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The future of Caribbean endemic bird conservation in the Anthropocene

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Abstract The insular Caribbean is a globally important hotspot of biological endemism, including 186 endemic bird species. Despite this importance, many of these species are highly vulnerable due to the human dominance that typifies the Anthropocene. The threats of habitat loss, invasive species, over-harvesting, pollution, and increasingly, climate change are amplified on islands. The limited land area of Caribbean islands, natural vulnerability to extreme natural events, human technical capacity constraints, fragile economic systems, and colonial legacies present a complex and unique conservation challenge for endemic birds. We discuss the current state of knowledge of these species and the challenges facing their conservation. In our analysis, we focus on emerging synergies between the human impacts that dominate the Anthropocene to prompt reflection on potential pathways for a viable future for these economically, culturally, and ecologically valued birds. The answers are rooted in fostering regional collaboration to develop human capacity, sustainable financing, and accountability to civil society, in order to establish locally-led solutions that are underpinned by robust evidence. While we focus on Caribbean endemic birds, our analysis is relevant and of interest to those working in island conservation more widely.

Keywords capacity, climate change, community conservation, landscape management, policy, protected areas, small island developing states

Resumen El futuro de la conservación de las aves endémicas del Caribe en el Antropoceno • El Caribe insular es un punto caliente de endemismo biológico de importancia mundial, que incluye 186 especies de aves endémicas. A pesar de su importancia, muchas de estas especies son altamente vulnerables debido a la dominación humana que caracteriza al Antropoceno. Las amenazas de pérdida de hábitat, especies invasoras, sobreexplotación, contaminación y, cada vez más, el cambio climático se amplifican en las islas. La limitada superficie terrestre de las islas del Caribe, la vulnerabilidad natural a fenómenos naturales extremos, las limitaciones de la capacidad técnica humana, los frágiles sistemas económicos y los legados coloniales presentan un desafío de conservación complejo y único para las aves endémicas. Discutimos el estado actual del conocimiento sobre estas especies y los retos a los que se enfrenta su conservación. En nuestro análisis, nos centramos en las sinergias emergentes entre los impactos humanos que dominan el Antropoceno para impulsar la reflexión sobre las posibles vías para un futuro viable para estas aves de gran valor económico, cultural y ecológico. Las respuestas se basan en fomentar la colaboración regional para desarrollar la capacidad humana, el financiamiento sostenible y la rendición de cuentas a la sociedad civil, con el fin de establecer soluciones dirigidas a nivel local que estén respaldadas por evidencias sólidas. Aunque nos centramos en las aves endémicas del Caribe, nuestro análisis es relevante y de interés para quienes trabajan en la conservación de las islas de forma más amplia.

Palabras clave áreas protegidas, cambio climático, capacidad, conservación comunitaria, manejo del paisaje, pequeños estados insulares en desarrollo, política

Résumé L'avenir de la conservation des oiseaux endémiques de la Caraïbe dans l'Anthropocène • La Caraïbe insulaire est un haut lieu d'endémisme biologique d'importance mondiale, avec notamment 186 espèces d'oiseaux endémiques. Malgré cette importance, nombre de ces espèces sont très vulnérables en raison de la domination humaine qui caractérise l'Anthropocène. Les menaces que représentent la perte d'habitats, les espèces envahissantes, la surexploitation, la pollution et, de plus en plus, le changement climatique sont amplifiées sur les îles. La superficie limitée des îles caribéennes, leur vulnérabilité naturelle aux événements naturels extrêmes, les contraintes en matière de capacités techniques humaines, les systèmes économiques fragiles et les héritages coloniaux représentent un défi complexe et unique pour la conservation des oiseaux endémiques. Nous discutons ici de l'état actuel des connaissances sur ces espèces et des défis à relever pour leur conservation. Dans notre analyse, nous nous concentrons sur les synergies émergentes entre les impacts humains qui dominent l'Anthropocène pour susciter une réflexion sur les voies potentielles d'un avenir viable pour ces oiseaux qui revêtent une valeur économique, culturelle et écologique. Les réponses sont ancrées dans la promotion de la collaboration régionale pour développer les capacités humaines, le financement

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durable et la responsabilité envers la société civile, afin de mettre en place des solutions locales reposant sur des bases solides. Bien que nous nous concentrions sur les oiseaux endémiques de la Caraïbe, notre analyse est pertinente et présente un intérêt pour les personnes qui œuvre pour la conservation insulaire de manière plus large.

Mots clés capacité, changement climatique, conservation communautaire, gestion du paysage, petits états insulaires en développement, politique, zones protégées

Setting the Scene

Islands have played an important role in our understanding of the living world since Darwin's time (Graham *et al.* 2017). Their geographic isolation ensures the opportunity for independent evolution from common continental ancestors, leading to high levels of evolutionarily unique species (Russell and Kueffer 2019). This remarkably high biological uniqueness or endemism means that their contribution to global biodiversity is disproportionate to their size (Russell and Kueffer 2019). While islands often host fewer absolute numbers of species than continents, more island species are endemic than on mainland areas (Graham *et al.* 2017). The Caribbean is among the five most important global Biodiversity Hotspots, with its endemic vertebrate species representing 3.5% of the world's total, while accounting for a mere 0.5% of global land mass (CANARI 2019).

Avian endemism of the insular Caribbean, encompassing Trinidad and Tobago to The Bahamas, includes 186 resident endemic species (Chesser *et al.* 2022, Remsen *et al.* 2022). Of these species, 128 are restricted to just one island, with the remainder found only on small groups of islands (Gerbracht and Levesque 2019, Remsen *et al.* 2022). Seven families are now widely considered endemic to the Caribbean region (Raffaele *et al.* 2020, Chesser *et al.* 2022): five tody species (Todidae) and four spindalis species (Spindalidae) in the Greater Antilles; the Palmchat (Dulidae), two chat-tanager species (Calyptophilidae), and four palm-tanager species (Phaenicophilidae) on Hispaniola; two Cuban warblers (Teretistridae); and a single Puerto Rican Tanager (Nesospingidae).

As well as being of evolutionary importance, endemic species play essential roles in ecosystem function. For example, hummingbirds are important pollinators, with some Caribbean plants having evolved exclusive relationships with these species (Dalsgaard *et al.* 2009), and endemic tanagers and bullfinches are important seed dispersers (Cruz 1981). Such ecosystem functions provide essential ecosystem services to humans. For instance, todies are important predators of the coffee berry-borer beetle, the world's most serious coffee pest (Johnson *et al.* 2010). However, the value of endemic birds extends beyond their ecological roles. Tourism is more important to Caribbean countries than to any other region, contributing directly and indirectly ~32% to GDP (Acevedo *et al.* 2017), with ecotourism accounting for ~5% of that total (Wilson *et al.* 2014) and much of it generated by birdwatching (Robertson 2013). Beyond economic value, these iconic species permeate Caribbean culture, from generating folklore and endemic bird festivals to inspiring Carnival costumes and art to being icons of national identity (Wunderle 2008, Garcia-Lau and Gonzalez 2019).

The factors that make these birds unique and valuable unfortunately also make them vulnerable. Historically, islands have been centers of extinctions much more so than continental systems, largely because island species have naturally small populations, limited distribution, and have evolved in isolation from many predators (Wood *et al.* 2017, Russell and Kueffer 2019). In addition, these island species are subject to large-scale natural disturbances such as hurricanes and volcanic activity, which can pose extinction-level threats to their persistence on these islands (Wunderle 2008, Bambini *et al.* 2017). Caribbean endemic birds have been particularly vulnerable to human-induced extinction, having some of the highest rates of documented island avian extinctions (Pimm *et al.* 2006). For example, 65% of the region's pre-Columbian parrot, parakeet, and macaw species have been lost, mostly hunted for food and feathers (Wiley *et al.* 2004). Today, ~25% of Caribbean endemic birds are threatened with extinction (IUCN 2020). By comparison, the threat rate for birds globally is ~13% (IUCN 2020). Further, among endemics with population trend estimates, ~60% have declining populations (IUCN 2020). Within the region, the Lesser Antilles has the highest number of threatened endemics, restricted to tiny island ranges (Stattersfield *et al.* 1998).

The impacts of the anthropogenic dominance of ecosystems that is now present in all planetary processes—through climate change, habitat modification, direct exploitation, invasion, and disease—are amplified due to the unique characteristics of islands (Graham *et al.* 2017). The scale, directionality, and tempo of these and other systems-level processes (e.g., nutrient flows) that are now dominated by human action will likely have tremendous impacts on island bird species (Gardner *et al.* 2009). In this perspective piece, we examine some of the key challenges facing the conservation of island birds in this new epoch of the Anthropocene, illustrating them with examples of endemic species across the Caribbean. We conclude by providing a brief comparison with Wunderle's (2008) similar perspective piece on the future of Caribbean bird conservation and discuss lessons from the last decade's efforts to secure the persistence of these endemic species in the Anthropocene.

Current Threats

Invasive species, habitat loss, and overexploitation present the greatest current threats to endemic species in the Caribbean, with climate change increasingly exacerbating all these threats (Wood *et al.* 2017, Russell and Kueffer 2019). The Caribbean is predicted to have the highest future extinction rates of endemic species of the 10 insular biodiversity hotspots, due to habitat loss and climate change (Bellard *et al.* 2014). Invariably, these threats do not function in isolation and species can face several or all of these threats at the same time, with potentially cumu-

lative impacts (Wood *et al.* 2017). Worryingly, the emergence of novel interactions between such anthropogenic threats can lead to unforeseen dangers to threatened birds. An example of such novel interactions was recently documented for Bald Eagles (*Haliaeetus leucocephalus*) in the southeastern USA (Breinlinger *et al.* 2021). Here, the interaction between an alien invasive species, anthropogenic pollution, and a previously unidentified cyanobacterium lead to a new form of lethal neurodegenerative disease in these birds (Breinlinger *et al.* 2021). The lesson here for island birds lies in the threat of unknown outcomes from the multitude of interacting individual anthropogenic threats.

An example of a species facing the interacting threats of invasive species, hurricanes, and habitat loss is the Critically Endangered Grenada Dove (*Leptotila wellsi*)—the national bird of Grenada—which is currently restricted to two small areas on Grenada and has a population of no more than a couple hundred birds (Rivera-Milán *et al.* 2015). In the Caribbean, the small Indian mongoose (*Herpestes auropunctatus*) is thought to be responsible for the extinction of several endemic species, such as the Jamaican Petrel (*Pterodroma caribbaea*; Lewis *et al.* 2011). On Grenada, mongoose predation is thought to substantially lower Grenada Dove nesting success (Rusk 2017). While devastating on its own, such predation compounds an even greater threat to the species, namely habitat loss and degradation from agriculture and housing and tourism development (Rusk 2017). Further, extreme weather events compound this loss and degradation, such as observed after Hurricane Ivan in 2004 (Rusk 2017). The Grenada Dove is found only in lowland dry forest (Rusk 2017), a habitat facing the greatest pressure for development on Caribbean islands due to its flat topography and often coastal location, as well as its perceived limited ecological value (IUCN 2011, CARICOM 2018). One of the key locations for the Grenada Dove, Mt. Hartman, was designated as a protected area in 1996 (Rusk 2009). However, the de-gazettement (change in legal status) of the park in 2008 to allow a hotel development—which later collapsed due to the 2009 economic crisis (B. Rusk pers. comm.)—illustrates the fragility of reliance on protected areas for conserving threatened species. Attempts to develop the area persist, and at the time of writing (2022), it faces the renewed threat of a new development just outside the park boundary (B. Rusk pers. comm.). The tragedy here is that even though these developments have so far failed to materialize, often large areas of habitat have been cleared before the halting of such projects. This story is not singular; this is playing out across many of the landscapes in the Caribbean (IUCN 2011, White *et al.* 2012).

An example of the impact of synergistic threats of overexploitation and habitat loss is the Critically Endangered Trinidad Piping-Guan (*Pipile pipile*). This species is now restricted to a small and largely undisturbed forested upland on the island, and estimated to number only a few hundred birds in the wild (Hayes *et al.* 2009). This species was highly valued for food and so their historical decline was primarily due to hunting and a reported lack of fear of humans, which increased their vulnerability (ffrench 2012). However, while there is still localized hunting, the birds have more recently become the focus of ecotourism activity (Waylen *et al.* 2009). Habitat loss throughout their former range is now considered a greater threat than hunting (Hayes *et al.* 2009, McGowan *et al.* 2010). An example of this ongoing threat is a proposed port development in the northeastern Toco peninsula, where piping-guans are found (Sookdeo 2019); while the development is not within the species' core habitat, it threatens to increase access and wider habitat disturbance due to increased human activity.

A final example of the synergy between anthropogenic threats, namely the interaction of extreme weather and socio-economic development, is the Near Threatened Barbuda Warbler (*Setophaga subita*), found only on the tiny 161 km² island of Barbuda (Diamond 2020). In 2017, the Category 5 Hurricane Irma devastated Barbuda with a direct hit (Lightfoot 2020). Initial surveys found only eight birds a couple of weeks after the hurricane (BirdsCaribbean 2017a), but a year and a half later, the species was reportedly recovering reasonably well (BirdsCaribbean 2019a). While such range-restricted species will have naturally small populations (Graham *et al.* 2017) and many island species are resilient to hurricanes since they have evolved with these natural events (Lloyd *et al.* 2019, Campos-Cerqueira and Aide 2021), this example illustrates their vulnerability to extreme weather events. Hurricanes are predicted to become more intense, wetter, and slower due to climate change (Knutson *et al.* 2019), which could negatively impact this resiliency. Indeed, the recent up-listing of the Bahama Warbler (*Setophaga flavescens*) from Near Threatened to Endangered was prompted by habitat loss from Hurricane Dorian in 2019 (IUCN 2020), the most intense hurricane to stall on record (Vosper *et al.* 2020). However, the impact of hurricanes on species and their habitats cannot be viewed in isolation from the socio-economic context, such as the complex land tenure found throughout the Caribbean (Lightfoot 2020). For instance, Barbuda has a long history of communal land ownership that has facilitated low-impact tourism (Lightfoot 2020). Since the passage of Hurricane Irma, the government has moved to privatize this land to support international hotel development, which local communities have challenged (Lightfoot 2020), with as yet unknown consequences for the Barbuda Warbler.

Clearly, changing land use is a major threat to endemic birds. In the Caribbean, most landscapes are already significantly affected by people, with over 95% of land area being human-modified (Venter *et al.* 2016). It is estimated that the Caribbean Biodiversity Hotspot has less than 30% forest cover remaining across the region (Gillespie *et al.* 2012). Here, land use change is propelled by the shifting economic value of agricultural lands, which often become focal points for physical development (CARICOM 2018). While land use change remains the biggest cause of regional biodiversity loss, climate change has rapidly become the next biggest threat (CANARI 2019). The complexities arising from interactions between climate change, the economic viability of agriculture, physical development, land ownership, and the socio-economic challenges of development in the Caribbean will ultimately shape the persistence of many endemic birds on the landscape.

One dimension of land-use change that is fundamental to understanding the challenge of avian conservation in the region is the issue of the temporal rapidity and scale of such changes. Ownership can be transferred, and the land cover transformed at the landscape scale from natural vegetation to anthropogenic dominated environments in a matter of hours to weeks (CARICOM

2018, Nelson 2018). In contrast, birds and their habitats have evolved to respond to these changes on time scales that are several orders of magnitude slower (Ewers and Didham 2006). In tropical systems, this is increasingly leading to unpredictable trophic cascades, novel communities, extinction debt, threshold effects, and regime shifts, while acting synergistically with other stressors such as climate change (Gardner *et al.* 2009). The Puerto Rican Parrot (*Amazona vittata*), for example, has been unable to adapt to habitat loss that has restricted its niche to a high-elevation forest, thus reducing its survival ability (White *et al.* 2014). Such temporal and spatial scale mismatches are central to understanding the threats faced by these Caribbean endemics in the Anthropocene.

The threats discussed thus far are proximate threats: factors that cause the immediate decline of a species. But what of the ultimate threats, those anthropogenic factors that are the root cause of the proximate threats? Addressing these ultimate threats is complicated. Most Caribbean countries are Small Island Developing States (SIDS) and are invariably challenged by a lack of knowledge, capacity, and resources, as well as weak legislation, enforcement, and economic fragility (Scobie 2016). Next, we illustrate some of these challenges using endemic birds and their habitats.

Knowledge Challenges

The ability to assess the effectiveness of conservation actions is dependent on our understanding of how species (Kindsvater *et al.* 2018) and people (Morales-Nieves 2022) respond to management. Baseline estimates of species population density can provide an index for monitoring management outcomes (Rivera-Milán *et al.* 2016) or species response to disturbances such as hurricanes, drought, or fire (Lloyd *et al.* 2019, Campos-Cerqueira and Aide 2021). Similarly, changes to species abundances that impact human livelihoods, values, and perceptions of native species and habitats can place important constraints on management options available for conservation of these species (John 2001, Gibson 2020). Yet, tropical and island species are typically less well studied than temperate species and often lack such fundamental baseline data (de Lima *et al.* 2011, Reboredo Segovia *et al.* 2020), and our understanding of local people's perception of, engagement in, and acceptance of conservation interventions is similarly limited (Gibson 2020, Morales-Nieves 2022). Since the nature and extent of our knowledge can affect how we prioritize conservation actions, such knowledge gaps can have important implications for conservation decision-making. One way we can assess our current knowledge is to review the published literature.

Our recent review of the published English language scientific literature on Caribbean endemic birds (Devenish-Nelson *et al.* 2019) revealed that most avian families received much less research attention than statistically expected based on the number of species within each family. A notable exception were the parrots (Devenish-Nelson *et al.* 2019), reflecting the great interest in these highly charismatic and threatened species. This does not mean that we should do less research on parrots. However, it provides a metric for understanding the scale and biases in the knowledge deficit facing the region's other evolutionarily unique species and species of Least Concern.

The literature also revealed substantial geographic bias in research effort, driven in part by the presence of extant endemic parrots (Devenish-Nelson *et al.* 2019). However, this bias also reflects funding and resources. For example, Puerto Rico—which we found had more research than statistically expected given the size of the island (Devenish-Nelson *et al.* 2019)—receives U.S. government funding, possesses well-established universities, and has robust legal conservation mandates that translate into a well-structured research agenda (Latta 2012). However, even in Puerto Rico, there is a notable emphasis on game species, migratory, and federally listed endemic species.

Importantly, there has been no significant increase in research effort in the Caribbean since the 1980s and no significant change in the number of studies on conservation and management of wild populations (Devenish-Nelson *et al.* 2019). The bias in the species, countries, and subjects that get attention is driven in part by the fact that most research on Caribbean endemics remains externally driven (Devenish-Nelson *et al.* 2017). The fact that much of the research in the region is undertaken by researchers from external institutions also reflects a lack of government investment in research, as well as external priorities, such as the focus on migratory species that receive substantial conservation funding from North American governments (Levy 2008). The study of Caribbean birds is not unique in this regard, and recently, bias in representation in scientific publishing and the decolonization of ecological research in general have become active areas of discourse in conservation and ecology (Maas *et al.* 2021, Trisos *et al.* 2021). This is a complex issue and it does not mean Caribbean nationals do not contribute to the body of avian research, but it does reflect ongoing regional human development challenges, including the 'brain drain' (Bristol 2010), a lack of sufficient trained researchers (Levy 2008), and government bureaucracy constraining scientific research (Ceballos *et al.* 2009). What this means for our understanding of endemic birds is that this externally driven research comes with a price. For example, international researchers are often influenced by the interests of funders that can result in a mismatch with the needs of on-the-ground conservation practitioners (Reboredo Segovia *et al.* 2020).

As a final point, we stress the need not just for data on birds, but on habitats and climate. The lack of downscaled climate data for islands (Foley 2018), as well as poorly understood habitat-climate-bird relationships (Campos-Cerqueira *et al.* 2017), remains an enormous challenge to the management of climate change impacts.

Capacity Challenges

Research effort provides only one indicator of knowledge and capacity within the region. Much knowledge does not end up in published literature, but rather embedded in gray literature and human capacity within state agencies, community-based organizations (CBOs), and NGOs (Haddaway and Bayliss 2015). This raises a related challenge to conservation in the Caribbean: human capacity. One dimension of this that has been voiced by many BirdsCaribbean members to us in recent years is an appetite to address capacity gaps in analytical skills. Among the amateur and NGO ornithological community, there is a growing body of trained professionals (Levy 2008, Wunderle 2008) who

are increasingly filling the knowledge gaps and are generating valuable long-term datasets. Yet, we are aware that many such researchers are still not receiving sufficient training in the advanced technical skills to perform the statistical and spatial analyses that are now needed to translate these growing data sets into meaningful applications. Many barriers to acquiring these skills are common across the Global South, including limited funding for training courses, software, and tuition fees, a lack of skilled educators within academic institutions, and limited availability of non-formal training opportunities, as well as inadequate institutional recognition of the value of these activities (Bonine *et al.* 2003, Ceballos *et al.* 2009). BirdsCaribbean has made strides to address this issue, such as the development support provided for local researchers by the Journal of Caribbean Ornithology.

While it is true that capacity among NGOs and CBOs is largely increasing, in SIDS this is often not similarly reflected in many national agencies that are mandated to manage their natural resources (Everest-Phillips and Henry 2018). This lack of human resources and technical capacity in leveraging knowledge about biodiversity, as well as strengthening inter-agency collaboration between NGOs and government agencies, has been highlighted as a key weakness in the Caribbean's recent report on its progress with the Aichi Targets (CARICOM 2018).

From this perspective, we often find capacity in Caribbean public agencies is 'one person deep,' with a single individual undertaking work in multiple technical areas (Chittoo 2011). By comparison, in higher income countries, the roles undertaken by such individuals are done by many people. The reasons for the lack of capacity in the Caribbean are complex, reflecting relic colonial administrative systems, skills shortages, low wages, and limited professional opportunities leading to a brain drain, as well as the enforced social proximity of small islands that hinders accountability and meritocracy (Chittoo 2011, Everest-Phillips and Henry 2018). However, as a counter-weight, the benefits of a shared sense of purpose and community on small islands can lead to adaptive and responsive governance (Everest-Phillips and Henry 2018).

The story of Grenada, where we have worked for many years, is representative of many Caribbean islands. At Grenada's Forestry and National Parks Department, there has been a slow and steady decline in personnel since we started working there in 2010, including the retirement of a cohort of senior trained foresters. In 2014, the government initiated a personnel attrition policy in order to meet loan conditions agreed upon with the International Monetary Fund (IMF 2019). This policy permits only one recruitment across the civil service for every three retirements, resulting in a decline in the total staff within management agencies. The lack of funds also means that junior forestry personnel have not received equivalent training that was provided to their senior colleagues, and we have observed that this leads to despondency within the agency. This has inevitably led to a mismatch between the agency's human resources and the degree of technical capacity needed for habitat and species management.

There is, however, a positive of such limited human resources. By working in multiple fields, Caribbean conservation professionals are forced to look beyond single issues and take a broad interdisciplinary view of the conservation challenges that face the islands. This is a huge strength of the Caribbean's human capacity, and this strength is reflected in the approaches that we see for many of the region's conservation problems. Examples of this multidisciplinary thinking are seen in the work of SusGren in restoring the Ashton Lagoon in the Grenadines (BirdsCaribbean 2019b), and efforts at Sierra de Bahoruco National Park to recover not only birds but their habitats and ecosystem services as well (Lloyd 2017).

Financial Challenges

Underpinning the Caribbean's capacity issues are complex, nuanced, and deep-rooted financial challenges that highlight the region's vulnerability to externalities. The region's nations have some of the highest debt globally, stemming from a confluence of historical power relationships, an over-reliance on tourism and imported goods, low export capacities that international trade policies do not favor, and intrinsically small-scale economies (Thomas and Theokritoff 2021). External shocks such as extreme weather events, natural disasters, and more recently, the COVID-19 pandemic, disproportionately impact Caribbean countries' GDPs and leave them with debt repayments well above their total government revenues (Scobie 2016, Thomas and Theokritoff 2021). The synergistic effects of multiple environmental and economic shocks on these fragile economies erode resilience among human communities in these islands. Nowhere is this exemplified more than in the case of Haitian nature conservation capacity, which faces the lowest Human Development Index and forest cover in the region (Mainka and McNeely 2011). Across the islands, the multiple demands on limited funds means that money for environmental projects is often diverted to sectors with a higher perceived immediate need (Scobie 2016). Further, the project-driven funding culture that is widespread in Small Island Developing States constrains capacity development and long-term financial sustainability, monitoring, and evaluation (Scobie 2016, Nunn and McNamara 2019).

The economic sanctions faced by Cuba, which represents half of the region's terrestrial landmass (Machlis *et al.* 2012) and 30% of its regionally endemic bird species (Gerbracht and Levesque 2019), present a unique example of financial vulnerability. Cuba has faced 60 years of a U.S. trade blockade, which, despite periods of optimism, has been reinforced by recent U.S. administrations (Reardon 2016). The prolonged and extraterritorial nature of the blockade exacerbates poverty and reduces access to resources, increasing the reliance of local people on natural resources while limiting capacity for law enforcement (L. Mugica pers. comm.). For example, the hunting of birds—for food and the local and international cage trade—is a significant threat to Cuba's endemic birds, including the Cuban Parakeet (*Psittacara euops*) and Cuban Bullfinch (*Melopyrrha nigra*) (Gonzales *et al.* 2020). Although the development of scientific capacity has been impressive despite this embargo (Machlis *et al.* 2012, Reardon 2016), the blockade's far-reaching impacts have hindered opportunities for Cuban researchers when, for instance, international conservation funders can no longer support Cuban projects (L. Mugica pers. comm.). Partnerships of NGOs that work across multiple jurisdictions are also required to adhere to national legal restrictions on excluding countries that are under sanctions

(S. Paterson pers. comm.). This has resulted in Cuban researchers being denied access to funding, training, information, and travel opportunities (Machlis *et al.* 2012, Reardon 2016), with the impact exacerbated by poor internet connections and the lack of official access to many video conferencing platforms (L. Mugica, pers. comm). While Cuba is an extreme example of geopolitical externalities impacting avian conservation, the influence of externally driven financing is evident throughout the region.

Political Challenges

The lack of knowledge and human capacity reflects not only resource and financial challenges in the islands, but also the importance of political will to support conservation. We illustrate this challenge with an example of protected areas planning. Protected areas remain the most effective tool in conservation, with evidence suggesting such areas protect more biodiversity (Gray *et al.* 2016) and suffer less from human impact (Jones *et al.* 2018) than the broader landscape. Indeed, the legacy of early colonial protection of montane systems for watershed values (Leach and Fairhead 2001, White *et al.* 2014) has provided refugia for numerous high-elevation endemic species in the Caribbean such as the Puerto Rican Parrot. However, as we have seen with Grenada, protected areas are vulnerable to de-gazetting and, despite their protection, a third of globally protected land area suffers from intense human impact (Jones *et al.* 2018). To put this in perspective in the Caribbean, ~84% of the total area under formal protection is considered to be under intense human impact, compared to 99% of land outside of these protected areas (data from Venter *et al.* 2016, UNEP-WCMC and IUCN 2021). Although under immense human pressure, protected habitats remain essential for Caribbean conservation. One case study in which we were involved was the recent re-design of the protected natural areas (PNAs) system of Trinidad and Tobago.

In Trinidad and Tobago, the protected areas system has been unchanged since the 1960s, apart from some minor changes in the early 2000s (Leach and Fairhead 2001). This system has been considered inadequate since the 1970s, lacking the coverage and representation to ensure the future resiliency of natural systems on the islands (FAO 2019). Despite three major attempts to revise this system since the 1970s, the country was unable to formalize the changes to its PNAs that would enable it to keep up with current best practices (FAO 2019). All these attempts at revising the system were thwarted by a lack of political will, with multiple governments failing to implement the plans due to apathy or lack of urgency. A weakness of previous PNA designations in Trinidad and Tobago was the under-representation of some ecosystem types (FAO 2019). Protection of such areas requires the buy-in of multiple stakeholders, even where the land is state-owned.

After 40 years, a large Global Environment Facility-funded project aimed at 'Improving Protected Area Management' enabled the development of a new protected area systems plan (FAO 2019). In 2019, the government of Trinidad and Tobago agreed to go forward with the resultant plan. At the time of this writing, the enabling legislative frameworks for these PNAs remains lacking. However, a key lesson of this project was the importance of timing in development of the PNAs system. Here, progress on the PNAs took 40 years, because not only was it necessary to have the finances in place for the project, but the right persons delivering the message, and the right persons in the NGOs, government agencies, and wider civil society to receive the message.

What does the new PNAs system plan mean for the conservation of endemic birds in Trinidad and Tobago? In developing the PNAs system, we modelled the range coverage of species under the new system and found a significant increase in protection across birds in several ecosystem types. We found that avian groups that would benefit from the new system were dry forest species, including the newly recognized endemic Tobago Greenlet (*Hylophilus insularis*) and high-elevation species like the Trinidad Piping-Guan and Trinidad Motmot (*Momotus bahamensis*) (HPN and ESDN unpubl. data). This increase in habitat representation is particularly important for ensuring future climate resiliency, given observed range shifts in endemic birds elsewhere in the Caribbean (Campos-Cerqueira *et al.* 2017).

A key component that we identified in breaking through the bottleneck of PNA designation in Trinidad and Tobago was "realism." In our modelling process, we emphasized reducing conflict by focusing on state lands and getting consensus from the stakeholders on the areas that they thought deserved protection (FAO 2019). In several cases, such as the Important Bird Areas located on the west coast of Trinidad (White 2009), this meant that we could not cover some areas that were nonetheless of high conservation value. The level of existing human disturbance, land ownership patterns, settlement density, and access issues made designation of these areas potentially high risk for stakeholder conflict and lack of consensus. We recognized that we would not be able to include them in the current round of PNA designations. Herein lies the central challenge for the Caribbean in moving from our current level of protected areas to an approach that effectively conserves birds across entire landscapes: such human landscapes are places where complex patterns of historical uses, ownership, access rights, and future development plans present a challenge to the integration of conservation.

Challenges of Limited Land Area

The final challenge we will highlight, which is central and unique to island conservation, is the problem of limited geographic land space. This physical constraint means that conservation in the Caribbean presents a compromise between striving for formal habitat protection and the reality of working landscapes. The Caribbean is one of the most densely populated biodiversity hotspots and is continuing to become more urbanized (CANARI 2019). On small islands, biodiversity conservation competes with the interests of housing, agriculture, tourism, and energy development over small geographic areas.

To put this in perspective, the Convention of Biological Diversity's (CBD) Aichi Targets for biodiversity called for 17% of global terrestrial area to be protected by 2020 (Aichi Target 11; Dinerstein *et al.* 2019). As a region, the Caribbean has achieved this, with an average of 19% of terrestrial areas protected (UNEP-WCMC and IUCN 2021), which should be celebrated. However, on some islands, even achieving the current target is not possible using formal PNAs, due to 10% or less of the land being state owned (e.g., Grenada and Barbados; Nelson 2018). As we have also seen from Trinidad and Tobago, there are often

inadequacies in protection and it is important to recognize that coverage alone does not imply effectiveness. Yet, amongst the international community there are growing demands to protect larger amounts of land (Dinerstein *et al.* 2019), and the Aichi Target is expected to be renegotiated in late 2022. Some call to increase the target to 30% by 2030 (Dinerstein *et al.* 2019), but it is clear that achieving this using only state lands is unrealistic for many islands. Increasing terrestrial protected areas to 30% on many islands is simply not possible since that would encompass all or almost all forms of state land (e.g., Jamaica and Montserrat).

Before considering how to address this challenge, it is pertinent to first consider how the current level of protection translates into protection of endemic bird habitats. We can explore this by comparing how much of a species range is covered within protected areas to a target based on species range size (Butchart *et al.* 2015). For species with large ranges, it is assumed that adequate protected area coverage does not need to cover as much of their range as for species with small ranges (Butchart *et al.* 2015). If we calculate these targets for Caribbean endemics, the current PNA coverage is not fully adequate for most species (~75%) given their small ranges (HPN and ESDN unpubl. data). If we cannot expand our formal PNAs to provide sufficient coverage for endemic birds because of the limits of state land, what else can we do? This question is especially urgent given the significant threat of climate change to island endemics (Manes *et al.* 2021). We must consider the ability of our PNAs to support species under future conditions, including potential range shifts of species or their habitats under future climate conditions, such as those at high elevations. Given the large number of regionally endemic species, a first step is to think beyond borders by taking an ecoregional approach by ensuring representation across the entire Caribbean protected areas network. However, whatever new protected areas target is decided, it is important to recognize that more than ~80% of lands today fall outside of formal protection.

Moving Beyond Protected Areas

The challenges of maintaining PNAs, ensuring climate resilient landscapes, and managing species about which we know very little, while continuing to ensure that Caribbean people benefit from their ecosystem services, means we cannot fully protect endemic species without taking a whole landscape approach to conservation. Human-managed systems, such as agroforestry and plantations, are important habitat for some endemic species (Johnson *et al.* 2010). The regional decline in agriculture and subsequent potential for regenerating secondary growth (CARICOM 2018) will also be valuable for supporting some endemic bird populations. Yet, these options should be considered one of a suite of tools, not as a panacea, especially given the increasing pressure on remaining habitat and the complex unintended consequences for threatened species, as we described earlier.

Currently, there is significant focus on a recent designation formalized by the CBD called Other Effective Area-based Conservation Measures (OECMs) that can contribute to a country's Aichi Target 11 (Donald *et al.* 2019). These can be thought of as an umbrella for managed areas other than formal protected areas that benefit biodiversity, such as indigenous lands, managed watersheds, or restricted areas (Dudley *et al.* 2018). OECMs have not yet been officially formalized by Caribbean governments, but they offer a potential solution for recognizing the conservation benefits of many areas that do not fall within formal PNAs.

Key Biodiversity Areas (KBAs) are geographically defined areas that have been designed to more systematically fill the gaps of existing protected area networks and build on Important Bird Area designations (Kullberg *et al.* 2019). Approximately 67% of existing KBAs are covered by PNAs in the Caribbean (data from BirdLife International 2020, UNEP-WCMC and IUCN 2021), with many KBAs encompassing private land (Anadón-Irizarry *et al.* 2012). The contribution of KBAs to achieving new targets is evident. If KBAs falling outside of existing protected areas are combined with the 19% of Caribbean land area already formally protected, the total area increases to 28% (data from BirdLife International 2020, UNEP-WCMC and IUCN 2021). KBAs are not currently recognized in meeting the Aichi Targets, but if integrated with the OECM approach, they present a viable option for achieving conservation beyond protected areas (Donald *et al.* 2019).

We found that half of all Caribbean National Biodiversity Action Plans identify private land management as a priority. Incentivizing private conservation provides tangible opportunities, and in our work in Trinidad and Tobago on PNAs, we found strong support for this amongst stakeholders during our consultations in Tobago. Public-private partnerships (PPP) are still largely underutilized for conservation in the Caribbean, with the focus to date primarily on infrastructure projects (Guasch 2013). Few environmental PPP schemes, such as developing payments for ecosystem services or agri-environmental partnerships, exist in the Caribbean (Monnereau 2017). PPPs are limited in the Caribbean, in part by weak legislation (Guasch 2013), as well as by many of the capacity and institutional challenges already raised here. What is central to the success of promoting such approaches at a broad scale is having strong leadership and governance that is committed to making these approaches economically viable through participation, accountability, and equitability (Guasch 2013). There does appear to be interest in the Caribbean for innovative environmental financing mechanisms (Monnereau 2017), which are essential for moving beyond the current fragile system of project-based funding (Scobie 2016).

National governance alone will not lead to successful buy-in of stakeholders. Endemic bird conservation programs that have been successful to date in the Caribbean are deeply rooted in the cultural importance of the birds, engaging stakeholders by recognizing and drawing on the local narratives about birds and their habitats. One early model that was extremely successful at this was the Rare Pride program for some of the region's most iconic endemic parrots (Jenks *et al.* 2010). This program was able to engage local communities by using marketing methods in a novel way for conservation, connecting communities with birds and highlighting their value to the collective national heritage (Jenks *et al.* 2010). There are many other local success stories across the spectrum of protected areas and private lands, many supported by BirdsCaribbean. We highlight just a few here, namely the control of invasive species in Antiguan offshore islands (Daltry *et al.* 2012), holistic species recovery planning for

Ridgway's Hawk (BirdsCaribbean 2017b), community management planning in Jamaica (C-CAMF 2013), sustainable tourism developed by the Caribbean Birding Trail (Robertson 2013), and awareness generated by the Endemic Bird Festival (Garcia-Lau and Gonzalez 2019). These projects use locally appropriate interventions that work to the benefit of all those who share the landscape. Reviewing lessons learned from such projects, we found the consistent attributes for success were strong leadership, truly participatory nature, engagement of local decision makers, investment in developing long-term partnerships, and integrating local knowledge. These projects demonstrate that even small investments can have big positive benefits for the conservation of endemic birds, as well as the habitats and communities that live alongside them.

Lessons for the Future Persistence of Endemics

The examples throughout this piece illustrate the intense and perpetuating entanglement of humans and nature that typifies the Anthropocene. The challenges raised by Wunderle's (2008) perspective piece remain the same, albeit accelerating, namely population growth, high rates of habitat loss, globalization, and the overarching challenge of climate change. There is increasing evidence of climate impacts on the region and its birds (Campos-Cerqueira *et al.* 2017), but our understanding remains weak. We cannot stress enough the importance of maintaining and expanding long-term climatological, habitat, and bird population studies to tackle these challenges and serve as early warning systems for systemic anthropogenically driven change.

We recognize that increasing formal protection of terrestrial habitats on many islands is becoming increasingly unrealistic. We see this as an opportunity for the Caribbean to lead the way during the re-negotiation of the Aichi Targets and reconceptualize how we achieve landscape conservation. Yet, the diversity of island voices are often drowned out during international negotiations (Nunn and McNamara 2019). Countering this demands engagement by all stakeholders to influence policy makers. The emerging civil society environmental awareness and activism in the region is beginning to effect change (e.g., the successful campaign to halt development on Goat Island; BirdsCaribbean 2016). We hope that a silver lining of the COVID-19 pandemic is an opportunity for the Caribbean to reflect on its relationship with nature and build the capacity necessary to adapt to a changing environment. Society must hold governments accountable for their commitment to embrace nature as a contribution to people through an equitable green recovery. We find it disheartening that over ten years after Wunderle's (2008) paper, we are still advocating to move beyond a 'business as usual' scenario for future conservation of endemic birds. COVID-19 has highlighted the need to go beyond 'reactive recovery' and search for whole-landscape solutions, finding alternatives to tourism, taking advantage of digital tools for knowledge transfer, and building capacity that is dispersed across all stakeholders.

Nonetheless, we share Wunderle's (2008) optimism that solutions to these Anthropocene challenges will come from the engagement and innovation of local communities and continued collaborative efforts of regional communities, such as those facilitated by BirdsCaribbean. The success of local projects demonstrates an opportunity to promote a sense of local ownership of the Caribbean's cultural and natural heritage, as well as to conserve the full suite of endemic birds necessary for maintaining ecosystem functioning and landscape resiliency. Decolonizing ecological research in the region is central to understanding the attitudes and values of local people in the region around biodiversity and its management (Trisos *et al.* 2021). Achieving this requires investment in human capacity across all stakeholders committed to managing natural resources. Coherence in policy development and implementation is achieved only when civil society organizations are supported by strong government agencies (Scobie 2016). We must draw on the strengths of those who work across multiple sectors to develop a common language to communicate the conservation message across disciplines.

We have drawn out common themes across the region, yet we recognize that Caribbean islands are as diverse in their development status and governance as their endemic birds, which influences their response to environmental challenges (Petzold and Magnan 2019). While 'islandness' reflects physical realities and commonalities, treating islands as homogenous leads to an oversimplification of their impacts and responses (Kelman 2018). Successful conservation actions are those that are locally applicable, but the future strength and resiliency of small islands lies in regional collaboration and knowledge transfer (Scobie 2016). As conservation tools undergo reconceptualization to address the challenges of the Anthropocene, such as emerging financing tools (e.g., new philanthropic models, blockchain, and carbon finance), changing modalities of function for NGOs, and the move to merge climate and nature conservation efforts through frameworks such as nature-based solutions (Tallack and Bruno-van Vijfeijken 2022), the challenge for small islands becomes the need to triage competing approaches and clearly define locally appropriate solutions. Here, collaboration is critical for finding such locally appropriate solutions, as demonstrated by Action Learning Groups that bring together government, public, and private sectors (Leotaud and McIntosh 2009). We have confidence that a shared approach to addressing the overarching challenges at a regional level will provide the support to scale up successful local conservation initiatives that will benefit the region's endemic birds and their habitats.

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Title Page Illustration

The Bee Hummingbird or zunzuncito (*Mellisuga helenae*), feeding from the hand of Bernabe Hernández Ulloa at Casa del Zunzun, Palpite, Cuba. Photograph taken by H.P. Nelson in July 2017.

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