

The Journal of Caribbean Ornithology

RESEARCH ARTICLE

Vol. 30(1):49–56. 2017

Long-term population monitoring of the Critically Endangered Grenada Dove (*Leptotila wellsi*) on Grenada, West Indies

Bonnie L. Rusk



Photo: Greg R. Homel

A Special Issue on the Status of Caribbean Forest Endemics

Long-term population monitoring of the Critically Endangered Grenada Dove (*Leptotila wellsi*) on Grenada, West Indies

Bonnie L. Rusk

Abstract The Grenada Dove (*Leptotila wellsi*) is an IUCN-listed Critically Endangered species endemic to the island of Grenada, West Indies. Long-term population monitoring was carried out episodically between 1987 and 2007 using territory (spot) mapping. Changes in distribution were also noted through 2016. The most recent population estimate of 136 individuals is based on territorial mapping of 68 males (assuming a 1:1 sex ratio) in 2007, representing a 25% decline from 182 individuals estimated immediately prior to Hurricane Ivan in 2003–2004. The species is limited almost exclusively to two areas in the southwest and on the west coast, with only a few individuals found outside these areas. Major threats include habitat loss and degradation due to residential and commercial development, small-scale agriculture, and fire. The impacts of these threats have been compounded by the impacts of extreme weather events such as Hurricane Ivan in 2004, and a high incidence of introduced mammalian predators.

Keywords abundance, endangered, endemic, Grenada Dove, *Leptotila wellsi*

Resumen Monitoreo poblacional a largo plazo de la En Peligro Crítico Paloma de Granada (*Leptotila wellsi*) en Granada, Caribe Insular—La Paloma de Granada (*Leptotila wellsi*) es catalogada por la UICN como una especie endémica y En Peligro Crítico en la isla de Granada, en el Caribe Insular. El monitoreo a largo plazo de la población se llevó a cabo de forma episódica entre 1987 y 2007 utilizando el mapeo de territorios (sitios). También se observaron los cambios en la distribución a lo largo de 2016. El estimado poblacional más reciente de 136 individuos está basado en el mapeo territorial de 68 machos (asumiendo una proporción de sexos de 1:1) en 2007, lo que representa una disminución del 25% de los 182 individuos estimados inmediatamente antes del huracán Iván en 2003–2004. La especie está limitada casi exclusivamente a dos áreas en el suroeste y la costa oeste, con sólo unos pocos individuos fuera de las mismas. Las principales amenazas incluyen la pérdida y degradación del hábitat para el desarrollo urbanístico y comercial, la agricultura a pequeña escala y el fuego. Los efectos de estas amenazas han sido agravados por los impactos de eventos climáticos extremos como el huracán Iván en 2004 y una alta incidencia de mamíferos depredadores.

Palabras clave abundancia, amenazada, endémica, *Leptotila wellsi*, Paloma de Granada

Résumé Surveillance à long terme de la population de la Colombe de Grenade (*Leptotila wellsi*) En danger critique sur Grenade, Antilles—La Colombe de Grenade (*Leptotila wellsi*) est une espèce endémique à Grenade, dans les Antilles, étiqueté En danger critique par l'UICN. Une étude à long terme de la population a été effectuée épisodiquement entre 1987 et 2007 en utilisant la cartographie de territoire par secteur. Les changements dans la distribution de la colombe ont également été observés en 2016. L'estimation de la population la plus récente de 136 individus est basée sur une cartographie territoriale de 68 mâles (en supposant un ratio sexuel de 1 : 1) en 2007, ce qui représente une baisse de 25% par rapport à les 182 individus estimés immédiatement avant l'ouragan Ivan en 2003-2004. L'espèce est limitée presque exclusivement à deux zones dans le sud-ouest et sur la côte ouest de Grenade, avec seulement quelques individus trouvés en dehors de ces zones. Les menaces principales comprennent la perte et la dégradation de l'habitat pour le développement résidentiel et commercial, l'agriculture à petite échelle, et le feu. Les effets de ces menaces ont été aggravés par les impacts des calamités météorologiques tels que l'ouragan Ivan en 2004 et une forte incidence de mammifères prédateurs introduits.

Mots clés abondance, Colombe de Grenade, en danger, endémique, *Leptotila wellsi*

Grenada Dove Conservation Programme, c/o Forestry and National Parks Department, Queen's Park, St. George's, Grenada; e-mail: blrusk1@gmail.com

The Grenada Dove (*Leptotila wellsi*; Fig. 1) is an IUCN-listed Critically Endangered species endemic to the island of Grenada, West Indies (BirdLife International 2017). The species was described by Lawrence (1884) and all modern records consider

it rare (Devas 1943, Lack and Lack 1973, Blockstein 1988, Rusk 2009, Rivera-Milán *et al.* 2015). Since its abundance and distribution were first described in 1987 (Blockstein 1988), the species has been confined primarily to two areas (Fig. 2) of secondary seasonal coastal dry and mixed deciduous forests in southwestern (Mt. Hartman Estate [Fig. 3] and surrounding forests totaling c. 423 ha) and western (Perseverance, Woodford, and Beausejour area totaling c. 160 ha) Grenada (Blockstein 1991, Rusk 1992, 1998, 2005, 2008, 2009, Rusk and Temple 1995, Rusk and Clouse 2004). Likely historically connected, these two populations are now separated by 9 km of extensive development, including the island's largest city, St. George's. Major threats to the species continue to be habitat loss and degradation, primarily for residential and commercial development, small-scale agriculture, and fire (Rusk 2009). These threats are compounded by impacts of extreme weather events such as Hurricane Ivan in 2004 (Rusk 2008) and fires during the 2010 drought (Peters 2015, BLR pers. obs.), and a high incidence of introduced mammalian predators, including mongooses (*Herpestes auro-punctatus*), rats (*Rattus* spp.), cats (*Felis catus*), and opossums (*Didelphis marsupialis*) (Rusk 2015, Bolton *et al.* 2016). Drying climatic trends leading to limited availability of fresh water during the dry season (January–May/June) pose a further threat to this species (Rusk 2011).

Occupied habitat includes both dry and mixed broadleaf evergreen-deciduous second-growth forests. These typically consist of closed canopy, predominantly thorny leguminous trees and shrubs, with a sparse understory of leguminous shrubs and saplings, little ground cover, and much exposed soil (Blockstein 1991, Rusk 2009, Rivera-Milán *et al.* 2015). Dominant species include *Haematoxylum campechianum*, *Bursera simaruba*, *Pisonia fragrans*, *Bourreria succulenta*, and *Leucaena leucocephala* (Rivera-Lugo 2005, Nelson *et al.* 2015, Rivera-Milán *et al.* 2015). Occupied habitat is also characterized by an abundance of legumes

that produce seeds less than about 5 mm in diameter, presumed to provide the bulk of the dove's food though its diet remains poorly known (Rusk *et al.* 1998).

Grenada Doves breed and establish territories during the rainy season (June/July–December; Fig. 3), when territorial males are heard singing (this study). However, the breeding season appears to be extended on the more mesic west coast where Grenada Doves may be heard singing outside of this period (Rusk 2008). The song is a distinctive descending “coo” repeated every 7–8 s, often for extended periods (Blockstein 1991, Rusk 2005, 2008). Grenada Doves often nest on gentle slopes or flat areas, where their song may be audible at distances of up to 100 m or greater (Blockstein 1991, this study), depending on topography, wind, and extraneous noise.

This paper describes the results of repeated territory mapping of Grenada Dove abundance between 1987 and 2007, as well as changes in distribution noted incidentally through 2016.

Methods

Territory mapping, also referred to as spot mapping (Ralph *et al.* 1993), was conducted between 1987 and 2007 (Table 1) at intervals of 1–5 yr in the areas known to be occupied by Grenada Doves to census territory-holding males in the population. In southwestern Grenada, this area included the Mt. Hartman Estate (195 ha) which encloses the 62 ha Mt. Hartman National Park, and forest adjacent to the estate boundaries, as well as the surrounding remaining patches of forest to the north (Petit Bouc and Woodlands north to Café; 198 ha) (Fig. 2). Individuals documented immediately adjacent to the Mt. Hartman Estate boundaries are included in the Mt. Hartman total. Occupied habitat on the west coast included the Perseverance Protected Area and Dove Sanctuary (32 ha) on the Perseverance Estate and adjacent habitat at the Beausejour and Grenville Vale Estates (101 ha) to the east and Woodford Estate and Black Bay (26 ha) to the north (Fig. 2; Rusk 2009). These intensive censuses were supplemented by incidental observations, casual searches in locations near these core areas, and an extensive island-wide search of coastal dry forests during the 2003–2004 census. Studies were carried out as resources permitted including following Hurricane Ivan in 2004 (Rusk 2005).

Both published (Blockstein 1988, 1991) and unpublished (Roberts and Taylor 1988, Sievert unpubl. data, this study) territory mapping results are included in this paper (Table 1). Blockstein's initial population estimates in 1987 (Blockstein 1988) and 1989–1990 (Blockstein 1991) were followed by BLR and colleagues' estimates of abundance from 1991 through 2007 (Table 1). These studies are supplemented by more recent (2013) multi-covariate distance sampling data by Rivera-Milán *et al.* (2015).

Territory mapping was carried out from the edge of forests or along roads and trails through occupied dove habitat to limit disturbance to the birds and to their singing behavior. Given that Grenada Dove songs are detectable at distances of 100 m or more (Blockstein 1988, this study), it is unlikely that singing birds were missed. Locations of all singing male Grenada Doves were marked on a topographical map, following the territory mapping techniques used by Blockstein (1988, 1991), and by Rusk (1992, 1998, 2005, 2008), Rusk and Clouse (2004), and Rusk



Fig. 1. Grenada Dove. Photo credit: Greg R. Homel/Natural Encounters Birding and Wildlife Photography.

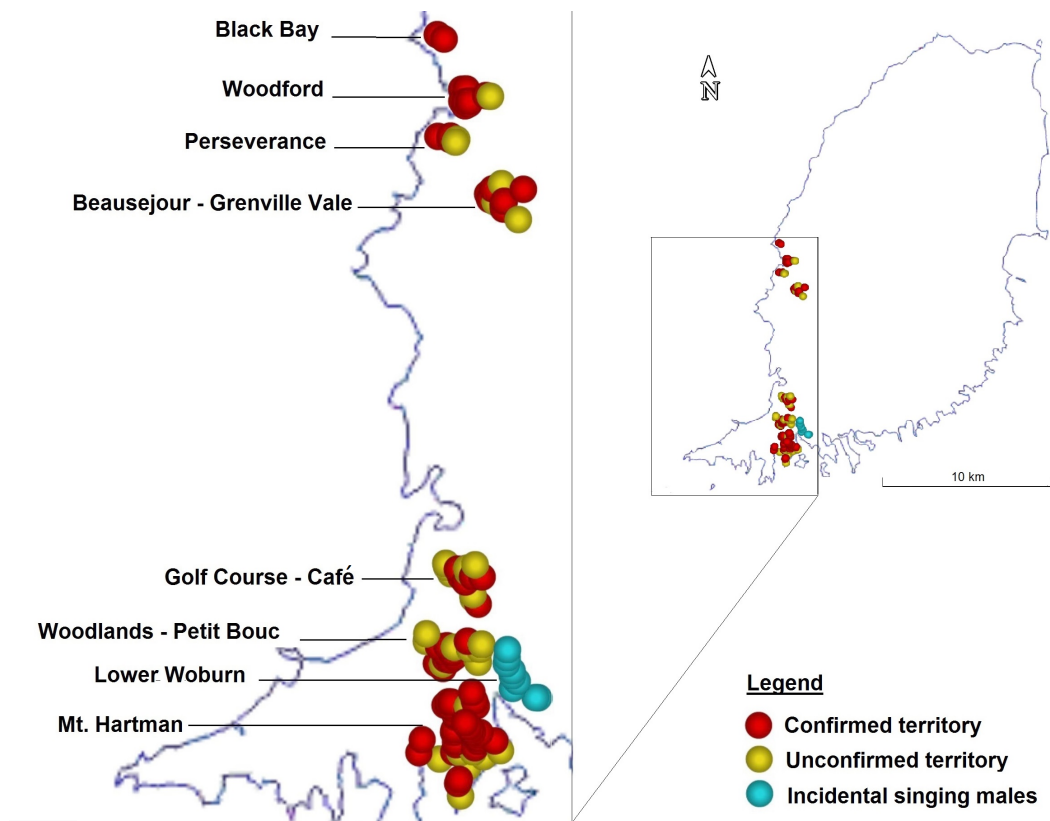


Fig. 2. 2007 distribution of Grenada Doves on Grenada.

and Temple (1995). Census routes were repeated 3–5 times within a period of up to 2 months (4 months during the 2003–2004 dry forest search) during the breeding season, depending on time availability, with the detection of a bird at a location on a majority of the counts indicating a confirmed territorial male. Individuals on unconfirmed territories (fewer detections) and incidental detections (such as incidental singing males) outside of the census are not included in population estimates, but those found in 2007 are indicated in Fig. 2. Routes were surveyed from approximately 0600 until approximately 1030, when frequency

of dove singing appeared to decline. Song playback was used to elicit songs when doves were not spontaneously singing.

Census routes were added as the species' distribution became better known, when singing males were documented incidentally outside the census area, and during the 2003–2004 search in dry forest areas. Initial 1987 census results (Blockstein 1988) included only the Mt. Hartman Estate and portions of nearby habitat at Petit Bouc and adjacent Mont Tout in the southwest, whereas the 1989–1990 census was expanded on the west coast to include a portion of the Beausejour, Perseverance, and Wood-



Fig. 3. Mt. Hartman National Park: (left) rainy season and (right) dry season. Photo credits: Bonnie L. Rusk and Greg R. Homel/Natural Encounters Birding and Wildlife Photography.

ford Estates (referred to as Halifax Harbor; Blockstein 1991). The 1991 and 1995 censuses estimated abundance at only discrete areas to document changes after proposed or known habitat loss. The 1991 census focused solely on Mt. Hartman and Beausejour where dove habitat was threatened by expanding agriculture and a proposed resort development, and road construction, respectively (Rusk 1992). The 1995 census (Rusk and Temple 1995) focused on two sites after habitat destruction: Perseverance (north half of the site was clear-cut for a proposed quarry) and Beausejour (road construction and housing development). The 1998 census (Rusk 1998) replicated the census areas of known distribution in the 1989–1990 study (Blockstein 1991), though with reduced effort in Mont Tout and Petit Bouc. This area of known distribution (all areas censused between 1987 and 1998) was subsequently expanded in 2003–2004 to include a new area of the Beausejour and Grenville Vale Estates and Black Bay on the west coast, and forest patches around Golf Course, Café, and Woodlands to the north of Mt. Hartman in the southwest (Fig. 2) after an island-wide dry coastal forest search discovered territorial individuals in these areas (Rusk and Clouse 2004).

Population estimates are presented as the number of singing males, with an assumption that an equal number of females exist in the population. Non-territory holding males, including floaters and sub-adult males, are not accounted for nor included in this estimate.

Results

All Grenada Doves were located within wooded areas, not in clearings, and most were seen perched or singing on branches typically at a height of approximately 3–5 m off the ground.

Doves were also seen either walking on the ground along paths and in open understory, or flying from a branch at an angle to the ground and walking away. A dove was also seen walking to the edge of a forest clearing and turning around. Only one individual was seen flying over an open area near Black Bay, from the forest edge to a fruit tree in an opening approximately 10 m away.

The Grenada Dove population appeared to decline by up to almost 50% between 1987 and 1990 in southwestern Grenada, from 49 singing males in 1987 to 25–30 in the same locations in 1989–1990 (Table 1, Fig. 4; Blockstein 1988, 1991). In 1998, the total Grenada Dove population was estimated to number only 49–62 singing males across all known habitat in Grenada (Table 1) with the population strongholds on the Mt. Hartman Estate and on the Perseverance and adjacent Woodford Estates in the west (Rusk *et al.* 1998, 2008). By 2003–2004, the island-wide population reached an estimated 91 males (Table 1), the highest count during the study period. At that time, 60% of the territorial males were found in the southwest, including 36% at Mt. Hartman and 24% in forest patches to the north of Mt. Hartman, from Petit Bouc north to Café (Table 1). A further 21% of the individuals were found at the Perseverance and Woodford Estates on the west coast (Table 1). This apparent increase can be attributed in part to 15 territorial males located at a previously undiscovered location at the Beausejour and Grenville Vale Estates and 8 males at a previously undiscovered location at Golf Course and Café north of Mt. Hartman.

In September 2004, a Category IV hurricane (Ivan) caused extreme damage to the island and was followed by a subsequent decline in the dove's population (Table 1, Fig. 4). Population

Table 1. Population counts of territorial singing male Grenada Doves (1987–2007).

Census Year	Southwest				West			Total	Total Population Abundance	Source ^a
	Mt. Hartman	Petit Bouc & Woodlands	Golf Course & Café	Total	Perseverance & Woodford Estates	Beausejour & Grenville Vale Estates	Black Bay			
1987	39	10	—	49	—	—	—	49	1	
1988	32	5	—	37	—	—	—	37	2	
1988	25	4	—	29	—	—	—	29	3	
1989–1990	23–28	2	—	25–30	10	3 ^b	—	13	38–43	4
1991 ^c	22–25	—	—	22–25	—	2 ^b	—	2	24–27	5
1995 ^c	—	—	—	—	7–9 ^d	0 ^b	—	7–9	—	6
1998 ^c	29–35	1 ^e	—	30–36	19–26	0 ^b	—	19–26	49–62	7
2003–2004 (pre-hurricane) ^c	33	14	8	55	19	15 ^f	2	36	91	8
2004 (post hurricane) ^{c,g}	17–33	7–8	5–7	29–48	1–5	1–6 ^f	1	3–12	32–60	9
2007 ^c	32	10	6	48	11	7 ^f	2	20	68	10

^aSource: 1 = Blockstein 1988, 2 = Sievert unpubl. data, 3 = Roberts and Taylor 1988, 4 = Blockstein 1991, 5 = Rusk 1992, 6 = Rusk and Temple 1995, 7 = Rusk 1998, 8 = Rusk and Clouse 2004, 9 = Rusk 2005, 10 = Rusk 2008

^bBeausejour: west (coast) facing area lost to road and housing development in 1995.

^cUnpublished census data from this author

^dPerseverance Estate only

^eNo census of area conducted. Incidental detection documented.

^fNew area on the Beausejour and Grenville Vale Estates contiguous to Perseverance Estate. Found in 2003–2004 dry forest search.

^gNo direct comparison should be made with 2004 data. Singing behavior was inconsistent due to Hurricane Ivan.

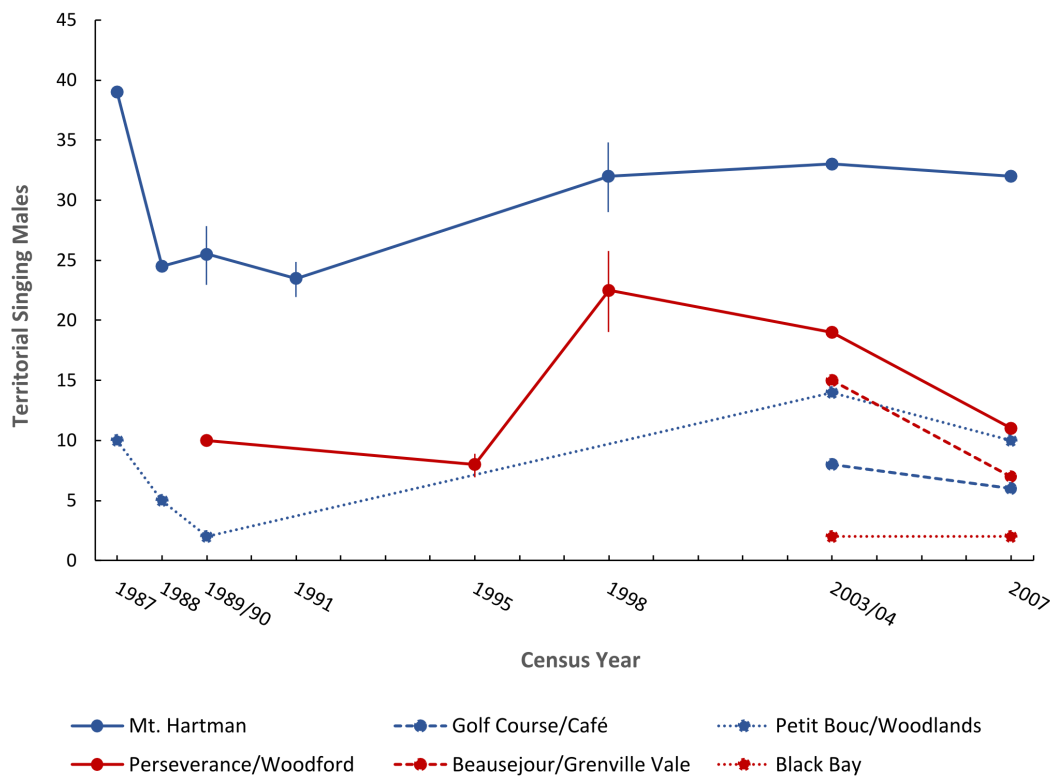


Fig. 4. Abundance estimates of singing territorial male Grenada Doves by year. 2004 post-Hurricane Ivan data are excluded due to inconsistent singing behavior. See Table 1 for associated citations.

abundance was most severely affected on the west coast, with a decline from 36 singing males to 3–12 singing males estimated (Table 1). Immediate post-hurricane declines were also documented in the southwest, falling from 55 males to 29–48 males (Table 1). However, the 2004 post-hurricane census, initiated 4 months post hurricane, revealed inconsistent singing behavior (Rusk 2005) and thus caution should be taken in making comparisons of abundance using these data. Population estimates reflecting this uncertainty are listed in Table 1. In 2007, 3 yr after Hurricane Ivan, the total population was only 75% of the 2003–2004 pre-Ivan estimates, reflecting a 44% decline in abundance on the west coast (Table 1, Fig. 4). However, two males documented in Black Bay, a discrete patch of habitat along the coast north of Perseverance (Fig. 2), in 2003–2004 were again present in 2007 (Table 1, Fig. 4).

In the southwest, where approximately 70% of the dove population occurred in 2007, Mt. Hartman consistently held the greatest number of individuals observed between 1987 and 2007 (Table 1, Fig. 4). Here, 80–90% of all individuals occurred on the slopes of the 1-km main ridge of the estate (Blockstein 1991, Rusk 1992, 1998, 2008, Rusk and Clouse 2004). Mt. Hartman has consistently held over a third of the global population, with 47% of all males found there in 2007 (32 males; Table 1). Of these males, all but 8 (5 on the estate and 3 immediately outside its boundaries) were found within the 62 ha Mt. Hartman National Park (Rusk 2008). On the west coast, 15% of recorded males were within the Perseverance Protected Area in 2007. In sum, of all documented territorial males in 2007, 40% were within the two protected areas, 16% on unprotected Crown land (Beause-

jour and areas of Mt. Hartman Estate not included in the national park), and 43% on private land.

In addition to the territory mapping census data, also reported are incidental individuals not previously documented in the southwest near Mt. Hartman in 2007 (Fig. 2) and north along the east coast in 2016. These incidental reports are not used for population estimates. In 2007, seven males were recorded in three valleys on the forested slopes of Lower Woburn, immediately across Woburn Bay from Mt. Hartman. Two individuals were also documented in a valley in Calivigny, just inland from the peninsula. An additional singing male was documented on the slopes of Egmont Bay ($12^{\circ}00'57.75''N$, $61^{\circ}43'34.25''W$) in St. David's in 2016. These areas were previously searched for Grenada Dove (Blockstein 1988, Rusk and Clouse 2004) with none documented. Rivera-Milán *et al.* (2015) also reported four solitary males in three new locations along the east coast.

Discussion

Long-term population monitoring of both abundance and distribution is an essential component of management and conservation efforts. Population studies of the Grenada Dove that documented its extreme rarity (Devas 1943, Blockstein 1988, 1991, Rusk 1992, Rusk and Temple 1995) contributed to the legal protection in 1996 of Crown lands on the Mt. Hartman and Perseverance Estates (BLR pers. obs.). Mt. Hartman is the core of the known population, with approximately 45% of the species' population within the estate's boundaries in 2007, and is a potential source of dispersal for individuals found in surrounding habitat. In 1987, habitat clearing for sugarcane was taking

place in the lowlands of Mt. Hartman (Blockstein 1991), with a subsequent population decrease of about 36% (from 39 males to ~25) recorded in 1990 (Blockstein 1991). Clearing for agriculture continued on the forested slopes until 1996 when the remaining wooded hillsides were legally designated as a national park. In 1999, all sugarcane production and agriculture on the estate, outside of the national park boundaries, ceased and the estate began to regenerate into secondary dry scrub woodlands. Excluding areas used for farming, soil extraction, and development activities, the dry scrub woodlands on the Mt. Hartman Estate continue to regenerate. Doves were first seen in newly (5 yr) regenerated vegetation abundant with legumes 4 months post Hurricane Ivan in 2004. Although only portions of this newly regenerated forest were occupied by doves in 2007, occupancy appears to be expanding on the estate, with Grenada Doves documented in 2016 in forested areas beyond those found in 2007 (Rusk 2008, this study), including a pair of doves seen walking along the bottom of the wooded hill between the coastal wetlands (12°00'25.69"N, 61°45'00.35"W). By 2007, abundance estimates on the estate had also increased from the 1989–1990 decline (Blockstein 1991), but had not reached the 1987 levels (Table 1, Fig. 4; Blockstein 1988). In 2008, in response to resort development plans, mitigation measures led to re-designation of the Mt. Hartman National Park boundaries into one contiguous parcel (Rusk 2008). This new area contained most territories on the estate (25 of the 29 documented in 2007), and included areas of documented dove use outside the 1996 boundaries. However, this site continues to be under threat of tourism and commercial development.

Overall population trends for the Grenada Dove should be interpreted with caution. Census years demonstrated differential sampling efforts and variations in locations included in the estimates prior to 2003–2004. Previously undiscovered territorial males were documented at new locations beginning primarily in 2003–2004, which included the discovery of the 15 territorial males at the Beausejour and Grenville Vale Estates and 8 males at a previously undiscovered location at Golf Course and Café (southwest). As such, population changes in this study are considered by site. Both Mt. Hartman and the Perseverance and Woodford Estates have been censused since 1989–1990 or earlier (Table 1, Fig. 4). Data from Mt. Hartman illustrate an overall decline (18%) in numbers since it was first censused (39 territorial males in 1987 and 32 in 2007). However, the 36% reduction documented between 1987 and 1989–1990 was followed by a subsequent increase to approximately 32 territorial males in 1998 (still documented in 2007). This might be in part due to the 1996 legal protection of Mt. Hartman National Park by the Government of Grenada and the conservation efforts of the Forestry and National Parks Department and the Grenada Dove Conservation Programme. Though appearing to be a relatively stable segment of the population, the estimates at this site have both fluctuated and consistently remained below the initial 1987 estimates. At the Perseverance and Woodford Estates, there was little overall change between initial 1989–1990 estimates (10 males) and those from 2007 (11 males), but fluctuations also took place in the interim. In 1994, half of the Perseverance site with doves was clear-cut in anticipation of a quarry (Rusk and Temple 1995), most of which is currently used as a sanitary land-

fill. The population later increased to ~23 territorial males (1998 census), but this again was followed by a subsequent 52% decline post Hurricane Ivan (2007 census). Within the Perseverance Protected Area itself (the remainder of the area not clear-cut), six territorial males were documented before Hurricane Ivan, but numbered only three in 2007. Outside of the protected areas, the individuals at the Beausejour and Grenville Vale Estates site declined by at least 53% post Hurricane Ivan, while the Petit Bouc and Woodlands site and the Golf Course and Café site simultaneously experienced 29% and 25% declines, respectively (Table 1, Fig. 4).

In addition to low numbers of individuals within each of the sites censused, three of the six population segments show a decline since initial sampling of the site (Table 1, Fig. 4). Of the remaining three population segments, two show the same population estimate and one shows an increase of one individual since initial sampling. Furthermore, variability within the consistently low population numbers (Table 1, Fig. 4), including declines following natural and anthropogenic events, does not bode well for the long-term viability of this species. Only 40% of all territories are on protected land, with the remainder of the species' critical habitat slated primarily for residential or commercial development (Rusk 2010). With the Mt. Hartman Estate currently the focus of development plans, the potential decline of the species within the national park, if appropriate mitigation measures are not put in place, could well exceed the 1–19% estimated in the IUCN species listing (BirdLife International 2017).

Although territory mapping is time intensive (Ralph *et al.* 1993, Christman 1984) and sampling efficiency can vary (Best 1975, Wakeley 1987), it can effectively and reliably map territorial individuals over a species' known habitat (Wakeley 1987). This method is particularly suitable for Grenada Dove given the ease of detecting territorial singing and its well-defined and accessible habitat. However, territory mapping does not account for females, juveniles, and non-territorial males in the population (Wakeley 1987). There is a tendency for male-dominated adult sex ratios in wild bird populations, and even more so in globally threatened species (Donald 2007). Nonetheless, a 1:1 sex ratio is at times used for estimating Grenada Dove population size for conservation and outreach purposes (Blockstein 1988, Rusk and Clouse 2004, Rusk 2005, 2008, Rusk *et al.* 2008). Using this ratio, the 2007 estimate of 68 males extrapolates to a total population of 136 individuals. In 2013, Rivera-Milán *et al.* (2015) used a distance sampling survey to estimate a mean population of 160 individuals (95% CI = 107–229) from 33 dove detections in 7,621 ha. Though methodologically different, the 2013 distance sampling survey estimate also indicates a small population size and is consistent with the territory mapping results.

Species recovery is clearly dependent on successfully maintaining the existing population and its habitat (reversing conditions that have led to its endangerment), and providing conditions that would lead to four (including two additional) self-sustaining populations (Rusk *et al.* 2008). Biologists that have studied the Grenada Dove agree that its status and distribution are closely tied to availability of suitable habitat (Rusk *et al.* 1998, Rivera-Milán *et al.* 2015). Rivera-Milán *et al.* (2015) found dove density was positively influenced by food abundance and vegetation cover (leguminous trees) and negatively influenced

by disturbance level (deforestation). Total known occupied habitat covers less than 450 ha, which although it is all located within Important Bird Areas (IBAs; Rusk 2009) and Key Biodiversity Areas (KBAs; BirdLife International 2010), remains at risk from both anthropogenic and environmentally induced changes.

Hurricane Ivan resulted in habitat destruction (Peters 2015) which was followed by reduced dove abundance. The greatest changes occurred on the west coast, where 3 yr post Ivan, population estimates were only 56% of pre-Ivan levels (Table 1, Fig. 4). This decline could be a result of mortality during the hurricane, mortality post hurricane due to predation or lack of food resources, movement to other areas that were not searched, or difficulty detecting birds due to post-hurricane behavioral changes (Rusk 2008). Further population reduction may have resulted from a failed breeding season post hurricane. Terrestrial bird species often suffer population declines post hurricanes as a result of damaged food resources (Wauer and Wunderle 1992, Wunderle *et al.* 1992). Wunderle *et al.* (1992) suggest that bird population declines in montane habitats in Jamaica after Hurricane Gilbert were related to food shortages, with the greatest stress occurring after the hurricane rather than as a result of its direct impact. In addition, birds weakened by the storm may be at greater risk of predation due to a loss of vegetation cover or roosting sites (Engstrom and Evans 1990).

Invasive mammalian predators likely also play a key role in this species' abundance (Rusk 2015). The devastating effects of introduced alien invasive mammals on island species are well known, and has included national and local extinctions or significant range and population reductions as a result of predation, competition for resources, or habitat modification (Allen 1911, Atkinson 1985, Horst *et al.* 2001, Long 2003, Jones *et al.* 2008, Higman 2011). Bolton *et al.* (2016) documented a high level of occupancy (98%) of mongoose at Mt. Hartman. Over an 18-month period between 2014 and 2015 as part of a Grenada Dove predator control program, 1,049 mongooses were trapped at Mt. Hartman alone using 25 to 50 traps and an additional 374 at Perseverance Estate, as well as rats, opossums, and cats (Rusk 2015). Though direct impacts of predation on nesting success have yet to be quantified, the extensive numbers of mongooses trapped strongly suggest an impact on nest success and survival, given their predation rates on birds elsewhere (Innes *et al.* 2010, BirdLife International 2013, Russell *et al.* 2015).

Ongoing and consistent long-term monitoring is needed to document and address population changes. Territory mapping should continue and serve as a baseline for comparison with other monitoring efforts (multi-covariate distance sampling efforts initiated in 2013; Rivera-Milán *et al.* 2015) as well as an indication of presence and abundance in discrete areas for conservation purposes. Monitoring should be part of an ongoing program coordinated with the Forestry and National Parks Department and Grenada Dove Conservation Programme to ensure consistency in monitoring methods, experience, and efficiency, and to support identification of population changes and trends.

Acknowledgments

This work was made possible thanks to the ongoing collaboration with the Forestry and National Parks Department, Government of Grenada. In particular, I would like to thank the current

Chief Forestry Officer, A. Jeremiah (Ag.), and the former Chief Forestry Officers A. Forteau and A. Joseph for their invaluable support over many years. Many thanks also go to Forestry and National Parks department staff, particularly D. Francis and P. Plenty for their continued excellent field work; A. Dragon, R. Caliste, D. Palmer, and D. McQueen for ongoing project assistance and outreach efforts; and V. Phillip and P. Jeremiah for their many months of invaluable field assistance. Numerous additional individuals provided support for this work, including but not only S. Temple, D. Blockstein, D. Wege, L. Sorenson, H. Nelson, E. Devenish, and A. Easter-Pilcher, with financial support from Organization of American States (OAS), PEW Charitable Trust, University of Wisconsin-Madison, Government of Québec, GEF/World Bank, BirdLife International, BirdsCaribbean, U.S. Fish and Wildlife Service, American Bird Conservancy, The Nature Conservancy, MBZ Species Conservation Fund, and others.

Author Information

Grenada Dove Conservation Programme, c/o Forestry and National Parks Department, Queen's Park, St. George's, Grenada; e-mail: blruska@gmail.com

Literature Cited

- Allen, G.M. 1911. Mammals of the West Indies. *Bulletin of the Museum of Comparative Zoology* 54:175–263.
- Atkinson, I.A.E. 1985. The spread of commensal species of *Rattus* to oceanic islands and their effects on island avifaunas. Pp. 35–81 in *Conservation of Island Birds* (P.J. Moors, ed.). International Council for Bird Preservation Technical Publication no. 3. International Council for Bird Preservation, Cambridge, UK.
- Best, L.B. 1975. Interpretational errors in the "mapping method" as a census technique. *Auk* 92:452–460.
- BirdLife International. 2010. Ecosystem profile: the Caribbean islands biodiversity hotspot. Prepared for Critical Ecosystem Partnership Fund, Washington, DC.
- BirdLife International. 2013. Small island birds are most at risk from invasive alien species. datazone.birdlife.org/sowb/casestudy/small-island-birds-are-most-at-risk-from-invasive-alien-species-.
- BirdLife International. 2017. *Leptotila wellsi*. The IUCN Red List of Threatened Species 2017:e.T22690874A110630534.
- Blockstein, D.E. 1988. Two endangered birds of Grenada, West Indies: Grenada Dove and Grenada Hook-billed Kite. *Caribbean Journal of Science* 24:127–136.
- Blockstein, D.E. 1991. Population declines of the endangered endemic birds on Grenada, West Indies. *Bird Conservation International* 1:83–91.
- Bolton, N.M., C. van Oosterhout, N.J. Collar, and D.J. Bell. 2016. Population constraints on the Grenada Dove *Leptotila wellsi*: preliminary findings and proposals from south-west Grenada. *Bird Conservation International* 26:205–213.
- Christman, S.P. 1984. Plot mapping: estimating densities of breeding bird territories by combining spot mapping and transect techniques. *Condor* 86:237–241.
- Devas, R.P. 1943. *Birds of Grenada, St Vincent and the Grenadines*. Carenage Press, St. George's, Grenada.
- Donald, P.F. 2007. Adult sex ratios in wild bird populations. *Ibis* 149:671–692.

- Engstrom, R.T., and G.W. Evans. 1990. Hurricane damage to Red-cockaded Woodpecker (*Picoides borealis*) cavity trees. *Auk* 107:608–610.
- Higman, B.W. 2011. *A Concise History of the Caribbean*. Cambridge University Press, Cambridge, UK.
- Horst, G.R., D.B. Hoagland, and C.W. Kilpatrick. 2001. The mongoose in the West Indies: the biogeography and population biology of an introduced species. Pp. 409–424 in *Biogeography of the West Indies: Patterns and Perspectives* (C.A. Woods and F.E. Sergile, eds.). CRC Press, Boca Raton, FL.
- Innes, J., D. Kelly, J.M. Overton, and C. Gillies. 2010. Predation and other factors currently limiting New Zealand forest birds. *New Zealand Journal of Ecology* 34:86–114.
- Jones, H.P., B.R. Tershy, E.S. Zavaleta, D.A. Croll, B.S. Keitt, M.E. Finkelstein, and G.R. Howald. 2008. Severity of the effects of invasive rats on seabirds: a global review. *Conservation Biology* 22:16–26.
- Lack, D., and A. Lack. 1973. Birds on Grenada. *Ibis* 115:53–59.
- Lawrence, G.N. 1884. Characters of a new species of pigeon of the genus *Egyptilia* from the island of Grenada, West Indies. *Auk* 1:180–181.
- Long, J.L. 2003. *Introduced Mammals of the World: Their History, Distribution and Influence*. CABI Publishing, Wallingford, UK.
- Nelson, H.P., E.S. Devenish-Nelson, M. Geary, A. Lawrence, and B.L. Rusk. 2015. Report on the re-sampling of the 2004 vegetation plots of the dry forest Grenada Dove (*Leptotila wellsi*) habitat. Unpublished report. Grenada Dove Conservation Programme and Forestry and National Parks Department, Government of Grenada, St. George's, Grenada.
- Peters, E.J. 2015. The 2009/2010 Caribbean drought: a case study. *Disasters* 39:738–761.
- Ralph, C.J., G.R. Geupel, P. Pyle, T.E. Martin, and D.F. DeSante. 1993. *Handbook of Field Methods for Monitoring Landbirds*. PSW-GTR-144. Pacific Southwest Research Station, USDA Forest Service, Albany, CA.
- Rivera-Lugo, P.J. 2005. Composition and structure of Grenada Dove (*Leptotila wellsi*) habitat. Unpublished report. Grenada Dry Forest Biodiversity Conservation Project. Government of Grenada, St. George's, Grenada.
- Rivera-Milán, F.F., P. Bertuol, F. Simal, and B.L. Rusk. 2015. Distance sampling survey and abundance estimation of the critically endangered Grenada Dove (*Leptotila wellsi*). *Condor* 117:87–93.
- Roberts, A.W.P., and L.J. Taylor. 1988. The Grenada Dove expedition. Unpublished report. University of Reading, Reading, UK.
- Rusk, B.L. 1992. The Grenada Dove and the Mt. Hartman Estate: management recommendations. Unpublished report. Forestry and National Parks Department, Government of Grenada, St. George's, Grenada.
- Rusk, B.L. 1998. Status of the endangered endemic Grenada Dove (*Leptotila wellsi*) on Grenada, West Indies. Unpublished report. Forestry and National Parks Department, Government of Grenada, St. George's, Grenada.
- Rusk, B.L. 2005. Draft post-Hurricane Ivan Grenada Dove evaluation. Unpublished report. St. George's, Grenada.
- Rusk, B.L. 2008. Grenada Dove census 2007. Unpublished report for the "Developing the Four Seasons Resort, Grenada" project. Government of Grenada and Cinnamon88, St. George's, Grenada.
- Rusk, B.L. 2009. Grenada. Pp. 229–234 in *Important Bird Areas Americas - Priority Sites for Biodiversity Conservation* (C. Devenish, D.F. Díaz Fernández, R.P. Clay, I. Davidson, and I. Yépez Zabala, eds.). BirdLife International, Quito, Ecuador.
- Rusk, B.L. 2010. Mt Hartman development and the Grenada Dove: finding a win-win solution. Unpublished report. The Nature Conservancy, St. Thomas, USVI.
- Rusk, B.L. 2011. Water sources on the Mt Hartman Estate: management recommendations for the Grenada Dove. Unpublished report. Grenada Dove Conservation Programme, St. George's, Grenada, and American Bird Conservancy, Washington, DC.
- Rusk, B.L. 2015. Predator control for the Grenada Dove. Unpublished report. Grenada Dove Conservation Programme, St. George's, Grenada, and American Bird Conservancy, Washington, DC.
- Rusk, B.L., D.E. Blockstein, S.A. Temple, and N.J. Collar. 1998. Draft recovery plan for the Grenada Dove. Unpublished report for the Government of Grenada and the World Bank, Washington, DC.
- Rusk, B.L., and L. Clouse. 2004. Status of the endangered endemic Grenada Dove (*Leptotila wellsi*). Unpublished report. Forestry and National Parks Department, Government of Grenada, St. George's, Grenada.
- Rusk, B.L., and S.A. Temple. 1995. Grenada Dove census, post habitat loss: west coast. Unpublished report. The World Bank, Washington, DC.
- Rusk, B.L., S.A. Temple, D. Wege, G. Wallace, D.E. Blockstein, G. Ledec, and L. Sorenson. 2008. Recovery and action plan for the Grenada Dove. Unpublished draft. Forestry and National Parks Department, Government of Grenada, St. George's, Grenada.
- Russell, J.C., J.G. Innes, P.H. Brown, and A.E. Byrom. 2015. Predator-free New Zealand: conservation country. *BioScience* 65: 520–525.
- Wakeley, J.S. 1987. Avian territory mapping: section 6.3.4, U.S. Army Corps of Engineers Wildlife Resources Management Manual. Technical Report EL-87-7. U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.
- Wauer, R.H., and J.M. Wunderle, Jr. 1992. The effect of Hurricane Hugo on bird populations on St. Croix, U.S. Virgin Islands. *Wilson Bulletin* 104:656–673.
- Wunderle, J.M., Jr., D.J. Lodge, and R.B. Waide. 1992. Short-term effects of Hurricane Gilbert on terrestrial bird populations on Jamaica. *Auk* 109:148–166.

Cite this article as:

Rusk, B.L. 2017. Long-term population monitoring of the Critically Endangered Grenada Dove (*Leptotila wellsi*) on Grenada, West Indies. *Journal of Caribbean Ornithology* 30:49–56. [https://doi.org/10.55431/jco.2017.30\(1\).49-56](https://doi.org/10.55431/jco.2017.30(1).49-56)