

**THE BIRDS OF DOLPHIN HEAD
AND THE EFFECTS OF HABITAT MODIFICATIONS
ON THEIR POPULATIONS**

**A Report on the Status of Avian Diversity, Dolphin Head Environs
for
BirdLife Jamaica
Dolphin Head Trust
United Nations Development Programme**

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29 August 2001

EXECUTIVE SUMMARY

Bird species composition and habitat associations were examined in the Dolphin Head environs during January-February (winter) and May-June (summer) of 2001. The area supported a rich community, including 21 of Jamaica's 28 endemic species, 23 of 70 resident breeding landbirds and 11 migratory species (9 wintering Neotropical and 2 summer breeding species). The richest avian communities were found within (a) broadleaf forest that was disturbed by either road or regenerating forest clearing at the break of hillslope; (b) broadleaf forest that was moderately disturbed with a network of trails; and (c) active farms that included mixed fruit trees. Species composition, however, differed among these habitat types, with larger birds, such as the resident White-crowned Pigeon, endemic Ring-tailed Pigeon and endemic Jamaican Woodpecker, being restricted to closed-canopy forested habitat. Other forest-dependent species included the endemic Jamaican Elaenia, the endemic Arrow-headed Warbler, and three species of wintering Neotropical migrants.

One of the recognized major threats to the biological diversity of Dolphin Head is the clearing of natural forest for marijuana production. Hilltops cleared for such purpose were used by only 7 endemic, 9 resident and 1 migratory species. Abandoned hilltops were dominated by non-native ferns and, consequently, presented little attraction for seed dispersers and pollinators. Habitats dominated by non-native plant species had the greatest negative effect on avian richness and abundance. In areas dominated by either Bamboo, Red Bead Tree, or Rose Apple, only 3 endemic, 4 resident, and 2 migrant species were recorded; all the bird species occurring in these patches are commonly associated with heavily degraded forest and urban habitats.

In order to preserve Dolphin Head as the important habitat it represents for Jamaica's endemic, native and migratory birds, management should be directed towards:

- (1) Preventing further clearing of natural forest to maintain the largest possible area of closed-canopy habitat for forest-dependent bird species; this strategy will serve further to protect endemic plants which depend upon birds for seed dispersal and pollination.
- (2) Restore degraded hilltops that are dominated by non-native, invasive plant species to prevent further encroachment into core forested areas; natural forest regeneration appears hindered in the absence of human intervention.

(3) Rehabilitate peripheral rural hillsides, notably those dominated by Bamboo, with forestry plantation and mixed-fruit tree species; this activity will provide viable habitat for resident and migrant bird species as well as provide long-term economic benefit from resource harvesting.

ACKNOWLEDGEMENTS

I would like to thank all of the community members in the Dolphin Head Area for their support in conserving this extraordinary landscape. In particular, I would like to thank Miss Norma Samuels for her wonderful hospitality and for providing history of the Askenish area. Thanks also to "Toots," Jennifer, "Boogie," Leisha, Chris, and Mr. Jack Samuels for the many hours I kept them from their work as we talked about The Dolphin. In Askenish, "Boxer," "Bones," and Peter assisted with locating trails and conducting surveys, while in Retirement "Joe" Samuel and Phillip assisted with trail surveys. Mr. Glen Ivey (Forestry Department) provided information on the activities being conducted in the Forest Reserves. I would also like to thank the Trees for Tomorrow Biophysical Survey Team (Forestry Department and CIDA sponsorship), led by Messrs. Grant and Boswell, and Dr. George Proctor for assistance in plant identification. And finally, to Paula Hurlock for her work and dedication to Dolphin Head.

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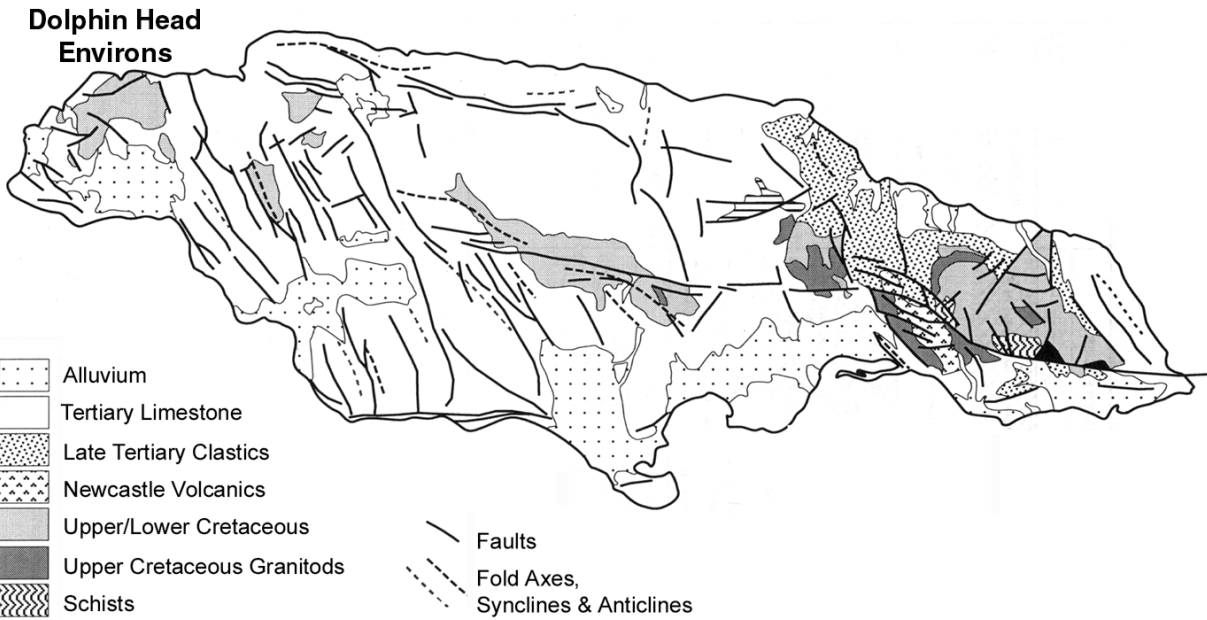
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1. INTRODUCTION

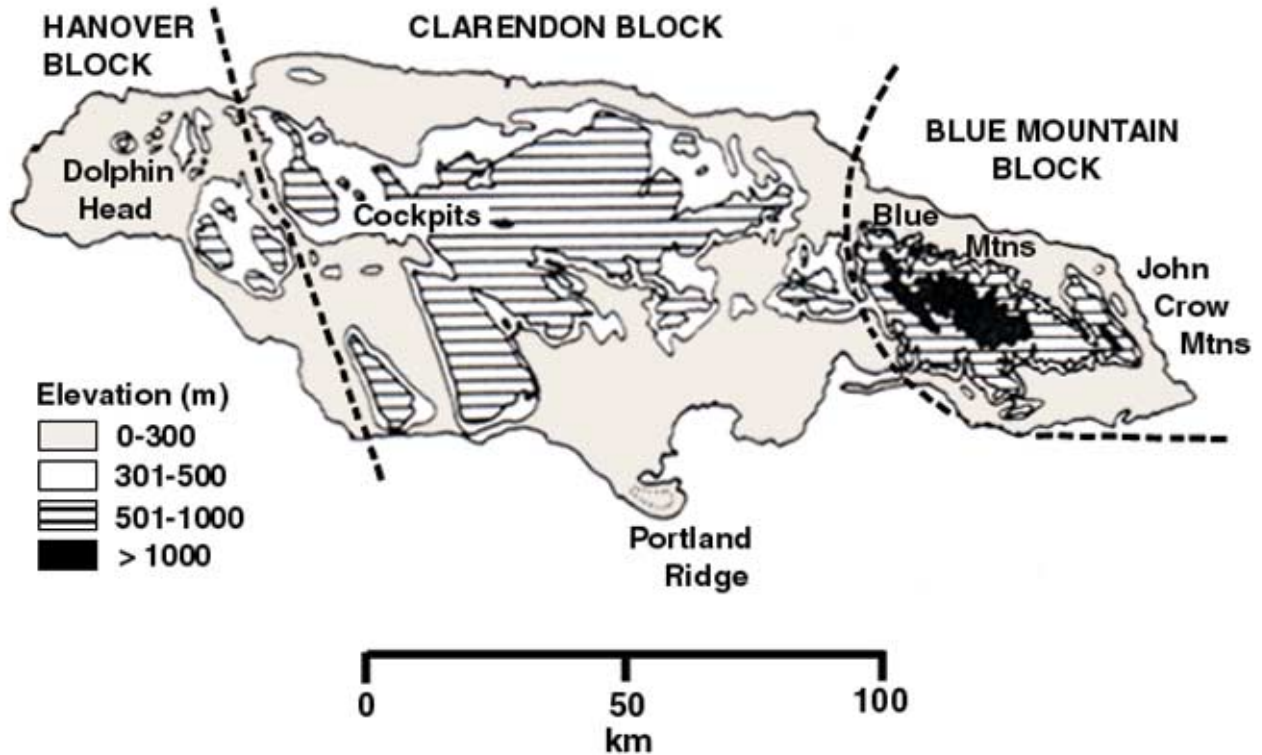
While Jamaica is only the third largest island in the Caribbean -- Cuba and Hispaniola, respectively are 10 and 7 times larger --, it supports the richest endemic avifauna in the region, with 29 species (including 5 genera) found nowhere else in the world. The majority of Jamaica's endemic birds rely on natural forest, with over 60 percent being absent from disturbed, open areas. Their dependence upon forest is of significant concern because approximately 70 percent of Jamaica's natural vegetation has been cleared for agriculture, urban, and industrial development. The 30 percent of forest remaining are disturbed and degraded and only about 8 percent of the island remains as natural forest showing little evidence of human disturbance (National Forest Management and Conservation Plan 2001). The result of human destruction of the environment is a highly fragmented landscape, with the remnant natural forest patches serving as refugia for much of Jamaica's endemic biological diversity as well as providing important habitat for native resident and migratory species. The effects of habitat loss, fragmentation, and degradation on animal and plant populations have become an increasingly important concern, particularly in the insular Caribbean, which is acknowledged as a biodiversity "hotspot" because of the high levels of endemism coupled with high levels of threats, including continuing deforestation and introductions of non-native invasive species (Myers *et al.* 2000).

The main types of remaining natural forest in Jamaica are dry limestone forest in the southern lowlands, moist mesic limestone forest in Dolphin Head, Cockpit Country, and Mount Diablo, wet limestone forest in John Crow Mountains, and wet montane forest on non-calcareous shales in Blue Mountains (Lack 1976). Although the forest of Dolphin Head falls into the category of and is similar in structure to the forests of Cockpit Country, the limestone forest of Dolphin Head is surrounded by shale and alluvium (Figure 1a) and probably always has experienced a degree of isolation from the central limestone forested plateau of Jamaica, either as Jamaica slowly emerged from the ocean 10-15 million years ago (Figure 1b) or more recently as humans have modified the surrounding landscape to create an "island within an island." The geologic discontinuity of Dolphin Head most certainly facilitated the evolution of species uniquely adapted to survive in a rugged limestone environment with punctuated drought-like conditions.

1a



1b



Figures 1a & 1b. Geologic and topographic maps of Jamaica highlighting the geologic discontinuity of Dolphin Head environs (limestone cap surrounded by shale and alluvium; 1a) and the three structural blocks that form the island (1b). As Jamaica was uplifted from the ocean 25 million years ago, the white limestone of north central Jamaica was the first land to emerge. The Blue Mountain Block soon followed, but was an island separated by the Wagwater Trough. Extreme western Jamaica (Hanover Block) is thought to have initially been a third island separated by the Montpelier-Newmarket graben. As uplift continued, these islands coalesced to the present configuration, although not until the late Miocene (8MYA). Thus, some of the flora and fauna of Dolphin Head may have evolved in relative isolation for up to 10-15 million years. Maps adapted from Fincham (1997) and Hedges (1989).

Dolphin Head, indeed, is recognized as hosting the highest density of endemic plant species and rare or threatened species per unit area for Jamaica. At present, 410 vascular plant species have been identified in the peripheral forest, 115 of which are endemic to Jamaica and 21 of which are restricted to Dolphin Head (Proctor pers. comm.) The core interior forest remains to be surveyed and will undoubtedly result in an even higher species total. Because of its extraordinary plant diversity, Dolphin Head has been identified as a high priority candidate protected area. Protecting the floral component of Dolphin Head will protect wildlife habitat. Protecting wildlife ensures that pollinators and seed dispersers will be present to assist in maintaining the vegetation, including many of the endemic plant species. In this simplistic view, an interactive, healthy ecosystem is preserved. It is critical, therefore, to identify the specific sources of stress to the Dolphin Head ecosystem and understand how these sources disrupt the natural processes that maintain this nationally and globally unique ecosystem. Underlying this need is the recognition that plant and animal species are not distributed evenly, both spatially and temporally, and distinguishing natural distribution patterns from human-mediated patterns is important.

In this paper I report on the avifauna of Dolphin Head. The primary goal was to examine the effects of human-related habitat modifications on avian communities. It was, therefore, first necessary to quantify species composition and abundance of resident and migratory birds in order to compare these indices among habitats, which were defined with respect to landuse and forest cover. It was also necessary to examine seasonal effects associated with turnover in migratory species and altitudinal migrations of resident breeding birds. Secondary objectives were to identify important areas for the species most sensitive to disturbance of the natural forest and to identify habitat patches within the environment that have negative effects on avifauna and which may require management interventions to promote forest regeneration.

2. METHODS

2.1 Study area

The study was conducted in the Dolphin Head environs of the parishes of Hanover and Westmoreland, western Jamaica (Figure 2). A core area, consisting of two Forest Reserves (Raglan Mtn. and Bath Mtn.), Crown Lands managed by the Forestry Department, and privately

owned lands, support natural, closed- and disturbed broadleaf forests, which are further classified as moist mesic limestone forest. Surrounding this core is a mosaic of mixed-

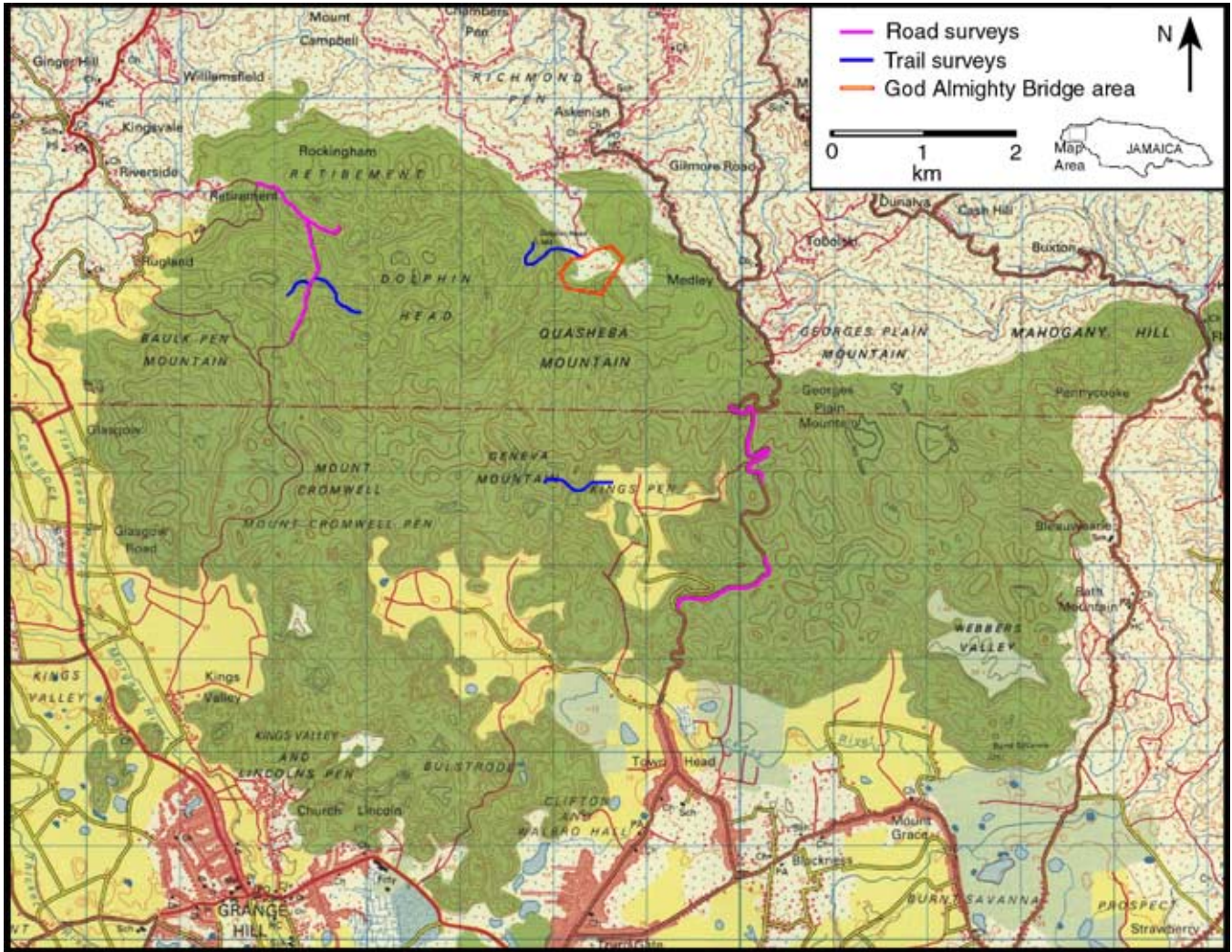


Figure 2. Dolphin Head study area and locations of fixed-radius point count survey lines, Hanover and Westmoreland, Jamaica.

and non-forest land use, including disturbed broadleaf forest and plantations, bamboo *Bambusa vulgaris*, sugarcane plantations, pasture, small family farm plots of yam, banana, and fruit trees, and rural communities. The remnant forest has been depleted for more than 300 years by the harvesting of valuable timber species and for fuelwood associated with sugarcane and slate lime production (N. Samuels pers. comm). Illegal timber harvesting and clearing of hilltops for marijuana *Cannabis sativa* cultivation continues within the Forest Reserves and on private lands. This latter activity facilitates the invasion of non-native plant species, which hinder natural forest regeneration. While botanists consider much of the forest to be affected by human activities (historic and present), it is believed that most plant species are present as young source stock (G. Proctor pers. comm).

2.2 Habitat structure

This study was conducted in conjunction with a biophysical survey undertaken by the Forestry Department (FD), Jamaica, with support from the Canadian International Development Agency (CIDA)-funded Trees for Tomorrow Project. Forestry Department established transects within the major land use/cover type classifications of the Dolphin Head area (Figure 2). Rectangular plots measuring 25 m x 20 m were demarcated at 100 m intervals along each transect and surveyed for a number of biotic and abiotic variables, including tree species composition and soil type (see Biophysical Inventory Manual, FD 2000). Slight modification was made to the FD classification to enable greater distinction among human-related alteration patterns (i.e. to determine the effects of variable human-related disturbance on bird communities). Six different habitats were identified as follows:

1. Closed broadleaf of moderate disturbance; if accessed by trail, canopy cover > 80% over trail
2. Disturbed broadleaf -- open canopy over access road or at break of slope (e.g., as when drainage bottoms or sinks are cleared while adjacent hillsides are left forested)
3. Disturbed broadleaf -- open canopy on hilltop, slopes under forest cover
4. Disturbed broadleaf and plantations of blue mahoe *Hibiscus elatus*

5. Dominated by non-native plant species (i.e. > 75% plant biomass identified as non-native and invasive, notably bamboo, red bead *Adenantha pavonina*, rose apple *Syzygium jambos*)
6. Active farm (e.g., yam, banana, fruit trees) adjacent to closed-canopy forest

A distinction was made between disturbance patterns (2) and (3) because of observed differences in forest regeneration on hilltops that had been cleared when compared to cleared sinks, valleys and roads. Cleared hilltops will have greater exposure to direct solar radiation and wind and possibly experience greater changes in microclimate in the absence of canopy cover compared to small sinks and valleys, which receive shading from adjacent hillsides. A low-lying cleared area may also be in a better position to intercept pollinators and seed-dispersing fauna because of its relationship to forest edge. Other factors of tropical karst limestone, such as how topography influences soil condition (e.g., acidic humus on hilltops, alkaline soils in valleys) and hydrology, may also be relevant (Vermeulen and Whitten 1999). While examining these factors was beyond the scope of this study, the preference of marijuana farmers to clear hilltops required a baseline assessment of how this might affect bird populations.

2.3 Bird censuses

Surveys were conducted during the periods of 17 January - 6 February, 15 - 30 May, and 12-14 June. These periods corresponded to the winter/dry season, when the majority of resident species were not engaged in breeding activities and Neotropical migrant species were present, and the summer/wet season, when resident and summer migrant birds were breeding. Birds were counted using the fixed-radius point count censusing technique of Hutto *et al.* (1986). All birds seen or heard within a radius of 25 m were recorded during a 10-min period at each point (see Wunderle *et al.* 1992, Wunderle 1994). The size of the radius was selected based on several pilot surveys conducted in the dense, closed-canopy habitat in which the distance of birds (detected visually and aurally) was estimated in conjunction with a 50 m measuring tape placed on the ground. Beyond 25 m, cryptic birds and those with soft or high frequency calls were difficult to detect, particularly canopy-dwelling species.

Bird surveys were conducted during early morning and late afternoon hours. Counts initiated at sunrise were terminated after three hours of sampling, the time when avian activity (e.g., dawn

chorus and first feeding of the day) noticeably decreased. Afternoon sessions were initiated 3 hours before sunset and were terminated 30 minutes before sunset as ambient light conditions became poor. Each point was at least 100 m from all others. Surveys were conducted within vegetation plots established by the Forestry Department as well as along existing roads and trails to obtain a minimum of four point counts for each habitat type. A total of 106 points were surveyed during the study period (Table 1).

Table 1. Number of fixed-radius point counts completed in each habitat of Dolphin Head environs, Jan - June 2001. The greater number of summer points in Habitat 2 resulted from an added survey along the road between Askenish and Frome, where there is increasing forest clearance by the owner of Mahogany Estate, and, consequently, a need for baseline survey data.

Habitat Type	Survey Period	
	Winter	Summer
1. Closed broadleaf	18	18
2. Disturbed broadleaf		
Road or open canopy at base of hill	11	21
3. Disturbed broadleaf		
Open canopy on hilltop	4	4
4. Forestry plantation	4	4
5. Non-native, invasive monoculture	5	5
6. Active farm	6	6
Total	48	58

Indices were calculated to compare differences in (1) the mean number of species and (2) the mean abundance of individuals (species data pooled) among the six habitat types. Birds were segregated by their status as either resident or migratory. An exploratory analysis of variance (ANOVA) was performed to examine the relationships between each index and habitat type by season. However, the low numbers of point counts in Habitats 3, 4, 5, and 6 (Table 1) restricted comparisons with Habitats 1 and 2. Consequently, analyses of the effects of habitat type and season on bird communities were limited to pairwise comparisons with a Student's *t*-test or, when data were not normally distributed, with Mann-Whitney *U*-test. Migratory species were excluded from between-season comparisons because the potential source-pool/number of migratory species and their diet preferences/foraging strategies differed between winter and summer. To compare seasonal changes in presence and abundance of resident species within each habitat, the mean number of detections was calculated for each species and tested with a

Student's *t*-test, except for Habitats 1 and 2, where ANOVA was used to examine habitat by season effects.

Data of 45 species were analyzed in detail for this report (Table 2). An additional six species were recorded in the point counts but these were excluded from the analyses because they either occurred at too few points (Lizard Cuckoo *Saurothera vitula*, Becard *Pachyramphus niger*, White-eyed Thrush *Turdus jamaicensis*, Ovenbird *Seiurus aurocapillus*) or their soaring and foraging activities occurred over multiple habitat types (Turkey Vulture *Cathartes aura*, Red-tailed Hawk *Buteo jamaicensis*). These birds, however, along with species observed outside the period of point count survey sessions, were included in a species composition list for the entire study area (Appendix 1). Notes on habitat association and breeding biology (e.g., location of nest, fledglings begging from adults) were recorded *ad libitum*. A total of 57 bird species, including 21 island-endemics, were recorded in the Dolphin Head environs.

Table 2. Summary total of bird species detected in Dolphin Head environs, Jan - June 2001. Abundance data were included for analysis when the species was detected in a minimum of three fixed-radius point counts.

Species status	No. included in analyses	No. observed in the area
Endemic	17	21
Resident	19	23
Introduced resident	1	1
Natural range expansion	1	1
Summer migrant	2	2
Winter migrant	5	9
Total	45	57

All analyses were done using SYSTAT 5.0 (Wilkinson 1989). A probability of type I error (alpha) of 0.05 was accepted as significant, although greater values were presented in the text for descriptive purposes. Throughout this report, standard error is used to describe variation around the mean. Birds were identified using *A guide to the birds of the West Indies* (Raffaele *et al.* 1998), *Field guide to the birds of North America* (National Geographic Society 1987), and *Bird songs in Jamaica* (Reynard and Sutton 2000).

3. RESULTS

3.1 Resident species

Among resident bird species, the mean number of species and the mean number of individuals detected per point count did not differ significantly among the habitats during the winter survey period (Table 3). A pattern that open hilltops (Habitat 3) and monocultures of non-native plant species (Habitat 5) supported less avian diversity and fewer individuals was not confirmed as statistical power was low because of the small number of point counts in Habitats 3, 4, 5 and 6. Because of the variance associated with the mean number of species per point count, a minimum 15-20 points would be required per habitat type to increase the confidence level of the analyses to detect differences where they exist.

During the summer surveys, areas dominated by non-native invasive plants (Habitat 5) had significantly fewer individuals per point count compared with each of the other habitat types ($P < 0.05$); the lesser number of species per point count in Habitat 5 was nearly significant ($P < 0.06$) (Table 3). Excluding Habitat 5, there were no significant differences in the mean number of species among the other habitats. However, as with the winter survey, there was a marginally significant trend for a greater number of species to be detected per point count in the disturbed broadleaf/open canopy of Habitat 2 than in the closed broadleaf Habitat 1, which showed less structural diversity in the understory (e.g., less herbaceous ground cover) ($t = 2.08$; $df = 17$, $P = 0.06$; Table 3). The comparison of Habitat 1 to the farm environment of Habitat 6, which showed a similar number of individuals to Habitat 2, was hindered by the low sample size of Habitat 6.

Seasonally, the number of species detected within each habitat was the same. Despite the fact that resident birds were engaged in breeding activities during the summer surveys (e.g., nests were observed as well as fledglings) and, consequently greater numbers of individuals would be expected as young birds fledge from the nest, the mean abundance of individuals per point count was not significantly different between the winter and summer surveys for each habitat type.

While the mean number of species per point count was not significantly different among the majority of habitat types (the exception being fewer species in Habitat 5 during the summer survey), species composition varied among habitats (Table 4). Areas dominated by non-native

plant species (Habitat 5) supported very low bird diversity. Had this habitat been further divided by plant species, diversity would have been even lower per site. For example, in point counts dominated by bamboo, only Yellow-faced grassquits *Tiaris olivacea* and Black-faced grassquits *Tiaris bicolor* were observed within the bamboo. Cave swallows *Pterochelidon fulva*

Table 3. Mean (\pm SE) number of individuals and total number of species in fixed-radius point counts in six habitats of Dolphin Head, Jan-June 2001. Comparison of seasonal changes in abundance and number, by habitat, was made only of resident species. Non-native, invasive monocultures were dominated (e.g., >75%) by Bamboo *Bambusa vulgaris*, Red Bead Tree *Adenanthera pavonina*, or Rose Apple *Syzygium jambos*.

Habitat	Winter/Dry season				Summer/Wet season			
	Indiv. per point count		No. of species		Indiv. per point count		No. of species	
	Resident	Migrant	Resident	Migrant	Resident	Migrant	Resident	Migrant
1. Closed broadleaf	8.9 + 0.8	0.7 + 0.3 ^a	6.6 + 0.5	0.5 + 0.2	8.2 + 1.0 ^{e,f}	1.0 + 0.2	6.7 + 0.7 ^g	0.9 + 0.1 ^h
2. Disturbed broadleaf Road or open canopy base of hill	10.6 + 1.0	1.5 + 0.3 ^{a,b,c}	8.2 + 0.7	1.4 + 0.3 ^d	10.5 + 1.1 ^{e,f}	1.8 + 0.2	8.0 + 0.8 ^g	1.1 + 0.1 ⁱ
3. Disturbed broadleaf Open canopy hilltop	6.3 \pm 2.9	0.0 + 0.0 ^b	5.3 + 2.0	0.0 + 0.0 ^d	8.8 + 4.2 ^f	2.2 + 0.6	6.3 + 2.6 ^g	1.6 + 0.2 ^{h,i}
4. Forestry plantation	9.5 + 0.5	1.0 + 1.0	7.0 + 0.3	1.0 + 0.6	8.8 + 3.2 ^f	1.8 + 0.3	6.3 + 1.8 ^g	1.3 + 0.3
5. Non-native, invasive monoculture	7.0 + 1.0	1.0 + 1.0	4.5 + 0.5	0.5 + 0.3	3.0 + 1.4 ^f	1.5 + 0.3	3.0 + 1.0 ^g	1.4 + 0.3
6. Active farm	14.0 + 5.5	0.3 + 0.3 ^c	6.7 + 1.8	0.2 + 0.2	10.8 + 1.6 ^f	1.8 + 0.4	7.4 + 0.3 ^g	1.4 + 0.2

^a $P = 0.09$

^b $P = 0.07$

^c $P = 0.09$

^d $P = 0.07$

^e $P = 0.06$

^fHabitat 5 less than each other habitat $P < 0.05$

^gHabitat 5 less than each other habitat $P < 0.06$

^h $P = 0.02$

ⁱ $P = 0.07$

Table 4. Habitats in which endemic (E), resident (R), introduced (I), natural range expansion (N) and migrant (WM-winter; SM-summer) bird species were detected in Dolphin Head, Jan-June 2001. Each bar represents a minimum of three detection events. Diet classifications from Lack (1976) and from personal observations: AI=aerial insectivore; AIV=aerial insectivore+vertebrates; LI=leaf-gleaning insectivore; BI=bark/twig-gleaning insectivore; GI=ground-level insectivore; N=nectarivore; F=frugivore; G=granivore; O=omnivore (seeds, nectar, fruits and insects).

Family	Common Name	Status	Diet	Habitat Type							
				1	2	3	4	5	6		
ARDEIDAE	Cattle Egret	N	GI								
FALCONIDAE	American Kestrel	R	AIV								
COLUMBIDAE	White-crowned Pigeon	R	F								
	Ring-tailed Pigeon	E	F								
	Zenaida Dove	R	G								
	Common Ground-Dove	R	G								
	Caribbean Dove	R	G								
	Ruddy Quail Dove	R	O								
PSITTACIDAE	Olive-throated Parakeet	E	O								
	Green-rumped Parrotlet	I	G								
APODIDAE	Antillean Palm Swift	R	AI								
TROCHILIDAE	Jamaican Mango	E	N								
	Red-billed Streamertail	E	N								
	Vervain Hummingbird	R	N								
TODIDAE	Jamaican Tody	E	LI								
PICIDAE	Jamaican Woodpecker	E	BI								
TYRANNIDAE	Jamaican Elaenia	E	AI								
	Greater Antillean Elaenia	R	O								
	Jamaican Pewee	E	AI								
	Sad Flycatcher	E	AI								
	Rufous-tailed Flycatcher	E	AI								
	Stolid Flycatcher	R	AI								
	Gray Kingbird	SM	AI								
	Loggerhead Kingbird	R	AI								
HIRUNDINIDAE	Cave Swallow	R	AI								
MUSCICAPIDAE	Rufous-throated Solitaire	R	O								
	White-chinned Thrush	E	O								
MIMIDAE	Northern Mockingbird	R	O								
VIREONIDAE	Jamaican Vireo	E	LI								
	Black-whiskered Vireo	SM	O								
EMBERIZIDAE	Northern Parula	WM	LI								
	Black-throated Blue Warbler	WM	O								
	Arrow-headed Warbler	E	LI								
	Black-and-white Warbler	WM	BI								
	American Redstart	WM	LI								
	Common Yellowthroat	WM	LI								
	Bananaquit	R	N								
	Jamaican Euphonia	E	F								
	Jamaican Stripe-headed Tanager	E	F								
	Yellow-faced Grassquit	R	G								
	Black-faced Grassquit	R	G								
	Yellow-shouldered Grassquit	E	G								
	Greater Antillean Bullfinch	R	F								
	Orangequit	E	N,F								
	Jamaican Oriole	R	BI								
Total number of endemic species				15	17	7	8	3	14		
Total number of resident species				9	17	9	8	4	14		
Total number of migrant species				5	7	1	4	2	4		
Total number of species				29	41	17	20	9	32		

were observed foraging for insects aerially, so their association with this habitat type was weak. The composition of bird species occurring on cleared hilltops similarly was dominated by the smaller species of aerial insectivores, several small frugivores and the ubiquitous endemic Red-billed Streamertail *Trochilus polytmus*.

Habitat 1 (closed forest) and Habitat 6 (farm) were nearly identical in the number of endemic, resident, and migrant species detected, but there were several important differences in species composition (Table 4). The farm habitats supported nearly all species of aerial (flycatching) insectivores and the small, granivorous grassquits and introduced Green-rumped Parrotlet *Forpus passerinus*. Although small flocks (2-6 birds) of this latter species were observed in-flight over disturbed forest habitats, they were not observed using forested areas for food or shelter. Notably absent from farm habitat and, indeed, from the heavily modified, open-canopy habitats 3 and 5, were the large, frugivorous Columbidae pigeons (Table 5). The endemic Jamaican Woodpecker *Melanerpes jamaicensis*, Jamaican Elaenia *Elaenia fallax*, and Arrow-headed Warbler *Dendroica phareta* also demonstrated strong forest-dependence and avoided flying across open expanses.

Table 5. Birds of Dolphin Head demonstrating the strongest closed-canopy forest dependence. Species are recognized as resident (R), endemic (E), or wintering Neotropical migrant (WM). No introduced or natural range expansion species were detected within natural forest. Habitat included closed-canopy broadleaf (1), disturbed broadleaf with road or open canopy at break of slope (2), disturbed broadleaf with open canopy on hilltop (3), forestry plantation (4), non-native monoculture (5), and mixed-fruit tree farm (6).

Family	Common Name	Status	Habitat Type					
			1	2	3	4	5	6
COLUMBIDAE	White-crowned Pigeon	R	■	■	■	■		
	Ring-tailed Pigeon	E	■	■	■	■		
PICIDAE	Jamaican Woodpecker	E	■	■	■	■		
TYRANNIDAE	Jamaican Elaenia	E	■	■	■	■		
MUSCICAPIDAE	Rufous-throated Solitaire	R	■	■	■	■		
EMBERIZIDAE	Northern Parula	WM		■				
	Arrow-headed Warbler	E		■				
	Black-and-white Warbler	WM	■	■	■	■		
	Common Yellowthroat	WM	■	■	■	■		

Several resident and endemic species demonstrated seasonal differences in their use of habitats. The most distinctive was the White-crowned Pigeon *Columba leucocephala*, which was rare in the winter months (4 detections within Habitats 1 and 2) but abundant in summer (47 detections; $F = 35.72$, $df_{1,28}$, $P < 0.001$). Few individuals were observed in flight during the winter, in marked contrast to summer. Consequently, it was assumed that the population migrated from lower elevation, wintering grounds rather than it being present but not detected in the winter. The Caribbean Dove *Leptotila jamaicensis*, similarly, was detected in greater abundance in Habitats 1 and 2 in the summer than in the winter (mean winter abundance per point count = 0.06 ± 0.31 vs. summer 0.47 ± 0.52 ; $F = 5.928$, $df_{1,28}$, $P < 0.02$), while the Ruddy Quail Dove *Geotrygon montana* was marginally more abundant in the summer in these habitats (winter abundance per point count = 0.18 ± 0.48 vs. summer 0.46 ± 0.44 ; $F = 3.635$, $df_{1,28}$, $P < 0.06$). Additionally, the Ruddy Quail Dove expanded its use of habitat to include the forest edge of cleared hilltops (Habitat 3) and mixed forest/mahoe plantations (Habitat 4) in the summer. The Jamaican Euphonia *Euphonia jamaica* displayed a similar expansion to use habitats 3 and 4 in the summer while showing no significant seasonal differences in its mean abundances within habitats 1, 2 and 6. For all other resident species, no seasonal variation in abundance was detected across habitat types or, at best, variation occurred in only one habitat.

3.2 Migrant species

Among winter Neotropical migrant species, there was a trend that species were detected more often in the disturbed broadleaf/edge environment of Habitat 2, which represented the most structurally-diverse habitat (i.e., dense understory, herbaceous groundcover) (Tables 3). No winter migrants were observed or heard in the most open habitat, the cleared hilltop (Habitat 3) and only one species occurred in the monoculture Habitat 5 (Tables 3 & 4). Three species demonstrated a strong pattern of forest-dependence (Table 5). However, because of the low number of point counts in each habitat type, with perhaps the exceptions of Habitat 1 and Habitat 2, the statistical power to detect significant differences among habitat types was poor. With the largest standard deviation from a mean score equal to 1.4, a minimum of 15 point counts per habitat type would improve the confidence of the analyses.

The two summer migrant species were detected in all habitat types (Table 3). In contrast to the winter migrants, cleared hilltops (Habitat 3) were used, although only by the Grey Kingbird

Tyrannus dominicensis. Black-whiskered Vireos *Vireo altiloquus* were detected in all habitats except Habitat 3 (Table 4). Although the number of bird species in Habitat 3 was greater than in Habitat 1 ($P = 0.02$), this significance applies solely to the Grey Kingbird, which hunts from exposed perches (e.g., bare treetops, telephone lines).

4. DISCUSSION

The forests and surrounding human-modified habitats of Dolphin Head support a diverse avian community, which includes 21 of Jamaica's 29 (72%) endemic species, 23 native resident species and 11 migratory species. These species differ in their distributions, both spatially and temporally. Consequently, the value of the habitat types found in Dolphin Head varies among species. While some species benefit from human modifications to the forest and landscape structure, others demonstrate greater sensitivity to degradation, fragmentation, and loss of natural forest cover. The results of this research reveal the importance of distinguishing not only the type of human modification but also the location of the disturbance in relation to forest cover in seeking to understand how habitat change affects species. It further reveals the need to identify and protect habitat that is not occupied year-round by many species.

Recognizing that the results will be interpreted with greater confidence with repeat surveys and increased number of sample points in the heavily-modified habitats, the salient trends warrant attention. As habitats became more homogenous, both in terms of plant species composition and structure, avian diversity decreased. Monoculture stands of non-native bamboo, red bead, and rose apple (Habitat 5) hosted the lowest mean number of resident species and abundances of individuals (Table 3). Perhaps more notable, species richness was 4 - 5 times lower across all classes of birds (endemics, residents and migrants) compared with the heterogeneous environment of broadleaf forest with road disturbance or clearing in small valleys (Habitat 2) and 2 - 3 times lower compared to moderately disturbed forest (Habitat 1) and active farms (Habitat 6) (Table 4). It was clear that food resources in Habitat 6 were highly seasonal for the granivorous Yellow-faced- and Black-faced grassquits and the nectar-feeding Red-billed Streamertail, bird species which occur commonly in heavily modified environments across Jamaica. In a concurrent study by the author of invertebrate diversity within the Dolphin Head

study area, leaf-litter invertebrate diversity and abundance was similarly very poor in Habitat 6, suggesting that food availability for insectivorous birds may have been limited.

In comparison to all other habitat types, monoculture stands of non-native plants must be considered biologically sterile environments. This was particularly salient in the plots dominated by rose apple, which were located on the Samuel's property in Askenish in an area known as "God Almighty Bridge" (Figure 2). A series of springs emerge and resubmerge to create a small area of cockpit-type sinks. Avian diversity was poor in plots where rose apple represented nearly 100% of the vegetative biomass. However, as the area was traversed to the forested edge on the eastern boundary of the drainage system and native plant species became dominant, avian diversity and abundance increased. Inadequate sample sizes precluded statistical analysis but it was within this microhabitat that the sole Northern Waterthrush *Seiurus noveboracensis* was detected, and only where rose apple composed < 50% of the vegetative cover.

Within the broadleaf forests, the effects of disturbance varied considerably. Clearing of hilltops (Habitat 3) had the greatest negative effect on species composition and abundance (Tables 3 and 4). This clearing location is preferred for marijuana cultivation because of the direct sunlight and good soil formation, in contrast to hillsides with little soil formation or low-lying areas where sunlight is restricted. Of the four hilltops that were assessed, one was under cultivation while the other three had been abandoned for at least 10 years (Anonymous, pers. comm.). The abandoned hilltops were dominated by the non-native fern *Nephrolepis multiflora* and lantana *Lantana* spp. and had one or two fire-burned snags. These patches showed low usage by both endemic and migratory birds (Table 4). With the exception of aerial hunters that perched on the snags (American Kestrel and Grey Kingbird), use of this habitat by other birds was restricted almost exclusively to the well-defined forest edge. Natural regeneration of these hilltops may be limited in the absence of human mitigation, particularly if the present vegetation either fails to attract seed-dispersing wildlife or competitively excludes native plant species.

In contrast, when clearing for marijuana cultivation occurred in low-lying areas of the closed broadleaf forest or when the forest canopy was kept open because of a road (that is, a gap was

created, but unlike on hilltops, the gap was bounded by forest), avian diversity increased. This type of disturbance may even be seen as beneficial to bird diversity because of the regeneration of early succession herbaceous ground cover and understory, which supported the granivores and small frugivores, and by the maintenance of open gaps which are preferred by the larger species of aerial (flycatching) insectivores. The adjacent closed-canopy forest supported the smaller aerial insectivores, many of which are endemic to Jamaica, and the larger frugivorous Columbids, which were restricted in their habitat use to closed and minimally-open canopy. Unfortunately, while the presence of a road, such as that from Askenish to Frome, may have no effect or, in fact, may enhance bird species diversity, this type of habitat modification of the environment facilitates the movement of humans, who engage in activities that will cause significant damage to biodiversity, including clearing of hilltops for marijuana cultivation, illegal sapling and timber extraction, and the development of private lands currently under forest cover, which includes clearing of hillsides with slopes exceeding 25° (pers. obs.). Additionally, it is not clear whether the road, a permanent gap/corridor in the forest, facilitates the spread of non-native species, both floral and faunal.

Small agriculture plots of mixed fruit trees located on the periphery of the forest, while creating an abrupt edge, may serve as preliminary ecological buffers. While single tree species provided a patchy, ephemeral food resource as a function of their flowering and fruiting phenology, the presence of a variety of plant and tree species, each with a slightly different season of reproduction, provided food resources beyond a one or two month period. For example, during the winter surveys, the majority of sightings of nectarivores and Neotropical migrants were in association with flowering Otaheite apple trees *Syzygium malaccense* and mango *Mangifera indica* varieties. During the summer, flowering guava *Psidium guajava* attracted the resident native birds, while the Otaheite apple trees remained unvisited. Aerial insectivores also appeared to benefit from the characteristics of this habitat type, which included snags from which to forage in an open environment.

Interestingly, the closed broadleaf forest and the active farm habitats were very similar in the mean number of species and mean number of individuals detected in each point count (Table 3) as well as in the total numbers of each category of birds (Table 4). Both habitat types included approximately 50% of Jamaica's landbirds, respectively. There were, however,

important differences in species composition between the forest and non-forest environments. Of the four species that were recorded exclusively in farm habitat, one was introduced to Jamaica (Green-rumped Parrotlet *Forpus passerinus*), one has been expanding its range naturally across the agriculture habitats of the West Indies (Cattle Egret *Bubulcus ibis*) and the other two prefer open cultivated areas and urban environments (Antillean Palm Swift *Tachornis phoenicobia* and Northern Mockingbird *Mimus polyglottos*). The presence of these species indicates an environment heavily modified by humans.

Absent from the open farm habitat but present in minimally and moderately-disturbed forested areas were the larger resident and endemic bird species, including the White-crowned and Ring-tailed pigeons, Jamaican Woodpecker, Rufous-throated Solitaire *Myadestes genibarbis*, and Jamaican Lizard Cuckoo *Saurothera veltula*, the latter of which was not detected during point counts but was recorded in two locations *ad libitum* during the summer survey. These species are all considered to be "forest dependent" birds and the observations in Dolphin Head supported this distinction. Protection of remaining natural forest, therefore, may be most critical for the persistence of these local populations and declines in their populations may serve as indicators of environmental degradation. For White-crowned Pigeons, which migrated from unknown locations during the summer, Dolphin Head represents important breeding habitat in western Jamaica. Winter surveys alone would have failed to capture the importance of the Dolphin Head habitat for this species.

Based on the natural forest of the area being classified as moist mesic limestone, its similarity to other mid-elevation limestone forests, and the size of area still under closed-canopy vegetation, several additional endemic, forest dependent species were expected. These include the Crested Quail Dove *Geotrygon versicolor*, Yellow-billed Parrot *Amazona collaria*, Black-billed Parrot *A. agilis*, Chestnut-bellied Cuckoo *Hyetornis pluvialis*, and the Jamaican Crow *Corvus jamaicensis*. These large, vocal species were not detected and local residents did not recognize photographs of the birds. Further, with respect to parrots, local people referred to the Olive-throated Parakeet *Aratinga nana* as "parrot," a strong indication that they lacked experience with the *Amazona* spp. In areas where the *Amazona* parrots co-occur with parakeets, the common names are applied correctly. The absence of these species raises several important questions concerning not only the management of Dolphin Head but also other natural habitats

on Jamaica. Was the failure to detect them because sampling occurred closer to the periphery and core habitat still must be surveyed? Did local populations of these species become extinct as clearing occurred of the surrounding forests (on shale and alluvium) of western Jamaica and the remnant forest of Dolphin Head became too small to support viable populations? Is the size-area under forest cover adequate but because of centuries of selective timber harvesting, is a late-succession/mature forest required for nesting resources absent? Did local populations go extinct because of other human pressures, such as hunting, and, because of extreme fragmentation of the natural forests, colonization from other areas (e.g., Cockpit Country) was precluded? Did these species ever occur in the mid-elevation forests of the parishes of Hanover and Westmoreland and, if not, what are the features/resources that enable them to survive in an area like Cockpit Country but not Dolphin Head? Questions pertaining to these factors (degree of isolation, minimum size area, forest type (e.g., limestone substrate) and physiognomy, breeding and food resources) are relevant not only for the persistence of the current assemblage of Dolphin Head's forest-dependent birds and, therefore, maintenance of ecological processes, but also for the protection and management all remnants of Jamaica's natural forests.

5. RECOMMENDATIONS

1. The forests of Dolphin Head environs represent a unique ecosystem, recognized both nationally and globally for their extraordinary plant endemism. Efforts should be directed to ensure that no large-scale clearing of natural forest occurs. A continued reduction of forest will eventually lead to local extinctions of the larger, forest-dependent bird species, which require large territories for feeding and breeding, as associated with the maintenance of a minimum viable population. Very little is known about the relationship of birds as pollinators and seed dispersers of Dolphin Head's endemic flora, but the potential exists that the loss of a bird species may lead to the extinction of bird-dependent plants. Research should be directed to understanding the life histories of endemic plants species and their dependence upon wildlife for their populations to persist.

2. The trails and roads leading into the Forest Reserves (e.g., Retirement) and along the eastern boundary, particularly Askenish to Frome, provide a stunning view of the forest and south coast with no apparent negative effect on bird populations. Their value as nature walks

should be assessed. However, these roads and trails also provide access for destructive human activities, including illegal extraction of timber products and clearing for agriculture. At present, there appears to be no monitoring of activities along the eastern boundary and illegal activities (e.g. extraction of small trees for posts and new clearing for marijuana cultivation) were observed during the period of this research). Any development along this road should be restricted, particularly because of the steep hillslopes, erosion potential and disruption of ecological processes, but also because it will lead to the degradation of the “natural beauty.” Bed-and-breakfast style accommodations in established communities (e.g., Medley, Askenish) would place visitors in close proximity to the nature walks along established roads. Based on observed current motorized vehicle, maintenance of the road for residents to conduct business on the south coast would not be expected to conflict with nature walks.

3. If there is local community interest, hillsides dominated by bamboo along the periphery of Dolphin Head should be targeted for conversion to improve the health of these biologically sterile habitats. Research is needed to develop methods to eradicate this non-native, pervasive and insidious grass species. While restoration of these hillsides to natural forest may be difficult, the replacement of bamboo with mixed fruit trees or forestry plantations of local native tree species will create new habitat for both resident and migratory bird species. Similarly, the biologically sterile areas of “God Almighty Bridge” that are dominated by rose apple should be targeted for rehabilitation. Remnant patches of natural forest persist in this geologically and hydrologically unique site of Dolphin Head and the composition of plant species of these patches should be the foundation for restoration. Restoration will assist not only in the protection of endemic species but also in the protection of the watershed. The Samuels family recognizes the pervasive and harmful effects of rose apple, which has become established only in the past 30 years, and the younger family members would like to work with Forestry Department to rehabilitate this area.

4. Although the cultivation of marijuana is illegal on Jamaica, this report recognizes the socio-economic realities of the communities in the Dolphin Head area. Law enforcement is difficult, particularly with market demand in the tourist area of Negril, and decriminalization or legalization (so that farmers can cultivate in their yard, rather than attempting to hide in forest patches) may not be politically viable. However, this activity has direct effects on the bird

communities and, ultimately, the health of the Dolphin Head ecosystem. The effects are seen with the direct extirpation of native plant species as hilltops are cleared and with the hindering of natural forest regeneration as non-native invasive plant species become established and form near-monocultures. These heavily modified areas offer poor habitat for native and migratory bird species and, consequently, forest regeneration is further hindered by the lack of seed-dispersing species. The marijuana farmers first should be educated on the differences in “natural forest” and “bush, dominated by non-native species,” classifications which they fail to distinguish as they abandon plots when productivity decreases. Second, the Forestry Department’s policy of “no-net-loss” should be applied to these farmers, who are benefiting from the use of public lands but not compensating the owners (i.e., the Jamaican People). A nursery of early-succession plant species that are native to Dolphin Head (e.g., Piperaceae, Trumpet tree *Cecropia peltata*), and appropriate for the areas targeted for reforestation, should be established and the marijuana farmers required to initiate forest recovery when they abandon a hilltop. Finally, the consumers of marijuana, notably the tourist market in Negril, should be educated that their illegal activity is contributing to the extinction of endemic species that have existed on Jamaica for millions of years.

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Appendix 1. Bird species recorded in Dolphin Head environs, Jan-June 2001. Key prepared by BirdLife Jamaica [formerly Gosse Bird Club] (1986). Nomenclature follows Raffaele *et al.* 1998.

+ Excluded from point count analysis because of too few observations or other factors.

++ Observed outside of point-count observation periods.

KEY

R - Resident	1 - Common in suitable habitat
E - Endemic	2 - Uncommon
I - Introduced by humans	3 - Rare
N - Natural expansion of range	4 - Vagrant
W - Winter migrant	
S - Summer migrant	

FAMILY	COMMON NAME	SCIENTIFIC NAME	STATUS
ARDEIDAE	Cattle Egret	<i>Bubulcus ibis</i>	N1
CATHARTIDAE	Turkey Vulture+	<i>Cathartes aura</i>	R1
ACCIPITRIDAE	Red-tailed Hawk+	<i>Buteo jamaicensis</i>	R1
FALCONIDAE	American Kestrel	<i>Falco sparverius</i>	R1
COLUMBIDAE	White-crowned Pigeon	<i>Columba leucocephala</i>	R1
	Ring-tailed Pigeon	<i>Columba caribaea</i>	E2
	White-winged Dove++	<i>Zenaida asiatica</i>	R1
	Zenaida Dove	<i>Zenaida aurita</i>	R1
	Common Ground-Dove	<i>Columba passerina</i>	R1
	Caribbean Dove	<i>Leptotila jamaicensis</i>	R1
	Ruddy Quail Dove	<i>Geotrygon montana</i>	R2
PSITTACIDAE	Olive-throated Parakeet	<i>Aratinga nana</i>	R1
	Green-rumped Parrotlet	<i>Forpus passerinus</i>	I1
CUCULIDAE	Jamaican Lizard-Cuckoo+	<i>Saurothera vetula</i>	E2
TYTONIDAE	Barn Owl++	<i>Tyto alba</i>	R1
STRIGIDAE	Jamaican Owl++	<i>Pseudoscops grammicus</i>	E2
APODIDAE	Antillean Palm Swift	<i>Tachornis phoenicobia</i>	R1
TROCHILIDAE	Jamaican Mango	<i>Anthracothorax mango</i>	E2
	Red-billed Streamertail	<i>Trochilus polytmus</i>	E1
	Vervain Hummingbird	<i>Mellisuga minima</i>	R1
TODIDAE	Jamaican Tody	<i>Todus todus</i>	E1
PICIDAE	Jamaican Woodpecker	<i>Melanerpes radiolatus</i>	E1
TYRANNIDAE	Jamaican Elaenia	<i>Myiopagis cotta</i>	E1
	Greater Antillean Elaenia	<i>Elaenia fallax</i>	R2
	Jamaican Pewee	<i>Contopus pallidus</i>	E1
	Sad Flycatcher	<i>Myiarchus barbirostris</i>	E1
	Rufous-tailed Flycatcher	<i>Myiarchus validus</i>	E2
	Stolid Flycatcher	<i>Myiarchus stolidus</i>	R2
	Gray Kingbird	<i>Tyrannus dominicensis</i>	S1
	Loggerhead Kingbird	<i>Tyrannus caudifasciatus</i>	R1
COTINGIDAE	Jamaican Becard+	<i>Pachyramphus niger</i>	E2
HIRUNDINIDAE	Cave Swallow	<i>Pterochelidon fulva</i>	R1
MUSCICAPIDAE	Rufous-throated Solitaire	<i>Myadestes genibarbis</i>	R1
	White-eyed Thrush+	<i>Turdus jamaicensis</i>	E1
	White-chinned Thrush	<i>Turdus aurantius</i>	E1

MIMIDAE	Northern Mockingbird	<i>Mimus polyglottos</i>	R1
VIREONIDAE	Jamaican Vireo	<i>Vireo modestus</i>	E1
	Black-whiskered Vireo	<i>Vireo altiloquus</i>	S1
EMBERIZIDAE	Northern Parula	<i>Parula americana</i>	W2
	Cape May Warbler++	<i>Dendroica tigrina</i>	W1
	Black-throated Blue Warbler	<i>Dendroica caerulescens</i>	W1
	Black-throated Green Warbler++	<i>Dendroica virens</i>	W3
	Arrow-headed Warbler	<i>Dendroica phareta</i>	E1
	Black-and-white Warbler	<i>Mniotilta varia</i>	W1
	American Redstart	<i>Setophaga ruticilla</i>	W1
	Ovenbird+	<i>Seiurus aurocapillus</i>	W1
	Northern Waterthrush++	<i>Seiurus noveboracensis</i>	W1
	Common Yellowthroat	<i>Geothlypis trichas</i>	W1
	Bananaquit	<i>Coereba flaveola</i>	R1
	Jamaican Euphonia	<i>Euphonia jamaica</i>	E1
	Jamaican Stripe-headed Tanager	<i>Spindalis nigricephalus</i>	E1
	Yellow-faced Grassquit	<i>Tiaris olivacea</i>	R1
	Black-faced Grassquit	<i>Tiaris bicolor</i>	R1
	Yellow-shouldered Grassquit	<i>Loxipasser anoxanthus</i>	E2
	Greater Antillean Bullfinch	<i>Loxigilla violacea</i>	R1
	Orangequit	<i>Euneornis campestris</i>	E1
	Jamaican Oriole	<i>Icterus leucopteryx</i>	R1