDITION |
| PIC MACAYA  | LOW          | UNKNOWN       | UNKNOWN      | LOW               |
| PIC LA VISITE   | HIGH         | HIGH          | HIGH         | HIGH              |
| MORNE VINCENT/<br>SIERRA DE<br>BAHORUCO   | MEDIUM       | MEDIUM        | HIGH         | MEDIUM            |
| VALLE NUEVO   | LOW          | LOW           | UNKNOWN      | LOW               |
| DOMINICA <sup>1</sup>   | LOW          | MEDIUM        | UNKNOWN      | UNKNOWN           |

<sup>1</sup> Included because of numerous inland detections and sightings of Black-capped petrels. No actual nesting has been documented to date.

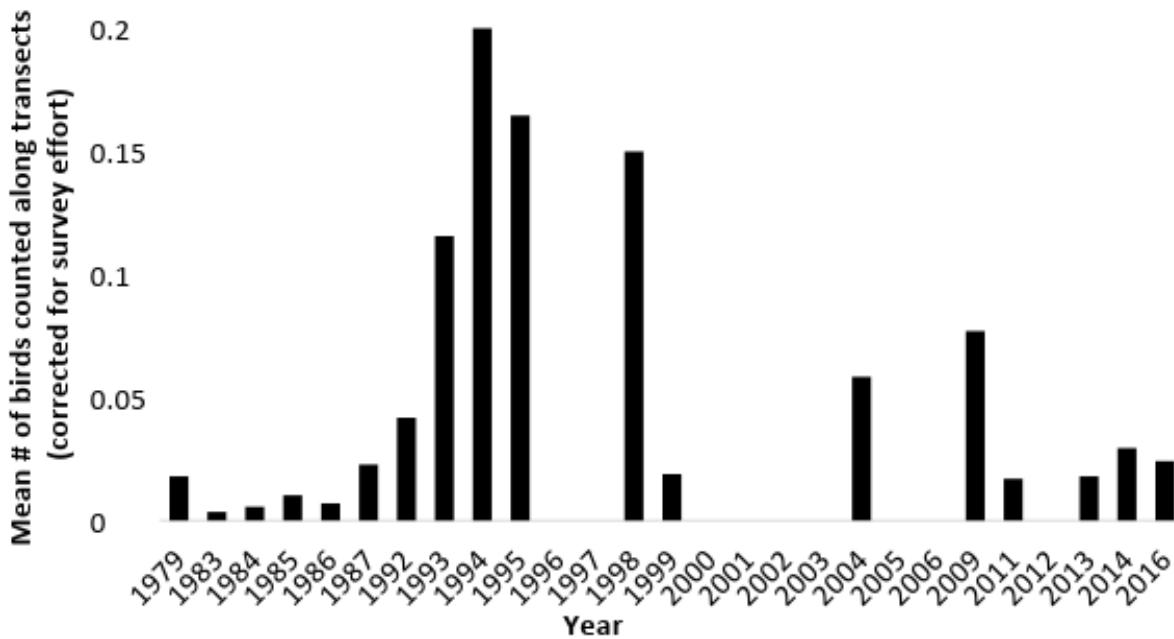


Figure 3.3. Black-capped petrel sightings on foraging grounds in pelagic zones of the Southeastern United States (ranging from Virginia to Florida). Survey effort varied greatly by year so the data were corrected for search effort to facilitate year-to-year comparison.



To determine and quantify current species-level overall resiliency we compared current population resiliency to the historical optimal, based on known prior distribution and number of breeding populations. To do so, we used the following methodology:

- (1) Assigned values of “3, 2, 1” for the categories of “High”, “Medium” and “Low” population resiliency, respectively (see Table 3.3).
- (2) Using the scale 0-1, defined overall resiliency categories of “Low” (<0.34), “Medium” (0.34- 0.66) and “High” (>0.66).
- (3) Determined current deviation from “optimal” (i.e. uniformly high historical population resiliency) by dividing sum of current population resiliencies ( $PRc$ ) by historical optimal ( $PROpt$ ):  $\sum_1^n (PRc) / PROpt = (1+3+2+1+0+0+0) / (3*7) = 7/21 = .333$  (i.e. current overall resiliency). Note: zeros represent and account for extirpated prior breeding populations; see Section 3.1).

Thus, from these calculations the current overall resiliency of the Black-capped petrel is low, being approximately a third (.333) of its historical optimal.

### **3.2.2. Population Redundancy**

Redundancy reflects the capacity of a species’ to persist in the face of catastrophic events. This is best achieved by having multiple, widely distributed populations across the geographical range of the species. Redundancy helps preserve genetic and adaptive diversity and evolutionary flexibility in the species.

Black-capped petrel redundancy is characterized by the number and geographic dispersion of breeding populations. Currently, redundancy is characterized by only 4 known breeding populations occurring on one island. Moreover, given the relatively close proximity and analogous life history characteristics of all known nesting colonies (Fig. 2.4), the probability that all colonies would be similarly affected by a given extreme climatic event is quite high. Although total numbers of nests per population are highly uncertain, the majority (80-90%) of nests are believed to be within the Pic Visite nesting area (J. Goetz, pers. comm.), an area currently subject to significant and increasing pressure from deforestation and other anthropogenic activities.

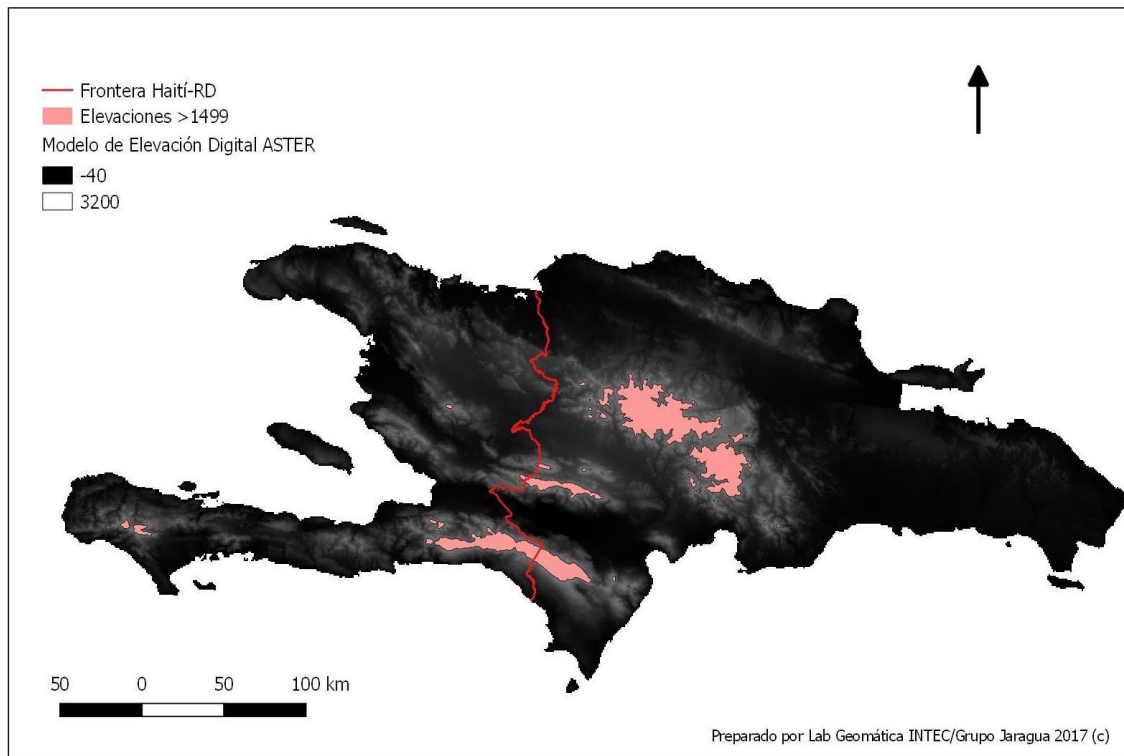
### **3.2.3. Population Representation**

Representation is a reflection of the adaptive capacity of a species in the face of current and future physical (e.g., climatic variations, habitat degradation, and anthropogenic structures) and biological (e.g., novel predators, pathogens) stressors. This capacity is typically expressed by the existence of genetic and phenotypic (e.g., behavioral) diversity.

For the Black-capped petrel, representation currently consists primarily of 2 distinct color forms or morphs (i.e. “light”, “dark”) of unknown genetic or geographic origin (Simons et al. 2013, p. S6). An approximate 1.2% fixed genetic difference has been measured between the two color forms (Manly et al. 2013, entire). This genetic difference is within the range typically observed within polytypic species or between sister species, suggesting the possibility of two distinct and genetically differentiated populations. However, the factors responsible for the existence and maintenance of these color forms are yet unclear, and this question cannot be resolved without additional behavioral and genetic research in breeding populations (Manly et al. 2013, entire). Exacerbating the uncertainty associated with the two color forms (and their associated contribution to adaptive capacity), is the paucity of data on the relative abundance of each color form, or regarding their geographic origin in terms of breeding population. Howell and Patteson (2008) reported seasonal differences in the relative abundance of color morphs on pelagic foraging grounds, with the lighter color form apparently being more common during May and June, while darker birds were more common during late summer and fall. Finally, although all currently known breeding populations occur on Hispaniola, there are currently no data on genetic structure or diversity within individual breeding populations, nor regarding the degree of genetic exchange, if any, between breeding populations (Simons et al. 2013, p. S6; T. Simons, in litt.). The Black-capped petrel also exhibits substantial latitudinal variation in terms of foraging areas (Fig. 2.1; see also Jodice et al. 2015, entire). Over the course of the year, individual birds are known to forage over a total range of approximately 25 degrees latitude (i.e. 10°-35°) with the greatest ranges exhibited during the nonbreeding season (Jodice et al. 2015, entire). Thus, the Black-capped petrel uses a wide range of pelagic habitats, with representation ranging from tropical southern Caribbean waters to more temperate and cooler areas of the mid-Atlantic Gulf Stream.

Overall, geographic representation for the species consists currently of a loose assemblage of 4 breeding populations on one Caribbean island: Hispaniola. Based on common habitat characteristics of existing nesting areas (see 3.1.6 above), there are up to approximately 2,343 km<sup>2</sup> of *potential* nesting habitat (i.e. >1500 m ASL) within the Dominican Republic portion of Hispaniola (Y. Leon, in litt; see also Fig. 3.4), of which the currently known nesting areas occupy only approximately 3-4 km<sup>2</sup> (see 3.1.6 above). Within the Haitian portion of Hispaniola there are also approximately 525 km<sup>2</sup> of *potential* nesting habitat, of which perhaps as little as 5 km<sup>2</sup> are known to be occupied by petrel nesting colonies (see 3.1.6 above). We emphasize “potential” nesting habitat, because, although the stated habitat area is >1500m ASL, we have no data on the extent or distribution of specific areas of microhabitat which would also be consistent with other known nest site characteristics (see 3.1.6 above). Nor do we have accurate quantitative data regarding the degree of anthropogenic perturbation or degradation of these microhabitat areas (Fig. 3.3). Accordingly, current representation in terms of nesting habitat is limited to a relatively narrow range of characteristics shared by all 4 known breeding areas (see 3.1.6 above). Historical records up to at least the early 19<sup>th</sup> century also documented nesting by

the petrel on at least 3 additional islands: Dominica, Guadeloupe, and Martinique (Simons et al. 2013, pp. S10-S13). Of these, only Dominica currently presents credible evidence of the possible existence of a yet extant breeding population (Brown 2015, entire). Thus, there are credible past records of up to at least 7 breeding populations of the species within the Caribbean, compared to perhaps only 4 currently, for an approximate 43% reduction in geographic representation since the early 19<sup>th</sup> century.



**Figure 3.4.** Areas of Hispaniola with elevations >1499 m ASL (pink shading) in which exist known or potential nesting sites of the Black-capped petrel. Graphics provided by Grupo Jaragua, Santo Domingo, Dominican Republic.

## Chapter 4. Future Conditions and potential effects on Species Viability

We have considered the known biological and ecological needs of the Black-capped petrel, including the factors driving the historical and current conditions of those needs (Chapters 2 and 3). In this Chapter, we now consider how those factors may affect future conditions for the species, relative to its continued viability as a species.

### 4.1 Introduction

Historically documented from at least four Caribbean islands, nesting populations of the Black-capped petrel currently are known to occur only on the island of Hispaniola, comprised of Haiti and the Dominican Republic. Additionally, although recent evidence (Jodice et al. 2015, entire)

suggests greater use of marine areas off the north coast of South America by the petrel than previously thought for foraging (e.g. Gulf of Venezuela, Guajira peninsula), most marine habitats utilized by the petrel for foraging are nevertheless associated with waters of the Gulf Stream. Thus, in terms of overall importance to the species, the geographic areas of Hispaniola (terrestrial and adjacent marine habitats) and the western North Atlantic areas containing the Gulf Stream, appear to be the most essential for species viability. In the long run, the viability of the species depends upon its continued access to adequate breeding and foraging areas. Any threats to, or continued loss of, current quality of these areas would likely have a significant negative effect on species viability. Our estimates of future conditions for the petrel are therefore focused primarily on these two geographic areas. Hence, this is the *spatial level of resolution* of this Chapter.

Given the imprecise and limited data on Black-capped petrel population dynamics (see Chapter 2), we also opted to focus efforts at estimating future environmental conditions for the species on the two most significant drivers of the numerous factors (see sections 2.9, 3.1) affecting the species: 1) regional climate change and, 2) human population growth. Together, these two drivers affect or influence all currently known factors which directly or indirectly affect Black-capped petrel viability. Moreover, there exist adequate data and recent studies (see, e.g. Smucker et al. 2007, entire; Campbell et al. 2011, entire; Hass et al. 2012, entire; Karmalkar et al. 2013, entire) upon which to make reasonable predictions of future conditions within the known range of the species, relative to these drivers. This is the *environmental process level of resolution* of this Chapter.

As stated in Chapter 1, we examine prospects of future conditions for the species at 10, 25 and 50 years into the future from the date of this assessment. These time periods correspond to approximately two, five, and ten generations for the Black-capped petrel (Simons et al. 2013, p. S22), and are also within the predictive range of existing supporting data. This is the *temporal level of resolution* of this Chapter.

In addition to the stated levels of resolution, we also explored three (3) different scenarios with respect to projected changes in human population growth on Hispaniola. Using available data and current demographic projections from the United Nations (UN 2017; <https://esa.un.org/unpd/wpp/>) for Haiti and the Dominican Republic, we projected estimated total human population and human population densities for both countries over the next 50 years (i.e. 2020 to 2070) according to the following scenarios:

*Scenario 1:* Human population growth on Hispaniola remains consistent with current UN projections (i.e. “baseline scenario”).

*Scenario 2:* Human population growth on Hispaniola occurs at annual rates 20% less than UN projections.

*Scenario 3: Human population growth on Hispaniola occurs at annual rates 20% greater than UN projections.*

We chose to explore Scenarios 2 and 3 due to the inherent uncertainties in projected long-term human population growth, particularly in developing countries. Thus, our “bracketing” of annual rates of increase by  $\pm 20\%$  in Scenarios 2 and 3 is intended to accommodate any such demographic uncertainties. That said, human population growth predictions in Scenario 1 are based on empirically derived data, while Scenarios 2 and 3 were chosen *ad hoc* to encompass a wider range of uncertainty than presented by the UN. Thus, Scenario 1, and associated predictions, is a much more likely scenario than Scenarios 2 and 3. Because of the past, current and projected socioeconomic conditions on Hispaniola, changes both in human population and human population density directly result in changes in environmental pressures associated with local natural resource consumption (see, e.g. Smucker et al. 2007, entire). These changes then both directly and indirectly affect current breeding habitat and nesting success of the Black-capped petrel (Smucker et al. 2007, entire; Checo 2009, entire; Goetz et al. 2012, pp. 6-8; Simons et al. 2013, pp. S30-S34).

#### ***4.1.1 Regional climate change***

The most recent analyses of projected future climate patterns in the Caribbean region (Campbell et al. 2010, entire; Karmalkar 2013, entire) predict a median increase in annual surface air temperature of 2.8°C (range 2.1-3.1) within the current petrel nesting areas on Hispaniola by year 2080. Additionally, precipitation is projected to substantially decrease during both the early (May-July) and late (August-October) wet seasons for these same areas with a generally drier precipitation pattern year-round. Percentage decreases in early wet season precipitation are projected to be greater (median -41%) than decreases in late wet season precipitation (median -22%). In general, decreases in wet season precipitation are particularly significant, as those months are when the greatest amount of annual rainfall occurs (Karmalkar et al. 2013, pp. 301-303). Decreases in dry season precipitation are projected to be comparatively less than decreases during the wet seasons by current models (Karmalkar et al. 2013, pp. 301-303), resulting in an overall future reduction in the degree of bimodality of current wet/dry seasons in the western Caribbean (e.g. Hispaniola). Thus, the local climate of the currently known petrel nesting areas on Hispaniola is projected to become hotter and drier over the next 50-60 years with less differentiation between wet season and dry season rainfall amounts.

Although the full ecological effects of a projected hotter and drier climate in the current Black-capped petrel nesting areas on Hispaniola are complex and yet unknown, it is intuitively obvious that such a change will likely increase the frequency and intensity of forest fires. Currently, anthropogenic forest fires cause substantial habitat degradation and loss both within and adjacent to the petrel nesting areas (Sergile et al. 1992, entire; Goetz et al. 2012, p. 7; Rupp and Garrido 2013, entire; Simons et al. 2013, p. S31; see also Figure 2.11), and any increases in this disturbance are likely to have significant adverse effects on species viability. Decreased rainfall

and humidity during the traditional wet seasons may also exacerbate effects of naturally-occurring fires from lightning strikes. As such, fires would likely become more intense and extensive, mimicking the effects of the more damaging dry season anthropogenic fires (see Section 2.9.3). Such effects include elimination of naturally-occurring seed banks, increased erosion and mudslides, and loss of accumulated organic humus layers which may be used as nest sites by Black-capped petrels (see, e.g. Figure 3.2). Moreover, because the early wet season (May-July) is projected to experience the greatest reduction in precipitation, increased occurrence of forest fires at such time may increase risks to nesting Black-capped petrels (see Figure 2.14) as well as fledglings which leave nests during this season (see Figure 2.5).

Changes in temperatures and rainfall patterns are not the only projected effects of regional climate change for Hispaniola. According to recent projections by Elsner et al. (2008, entire) and Knutson et al. (2013, entire), the frequency of intense hurricanes (i.e. Categories 4 and 5) are predicted to not only increase for the region, but also the amount of precipitation associated with these atmospheric events is also projected to increase by at least 11%, with up to 20-30% increases in precipitation near the center of these storms. As summarized by Bender et al. (2010, p. 458): *“...results suggest that a significant anthropogenic increase in the frequency of very intense Atlantic hurricanes may emerge from the background climate variability in the latter half of the 21<sup>st</sup> century, despite a projected decrease in the overall number of hurricanes.”* In upper elevation Caribbean forests, intense hurricanes cause widespread and severe damage to vegetation at all strata, including large accumulations of organic debris (Figure 4.1) which may block or otherwise impede access by petrels to previously existing nest burrows. The physical and ecological effects of these storms may persist for decades (Lugo 2008, entire) and include redirection of ecological succession, changes in the ecological space available to organisms, and wholesale changes in forest microhabitats (Figure 4.1). In particular, hurricane-induced erosion and landslides could have potentially severe effects on Black-capped petrels by degrading or eliminating currently productive nesting areas, particularly if said areas undergo prior degradation and ground cover loss due to forest fires or anthropogenic land-clearing (see, e.g. Figures 2.11, 3.1). This would not be unprecedented; a massive landslide is believed to have eliminated the only known nesting area for the Black-capped petrel on the island of Guadeloupe, resulting in its extirpation from that island (Simons et al. 2013, pp. S11-S12).

Projected climate change and associated effects on hurricane intensities may also have repercussions for Black-capped petrels in their marine foraging areas. For example, Hass et al. (2012, entire) modeled over 100 years of data on the relationship between Black-capped petrel inland strandings (i.e. birds found far inland from normal marine habitat) and resultant mortalities in the continental USA in relation to Atlantic hurricane intensities and trajectories, and found that on at least 8 occasions over the past century, major (Categories 3 to 5) hurricanes had likely resulted in mortalities of 10s to 100s of Black-capped petrels. Hass et al. (2012, entire) also modeled recent projected increases in major hurricane activity in the region due to climate change (Bender et al. 2010, entire; Knutson et al. 2010, entire), and predicted that

hurricane-related mortalities of Black-capped petrels could nearly double over the next 100 years (i.e. 50% increase over a 50-year period) from this factor (Figure 4.2), particularly from the powerful “Cape Verde” hurricanes (Figure 4.3) for which landfall rates along the southeastern USA coast are projected to increase 10% per decade over the next century (Hass et al. 2012, pp. 256-257). Because Black-capped petrels tend to congregate at high densities on marine foraging grounds off the eastern USA during the peak of the Atlantic hurricane season (see Figure 2.3), they are especially vulnerable to such atmospheric events (Hass et al. 2012, p. 258-260). Based on the climatic projections of Hass et al. (2012, entire) and the current Black-capped petrel population, such losses could constitute up to 5-10% of the current known breeding population of the species over the next 50 years. However, any reductions in the current Black-capped petrel breeding population from other unrelated factors (e.g. predation, tower collisions, and forest fires) could thereby amplify and exacerbate the effective proportion of hurricane-related losses.



Figure 4.1. Examples of damage to upper elevation rainforest in Puerto Rico caused by the category 5 hurricane Maria on 20 September 2017. Note widespread severe defoliation and major structural damage to trees in both images, and landslides in background of lower image. Photos taken by T. White, 4 October 2017.



### Predicted deaths in 100 years due to storms

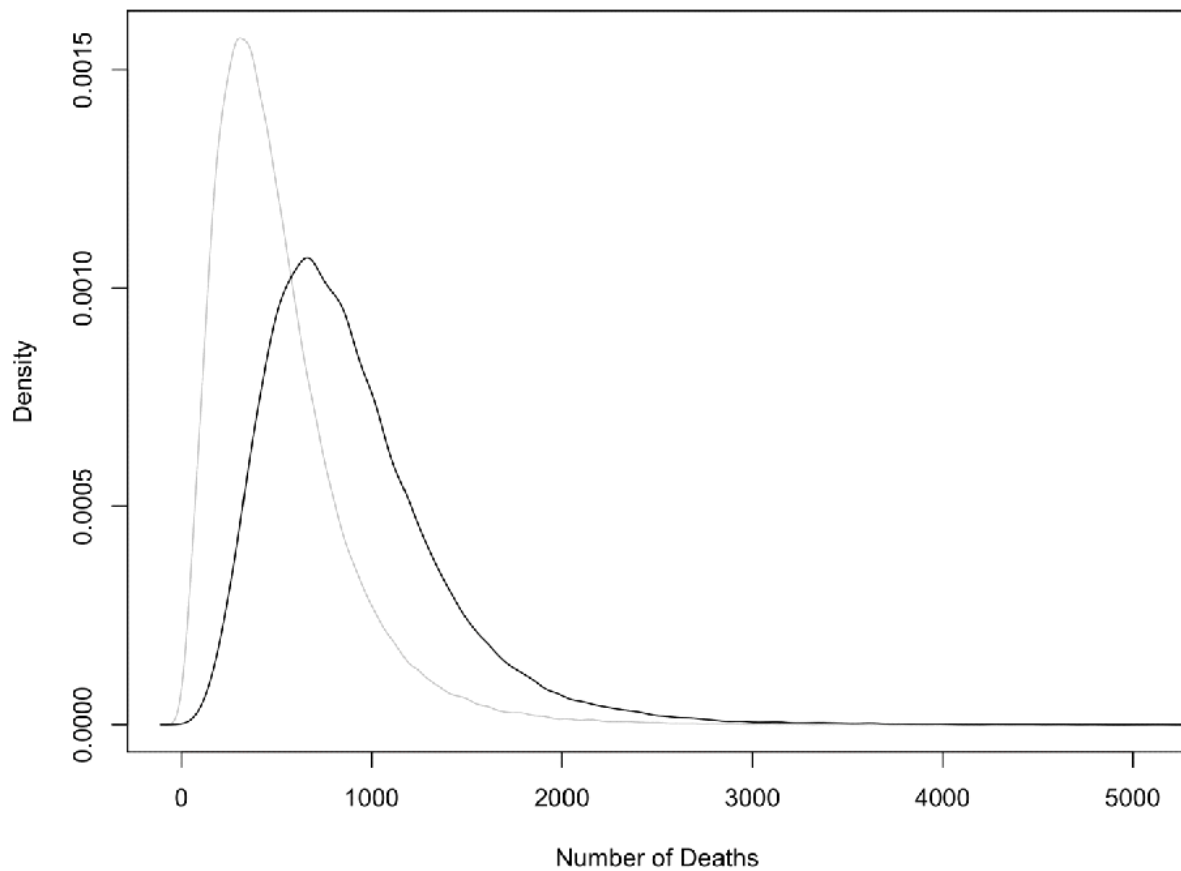


Figure 4.2. Predicted mortalities of Black-capped petrels in 100 years due to Atlantic storms. Under the assumption that hurricane activity over the next century is similar to that of the past century, the median cumulative number of mortalities is 437 (gray line). The probability that >1050 petrels will die is 7%. Assuming rate of landfalling hurricanes increases 1% annually due to climate change (doubling over next century as predicted), the median cumulative mortality is 807 petrels (black line), with a 3% chance that 2100 individuals would die due to hurricanes. Figure adapted from Hass et al. (2012) and used with permission of primary author.

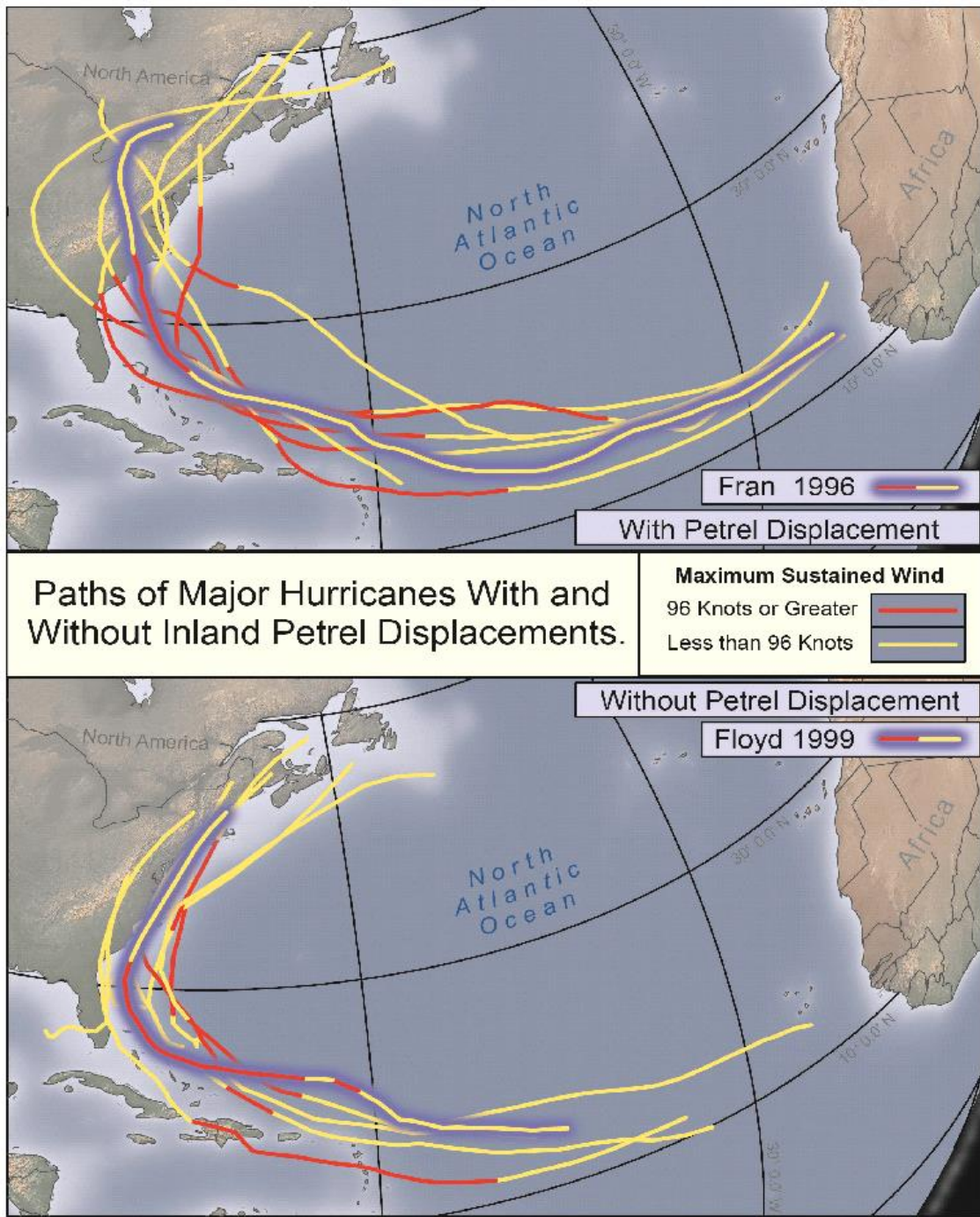


Figure 4.3. Top: Trajectories of all major landfalling hurricanes (1893-2003) that displace Black-capped petrels inland originate near Cape Verde islands and strike coast before recurving. Hurricane Fran depicts typical path of such storms. Bottom: Trajectories of all major landfalling hurricanes (1960-2003 only) that did not displace Black-capped petrels inland display more westward origins and recurved paths prior to landfall. Hurricane Floyd depicts typical path of such storms. Figure adapted from Hass et al. (2012) and used with permission of primary author.

#### 4.1.2 Human population growth – Hispaniola

The current human population of the island of Hispaniola is approximately 21 million, of which Haiti contributes approximately 10.7 million, and the Dominican Republic approximately 10.5 million (UN 2017). Moreover, during the period 2010-2015, the annual rate of population growth for Haiti and the Dominican Republic was 1.38% and 1.24%, respectively (UN 2017). However, the current rate of population growth is projected to gradually decline for each country, albeit at different rates, with rates for Haiti declining at a lesser rate than that of the Dominican Republic. Nevertheless, total population and population densities are projected to increase for each country until at least 2055, when the population of the Dominican Republic enters into a period of slightly negative growth through 2070 (Figure 4.4). The population of Haiti is projected to continue to increase beyond 2070. Based on UN data and our baseline projections, the total human population of Haiti and the Dominican Republic in 2070 will be approximately 15 million and 13 million people, respectively (Figure 4.4). Thus, the total human population on Hispaniola is projected to increase by approximately 33% over the next 50 years (i.e. *Scenario 1*). Given *Scenario 2*, which predicts annual rates of increase corresponding to 20% less than current baseline projections *Scenario 1* (or baseline) projections, the human population of Haiti and the Dominican Republic will be approximately 14.6 million and 12.8 million, respectively (Figures 4.5, 4.6). Given *Scenario 3*, which predicts annual rates of increase corresponding to 20% greater than *Scenario 1* projections, the population of Haiti and the Dominican Republic will be 20.4 million and 13.7 million, respectively (Figures 4.5, 4.6). Note that projections are asymmetric with respect to distribution around the baseline projections. This asymmetry is due to the effect of “population momentum” associated with the progressively larger and comparatively faster-growing population of *Scenario 3*. In this instance, slight *decreases* in annual population growth rates have less effect on changes in total population than that of slight *increases* in rate of growth. That is, under *Scenario 2*, the human population of Hispaniola will increase to 30% beyond the current level, while under *Scenario 3*, the human population will increase to 62% beyond its current size.

Although the current and projected human populations of Haiti and the Dominican Republic are numerically quite similar, there are substantial differences in human population *densities* between the two countries (Figure 4.7). Because Haiti comprises only 36% of the land area of Hispaniola, its current human population equals that of the Dominican Republic (occupying 64% land area) which translates to a population density (398 persons/km<sup>2</sup>) that is nearly twice that of the Dominican Republic (223 persons/km<sup>2</sup>). Haiti is the second most densely populated country in the western hemisphere (Smucker et al. 2007), with increasing numbers of people living in densely-populated lowland urban areas. This has significant environmental implications given that nearly 80% of household energy requirements in Haiti are met with firewood and charcoal (Ghilardi et al. 2018; p. 1), with 80% of the demand for charcoal attributed to a growing urban population without access to firewood (Smucker et al. 2007). In contrast, 80% of energy needs of rural inhabitants are met via collection and use of locally obtained firewood (Smucker et al. 2007), with charcoal supplying the remainder. The widespread reliance on wood-based fuels in

Haiti is directly linked to poverty, limited access to alternate energy sources, and cultural preferences for food preparation. Poor forest management practices and the clearing of land for agriculture and construction materials, contribute significantly to forest loss, fragmentation and degradation in Haiti (Smucker et al. 2007, entire). Given limited forest cover, 86% of the charcoal consumed in Haiti is produced in the Dominican Republic, primarily in montane forested areas adjacent to the Haitian border (Checo 2009, entire).

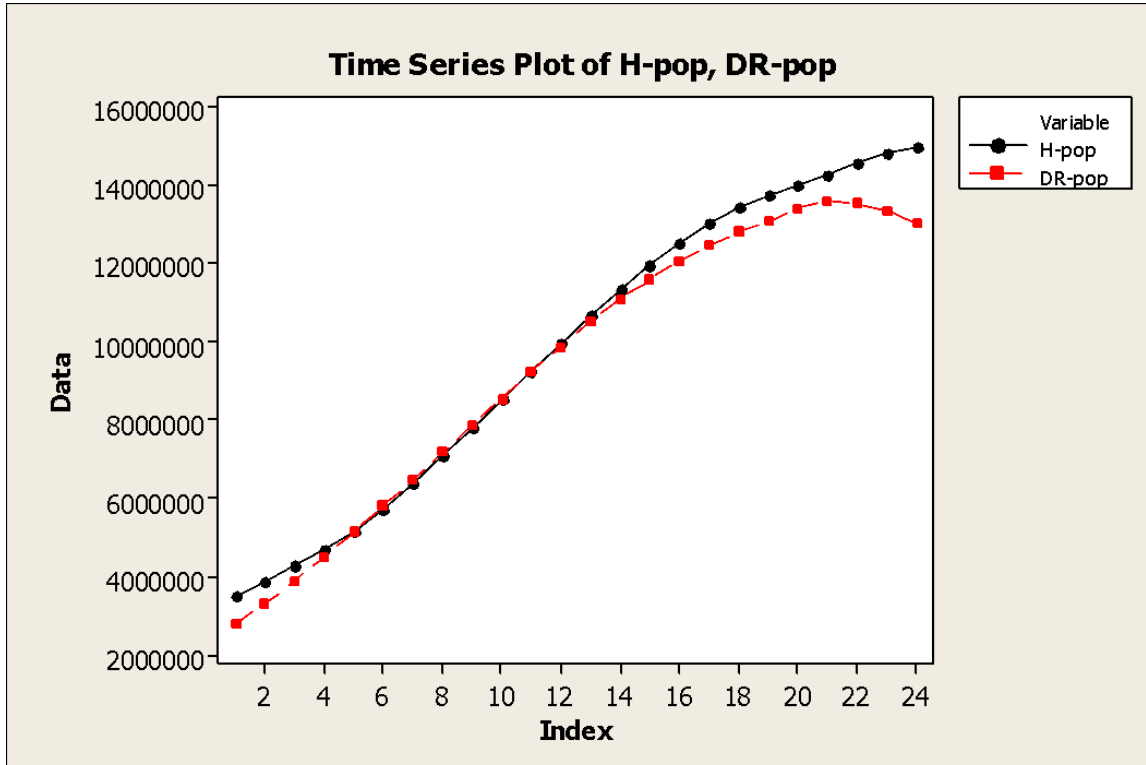


Figure 4.4. Total human population of Haiti (H-pop) and the Dominican Republic (DR-pop) from 1955 to 2070, based on data and projections from the United Nations (2017). Y-axis (Data) indicates population; X-axis (Index) indicates 5-year increments from 1955.

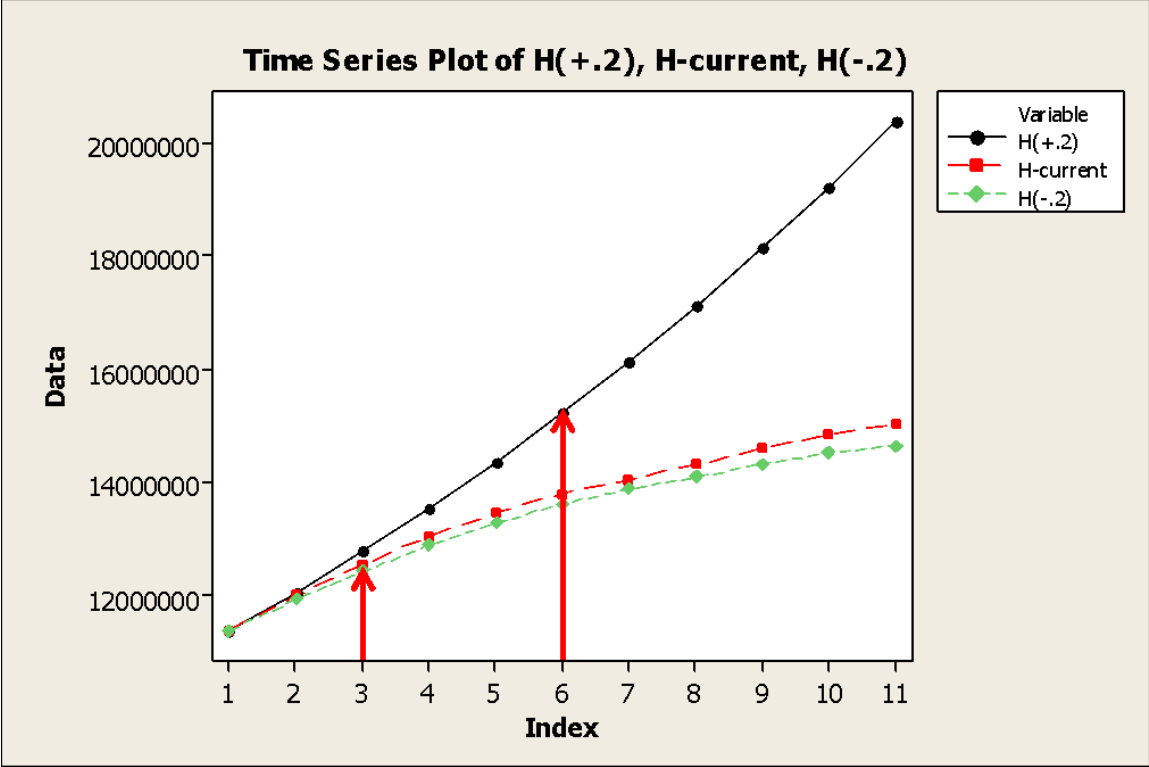


Figure 4.5. Human population projections for Haiti, 2020-2070, under assumptions of no change in future (UN 2017) annual rates of increase projections (H-current), a 20% increase in annual rates (H(+.2)) and a 20% decrease in annual rates (H(-.2)). Red arrows denote populations at 10 (2030) and 25 (2045) years into the future. Projections based on data from United Nations (2017). Y-axis (Data) indicates population; X-axis (Index) indicates 5-year increments from 2020.

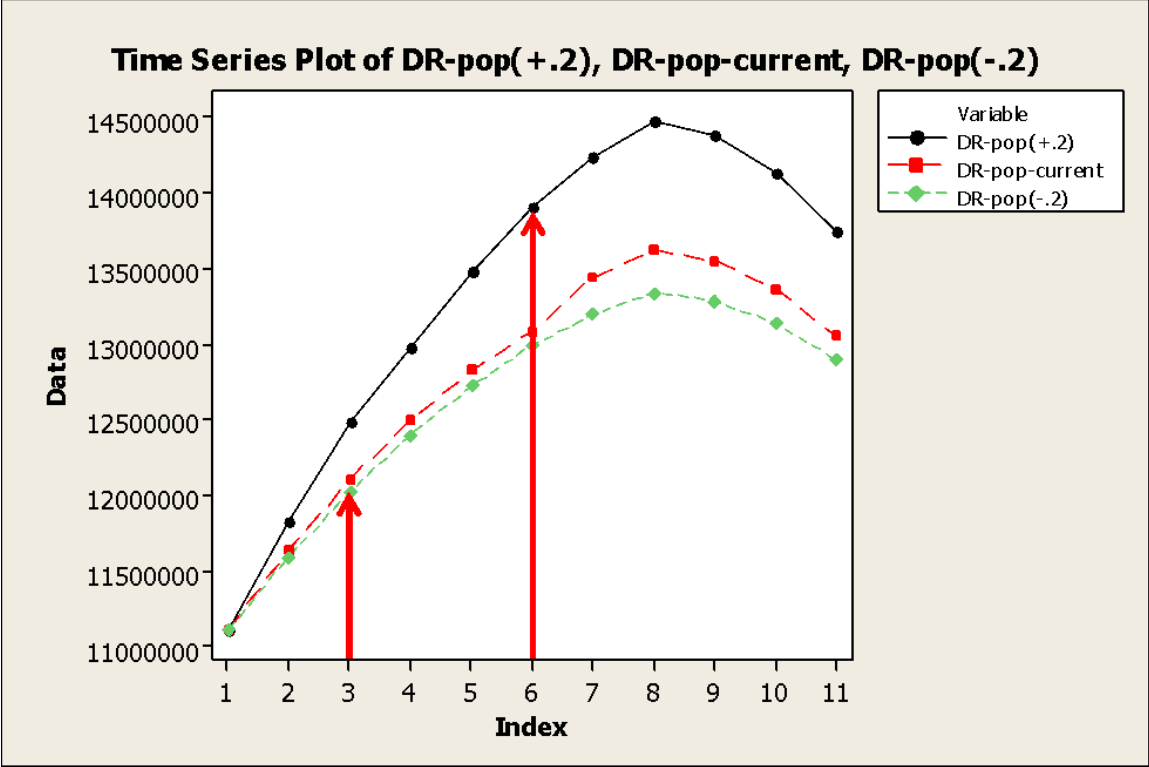


Figure 4.6. Human population projections for the Dominican Republic, 2020-2070, under assumptions of no change in future (UN 2017) annual rates of increase projections (DR-pop-current), a 20% increase in annual rates (DR-pop(+.2)) and a 20% decrease in annual rates (DR-pop(-.2)). Red arrows denote populations at 10 (2030) and 25 (2045) years into the future. Y-axis (data) indicates population; X-axis (Index) indicates 5-year increments from 2020. Projections based on data from United Nations (2017).

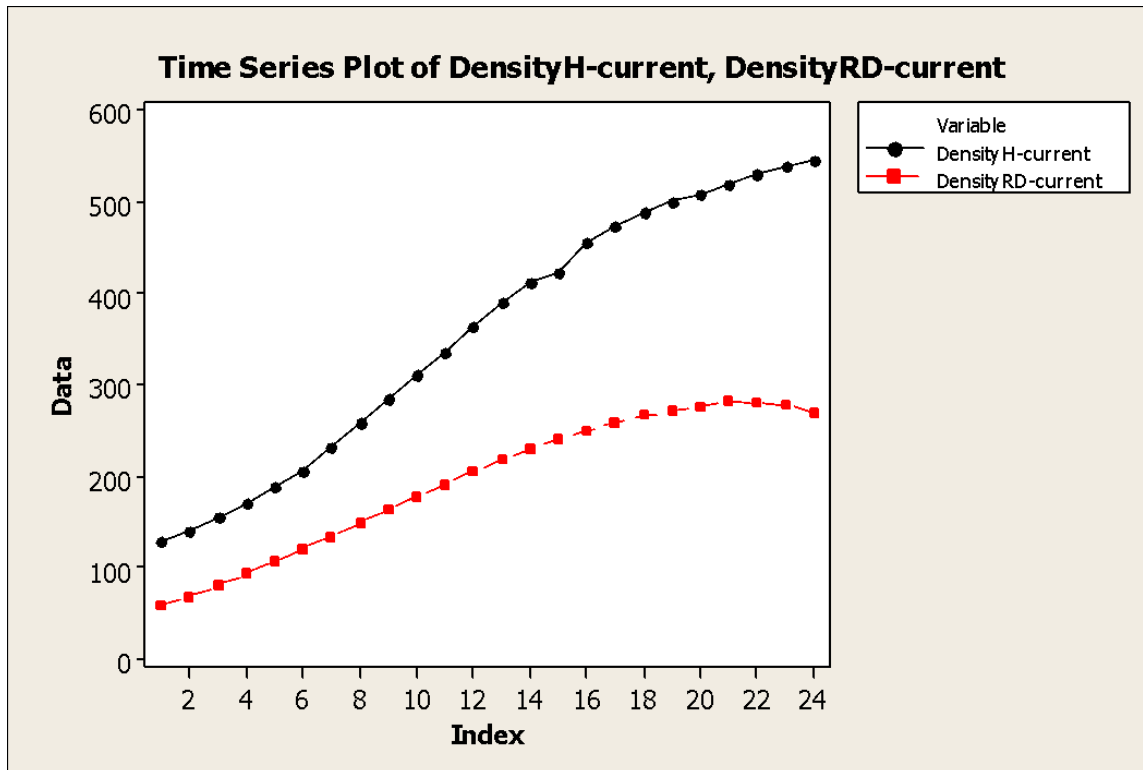


Figure 4.7. Human population density (persons/km<sup>2</sup>) in Haiti (DensityH-current) and the Dominican Republic (DensityRD-current) from 1955 to 2070, based on data and projections from the United Nations (2017). Y-axis (Data) indicates density; X-axis (Index) indicates 5-year increments from 1955.

These same montane forests also comprise Black capped petrel nesting habitat. Because the majority of the charcoal produced and exported to Haiti from the Dominican Republic is done so illegally and clandestinely, accurate estimates of the total amount exported are elusive, with recent published estimates ranging from 21 to 50 thousand tons per year (Smucker et al. 2007, pp. 113-115; Checo 2009, p. 1). Based on area/volume studies by Checo (2009, entire), an average of 12.2 tons of charcoal is produced per hectare of forest cleared. This represents an estimated annual forest loss of approximately 1,700 to 4,100 hectares in the Dominican Republic, of which approximately 45-70% occurs within the Provinces of Independencia and Bahoruco. The montane forest of the Sierra del Bahoruco, located within the Bahoruco Province, supports known Black-capped petrel nesting. Although charcoal is also used for household cooking in the Dominican Republic, the use there (3.1% of households) is significantly less than that of Haiti, given that most Dominican households have access to – and can afford – liquefied propane gas, which supplies 79% of the country’s energy needs. Recent work by Checo (2009, entire) suggests that household consumption of charcoal is actually on the decline in the Dominican Republic, while in Haiti charcoal consumption is predicted to increase as a result of human population growth (Smucker et al. 2007, pp. 113-115; Checo 2009, entire).

Clearly, as human populations and densities increase in both Haiti and the Dominican Republic – particularly Haiti – this will almost certainly result in further and accelerated degradation and loss of current Black-capped petrel nesting habitat, particularly in those nesting colonies within or adjacent to Haiti. To date, virtually all known nest sites of the species occur within this increasingly vulnerable region (See section 3.1.6). Assuming a continuous and linear relationship between human population and demand for fuelwood and charcoal in Haiti, this would mean a concomitant increase in forested areas cleared or otherwise degraded for charcoal production, as well as subsequent small-scale agriculture within cleared areas (see, e.g. Figure 2.10). Thus, based on our three scenarios and the most recent (Checo 2009, entire) estimate of the annual demand for charcoal as fuel in Haiti (352,942 tons in 2005), the future demand annually for charcoal in Haiti over the next 10, 25 and 50 years would be as follows:

*Scenario 1:* 10 years – 477,942 tons; 25 years – 525,211 tons; 50 years – 647,060 tons

*Scenario 2:* 10 years – 473,741 tons; 25 years – 519,959 tons; 50 years – 558,824 tons

*Scenario 3:* 10 years – 487,396 tons; 25 years – 580,883 tons; 50 years – 777,313 tons

Again, based on the above area/volume relationship for charcoal production, this would result in an estimated annual clearing ranging from 45,728 ha (*Scenario 2*) to 63,598 ha (*Scenario 3*) of forest on Hispaniola to supply future demand in 50 years (i.e. 2070). These scenarios represent a 58-220% increase in forest conversion for this purpose over that of 2005; with *Scenario 1* (baseline projection) representing an estimated increase of 62% over 2005 levels (Figure 4.8). This estimate of forest conversion is however, conservative given that cutting of forests for charcoal production also frequently occurs concurrent with, or prior to, expansion of agricultural production into previously forested areas. Thus, these population-driven anthropogenic factors (charcoal production, agricultural clearing) are not mutually exclusive.

## **4.2. Resiliency**

Black-capped petrels are adapted to breeding at high elevations on Caribbean islands, a region that has historically been subject to stochastic, periodic disturbances in the form of tropical storms and hurricanes. The timing of their nesting season (January-June) allows them to effectively avoid direct effects of such atmospheric events during a critical life phase. Moreover, their high adult survival rates and longevity (see section 2.6) make populations resilient to occasional stochastic fluctuations in annual reproductive output. However, based on the best available population estimates, total numbers have apparently declined by approximately 50-75% over the past 50 years, resulting in an actual population of approximately 2,000 to 4,000 individuals at present (Simons et al. 2013, p. S22). A similar numerical decline over the next 50 years could result in as little as 500 to 1,000 birds remaining, rendering the species more vulnerable to both stochastic environmental and anthropogenic disturbances. This however, assumes no change in the recent or current extent or intensity of those factors and threats (see section 2.9) recognized as adversely affecting the species. As previously explained, there are two



primary drivers of these threats: regional climate change, and human population growth. Current projections predict substantial changes in both of these drivers over the remainder of this century.

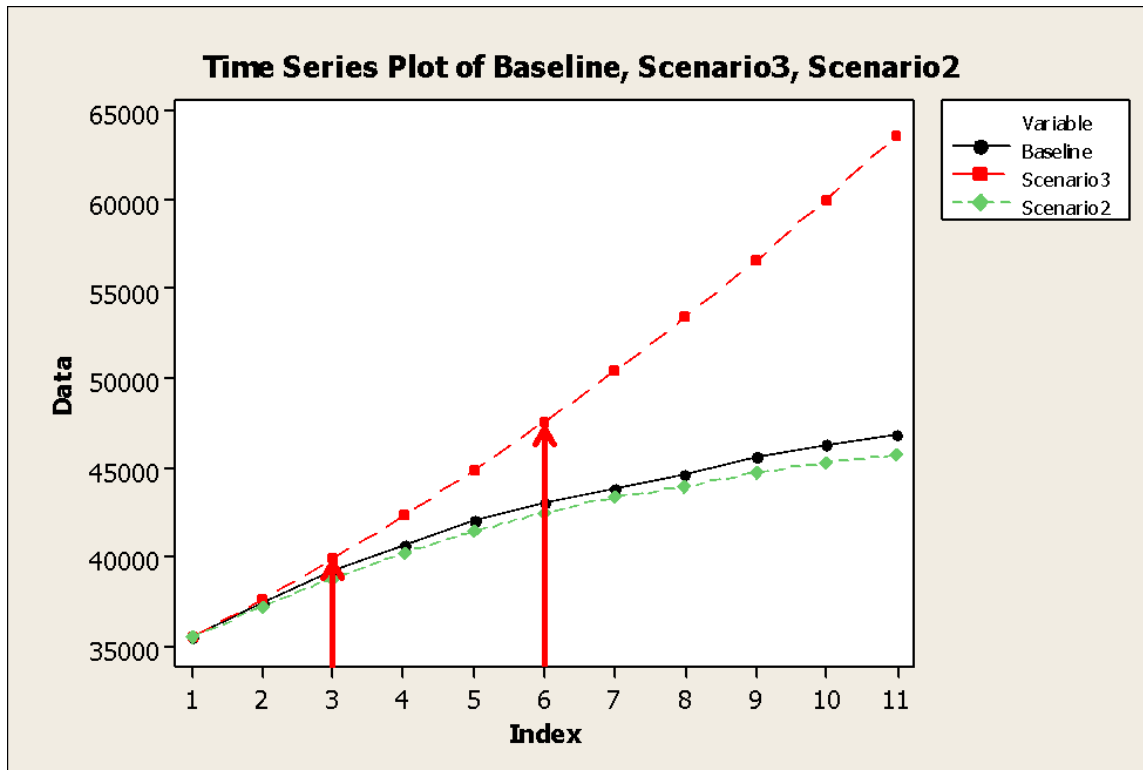


Figure 4.8. Estimated amount (hectares) of annual forest clearing on Hispaniola to meet demand for charcoal as fuel in Haiti, 2020-2070. Red arrows indicate amounts at 10 (2030) and 25 (2045) years from present. Y-axis (Data) indicates hectares; X-axis (Index) indicates 5-year increments from 2020. Projections based on data and assessments of Checo (2009) and United Nations population projections for Haiti (UN 2017).

Under current regional climate projections, resiliency of Black-capped petrel breeding populations is likely to be affected by reduced reproductive success associated with loss or degradation of existing nesting areas due to increased occurrence of both natural and anthropogenic forest fires, loss of nest sites to combined effects of increased erosion, landslides and structural collapse, and potential habitat-related changes (e.g. plant species composition, nest cavity microclimate) arising from overall hotter and drier conditions, especially during the active nesting season. Although reports exist of several montane avian species shifting their ranges upward along elevational gradients in response to climate-related changes (Tingley et al. 2009, entire), Black-capped petrels already nest at some of the highest elevations on Hispaniola, leaving them few options for a similar adaptive response. In montane tropical rainforests of

Australia, Hilbert et al. (2004, entire) forecast significant reductions in breeding habitat for the Golden bowerbird (*Prionodura newtonia*) with increases in mean annual temperatures, leading to probable extinction of the species. Further, projected increases in numbers of direct mortalities of Black-capped petrels due to hurricane-induced inland strandings (Figure 4.2) may also adversely affect resiliency, particularly at lower population levels. This is because as populations become smaller, the *per capita* demographic effect of mortalities on overall population persistence increases as a result of the Allee effect (Courchamp et al. 1999, entire) of which small populations of *k*-selected species are particularly susceptible (White et al. 2014, pp. 49-51).

The second factor that may affect Black-capped petrel resiliency is human population growth. Barring a major cataclysmic event, the human population on Hispaniola is certain to increase over the next 50 years. The rate of increase is projected to be greater for Haiti than for the Dominican Republic (Figs 4.4, 4.6). Continued population growth has significant implications for Black-capped petrel resiliency. This is because 90-95% of all known nests of the species occur in Haiti where they are increasingly threatened by anthropogenic activities associated with producing food, fuel and building materials. In particular, extremely high reliance on wood-based fuels (charcoal, firewood) for cooking in Haiti results in significant and growing demand for this resource, which results in deforestation and forest degradation. Logically, as the demand increases, so will the amount of forest cleared or otherwise degraded for energy production. Below we assess the implications of human population growth (and other threats) to Black-capped petrel species resiliency according to each of our three potential future scenarios. To quantify changes in overall resiliency under each Scenario, we used the following methodology:

- Determined proportional change in overall resiliency under future Scenarios 1-3 (i.e. *PRs*) by dividing future overall resiliency under each Scenario by current overall resiliency (*Rcov*), expressed as:  $(\sum_1^n (PRs) / PR_{opt}) / R_{cov}$

*Scenario 1: Human population of Hispaniola increases per current UN projections*

If the population of Hispaniola increases as currently projected, there will be 28 million inhabitants on the island by 2070, of which 15 million will reside in Haiti. At such time, the human population density of Haiti will exceed 545 persons/km<sup>2</sup> with most people living in densely-populated urban areas where charcoal is currently the primary fuel used for cooking. Unless there is a significant shift away from the use of wood-based fuels to (perhaps) propane gas (as is the case of the Dominican Republic) the rate of land-clearing and forest degradation both within and near Black-capped petrel nesting areas will likely increase by 62% over the next 50 years. Moreover, the demand for food and building materials to support the human population will also increase substantially over current levels resulting in additional deforestation for agricultural purposes. Deforestation concurrent with population growth is expected to occur in both in Haiti and adjacent areas of the Dominican Republic. Anthropogenic fires associated with land-clearing activities are also expected to increase, further threatening Black-capped petrel nesting habitat. Given the level of this threat to nesting areas in Scenario 1, the magnitude of

forest conversion (i.e., for charcoal production, agriculture) the resiliency of the Black-capped petrel is predicted to be very low, as per the following:

- *Scenario 1:*  $(\sum_1^n(PRs)/PR_{opt})/R_{cov} = ((0+0+1+1+0+0+0)/(3*7))/.333 = .095/.333 = .286$  of current overall resiliency (-71.4% of current)

The populations most likely to be adversely affected under this scenario are those within Haiti and along the Haiti-Dominican Republic border. In particular, the Pic Macaya and Pic La Visite breeding populations in Haiti which have apparently suffered the greatest recent declines in both habitat quality and quantity (Goetz et al. 2012, pp. 9-10; Simons et al. 2013, p. S13-S15), and a subsequent loss in the number of nesting petrels, are likely to face extirpation. If so, this could potentially result in a loss of 85-95% of the currently known breeding population (see Goetz et al. 2012, p. 5). The Haitian portion of the Morne Vincent/Sierra del Bahoruco breeding colony, having already been largely deforested, may experience slightly less adverse effects from continued deforestation. However, there exists a significant potential for increased land clearing for agricultural activity in this nesting area as it is not within any officially protected area. The Dominican Republic portion of this nesting area will most likely also be subject to at least some increased clearing for agricultural activities as well as charcoal production. Because much of the nesting habitat lies within an officially protected area, which is at least somewhat protected in the Dominican Republic, may help to reduce or slow future degradation. The remaining, and only recently discovered, nesting area is in Valle Nuevo National Park in the central mountains of the Dominican Republic. This nesting area faces many similar threats but is nevertheless more remote and slightly more distant from the growing market for charcoal in Haiti. This distance from anthropogenic influence, along with its protected status, may result in this nesting area being less adversely affected than the others. It should be noted, however, that only one Black-capped petrel nest has been identified in this Park, so its overall importance to species resiliency and persistence is uncertain at best.

*Scenario 2: Human population of Hispaniola increases at annual rates 20% less than UN projections*

In *Scenario 2*, the human population on Hispaniola is projected to increase at an annual rate that is 20% less than currently predicted resulting in approximately 27.5 million inhabitants by 2070, of which 14.6 million of those inhabitants will reside in Haiti. Note that this projected total population is only about 2% less than was projected in *Scenario 1*. Likewise, the projected population density of Haiti under this scenario is 532 persons/km<sup>2</sup>, only about 2% less than projected in *Scenario 1*. Accordingly, the future for Black-capped petrel under *Scenario 2* is expected to look very similar to that described in Scenario 1, resulting in a predicted very low future resiliency, as per the following:

- *Scenario 2:*  $(\sum_1^n(PRs)/PR_{opt})/R_{cov} = ((0+0+1+1+0+0+0)/(3*7))/.333 = .095/.333 = .286$  of current overall resiliency (-71.4% of current)

*Scenario 3: Human population of Hispaniola increases at annual rates 20% greater than UN projections*

In *Scenario 3*, the human population on Hispaniola is projected to increase at an annual rate that is 20% greater than predicted in *Scenario 1*. Given *Scenario 3*, there will be approximately 34 million inhabitants on the island by 2070 of which just over 20 million will reside in Haiti. Under this scenario, human population densities would reach 740 persons/km<sup>2</sup> in Haiti and 285 persons/km<sup>2</sup> in the Dominican Republic. At such time, the projected demand for charcoal and firewood in Haiti (assuming all other required resources would support such a population) would result in a 220% increase in the amount of deforested and degraded areas on Hispaniola just for energy production. In addition to deforestation for charcoal, additional forest lost is projected to occur as a result of intensified agricultural activities. Given the projections in *Scenario 3*, the magnitude of forest conversion would likely result in widespread catastrophic loss of nesting habitat, and in turn, likely extinction of the species in the wild. Because of the inherent uncertainty of projections for the more severe outcome of *Scenario 3*, we opted to subdivide this scenario into two equally likely outcomes; *Scenario 3a* (one remaining very low resiliency population; i.e. Valle Nuevo NP), and *Scenario 3b* (no remaining populations; i.e. species extinction), as per the following:

- *Scenario 3a*:  $(\sum_1^n(PRs)/PROpt)/Rcov = ((0+0+0+1+0+0+0))/(3*7)/.333 = .048/.333 = .142$  of current overall resiliency (-**85.8%** of current)
- *Scenario 3b*:  $(\sum_1^n(PRs)/PROpt)/Rcov = ((0+0+0+0+0+0+0))/(3*7)/.333 = \mathbf{0.00} =$   
**Extinction**

### 4.3. Redundancy

Redundancy is a measure of both the number and distribution of resilient populations across a species' range. A species with numerous, broadly distributed resilient populations is more likely to withstand catastrophic events than those with few, closely clustered populations. The most likely catastrophic event for the Black-capped petrel would be an extremely intense hurricane that results in significant degradation or loss of suitable nest sites via accelerated erosion, flooding and collapse of nesting burrows, and extensive landslides. The incidence of intense hurricanes is forecast to increase 1% annually over the next 100 years (Hass et al. 2012, pp 255-257). This means that the annual probability of such storms will be at least 50% greater in 2070 than present. Because all known breeding populations occur on a single island, and are located in relatively close proximity to one another, they are all susceptible to the effects of any given hurricane that makes landfall at or near the nesting areas. Moreover, all four known breeding populations nest within the area of Hispaniola most vulnerable to hurricane effects. Further exacerbating their susceptibility to storms is their occupation of nesting areas that have high soil erosion potential (Smucker et al. 2007, pp 54-61). The contemporary population of Black-

capped petrel is thus predicted to have little to no redundancy to protect the species' in the face of a catastrophic event that affects their nesting habitat on Hispaniola.

#### **4.4. Representation**

Representation reflects the adaptive potential of a species. Although few data exist regarding genetic diversity of the Black-capped petrel, Manly et al. (2013, entire) report a 1.2% fixed genetic difference between the light and dark color morphs of the species, suggesting the possibility of potential isolation (seasonal or geographic) of the two forms. While these findings do not rule out the possibility of sub speciation, Manly et al. (2013) cautioned that a more rigorous analysis is needed on genetic identity of individuals from known breeding colonies to either refute or substantiate such a possibility.

In the absence of conclusive data on species genetic and ecological diversity, we consider the extent and diversity of habitat characteristics within the geographic range; in this case, the known current breeding range. Given that all known breeding populations nest on one island, and within similar habitat types, any further reduction in the number of breeding populations will have adverse effects on population representation. Based on past extirpations of the species from other islands, it appears that once an island-specific population is extirpated, the island is apparently not recolonized. This could be due to the typically high natal philopatry and nest site fidelity demonstrated by members of the genus *Pterodroma*. Assuming that the potential for colonization is limited due to the behavioral and biological characteristics of the species, alongside the lack of widespread suitable nesting habitat in the region, it is unlikely that breeding pairs on Hispaniola would re-colonize alternate islands should habitat conditions on Hispaniola be rendered unsuitable.

## **Chapter 5. Summary and Synthesis**

We used the best available information to assess the current and predicted future condition of the Black-capped petrel relative to its continued viability as a species. In doing so, we considered all recognized threats to the species and how and why they may impinge upon species viability. In the process, we observed that the numerous distinct threats shared common underlying drivers, and of these, the two which encompassed virtually all threats were 1) regional climate change, and 2) human population growth – particularly on Hispaniola where all currently known nesting by the petrel occurs. Importantly, for each of these identified drivers there exists a body of empirical data on which to base reasonable predictions of future conditions for the Black-capped petrel. Rather than attempting to predict future levels of diverse threats, many of which lack adequate quantitative data, we chose instead to examine future projections for these two overarching drivers. That is, we employed a parsimonious yet inclusive analytical model. To employ this approach, we used a combination of Black-capped petrel population trajectories over the past 50 years, past trends and current levels of threats, and recognized causal relationships

between and among drivers and threats, to arrive at what we believe to be the most likely current and future status of the Black-capped petrel.

We predicted factors affecting Black-capped petrel status at two intermediate time frames, 10 and 25 years, and chose 50 years as the end of our predictive time horizon. To assess the influence of human population growth on petrel nesting habitat on Hispaniola, we considered three (3) different scenarios. The three scenarios correspond to baseline, plus 20%, and minus 20%, United Nations population growth projections for Haiti and the Dominican Republic. By “bracketing” our projections, we were attempting to account for inherent uncertainties that can arise from long-term projections. By accounting for potential variation, we increased our confidence that the “true” population growth, and its subsequent effects on Black-capped petrel nesting habitat, was captured within the range of our scenarios. This also provided a means of graphically depicting and examining relative differences in population growth over time which may allow for the identification of “critical time points” beyond which certain threats may more rapidly increase in severity.

The results of our assessment reflect that the Black-capped petrel has experienced a progressive reduction in two key demographic parameters over (at least) the past five centuries: 1) population size and, 2) number of breeding populations. It should be noted that these components are not mutually exclusive as loss of breeding populations typically results in a decline in total population. Historical information also suggests that reductions were – and continue to be – primarily a result of human activities on the Caribbean islands which historically hosted Black-capped petrel breeding populations. Although declines largely occurred following the European colonization of the Caribbean region in the 16<sup>th</sup> century, there is evidence that at least one breeding population (i.e. Martinique) was eliminated during pre-Columbian times by overharvesting for food by the resident Carib Indians. Thus, the cumulative actions of human populations on Caribbean islands have progressively reduced the overall extent of known Black-capped petrel breeding populations from that of at least seven (7) populations on four different islands, to four current populations, all located on one island (i.e. southwestern Hispaniola). Geographic isolation has the associated effect of increasing the vulnerability of the species to catastrophic events, such as major hurricanes. Our estimates of little to no redundancy and representation are reflective of the species vulnerability to such events.

Once breeding populations of the Black-capped petrel became geographically limited to southwestern Hispaniola, a suite of additional factors (see section 2.9) began to work synergistically to further reduce the overall population of the species. Among these, habitat loss and degradation is considered to have been, and continue to be, the most pernicious. Anthropogenic habitat loss and associated factors threaten the remaining breeding populations on Hispaniola and have almost certainly contributed to the substantial decline in overall numbers of the Black-capped petrel over the past 50 years. There has also been an apparent concomitant decrease in petrel numbers within most individual breeding populations. Our estimate of low

resiliency for the Black-capped petrel reflects extensive nesting habitat loss and degradation and subsequent declines in petrel population size.

As the human population on Hispaniola increases, the attendant anthropogenic factors which currently influence species viability are virtually certain to increase concomitantly. In particular, the overwhelming dependence of the human population of Haiti on wood-based cooking fuels (e.g., charcoal and firewood) has resulted in substantial deforestation and forest conversion in both Haiti and adjacent regions of the Dominican Republic. Future increases in the human population of Haiti will almost certainly result in increased deforestation rates throughout Black-capped petrel nesting areas, both for production of charcoal and necessary agricultural products and building materials. Based on the best available information, our more conservative projections (Figure 4.8) suggest a future increase of approximately 0.56-0.65%/year in the areal extent of forest conversion on Hispaniola. Of the four (4) known breeding populations on Hispaniola, two (2) (Pic Macaya and Pic La Visite) are likely to face extirpation by 2070 given all projected future scenarios. Pic Macaya because of the lack of control of human access or ongoing conservation efforts, and Pic La Visite because of ongoing and increasing rates of degradation and its close proximity to the capital city, Port-au-Prince, where anthropogenic demand for resources (food, fuel, building material) is very high. In the case of Pic La Visite, the discovery of any additional petrel nesting sites in the adjacent and contiguous areas of Pic La Selle (see section 3.1.6.2) could potentially attenuate such losses but no such additional nest sites have been found to date. The loss of these two breeding populations would therefore represent a potential loss of up to 85-95% of the currently known breeding population of the Black-capped petrel.

The primary effects of anthropogenic actions on Black-capped petrel viability have apparently occurred over the past four or five centuries, a relatively short time in an evolutionary context. However, the petrel has been subject to the stochastic occurrences of tropical storms and hurricanes in the Caribbean for much longer, and has presumably evolved adaptive strategies in response to such storm events. However, such adaptations evolved in the context of multiple breeding populations across multiple islands, larger populations, and under previous regional climatic regimes. The conditions in which the Black-capped petrel evolved have experienced drastic changes which are only predicted to worsen. In the case of regional climate regimes, the best available information suggests a hotter and drier future climate within the specific area where Black-capped petrels currently nest along with a steady increase in the number of intense (Category 3-5) hurricanes across the region over the next century. Although major hurricanes were likely not an existential threat to the Black-capped petrel under their historic (i.e. pre-Columbian) population conditions, the combination of fewer and smaller breeding populations, ongoing nesting habitat loss and degradation, and more frequent and intense tropical storms will likely result in adverse effects to the petrel from these stochastic atmospheric phenomena. Based on past trends and evidence, these adverse effects will likely also include increased mortalities of

adults on the western Atlantic foraging grounds due to increased frequency of hurricane-induced inland strandings.

There remains an additional factor which could conceivably influence Black-capped petrel viability that we were unable to evaluate in this document. For many species, particularly species that form breeding colonies or other such aggregations, as population numbers decline they may reach a “critical level” below which normal social and ecological interactions become impaired or inhibited. This is commonly referred to as the Allee effect (see, e.g. Courchamp et al. 1999, entire; Stephens et al. 1999, entire; and many others). Examples of such effects include increased *per capita* demographic effects of mortalities, disruption of normal pair-bond formation, skewed sex ratios, lower reproductive success, and reduced foraging efficiency. These combined effects can result in an extinction vortex from which a species cannot demographically recover (Dennis 2002; entire). We do not know if the Black-capped petrel is currently subject to such effects and, if so, to what extent. Nevertheless, as the population declines the potential for future manifestations of demographic Allee effects in this species should not be discounted or ignored.

Finally, given the best available science at the time of this analysis, it is certain that the future viability of the Black-capped petrel is inextricably linked to the complex and challenging socioeconomic and environmental landscape that is Haiti. Up to as many as 90-95% of all known Black-capped petrel nest sites occur in what is internationally recognized as the poorest, least developed and most environmentally degraded country in the western hemisphere. The current and future challenges faced by Haiti in terms of political and economic stability, environmental protection, food security and public health are daunting. And while there are, and will continue to be, numerous successful initiatives by both local and international conservation and humanitarian organizations to provide needed financial and technical support for environmental conservation in Haiti, these efforts are nonetheless subject to the vicissitudes of donor funding in an ever unpredictable global financial setting. Natural resource conservation and management in Haiti would be seriously hampered in the event of a major global financial crisis, widespread social unrest in Haiti, or a military confrontation between Haiti and the Dominican Republic, all of which have occurred at some point in the past. Meanwhile, Haiti, and to a lesser but still significant degree, the Dominican Republic remain highly vulnerable to stochastic and catastrophic natural events such as major earthquakes and hurricanes which can result in significant setbacks for ongoing conservation efforts (Castro et al. 2005, entire; Smucker et al 2007, entire). In the end, the future of the Black-capped petrel will depend in large measure on the long-term effectiveness of ongoing and future conservation efforts in Haiti.



## Literature Cited

- American Bird Conservancy. 2014. Interim Report to the U.S. Fish and Wildlife Service. Submitted September 2014.
- Barun. A., C.C. Hanson, K.J. Campbell and D. Simerloff. 2011. A review of small Indian mongoose management and eradications on islands. In C. R. Veitch, M. N. Clout and D. R. Towns (eds). *Island Invasives: Eradication and Management*. IUCN, Gland, Switzerland, pp. 17–25.
- Bender, M.A., T. R. Knutson, R. E. Tuleya, J. J. Sirutis, G. A. Vecchi, S.T. Garner, I. M. Held. 2010. Modeled Impact of Anthropogenic Warming on the Frequency of Intense Atlantic Hurricanes. *Science* 327, 454.
- Birdlife International. 2010. Catastrophic forest fire delivers huge blow to Europe's rarest seabird. <http://www.birdlife.org/news/news/2010/08/Zinos-petrel-disaster.html>. Visited 13 March 2018.
- Brown, A. 2013. Results of 2013 radar surveys on Hispaniola. Report for American Bird Conservancy.
- Brown, A. 2015. Radar surveys for the endangered Black-capped petrel on Dominica, West Indies. Report by Environmental Protection in the Caribbean.
- Brown, A. 2016. Diablotin Conservation Expedition: Haiti 2016. Environmental Protection in the Caribbean.
- Campbell, J.D., M.A. Taylor, T.S. Stephenson, R.A. Watson and F.S. Whyte. 2010. Future climate of the Caribbean from a regional climate model. *International Journal of Climatology* 31: 1866–1878.
- Campbell, K.J., G. Harper, D. Algar, C.C. Hanson, B.S. Keitt, and S. Robinson. 2011. Review of feral cat eradications on islands. Pages 37–46 in Veitch CR Clout MN Towns DR , eds. *Island Invasives: Eradication and Management* . International Union for Conservation of Nature.
- Castro, M., C. Mataya and J. Stark. 2005. Environmental Security in the Dominican Republic: Promise or Peril? Report for the Foundation for Environmental Security and Sustainability.
- Checo, I.H. 2009. Identificación y descripción de la red de comercialización del carbón vegetal en comunidades de las provincias Independencia y Bahoruco. Red de comercialización del carbón en Independencia y Bahoruco Página.
- Churches, C.E., P.J. Wampler, W. Sun and A.J. Smith. 2014. Evaluation of forest cover estimate for Haiti using supervised classification of Landsat data. *International Journal of Applied Earth Observation and Geoinformation*, Vol 30, pp. 203-216.

- Clapp, R., D. Morgan-Jacobs and R.C. Banks. 1992. Marine birds of the southeastern United States and Gulf of Mexico. Part I. Gaviiformes through Pelecaniformes. Washington, DC: US Fish & Wildlife Service. FWS/DBS-83/30.
- Collar, N.J., L.P. Gonzaga, N. Krabbe, A. Madroño Nieto, L.G. Naranjo, T.A. Parker, and D.C. Wege. (1992) Threatened Birds of the Americas: the ICBP/IUCN Red Data Book. Cambridge, UK: International Council for Bird Preservation.
- Courchamp, F. T. Clutton-Brock and B. Grenfell. 1999. Inverse density dependence and the Allee effect. *Trends in Ecology and Evolution* (10):405-410.
- Dennis, B. 2002. Allee effects in stochastic populations. *OIKOS* 96, pp. 389-402.
- Elsner, J.B., J.P. Kossin and T. H. Jagger. 2008. The increasing intensity of the strongest tropical cyclones. *Nature* Vol 455|4 September 2008.
- Faulquier, L., R. Fontaine, E. Vidal, M. Salamolard and M. Le Corre. 2009. Feral Cats *Felis catus* threaten the endangered endemic Barau's Petrel *Pterodroma barau* at Reunion Island (Western Indian Ocean). *Waterbirds: The International Journal of Waterbird Biology*, Vol. 32, No. 2 (June 2009), pp. 330-336.
- Furness, E.F. 2003. Impacts of fisheries on seabird communities. *Scientia Marina*, 67 (Supple. 2):33-45.
- Gallagher, T. 2015. Illegal deforestation continues in the Dominican Republic; Threatens Bicknell's Thrushes. *Living Bird* magazine, Summer 2015 edition.
- Garthe, S., N. Markones and A. Corman. 2016. Possible impacts of offshore wind farms on seabirds: a pilot study in Northern Gannets in the southern North Sea. *Journal of Ornithology*, Vol. 158, pp. 345-349.
- Goetz, J.E., J. H. Norris, and J.A. Wheeler. 2012. Conservation Action Plan for the Black-capped petrel (*Pterodroma hasitata*). International Black-capped petrel Conservation Group.
- Grupo Jaragua. 2011. Repetidos cortes de bosque dentro del Parque Nacional Lago Enriquillo e isla Cabritos y Reserva Científica Loma Charco Azul para la fabricación de carbón vegetal. Por Grupo Jaragua. Denuncia ante la procuraduría para la Defensa del Medio ambiente y los recursos naturales.
- Haney, J.C. 1987. Aspects of the pelagic ecology and behavior of the Black-capped petrel. *The Wilson Bulletin*, Vol. 99, No. 2, pp. 153-312.
- Haney, J.C., K.M. Fristrup, and D.S. Lee. 1992. Geometry of visual recruitment by seabirds to ephemeral foraging flocks. *Ornis Scandinavica* 23: 49–62.

- Hass, T., J. Hyman and B. X. Semmens. 2012. Climate change, heightened hurricane activity, and extinction risk for an endangered tropical seabird, the Black-capped petrel *Pterodroma hasitata*. *Marine Ecology Progress Series* 454:251-261.
- Henderson, R. W. 1992. Consequences of predator introductions and habitat destruction on amphibians and reptiles in the post-Columbus West Indies. *Caribbean Journal of Science* 28:1–10.
- Hilbert, D.W., M. Bradford, T. Parker and D.A. Westcott. 2004. Golden bowerbird (*Prionodura newtonia*) habitat in past, present and future climates: predicted extinction of a vertebrate in tropical highlands due to global warming. *Biological Conservation*, Vol. 116, pp. 367-377.
- Howell, S.N.G. and J.B. Patteson. 2008. Variation in the Black-capped petrel- one species or more? *Alula* 14: 70-83.
- Imber, M.J. 1975. Behaviour of petrels in relation to the moon and artificial lights. *Notornis* 22: 302–306.
- Imber, M.J. 1985. Origins, phylogeny and taxonomy of the gadfly petrels *Pterodroma* spp. *Ibis* 127: 197–229.
- International Black-capped Petrel Conservation Group (IBPCG). 2016. Update on Activities June 2016.
- International Black-capped Petrel Conservation Group (IBPCG). 2017. Update on Activities February 2017.
- Jodice, P., R. A. Ronconi, E. Rupp, G. E. Wallace and Y. Satgé. 2015. First satellite tracks of the Endangered Black-capped petrel. *Endangered Species Research* 29:23-33.
- Karmalkar, A.V. 2013. A review of observed and projected changes in climate for the islands in the Caribbean. *Atmósfera* 26(2), 283-309.
- Kim, E.Y., T. Murakami, K. Saeki and R. Tatsukawa. 1996. Mercury levels and its chemical form in tissues and organs of seabirds. *Archives of Environmental Contamination and Toxicology*, 30, 259-266.
- Knutson, T.R., J.L. McBride, J. Chan, K. Emanuel, G. Holland, C. Landsea, I. Held, J.P. Kossin, A.K. Srivastava, and M. Sugi. 2010. Tropical Cyclones and Climate Change. *Nature Geoscience* 3.3 (2010): 157-163.
- Knutson, T.R., J.J. Sirutis, G.A. Vecchi, S. Garner, M. Zhao, H. Kim, M. Bender, R.E. Tuleya, I.M. Held, and G. Villarini. 2013. Dynamical downscaling projections of twenty-first-century Atlantic hurricane activity: cmip3 and cmip5 model-based scenarios. *Journal of Climate* 26:17 6591-6617.

- Kojadinovic, J., M. Le Corre, R. Cosson, and P. Bustamante. 2007a. Trace elements in three marine birds breeding on Reunion Island (Western Indian Ocean) Part 1: Factors influencing their bioaccumulation. *Archives of Environmental Contamination and Toxicology*, Springer Verlag, 52, pp. 418-430.
- Kojadinovic, J., P. Bustamante, C. Churlaud, R. Cosson and M. Le Corre. 2007b. Mercury in seabird feathers: Insight on dietary habits and evidence for exposure levels in the western Indian Ocean. *Science of the Total Environment*, Elsevier, 384 (1-3), pp. 194-204.
- Le Corre, M., and P. Jouventin. 2002. Light-induced mortality of petrels: a 4-year study from Réunion Island (Indian Ocean). *Biological Conservation*, Vol 105, pp. 93-102.
- Lee, D.S. 1977. Occurrence of the Black-capped petrel in North Carolina waters. *Chat* 41: 1-2.
- Lewis, D.S., R. van Veen and B.S. Wilson. 2010. Conservation implications of small Indian mongoose (*Herpestes auropuntatus*) predation in a hotspot within a hotspot: the Hellshire Hills, Jamaica. *Biological Invasions*, 13, pp. 25-33.
- Li, Y., J.A. Browder and Y. Jiao. 2012. Hook effects on seabird bycatch in the United States Atlantic pelagic longline fishery. *Bulletin of Marine Science*, 88(3):559-569.
- Longcore, T., C. Rich and S.A. Gauthreaux, Jr. 2008. Height, guy wires and steady-burning lights increase hazard of communication towers to nocturnal migrants: a review and meta-analysis. *The Auk*, Vol. 125, No. 2, pp. 485-492.
- Longcore, T., C. Rich, P. Mineau, B. MacDonald and D.G. Bert. 2013. Avian mortality at communication towers in the United States and Canada: which species, how many, and where? *Biological Conservation*, Vol. 158, pp. 410-419.
- Lugo, A.E. 2008. Visible and invisible effects of hurricanes on forest ecosystems: an international review. *Austral Ecology* 33, 368–398.
- Madeiros, J.C., C. Nicholas and D. Priddel. 2012. Breeding biology and population increase of the Endangered Bermuda Petrel *Pterodroma cahow*. *Bird Conservation International* 22: 35–45.
- Manly, B., B.S. Arbogast, D.S. Lee and M. van Tuinen. 2013. Mitochondrial DNA Analysis Reveals Substantial Population Structure within the Endangered Black-capped petrel (*Pterodroma hasitata*). *Waterbirds* 36: 228-233.
- McKown M. 2014. Acoustic monitoring of diablootin activity on Hispaniola: Pilot data and potential next steps. Report by Conservation Metrics.
- Moser, M.L. and D.S. Lee. 1992. A fourteen-year survey of plastic ingestion by western North Atlantic seabirds. *Colonial Waterbirds*: 83–94

O'Connell, A., B. Gardner, A. Gilbert, and K. Laurent. 2009. Compendium of avian occurrence information for the continental shelf waters along the Atlantic coast of the United States. Final report to US Fish & Wildlife Service and Minerals Management Service. Laurel, MD: Patuxent Wildlife Research Center.

Rimmer, C.C., E.G. Gomez and J.L. Brocca. 2005. Ornithological field investigations in La Visite National Park, Haiti, 26 January – 1 February 2005. Report in collaboration with Société Audubon Haiti.

Robbins, A.M.J., C. Eckelmann and M.Q. Ambio. 2008. Forest Fires in the Insular Caribbean. *Fire Ecology and Management*, Vol. 37, No. 7/8, pp. 528-534.

Rodríguez, A. and B. Rodríguez. 2009. Attraction of petrels to artificial lights in the Canary Islands: effects of moon phase and age class. *Ibis* 151: 299–310.

Rupp, E., E. Garrido, J.I. Matos, G. Feliz, J.L. Castillo, J. Goetz, and J. Gerwin. 2011. Discovery of a new nesting location for Black-capped petrel (*Pterodroma hasitata*) in Haiti. 2011 Annual Meeting of the Society for the Conservation and Study of Caribbean Birds, 21-25 July 2011, Freeport, Grand Bahama.

Rupp, E., E. Garrido, and G.E. Wallace. 2012. Summary of Black-capped petrel (*Pterodroma hasitata*) nesting activity during the 2011/2012 nesting season at Loma del Toro and Morne Vincent, Hispaniola. International Black-capped petrel Conservation Group. <http://www.fws.gov/birds/waterbirds/petrel>.

Rupp, E. and E. Garrido. 2013. Interim Report on Black-capped petrel Activities. Grupo Jaragua, May 16 2013.

Saether, B.E. and B. Oyvind. 2000. Avian life history variation and contribution of demographic traits to the population growth rate. *Ecology*, Vol 81, No. 3, pp. 642-653.

Sergile, F.E., C.A. Woods and P.E. Paryski. 1992. Final Report of the Macaya Biosphere Reserve Project. Florida Museum of Natural History, Gainesville, Florida USA.

Simons, T.R. 1984. A population model of the endangered Hawaiian Dark-rumped Petrel. *Journal of Wildlife Management*, Vol 48, No. 4, pp. 1065-1076.

Simons, T.R. 1985. Biology and behavior of the endangered Hawaiian Dark-rumped Petrel. *The Condor*, Vol 87, No. 2, pp. 229-245.

Simons, T.R., D.S. Lee, and J.C. Haney. 2013. Diablotin *Pterodroma hasitata*: a Biography of the endangered Black-capped petrel. *Marine Ornithology* 41(Special Issue): S 3–S 43.

Smucker, G.R., M. Bannister, H. D'Agnes, Y. Gossin, M. Portnoff, J. Timyan, S. Tobias and R. Toussaint. 2007. Environmental Vulnerability in Haiti Findings & Recommendations. This

publication was produced for review by the United States Agency for International Development, prepared by Chemonics International Inc. and the U.S. Forest Service.

Stephens, P.A., W.J. Sutherland and R.P. Freckleton. 1999. What is the Allee effect? *Oikos*, Vol. 87, No 1.

Tingley, M.W., W.B. Monahan, S.R. Beissinger, and C. Moritz. 2009. Birds track their Grinnellian niche through a century of climate change. *Proceedings of the National Academy of Science (USA)* 106:19637–19643.

United Nations, Department of Economic and Social Affairs, Population Division. 2017 Revision of World Population Prospects, <https://esa.un.org/unpd/wpp/>. Accessed 27 February 2018.

Wetmore, A. 1952. A record for the Black-capped petrel, *Pterodroma hasitata*, in Martinique. *Auk* 69: 460.

White, Jr., T.H., J. A. Collazo, S. J. Dinsmore and I. Llerandi-Román. 2014. Niche restriction and conservatism in a neotropical psittacine: the case of the Puerto Rican Parrot. Pgs. 1-83 in *Habitat Loss: Causes, Impacts on Biodiversity and Reduction Strategies*. Nova Science Publishers, New York, NY, USA.

Wingate, D.B. 1964. Discovery of breeding Black-capped petrels on Hispaniola. *The Auk*, Vol. 81, No. 2, pp. 147-159.

Wolf, S., B. Hartl, C. Carroll, M.C. Neel, and D.N. Greenwald. 2015. Beyond PVA: Why Recovery under the Endangered Species Act Is More than Population Viability. *BioScience*, Volume 65, Issue 2, 1 February 2015, Pages 200–207, <https://doi.org/10.1093/biosci/biu218>

Woods, C.A. 1987. The threatened and endangered birds of Haiti: lost horizons and new hopes. *Proceedings Jean Delacour/IFCB Symposium*: 385–429.

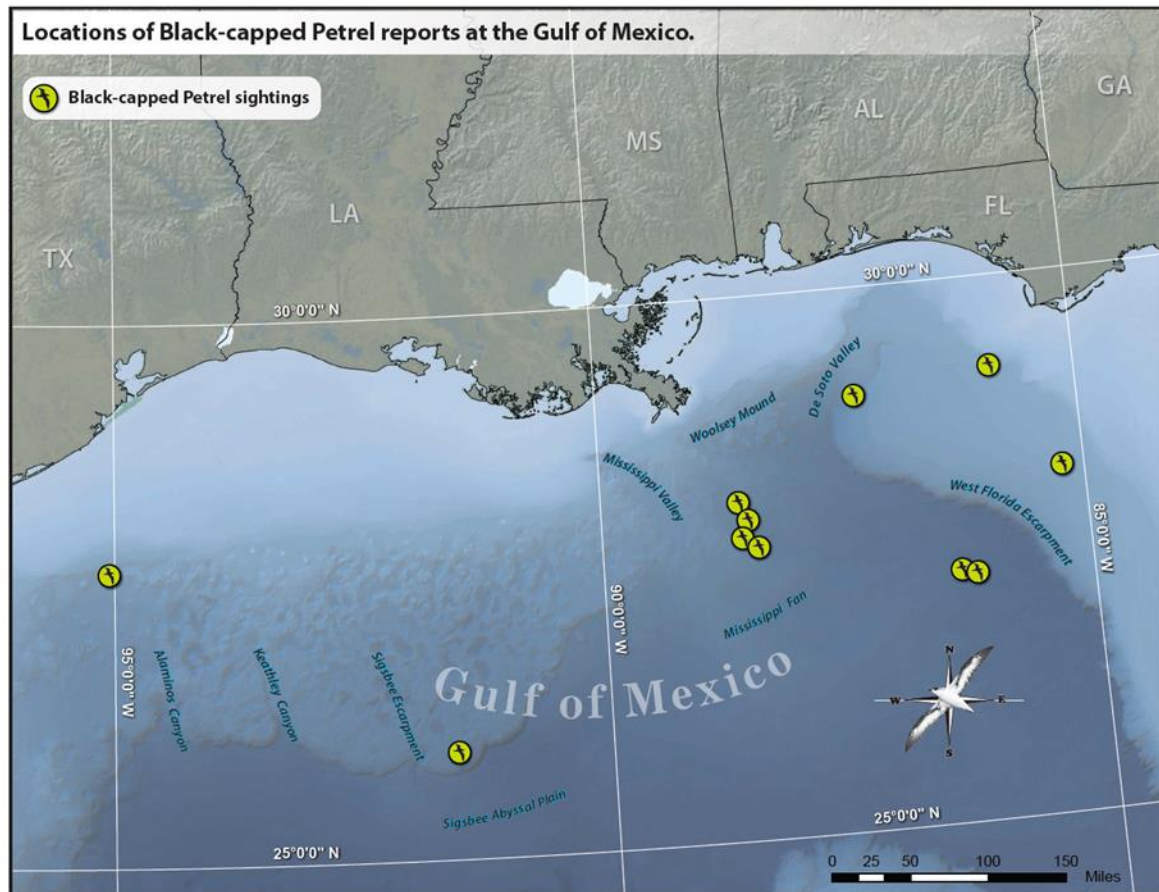
Woods, C.A., F.E. Sergile and J.A. Ottenwalder. 1992. Stewardship Plan for the National Parks and natural areas of Haiti. Florida Museum of Natural History. Prepared for United States Agency for International Development/Haiti.

Wurster, Jr., C.F. and D.B. Wingate. 1968. DDT residues and declining reproduction in the Bermuda Petrel. *Science*, New Series, Vol. 159, No. 3818, pp. 979-981.

## Appendices

### Appendix A – Black-capped petrel Gulf of Mexico sightings 18 May 2017-14 March 2018

| CRUISE #      | DATE   | LAT  | LONG  | OBS #1   | OBS #2      | SPECIES | COMMENTS  |
|---------------|--------|------|-------|----------|-------------|---------|---|
| Oregon II     | 170518 | 26.0 | -91.6 | C. Haney | M. McDowell | BCPE    | Got up and flew, diagnostic to id, when did fly, flight height 2  |
| Gordon Gunter | 170723 | 27.3 | -86.3 | C. Haney | J. Gleason  | BCPE    | 95% certain on ID; very far; gray to gray brown dorsally, likely white nape/black cap. Following slick line |
| Gordon Gunter | 170723 | 27.3 | -86.2 | C. Haney | J. Gleason  | BCPE    | Feeding back and forth along a convergence line with Sargassum, dispersed, post-feeding flock               |
| Gordon Gunter | 170726 | 29.2 | -85.9 | C. Haney | J. Gleason  | BCPE    | Actively feeding over predator fish school; white underwing, black cap, white rump                          |
| Gordon Gunter | 170810 | 27.9 | -88.5 | C. Haney | D. Bauer    | BCPE    | Gray-brown dorsal, white rump, flying low, sitting and feeding for short while                              |
| Gordon Gunter | 170810 | 27.8 | -88.5 | C. Haney | D. Bauer    | BCPE    | White rump, gray-brown dorsal   |
| Gordon Gunter | 170810 | 27.8 | -88.5 | C. Haney | D. Bauer    | BCPE    | Mixed foraging flock over tuna; most time on water (gray-brown dorsal, white rump)                          |
| Gordon Gunter | 170810 | 27.7 | -88.4 | C. Haney | D. Bauer    | BCPE    | Dynamic soaring   |
| Gordon Gunter | 170821 | 27.7 | -95.1 | C. Haney | D. Bauer    | BCPE    | White rump, nape; arcing flight   |
| Gordon Gunter | 180311 | 29.0 | -87.3 | C. Haney | J. Andrew   | BCPE    | White face; gray-brown plumage, arced wings; direct comparison with AUSH                                    |
| Gordon Gunter | 180314 | 28.2 | -85.2 | C. Haney | J. Andrew   | BCPE    | White-faced morph; zig-zag foraging flight, doubling back   |

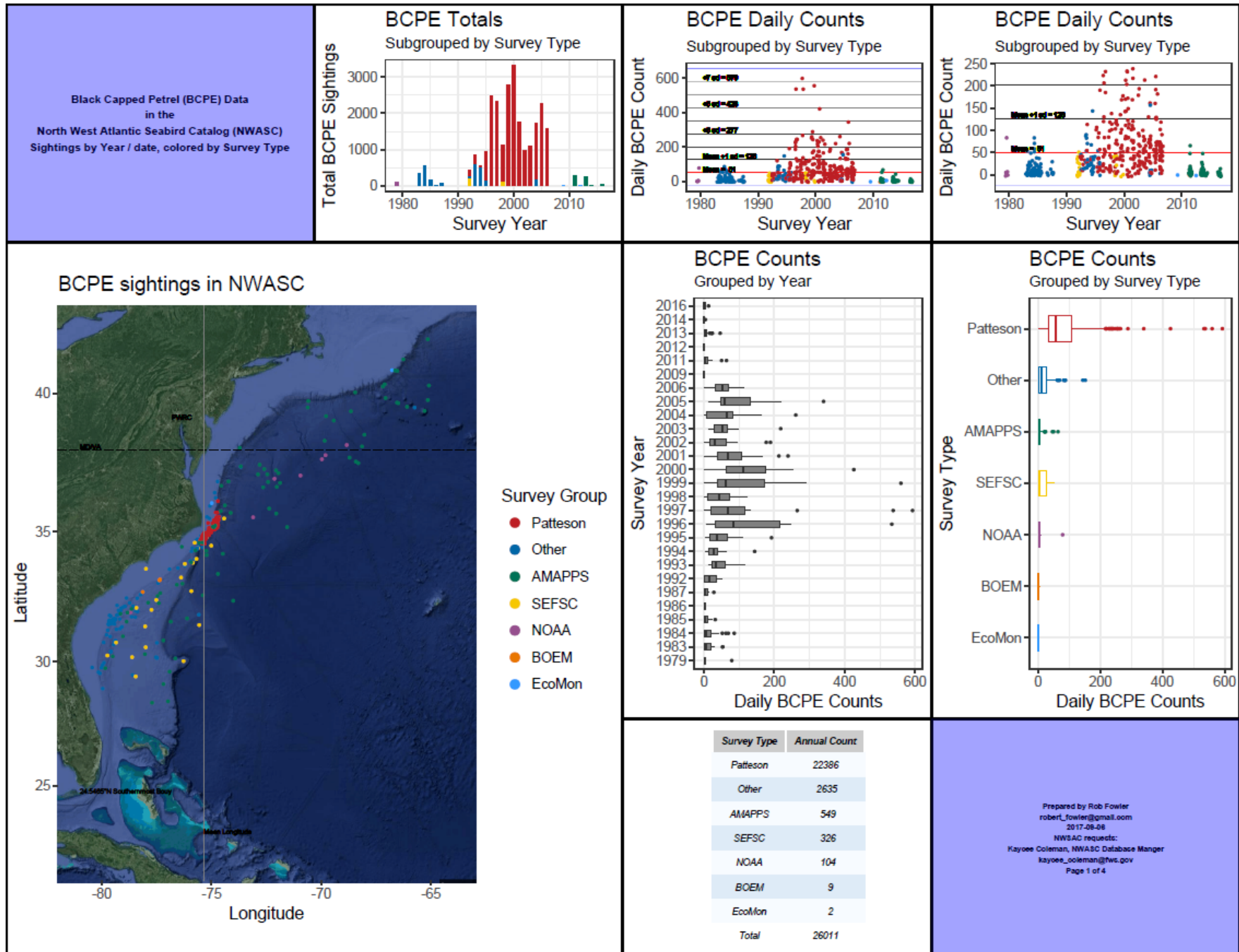


Data are from ship-based surveys supporting the Gulf of Mexico Marine Assessment Program for Protected Species (GoMMAPPS); reports from the surveys can be found on <https://www.boem.gov/GOMMAPP>. Methods described in Ballance, L. and M. Force. 2016. Seabird Distribution and Abundance Survey Protocols: A summary of seabird protocols and data collection procedures used on NEFSC/AMAPPS surveys. All Black-capped petrel records were single birds.

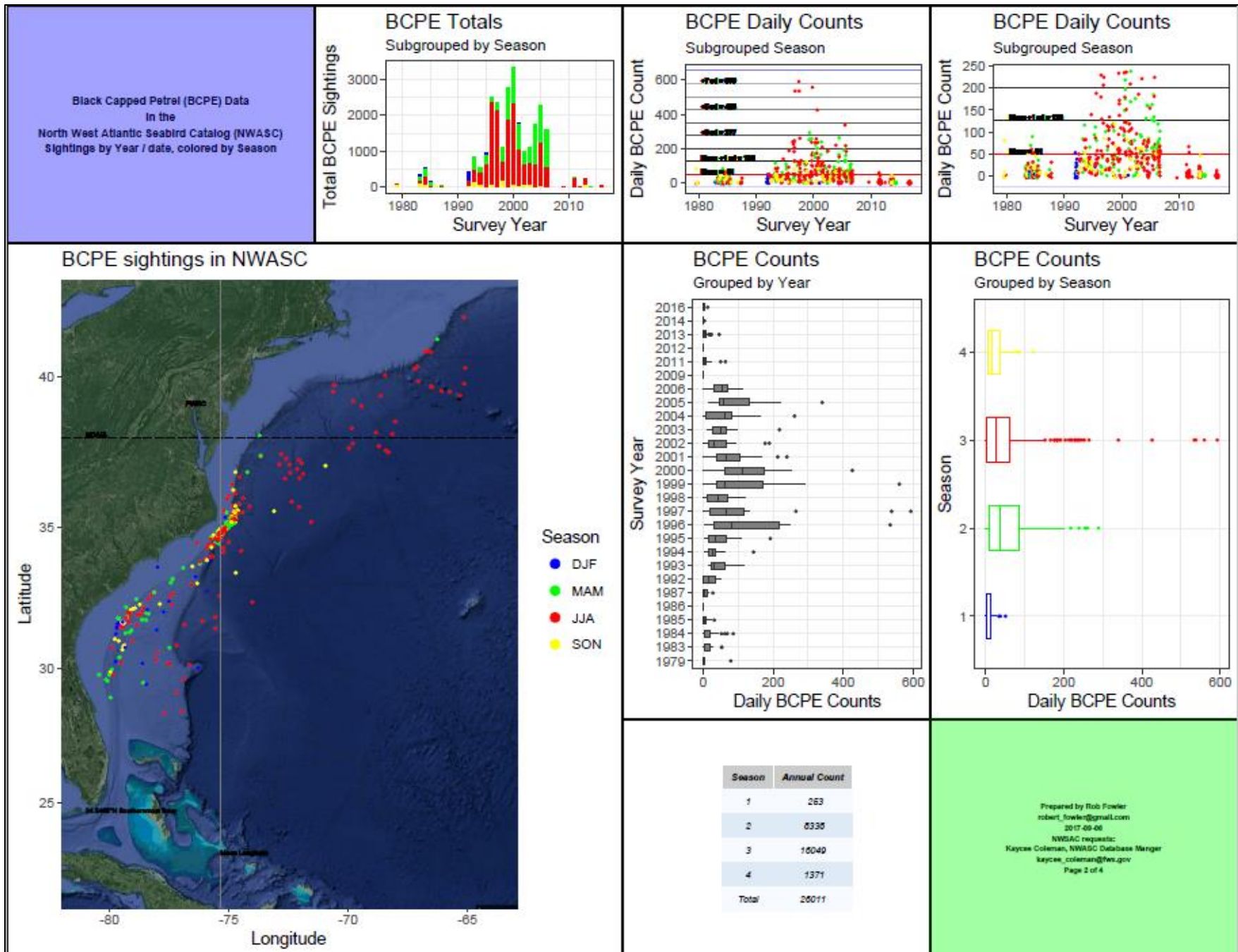
**Appendix B – Black-capped petrel Data in the North West Atlantic Seabird Catalog (NWASC)**

U.S. Fish and Wildlife Service, U.S. Department of Interior. Accessed through U.S. Department of Interior, Northwest Atlantic Seabird Catalog, Version 2. Accessed 25 Aug. 2017.

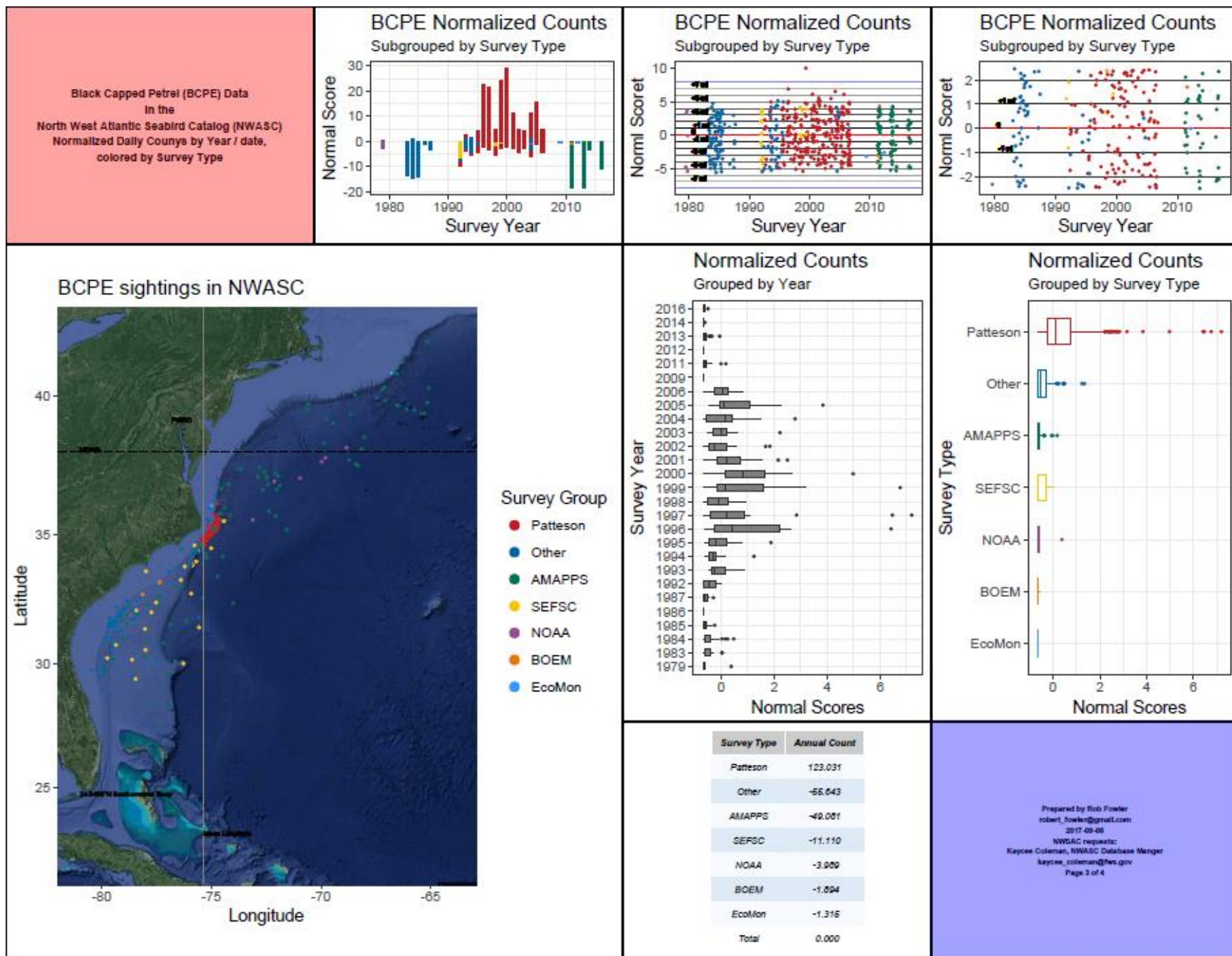




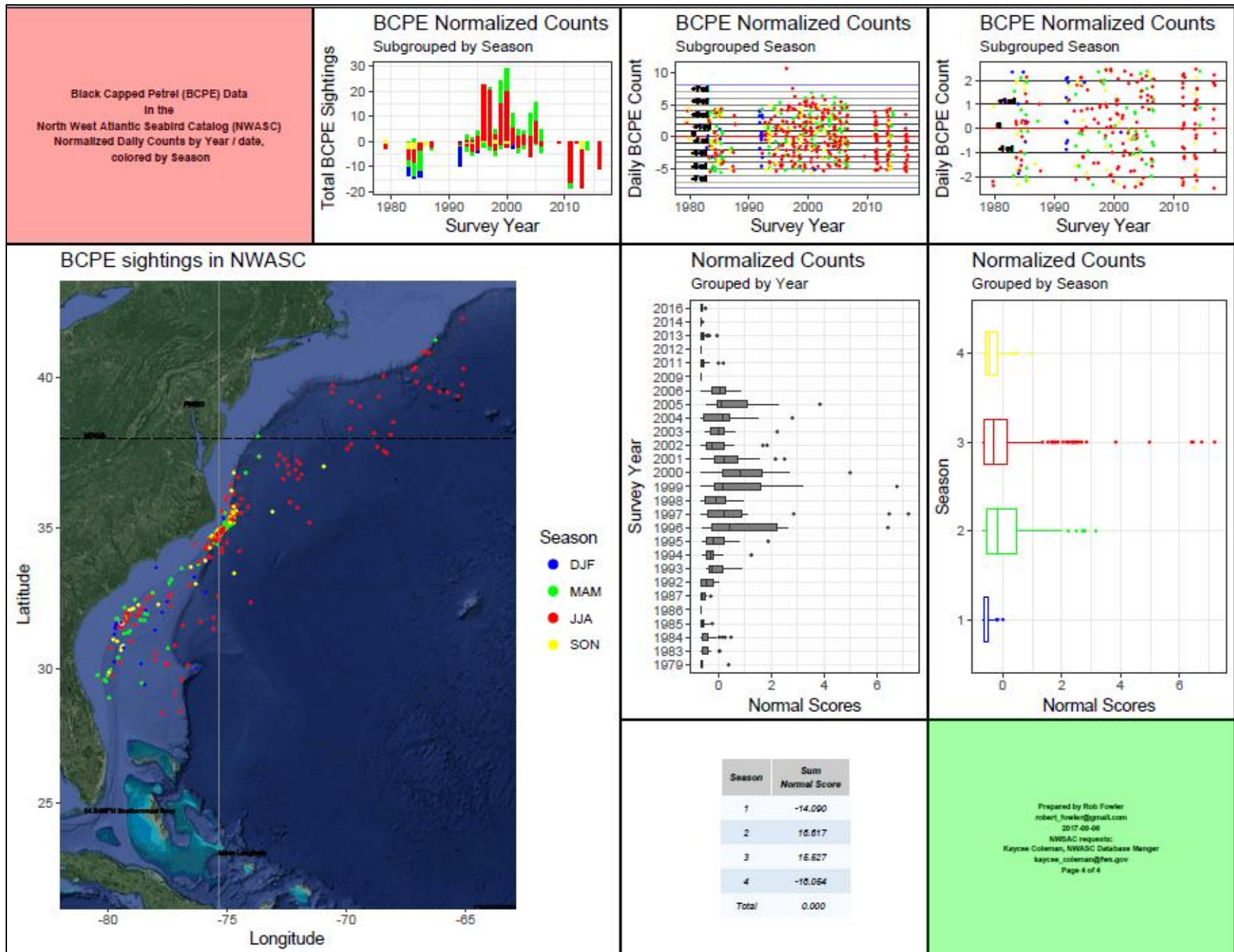
(i) Black-capped Petrel data in the North West Atlantic Seabird Catalog (NWASC) sightings by year/data, colored by survey type.



(ii) Black-capped Petrel data in the North West Atlantic Seabird Catalog (NWASC) sightings by year/data, colored by season.



(iii) Black-capped Petrel data in the North West Atlantic Seabird Catalog (NWASC) normalized daily counts by year/date, colored by survey type.



(iv) Black-capped Petrel data in the North West Atlantic Seabird Catalog (NWASC) normalized daily counts by year/date, colored by season.