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FROM THE PAST TO THE GLOBALIZED FUTURE FOR CARIBBEAN BIRDS

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Abstract: Extinctions of Caribbean animals were well underway during the period of Amerindian occupation and have continued since the arrival of Columbus. Despite high extinction rates, the Caribbean still retains high levels of terrestrial biodiversity and, for some taxa, exceptionally high levels of endemism relative to other parts of the world. The fate of the Caribbean's biodiversity is considered especially precarious, given the region's contribution of unique species to the Earth's biodiversity and its high rate of habitat loss, which together qualify the region as a global biodiversity hotspot. Of the 25 global biodiversity hotspots the Caribbean ranks in the top six, in part due to considerable habitat loss associated with the region's high human population densities. Given the already precarious state of Caribbean biodiversity, a "business as usual" scenario for the future does not bode well for conservation and suggests that substantial challenges will face conservation efforts in the region. As the future pace of globalization accelerates, the challenges to biodiversity conservation will likely include global warming effects (i.e., drier conditions, possibly stronger hurricanes, rise in sea level), increased urbanization, and faster spread of invasive exotic pests and diseases into the region. Despite a gloomy assessment of future challenges to biodiversity in the Caribbean, conservation problems in the past have been found to be tractable, especially when conservation education has been linked to island pride. If conservation education and outreach activities continue to increase in the region there is hope that the citizens of the Caribbean will come to appreciate and ultimately preserve much of the biodiversity unique to their islands.

Key words: biodiversity, birds, Caribbean, conservation, education, extinctions, future challenges

Resumen: DESDE EL PASADO AL FUTURO GLOBALIZADOS PARA LAS AVES DEL CARIBE. La extinción de los animales del Caribe se hallaba en progreso durante el periodo de ocupación Amerindio y se mantuvo luego de la llegada de Colón. No empecé a los ritmos acelerados de extinción, el Caribe todavía retiene un alto nivel de biodiversidad terrestre y algunos taxones, exhiben altos niveles de endemismo en comparación con otras áreas del planeta. El destino de la biodiversidad caribeña es especialmente precario debido a la contribución de la región con especies únicas a la biodiversidad del Tierra y sus altos ritmos en la perdida de hábitat, ambos factores cualifican a la región como un punto caliente de biodiversidad. De los 25 puntos calientes de biodiversidad, el Caribe se clasifica entre los primeros seis en parte por la pérdida de hábitat asociado con la alta densidad poblacional de la región. Dado al actual estado de precariedad de la biodiversidad del Caribe y los "escenarios usuales de fomento de negocios", el futuro no se percibe como uno positivo para la conservación y sugiere retos substanciales hacia los esfuerzos de conservación en la región. Mientras el futuro de la globalización mantenga un paso acelerado los retos para la conservación de la biodiversidad debe incluir los posibles efectos del calentamiento global con (condiciones áridas, una probabilidad de huracanes de mayor fuerza y un aumento en el nivel del mar), el incremento de zonas urbanas y la dispersión rápida de especies exóticas invasivas y enfermedades en la región. No empecé a un avaluó tenebroso y los retos futuros que enfrenta la biodiversidad del Caribe, los problemas de conservación en le pasado han podido ser rastreados, especialmente a través de la educación sobre conservación y su relación asociada al orgullo isleño. Si la educación sobre conservación en conjunto a las actividades de alcance continúa en aumento en la región habrá esperanza a la vez que los ciudadanos caribeños comiencen a apreciar y finalmente a preservar gran parte de la biodiversidad única a sus islas.

Palabras clave: aves, biodiversidad, Caribeño, conservación, educación, extinción, retos futuros

Résumé : LE FUTUR DES OISEAUX DE LA CARAÏBE FACE AUX CHANGEMENTS GLOBAUX. Les extinctions dans la faune de la Caraïbe étaient déjà en cours pendant la période d'occupation amérindienne et ont continué depuis l'arrivée de Christophe Colomb. Malgré des taux d'extinctions élevés, la Caraïbe possède encore un niveau élevé de biodiversité terrestre et, pour certains taxons, des taux d'endémisme importants par rapport à d'autres régions du monde. La situation de la biodiversité caraïbe est considérée comme très précaire, en raison de la contribution de cette région à la biodiversité de la Terre en espèces uniques et pour son taux élevé de perte d'habitats, qui ensemble lui confèrent son statut de point chaud de la biodiversité. Ce dernier fait partie des 6 points chauds les plus importants sur les 25 répertoriés, en partie en raison de l'érosion importante de ses habitats associée avec de fortes densités de populations.L'état déjà précaire de la biodiversité caraïbe, fait qu'un scénario du type "business as usual" n'est pas de bon augure et poserait des obstacles sérieux à la conservation dans la région. Comme le rythme de la globalisation va encore s'accélérer, les pressions sur la biodiversité devraient concerner les effets des changements globaux (sécheresses, force des cyclones, montée du niveau de la mer), une urbanisation croissante, et un développement croissant des espèces exotiques envahissantes et des maladies. Malgré cette situation morose des défis posés à la conservation de la biodiversité dans la Caraïbe, des défis de conservation ont déjà pu être gérés dans le passé, en particulier quand l'éducation à la conservation était associée à la fierté insulaire. Si l'éducation à la conservation et les activités de mobilisation liées continuent à progresser dans la région, il y aura un espoir pour que les citoyens de la Caraïbe viennent à apprécier et enfin à préserver largement la biodiversité unique de leurs îles.

Mots clés : biodiversité, oiseaux, Caraïbe, conservation, éducation, extinctions, défis futurs

SETTING THE STAGE

To provide a perspective on the current status of Caribbean biodiversity and its future, it is useful to first examine the past to envision the state of biodiversity on the Caribbean islands before the arrival of the Amerindians. If we go back in time before the colonization of the Caribbean by Amerindians to about 7,000 years BP we might imagine a beach covered with basking seals. At that time, Caribbean monk seals (*Monachus tropicalis*) were widespread in the region, but they were overexploited in the 18th Century, became rare by 1850, and are believed to have mostly disappeared by the 1950s (Nowak and Paradiso 1983). It is thought that the monk seal's "trustworthiness" largely contributed to its demise. This island tameness is a trait of animals that evolved on islands in the absence of predators. Such island tameness can still be found in the animals of the Galápagos, especially on the protected uninhabited islands, but has largely disappeared from the Caribbean fauna. It is likely that when the Amerindians first arrived in these islands they encountered animals that were exceptionally tame and could easily be dispatched for food. Thus it is reasonable to expect that waves of extinction followed the arrival of Amerindians as they colonized the islands of the Caribbean, in part because tasty unwary animals would be especially vulnerable. These waves of prehistoric extinction associated with the initial human colonization of islands have been well documented in the Pacific where bird extinctions followed shortly after the arrival of humans on various islands (Steadman 1995).

One of the best documented cases of extinction or species loss from a Caribbean island associated with the period of Amerindian occupation comes from the island of Antigua (Steadman *et al.* 1984). Here 14 animal taxa that coincided with the occupation of the island by Amerindians (from 3,500 years BP) disappeared before the arrival of Columbus. The species lost include taxa of lizards, snakes, birds, bats, and rodents. Five of these taxa became globally extinct and the remainder permanently lost from Antigua. Only three species have been lost from Antigua since the arrival of Columbus, although they survive elsewhere in the region. All of these species losses occurred long after Pleistocene climate changes and are best attributed to human activities including over-hunting, introduced predators, and habitat loss or degradation. The important point is that species loss and extinction attributable to the Amerindians on Antigua was well underway before the arrival of the Europeans, a pattern documented elsewhere in the Caribbean (e.g., loss of Puerto Rico's land mammals; Turvey *et al*. 2007).

Since the arrival of Columbus, extinctions have continued apace in the Caribbean (Brooks *et al*. 2002) taking an especially heavy toll on the region's land mammals, of which 27 species have been lost. Loss of bird species was not quite as high during that period, although at least 12 species have become extinct (Brooks *et al*. 2002), most of which were parrots, parakeets, and macaws. For instance, at the time of the arrival of Columbus the Caribbean may have had a minimum of 26-27 species of psittacines, of which 14-15 species (about 55%) have

disappeared (Snyder *et al*. 1987). In comparison, few cases of extinctions of reptile and amphibian species have been documented in the region (four and two, respectively). However, as a caveat, I would caution against uncritical acceptance of these extinction numbers as it is likely that some species disappeared after 1500, but before they were scientifically described. Therefore, these post-Columbus extinction numbers undoubtedly underestimate species loss for the Caribbean (especially for reptiles and amphibians) and, coupled with our ignorance regarding the magnitude of pre-Columbian Amerindian-induced extinctions from many islands, it is likely that numerous vertebrate species have been lost since the arrival of humans in the Caribbean.

The loss of one or more species from an island is likely to have consequences for the surviving biotic community, especially in instances where the missing species played a critical role as a pollinator, seed disperser, predator, or prey species. For instance, the loss of a major predator may allow herbivores to overgraze their food plants resulting in the herbivores' subsequent starvation and changes in plant community composition. Such effects of species loss can move down through the food web and are known as trophic cascades. Trophic cascades have been observed in the biota on small islands created by a hydroelectric impoundment in Venezuela, where an absence of predators resulted in a "hyperabundance" of consumers that overexploited adult trees contributing to loss of tree species and selection for a limited collection of herbivore-resistant trees (Terborgh *et al*. 2001). Some plants may be placed at further risk due to the loss of animal seed dispersers, thereby limiting their ability to colonize new sites and consequently restricting their distribution and adding to the risk of extinction. This may have been the case in the endangered tree *Goetzea elegans* (Solanaceae) in Puerto Rico, where Marcos Caraballo was unable to detect any evidence for fruit consumption or seed dispersal, and seeds were not dispersed beyond the parent tree (Caraballo Ortiz 2007). The limited distribution of a few scattered populations along the north coast of Puerto Rico contributes to the endangered status of *Goetzea elegans*, possibly caused by the extinction of animal seed dispersers. Potential seed dispersal candidates for *G. elegans* among Puerto Rico's extinct species include a rock iguana, at least six terrestrial mammal species, and the White-necked Crow (*Corvus leucognaphalus*). This may not be an atypical case, as it is not unusual for botanists to remark on the absence of frugivory or seed dispersal in various Caribbean plants with fleshy fruits, a classic trait of animal seed dispersal. Given that a high proportion of canopy trees and understory shrubs in the Caribbean have fleshy fruits, the loss of animal seed dispersers could substantially hinder the abilities of certain plants to respond to natural and anthropogenic disturbances.

THE PRECARIOUS PRESENT

Despite the high extinction rates, the Caribbean still retains reasonably high levels of biodiversity and, for some taxa, exceptionally high levels of endemism relative to other areas of the world. The region's extant terrestrial biodiversity and rates of endemism as summarized by Myers *et al*. (2000) for the insular Caribbean (exclusive of the continental islands, Trinidad and Tobago) include about 12,000 plant species of which 58% are endemics. For vertebrates, high proportions of endemic species characterize the herpetofauna (87% of 189 amphibian species and 84% of 487 reptile species), likely due to their low dispersal rates, in contrast to the more mobile birds (25% of 564 species) and mammals (30% of 164 species, most of which are bats). Endemism in birds occurs mostly at the species level (148 endemic species with 71% confined to a single island) as only two endemic families occur here: the todies (Todidae) and Palm Chat (Dulidae). In addition to endemic birds, the Caribbean as a result of its location between continents hosts 120 migrant bird species, most from North America, either as passage migrants or as nonbreeding part-time residents. The Caribbean is the exclusive wintering grounds for two threatened migrant species and near exclusive wintering grounds for five migrant warblers. Thus the Caribbean has high levels of biodiversity and especially high numbers of endemic species confined to a relatively small land area.

The Caribbean easily qualifies as a biodiversity hotspot based on the definition of a site with exceptional concentrations of endemic species, which is undergoing exceptional loss of habitat (Myers *et al.* 2000). The hotspot concept devised by Myers and colleagues was developed to prioritize biodiversity conservation efforts. They note that the 25 global biodiversity hotspots comprise only 1.4% of the land surface of the Earth yet contain as many as 44% of all species of vascular plants and 35% of all species in four vertebrate classes. Thus, these sites are of exceptional importance for conservation, and the Caribbean ranks in the top six of the world's 25 biodiversity hotspots. In other words, the fate of the Caribbean's biodiversity is deemed especially pre-

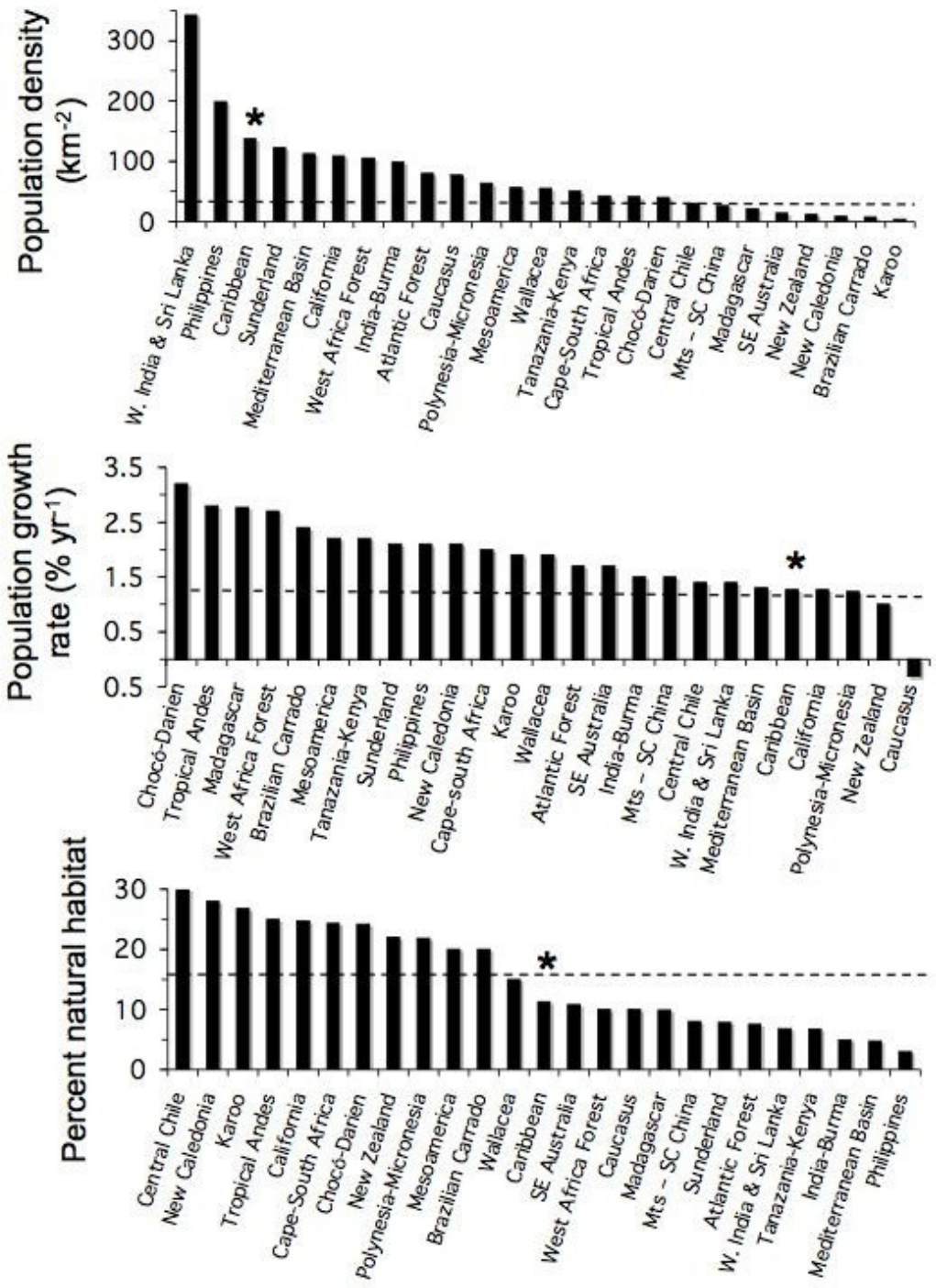

Fig. 1. A comparison of the Caribbean biodiversity hotspot with 24 other global biodiversity hotspots in terms of human population density (upper graph), human population growth rates (middle graph), and percentage of the natural habitat remaining (lower graph) in the hotspots. The Caribbean hotspot is indicated with an asterisk. For definition of the hotspot concept and location of the 25 hotspots see Myers *et al*. (2000). The information on human population density and human population growth rates in the hotspots is from Cincotta *et al*. (2000) and the information on the percentage of habitats remaining in the hotspots is from Brooks *et al*. (2002).

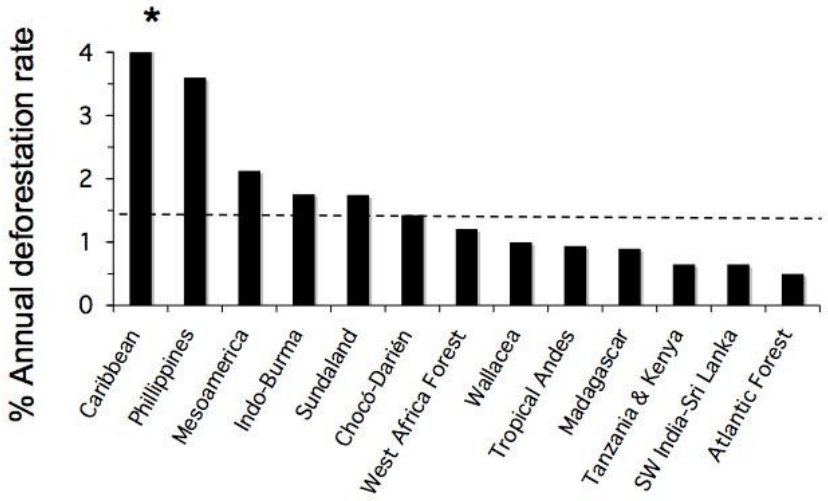

Fig. 2. Percent annual deforestation rates in the Caribbean biodiversity hotspot in comparison with 12 other tropical forest hotspots, during 1990-1995. The rate for the Caribbean includes the average for Cuba, Hispaniola, and Jamaica as summarized by Brooks *et al.* (2002), who obtained the original data from the Food and Agriculture Organization (1997).

carious, given its contribution of unique species to the Earth's biodiversity and its high rate of habitat loss.

Several factors contribute to the precarious state of the Caribbean's biodiversity and the relative significance of each becomes apparent in comparisons with the magnitude of each factor in the other global biodiversity hotspots. For the Caribbean, human population density is the ultimate driver of threat to the region's biodiversity, as evident in its number three ranking in population density relative to the other 24 hotspots (Fig. 1) based on Cincotta *et al*. (2000). The Caribbean's human population density at the time of Cincotta *et al*.'s analysis was roughly five times the mean density for the world's land area. Only the hotspots in Sri Lanka–SE India and the Philippines have higher population densities than the Caribbean. Given this very high human population density it is evident that there is limited space to spare for the Caribbean's biodiversity, leading in part to the theme of the Society for Conservation and Study of Caribbean's 2007 meeting. Fortunately for the region's biodiversity, the Caribbean's human population growth rate, at about the world average in the period 1995-2000, is situated in the lower fifth of the growth rates in the global biodiversity hotspots (Cincotta *et al*. 2000; Fig. 1). Nevertheless, the human population is still growing in the region (approximately 1.03% per year) and, given its high density already, human populations will continue to place pressure on the remaining habitat fragments in the Caribbean.

Given very high human population densities, it should not be surprising that only a small proportion of the original natural habitat remains on Caribbean islands. Estimates of the proportions of natural habitat remaining in global biodiversity hotspots as estimated by Brooks *et al*. (2002) indicate that the Caribbean, at 11%, falls in the middle of the range for the percentage of natural habitats remaining in the hotspots, but below the hotspot average of 16% (Fig. 1). However, loss of habitat has not been equivalent among Caribbean habitats, because agriculture and urbanization have usurped a disproportionate share of lowland and coastal habitats relative to the habitats on steep slopes at higher elevations (Lugo *et al*., 1981). Loss of habitat continues (Brooks *et al*., 2002) and, for some of the larger Caribbean islands (Cuba, Hispaniola, and Jamaica), deforestation rates are especially high relative to rates occurring in other tropical biodiversity hotspots (Fig. 2). Caution should be exercised in interpreting these high values as typical of the entire region because current deforestation rates vary widely among Caribbean islands, as evident in Barbados and other eastern Caribbean territories, Puerto Rico, the Caymans, and islands of the Bahamas archipelago where high deforestation rates occurred

in the past.

CHALLENGES OF THE FUTURE

Given the already precarious state of Caribbean biodiversity, a "business as usual" scenario for the future does not bode well for conservation and suggests that substantial challenges will face conservation efforts in the region. These challenges to conservation will become more daunting if effects of globalization increase as expected. Economic globalization, of course, is not new to the Caribbean as it was initiated with Columbus and led to substantial habitat degradation and loss in the colonial period and continues today. The difference now is that globalization has become ever more "global" in reach and impact, and the speed with which impacts (both positive and negative) affect the region is increasing. The specific globalization challenges of the future will include increases in urbanization, global warming impacts, and the spread of exotic pests and diseases into the region.

Not all globalization effects have negative consequences for the environment, as evident in the increasing trend in human migration from rural lands into cities. An early instance of this trend in the region occurred in Puerto Rico in the 1950s, when government policies increased industrialization and stimulated the abandonment of agricultural lands and the migration of rural people to work in factories in cities of the island. The abandoned agricultural lands reverted to second growth forest causing an expansion of natural forest cover from a low of 6% of the island in the 1940s to 30% in 1980 (Birdsey and Weaver 1987). By 1992 the amount of the island covered by closed forest was 42%, with most of the recent increase attributable to the abandonment of shade coffee plantations (Helmer *et al*., 2002). More recently, a similar trend in migration of rural people to cities occurs elsewhere in Latin America and the Caribbean (Aide and Grau 2004). For example, this pattern of rural land abandonment and migration is now apparent in the Cordillera Central of the Dominican Republic, where abandoned farmlands are reverting to second growth forest as people migrate to the cities to work in manufacturing and tourism. Thus, these shifts in human populations on some islands are causing increases in second growth forest coverage, primarily in the subtropical moist and wet zones, and increases in urbanization in lowland and coastal areas.

Increases in urbanization, driven in part by the global economy, have mixed effects on regional birdlife resulting in some distinct "winners" and "losers" among Caribbean birds. The evidence for changes in bird composition along an urbanization gradient has been provided by Vázquez (2008). Using point count censuses conducted across a gradient of urbanization (from lowland tabonuco forest, rural, suburban, to urban habitats) he documented increases in some resident species such as Gray Kingbird (*Tyrannus dominicensis*), Greater Antillean Grackle (*Quiscalus niger*), and White-winged Dove (*Zenaida asiatica*), and exotic species in samples from suburban and urban habitats in northeastern Puerto Rico. However, abundance and species richness of endemic species were greatest in the native tabonuco forest and decreased markedly along the gradient into the urban zone, where almost no endemic species were encountered. Thus, urbanization in Puerto Rico has negative consequences for endemic bird species, a pattern expected elsewhere in the Caribbean. Not only are terrestrial endemic bird species threatened by increased urbanization, but aquatic species, too, will suffer as urbanization continues to contribute to wetland loss and degradation.

Even with the appropriate protection of threatened and endangered species and their critical habitats, future Caribbean conservation efforts will be further challenged by global warming effects. Global warming and its effects are already well documented for the Caribbean and the severity of the effects are expected to intensify in the future (IPCC 2007). Obviously, as environmentally conscientious citizens we must do our best to reduce the production of greenhouse gases and work to encourage our respective governments and various organizations to do the same. Evidence for global warming in the region is well documented, for example, in the Bahamian islands of New Providence and Long Island where both mean daily maximum temperatures for January and July have increased significantly from 1945 through 2000 (Martin and Weech 2001). Some of the more visible recent effects of global warming in the region have occurred on coral reefs, where an increase in coral bleaching events correlated with increases in sea temperature has raised concern among marine biologists (e.g., Jeffrey *et al*. 2005), because bleaching indicates stress and causes coral mortality if prolonged.

Associated with global warming is the likelihood that the Caribbean will become drier in the summer based on congruence of several different global warming model simulations (Neelin *et al*. 2006). Decreases in average annual rainfall have already been observed at several Caribbean sites including

New Providence in the Bahamas (Martin and Weech 2001) and in the Luquillo Mountains of Puerto Rico (Heartsill-Scalley *et al*. 2007). More recent analyses demonstrate long-term declines in rainfall consistent with model simulations indicating human influences on these precipitation trends in the subtropics (Zhang *et al*. 2007). Therefore, given drying trends it is reasonable to expect continued loss of wetlands, with freshwater wetlands becoming more vulnerable to saltwater intrusion. In addition, droughts may affect the timing of avian breeding by changing phenological patterns of fruit, seed, and insect availability for certain breeding species, potentially reducing reproductive success. Moreover, if sufficiently severe, droughts could reduce survival of some bird species.

Given drying trends throughout the Caribbean, it should not be surprising that an increase in the frequency of wildland fires has been noted in the region. In fact, concern with wildland fires resulted in the selection of wildfire management and restoration as the theme for the first time for a recent meeting of the Caribbean Foresters (Weaver and González 2005). Natural fire has been an integral component of the disturbance regime in the native pine forests on the islands of the northern Bahamas as well as on Hispaniola and Cuba, although the natural fire regime on these islands has been altered by humans in the historic period. Drying of forests through global warming may combine with altered burning regimes, which have already been implicated in declines of the threatened Hispaniolan Crossbill (*Loxia leucoptera*; Latta *et al*. 2000), to place even more severe stress on pine forests and other ecosystems.

Elsewhere in the Caribbean, fire was never a natural component of the disturbance regime and is largely attributable to anthropogenic causes. The increases in brush fires reported from Dominica (James and Dupuis 2005) and Barbados (Jones 2005) may represent actual increases in fire susceptibility due to dry conditions rather than changes in human behavior. An increased frequency of wildland fires in the Caribbean may further stress lowland dry and even moist forests by killing native trees and shrubs and favoring invasive grasses and exotic plant species. Moreover, once a fire passes through an area it increases the likelihood of reoccurrence by favoring grasses and vines that may be especially prone to burning. Given future increases in wildfire risk, conservation efforts will be well served by supporting wildland fire prevention and fighting efforts in the Caribbean.

The frequency of severe hurricanes in the Atlantic has increased during the past decade and some have argued that such increases result from warmer sea surface temperatures due to global warming (Emanuel 2005) while others have argued that the increases in storm frequency are simply attributable to natural long-term variation. For instance, the especially active storm period of 1995-2000 is believed to be part of a multidecadal hurricane cycle and the high level of activity of this period is likely to persist for an additional 10 to 40 years (Goldberg *et al.* 2001). Regardless of how science resolves the debate, it is apparent that we are in a period of increased hurricane activity and that the north Atlantic basin has shown an increase in frequency of hurricanes and tropical storms as demonstrated for the period of 1905 through 1998 by Martin and Weech (2001). Even without a marked increase in hurricane frequency in the Caribbean, hurricanes are a cause for concern for biodiversity conservation because of increased vulnerability to storms due to habitat loss and fragmentation on many islands.

Several factors contribute to the risk of severe population loss or even extinction of terrestrial bird populations due to hurricanes (e.g., Wiley and Wunderle 1993, Wunderle 2005). Some of these factors include small population size, confinement to small habitat patches, and a diet of fruit, seeds, or nectar. Supporting the importance of these factors for predisposing a population to hurricane loss are examples of two avian extinctions that occurred in the aftermath of powerful hurricanes. The first example comes from St. Kitts, where the Puerto Rican Bullfinch *(Loxigilla portoricensis grandis*) disappeared from a relatively small patch of montane forest where it was confined prior to 1899 when two hurricanes struck the island. The bullfinch, a fruit and seedeater, likely could not find sufficient food in the storm-damaged montane forest patch and subsequently moved into the lowlands in search of food. The slow growth rate typical of high elevation vegetation likely prolonged the recovery of fruit and seed production in the montane forest of St. Kitts and the absence of forests in the sugar cane-dominated lowlands meant that post-hurricane refugia were unavailable where the bullfinch population could recover. Similarly, the Grand Cayman Thrush (*Turdus ravidus*) survived in a few forest patches on Grand Cayman before a major hurricane in 1932, after which it became rare and finally disappeared between 1938 and 1965 (Bradley 2000). Undoubtedly the thrush population was reduced at the time of early European settlement when the dry lime-

stone forest was cut over for mahogany and other hardwoods, thereby confining the species to remnant forest patches. As a member of the genus *Turdus*, it is likely that fruit was an important part of the Grand Cayman Thrush's diet; therefore, given the limited habitat and likelihood that the hurricane stripped fruits from plants, thrushes probably starved after the storm, driving the population to an unsustainable level. These two cases are instructive and justify concern for the effects of hurricanes on endemic species with these vulnerability traits (e.g., Caribbean parrots), especially as habitat loss and fragmentation continues.

Finally, as globalization continues, it is reasonable to expect that more pest species will colonize the Caribbean and potentially threaten wildlife, as evident in the legacies of introduced rats (*Rattus* spp.), cats (*Felis catus*), dogs (*Canis lupus*), pigs (*Sus scrofa*), goats (*Capra aegagrus*), mongooses (*Herpestes javanicus*), and other invasive exotic species on islands. For instance, Africanized honeybees (*Apis mellifera*) recently arrived in Puerto Rico, presumably as vagrants on a ship from South or Central America, and quickly colonized the Luquillo Mountains (Arendt 2000). Here the Africanized bees have hybridized with the naturalized European honeybees, resulting in an aggressive competitor for tree cavities, thereby limiting nesting options for cavity nesting birds such as the endangered Puerto Rican Parrot (*Amazona vittata*). Noteworthy, too, is the speed with which invasive exotic species, especially disease agents, can colonize the region as illustrated by the arrival of the West Nile virus (WNV) in the Caribbean, presumably transported by migrant birds. The virus, maintained by birds and *Culex* mosquitoes, first appeared in New York City in 1999 and, in just a few years, spread across North America. Antibodies to WNV were subsequently found in the permanent resident birds in the Cayman Islands (2001), Yucatán, Mexico (2002), Jamaica (2002), Guadeloupe (2002), Dominican Republic (2003), Puerto Rico (2003), and Cuba (2004), indicating that the virus had colonized most of the Caribbean within 2-5 years of its appearance in New York (Dupuis *et al*. 2003, Komar *et al*. 2003, Quirin *et al*. 2004, Dupuis *et al*. 2005). Although the WNV or its antigen has occurred in diverse taxa of North American birds (LaDeau *et al*. 2007), the virus has caused significant population declines, primarily in seven species represented by the families Paridae (chickadees), Turdidae (thrushes), and Corvidae (crows). The effects of WNV on Caribbean birds are currently unknown, although instances of mass mortalities of birds such as the dead crows found in the US shortly after the virus's arrival have not yet been documented in the Caribbean. Reference to the region's few bird monitoring efforts may provide baseline data for detection of WNV effects, thereby illustrating the value of long-term monitoring for revealing population responses to a changing Caribbean environment.

PROMISING POTENTIAL TO MEET FUTURE CHALLENGES

Despite my gloomy assessment of future challenges to biodiversity in the Caribbean, I am optimistic that many conservation problems in the region will continue to be tractable, as have some in the past. Reason for optimism comes in part from a successful and now classic case of outreach and education mounted in the eastern Caribbean to quell the loss of endemic parrots from hunting, habitat loss, and the pet trade (Butler 1992). To promote the preservation of each island's endemic parrot species the forestry departments of Dominica, St. Lucia, and St. Vincent and the Grenadines used an innovative conservation education program emphasizing island pride. Imaginative outreach efforts involving song, theatre, dance, and mass media targeted to all sectors of the society through schools, youth groups, churches, and local businesses were used to promote pride in each island's parrot(s) as a unique symbol of nationhood. Linking island pride to each island's unique parrot species facilitated a positive change in local attitudes towards the parrots, resulting in a reduction of human threats to the parrots and subsequent increases in parrot populations (Butler 1992). Although this education program's success was aided by the accessibility to decision makers in the close-knit societies typical of small island territories, the linkage of island pride to an island's unique species was undeniably the key to success of these efforts and such linkage holds promise for future conservation successes on other islands.

Contributing further to optimism for the future has been the growth of the Society for Conservation and Study of Caribbean Birds (SCSCB) and its stimulation of conservation activities in the region. Originally named the Society for Caribbean Ornithology (SCO), the SCSCB grew out of the Puerto Rican Ornithological Society (SOPI, for its name in Spanish "Sociedad Ornitológica Puertorriqueña, Inc."). The first meeting of the SCO/SCSCB was held in 1988 on St. Croix, USVI, and was organized by SCO/SCSCB's founding president, Jorge Mo-

reno of the Puerto Rican Department of Natural Resources and a member of SOPI. Since that meeting, the society has held 16 meetings throughout the Caribbean, yearly from 1988 through 1999 and every two years since. The SCSCB's publication, *El Pitirre*, first appeared as a newsletter in 1988 under the editorship of Jim Wiley who for 9 yr guided the evolution of *El Pitirre* into the *Journal of Caribbean Ornithology*, now under the editorship of Floyd Hayes. The SCSCB has initiated several working groups focusing on conservation issues in the Caribbean. For example, the West Indian Whistling-Duck Working Group, initiated in 1996, has pioneered in outreach and education focusing on the whistling duck and conservation of its wetland habitats in several key island territories. The Seabird Working Group has also sponsored education and training efforts in the region, as well as summarizing for the first time the conservation status of the region's seabirds (Schreiber and Lee 2000). Furthermore, the SCSCB sponsored the Endemic Bird Festival; now in its sixth year, it has grown to include 18 countries providing invaluable public outreach and education emphasizing the region's unique avifauna (Díaz-Méndez 2007). Hence, the SCSCB is increasingly playing a significant role in conservation education in the Caribbean.

In addition to the SCSCB's activities, the continued growth of SOPI's activities (Miranda Castro 2005) provides further reason for optimism for the future of biodiversity conservation, especially in Puerto Rico. For example, a tally of some of SOPI's activities since the 1992 SCO/SCSCB meeting in San Juan provides evidence for growth in the organization's activities and include: the newsletter, *El Bien-te-Veo*; an important bird areas program with BirdLife International; surveys for a breeding bird atlas; participation in breeding bird surveys; increased support for Christmas bird counts; a shorebird monitoring program; various workshops on bird identification; field trips; participation in the endemic bird festival; assistance with censuses of threatened and endangered birds; and providing input on legislation pertaining to birds. If conservation education and outreach activities sponsored by SOPI, SCSCB, and others continue to grow in the region there is hope that the citizens of the Caribbean will come to appreciate and ultimately preserve much of the biodiversity unique to their islands.

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