Monitoring Puerto Rican Avifauna Using Roadside Surveys[1]

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Abstract

In 1997 we began investigating the use of roadside point counts to monitor the long-term status and trends of Puerto Rican bird populations. If such a methodology proves feasible it may provide the empirical data needed for the development of sound conservation plans for the island's avifauna in much the same way that North American Breeding Bird Survey data are used by the avian conservation prioritization process of Partners in Flight, the U.S. Fish and Wildlife Service, and the Canadian Wildlife Service. By the end of the 2003 field season, we will have the data needed to quantitatively evaluate the utility of the program for tracking the population trends of Puerto Rican avifauna. Here we present data from the 2001 and 2002 field seasons to demonstrate the potential utility of these data for quantifying and portraying avian distributions, abundances, and population trend estimates. In 2001, 27 of the 44 available 5-mile roadside routes (11 stops/route) were sampled between 15 April and 15 May. At each stop a 5-minute point count was conducted. The surveys detected 5,471 individuals representing 70 species. Distribution and abundance maps are depicted for seven endemic species. In 2002, 29 routes were sampled. A total of 6,252 individuals was detected representing 79 species. Significantly fewer species and individuals were detected on wet zone routes as compared to moist and dry zone routes.

Introduction

Island bird communities are particularly susceptible to catastrophic declines due to their small population sizes and the fact that the species are often narrowly adapted to the conditions of their limited range (Temple 1985). Since the 1600s, 93 percent of extinct species were from islands (King 1980). Moreover, Collar and Andrew (1988) estimated that approximately 46 percent of all threatened bird species are island inhabitants. For these reasons, the International Council for Bird Preservation identified the long-term monitoring of endemic island species as a conservation priority (Johnson 1988). However, over a decade later few such programs exist for the avian species endemic to the Caribbean basin.

Puerto Rico, in particular, harbors numerous endemic avian species whose populations are not being monitored on an island-wide scale. Out of 141 breeding bird species (Raffaele 1989), 16 species are Puerto Rican endemics, while another 15 are endemic to the Caribbean basin (AOU 1998). Yet only about 13 percent of all species found in Puerto Rico benefit from any type of long-term island-wide monitoring program. For example, species being monitored consist primarily of game birds (Rivera-Milan 1993) and threatened or endangered species (D. Ramos, Puerto Rico Department of Natural and Environmental Resources, pers. comm.), leaving the majority of the avian species, including two-thirds of the endemics, outside of an existing monitoring framework. Thus in cooperation with the Puerto Rico Department of Natural and Environmental Resources, we are investigating the feasibility of using roadside avian surveys to monitor the long-term status and trends of the island's bird populations. If feasible, this information will allow bird population changes to be identified, and declines reversed through further research and management actions, before populations reach critically low levels.

Methods

We used 44, 8-kilometer (5-mile) roadside routes that were randomly established throughout the island by the Puerto Rico Department of Natural and Environmental Resources (*fig. 1*). The routes were originally developed to monitor columbid populations at 1.6-kilometer (1-mile) intervals (Rivera-Milan 1993). For the purposes of our study, stops were added at 0.8-kilometer (0.5-mile) intervals for a total of 11 stops per route. At each stop, a skilled observer conducts a 5-minute point count recording every bird seen within a 400-meter (0.25-mile) radius or heard. Surveys begin at local sunrise and take approximately 2 hours to complete. Routes are run once per year between 15 April and 15 May.

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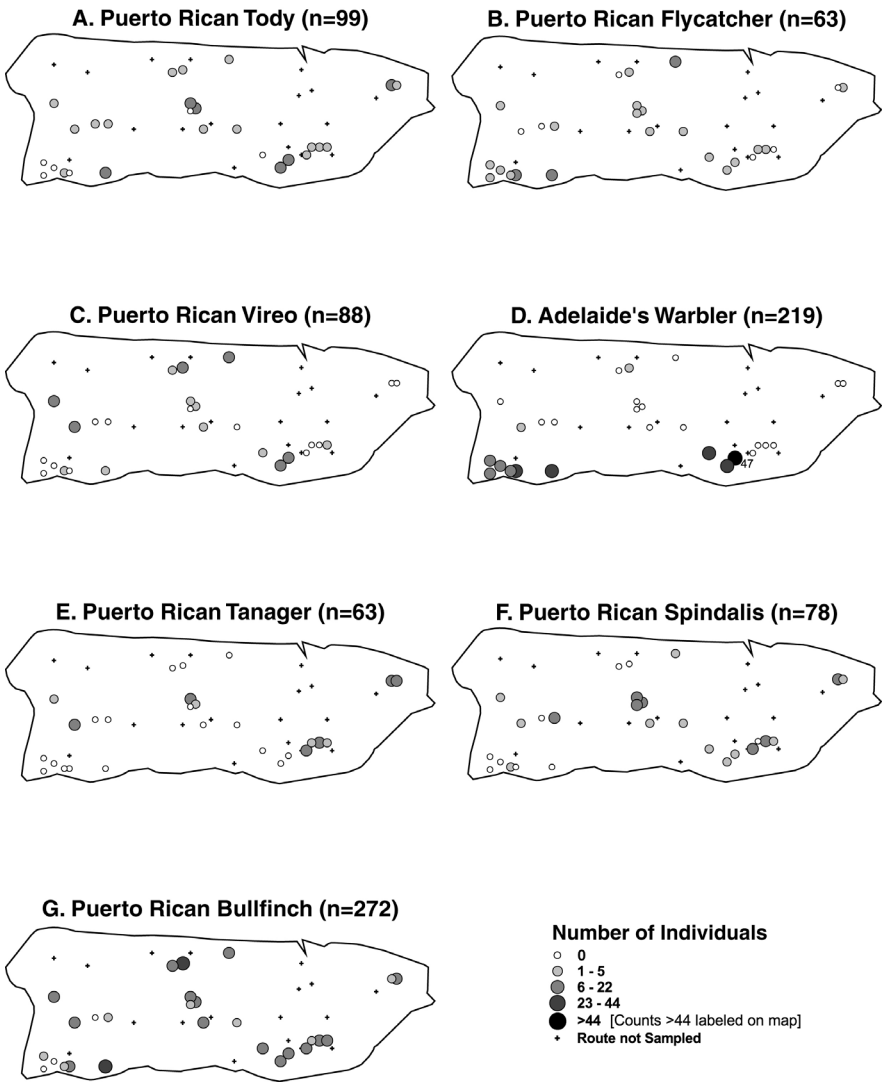

Figure 1— Locations of the 44 sample routes in Puerto Rico and the number of individuals of seven island-endemic species detected on 27 routes sampled in 2001.

Routes were classified into ecological life zones by overlaying maps depicting route locations and life zone boundaries (Ewel and Whitmore 1973). Routes crossing a life zone boundary were assigned to the boundary with the majority of the route path. Although six life zones are present in Puerto Rico, no effort was made to distinguish between the four wettest life zones. Thus, routes in this study were assigned to one of the following life zone groups: dry – Subtropical Dry Forest (17.6 percent of the island's area); moist – Subtropical Moist Forest (58.4 percent); and, wet – which includes, Subtropical Wet Forest (22.6 percent), Subtropical Rain Forest (0.1 percent), Lower Montane Wet Forest (1.2 percent) and Lower Montane Rain Forest (0.1 percent; Ewel and Whitmore 1973). No attempt was made to further classify habitats along routes.

All statistical analyses were conducted using Minitab™ Statistical Software (2000) (Use of trademark or brand name does not constitute government endorsement). Kolmogorov-Smirnov normality tests were conducted on life zone samples within years and pooled between years. Means of normally distributed data were compared between years using two-sample, two-tailed t-tests, while medians of non-normally distributed data were compared using the non-parametric Mann-Whitney test. Means of normally distributed life zone data pooled over the two-year sample period were compared between life zones using one-tailed, t-tests. All tests were considered significant when $P < 0.05$.

Mean species richness (MSR) was significantly lower on wet zone routes than on moist zone routes ($t = 4.82$, $P < 0.001$), or dry zone routes ($t = 3.89$, $P = 0.001$; see *table 1* for mean values). No difference in mean species richness was found between the moist and dry zone routes ($t = -0.13$, $P = 0.552$). Similar to species

Table 1— *Species detected along Puerto Rico Breeding Bird Survey routes in 2001 and 2002. Status codes: BR = breeding resident, E = endangered, ES = endangered species, N = island endemic, R = resident, RN = regional endemic, X = exotic.*

		Ecological Life Zone							
		Wet		Moist		Dry		Totals	
	Status	2001 (N = 15)	2002 (N = 15)	2001 (N = 5)	2002 (N = 9)	2001 (N = 7)	2002 (N = 5)	2001 (N = 27)	2002 (N = 29)
Brown Pelican (*Pelecanus occidentalis*)	R	0	0	0	1	1	4	1	5
Magnificent Frigatebird (*Fregata magnificens*)	R	0	0	0	0	2	2	2	2
Great Blue Heron (*Ardea herodias*)	R	0	0	0	1	2	0	2	1
Great Egret (*Ardea alba*)	R	3	8	6	14	15	16	24	38
Snowy Egret (*Egretta thula*)	R	2	0	5	11	1	0	8	11
Little Blue Heron (*Egretta caerulea*)	R	0	0	0	0	3	4	3	4
Tricolored Heron (*Egretta tricolor*)	R	0	0	0	0	0	1	0	1
Cattle Egret (*Bubulcus ibis*)	R	18	1	36	68	102	307	156	376
Green Heron (*Butorides virescens*)	R	1	2	7	8	0	2	8	12
Black-crowned Night-Heron (*Nycticorax nycticorax*)	R	0	0	0	2	0	0	0	2
Yellow-crowned Night-Heron (*Nyctanassa violacea*)	R	0	0	0	1	0	0	0	1
Turkey Vulture (*Cathartes aura*)	R	0	0	0	0	10	8	10	8
Osprey (*Pandion haliaetus*)	M	0	0	0	2	0	0	0	2
Sharp-shinned Hawk (*Accipiter striatus*)	ES	0	1	0	0	0	0	0	1
Broad-winged Hawk (*Buteo platypterus*)	ES	1	2	0	0	0	0	1	2
Red-tailed Hawk (*Buteo jamaicensis*)	R	23	17	4	12	7	3	34	32
American Kestrel (*Falco sparverius*)	R	10	6	1	9	20	9	31	24
Clapper Rail (*Rallus longirostris*)	R	0	0	0	0	0	2	0	2
Common Moorhen (*Gallinula chloropus*)	R	0	0	4	4	0	0	4	4
Wilson's Plover (*Charadrius wilsonia*)	R	0	0	0	0	1	2	1	2
Killdeer (*Charadrius vociferus*)	R	0	0	3	3	14	14	17	17
Black-necked Stilt (*Himantopus mexicanus*)	R	0	0	2	0	9	9	11	9
Least Tern (*Sterna antillarum*)	R	0	0	0	0	12	22	12	22
Rock Pigeon (*Columba livia*)	X	25	85	14	33	13	20	52	138
Scaly-naped Pigeon (*Patagioenas squamosa*)	RN	239	189	31	73	0	0	270	262
White-crowned Pigeon (*Patagioenas leucocephala*)	R	0	1	12	3	0	0	12	4
Plain Pigeon (*Patagioenas inornata*)	ES	0	0	0	4	0	0	0	4
Ringed Turtle-Dove (*Streptopelia risoria*)	X	0	0	0	0	0	6	0	6
Eurasian Collared-Dove (*Streptopelia decaocto*)	X	0	0	0	0	9	4	9	4
White-winged Dove (*Zenaida asiatica*)	R	45	153	26	80	102	87	173	320
Zenaida Dove (*Zenaida aurita*)	R	51	21	77	119	50	13	178	153
Mourning Dove (*Zenaida macroura*)	R	1	6	5	4	24	9	30	19
Common Ground-Dove (*Columbina passerina*)	R	3	5	48	84	136	84	187	173

Table 1— *contd.*

		Ecological Life Zone							
		Wet		Moist		Dry		Totals	
	Status	2001 (N = 15)	2002 (N = 15)	2001 (N = 5)	2002 (N = 9)	2001 (N = 7)	2002 (N = 5)	2001 (N = 27)	2002 (N = 29)
Key West Quail-Dove (*Geotrygon chrysia*)	RN	0	0	0	1	2	0	2	1
Ruddy Quail-Dove (*Geotrygon montana*)	R	3	0	4	7	0	0	7	7
Yellow-billed Cuckoo (*Coccyzus americanus*)	R	0	0	0	0	2	2	2	2
Mangrove Cuckoo (*Coccyzus minor*)	R	8	4	19	19	11	7	38	30
Puerto Rican Lizard-Cuckoo (*Saurothera vieilloti*)	N	6	5	7	15	9	0	22	20
Smooth-billed Ani (*Crotophaga ani*)	R	2	6	10	17	42	44	54	67
Puerto Rican Screech-Owl (*Megascops nudipes*)	N	2	3	2	4	2	0	6	7
Antillean Nighthawk (*Chordeiles gundlachii*)	BR	0	1	0	0	21	4	21	5
Black Swift (*Cypseloides niger*)	BR	12	2	0	0	0	0	12	2
Antillean Mango (*Anthracothorax dominicus*)	RN	2	0	7	6	2	4	11	10
Green Mango (*Anthracothorax viridis*)	N	11	12	1	5	0	0	12	17
Puerto Rican Emerald (*Chlorostilbon maugaeus*)	N	20	17	2	3	1	0	23	20
unidentified hummingbird	--	1	0	0	0	0	0	1*	0
Puerto Rican Tody (*Todus mexicanus*)	N	53	94	23	33	23	6	99	133
Puerto Rican Woodpecker (*Melanerpes portoricensis*)	N	76	79	28	51	27	4	131	134
Caribbean Elaenia (*Elaenia martinica*)	RN	0	0	0	0	5	5	5	5
Lesser Antillean Pewee (*Contopus latirostris*)	RN	2	3	1	4	2	3	5	10
Puerto Rican Flycatcher (*Myiarchus antillarum*)	N	15	15	19	29	29	13	63	57
Gray Kingbird (*Tyrannus dominicensis*)	R	202	198	106	195	195	160	503	553
Loggerhead Kingbird (*Tyrannus caudifasciatus*)	RN	5	17	11	13	2	2	18	32
Puerto Rican Vireo (*Vireo latimeri*)	N	26	56	52	40	10	5	88	101
Black-whiskered Vireo (*Vireo altiloquus*)	BR	317	265	149	203	38	38	504	506
Caribbean Martin (*Progne dominicensis*)	BR	0	0	5	20	5	6	10	26
Cave Swallow (*Petrochelidon fulva*)	R	20	18	17	34	4	9	41	61
Barn Swallow (*Hirundo rustica*)	R	0	0	0	0	2	0	2	0
Red-legged Thrush (*Turdus plumbeus*)	RN	22	28	27	38	4	1	53	67
Northern Mockingbird (*Mimus polyglottos*)	R	13	25	24	39	66	51	103	115
Pearly-eyed Thrasher (*Margarops fuscatus*)	RN	101	75	20	70	3	3	124	148
Yellow Warbler (*Dendroica petechia*)	R	0	0	0	0	22	19	22	19
Adelaide's Warbler (*Dendroica adelaidae*)	N	1	0	80	94	138	94	219	188
Elfin-woods Warbler (*Dendroica angelae*)	E, N	3	0	0	0	0	0	3	0
Bananaquit (*Coereba flaveola*)	R	514	583	118	219	95	66	727	868
Puerto Rican Tanager (*Nesospingus speculiferus*)	N	63	41	0	0	0	0	63	41
Puerto Rican Spindalis (*Spindalis portoricensis*)	N	67	114	7	14	4	2	78	130
Yellow-faced Grassquit (*Tiaris olivacea*)	R	37	63	3	21	20	11	60	95

Table 1—*contd.*

		Ecological Life Zone							
		Wet		Moist		Dry		Totals	
	Status	**2001 (N = 15)**	**2002 (N = 15)**	**2001 (N = 5)**	**2002 (N = 9)**	**2001 (N = 7)**	**2002 (N = 5)**	**2001 (N = 27)**	**2002 (N = 29)**
Black-faced Grassquit (*Tiaris bicolor*)	R	98	100	45	38	66	63	209	201
Puerto Rican Bullfinch (*Loxigilla portoricensis*)	N	147	136	83	122	42	19	272	277
Grasshopper Sparrow (*Ammodramus savannarum*)	R	0	0	0	0	0	4	0	4
Greater Antillean Grackle (*Quiscalus niger*)	RN	7	12	61	101	446	339	514	452
Shiny Cowbird (*Molothrus bonariensis*)	R	15	22	11	17	2	1	28	40
Greater Antillean Oriole (*Icterus dominicensis*)	RN	20	19	3	11	3	19	26	49
Troupial (*Icterus icterus*)	X	0	0	0	0	7	2	7	2
Antillean Euphonia (*Euphonia musica*)	RN	10	9	0	1	0	0	10	10
House Sparrow (*Passer domesticus*)	X	1	0	1	5	8	17	10	22
Orange-cheeked Waxbill (*Estrilda melpoda*)	X	2	12	5	10	4	0	11	22
Bronze Mannikin (*Lonchura cucullata*)	X	0	0	0	2	0	0	0	2
Nutmeg Mannikin (*Lonchura punctulata*)	X	2	0	5	9	4	0	11	9
Unidentified munia (*Lonchura malacca* / *L. atricapilla*))	X	0	0	0	3	0	20	0	23
Pin-tailed Whydah (*Vidua macroura*)	X	0	0	0	1	6	0	6	1
Total individuals		2328	2531	1237	2050	1907	1671	5471	6252
Species richness		50	45	49	60	59	55	70	79
Average species richness per route		20.8	21.9	28.4	29.7	28.1	30.0		
Average number of individuals per route		155	169	247	228	272	334		

Not included in total individuals or species richness.

richness, mean abundance (MA) was significantly lower on wet zone routes than on moist ($t = 3.99$, $P < 0.001$), or dry zone routes ($t = 4.97$, $P < 0.001$). Dry zone routes also had greater mean abundance than moist zone routes ($t = 2.07$, $P = 0.027$). See *table 2* for the ten most abundant species by life zone.

Discussion

For 38 years the North American Breeding Bird Survey (BBS) program has provided the United States and Canadian avian conservation communities with critical population data needed to manage North American bird populations. The U.S. Fish and Wildlife Service, Canadian Wildlife Service, Partners in Flight, and state agencies all use BBS data along with other indicators to set avian conservation priorities at various scales (Peterjohn 1994, Carter et al. 2000). Similar to the BBS, an island-wide avian monitoring program like that described here could provide Puerto Rican natural resource managers with the population information needed to plan and implement effective avian conservation strategies for species not currently being monitored. In its current form, this pilot Puerto Rican monitoring program is relatively inexpensive, relying on skilled volunteers to gather data, and appears to be an effective means of collecting population data on a large portion of Puerto Rican avifauna, including approximately 75 percent of the locally and regionally endemic species (*table 1*).

Figure 1 depicts sample distribution and range maps for seven island-endemic species based on 2001 data. The maps demonstrate the potential utility of these data for quantifying and portraying avian distributions, abundances, and population trend estimates for Puerto Rican avifauna. Future maps could demonstrate temporary range shifts induced by hurricane events, population declines due to habitat loss, or the spread of exotic species.

The potential utility of this program is further demonstrated by our results that mean species richness and abundance were significantly greater on dry zone routes (MSR = 28.9 species, MA = 298.2 individuals)

Table 2— *Relative abundance of species per life zone per year in descending rank order. The four-letter species codes are defined in* table 3.

Wet Life Zone		Moist Life Zone		Dry Life Zone	
2001	**2002**	**2001**	**2002**	**2001**	**2002**
BANA	BANA	BWVI	BANA	GAGR	GAGR
BWVI	BWVI	BANA	BWVI	GRKI	CAEG
SNPI	GRKI	GRKI	GRKI	ADWA	GRKI
GRKI	SNPI	PRBU	PRBU	CGDO	ADWA
PRBU	WWDO	ADWA	ZEDO	WWDO	WWDO
PETH	PRBU	ZEDO	GAGR	CAEG	CGDO
BFGR	PRSP	GAGR	ADWA	BANA	BANA
PRWO	BFGR	PRVI	CGDO	BFGR	BFGR
PRSP	PRTO	CGDO	WWDO	NOMO	NOMO
PRTA	ROPI	BFGR	SNPI	ZEDO	SBAN

Table 3— *Definitions of species codes found in* table 2.

Common Name	Four-Letter Code
Adelaide's Warbler	ADWA
Bananaquit	BANA
Black-faced Grassquit	BFGR
Black-whiskered Vireo	BWVI
Cattle Egret	CAEG
Common Ground-Dove	CGCO
Gray Kingbird	GRKI
Great Egret	GREG
Greater Antillean Grackle	GAGR
Northern Mockingbird	NOMO
Pearly-eyed Thrasher	PETH
Puerto Rican Bullfinch	PRBU
Puerto Rican Spindalis	PRSP
Puerto Rican Tanager	PRTA
Puerto Rican Tody	PRTO
Puerto Rican Vireo	PRVI
Puerto Rican Woodpecker	PRWO
Rock Pigeon	ROPI
Smooth-billed Ani	SBAN
Scaly-naped Pigeon	SNPI
White-winged Dove	WWDO
Zenaida Dove	ZEDO

than on wet zone routes (MSR = 21.3 species, MA = 162.0 individuals). Kepler and Kepler (1970) found similar differences in bird species richness and abundance between the El Yunque Rain Forest and Guanica Forest in Puerto Rico. Our data indicate that island habitats (coastal and low-elevation sites) under the heaviest development pressure (Lopez et al. 2001) also harbor the most bird species and individuals, suggesting that continued urban development in those areas should follow sound conservation practices in order to preserve Puerto Rico's unique natural habitats and associated avifauna.

These data are taken from a pilot Puerto Rican avian monitoring program initiated in 1997. Upon completion of the 2003 season the entire data set will be quantitatively evaluated to determine the utility of the program for tracking population trends of island species.

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Literature Cited

American Ornithologist's Union. 1998. **Check-list of North American Birds.** 7th edition. Washington, DC: American Ornithologist's Union.

Carter, M. F., W. C. Hunter, D. N. Pashley, and K. V. Rosenberg. 2000**. Setting conservation priorities for landbirds in the United States: The Partners in Flight approach.** Auk 117: 541-548.

Collar, N. J. and P. Andrew. 1988. **Birds to watch: The International Council for Bird Preservation world checklist of threatened birds.** Cambridge: International Council on Bird Preservation. Technical Publication 8.

Ewel, J. J. and J. L. Whitmore. 1973. **The ecological life zones of Puerto Rico and the U.S. Virgin Islands.** Research Paper ITF-18. Rio Piedras, Puerto Rico: U.S. Department of Agriculture, Forest Service, Institute of Tropical Forestry.

Johnson, T. H. 1988. **Biodiversity and conservation in the Caribbean: Profiles of selected islands.** Cambridge, U.K.: International Council on Bird Preservation. Monograph No. 1.

Kepler, C. A. and A. K. Kepler. 1970. **Preliminary comparison of bird species diversity and density in Luquillo and Guanica Forests.** In: H. T. Odum and R. F. Pigeon, editors. A Tropical Rain Forest: a study of irradiation and ecology at El Verde, Puerto Rico. Oak Ridge, TN: U.S. Atomic Energy Commission; Chapter E-14; E183-E186.

King, W. B. 1980. **Ecological basis of extinctions in birds.** Acta XVII Congress on International Ornithology; 905-911.

Lopez, T. del M., T. M. Aide, and J. R. Tomlinson. 2001. **Urban expansion and the loss of prime agricultural lands in Puerto Rico.** Ambio 30: 49-54.

Minitab™ Statistical Software. 2000. **Minitab Release 13.1.** State College, PA: Minitab Inc.

Peterjohn, B. 1994. **The North American Breeding Bird Survey.** Birding 26: 386-399.

Raffaele, H. A. 1989. **A guide to the birds of Puerto Rico and the Virgin Islands.** New Jersey: Princeton University Press.

Rivera-Milan, F. F. 1993. **Standardization of roadside counts of columbids in Puerto Rico and on Vieques Island.** Washington, DC: Resource Publication 197. National Biological Survey, U.S. Department of the Interior.

Temple, S. A. 1985. **Why endemic island birds are so vulnerable to extinction.** In: S. A. Temple, editor. Bird Conservation 2. International Council on Bird Preservation, U.S. Section. Madison, WI: The University of Wisconsin Press; 3-6.