Rapid Ecological Assessment of the avian community and their habitats on Andros, The Bahamas

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INTRODUCTION

Covering roughly 6,000 km^2 (2,300 sq. mi), Andros is the largest land body in the Bahamian Archipelago. An extensive network of tidal creeks and interlacing channels, divides Andros into numerous smaller islands and cays, creating a unique patchwork of marine, freshwater and terrestrial ecological communities. The three major islands of Andros are North and Central Andros, Mangrove Cay, and South Andros. Andros supports a population of <10,000 people with most development along the eastern coast and on the northern islands.

Andros is the site of a large-scale demonstration project funded by the Global Environment Facility - Integrating Watershed and Coastal Areas Management program (GEF-IWCAM). Primary goals of the project include crafting a Land and Sea Use Plan, developing water conservation strategies and educational programs in coordination with local communities, and mapping the island's marine and terrestrial resources to identify threats and concerns for biodiversity conservation. Andros contains the largest freshwater aquifer in the Bahamas and lies adjacent to the 3rd largest barrier reef in the world, making appropriate management of freshwater and coastal/marine resources key to the prosperity of its people and the long-term conservation of its unique flora and fauna.

As part of the effort to map the island's terrestrial resources, we conducted a rapid ecological assessment of avian communities and their habitats on Andros. Our objective was to provide broad descriptions of bird assemblages and their habitats and to identify areas of significant conservation value. The avifauna of Andros is poorly known; the collecting trip reported on by (Northrop 1891) and White's (White 1998) birding guide remain the only extensive surveys of the island's birds. However, Andros, with its low density of human inhabitants and extensive areas of undisturbed natural vegetation, is almost certainly an important source of habitat for wintering birds, including the endangered Kirtland's Warbler (scientific names of birds are located in Appendix 1) (Currie et al. 2005), and breeding species, including West Indian endemics such as Great Lizard Cuckoo, Bahama Mockingbird, Bahama Woodstar, Bahama Yellowthroat, and Bahama Swallow. Although the human population on Andros is relatively low, habitat destruction and degradation from population growth and land use practices (e.g., logging, farming) likely have had significant impacts to birds, including population declines and local extirpations. A better understanding of the distribution of birds on Andros may allow for future growth to proceed in a manner that minimizes impacts to the island's unique avifauna.

METHODS

We surveyed birds on Andros during the period from 24 April – 30 April 2010. Given the nature of the rapid assessment approach, we identified specific areas in which to assess birds and their habitats based on ecological (e.g., ensuring at least some coverage of all major vegetation types) and logistical considerations (e.g., focusing on areas easily accessible by foot, boat, or car) that also allowed us to cover as much area as possible. We used a combination of quantitative and qualitative methods to characterize bird

assemblages. We directed our quantitative efforts towards two of the dominant forest communities on the island, Caribbean pine (*Pinus caribaea*) forest and dry, broadleaved-evergreen forest ("coppice"). Both forest types are identified as Conservation Targets in The Nature Conservancy's Conservation Area Plan based on the high levels of biodiversity they support, their economic value in terms of forest products, and their close relationship to available freshwater on the island. On Andros, coppice forests primarily occur at higher elevations and ridges along the eastern edge of the island; as elevation decreases westward, coppice forest tends to transition to pine forest and pine forest transitions to mangroves (Fig. 1).

We conducted surveys in pine and coppice habitats in two areas of Andros. On South Andros, we surveyed old-growth Caribbean pine and coppice forests in the area of the proposed South Andros agricultural development on 26-27 April 2010 (Fig. 2). At the time of the surveys, the Bahamas Agricultural and Investment Corporation was constructing a road, beginning in the settlement of Duncombe Coppice and cutting across approximately 3 miles of coppice before reaching the pine forest, to provide access to the old-growth pine forests. As these are the only intact old-growth pine forests remaining in the Caribbean, they provide unique insight into an ecosystem largely unmodified by human activities and thus may provide valuable guidance for the management and restoration of degraded pine forests elsewhere in the Bahamas, and beyond (for example, in the similar pine-rocklands of South Florida, USA). Documenting baseline ecological conditions prior to the removal of these forests for agricultural development is also important simply because the structure and composition of old-growth Caribbean-pine forests is unknown to science. Prior to the construction of the road, the coppice in this area was also intact and unchanged by anthropogenic disturbance, and therefore provides an exceptional snapshot of baseline conditions in this forest type; nowhere else in the West Indies or south Florida do such extensive areas of pristine coppice still remain.

For comparison to the old-growth sites, we also conducted bird and habitat surveys in fragmented, second-growth pine forests and coppice on 25 April, 29 April, and 30 April 2010. The second-growth, even-aged pine forests were located in North Andros (Fig. 2), and had been clear-cut for timber in the 1970s. Since then, these stands had been subject to periodic fires, mostly started accidentally by humans and often occurring outside of the natural fire season (T. Thompson, Bahamas National Trust, personal communication). We surveyed two areas of disturbed tall coppice (Fig. 2). The first was along a road leaving the main highway north of Kemp's Bay Settlement (South Andros) and running approximately 1.5 miles through the coppice. In addition to the road, the coppice we surveyed was also fragmented by numerous small clearings cut by hunters to facilitate the shooting of White-crowned Pigeons. The second disturbed coppice site was along a ridge west of the main highway between Fresh Creek and Staniard Creek on North Andros and was adjacent to a residential area. Although the second-growth, disturbed pines and coppice that we surveyed differed in many ways from one another, they provide at least a coarse approximation of the changes in bird assemblages and habitat conditions that might be expected following the exploitation of the old-growth, unmodified pine and coppice of South Andros.

In pine and coppice forests, we conducted 5-minute fixed-radius point counts between sunrise and 11:00AM. Survey stations were established $\geq$ 250 m apart. In the old-growth pine forest, points were established along two routes that allowed two observers to maximize the number of surveys conducted in one morning. In North Andros pine forests, we conducted surveys along old logging tracks, which were fairly narrow (< 4m) and overgrown with grasses and hardwood understory vegetation; most tracks also had an unbroken pine canopy. The area we surveyed was chosen based on ease of access and because the vegetation structure and stand age appeared representative of other pine forests in the area. In the old-growth coppice forests, survey points were established perpendicular to the newly established road; in the second-growth coppice, surveys were conducted such that no major roads were within 100 m of the survey point. During each 5-minute survey, we counted all birds heard or seen and estimated the distance to each individual, assigning distance to one of four intervals: within 25 m, 25 – 50 m, 51-100, or >100 m from the point. To evaluate relative abundance, we report the average number of individuals detected within 100 m of survey points.

Due to time and logistical constraints, quantitative assessments of other habitats and regions of Andros Island were unfeasible. Thus, to characterize bird assemblages across as much of Andros as possible, we conducted area searches either on the ground or by vehicle. We focused our efforts on four broad habitat categories: wetlands, mangrove/scrub forests, coastal (beach and sandflats), and human-modified (non-wetland; low to moderate development), acknowledging that the range of ecological conditions within habitats was quite diverse. Mangrove/scrub forests were probably the broadest habitat category. Mangrove habitats were characterized by the presence of any of the four mangrove species: red mangrove (*Rhizophora mangle*), black mangrove (*Avicennia germinans*), white mangrove (*Laguncularia racemosa*), and buttonwood (*Conocarpus erectus*). Most of the mangrove habitats we observed were associated with, or transitioned to, scrub habitats, which were typically characterized by a high density of broad-leaved evergreen and palm species and a canopy of 2-4 m. Surveys were conducted in South Andros, Mangrove Cay, and North and Central Andros, and where possible, we visited unique areas considered of high conservation value to Bahamians (e.g., blueholes). We spent 3.5 days on South Andros, 0.5 days on Mangrove Cay, and 2.5 days on North Andros. For each habitat we recorded whether a species was present or absent and noted the number of individuals observed. The results of the area searches do not provide a valid comparison of species richness or species composition between regions and habitats because we were unable to exert a similar effort in each region or habitat, and because we did not visit every habitat in each region. However, these data allow us to provide broad descriptions of bird and habitat assemblages across Andros Island and highlight unique natural features in the three regions (South Andros, Mangrove Cay, and North and Central Andros).

RESULTS AND DISCUSSION

Pine Forest

The old-growth pine stand that we examined had a high degree of structural complexity and heterogeneity. For example, some areas had a tall, dense understory of hardwoods

(Fig. 3), whereas other areas had open, grassy understories (Fig. 4). Still other areas had extensive stands of thatch palm (*Thrinax morrisii*) in the understory (Fig. 5). This structural and compositional diversity contrasted sharply with conditions observed in the pine forests of North Andros, most of which were logged in the 1970s, in which understory conditions are homogenous both in composition and structure (Fig. 6).

Also notable in this stand was the wide range of age classes represented, from seedlings (Fig. 7) to large individuals that showed many of the characteristics associated with old-growth Caribbean pine (e.g., the gnarled, flat-top appearance of the snag in the middle-ground of Fig. 3). Again, this contrasted sharply with conditions in the logged pine forests on North Andros, which were even aged and showed no evidence of ongoing recruitment (Fig. 6). The lack of seedlings and young individuals on North Andros was likely a consequence of the dense canopy cover, itself a product of stands still in the stem-exclusion phase of stand development following the relatively recent and uniform clear-cutting of large areas of forest.

The old-growth pine forest on South Andros contained high densities of standing dead trees (Fig. 8), which are an important habitat element for many species of wildlife, including the endemic Bahama Swallow, which we found nesting in the old-growth pines of South Andros (Fig. 9). In contrast, standing dead trees were rare in the second-growth pinelands of North Andros. The old-growth pine forests also contained abundant downed dead wood (Fig. 10), an important component of wildlife habitat, whereas downed wood was largely absent from the second-growth pine forests.

The greater structural complexity and structural diversity of the old-growth pine influenced the composition of the bird assemblage (Table 1). In general, all of the endemic or near-endemic species – Bahama Mockingbird, Bahama Yellowthroat, Bahama Swallow, and Bahama Woodstar – were detected more frequently in the old-growth pine forest than in the second-growth pinelands. Species that nest in cavities within standing dead trees – Hairy Woodpecker and Bahama Swallow – were also more frequently detected in the old-growth pine forest, perhaps because of the increased availability of nest sites in the old-growth forest. The old-growth forest also supported greater abundances of species utilizing understory vegetation for nesting and foraging, including Thick-billed Vireo, Greater Antillean Bullfinch, and Bahama Yellowthroat. Increased abundance of these species likely reflects the presence of a more structurally diverse understory in the old-growth pine forest.

Coppice

The farm road cuts through what was once likely the largest intact stand of dry, evergreen broadleaf forest in the region. The areas that we surveyed included a range of structural conditions, from tall-canopied stands with open, park-like understories to stands with lower canopies and densely stocked understories. In general, the fragmented, second-growth coppice stands that we surveyed supported structural conditions similar to those found in the old-growth coppice along the farm road, although we found no areas of tall, open forest in the second-growth coppice. Bird assemblages in the old-growth and second-growth coppice differed only slightly, although bird abundance was much higher in the old-growth coppice. The most notable difference was the absence or near-absence

of Key West Quail Dove, Mangrove Cuckoo, and Great Lizard Cuckoo from the second-growth coppice. White-crowned Pigeon and Black-whiskered Vireo were more abundant in the old-growth coppice; only the Thick-billed Vireo was substantially more abundant in the second-growth coppice.

Qualitative Assessments

Our ground- and vehicle-based surveys across Andros Island yielded a total of 89 bird species (Table 2), about half of the species listed in other published records (e.g., checklists, Christmas Bird counts, historic surveys, and Bird Banding recoveries). We identified two species not listed on other published reports: Gray-cheeked Thrush and Bicknell's Thrush. These species are best distinguished by voice on the breeding ground, thus we cannot say definitively which species we observed. The taxonomic group with the highest number of species was breeding landbirds (31 species), followed by waterbirds (29), migratory landbirds (22), raptors (5), and introduced species (2) (Table 3).

In general, there was substantial overlap in habitat use by birds on Andros Island. Forty-six species were detected in > 1 habitat and 24 species (28%) were observed in $\geq$3 habitats. Not surprisingly, waterbirds were restricted to those habitats with access to water: wetlands, shorelines/flats, and mangrove/scrub. Species richness of breeding and migrant landbirds was approximately equal among the forested habitat types.

We found the largest number of species (40) in mangrove/scrub habitats. Mangrove/scrub habitats covered the largest range of habitat conditions, from stands of pure mangroves to stands of pure scrub. The large amount of variation in habitat conditions likely explains the higher number of species detected in this habitat category. Furthermore, the distinction between scrub and coppice is not abrupt and many of the species found in coppice habitats were also found in mangrove/scrub habitats (e.g., Mangrove Cuckoo, Great Lizard Cuckoo, Bahama Mockingbird). We surveyed mangrove/scrub habitats on all three of the major islands, and found no unique habitat features or birds assemblages in any one location.

Human-modified habitats were also surveyed on all three islands. In general, the extent of human-modified areas on Andros is low, due to the low population density. We found that vegetation complexity was fairly high in individual settlements and residential areas, even in population centers such as Fresh Creek. In most areas, a mixture of overstory trees and palms and understory shrubs were present, and although vegetation patches were present at relatively low densities, most were fairly well connected. We detected the largest number of migratory landbirds in human-modified habitats (Table 3). These patches of habitat may be favored by migrants because resident species are at lower densities, reducing competition for food. Northern Mockingbirds were abundant in human-modified habitats while the Bahama Mockingbird was absent, highlighting the vulnerability of this species to even low levels of development. One of the most abundant species in human-modified habitats was the Greater Antillean Oriole, a species that has been extirpated on Abaco Island. Orioles were typically found in, or adjacent to, patches of coconut palm trees. Clearly, the greatest threat to the ability of these habitats

to support birds in the future is intensification of development brought on by population growth and increased tourism.

We visited various types of wetlands across Andros including ephemeral backwater tidal habitats, human-created wetlands, lakes, and several blueholes. Heron and egret species dominated this group and were found in a wide variety of wetland types. The West Indian Whistling Duck, a species listed as globally threatened – vulnerable by Birdlife International, was recorded at a small human-created wetland in Driggs Hill (South Andros).

The lowest diversity of bird species were found on shoreline beaches and sandflats, presumably because few species are using these habitats during the period we conducted the rapid assessment. Surveys of this habitat would be better conducted during migration and overwintering periods when shorebirds are traveling to or from their arctic breeding grounds and other coastal species are not on breeding colonies. During the winter, sandflats in the Bahamas support substantial numbers of Piping Plovers, a globally threatened – near threatened species, and Wilson's Plovers (Predensa Moore, pers. comm.). These habitats are especially vulnerable to further development on the east side of the island, where most human development is located. There is no information on the use of sandflat habitats in West Andros, and this is a significant information gap for developing conservation actions for these habitats and species groups.

On all three islands, the physical makeup of habitats is relatively similar with a mix of coppice and pine forest habitats on higher elevations to the east transitioning to mangroves and shallow sandflats to the west. Although we have described the general conditions of these habitats, individual hotspots or unique characteristics are not clearly apparent from this assessment, except for the case of the pristine pine and coppice habitats in South Andros. Further quantitative studies of avian-habitat relationships would be beneficial to identify specific habitat elements important to the maintenance of bird assemblages in the habitats we surveyed.

SUMMARY

A video documenting the highlights of our visit to the old-growth forest on South Andros has been posted on the Web (http://www.youtube.com/watch?v=i1Mn5W84r3A) or is available from the authors of this document.

Summary and potential consequences of agricultural development in old-growth pine forest.—Our surveys in old-growth and second-growth pine forests revealed large differences between the two. Old-growth pine forests were not simply older, but were vastly more complex and supported a greater diversity of structural conditions, which likely allows for a greater number of species to coexist. In other regions of the world, for example in the Pacific Northwest of the United States, the complex structural conditions associated with old-growth forests results in enhanced provision of ecosystem services such as clean water, clean air, and sequestration of carbon, relative to those provided by younger, less complex forests. The old-growth pine forests on South Andros are also apt to be more resilient in the face of disturbances, such as hurricanes, because of the

presence of a range of age classes of pines. In contrast, the second-growth pine forests supported relatively few young individuals, and thus they will be slow to recover from any widespread loss of canopy trees. Clearing for agricultural development will not only eliminate large areas of this globally unique forest, but it will fragment and degrade even those remaining stands of old-growth pine that are left untouched. The road will allow access by humans to previously inaccessible areas, and the increased frequency of use may result in increased trash dumping, illegal hunting, illegal clearing of additional forest, increased opportunity for the spread of invasive plants, and, perhaps most importantly, may alter the existing fire regime by increasing the likelihood of human-started fires. In south Florida, for example, pine forests adjacent to agricultural fields have understories dominated by noxious weeds and have highly unnatural fire regimes, with frequent human-started fires, most of which occur outside of the normal fire season. These degraded pine forests support relatively few species of wildlife, and are highly vulnerable to disturbance. For example, in 1992, nearly every overstory pine in small patches within the greater south Florida metropolitan area were killed by the joint effects of Hurricane Andrew and a subsequent pine bark beetle outbreak, whereas more intact stands nearby suffered far less destruction. Agricultural development on South Andros may also result in indirect changes in the structure of remaining pine forests via a lowering of the water table. The substrate in the pine forests of South Andros is bare limestone, and thus massive inputs of water and nutrients will be required to grow crops even after the substrate has been scraped and rock-plowed. A likely consequence is the lowering of the water table. Studies in Florida by Ecostudies Institute have shown that changes in water-table elevation produced substantial changes in the structure of pine forests and in the ability of these pine forests to support healthy populations of wildlife.

Summary and potential consequences of agricultural development in old-growth coppice.—Construction of the access road is likely the primary direct impact of the proposed agricultural development. The road footprint itself has resulted in the direct loss of approximately 25-30 acres of coppice. A similar amount of coppice along the edge of the road will be altered by changes in microclimate brought about the presence of the road clearing and by heavy dust loads generated by vehicle traffic. The road clearing may also act as a barrier for some wildlife species, resulting in the fragmentation and isolation of populations. Whereas the direct effects of the agricultural development are apt to be relatively minor, the indirect effects may be far more substantive. The road, by providing increased access to the coppice, will almost certainly generate increased levels of use by humans. Based on our surveys of other stands of coppice that have road access, likely consequences of increased human use include illegal dumping of trash, including hazardous materials; increased frequency of fire, which under natural circumstances is exceedingly rare in coppice; and extensive clearing of remaining coppice to facilitate hunting of White-crowned Pigeon. In our survey of other coppice that can be accessed by roads, we noted the presence of numerous small (c.a. 0.5 acre) clearcuts, which, based on the number of shell casings left on the ground, are created and maintained by hunters.

RECOMMENDATIONS

- Protection of large representative tracts of pristine Caribbean pine forest and dry, broad-leaved evergreen formations in South Andros should be a top-level conservation priority.

- As few other unique "hotspots" were found on any specific island, conservation and management should attempt to protect representative habitat types across Andros Island.

- Development plans should consider incorporating the economic value of ecotourism, particularly related to birding activities. The old-growth pines and coppice on South Andros may be especially well suited for ecotourism, as these areas are the only remaining example of these habitats in the world.

- Further quantitative work is warranted to assess avian-habitat relationships. Such research can reveal specific habitat features associated with bird assemblages that should be contained in long-term management plans for birds.

- The greatest threats to birds and their habitats are increased development through population growth and land-use changes (logging, agriculture). Wise development will be predicated on a better understanding of the value of ecosystem services provided by intact areas of natural vegetation and on the potential value of intact areas of natural vegetation as a magnet for ecotourism.

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Table 1. Average number of individuals detected within 100 m of survey points during 5-minute counts conducted between 25 April 2010 and 30 April 2010. Maximum abundance for each species shown in bold; species endemic to the Bahamas are italicized in bold.

	Habitat			
Species	Old-growth pine forest (n=15)	Second-growth pine forest (n=35)	Old-growth Coppice (n=11)	Second-growth coppice (n=17)
American Redstart	0.07	**0.49**	0.00	0.24
Bahama Swallow	**0.80**	0.09	0.00	0.00
Bahama Mockingbird	1.27	**1.31**	0.82	0.65
Banaquit	**1.00**	0.03	0.91	0.59
Bahama Woodstar	**0.07**	0.00	0.00	0.00
Black-and-white Warbler	0.00	0.03	0.00	**0.12**
Bahama Yellowthroat	**0.47**	0.34	0.36	0.24
Black-bellied Plover	0.00	0.00	0.00	0.00
Black-faced Grassquit	0.20	**0.54**	0.00	0.00
Blue-gray Gnatcatcher	1.13	**1.31**	0.00	0.00
Blackpoll Warbler	0.00	0.00	0.00	0.00
Black-throated Blue Warbler	0.07	0.03	**0.18**	0.06
Black-whiskered Vireo	0.47	0.34	**3.09**	1.76
Crescent-eyed Pewee	**0.27**	0.26	0.00	0.00
Clapper Rail	0.00	0.00	0.00	0.00
Cape May Warbler	0.00	0.00	**0.18**	0.00
Common Ground Dove	0.00	0.00	0.00	**0.18**
Cuban Emerald	**0.53**	0.29	0.09	0.06
Greater Antillean Bullfinch	**1.07**	0.09	0.45	0.47
Greater Antillean Oriole	0.00	**0.03**	0.00	0.00
Great Lizard Cuckoo	0.00	0.00	**0.18**	0.06
Green Heron	0.00	0.00	0.00	0.00
Gray Kingbird	0.00	0.03	0.00	0.12
Hairy Woodpecker	**0.73**	0.34	0.00	0.00
Key West Quail Dove	0.07	0.00	**1.45**	0.00
La Sagra's Flycatcher	**0.33**	0.20	0.00	0.06
Laughing Gull	0.00	0.00	0.00	0.00
Loggerhead Kingbird	0.00	**0.09**	0.00	0.00
Mangrove Cuckoo	0.00	0.00	**0.55**	0.06
Northern Mockingbird	0.00	0.00	0.00	0.00
Northern Parula	0.00	**0.14**	0.00	0.00
Ovenbird	0.00	**0.03**	0.00	0.00
Unidentified peep	0.00	0.00	0.00	0.00
Pine Warbler	1.47	**2.31**	0.00	0.00
Prairie Warbler	0.00	0.00	0.00	0.00

Table 1. Average number of individuals detected within 100 m of survey points during 5-minute counts conducted between 25 April 2010 and 30 April 2010. Maximum abundance for each species shown in bold; species endemic to the Bahamas are italicized in bold.

	Habitat			
Species	Old-growth pine forest (n=15)	Second-growth pine forest (n=35)	Old-growth Coppice (n=11)	Second-growth coppice (n=17)
Red-legged Thrush	**0.33**	0.17	0.00	0.00
Red-winged Blackbird	0.00	0.00	0.00	0.00
Thick-billed Vireo	0.60	0.29	0.45	**1.29**
Turkey Vulture	0.00	0.03	0.00	0.00
Unidentified shorebird	0.00	0.00	0.00	0.00
White-crowned Pigeon	0.00	0.00	**1.64**	0.12
Western Spindalis	0.33	**0.40**	0.00	0.00
Willet	0.00	0.03	0.00	0.00
Yellow Warbler	0.00	0.00	0.00	0.00
Zenaida Dove	0.07	**0.14**	0.00	0.00
Total average individuals	**11.33**	9.37	10.36	6.06
Total number of species	21	**27**	13	16

Table 2. Presence/absence (• denotes presence) of bird species in six habitat categories detected during surveys on Andros Island from 24 – 30 April 2010.

	HABITAT					
Species	Wetlands	Shoreline/ Flats	Mangrove/ Scrub	Coppice	Pine Forest	Human-modified (non-wetland)
Least Grebe	•					
Brown Pelican	•	•				
Double-crested Cormorant		•				
Great Blue Heron	•	•				
Great Egret	•	•	•			
Reddish Egret	•	•	•			
Tricolored Heron	•	•	•			
Little Blue Heron	•	•	•			
Snowy Egret			•			
Cattle Egret	•		•			•
Green Heron	•		•			
Yellow-crowned Night-Heron	•					•
White Ibis			•			•
West Indian Whistling-Duck	•					
Turkey Vulture	•		•			•
Osprey			•			
Red-tailed Hawk					•	
American Kestrel			•			•
Northern Bobwhite					•	
Clapper Rail			•			
Common Moorhen	•					
Black-necked Stilt	•					
Black-bellied Plover	•	•	•			
Semipalmated Plover		•				
Killdeer						•
Solitary Sandpiper			•			
Spotted Sandpiper	•		•			
Willet			•			
Ruddy Turnstone		•				
Sanderling		•				
Laughing Gull		•	•			
Royal Tern		•				
Least Tern		•				
White-crowned Pigeon			•	•		
Eurasian Collared-Dove						•
Mourning Dove						•
Zenaida Dove			•		•	
Common Ground-Dove			•	•		•

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	HABITAT					
Species	Wetlands	Shoreline/ Flats	Mangrove/ Scrub	Coppice	Pine Forest	Human-modified (non-wetland)
Key West Quail-Dove				•		
Mangrove Cuckoo			•	•	•	
Great Lizard Cuckoo			•	•		
Smooth-billed Ani	•		•			•
Barn Owl	•					
Antillean Nighthawk					•	
Cuban Emerald			•	•	•	•
Bahama Woodstar						•
Yellow-bellied Sapsucker						•
Hairy Woodpecker					•	
Cresecent-eyed Pewee					•	
La Sagre's Flycatcher				•	•	
Gray Kingbird	•		•	•		•
Loggerhead Kingbird					•	
Bahama Swallow	•				•	•
Bahama Mockingbird			•	•	•	
Northern Mockingbird			•			•
Veery						•
Swainson's Thrush						•
Gray-cheeked Thrush						•
Bicknell's Thrush						•
Wood Thrush						•
Red-Legged Thrush				•	•	
lue-gray Gnatcatcher					•	
Thick-billed Vireo			•	•	•	
Black-whiskered Vireo			•	•	•	•
Northern Parula			•	•	•	
Yellow Warbler			•			•
Cape May Warbler				•	•	•
Black-throated Blue Warbler			•	•	•	•
Black-throated Green Warbler			•			
Pine Warbler					•	
Prairie Warbler			•	•		
Palm Warbler						•
Blackpoll Warbler			•	•		
Black-and-white Warbler				•		•
American Redstart			•	•	•	•
Ovenbird					•	•
Northern Waterthrush	•					•

Table 2. Presence/absence (• denotes presence) of bird species in six habitat categories detected during surveys on Andros Island from 24 – 30 April 2010.

	HABITAT					
Species	Wetlands	Shoreline/ Flats	Mangrove/ Scrub	Coppice	Pine Forest	Human-modified (non-wetland)
Common Yellowthroat						•
Bahama Yellowthroat				•	•	•
Bananaquit			•	•	•	
Western Spindalis					•	
Scarlet Tanager						•
Black-faced Grassquit			•		•	•
Greater Antillean Bullfinch			•	•	•	
Bobolink						•
Red-winged Blackbird	•		•			
Greater Antillean Oriole					•	•
Total number of species	**22**	**14**	**40**	**22**	**28**	**36**

Table 3. The total number of bird species found in taxonomic groups and the species richness of each taxonomic group by habitat type.

Species group	Total # species	Wetlands	Shoreline/ Flats	Mangrove/ Scrub	Coppice	Pine Forest	Human-modified (non-wetland)
Breeding Landbirds	31	4	0	16	15	21	12
Waterbirds	28	15	14	14	0	0	4
Migratory Landbirds	21	1	0	7	7	5	17
Raptors	5	2	0	3	0	1	2
Introduced Species	2	0	0	0	0	1	1

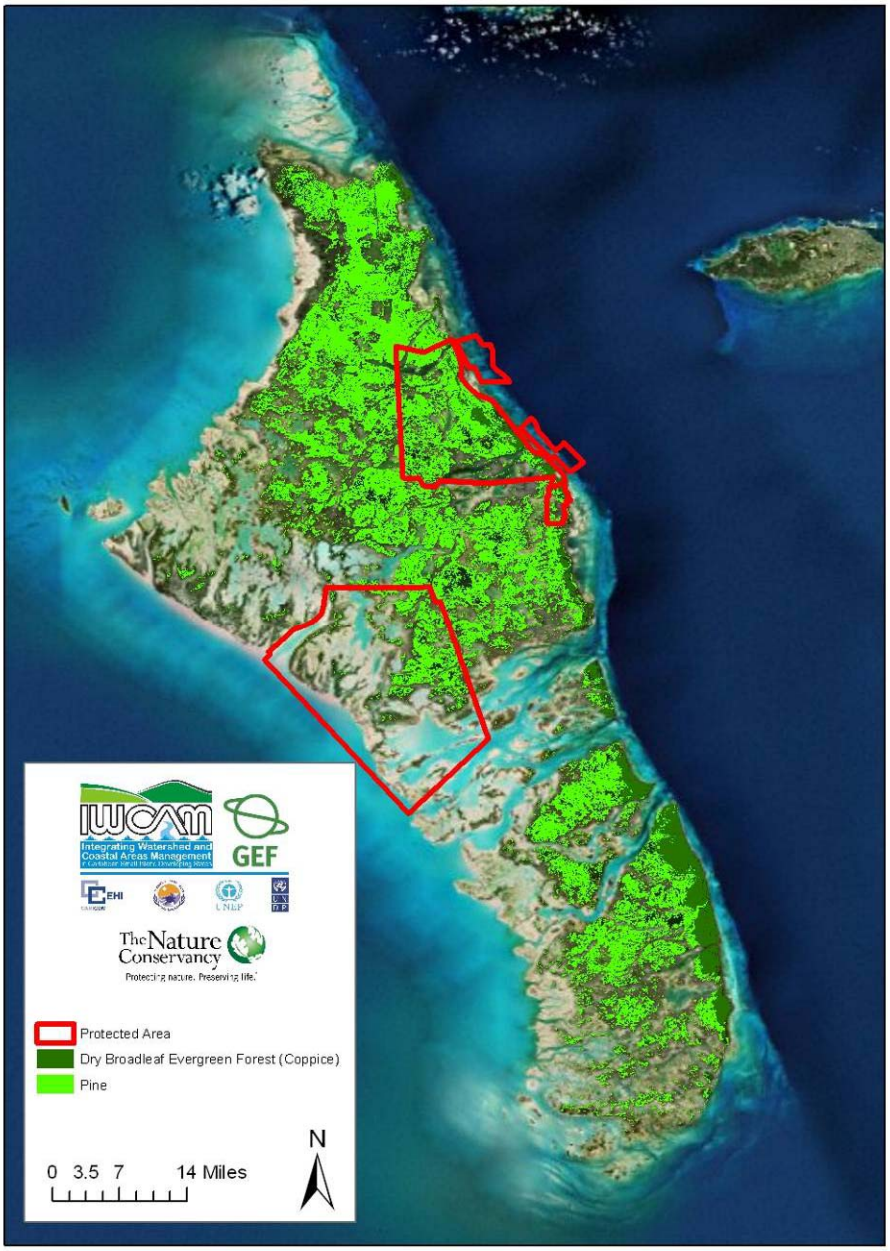

Figure 1. Coppice and Pine habitats on Andros Island.

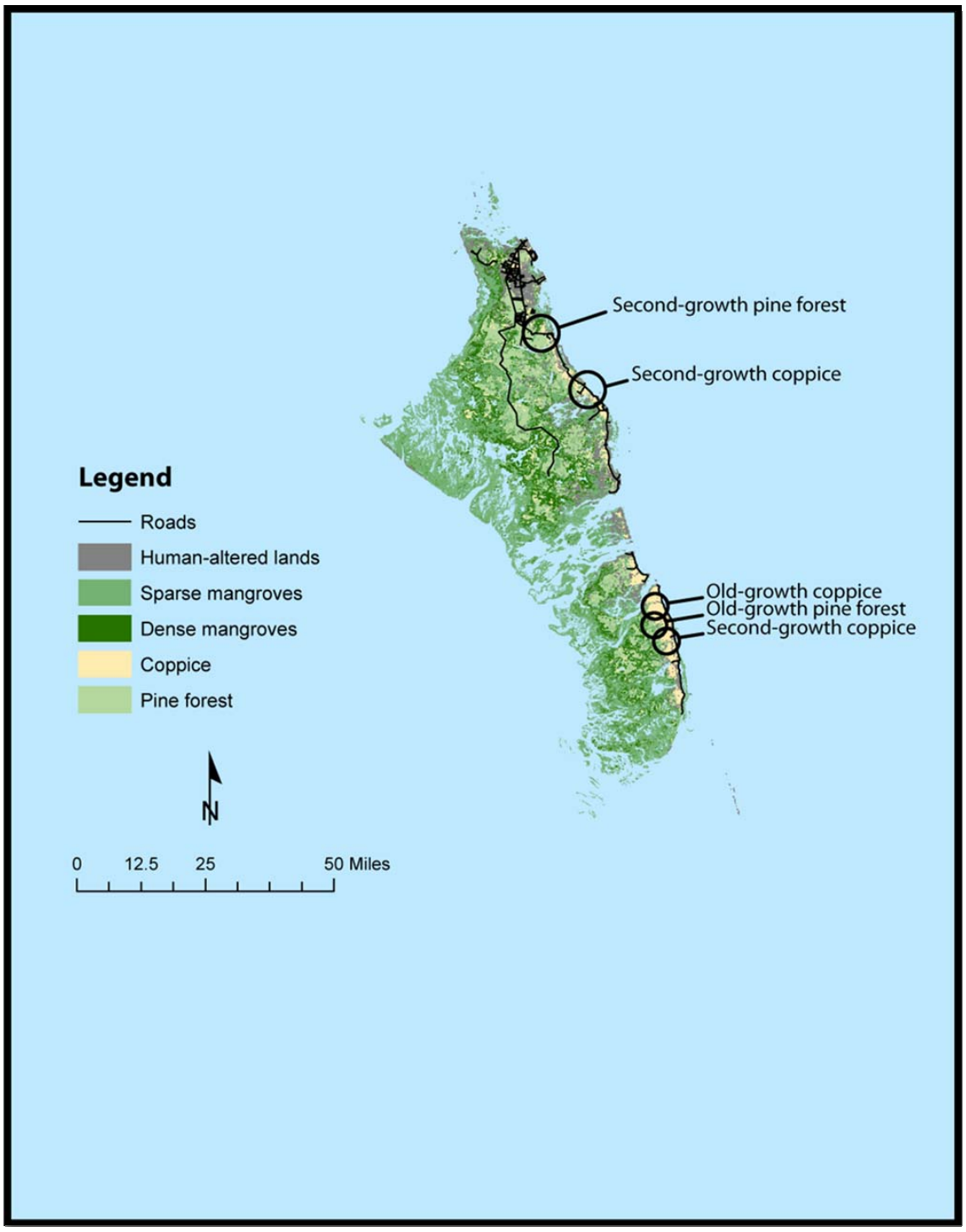

Figure 2. General location (black circles) of habitat and bird surveys in four different forest types on Andros.

Figure 3. Dense and tall (c.a.10-12 ft) hardwoods in the understory of an old-growth Caribbean pine forest on South Andros.

Figure 4. Open, grassy understory in a stand of old-growth Caribbean pine on South Andros.

Figure 5. An extensive stand of thatch palm beneath a canopy of old-growth Caribbean pine on South Andros.

Figure 6. Previously logged pine forest on North Andros was less structurally diverse than old-growth pine forest on South Andros. Understory conditions in every stand sampled were similar to those pictured here.

Figure 7. An old-growth stand of Caribbean pine on South Andros supported a range of age classes of pine, from young seedlings to mature individuals.

Figure 8. Standing dead trees, an important habitat element for many species of wildlife, were abundant in the old-growth pine forest but nearly absent from the second-growth pine forest.

Figure 9. A Bahama Swallow perches above its nest in a standing dead tree in an old-growth pine forest on South Andros. This pineland endemic was far more abundant in old-growth pines than in second-growth pines.

Figure 10. Downed wood, also an important habitat element for many species of wildlife, was common in the old-growth pines of South Andros.

APPENDIX 1.

Species	Scientific name
American Redstart	*Setophaga ruticilla*
Anhinga	*Anhinga anhinga*
Antillean Nighthawk	*Chordeiles gundlachii*
Bahama Mockingbird	*Mimus gundlachii*
Bahama Swallow	*Tachycineta cyaneoviridis*
Bahama Woodstar	*Calliphlox evelynae*
Bahama Yellowthroat	*Geothlypsis rostrata*
Bananaquit	*Coereba flaveola*
Barn Owl	*Tyto alba*
Bicknell's Thrush	*Catharus bicknelli*
Black-and-white Warbler	*Mniotilta varia*
Black-bellied Plover	*Pluvialis squatarola*
Black-crowned Night-Heron	*Nycticorax nycticorax*
Black-faced Grassquit	*Tiaris bicolor*
Black-necked Stilt	*Himantopus mexicanus*
Blackpoll	*Dendroica striata*
Black-throated Blue Warbler	*Dendroica caerulescens*
Black-throated Green Warbler	*Dendroica virens*
Black-whiskered Vireo	*Vireo altiloquus*
Blue-gray Gnatcatcher	*Polioptila caerulea*
Bobolink	*Dolichonyx oryzivorous*
Brown Pelican	*Pelecanus occidentalis*
Cape May Warbler	*Dendroica tigrina*
Cattle Egret	*Bubulcus ibis*
Clapper Rail	*Rallus longirostris*
Common Ground-Dove	*Columbina passerina*
Common Moorhen	*Gallinula chloropus*
Common Yellowthroat	*Geothlypsis trichas*
Crescent-eyed Pewee	*Contupus caribaeus*
Cuban Emerald	*Chlorostilbon ricordii*
Double-crested Cormorant	*Phalacrocorax brasilianus*
Eurasian Collared-Dove	*Streptopelia decaocto*
Glossy Ibis	*Plegadis falcinellus*
Gray Catbird	*??*
Gray Kingbird	*Tyrannus dominicensis*
Gray-cheeked Thrush	*Catharus minimus*
Great Blue Heron	*Ardea herodias*
Great Egret	*Ardea alba*
Great Lizard Cuckoo	*Saurothera merlini*
Greater Antillean Bullfinch	*Loxigilla violacea*
Greater Antillean Oriole	*Icterus domincensis*
Green Heron	*Butorides virescens*
Hairy Woodpecker	*Picoided villosus*
Indigo Bunting	*Passerina cyanea*
Kestrel	*Falco sparverius*
Key West Quail-Dove	*Geotrygon chrysia*
Killdeer	*Charadrius vociferus*
Kirtland's Warbler	*Dendroica kirtlandii*

Species	Scientific name
La Sagre's Flycatcher	*Myiarchus sagrae*
Laughing Gull	*Larus atricilla*
Least Grebe	*Tachybaptus dominicus*
Least Tern	*Sterna antillarum*
Little Blue Heron	*Egretta caerulea*
Loggerhead Kingbird	*Tyrannus cubensis*
Magnificant Frigatebird	*Fregata magnificens*
Mangrove Cuckoo	*Coccyzus minor*
Mourning Dove	*Zenaida macroura*
Northern Bobwhite	*Colinus virginianus*
Northern Mockingbird	*Mimus polyglottos*
Northern Parula	*Parula americana*
Northern Waterthrush	*Seiurus novaboracensis*
Osprey	*Pandion haliaetus*
Ovenbird	*Seiurus aurocapilla*
Palm Warbler	*Dendroica palmarum*
Pine Warbler	*Dendroica pinus*
Piping Plover	*Charadrius melodus*
Prairie Warbler	*Dendroica discolor*
Reddish Egret	*Egretta rufescens*
Red-Legged Thrush	*Turdus plumbeus*
Red-tailed Hawk	*Buteo jamaicensis*
Red-winged Blackbird	*Agelaius phoeniceus*
Royal Tern	*Sterna maxima*
Ruddy Turnstone	*Arenaria interpres*
Sanderling	*Calidris alba*
Scarlet Tanager	*Piranga olivaea*
Semipalmated Plover	*Charadrius semipalmatus*
Smooth-billed Ani	*Crotophaga ani*
Snowy Egret	*Egretta thula*
Solitary Sandpiper	*Tringa solitaria*
Spotted Sandpiper	*Actitis macularia*
Swainson's Thrush	*Catharus ustulatus*
Thick-billed Vireo	*Vireo crassirostris*
Tricolored Heron	*Egretta tricolor*
Turkey Vulture	*Cathartes aura*
Veery	*Catharus fuscescens*
West Indian Whistling-Duck	*Dendrocygna arborea*
Western Spindalis	*Spindalis zena*
White Ibis	*Eudocimus albus*
White-crowned Pigeon	*Patagioenas leucocephala*
Willet	*Catoptrophorus semipalmatus*
Wilson's Plover	*Charadrius wilsonia*
Wood Thrush	*Hylocichla mustelina*
Yellow Warbler	*Dendroica petechia*
Yellow-bellied Sapsucker	*Sphyrapicus varius*
Yellow-crowned Night-Heron	*Nyctanassa violacea*
Zenaida Dove	*Zenaida aurita*